AN INTERNSHIP REPORT on

DESIGN AND FABRICATION OF LOW POWER 5V SMPS

Dissertation Submitted in partial fulfilment of the requirements for the award of the degree in

BACHELOR OF TECHNOLOGY

IN

ELECTRICAL AND ELECTROINCS ENGINEERING

Submitted By

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PALNADU DISTRICT, ANDHRA PRADESH

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CERTIFICATE

This is to certify that the thesis entitled "**DESIGN AND FABRICATION OF LOW POWER 5V SMPS**" is being submitted by **GEDELELA JAGADISH (21035A0206)** in partial fulfilment for the award of **Bachelor of Technology** in **ELECTRICAL AND ELECTRONICS ENGINEERING** to the University College of Engineering Narasaraopet, Jawaharlal Nehru Technological University Kakinada is a record of Bonafede work carried out by them under my guidance and supervision.

The results embedded in this thesis have not been submitted to any other University/Institute for the award of any Degree/Diploma

Dr. M. RAVINDRA BABU	**Dr. Y. S. KISHORE BABU**
Assistant Professor	Associate Professor
Project Supervisor	Head of Department

Signature of the External

CERTIFICATE

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This is to certify that Mr. Gedela Jagadish, S/o Mr. Narasimhamurthy, a final year student of University College of Engineering, Narasaraopet, Andhra Pradesh from EEE stream having Roll Number 21035A0206 has successfully completed his internship on "Design & Fabrication of Low Power 5V SMPS" from the period 29th January 2024 to 22nd April 2024 in our Organization.

During his internship, he has demonstrated a deep interest in learning new skills and technologies. We also appreciate his dedication and hard work.

We wish him all the best for her future endeavours.

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ABSTRACT

Switched Mode Power Supply (SMPS) is the most prevailing architecture for DC power supply in modern systems, primarily for its capability to handle variable loads. Apart from efficiency the size and weight of the power supplies is becoming a great area of concern for the Power Supply Designers. In this thesis an AC to DC converter SMPS circuit, having a power MOSFET for switching operation and a PWM based Feedback circuit for driving the switching of the MOSFET, is designed and simulated in KiCad PCB circuit design environment.

This design and fabrication process of a 5V 2A Switched-Mode Power Supply (SMPS) employing the AP8022 MOSFET IC, PC817 Optocoupler, and EE16 Transformer. The project aimed to develop a compact and efficient power supply solution suitable for various low-power electronic applications. Key objectives included meticulous component selection, schematic design, PCB layout, soldering, and testing to ensure optimal performance and reliability. The report provides detailed insights into each phase of the project, emphasizing the integration of components and adherence to industry standards throughout the fabrication process. Further SMPS Output is given to the Esp32 for Home automation.

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CHAPTER-1

INTRODUCTION

Power Electronics is the art of converting electrical energy from one form to another in an efficient, clean, compact, and robust manner for convenient utilization. The never-ending drive towards smaller and lighter product poses serious challenges for power supply designers. The aim of the project is to design, test and implement a switched mode power supply (SMPS) circuit for AC to DC conversion, having a power MOSFET for switching operation and a PWM based feedback circuit to drive the MOSFET switch using KiCad circuit design environment and testing hardware using Breadboard.

This project embarks on the design and fabrication of a 5V 2A Switched-Mode Power Supply (SMPS) circuit. At the core of this endeavor lies the aspiration to craft a power supply unit that excels in efficiency, reliability, and versatility. The primary aim is to meticulously engineer a circuit that can provide a consistent 5V output while accommodating a maximum load of 2A. By harnessing the capabilities of cutting-edge components and adhering to best practices in electronic design, this project seeks to realize a SMPS circuit that meets the stringent demands of modern electronics applications.

Furthermore, this project extends beyond the mere construction of a power supply unit. It integrates the SMPS circuit into the realm of home automation, wherein it assumes the crucial role of supplying power to an ESP32 microcontroller. This secondary objective underscores the project's broader aspiration to fuse innovation with practicality, demonstrating how the fruits of electronic design can seamlessly integrate into everyday life. Through this holistic approach, the project endeavors to showcase not only the technical prowess of SMPS design but also its tangible utility in real-world scenario.

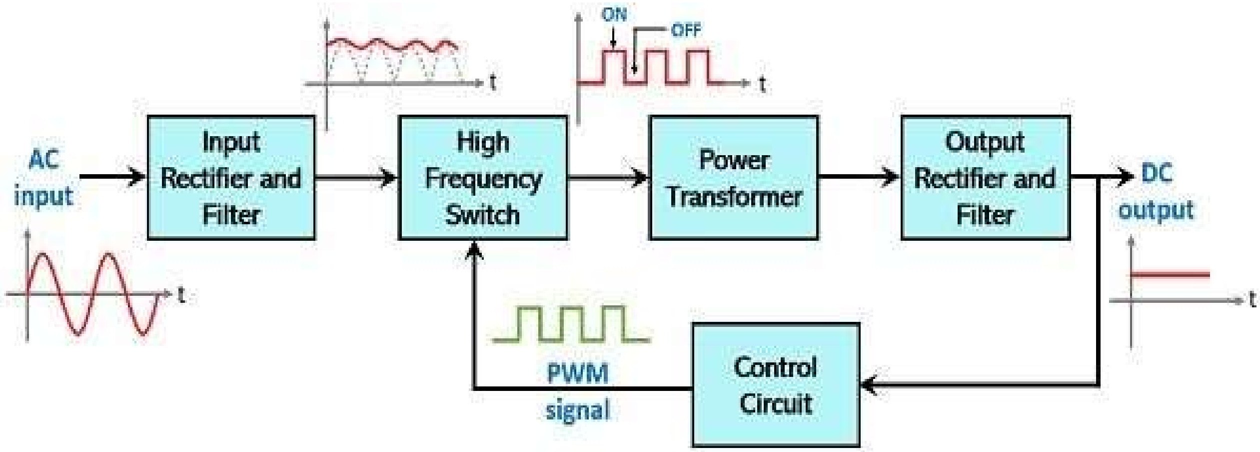
1.1 OBJECTIVE:

The main objective is to develop a robust SMPS circuit capable of delivering a stable 5V output at up to 2A of current, suitable for powering various electronic devices. Special attention will be given to component selection, schematic design, PCB layout, and soldering techniques to ensure optimal performance and reliability. This entails meticulous component selection, schematic design, PCB layout, and soldering techniques to ensure optimal performance and reliability. Key considerations include the choice of components such as the AP8022 MOSFET IC, PC817 Optocoupler, and EE16 Transformer, as well as the implementation of feedback control mechanisms to regulate output voltage and current. Through systematic design iterations and rigorous testing, the aim is to develop a SMPS circuit that meets the stringent requirements of modern electronics applications, providing a stable 5V output while accommodating loads of up to 2A.

Building upon the foundation of the designed SMPS circuit, the secondary objective is to integrate it into a home automation system, specifically for providing power to an ESP32 microcontroller. This involves designing the SMPS circuit with compatibility and reliability in mind to seamlessly integrate into the broader automation framework. Special attention will be given to ensuring compatibility with ESP32 power requirements, including voltage stability and current capacity. By achieving this objective, the project aims to demonstrate the practical application of the SMPS in a real-world scenario, showcasing its utility in powering essential components of a home automation setup and enabling the realization of innovative smart home functionalities

CHAPTER-2

2.1 BLOCK DIAGRAM:



Block diagram of Switch Mode Power Supply

2.2 TOPOLOGIES OF SMPS:

Switched Mode Power Supplies (SMPS) can be classified into several different topologies, each with its own characteristics and advantages. Here are some common SMPS topologies:

- **Buck Converter:** The buck converter steps down the input voltage to a lower output voltage. It is widely used for applications requiring a lower output voltage than the input, such as in DC-DC converters.
- **Boost Converter:** The boost converter steps up the input voltage to a higher output voltage. It is commonly used in applications such as LED drivers and power factor correction circuits.
- **Buck-Boost Converter:** The buck-boost converter can step up or step down the input voltage to provide a stable output voltage. It is often used in battery-powered devices where the input voltage can vary over time.
- **Flyback Converter:** The flyback converter is a type of isolated topology that stores energy in the transformer during the on-time of the switch and transfers it to the output during the off-time. It is commonly used in low-power applications such as USB chargers.
- **Forward Converter:** The forward converter is another isolated topology that transfers energy to the output during the on-time of the switch. It is commonly used in medium to high-power applications.
- **Push-Pull Converter:** The push-pull converter is a type of forward converter that uses two switches to control the energy transfer to the output. It is often used in high-power applications.

- **Half-Bridge Converter:** The half-bridge converter is similar to the push-pull converter but uses only one switch. It is often used in medium-power applications.
- **Full-Bridge Converter:** The full-bridge converter uses four switches to control the energy transfer to the output. It is often used in high-power applications.

Each SMPS topology has its own advantages and disadvantages, and the choice of topology depends on the specific requirements of the application, such as input voltage range, output voltage and current requirements, efficiency, and cost.

A particular topology may be more suitable than others on the basis of one or more performance criterions like cost, efficiency, overall weight and size, output power, output regulation, voltage ripple etc.

All the topologies listed above are capable of providing isolated voltages by incorporating a high frequency transformer in the circuit. From the above topologies we have chosen flyback converter topology.

2.3 WORKING PRINCIPLE:

For a basic 5V SMPS (Switched Mode Power Supply), here's a simplified explanation of its working principle:

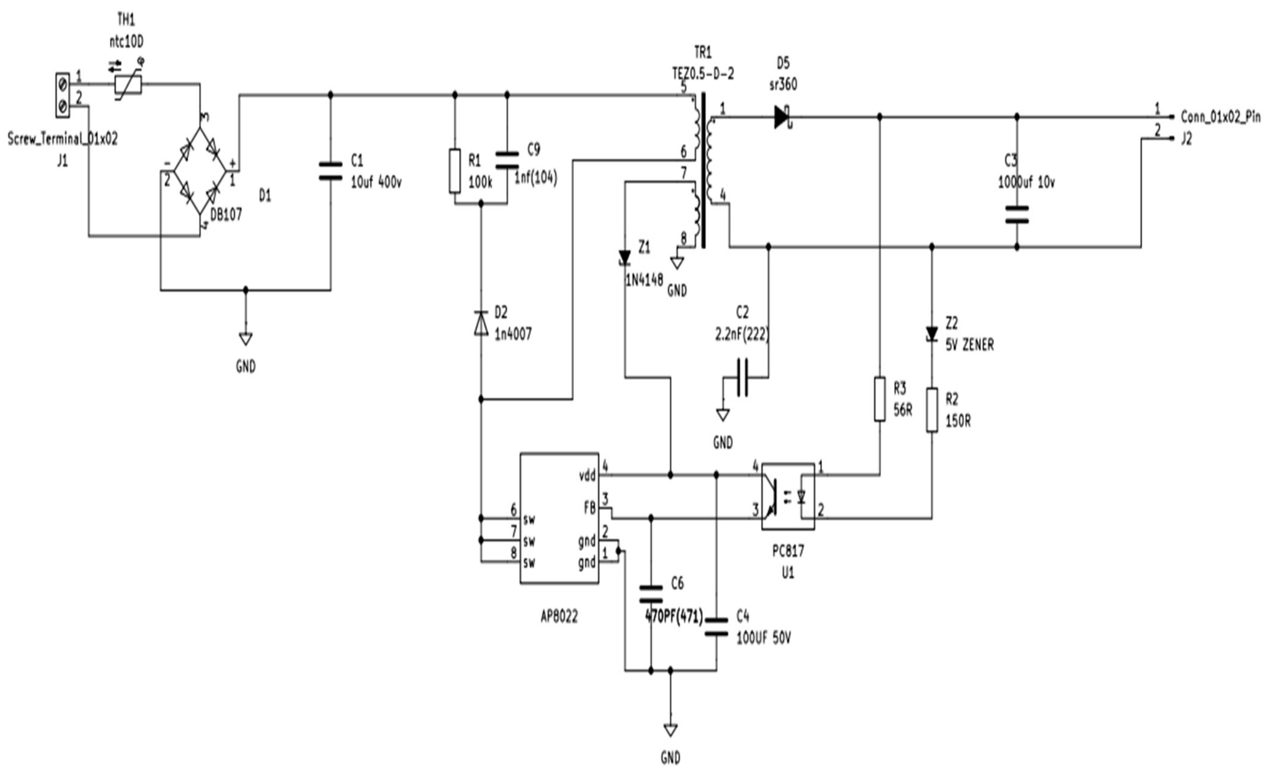
- **Input AC to Rectifier:** The input AC voltage (typically 110V or 220V depending on the region) is first rectified by a bridge rectifier, converting it into pulsating DC.
- **Filtering:** The rectified DC voltage is then smoothed using a capacitor to reduce the ripple voltage.
- **High-Frequency Switching:** The smoothed DC voltage is fed into a high-frequency switch (like a MOSFET) in the SMPS controller. The switch rapidly turns on and off, creating a square wave voltage.
- **Transforming and Isolating:** The square wave voltage is fed into a transformer. The transformer converts the voltage to the desired output level (5V in this case) and isolates the output from the input, ensuring safety.
- **Rectification and Regulation:** The output of the transformer is rectified again to convert the AC back to DC. This DC voltage is then regulated by a feedback mechanism that adjusts the switching frequency to maintain a stable 5V output, regardless of input voltage or load changes.
- **Output Filtering:** The regulated DC voltage is filtered again to reduce any remaining ripple, ensuring a clean and stable 5V output.
- **Output Voltage Sensing:** Some SMPS designs include a feedback loop that continuously monitors the output voltage and adjusts the switching frequency to maintain the desired output voltage.

Overall, the key features of an SMPS are its high efficiency, compact size, and ability to handle a wide range of input voltages, making it suitable for a variety of electronic devices.

2.4 ADVANTAGES OF SMPS:

- **High Efficiency**: SMPS systems are efficient due to reduced power loss during conversion.
- **Compact**: SMPS designs are compact and space-saving.
- **Cost-Effective**: They offer cost savings over traditional linear power supplies.
- **Flexible Technology**: SMPS can adapt to various loads and input conditions.

2.5 CIRCUIT DIAGRAM:



COMPONENTS:

1. **NTC100 Thermistor:**
    - An NTC thermistor (Negative Temperature Coefficient thermistor) can be utilized as a circuit protection device, often serving a similar function to a traditional fuse.
    - Unlike a fuse, which interrupts the circuit when a preset current threshold is exceeded, an NTC thermistor operates based on its temperature-dependent resistance characteristics.
2. **DB107:**
    - The DB107 is a bridge rectifier diode commonly used for single-phase applications. The maximum input AC RMS voltage of this IC is 700V hence, can be used for a broad range of applications.
    - The maximum DC current that this IC can handle is 1A. This IC has a reverse breakdown voltage of 1000V and a low forward voltage drop of 1.1V. It has high efficiency and a high surge current capability of 50A
3. **Snubber Circuit:**
    - Snubber Circuit is a circuit consisting of series combination of resistance and capacitance in parallel with SCR.
    - In this circuit it is used to reduce voltage spikes and lower EMI by lessening voltage and current ringing.
4. **EE16 Transformer:**
    - In a flyback SMPS, the transformer operates in discontinuous mode. During the ON time of the MOSFET switch, energy is stored in the transformer's primary winding.
    - When the MOSFET switch turns OFF, the energy stored in the primary winding is transferred to the secondary winding, where it is rectified and filtered to produce the desired output voltage.
5. **SR360:**
    - The SR360 can be used as a rectifier diode in the output stage of the SMPS.
    - It rectifies the AC voltage induced in the secondary winding of the flyback transformer, converting it into DC.
6. **AP8022 MOSFET:**
    - The AP8022 combines a dedicated current mode PWM controller with a high voltage power MOSFET on the same silicon chip. It acts as a switch within the SMPS circuit.
    - It controls the flow of current from the input voltage source (often a rectified AC

mains or a DC input) to the output load (such as a regulated DC voltage).

7. **PC817 Optocoupler:**
    - The PC817 is an optocoupler device, also known as an opto-isolator or photocoupler, which consists of a light-emitting diode (LED) and a photodetector (usually a phototransistor or photodiode) enclosed in a single package.
    - It acts as a feedback circuit, the output voltage of the SMPS circuit is connected to the input side of the PC817 through a voltage divider network. This network scales down the output voltage to a level suitable for the PC817's input.

CHAPTER 3
SOFTWARE TOOL

3.1 KiCad 8.0:

KiCad is an open source software suite for Electronic Design Automation (EDA). The programs handle Schematic Capture, and PCB Layout with Gerber and IPC-2581 output. The goal of the KiCad project is to provide the best possible cross platform electronics design application for professional electronics designers. Every effort is made to hide the complexity of advanced design features so that KiCad remains approachable by new and inexperienced users, but when determining the direction of the project and the priority of new features, the needs of professional users take precedence.

The key features are:

- **Schematic Capture:** KiCad provides an intuitive interface for creating electronic schematics, allowing users to design circuits using a comprehensive library of components.
- **PCB Layout Design:** With KiCad's PCB layout editor, users can create professional-quality PCB layouts, including component placement, routing, and copper pour, while adhering to design rules and constraints.
- **3D Viewer:** KiCad includes a built-in 3D viewer that enables users to visualize their PCB designs in three dimensions, helping to identify potential issues and optimize component placement for mechanical compatibility.
- **Symbol and Footprint Editor:** KiCad allows users to create custom symbols and footprints for components, facilitating the integration of proprietary or specialized components into their designs
- **Gerber File Generation:** KiCad supports the generation of Gerber files, which are industry-standard files used for manufacturing PCBs. Users can export their designs in Gerber format for fabrication by PCB manufacturers
- **Design Rule Checking (DRC):** KiCad includes DRC tools that automatically check PCB designs against user-defined design rules, helping to identify and resolve potential errors or violations before fabrication.
- **Open-Source:** KiCad is open-source software, meaning its source code is freely available for modification and redistribution. This fosters collaboration and innovation within the KiCad community and ensures transparency and independence in the development process.

CHAPTER 4

PCB DESIGN

4.1 DESIGN AND FABRICATION:

Steps followed to design PCB on KiCad:

1. Define Requirements:

Determine the requirements and specifications of your circuit, including the type of components needed, their placement, and the connections between them.

2. Choose a Design Tool:

Select a PCB design software or tool. There are many options available, ranging from free/open-source tools like KiCad and EasyEDA to professional software like Altium Designer and Cadence Allegro.

3. Create Schematic Symbols:

Design or import schematic symbols for each component in your circuit. Schematic symbolsrepresent the electrical characteristics and connections of components. Most PCB design toolsprovide libraries of standard symbols that can be customized or extended as needed.

4. Place Components:

Place the schematic symbols for your components onto the schematic canvas. Arrange them in a logical and organized manner, considering factors such as signal flow, proximity of related components, and ease of routing.

5. Connect Components:

Use wires or "nets" to connect the pins of components according to the desired circuit connections. Ensure that connections are made accurately and that there are no overlapping or crossed wires.

6. Add Labels and Annotations:

Label components, nets, and other elements of the schematic for clarity and documentation purposes. Include annotations such as part numbers, values, and descriptions to provide additional information about the circuit.

7. Verify the Design:

Perform a design rule check (DRC) to ensure that the schematic adheres to design rules and constraints, such as minimum clearance, trace width, and electrical constraints. Fix any errorsor warnings identified by the DRC tool.

8. Review and Iterate:

Review the schematic design to verify correctness, completeness, and compliance with specifications. Iterate on the design as needed to address any issues or improvementsidentified during the review process.

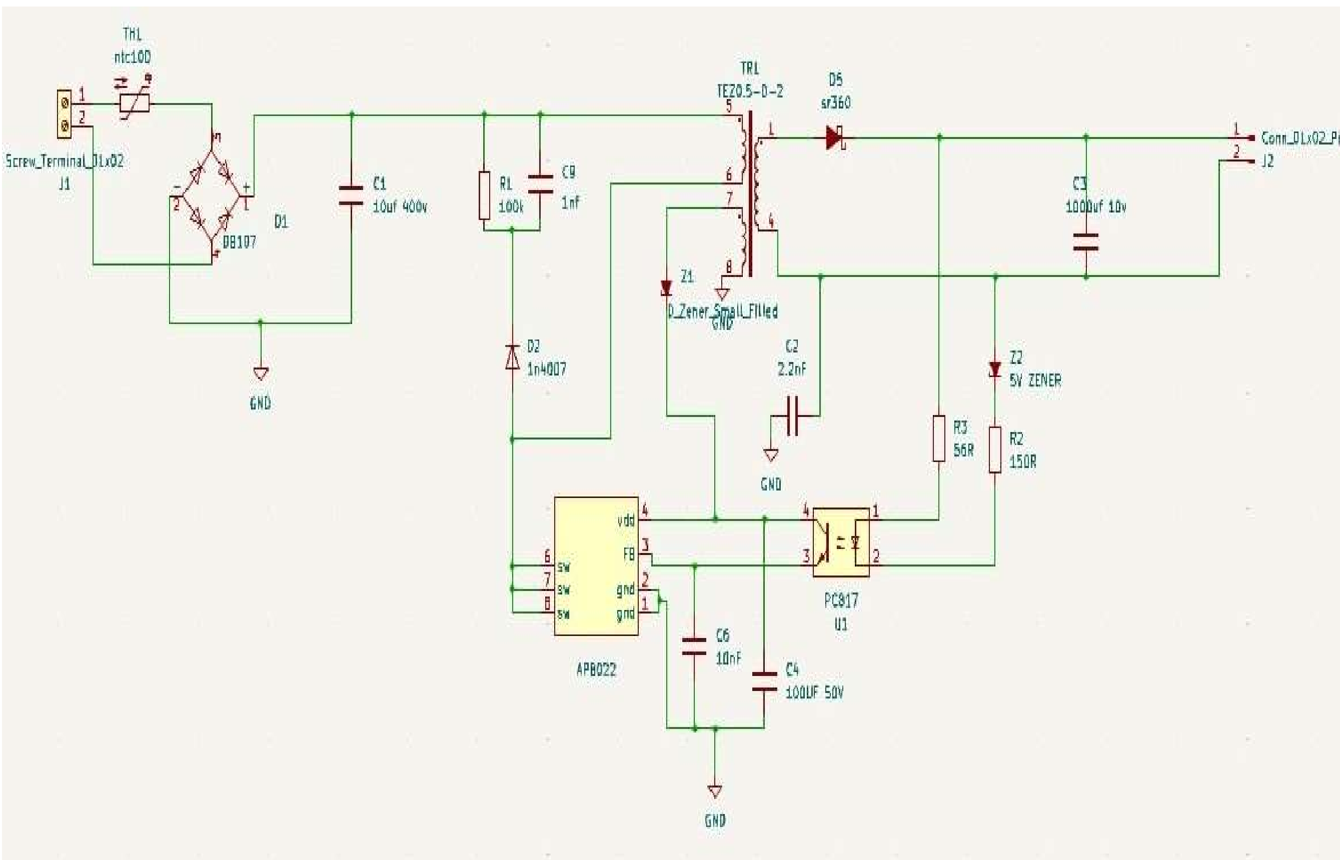
9. Generate Documentation:

Generate documentation such as a Bill of Materials (BOM), component placement diagram, and schematic printout. These documents provide essential information for manufacturing, assembly, and testing of the PCB.

10. Collaborate and Share:

Collaborate with team members or stakeholders by sharing schematic design files. Use version control systems or collaborative platforms to manage revisions, track changes, and facilitate communication.

4.2 PCB SCHEMATIC DESIGN:



This schematic depicts the design of a Switched-Mode Power Supply (SMPS) implemented in KiCad. The SMPS is designed to convert an AC input voltage of 230V to a regulated DC output voltage of 5V at a maximum current of 2A. The schematic consists of several key components:

1. **Input Stage:**

   The AC input voltage is rectified by a bridge rectifier circuit, comprising diodes D107, to convert it into pulsating DC. An NTC thermistor (NTC100) is used for inrush current limiting during startup.

2. **MOSFET Switching:**

   The rectified DC voltage is then fed into the gate of the MOSFET (e.g., AP8022), which acts as a switch. The MOSFET controls the energy flow to the primary winding of the flyback transformer (e.g., EE16).

3. **Flyback Transformer:**

   The primary winding of the flyback transformer stores energy during the ON time of the MOSFET. When the MOSFET turns OFF, the stored energy is transferred to the secondary winding, where it is rectified by diode D5 and filtered by capacitor C1 to produce the output voltage.

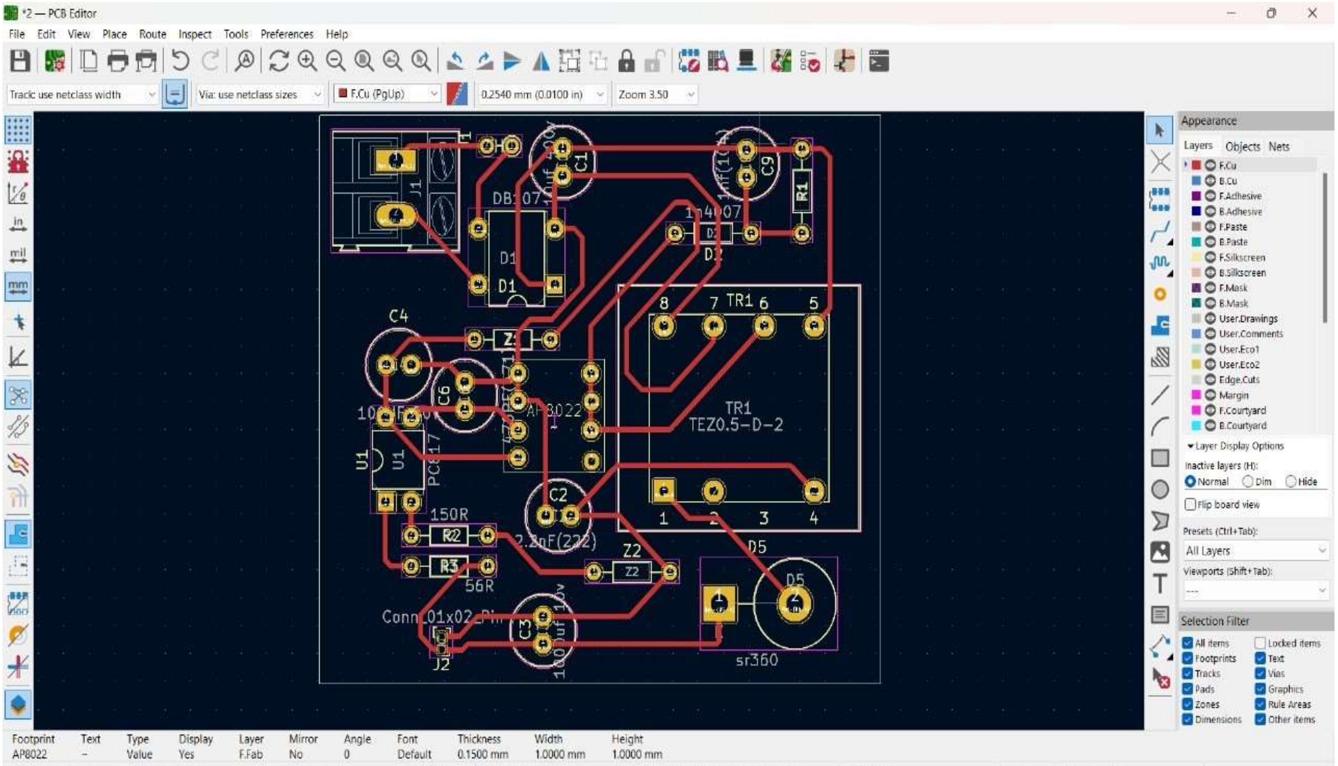
4. **Feedback Control:**

   The output voltage is monitored by the optocoupler (e.g., PC817), which provides feedback to the SMPS controller. The controller adjusts the duty cycle of the PWM signal based on the feedback to regulate the output voltage.

5. **Output Stage:**

   The regulated DC output voltage of 5V is obtained at the output, capable delivering a maximum current of 2A. Capacitor C3 is used for output filtering and smoothing.

4.3 BOARD DESIGN:



The board design for the Switched-Mode Power Supply (SMPS) in KiCad is a Single Layer PCB represents the culmination of meticulous planning, precise execution, and thorough verification to achieve a high-quality and reliable power supply solution. Our design leverages the robust capabilities of KiCad, including its intuitive user interface, powerful layout tools, and comprehensive design rule checks, to deliver a PCB layout that meets the stringent requirements of the SMPS application.

Our board design encompasses the following key features:

- **Optimized Component Placement:**

  Components are strategically placed on the PCB to minimize signal interference, optimize thermal management, and ensure efficient routing of traces.

  Careful consideration is given to the placement of critical components such as the MOSFETs, diodes, capacitors, and inductors to maximize performance and reliability.

- **Robust Power Distribution:**

  The layout incorporates dedicated power planes and traces designed to handle high-current paths efficiently while minimizing voltage drops and EMI (Electromagnetic Interference).Power delivery to sensitive components is carefully routed to minimize noise and ensure stable operation under varying load conditions.

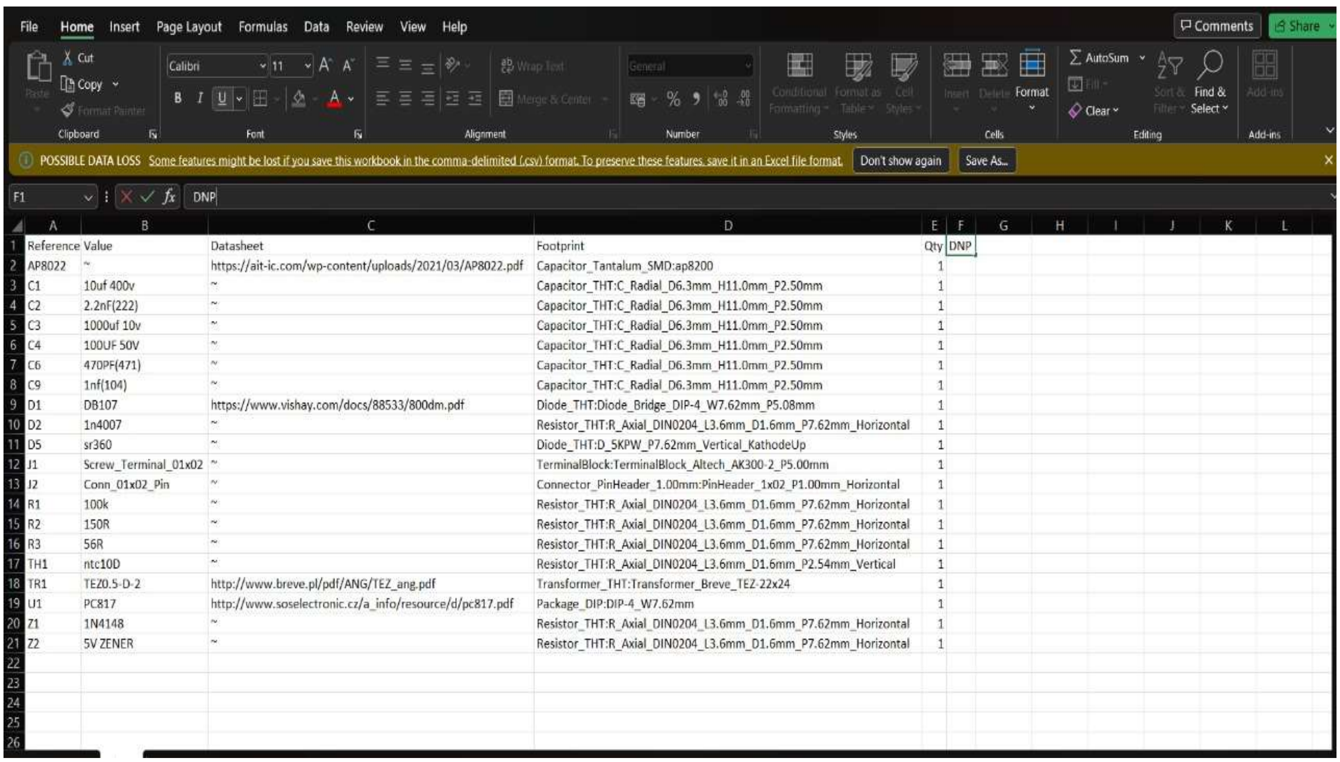
- **Signal Integrity and EMI Mitigation:**

  Signal traces are routed with controlled impedance and proper termination to maintain signal integrity and minimize reflections EMI mitigation techniques such as ground planes, shielding, and routing practices are employed to reduce electromagnetic emissions and ensure compliance with regulatory standards.

- **Comprehensive Design Rule Checks (DRC):**

  The board design undergoes rigorous DRC to verify compliance with design rules, constraints, and manufacturing guidelines checks for trace width, clearance, spacing, via sizes, and other parameters are performed to identify and rectify potential issues early in the design process.

4.4 BILL OF MATERIAL:



Reference	Value	Datasheet	Footprint	Qty	DNP
AP8022	~	https://ait-ic.com/wp-content/uploads/2021/03/AP8022.pdf	Capacitor_Tantalum_SMD:ap8200	1	
C1	10uf 400v	~	Capacitor_THT:C_Radial_D6.3mm_H11.0mm_P2.50mm	1	
C2	2.2nF(222)	~	Capacitor_THT:C_Radial_D6.3mm_H11.0mm_P2.50mm	1	
C3	1000uf 10v	~	Capacitor_THT:C_Radial_D6.3mm_H11.0mm_P2.50mm	1	
C4	100UF 50V	~	Capacitor_THT:C_Radial_D6.3mm_H11.0mm_P2.50mm	1	
C6	470PF(471)	~	Capacitor_THT:C_Radial_D6.3mm_H11.0mm_P2.50mm	1	
C9	1nf(104)	~	Capacitor_THT:C_Radial_D6.3mm_H11.0mm_P2.50mm	1	
D1	DB107	https://www.vishay.com/docs/88533/800dm.pdf	Diode_THT:Diode_Bridge_DIP-4_W7.62mm_P5.08mm	1	
D2	1n4007	~	Resistor_THT:R_Axial_DIN0204_L3.6mm_D1.6mm_P7.62mm_Horizontal	1	
D5	sr360	~	Diode_THT:D_5KPW_P7.62mm_Vertical_KathodeUp	1	
J1	Screw_Terminal_01x02	~	TerminalBlock:TerminalBlock_Altech_AK300-2_P5.00mm	1	
J2	Conn_01x02_Pin	~	Connector_PinHeader_1.00mm:PinHeader_1x02_P1.00mm_Horizontal	1	
R1	100k	~	Resistor_THT:R_Axial_DIN0204_L3.6mm_D1.6mm_P7.62mm_Horizontal	1	
R2	150R	~	Resistor_THT:R_Axial_DIN0204_L3.6mm_D1.6mm_P7.62mm_Horizontal	1	
R3	56R	~	Resistor_THT:R_Axial_DIN0204_L3.6mm_D1.6mm_P7.62mm_Horizontal	1	
TH1	ntc10D	~	Resistor_THT:R_Axial_DIN0204_L3.6mm_D1.6mm_P2.54mm_Vertical	1	
TR1	TEZ0.5-D-2	http://www.breve.pl/pdf/ANG/TEZ_ang.pdf	Transformer_THT:Transformer_Breve_TEZ-22x24	1	
U1	PC817	http://www.soselectronic.cz/a_info/resource/d/pc817.pdf	Package_DIP:DIP-4_W7.62mm	1	
Z1	1N4148	~	Resistor_THT:R_Axial_DIN0204_L3.6mm_D1.6mm_P7.62mm_Horizontal	1	
Z2	5V ZENER	~	Resistor_THT:R_Axial_DIN0204_L3.6mm_D1.6mm_P7.62mm_Horizontal	1	

- The BOM lists each component used in the design, along with its unique identifier or reference designator. This identifier helps assembly technicians locate and install the correct components on the PCB.

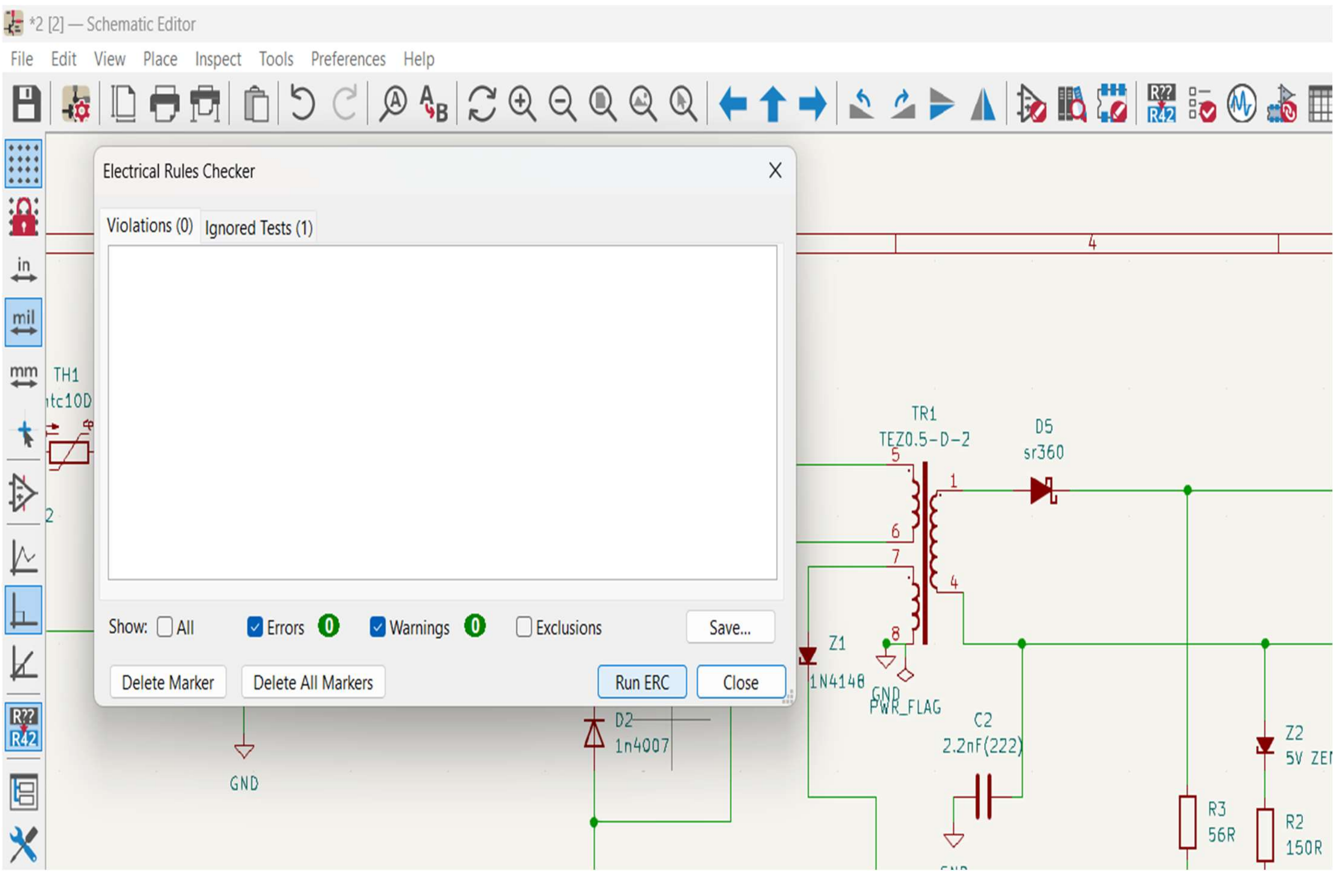
- Each component in the BOM is associated with a specific part number, which uniquely identifies the component and helps procure the exact part required for assembly.

- The BOM also includes detailed descriptions of each component, including its type, value (if applicable), package type, and specifications.
- Detailed documentation, including assembly drawings, fabrication files (Gerber files), bill of materials (BOM), and component placement files, is generated to facilitate manufacturing and assembly.
- Clear and concise annotations, labels, and designators are added to the layout to aid in assembly and troubleshooting.

CHAPTER 5

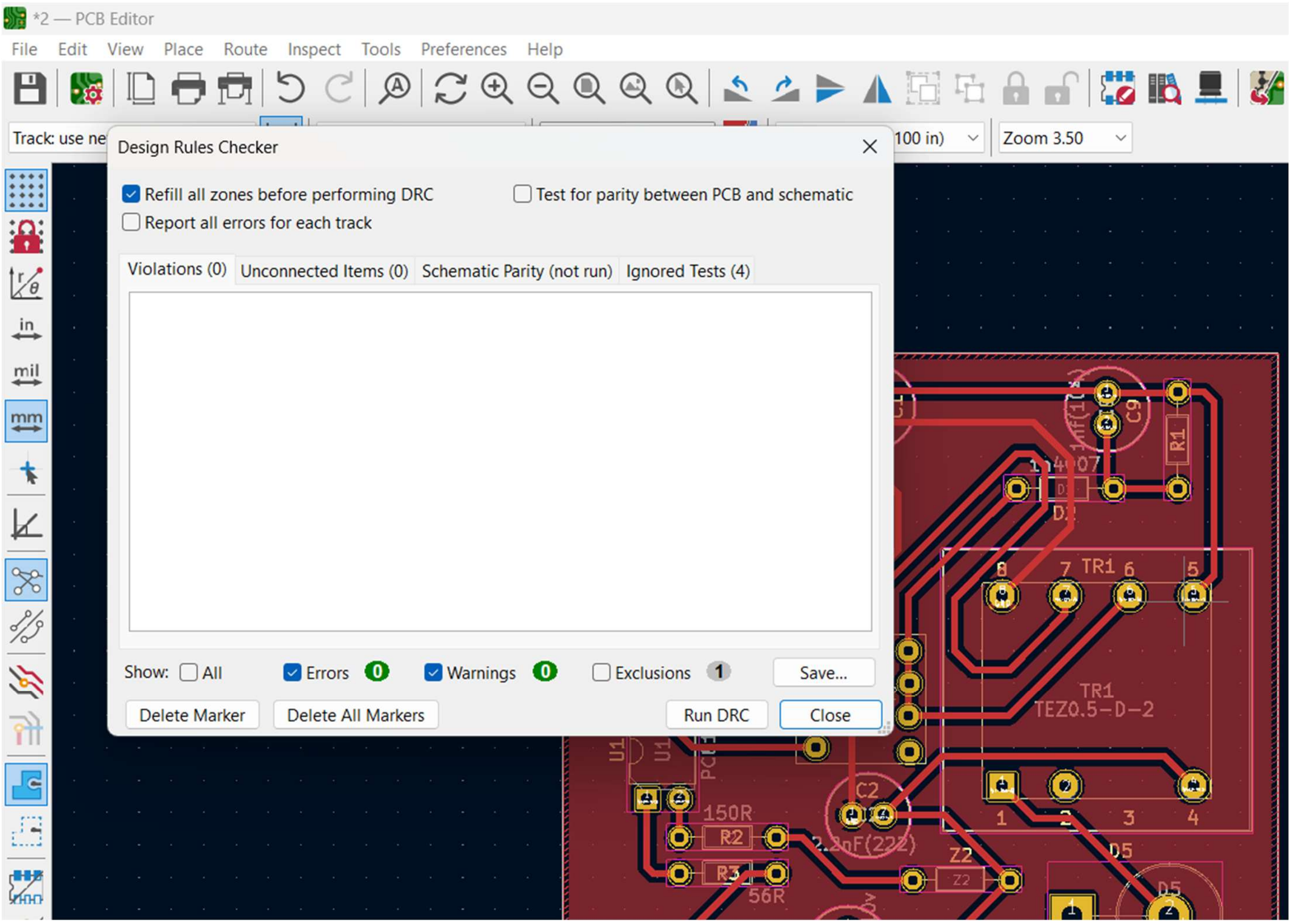
VERIFICATION OF SCHEMATIC AND BOARD DESIGN

5.1 SCHEMATIC VERIFICATION (ERC):



- ERC is performed on the schematic design to identify and flag potential electrical connectivity issues, errors, and violations of design rules.
- It verifies the logical integrity of the schematic by analyzing the connections between components and identifying any inconsistencies or missing connections.
- ERC checks include ensuring proper power and ground connections, identifying unconnected pins, detecting short circuits, and verifying the correctness of component properties and values.
- By running ERC on the schematic, designers can catch errors early in the design process, preventing costly mistakes and ensuring the schematic accurately represents the intended circuit functionality.

5.2 BOARD VERIFICATION (DRC):

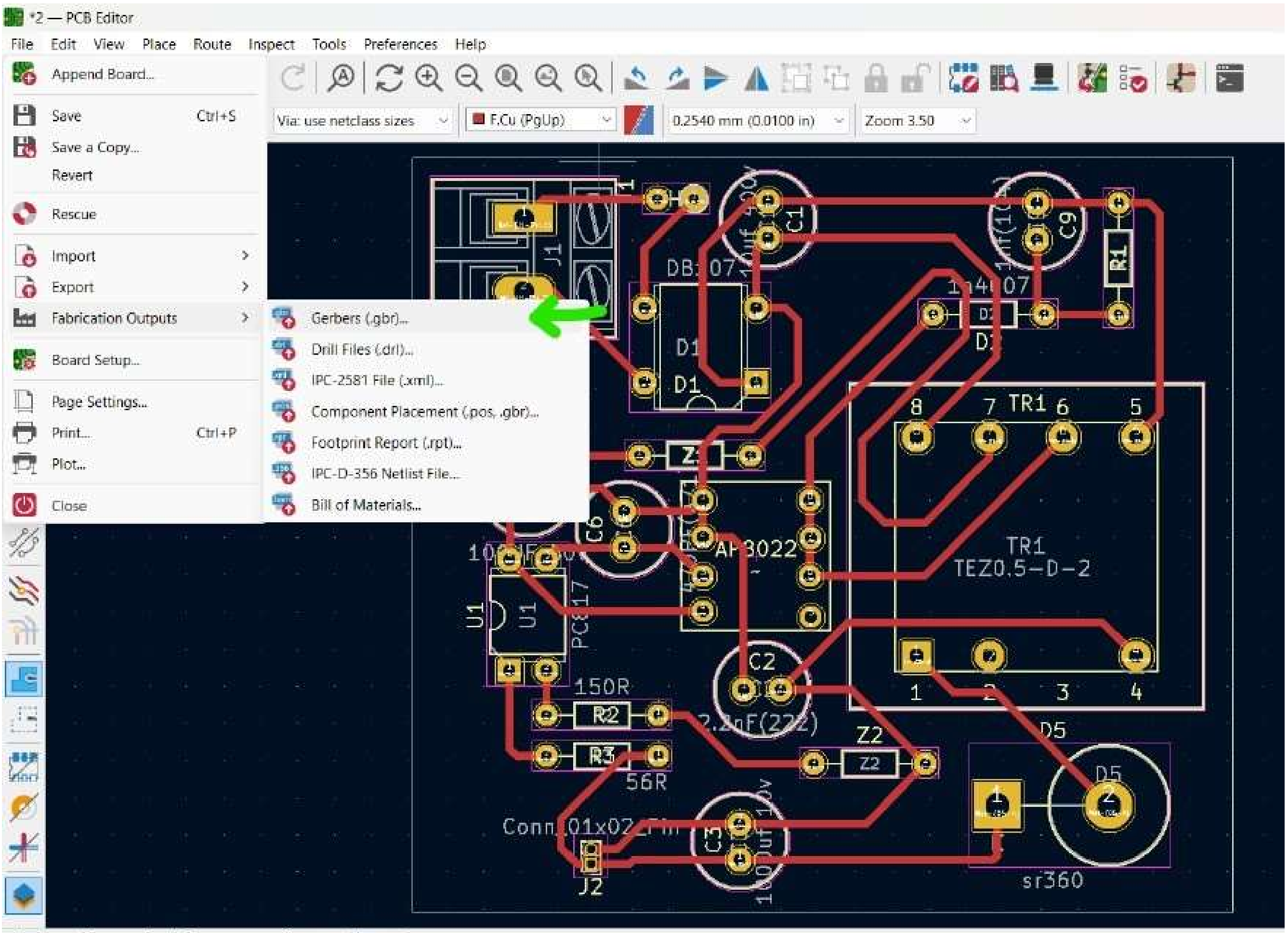


- DRC is conducted on the PCB layout to validate the physical implementation of the design against specified design rules and constraints.
- It checks various aspects of the PCB layout, including trace width, clearance, spacing, via sizes, hole sizes, and component placement, to ensure compliance with manufacturing capabilities and design specifications.
- DRC identifies potential issues such as trace-to-trace or trace-to-pad clearance violations, overlapping components or traces, and minimum annular ring violations.
- By performing DRC, designers can ensure that the PCB layout meets industry standards, manufacturing requirements, and specific project constraints, minimizing the risk of manufacturing defects and ensuring the functionality and reliability of the final product.

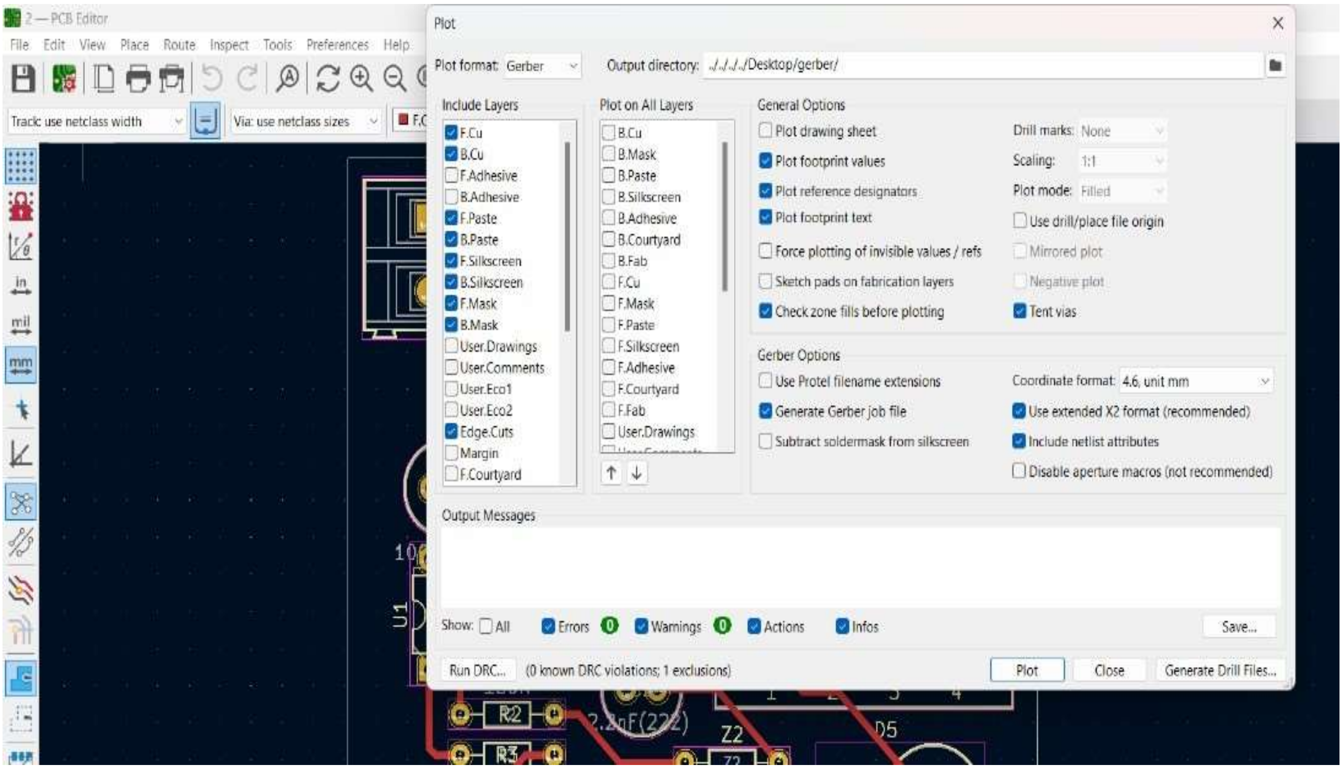
5.3 EXPORTING BOARD FILES TO GERBER:

Before exporting we need to check for DRC and then we need to generate fabrication files.

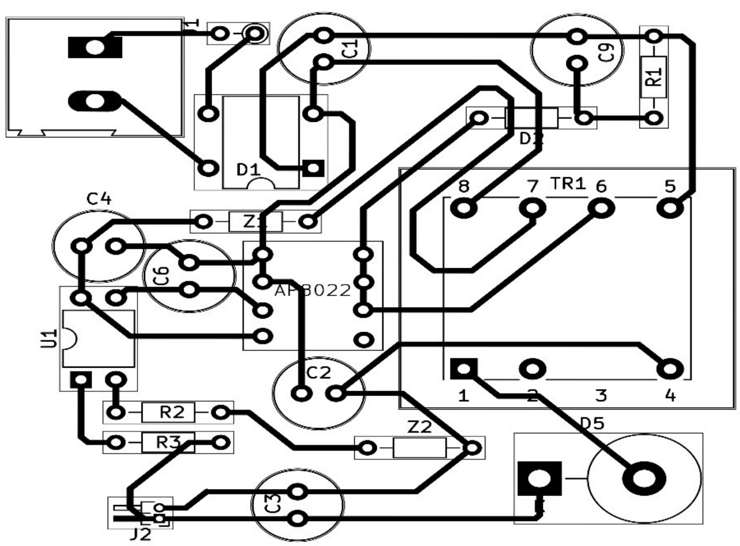
Generating Fabrication Files:



- In the PCB Layout Editor, go to "File" > "Plot..." to open the Plot dialog box.
- In the Plot dialog box, select the layers we need to include in the Gerber files. Typically, this includes copper layers (Top Copper, Bottom Copper), silkscreen layers (Top Silk, Bottom Silk), solder mask layers (Top Solder, Bottom Solder), and others as needed.



- Check "Plot format" and select "Gerber".
- It's common practice to zip all the Gerber and drill files into a single compressed folder. Name the zip file appropriately for easy identification.



GERBER FILE

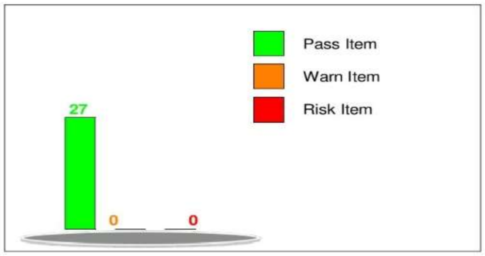
5.4 VERIFICATION OF GERBER FILE:

HQ NextPCB www.nextpcb.com

HQDFM Design for Manufacture(DFM) Report

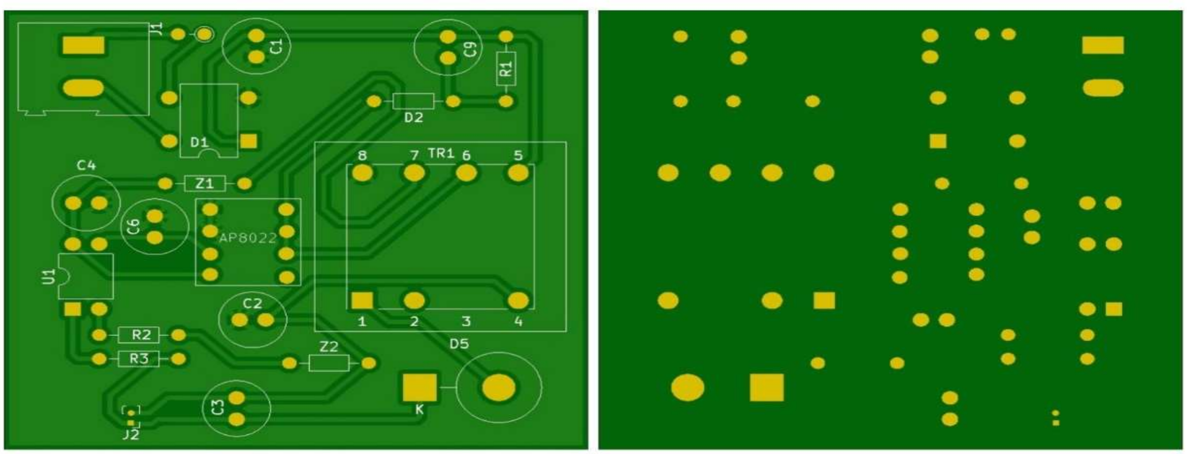
File name: 0000A103604_1

Time: 2024-04-16Layer num:2 pcb thickness:1.60 quantity:5 Board Size:56.13*51.56 mm



param_analyze	Trace Width/Spacing	10.00/10.00mil+
	Milling Density	77.2211m/m²
	Surface Finish Area	9.21%
	Test Point Count	110
	Panel Efficiency	85.2179%

The board's small size may complicate machine assembly. We recommend increasing the dimensions to at least 70 x 70mm by panelizing the boards and/or adding break-away rails.



- By Using a Gerber viewer software (NextPCB) we have visualized the Gerber files and inspected each layer of our PCB design.
- The NextPCB Gerber viewer allows designers to visualize and inspect these files in a user-friendly interface, providing a clear representation of each layer's content and layout.
- We have analyzed the panel efficiency of 85.2% for our PCB design. The efficiency percentage indicates the proportion of the panel area occupied by actual PCBs compared to the total available area.

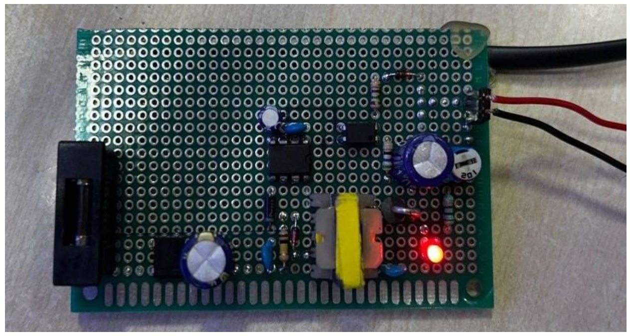
REPORT:

type	checkitem	checksubitem	result
pcb_signal	Smallest Trace Width	1	Pass
	Smallest Trace Spacing	3	Pass
	Pad Spacing	2	Pass
	Pad Size	3	Pass 4
	Hatched Copper Pour	2	Pass
	RingHole	2	Pass
	Drill to Copper	5	Pass
	Signal Integrity	4	Pass
	Board Edge Clearance	2	Pass 8
	Holes on SMD Pads	4	Pass
	Open/Shorts (IPC)	1	Pass
pcb_drill	Hole Diameter	8	Pass
	Drill Hole Density	1	Pass
	Hole Diameter	8	Pass
	Drill Hole Spacing	4	Pass
	Drill to Board Edge	4	Pass
	Drill Hole Density	1	Pass
	Special Drill Holes	2	Pass
pcb_soldmask	Solder Mask Spacing	2	Pass
	Missing SMask Openings	1	Pass
pcb_silk	Silkscreen Spacing	1	Pass 7
ass_markpoint	Fiducials	1	Pass 42

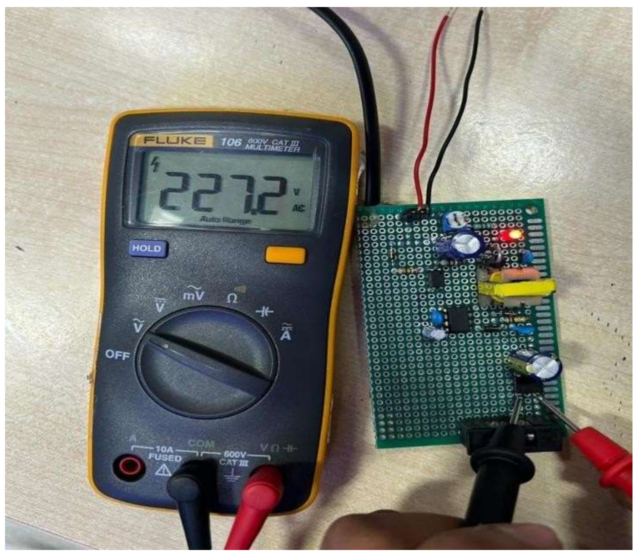
Comprehensive analysis of our Gerber files generated by NextPCB

CHAPTER 6

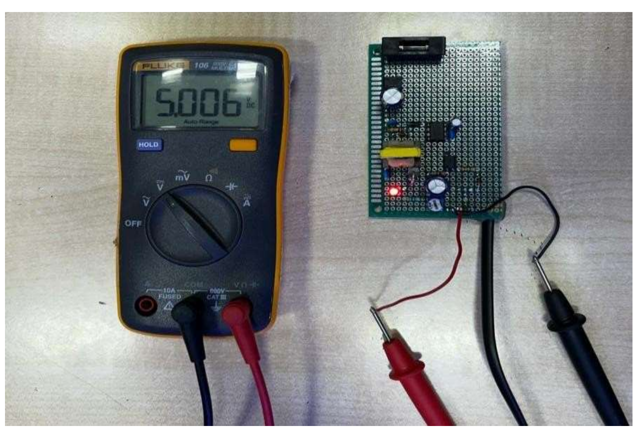
OBSERVATION:



Overall working model of the project



Input AC Voltage



Output DC Voltage

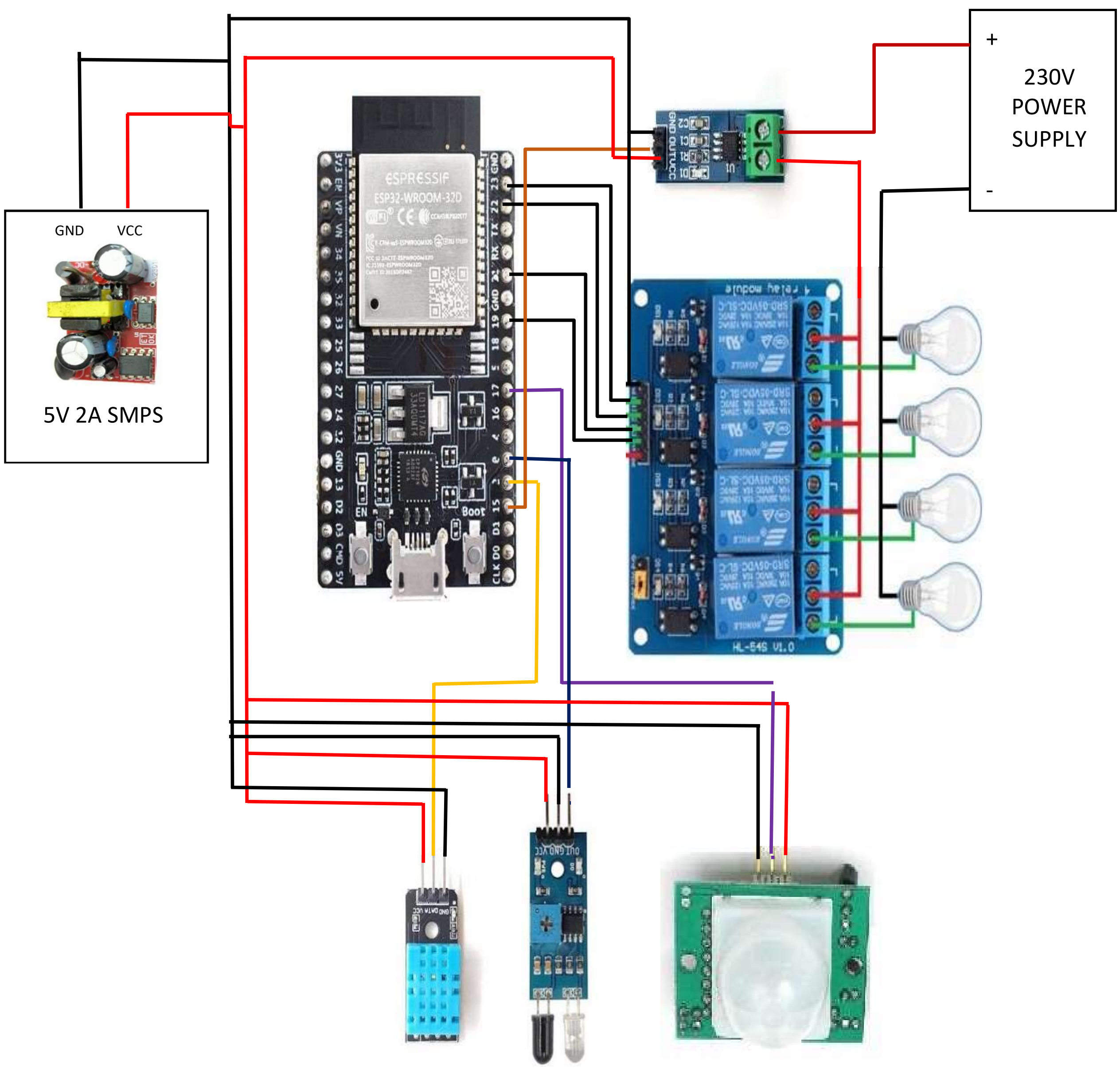
CHAPTER 7

APPLICATIONS

7.1 Application of SMPS in IOT:

Switched-Mode Power Supplies (SMPS) have various applications in smart home systems, contributing to their efficiency, reliability, and functionality. One of the applications that is used by us is connecting SMPS output to the Esp32 and done.

7.1.1 Smart home automation:



Here is the detailed description and circuit diagram of the application.

- The SMPS converts the high-voltage AC input (e.g., 230V AC) to a low-voltage DC output suitable for powering electronic devices.
- It regulates the output voltage to ensure stable and reliable power delivery to the ESP32 board and other components in the system.
- The ESP32 board serves as the brain of the system, controlling the operation of the relay modules, receiving input from push buttons, and interfacing with the PIR sensor.
- It runs a program or firmware that defines the logic for controlling the bulbs based on user input and motion detection events.
- The relay modules are connected to the ESP32 board via digital output pins.
- Each relay channel has a control input that is driven by the ESP32 to switch the corresponding relay on or off.
- When a relay is energized, it closes the circuit between its common terminal and the normally open (NO) terminal, allowing current to flow to the connected bulb.
- The bulbs are connected to the relay modules, with each bulb corresponding to one relay channel.
- When a relay is activated by the ESP32, it supplies power to its associated bulb, causing it to illuminate.
- The push buttons are connected to the ESP32 board via digital input pins.
- Each push button is associated with a specific relay channel, allowing users to manually control the state of the bulbs by pressing the buttons.
- When a push button is pressed, the corresponding relay channel is toggled, turning the associated bulb on or off.
- The PIR sensor detects motion by sensing changes in infrared radiation within its detection range.
- It is connected to the ESP32 board via a digital input pin.
- When motion is detected, the PIR sensor sends a signal to the ESP32, triggering the automatic illumination sequence.

7.1.2 Working sequence:

- Upon power-up, the ESP32 initializes and enters a standby mode, awaiting user input or motion detection events.
- If a user presses a push button, the ESP32 detects the button press and toggles the corresponding relay channel, turning the associated bulb on or off.
- If motion is detected by the PIR sensor, the ESP32 receives the motion detection signal and activates the relay channels connected to the bulbs, illuminating the area.
- The ESP32 continues to monitor for user input and motion detection events, adjusting the state of the

bulbs accordingly.

7.2 Applications in general:

Switched-Mode Power Supplies (SMPS) have various applications in smart home systems, contributing to their efficiency, reliability, and functionality. Here are some ways SMPS can be applied in smart homes:

1. **Powering Smart Devices:**

   SMPS are commonly used to power various smart devices and appliances in the home, such as smart thermostats, Wi-Fi routers, smart lighting systems, and smart speakers.

   Their compact size and high efficiency make them ideal for integration into small form factor devices and IoT (Internet of Things) products.

2. **Powering Control Units:**

   Smart home control units, hubs, and gateways require stable and efficient power sources to operate reliably.

   SMPS can provide the necessary power conversion and regulation for these control units, ensuring smooth operation of the smart home ecosystem.

3. **Charging Stations:**

   SMPS-based charging stations for smartphones, tablets, laptops, and other portable devices are essential components of modern smart homes.

   These charging stations can incorporate fast-charging capabilities and multiple ports to accommodate the charging needs of various devices simultaneously.

4. **Energy Management Systems:````**

   SMPS-based energy management systems play a crucial role in monitoring and optimizing energy usage in smart homes.

   They can regulate the power supply to different devices based on usage patterns, prioritize energy-efficient operation, and integrate with renewable energy sources such as solar panels and batteries.

5. **Power Over Ethernet (PoE) Devices:**

   PoE technology allows power and data to be transmitted over Ethernet cables, eliminating the need for separate power cables for certain smart devices.

   SMPS can be integrated into PoE switches and injectors to provide the necessary power to devices such as IP cameras, VoIP phones, and access points.

6. **Wireless Charging Solutions:**

   SMPS-based wireless charging pads and stations enable convenient charging of devices without the need for cables.

   These solutions can be integrated into smart furniture, countertops, or wall-mounted charging docks, enhancing the usability and aesthetics of the smart home environment.

7. **Backup Power Systems:**

   SMPS-based uninterruptible power supplies (UPS) and backup power systems provide reliable power backup during outages or fluctuations in the main power supply.

   They ensure continuous operation of critical smart home devices, such as security cameras, alarms, and communication systems, to maintain home security and connectivity.

CHAPTER 8

CONCLUSION

8.1 CONCLUSION AND FUTURESCOPE:

In conclusion, the design and development of the SMPS using KiCad represent a significant milestone in achieving a reliable and efficient power supply solution. Leveraging the advanced features and capabilities of KiCad, we have successfully designed and validated a compact and robust SMPS circuit capable of converting high-voltage AC input to stable 5V DC output. The meticulous design process, including schematic capture, PCB layout, and verification, has ensured the accuracy, integrity, and manufacturability of the SMPS design.

Through rigorous testing and validation, we have verified the functionality and performance of the SMPS, meeting the specified output voltage and current requirements while adhering to design rules and constraints. The integration of KiCad's comprehensive design tools, coupled with careful component selection and layout optimization, has enabled us to achieve a high-quality and reliable SMPS solution suitable for various electronic applications.

Looking ahead, there are several avenues for further enhancement and expansion of the SMPS design using KiCad:

- **Efficiency Optimization:** Explore methods to further improve the efficiency of the SMPS design through component optimization, topology refinement, and advanced control techniques, such as synchronous rectification and adaptive feedback control.
- **Integration with Microcontroller:** Integrate the SMPS with an microcontroller to create a smart power management system capable of remote monitoring, control, and automation. This integration enables features such as real-time voltage monitoring, overcurrent protection, and IoT connectivity for enhanced functionality and versatility.
- **Enhanced Protection Features:** Implement additional protection features in the SMPS design, such as overvoltage protection, reverse polarity protection, and temperature monitoring, to enhance reliability and safety in various operating conditions, possibilities for improving comfort, efficiency, and convenience in the modern home.

8.2 REFERENCES

Datasheet reference of components:

Thermistor NTC100	**https://datasheetspdf.com/mobile/944190/Danfoss/NTC100K/1**
DB 107:	**https://www.alldatasheet.com/datasheet-pdf/pdf/35522/RECTRON/DB107.html**
AP8022	**https://ait-ic.com/wp-content/uploads/2021/03/AP8022.pdf**
PC817	**https://www.farnell.com/datasheets/73758.pdf**
SR360	**https://html.alldatasheet.com/html-pdf/34132/WTE/SR360/44/1/SR360.html**