EXTENDED TIME UPS FOR PC WITH EXTERNAL BATTERY AND SOFTWARE SUPPORT

Final Year Project Proposal Report

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In Partial Fulfillment
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Department of Electrical Engineering
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CERTIFICATE OF ORIGINALITY

We hereby declare that this report titled “Extended Time UPS for PC with External Battery and Software Support” is our own work to the best of our knowledge. It contains no materials previously published or written by another person, nor material which to a substantial extent has been accepted for the award of any degree or diploma at ITU or any other education institute, except where due acknowledgment, is made in the thesis. Any contribution made to the research by others, with whom we have worked at ITU or elsewhere, is explicitly acknowledged in the thesis.

We also declare that the intellectual content of this report is the product of our own work, except to the extent that assistance from others in the project’s design and conception or in style, presentation and linguistic is acknowledged. We also verified the originality of contents through plagiarism software.

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The undersigned hereby certify that they have read and recommended the report entitled "Extended Time UPS for PC with External Battery and Software Support " by Junaid Akbar (BSEE20020), Masood Zafar (BSEE20036)and M.Umar Shakir (BSEE20075) for the degree of Bachelor of Science in Electrical Engineering.

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DEDICATION

This dissertation is dedicated to our parents and our teachers.

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Abstract

Power outage is a frequent and serious problem in Pakistan. For this reason, desktop computers are being replaced with laptops although the former is cheaper and offers more computing power. Therefore, eliminating or even reducing the impact of intermittent electricity supply can significantly improve the usability of desktop personal computers (PCs). Uninterrupted Power Supply (UPS) is a viable solution. Typically, comsumer PCs are rated at less than 500W max, commercial UPS can provide protection as well as backup for a few minutes (3-5 minutes) until backup generator starts up. This approach is not feasible in Pakistan due to economic conditions, gasoline prices and requirements of real estate to accommodate the generators. Moreover, commercially available UPS for PCs are significantly more costly than generic inverters of equivalent or even greater power rating. Therefore, we propose to design a UPS which can handle the load of a PC of 500W maximum with standard protections but with extended backup time of 30 minutes or more. The UPS will act as an inverter during power outage, using the battery backup, and act as battery charger and also power the PC when electricity is available. The end goal is to provide a cost effective product with greater utility from longer backup time while maintaining features offered by commercially available UPS.

CHAPTER 1

INTRODUCTION

We start by defining our motivation for carrying out this project, which will guide our design choices and the path forward throughout the rest of the project.

1.1 Motivation

Our concept is motivated by the growing reliance on personal computers (PCs) and the urgent necessity to secure data and continue working during power outages. To overcome these difficulties, we strive to offer extended power backup solutions with user-friendly software assistance, assuring data integrity, cutting down on downtime, and improving the overall computing experience.

1.2 Challenges

When developing a long-life UPS for PCs with integrated software support, several important challenges emerged during the research process. The key was to ensure seamless compatibility of components, from batteries to inverters to control circuitry, to create a reliable and consistent system capable of providing extended backup power. Another key hurdle was achieving harmonious integration between the UPS hardware and associated software to enable effective energy management and user-friendly control. It turns out that finding a balance between cost efficiency and the integration of high-quality components is always a consideration, with the aim of providing accessible and robust solutions. Designing an intuitive interface proved to be a key challenge, and providing clear and actionable information required a thorough understanding of user needs. Additionally, there are significant challenges in implementing fault protection mechanisms to protect UPS systems and connected devices from electrical anomalies, with the main goal being to maximize energy efficiency and minimize losses during conversion. Compliance with safety standards and regulatory requirements is essential to ensure the safe operation of UPS systems in a variety of environments. Another important aspect was to build a UPS system that would prove durable and reliable even with long-term use and relatively environment friendly (by improving battery and PC component life and reducing waste). Scalability and adaptability were paramount, and we needed a design that could accommodate a variety of PC configurations and adapt to technology that evolves over time. Rigorous testing and validation under a variety of conditions are essential to verify the performance, efficiency, and reliability of the UPS system. Additionally, gathering market insights and user feedback plays a key role in refining the UPS system and tailoring it to real-world needs and preferences. Thorough documentation and reporting are being performed throughout the project, including design specifications, test results, and operational guidelines to ensure a complete record of research activities.

1.3 Problem Statement

Intermittent (power outages, voltage fluctuations and poor power signal quality) utility power is a serious concern for PC users. Therefore a solution is required to provide uninterrrupted power supply for medium to long duration with regulated power signal quality. Commerical solutions exist but we aim to provide a better value for money solution.

1.3.1 Unmet Need

The lack of a complete power backup solution for personal computers (PCs) that combines prolonged runtime, user-friendly software support, and resource efficiency is the ”Unmet Need” that our project aims to answer. Current UPS systems frequently fall short in their ability to provide enough power backup, leaving PCs susceptible to data loss and productivity lapses during protracted outages. Additionally, the absence of user-friendly software solutions makes power management more difficult for consumers. In order to fulfill the unmet demands for improved data security, user ease, resource conservation, and cost-effective power backup solutions in a setting that is becoming more and more dependent on technology, our project offers an extended-duration UPS with integrated software support.

1.3.2 Potential Market

Designed specifically for the unique demands of the Pakistani market, our Extended Time UPS for PCs addresses a crucial issue in areas where power interruptions are a frequent occurrence. Given Pakistan's sporadic power supply, both businesses and households often encounter difficulties in maintaining uninterrupted operations. Our solution meets this demand by providing a dependable, budget-friendly UPS capable of sustaining essential computing tasks during outages, thus boosting productivity and ensuring the protection of crucial data within the local context.

1.4 Report Outlines

The main scope of this report is the following.

Chapter 1: Describes the introduction of the project including the motivation, challenges, sustainability, problem statement, unmet need, and the potential market of our project.

Chapter 2: Including proposed designs in the literature, commercially adopted practices and commercially available features. Desireable features that are commercially absent are also discussed.

Chapter 3: Proposed methodology and architecture include the proposed solution, packing, hardware components, and software components.

Chapter 4: Consists of milestones, work division, and cost.

Chapter 5: Concludes the complete project.

CHAPTER 2

LITERATURE REVIEW

The literature review offers a comprehensive overview of current research and advancements in the field of extended-time Uninterruptible Power Supplies (UPS) designed for PCs. It specifically concentrates on solutions capable of providing uninterrupted power supply for PCs with a capacity of up to 500W. This review encompasses various types of UPS, such as Line-Interactive, Standby, and Online (Double Conversion) systems. Existing literature underscores the vital significance of reliable power backup, particularly in regions with unstable power grids, which closely aligns with the challenges faced by small to medium-sized businesses and home offices in Pakistan. While previous studies have delved into different UPS technologies and their applications, there exists a noticeable gap in the literature concerning cost-effective solutions tailored to this specific power range and market segment. Moreover, limited attention has been given to the integration of software support with UPS systems, a pivotal feature of our project. By amalgamating this body of knowledge, our objective is to expand upon existing research and cater to the distinctive demands of this underserved market. [1]

2.1 Technological Architecture of UPS System

The technological architecture in [1] is centered around key components an advanced battery system, an inverter for power conversion, a software control unit for real-time monitoring and control, a user-friendly interface, safety systems, communication ports, and remote monitoring capabilities which are most key features of advanced UPS.According to these architectures extended power backup, data protection, and user convenience is important while addressing critical needs in the field of power backup solutions for personal computers.

2.2 Comparison with Existing UPS Solutions

According to [2] the short duration of existing UPS systems, which frequently fails during lengthy power outages, is one of the major problems. Our study concentrates on boosting runtime by utilizing cutting-edge battery technology to get around this problem. By doing this, we increase the amount of time that consumers can rely on our UPS system to protect their work and data during protracted power outages. Another big issue is that many UPS systems lack software support that is user-friendly. Users frequently suffer with confusing user interfaces, making it difficult for them to properly manage their authority and secure their data.

2.3 Advanced Battery Technologies

It is shown in [3] that in order to increase UPS runtime, cutting-edge battery technologies, more notably high-energy-density lithium-ion batteries are much useful. The performance and dependability of our system are improved by these batteries, giving users plenty of time to save work during power outages. In order to maximize battery health and efficiency,Battery Management System (BMS) is used for longer battery life, which promotes sustainability and financial viability.

2.4 Software Support in UPS Systems

Software assistance is necessary in advanced design.Improved functionality and accessibility of UPS systems by providing user-friendly and effective software assistance.software support component offers consumers a complete solution for efficiently controlling electricity. It has an easy-to-use user interface that provides real-time power status, battery health, and load capacity monitoring. Users may easily alter power management profiles to suit their own requirements, delivering a smooth and customized experience. software support's capacity to allow automatic shutdown processes is one of its primary features.software makes sure that the linked PC shuts down gently during power interruptions, protecting data and reducing downtime. This feature directly addresses the challenge of data protection during extended outages Furthermore, remote monitoring capabilities empower users to stay connected with their UPS systems, even when they are away from their PCs. Users receive alerts and notifications about power events, enabling them to take timely actions to safeguard their data and equipment. [4]

2.5 Our Project and Economic Viability

The foundation is the economic viability. Our focus has been on reducing downtime expenses, which can have a significant financial impact on customers and enterprises. Additionally, by combining energy-efficient technology and sophisticated battery management, our UPS system offers a cost-effective solution that not only addresses consumers' financial worries but also improves their entire economic sustainability and value proposition. [5]

2.6 Market Analysis and Potential Impact

Our strategy is determined by a thorough market study we have done. We comprehend the growing need for long-duration UPS systems, particularly in industries like remote work and healthcare. In addition to meeting market demands, our project has the potential to set new standards for user-friendly software support, energy efficiency, and cost-effectiveness. With our solution staying current and influential, we are in a position to have a significant beneficial influence on the UPS industry by following trends in sustainability and cost-consciousness.

2.7 Gaps in Existing Literature

Our research immediately fills in knowledge gaps in the field of computer power backup systems. These flaws include short runtimes, [6] difficult software interfaces, [7] energy waste, [8]and financial losses [9] from power outages. By increasing runtime, giving intuitive software control, encouraging energy saving, and delivering an economically feasible solution, our proposal addresses these problems and closes significant gaps in the field of power backup systems. [10]

2.8 Summary

This chapter provides a strong foundation for our project by highlighting the challenges and opportunities in the field of power backup systems. It positions our project as a solution that not only bridges existing gaps but also sets new standards for extended time UPS systems with software support, offering enhanced user convenience, data protection, sustainability, and economic viability.

CHAPTER 3

PROPOSED METHODOLOGY AND ARCHITECTURE

Start by thoroughly analyzing the project's needs, which should include the intended backup time, load capacity, input/output voltage requirements, and cost factors.

3.1 Component Selection

we choosed the proper parts for the discharge path, such as a 12V battery, a full bridge square wave inverter that can handle 500W, and any necessary protection circuits.

1. Controller
2. Switch
3. Gate Driver
4. Transformer

3.1.1 Controller

We selected the STM module for its robust ARM processor, ensuring efficient data handling. Unlike Raspberry Pi, which faced library issues, and ESP, with a weaker processor, STM emerged as the ideal choice, offering a balance of clock speed and sustainability.STM32 Blackpill will be suitable.

3.1.2 Switch

The switch component was chosen based on criteria such as low internal resistance, ensuring minimal energy loss, along with optimal off and on times for seamless power transitions.P75nf75 will be suitable.

3.1.3 Gate Driver

Our selection for the gate driver focused on units capable of providing two signals on a single input. This design choice allows for enhanced control and flexibility, catering to the specific needs of our project.We selected IR2104 for Dual Signal Amplification.

3.1.4 Transformer

Ferrite for High-Frequency Efficiency.Opting for a ferrite transformer over an iron core, our decision prioritized high-frequency performance, reduced core losses, and a more compact design. Ferrite transformers align with our project's requirements, offering improved efficiency and size advantages in power electronics applications.

3.2 Charging Path

The charging process begins with a rectifier that converts 220V AC into DC. Following this, a filter, typically a capacitor, is employed to refine the DC output, bringing it to a specific voltage level. Subsequently, a step-down converter is utilized to stabilize the voltage at 12V, intended for charging the battery. The charging algorithm is optimized for efficiency and is characterized by a constant current followed by a constant voltage phase to ensure effective and controlled charging. In summary, the SMPS efficiently transforms and regulates the incoming AC power to a stable 12V DC for the battery, utilizing a filtering process and a carefully designed charging algorithm.

3.2.1 IC TL494 Testing

We have been working on the development of an SMPS (Switched-Mode Power Supply) for an inverter, and we began by testing the components to be used on a breadboard. For instance, we utilized the IC TL494 and conducted tests to understand how each of its pins functions.Initially, we constructed a circuit on the breadboard, incorporating a capacitor and resistor on the RT and CT pins, resulting in a sawtooth waveform that indicated the oscillation of charging and discharging.

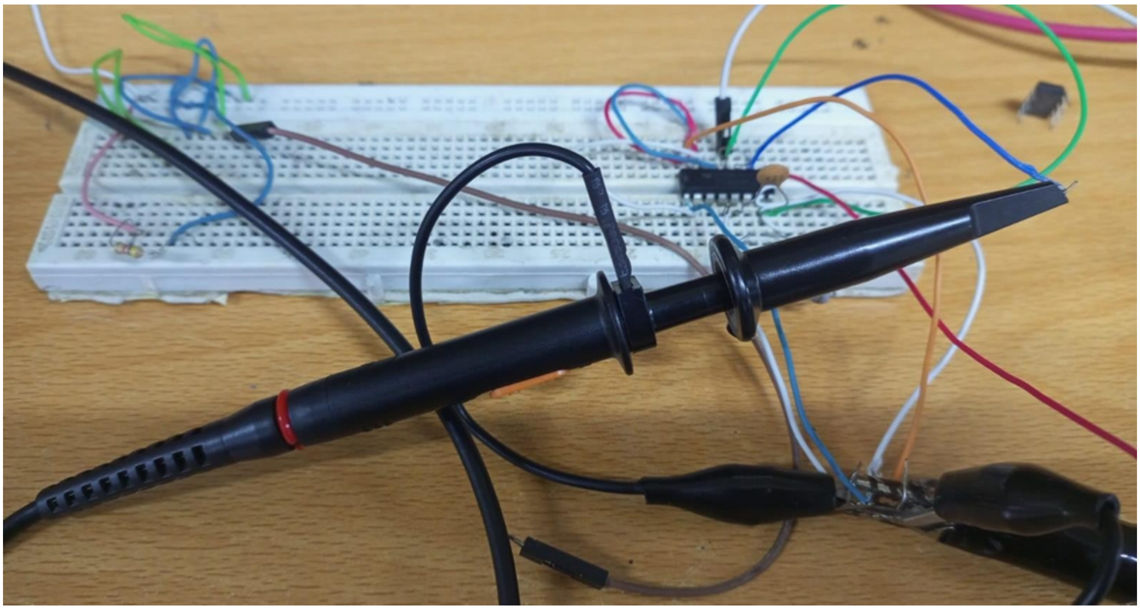

Figure 3.1: Testing of RT and CT

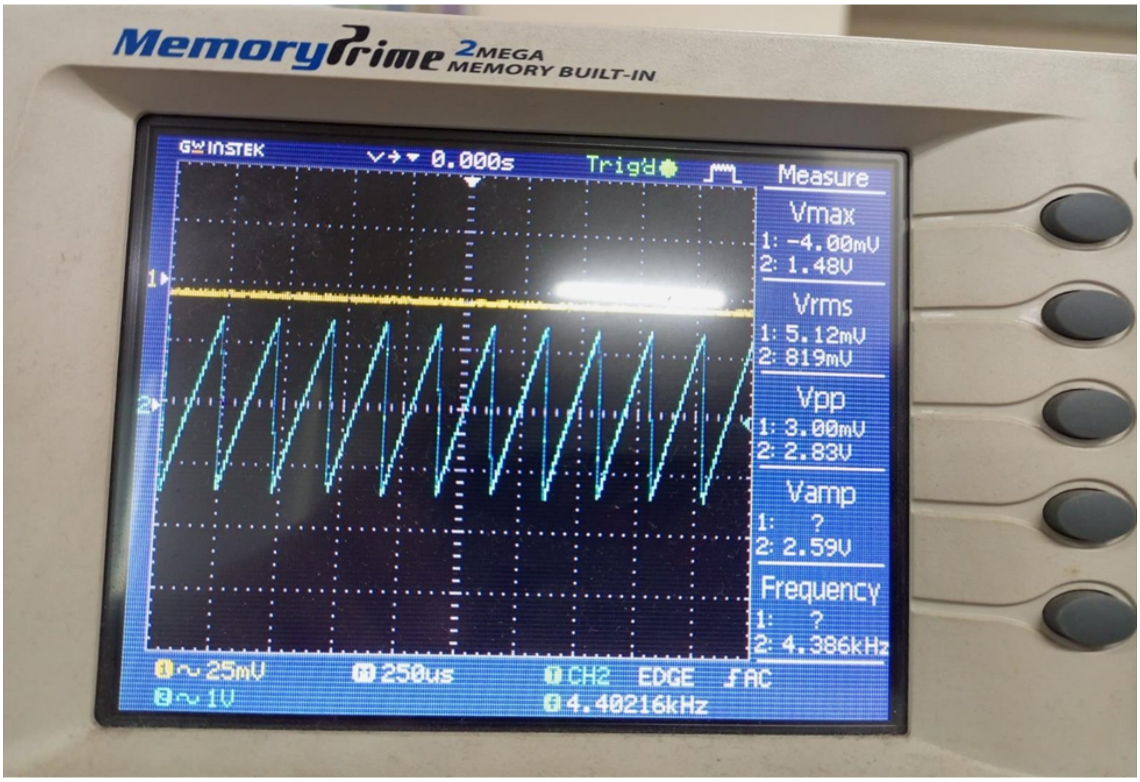

Figure 3.2: Testing of RT and CT

3.2.2 Feedback circuit testing

In the feedback circuit, the TL494 integrated circuit plays a central role, operating in a push-pull configuration to generate the output signal that drives the gate drivers controlling the MOSFETs. Voltage comparison is facilitated through pins 1 of the TL494, where a voltage divider circuit provides a reference voltage for comparison with the actual output voltage. An error amplifier compares these voltages, amplifying any discrepancies to adjust the output accordingly. Additionally, current feedback is monitored using an LM358M amplifier which amplify the 0.7 V voltage drop across the shunt resister to measure the current flowing through the system, then it goes into the programed IC which compare the Voltage for current feedback ensuring efficient regulation of the charging process.

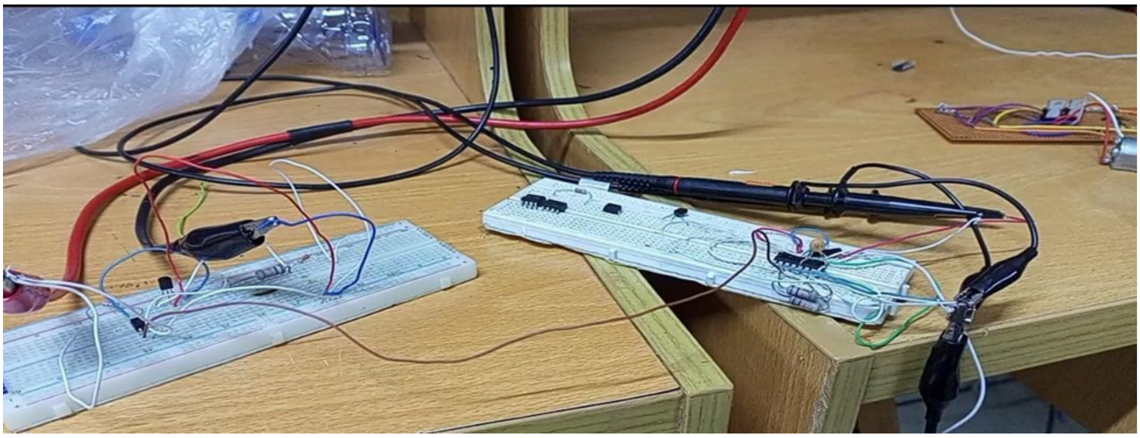

Figure 3.3: SMPS feedback circuit on breadboard

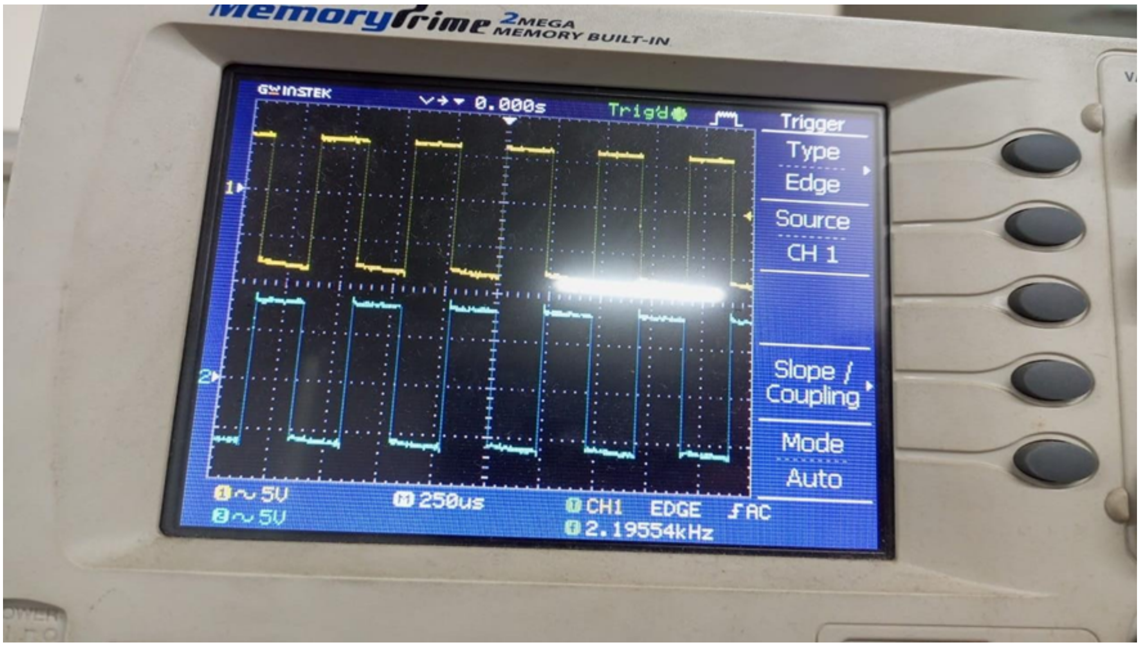

Figure 3.4: ADJUSTED DUTY CYCLE BY TL494

3.2.3 Charger Design

We begin with a 220V AC input which undergoes protection measures before entering an MB5010 bridge rectifier, converting it into 310V DC. This DC voltage is then fed into an H-bridge circuit, where MOSFETs are controlled by IR2104S gate drivers. Subsequently, a step-down transformer (ET29) reduces the voltage to 12V AC. Using RHRP860 diodes, a full bridge rectifier converts the 12V AC to DC. Capacitors are then employed for smoothing, resulting in a final output of 12V DC. This sequence effectively converts the 220V AC input into a 12V DC output suitable for charging. To prevent overcharging and safeguard the battery, we implement a dedicated circuit. An LM358M amplifier, relay, and a BC547BG BJT are utilized for this purpose. When the battery reaches full charge, a green LED is illuminated, signaling the termination of the charging process. This is achieved by cutting off the SMPS supply to the battery via the relay. Conversely, if the battery voltage drops below a predefined level, indicating a need for charging, a red LED is activated to indicate the initiation of the charging process. This system effectively prevents overcharging and ensures the battery remains within safe operating parameters.

3.2.4 Charger Circuit Design Using Altium Software

Using Altium software, we designed the charger circuit, focusing first on the input section to convert AC power into DC for charging. We carefully selected components like rectifiers and voltage regulators for efficiency and safety. Protective measures against overcharging and overvoltage were integrated. Then, we developed the output stage, incorporating charging algorithms and safety features like voltage sensing and current limiting. Throughout the design, we prioritized safety and performance, optimizing component placement and layout. Completion of both input and output sections in Ltium marked a major milestone in charger circuit development.

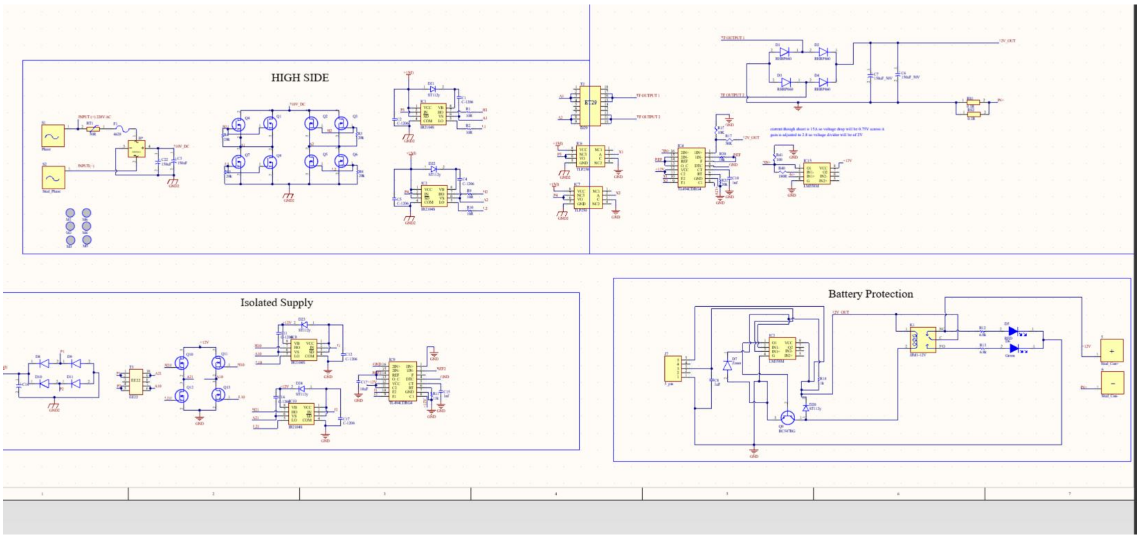

Figure 3.5: Schematics

3.2.5 Charger PCB Layout in Altium

Following the completion of the schematic in Ltium software, the subsequent step involved PCB routing for the charger circuit. This encompassed establishing physical connections between components on the printed circuit board (PCB). Special consideration was given to spacing, impedance matching, and signal integrity to optimize charging efficiency. Once routing for both input and output sections was finalized, the PCB layout was prepared for manufacturing and testing.

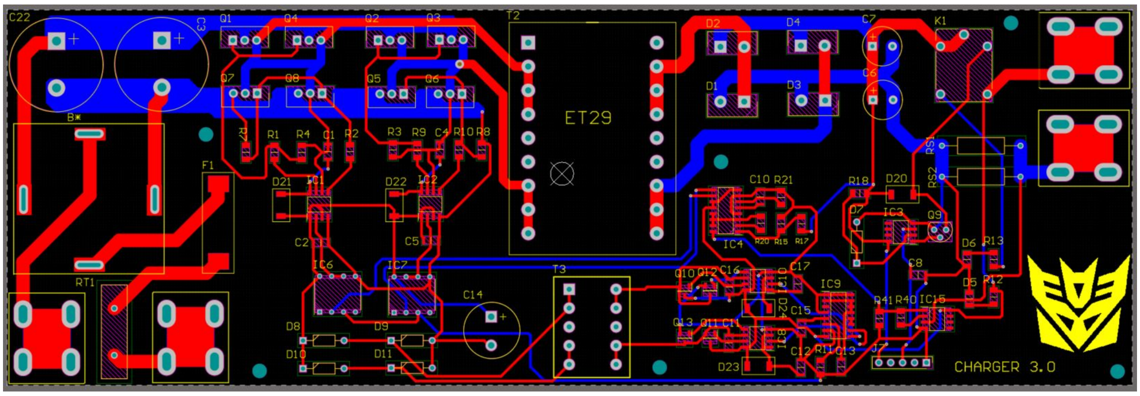

Figure 3.6: PCB

3.2.6 Assembling and Testing the Charger Circuit

After receiving the manufactured PCB, we meticulously assembled the charger circuit by soldering each component onto the board. Components were placed with precision and aligned properly before soldering to ensure secure connections. Rigorous testing of individual components was conducted prior to soldering to ensure functionality. Soldering was done systematically, starting with smaller parts, following industry-standard techniques to prevent defects. Visual inspections confirmed proper soldering and component orientation. With all components securely soldered, the charger circuit was ready for testing to validate its performance.

3.2.7 Hardware of Charger

With the successful soldering of components onto the PCB and comprehensive testing of each element, the charger circuit assembly reached its final form. This critical stage symbolized the culmination of meticulous design, fabrication, and validation processes. Assembled with precision and meticulous attention to detail, the charger circuit stood poised to fulfill its vital role in the SMPS system, delivering efficient charging capabilities to the connected batteries.

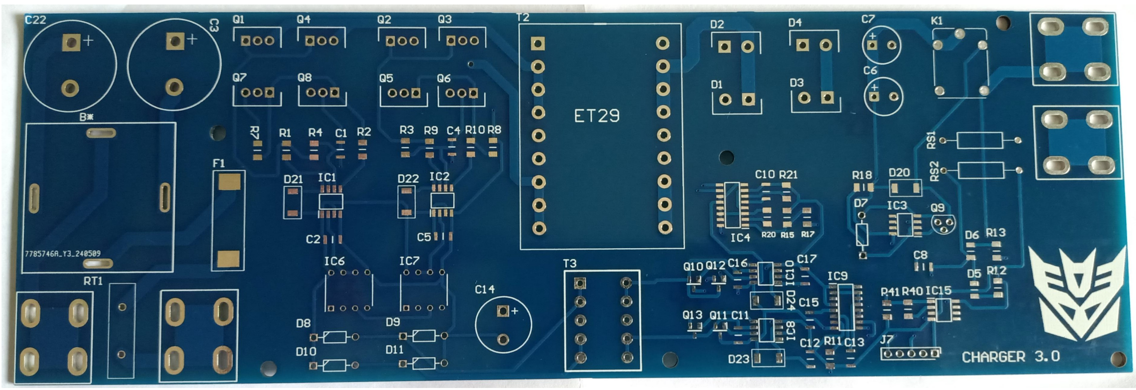

Figure 3.7: Charger Manufactured PCB

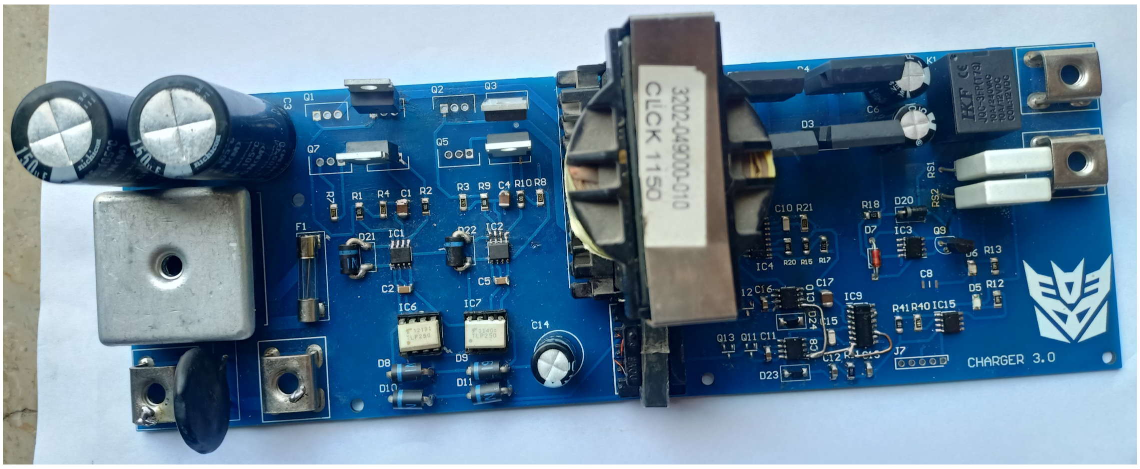

Figure 3.8: Charger Hardware

3.3 Discharging Path(inverter on simulations)

The discharging path consists of a Full Bridge Square Wave Inverter for efficient DC to AC conversion. A dedicated Sine PWM Generation Circuit ensures a clean sine wave output. A Voltage Divider provides real-time voltage monitoring. A 12V Battery serves as the primary power source. Protection Circuitry guards against overcurrent and overvoltage situations, ensuring a reliable power supply

We achieved a significant milestone in our project by successfully simulating the gate driver within the charging path using Proteus. During the simulation, we closely monitored and analyzed the output waveform. The observed output waveform precisely matched our predetermined specifications and design criteria. This outcome, depicted in the diagram below, validates the effectiveness of our gate driver configuration in the charging path.

3.3.1 Gate-Driver(proteus)

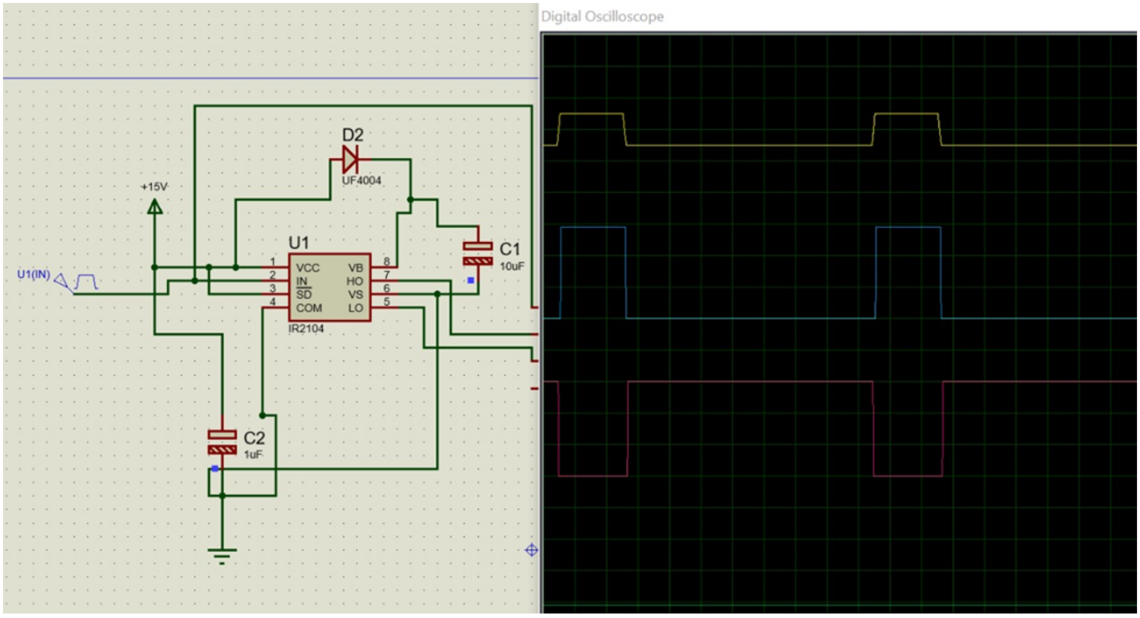

Figure 3.9: IR2104

3.3.2 PWM ion STM32(proteus)

After successfully simulating the gate driver in Proteus, we proceeded to generate the PWM signal using the STM module. We wrote the necessary code and generated the corresponding Hex file. Subsequently, we integrated this file into Proteus and ran a simulation. The observed results, as illustrated below, depict the generated signal, confirming the successful implementation of the PWM signal through the STM module in our project.

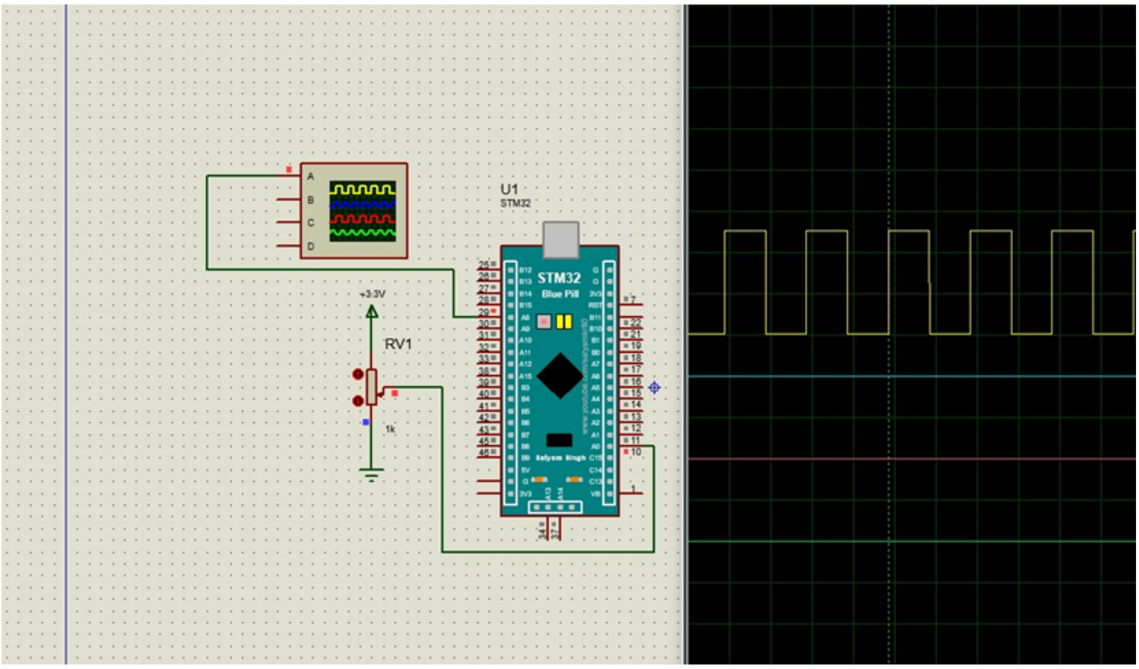

Figure 3.10: STM32

3.3.3 STM32 Programming in STM32cubeIDE

Below are the two programming diagrams depicting the process through which we generated the signal using the STM module.

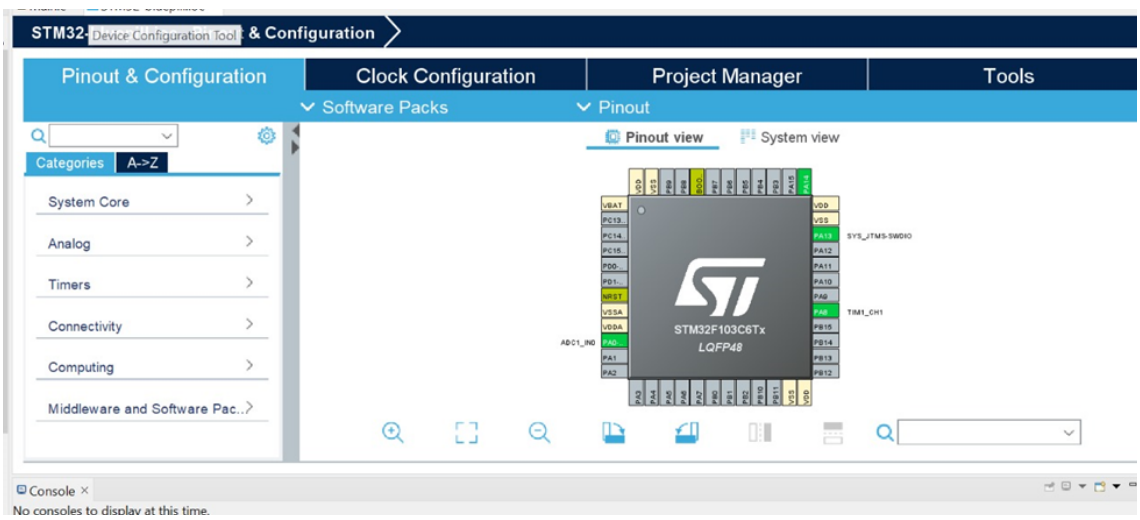

Figure 3.11: STM32cubeide

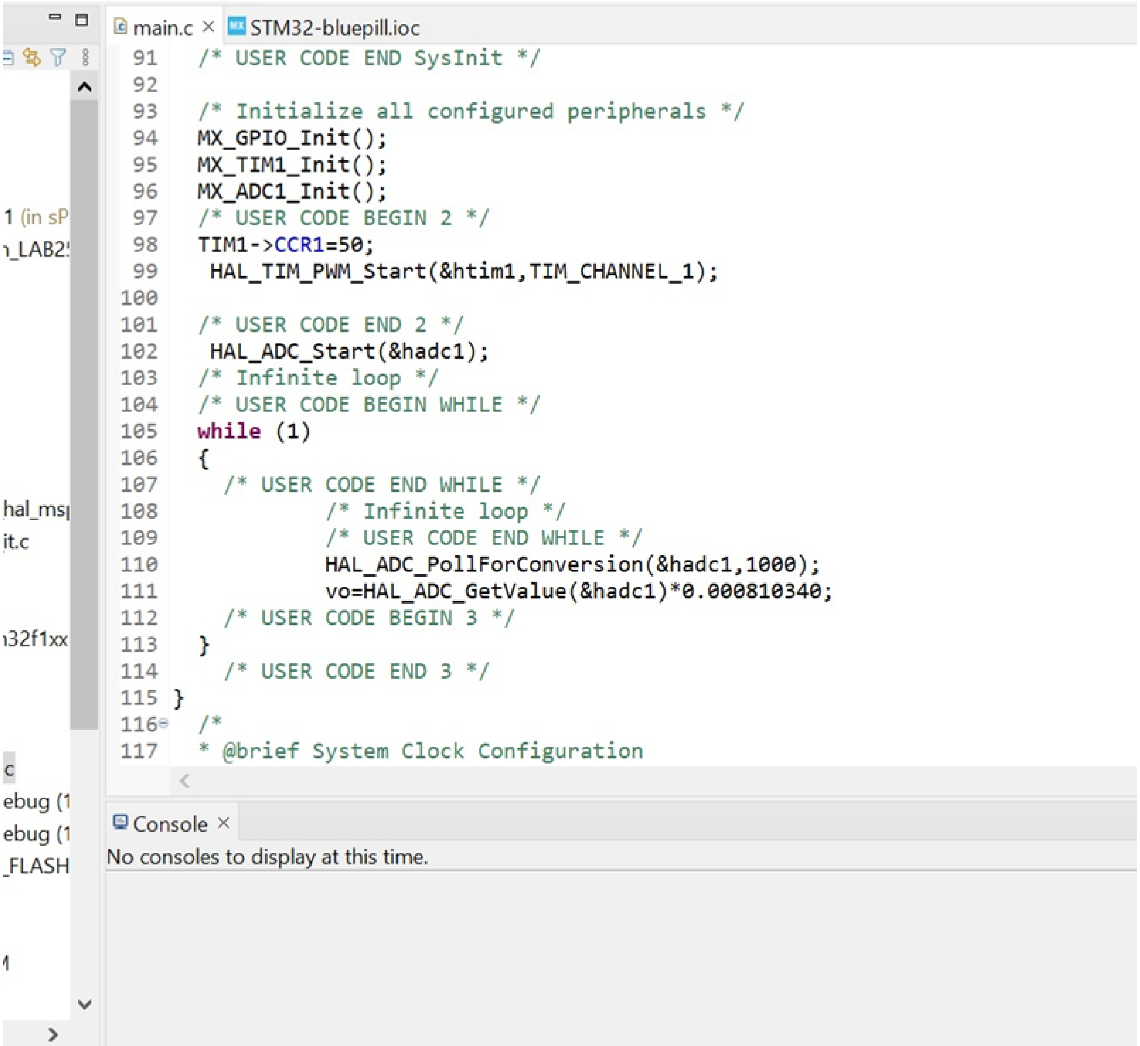

Figure 3.12: STM32cubeide

3.3.4 H-Bridge in Proteus

We proceeded to construct an H-Bridge inverter by integrating the gate driver. Upon inspecting its output, we observed that the square wave transformed into a sine wave after filtering. However, the generated sine wave has limitations, primarily in terms of frequency, and the filtering process, although implemented, may require further refinement. Additionally, the generic nature of the transformer and the software-based simulation contribute to these constraints. The diagram illustrating this process is presented below.

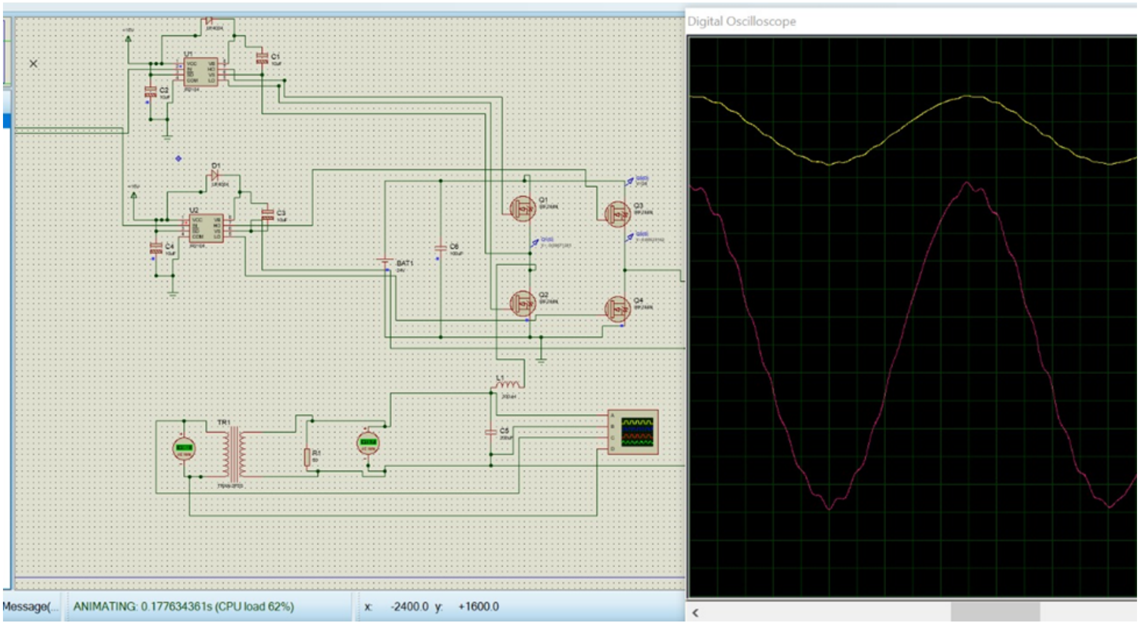

Figure 3.13: H-Bridge on proteus

3.3.5 Specified voltage (Inside inverter)

In the subsequent phase of our project, we focused on addressing specific power supply requirements within the inverter system. While the initial input voltage remained at 12 volts, our objective was to generate two distinct output voltages: 15 volts for the gate driver and 5 volts for other essential components. In the software simulation (Proteus), we configured the system to supply a constant 15 volts to the gate driver. However, in the hardware implementation, we opted for the MC34063 IC, a versatile converter capable of both step-up and step-down operations. This strategic decision allowed us to tailor our power supply voltages according to the specific needs of our components. The MC34063 IC's configuration, involving adjustments to the values of inductors and capacitors, enabled us to achieve a step-down conversion from 12 volts to 5 volts. This particular power supply circuit is dedicated to powering our STM controller. Simultaneously, we configured another instance of the MC34063 IC to perform a step-up conversion, elevating the voltage from 12 volts to the required 15 volts. This power supply circuit is intended to meet the voltage specifications for the gate driver. The provided diagrams visually depict the versatility and effectiveness of the MC34063 IC in accommodating diverse voltage requirements within our inverter system, a crucial aspect of ensuring the optimal performance of our components.

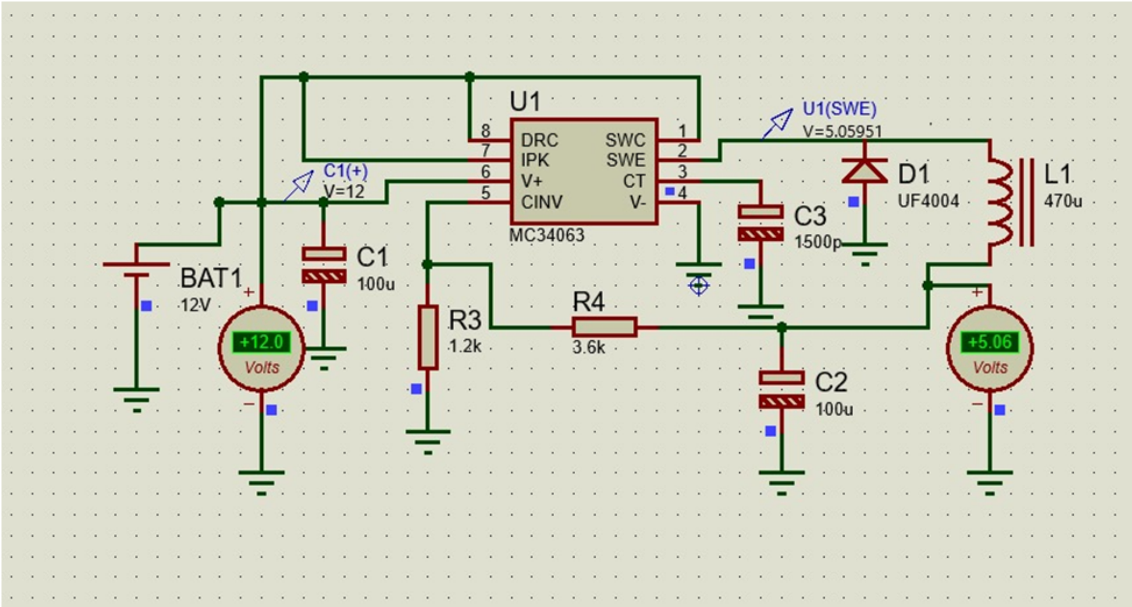

Figure 3.14: 5V for STM32

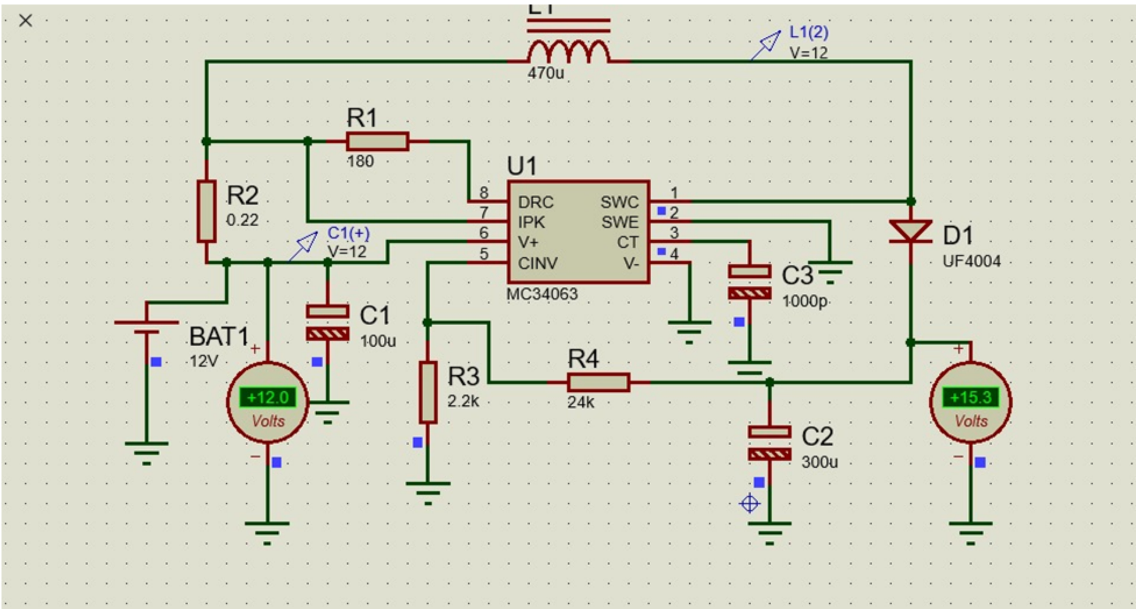

Figure 3.15: 15V for gate drivers

3.3.6 OPTO coupler

Following the power supply configurations, we implemented an optocoupler circuit to provide isolation between the high side and low side components. The optocoupler ensures effective isolation, enhancing the overall safety and performance of our inverter system.

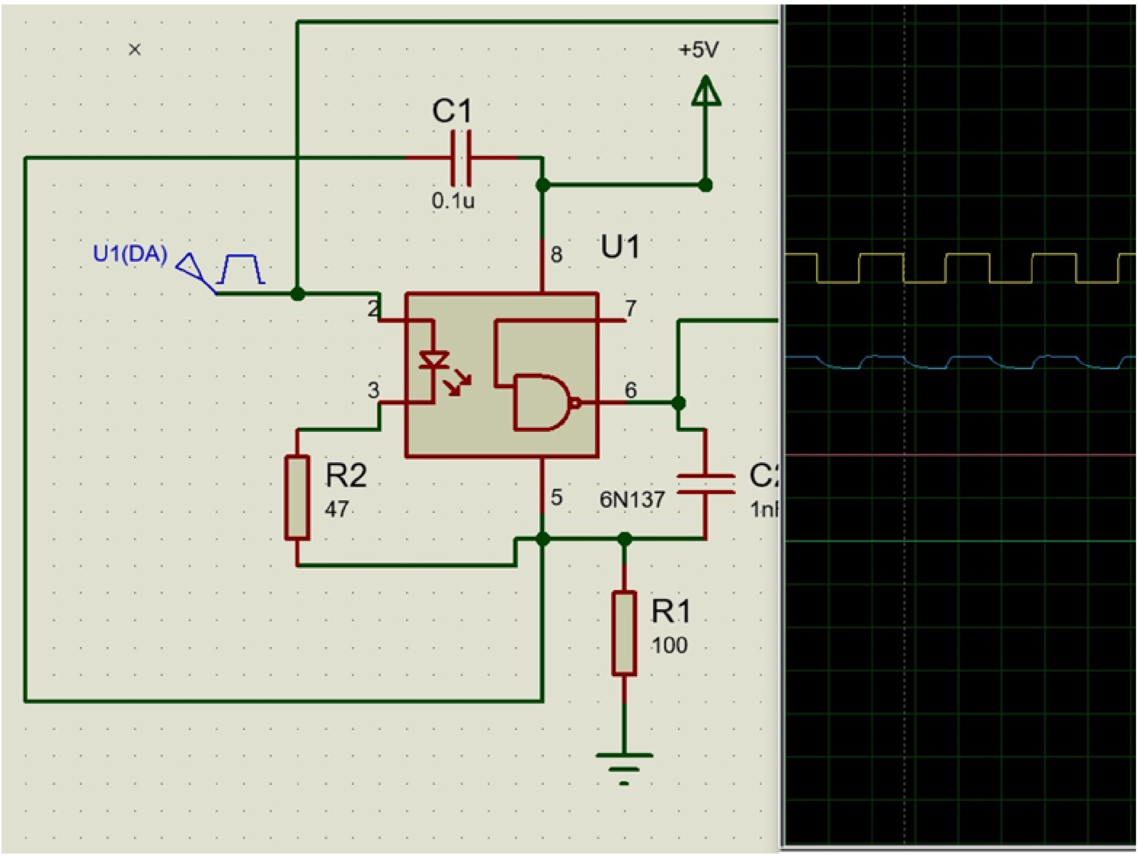

Figure 3.16: OPTO coupler

3.4 Discharging Path on Hardware

3.4.1 H-BRIDGE-INVERTER

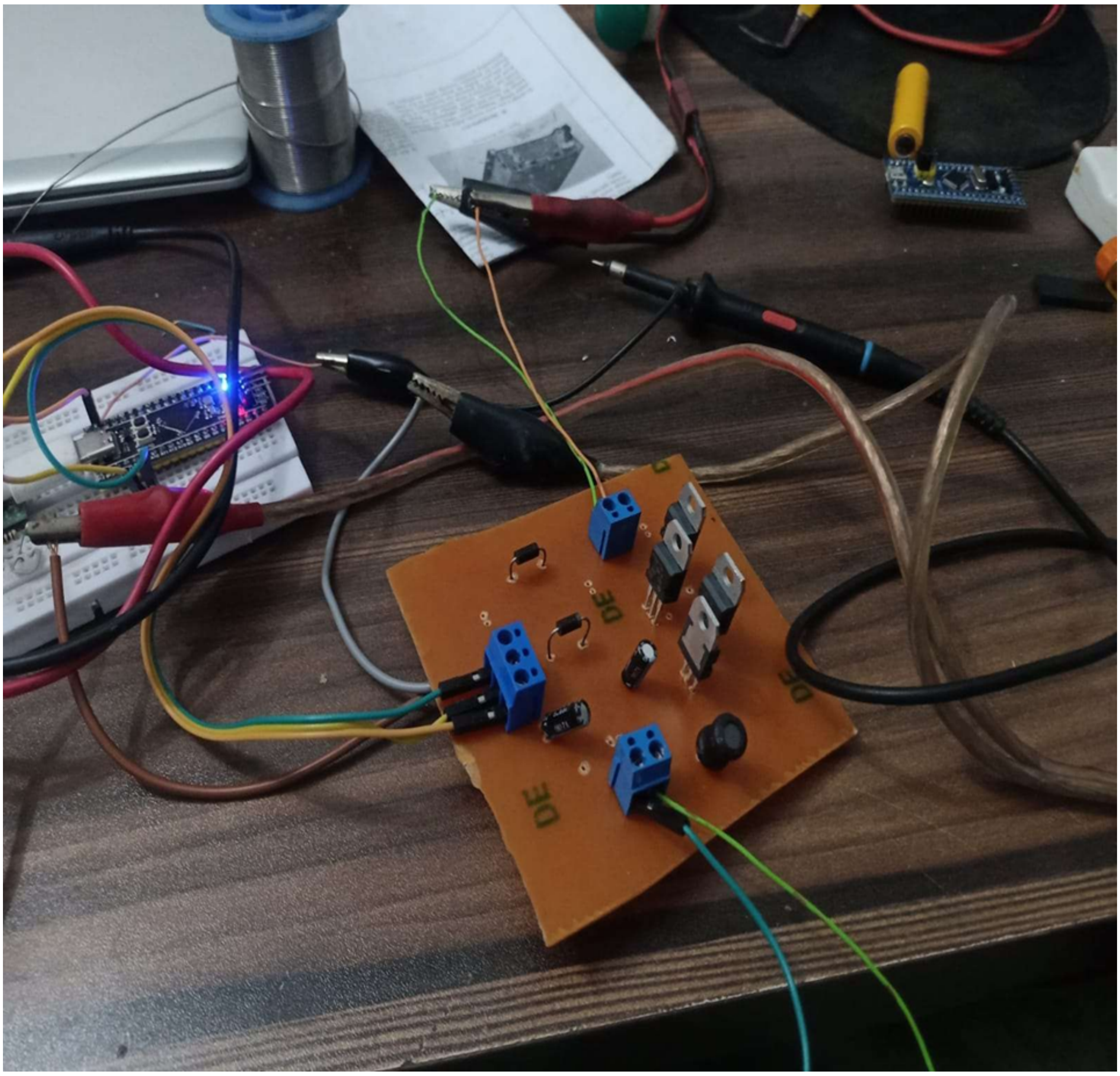

Figure 3.17: H-Bridge on Hardware

3.4.2 Output Waveform

Figure 3.18: Waveform

3.4.3 Square Wave

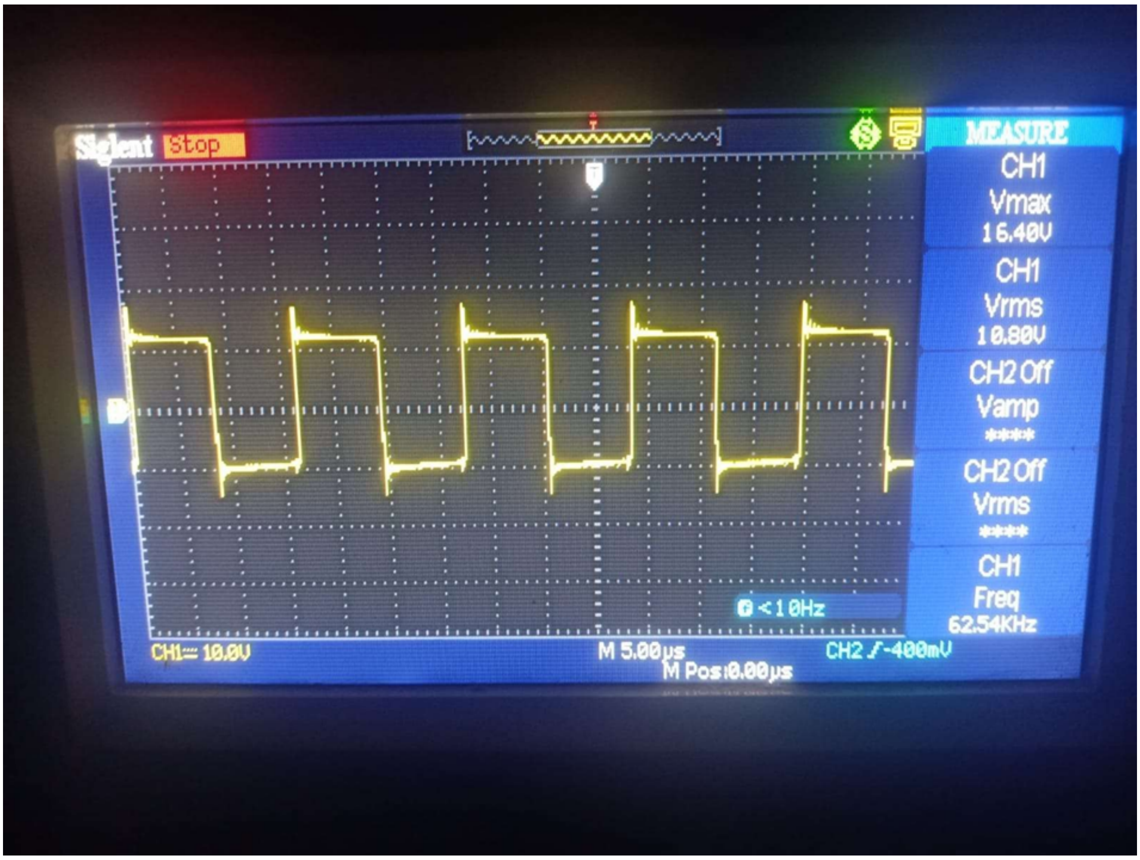

Figure 3.19: Square Wave

3.4.4 Ferrite Transformer

A type of electrical transformer known as a ferrite transformer substitutes ferrite cores for conventional laminated iron cores. Due to their special magnetic characteristics, ferrite transformers are frequently utilized in high-frequency and switch-mode power supply applications. Here is a description of ferrite transformers and some of their benefits Iron oxide and other metal oxides make up the ceramic material known as ferrite, which is used to make the core of ferrite transformers. Due to their high permeability, ferrite materials may effectively store magnetic energy at high frequencies. Operation at High Frequency: Compared to conventional iron-core transformers, ferrite transformers have lower magnetic losses and can manage larger flux densities, making them well-suited for high-frequency applications. Consequently, they are perfect for switch- mode power supply

Using a step-up transformer design, a 12V square wave at 50 kHz can be transformed to 310V through a ferrite transformer. Ferrite transformers are appropriate for this task since they are well-suited for high-frequency applications. Here is a general description of what happens: Selected a ferrite core transformer that has the necessary frequency and power handling capacity. To reduce losses and assure effective energy transfer, the transformer should be built for high-frequency operation.

Calculated the turn ratio the transformer's turns ratio controls how the voltage is converted. The turns ratio (Np/Ns) for a step-up conversion from 12V to 310V can be estimated using the formula below: Turns ratio = Vout / Vin (Np/Ns) Where: Vout = 310V, the desired output voltage Vin denotes input voltage (12V).

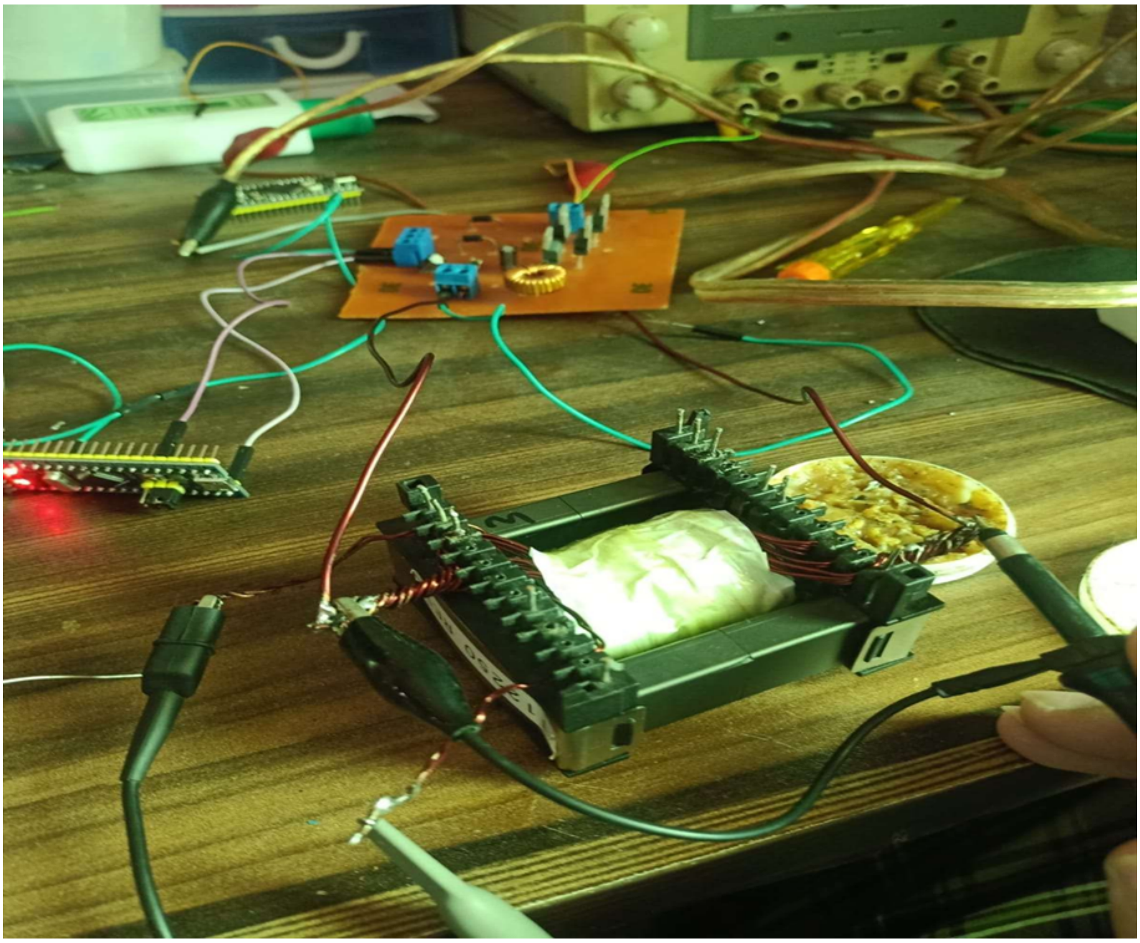

Figure 3.20: Ferrite Core

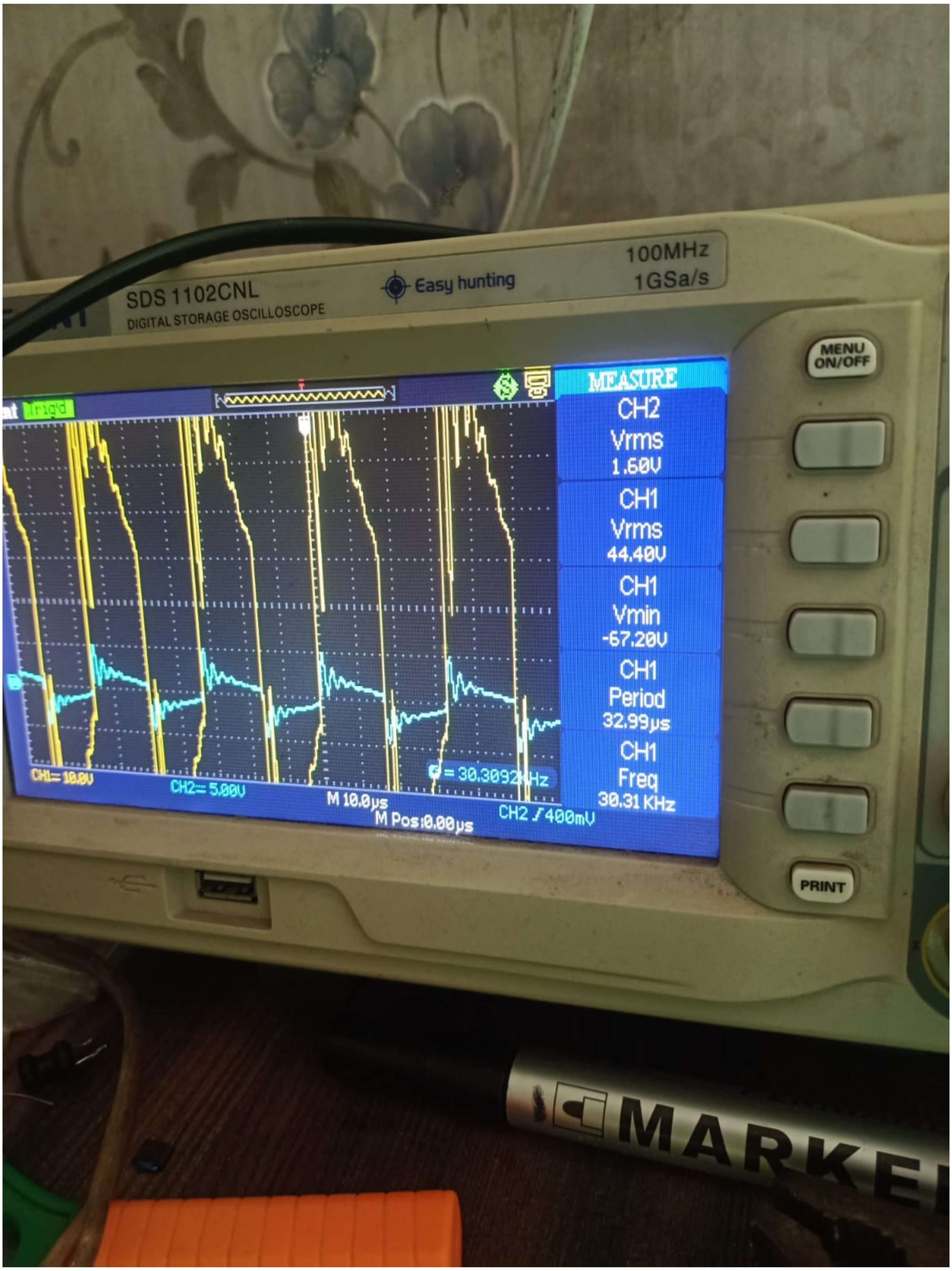

Figure 3.21: Testing Waveforms

3.4.5 Inverter Circuit Design Using Altium

Initiating the inverter design process, we employed Altium software to create the schematic diagram. Beginning with the low-side section, we meticulously placed and interconnected components to facilitate the conversion of DC power from the battery into AC power. This involved selecting appropriate transistors, gate drivers, and control circuitry to ensure efficient and reliable operation. Additionally, protective devices were incorporated to safeguard against overcurrent and overvoltage conditions. Once the low-side circuit was finalized, attention turned to the high-side section. Here, complementary transistors and supplementary control circuitry were integrated to generate the opposite phase of the AC signal. Proper isolation techniques were employed to prevent cross-conduction and ensure safe operation of the inverter. Throughout the design process, careful consideration was given to component placement and layout optimization to minimize parasitic effects and maximize performance. The completion of both low-side and high-side sections in Ltium marked a significant milestone in the development of the inverter circuit. [10]

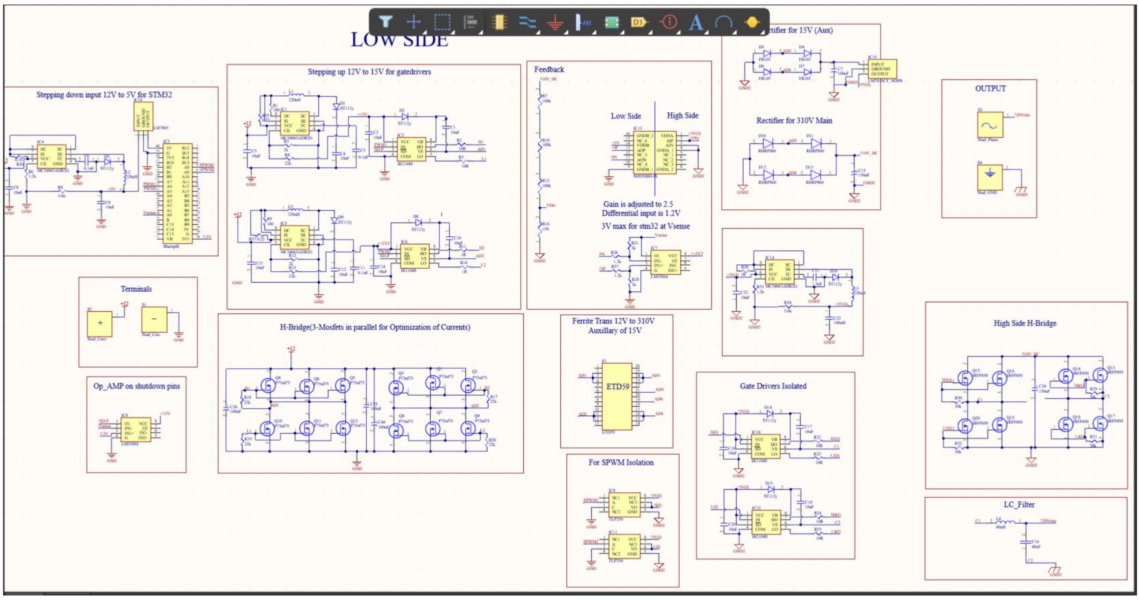

Figure 3.22: Schematic

3.4.6 Inverter PCB Layout in Altium

After completing the schematic in Ltium software, the next step was routing the PCB of the circuit. This involved establishing physical connections between components on the printed circuit board (PCB). Careful attention was paid to ensure proper spacing, impedance matching, and signal integrity. Once routing for both low-side and high-side sections was completed, the PCB layout was finalized for fabrication and testing.

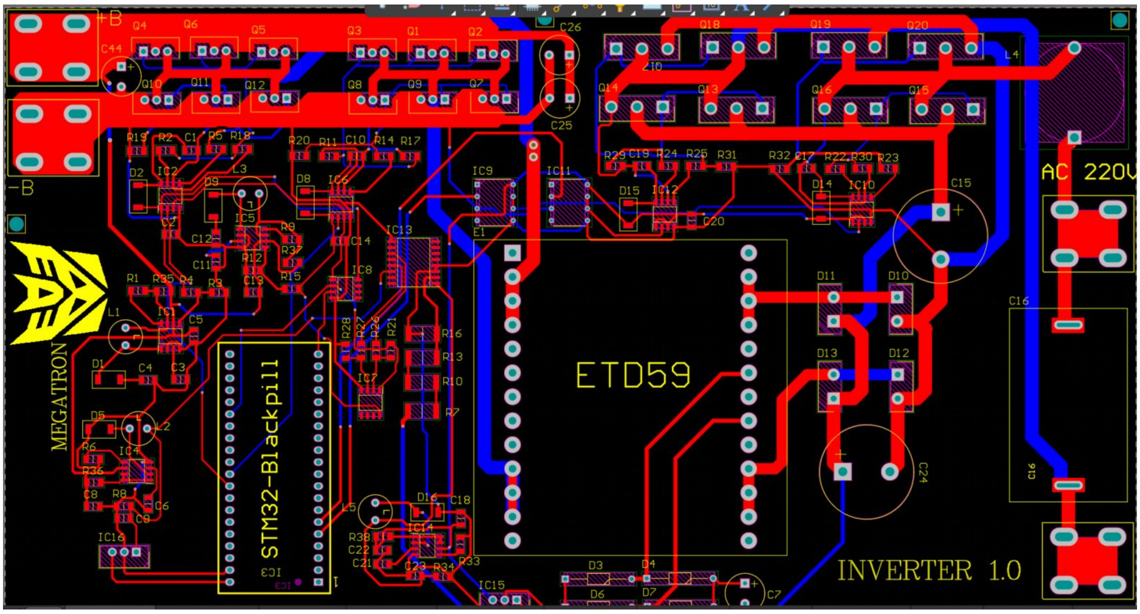

Figure 3.23: PCB

3.4.7 Assembling and Testing the Inverter Circuit

Once the manufactured PCB arrived, we proceeded to connect the components by soldering them onto the board. This meticulous process involved carefully placing each component into its designated position on the PCB, aligning the pins or leads with their corresponding pads. With precision and attention to detail, we soldered each component onto the board, ensuring secure and reliable connections. Before soldering each component, we rigorously tested it individually to confirm its functionality. Following a systematic approach, we soldered components one by one, starting with the smallest and most delicate parts before moving on to larger components. Throughout the soldering process, we adhered to industry-standard soldering techniques to prevent solder bridges, cold joints, or other soldering defects. Once all components were soldered in place, we conducted thorough visual inspections to verify proper soldering and component orientation. This step was crucial to ensure the integrity and functionality of the inverter circuit. With the components securely soldered onto the PCB, we were ready to proceed with testing the inverter circuit to validate its performance and functionality.

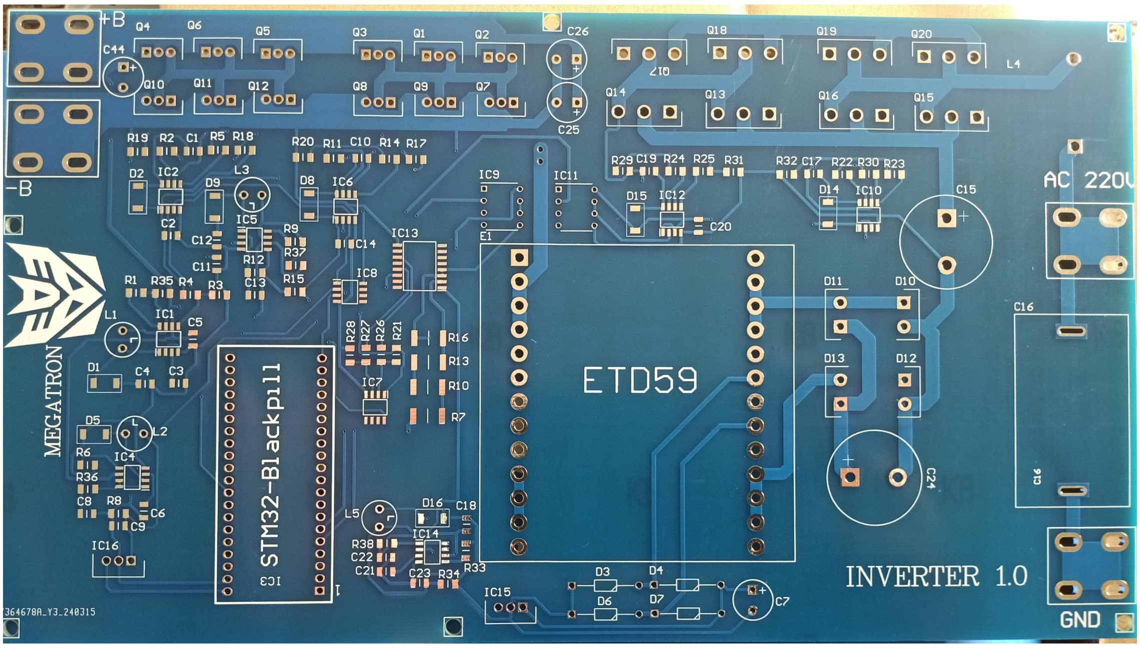

Figure 3.24: Inverter Manufactured PCB

3.4.8 Hardware of inverter

With the meticulous soldering of components onto the PCB and comprehensive testing of each element, the inverter circuit assembly reaches its final form. This pivotal stage marks the culmination of rigorous design, fabrication, and validation processes. Assembled with precision and attention to detail, the inverter circuit stands ready to fulfill its crucial role in the extended time UPS system, delivering reliable power supply to connected PCs.

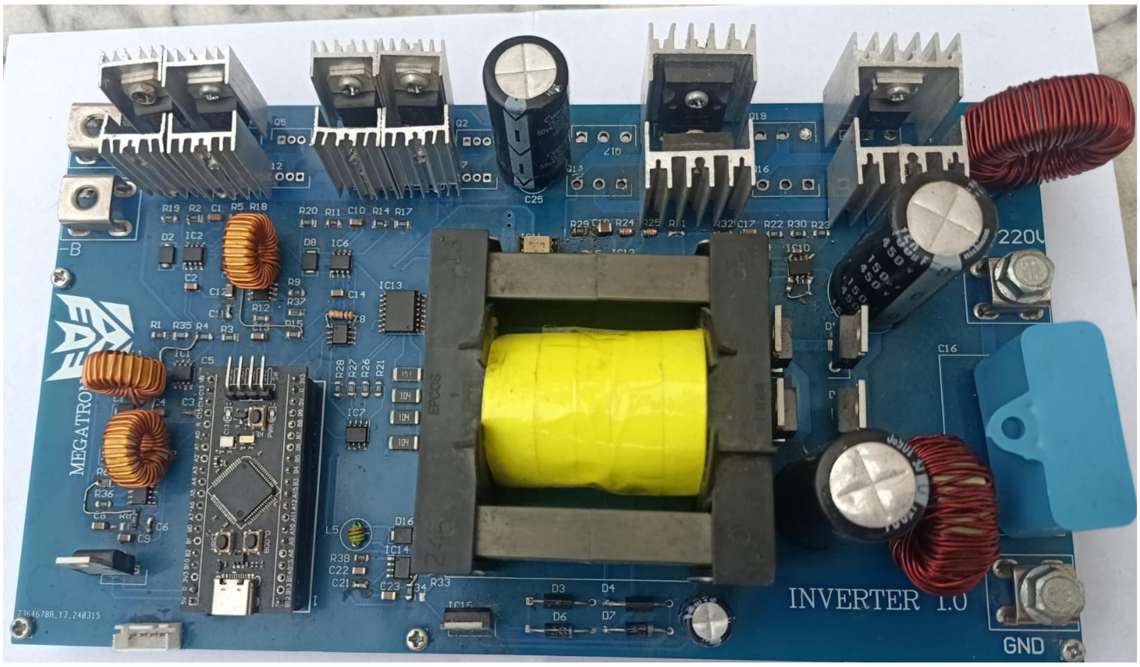

Figure 3.25: Inverter Hardware

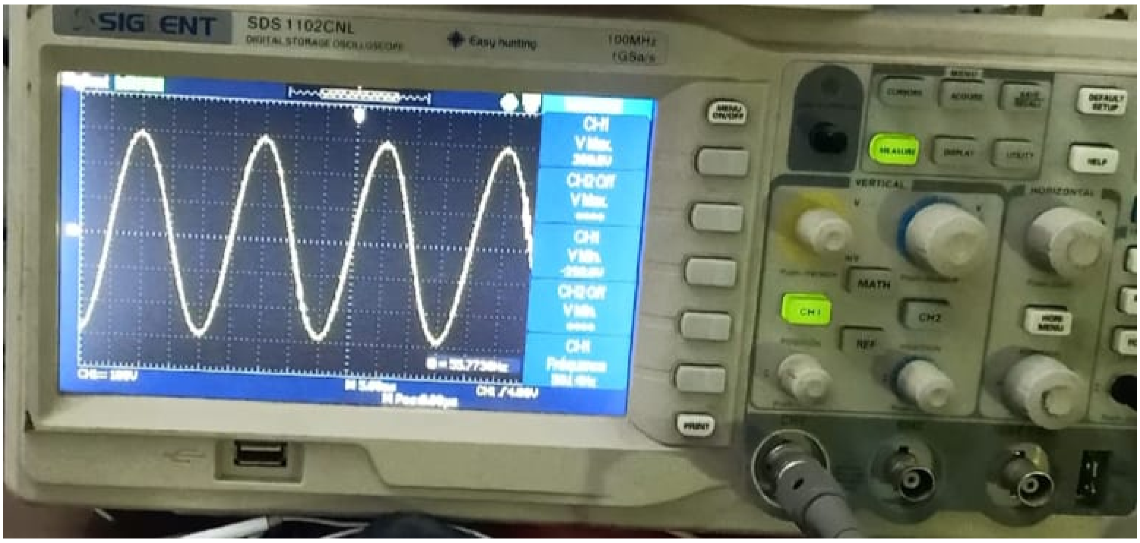

Figure 3.26: Inverter Output Waveform

3.5 Software Support

To implement software support in our project, we integrated IoT functionality using the Firebase database platform. Here's a detailed breakdown of how we accomplished this. [11]

3.5.1 Setting up Firebase Database

We initiated the software support aspect by creating a project on the Firebase platform. This involved navigating to the Firebase console, logging in with our credentials, and creating a new project. We then enabled the Realtime Database feature within the project settings. Firebase Realtime Database was chosen due to its capability to store and synchronize data in real-time across multiple clients, making it ideal for our project's requirements.

3.5.2 Arduino IDE Integration

To establish seamless communication between our hardware setup and the Firebase database, we utilized the Arduino Integrated Development Environment (IDE). Within the Arduino IDE, we wrote and compiled firmware for our ESP32 microcontroller, which served as the intermediary between the hardware components and the Firebase platform. This firmware was responsible for collecting data from sensors, formatting it, and transmitting it to the Firebase database.

3.5.3 Linking Firebase with Microcontroller

Within the Arduino code, we integrated Firebase libraries and dependencies to enable communication with the Firebase Realtime Database. This involved configuring the microcontroller to establish a secure and authenticated connection with the Firebase servers. To do this, we provided the Firebase project's URL and API key in the code, ensuring proper authentication and authorization for data transmission.

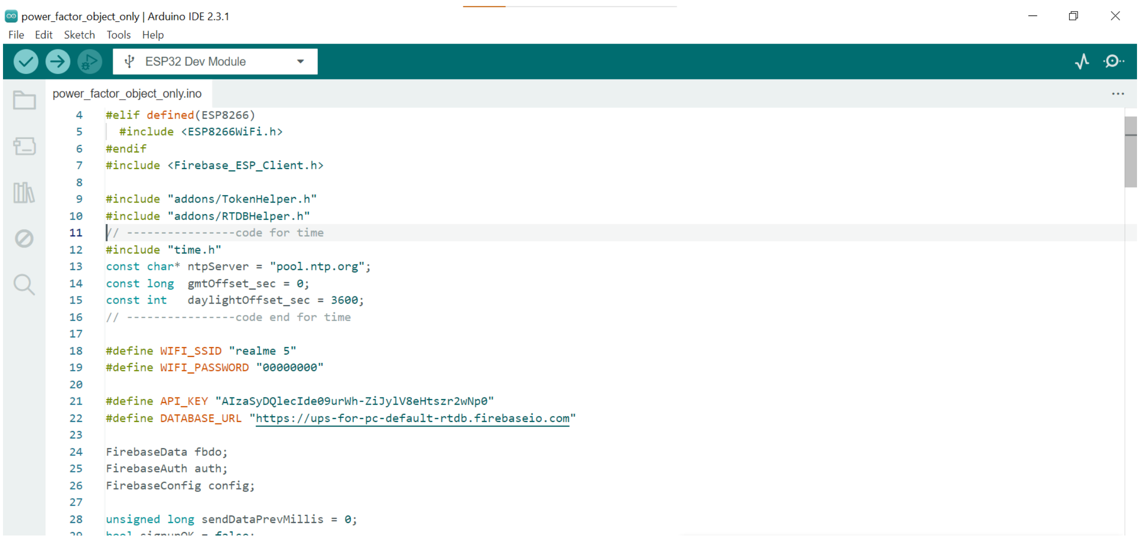

Figure 3.27: Firebase connection

3.5.4 Data Transmission

The data transmitted to the Firebase database consisted of critical UPS parameters such as output voltages, current, power factor, and operational status (online/offline). These values were captured in real-time from the inverter outputs using appropriate sensors and conditioning circuits. For instance, voltage dividers were employed to measure output voltages accurately, while current sensors were utilized to monitor current flow. These sensor readings were then processed by the microcontroller and transmitted to the Firebase database.

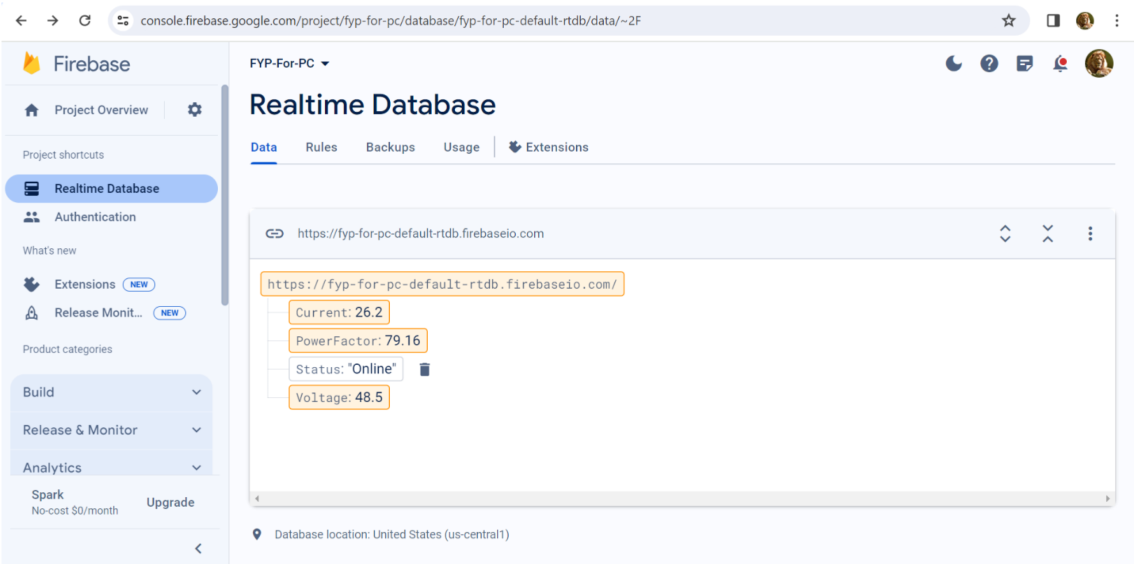

Figure 3.28: Firebase Realtime database connection

3.5.5 Web Page Development (UI)

After successfully establishing data transmission to Firebase, we embarked on the development of a web-based user interface (UI) to visualize and monitor the UPS parameters. Leveraging our expertise in front-end development, we utilized a combination of HTML, CSS, and JavaScript to design an intuitive and user-friendly interface. The UI was meticulously crafted to provide a seamless and responsive experience across different devices and screen sizes.

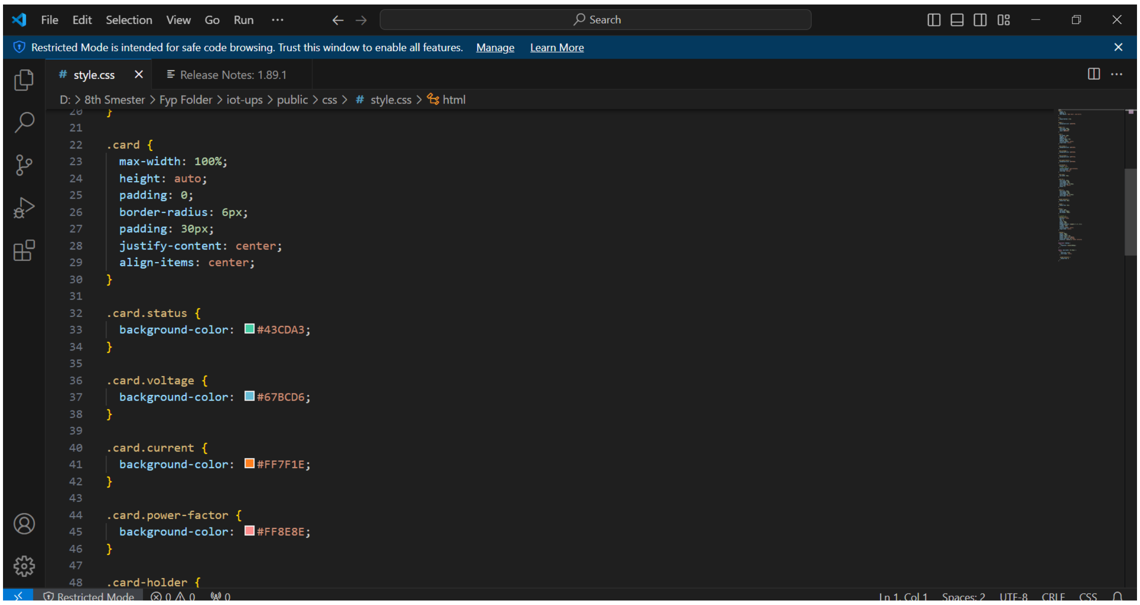

Figure 3.29: CSS code for web page

3.5.6 Graphical Representation

As part of the UI development, we integrated graphical representations of UPS parameters using popular charting libraries such as Chart.js. Graphs and charts depicting trends over time, such as the power factor versus time, were included to provide users with visual insights into the system's performance and behavior. These visualizations enhanced the user experience and facilitated better understanding and analysis of UPS data.

3.5.7 Firebase Integration with Web Page

Leveraging the Firebase Software Development Kit (SDK) for web, we established a bidirectional connection between the Firebase database and the web page. This involved implementing Firebase SDK functionalities within the web page's JavaScript code to listen for real-time updates from the database and update the UI accordingly. Through this integration, any changes or updates to UPS parameters in the Firebase database were immediately reflected in the web page, ensuring real-time synchronization of data.

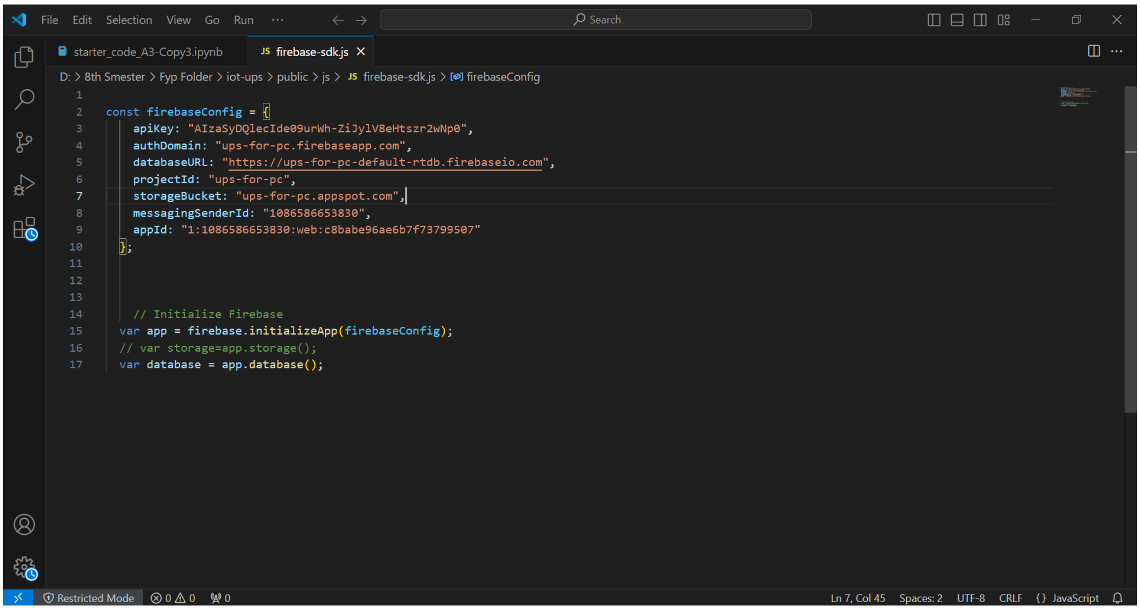

Figure 3.30: Firebase sdk

3.5.8 Database Hosting and Accessibility

Finally, we hosted the Firebase database on Firebase's cloud infrastructure, ensuring high availability and reliability. This hosted database was accessible via a secure URL, allowing users to monitor UPS data from anywhere with internet connectivity. By providing users with easy access to real-time UPS data, we empowered them to make informed decisions and effectively manage their UPS systems, enhancing overall reliability and uptime.

3.5.9 Completing Software Support

With the successful integration of Firebase with the web page, our software support implementation was finalized. Users could now access and monitor real-time UPS data through the web interface, with data updates occurring instantly as values changed in the Firebase database. This comprehensive software support system provided users with valuable insights into UPS performance and status, enabling them to make informed decisions and take proactive measures to address any issues.

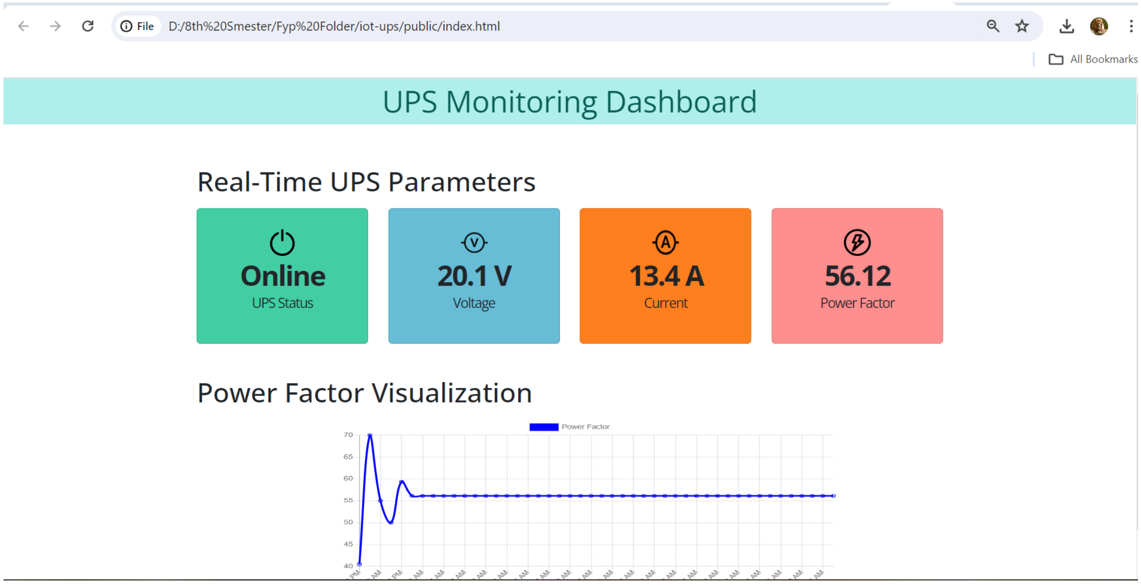

Figure 3.31: UPS monitoring Dashboard

3.5.10 Mobile Responsiveness

Recognizing the importance of accessibility, we ensured that the web page was responsive and optimized for various devices, including smartphones and tablets. This involved implementing responsive design principles and CSS media queries to adapt the layout, styling, and functionality of the web page based on the user's device. By prioritizing mobile responsiveness, we ensured that users could access and monitor UPS data seamlessly from any device, enhancing the overall user experience.

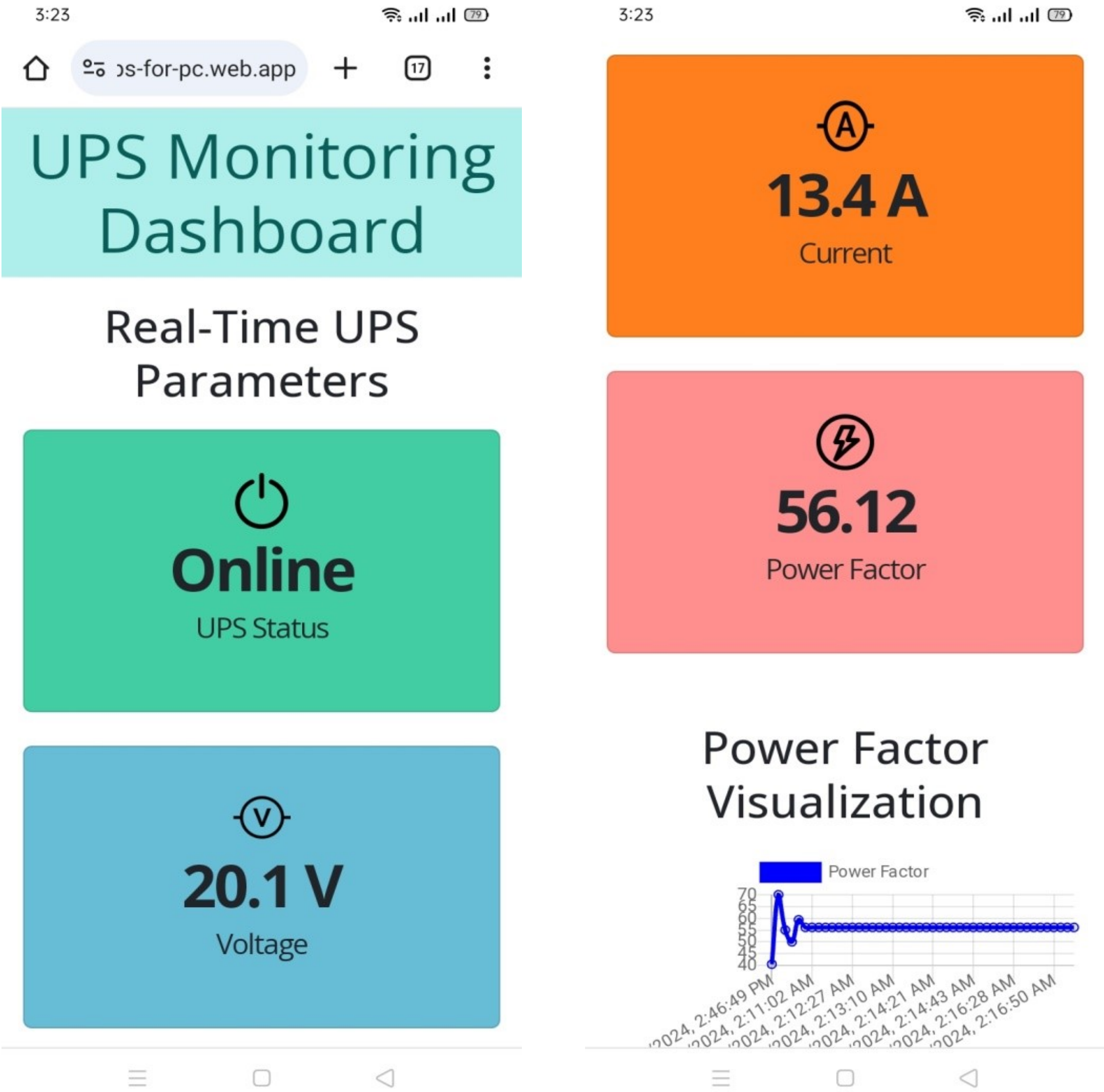

Figure 3.32: UPS monitoring mobile page

3.5.11 Interfacing STM and ESP32 for IoT Implementation

To implement IoT capabilities in our project, particularly since the STM microcontroller lacks built-in Wi-Fi functionality, we established communication between the STM and ESP32 microcontrollers. The ESP32, equipped with Wi-Fi capabilities, serves as the interface for connecting our UPS system to the internet. Through a serial communication interface, such as UART or SPI, the STM microcontroller exchanges data with the ESP32, enabling seamless transmission of UPS parameters to online platforms such as Firebase. This communication protocol allows the STM to focus on critical control tasks while offloading the networking and data transmission responsibilities to the ESP32. Additionally, by leveraging the ESP32's Wi-Fi capabilities, we ensure that our UPS system remains connected to the internet, enabling real-time monitoring and management from remote locations. Through this innovative approach, we bridge the gap between the STM microcontroller and the IoT ecosystem, empowering our UPS system with advanced connectivity and remote access capabilities.

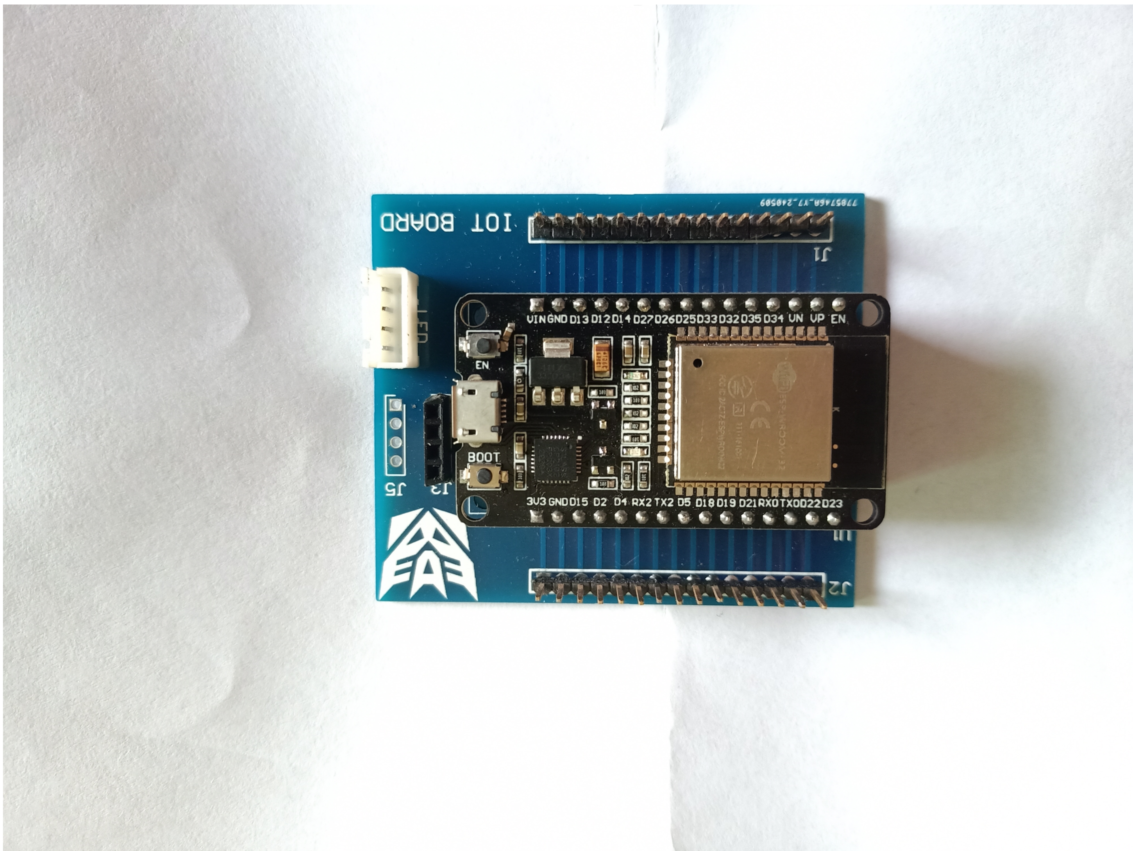

Figure 3.33: IOT Board for interfacing stm32 and esp32

3.6 Complete Hardware

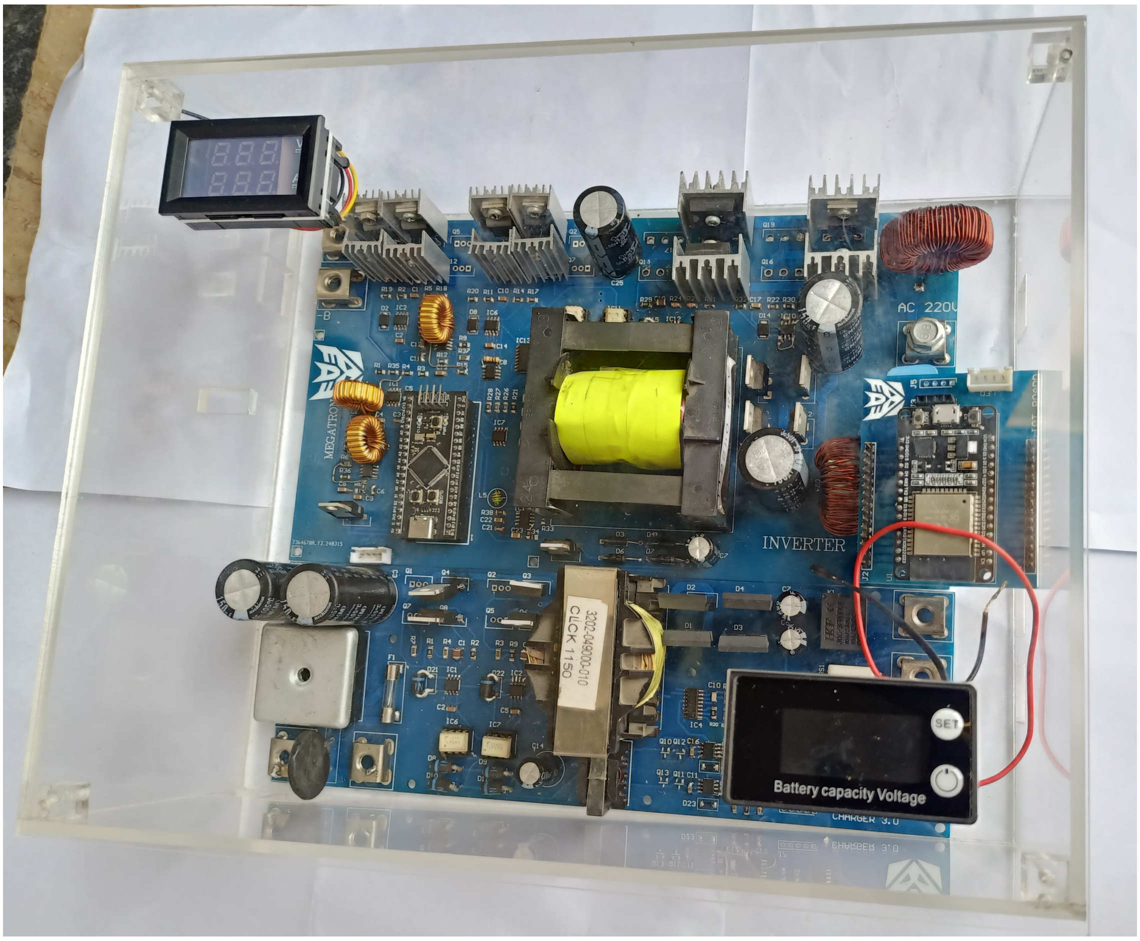

Figure 3.34: Complete Hardware of UPS for PC

3.7 Summary

The proposed methodology entails a comprehensive approach to constructing an uninterruptible power supply (UPS) system for lengthy periods of time. It starts with a thorough needs analysis that takes backup time, load capacity, voltage requirements, and cost into account. Component selection, efficient charging and discharging pathways, and the development of control algorithms are all critical steps. In addition, software for monitoring and control is created, and the system is rigorously tested and calibrated. For central processing activities, the STM32 microcontroller is used. This methodology assures that the UPS system meets performance and reliability requirements for continuous power supply

CHAPTER 4

MILESTONES, WORK DIVISION AND COST

4.1 Milestones

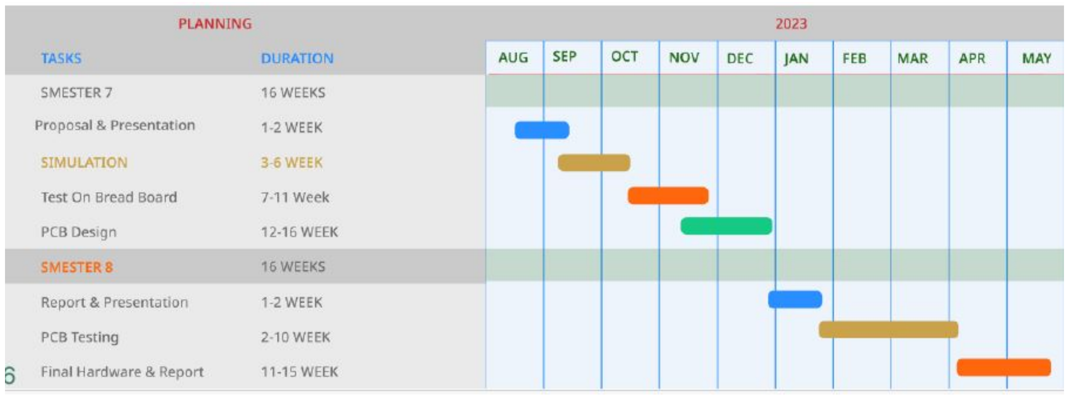

Figure 4.1: Gantt Chart Showing Deliverables

4.2 Work division Table

DATE	Task distribution among group members
September 2023	**Junaid Akbar-** charger and inverter design principles outlined the project plan and timeline. **Masood-** Defined UPS scope and objectives, conducted initial UPS research, outlined project plan and timeline. **Umar-** Conducted research and literature review on charger and inverter design principles and sustainable energy goals.
October 2023	**Junaid Akbar-** learned about SMPS techniques and Inverter circuit functionality **Masood-** Research on PC chargers, specifically focusing on SMPS technique and components, was conducted. **Umar-** Started breadboard testing for charger components, focusing on basic circuit functionality.
November 2023	**Junaid Akbar-** Identifying components and voltage supplies that are needed internally **Masood-** Thoroughly grasped MC34063 IC intricacies for efficient voltage regulation. Stabilized PWM signal for Extended Time UPS **Umar-** Continued breadboard testing, fine-tuning component selection and circuit layout based on initial results
December 2023	**Junaid Akbar-** Design techniques that how can we improve our circuit with all those ratings **Masood-** Verified optimal resistor value for gate driver PWM signal stability. Determined optimal inductor value for PWM signal stability **Umar-** Progressed to Proteus simulation for charger circuit design, ensuring compatibility and efficiency of components.

January 2024	**Junaid Akbar-** Working on Inverter Design implemented on bread board techniques to improve the design like using ferrite core **Masood-** Explored Solid State Relays (SSRs), focusing on their fast response times, longevity, noiseless operation, reliability, compact design, and safety features **Umar-** Conducted Proteus simulations, iteratively refining the charger circuit design for optimal performance and safety.
Feburary 2024	**Junaid Akbar-** Performed PCB etching and soldered components on it tested sine wave **Masood-** Completed project setup on Firebase, enabling Realtime Database for data synchronization. **Umar-** Feb 2024 Transitioned to Altium for schematic design of the charger, carefully laying out components and connections.
March 2024	**Junaid Akbar-** Started Design of Inverter on Altium designer Schematics and PCB. **Masood-** Integrated Firebase libraries into Arduino code, configuring microcontroller for secure connections. **Umar-** Mar 2024 Completed PCB design on Altium, ensuring proper placement and routing of components for manufacturing.
April 2024	**Junaid Akbar-** Started Charger Design on Altium its schematic and PCB. **Masood-** Established bidirectional connection between Firebase database and web page using Firebase SDK for web. **Umar-** Manufactured PCBs for the charger circuit, performed hardware testing to validate functionality and reliability.

May 2024	**Junaid Akbar-** tested Inverter PCB by installing all the components on it and recorded its sine wave **Masood-** Completed software support implementation by integrating Firebase with the web page, enabling real-time UPS data access and monitoring **Umar-** tested charger PCB by installing all the components on it and recorded the tested data

Table 4.1: **Work division Table**

4.3 Cost division

Name of component	Quantity	Total item cost (Rs)
STM32 Blackpill	3	3300
Debugger	2	1600
Ferrite transformers	3	10000
PCB Fabrication China	3	40000
Resistor	100	1000
Capacitor	100	3000
Inductor	50	3000
Gate Drivers	30	3000
MOSFET	50	10000
Diode	20	1000
Feedback IC	2	4000
Converter IC	10	2000
PWM ICs	20	1000
ESP	2	1600
BOX	1	5000
Battery	1	7000
TOTAL COST		**96,500**

Table 4.2: Cost division table

4.4 Summay

This chapter provides a comprehensive overview of the key milestones achieved during the course of our project, detailing the workflow and contributions of each team member. It outlines the challenges faced and the efforts invested by every individual, along with the dynamic allocation of roles throughout the project duration. Additionally, it presents a breakdown of the incurred costs associated with the development and implementation of our proposed solution. Despite our endeavor to minimize expenses, ensuring accessibility to a broader audience, the chapter highlights the financial aspects involved in making our solution feasible and effective for maximum impact.

CHAPTER 5

CONCLUSION

5.1 Conclusion

Our journey in developing the ”Extended Time UPS for PC with Software Support” project has been marked by dedication, collaboration, and innovation. From the initial conceptualization to the final implementation, each step was guided by a commitment to excellence and a drive to address the pressing need for reliable power solutions in the modern computing landscape. Throughout the project, we navigated through various challenges and obstacles, leveraging our collective expertise and resourcefulness to overcome them. The milestones achieved, as detailed in our project documentation, stand as a testament to our perseverance and determination. Our work division was dynamic and adaptive, with each team member contributing their unique skills and insights to different phases of the project. The detailed breakdown of our roles and responsibilities underscores the collaborative spirit that defined our team dynamics. One of the most significant achievements of our project lies in the successful integration of hardware and software components to create a robust and user-friendly UPS system. The design and implementation of the inverter circuit, meticulously documented and validated, demonstrate our technical proficiency and attention to detail. Furthermore, the incorporation of software support, including real-time monitoring and management capabilities through Firebase integration, adds a layer of sophistication to our solution. The development of a web-based user interface enhances accessibility and usability. In terms of costs, we endeavored to keep expenses to a minimum without compromising on the quality and effectiveness of our solution. Our commitment to affordability ensures that our UPS system remains accessible to a wide range of users, thereby maximizing its societal impact. As we conclude this project, we reflect on the journey undertaken, the lessons learned, and the achievements attained. Our project not only represents the culmination of our academic endeavors but also serves as a testament to our ability to innovate and create tangible solutions to real-world problems. Moving forward, we are confident that our ”Extended Time UPS for PC with Software Support” project will make a meaningful difference in ensuring reliable power supply for computing devices, ultimately contributing to a more connected and empowered society.

5.2 Future Work

In our future work, we will also optimize the UPS design to improve repairability and compatibility, allowing the use of third-party spare parts. This will further enhance feasibility and reduce e-waste. In our future endeavors, we aim to enhance the software component of our ”Extended Time UPS for PC with Software Support” project by incorporating additional features such as predictive maintenance alerts, remote firmware updates, and advanced data analytics capabilities. This will require further refinement of the software architecture and integration with IoT platforms to enable seamless communication and management of UPS parameters. Moreover, we plan to optimize the energy efficiency of the UPS system by implementing dynamic voltage and frequency scaling (DVFS) algorithms and exploring energy harvesting techniques. Scalability and modularity will be key areas of focus, with efforts directed towards developing modular hardware components and software modules that can accommodate varying user requirements and system configurations. Furthermore, ensuring compatibility and interoperability with a wide range of computing devices and operating systems will be essential for market acceptance and adoption. This will involve rigorous compatibility testing and certification programs to validate compliance with industry standards and regulatory requirements. Additionally, ongoing market research and commercialization efforts will involve identifying target markets, establishing distribution channels, and fostering partnerships to facilitate the successful deployment of our UPS solution.

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