DEVELOPMENT OF ESP32 BOARD USING PCB

A MINOR PROJECT - IV REPORT

Submitted by

KEERTHANA SP	**927621BEC084**
LAKSHANA K	**927621BEC099**
MADHUSRI J	**927621BEC109**
RANJANA PRIYA R	**927621BEC310**

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BONAFIDE CERTIFICATE

Certified that this **18ECP106L - Minor Project - IV** report "**DEVELOPMENT OF ESP32 BOARD USING PCB"** is the bonafide work of "carried out the project work under my supervision in the academic year "**KEERTHANA SP (927621BEC084), LAKSHANA K (927621BEC099), MADHUSRI J (927621BEC109), RANJANA PRIYA R (927621BEC310)**" who **2023 - 2024 - EVEN SEMESTER**.

SIGNATURE	**SIGNATURE**
Dr.A.KAVITHA B.E., M.E., Ph.D.,	**Dr.E.Dinesh B.E., M.E., Ph.D.,**
HEAD OF THE DEPARTMENT,	**SUPERVISOR,**
Professor,	Associate Professor,
Department of Electronics and	Department of Electronics and
Communication Engineering,	Communication Engineering,
M.Kumarasamy College of Engineering,	M.Kumarasamy College of Engineering,
Thalavapalayam,	Thalavapalayam,
Karur-639113.	Karur-639113.

This report has been submitted for the **18ECP106L – Minor Project - IV** final review held at M. Kumarasamy College of Engineering, Karur on ____________________

PROJECT COORDINATOR

INSTITUTION VISION AND MISSION

Vision

To emerge as a leader among the top institutions in the field of technical education.

Mission

M1: Produce smart technocrats with empirical knowledge who can surmount the global challenges.

M2: Create a diverse, fully -engaged, learner -centric campus environment to provide quality education to the students.

M3: Maintain mutually beneficial partnerships with our alumni, industry and professional associations

DEPARTMENT VISION, MISSION, PEO, PO AND PSO

Vision

To empower the Electronics and Communication Engineering students with emerging technologies, professionalism, innovative research and social responsibility.

Mission

M1: Attain the academic excellence through innovative teaching learning process, research areas & laboratories and Consultancy projects.

M2: Inculcate the students in problem solving and lifelong learning ability.

M3: Provide entrepreneurial skills and leadership qualities.

M4: Render the technical knowledge and skills of faculty members.

<u>Program Educational Objectives</u>

PEO1: **Core Competence:** Graduates will have a successful career in academia or industry associated with Electronics and Communication Engineering

PEO2: **Professionalism:** Graduates will provide feasible solutions for the challenging problems through comprehensive research and innovation in the allied areas of Electronics and Communication Engineering.

PEO3: **Lifelong Learning:** Graduates will contribute to the social needs through lifelong learning, practicing professional ethics and leadership quality

<u>Program Outcomes</u>

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes

PSO1: Applying knowledge in various areas, like Electronics, Communications, Signal processing, VLSI, Embedded systems etc., in the design and implementation of Engineering application.

PSO2: Able to solve complex problems in Electronics and Communication Engineering with analytical and managerial skills either independently or in team using latest hardware and software tools to fulfil the industrial expectations.

Abstract	Matching with POs, PSOs
ESP32 board, PCB layer	PO1, PO2, PO3, PO4, PO5, PO6, PO7, PO8,PO9, PO10, PO11, PO12, PSO1, PSO2

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ABSTRACT

This paper presents the development process of an ESP32 board utilizing the EasyEDA platform, aiming to provide a cost-effective and accessible solution for Internet of Things (IoT) projects. The ESP32 microcontroller, renowned for its versatility and robustness, serves as the core component in this development. EasyEDA, a web-based PCB design tool, facilitates the schematic capture, component selection, and layout design stages with its intuitive interface and extensive component library.The development process begins with the creation of a schematic diagram, where the functionalities and connections of various components are defined. Once the schematic is finalized, the layout design phase ensues, wherein components are arranged optimally to ensure efficient use of board space and signal integrity.Through the integration of EasyEDA's simulation capabilities, designers can perform pre-layout and post-layout simulations to validate the circuit's functionality and performance.Furthermore,EasyEDA simplifies the manufacturing process by offering direct integration with PCB fabrication and assembly services, enabling designers to seamlessly transition from design to production. The platform also provides a comprehensive suite of design validation tools, including Design Rule Checks (DRC) and Electrical Rule Checks (ERC), ensuring the design meets industry standards and specifications.In conclusion, the development of ESP32 boards using EasyEDA offers a cost-effective and user-friendly solution for IoT enthusiasts and professionals alike. By harnessing the collaborative features, simulation capabilities, and manufacturing integration provided by EasyEDA, designers can expedite the development process while maintaining high standards of quality and reliability in their designs.

Keywords -ESP32 board, PCB layer

TABLE OF CONTENTS

CHAPTER No.	CONTENTS	PAGE No.
	Institution Vision and Mission	iii
	Department Vision and Mission	iii
	Department PEOs, POs and PSOs	iv
	Abstract	viii
	List of Figures	x
	List of Abbreviations	xi
1	**INTRODUCTION**	**1**
2	**LITERATURE SURVEY**	**2**
3	**EXISTING SYSTEM`**	**4**
4	**PROPOSED SYSTEM**	**6**
5	**METHODOLOGY**	**8**
	5.1 BLOCK DIAGRAM	**8**
	5.2 COMPONENT DESCRIPTION	**10**
6	**SOFTWARE**	**12**
7	**RESULT AND DISCUSSION**	**15**
8	**CONCLUSION AND FUTUTE WORK**	**17**
	REFERENCES	**19**

LIST OF FIGURES

FIGURE No.	TITLE	PAGE No.
3.1	Existing Block Diagram	**4**
4.1	Proposed Block diagram	**6**
5.1	Block Diagram	**8**
7.1	Layout of ESP32 Board	**15**

LIST OF ABBREVIATIONS

ACRONYM		ABBREVIATION
PCB	-	Printed Circuit Board
ESP32	-	Espressif Systems

CHAPTER 1

INTRODUCTION

ESP32 is a chip that provides Wi-Fi and (in some models) Bluetooth connectivity for embedded devices – in other words, for IoT devices. While ESP32 is technically just the chip, the modules and development boards that contain this chip are often also referred to as "ESP32" by the manufacturer.The original ESP32 chip had a single core Tensilica Xtensa LX6 microprocessor. The processor had a clock rate of over 240 MHz, which made for a relatively high data processing speed. More recently, new models were added, including the ESP32-C and -S series, which include both single and dual core variations. These two series also rely on a Risc-V CPU model instead of Xtensa. Risc-V is similar to the ARM architecture, which is well-supported and well-known, but Risc-V is open source and easy to use. Specifically, Risc-V and ARM have good support from GNU compilers, while the Xtensa needed extra support and development to work with the compilers. **T**he ESP32 is a series of chip microcontrollers developed by Espressif.Low-power: the ESP32 consumes very little power compared with other microcontrollers, and it supports low-power mode states like deep sleep to save power.Wi-Fi capabilities: the ESP32 can easily connect to a Wi-Fi network to connect to the internet (station mode), or create its own Wi-Fi wireless network (access point mode) so other devices can connect to it—this is essential for IoT and Home Automation projects—you can have multiple devices communicating with each other using their Wi-Fi capabilities;Bluetooth: the ESP32 supports Bluetooth classic and Bluetooth Low Energy (BLE)—which is useful for a wide variety of IoT applications;Dual-core: most ESP32 are dual-core— they come with 2 Xtensa 32-bit LX6 microprocessors: core 0 and core 1.

CHAPTER 2

LITERATURE SURVEY

Najuka Jagtap, Jagannath Wadgaonkar, Kalyani Bhole, “ESP32 Board”, 2016 IEEE Students' Conference on Electrical, Electronics and Computer Science (SCEECS).

It provides details of important body parameters. This data is stored in EEPROM by date and time, so that one can reset or read the stored data. Since it uses a PIC microcontroller the length of the program will be big because of using RISC (35 instructions). Program memory is not accessible and only one single accumulator is present in PIC microcontroller. This board has multiple features which include calorie burn calculator, temperature measurement oxygen saturation measurement and the important one.The only problem with this design is the microcontroller i.e. the PIC microcontroller. It has got outdated and the ATmega328 is much better with larger amount of memory and RAM.

Jagmohan Chauhan, Suranga Seneviratne, Mohamed Ali Kaafar, Anirban Mahanti, Aruna Seneviratne, “Characterization of Early ESP32 Board”, IEEE International Workshop on Sensing Systems and Applications Using Wrist Worn Smart Devices, 2016. The ESP32 Board makes it easier for the user to communicate with the smartphone. Apps provides large number of customization applications for the ESP32 Board. There is chance of leakage of data through third party advertising and analytics companies. Around 20% tested across all platforms send ESP32 Board specific user activity to third party trackers.

Manal Al-Sharrah, Ayed Salman, Imtiaz Ahmad, 2018 International Conference on Computing Sciences and Engineering (ICCSE), 2018. Since ESP32 Board consist of user’s personal information this paper various techniques to keep those information secure. The backup data should be encrypted as it contains lot of sensitive information. Since the size of watch is small it creates difficulties in establishing good authentication techniques. The ESP32 Board use to perform test was Apple Watch and wasn’t performed on any other watch. ESP32 Board stores a lot of personal information and sensitive data which can directly extracted from the backup. It is important to encrypt the data stored so that even it is stolen the information stored in it is safe.

Siddharth Sathe, Arjun Gade, Ajay Jadhav, “ARDUINO BASED SMART Board”, International Research Journal of Engineering and Technology (IRJET), 2017. Here Arduino Mini is used which has an ATmega microcontroller which has better performance than other microcontroller. It provides less number of steps to access an app in comparison to a ESP32 Board. The generic principle is that the interaction should be natural, simple and easy-to use with minimum number of menus on screen, apps should be easily accessible. This ESP32 Board is developed with minimum cost. It consists of two mechanisms. The first mechanism consists of the sensors embedded in the circuitry, whereas the second mechanism is the interaction between ESP32 Board.

CHAPTER 3

EXISTING SYSTEM

An existing ESP32 PCB board, typically referred to as an ESP32 development board or module, integrates the ESP32 chip along with necessary peripherals and components to facilitate easy development and deployment. Here are some common features and components found on an existing ESP32 PCB board: Development board based on the ESP32.USB-to-serial converter for easy programming and debugging.Pin headers for easy access to ESP32's GPIOs and other interfaces.Voltage regulator (usually 3.3V) to ensure stable power supply.

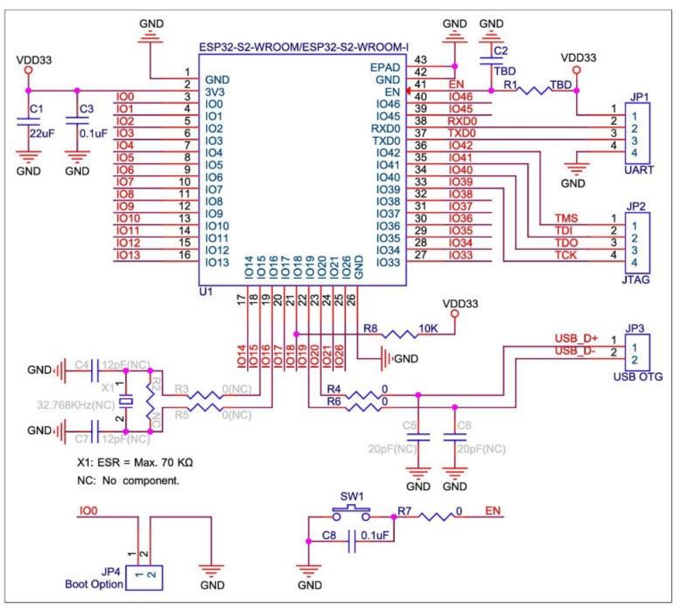

Figure 3.1: Existing System Block Diagram

Power input options via USB, battery, or external power sources.Decoupling capacitors to filter noise and stabilize voltage Integrated USB-to-serial converters make programming straightforward.By choosing an appropriate ESP32 development board, you can streamline the development process and quickly bring your projects to life. PCB (Printed Circuit Board) design, the integration of an ESP32 microcontroller involves several considerations to ensure optimal performance, signal integrity, and power management. Here's an overview of the key aspects of incorporating an ESP32 in PCB design. Ensure the ESP32 receives a stable voltage, typically 3.3V. Use voltage regulators to step down from higher voltages if necessary. Using the built-in antenna of the ESP32, ensure there is a clear area free from ground planes and other traces around the antenna for optimal signal strength. PCB (Printed Circuit Board) design, the integration of an ESP32 microcontroller involves several considerations to ensure optimal performance, signal integrity, and power management. Power input options via USB, battery, or external power sources.Decoupling capacitors to filter noise and stabilize voltage Integrated USB-to-serial converters make programming straightforward. Here are some common features and components found on an existing ESP32 PCB board: Development board based on the ESP32.USB-to-serial converter for easy programming and debugging.Pin headers for easy access to ESP32’s GPIOs and other interfaces.Voltage regulator (usually 3.3V) to ensure stable power supply.

CHAPTER 4

PROPOSED SYSTEM

Designing a proposed ESP32-based system on a PCB board involves several steps, from defining the requirements and components to the layout and validation of the design. Below is a detailed guide to creating a custom ESP32 PCB board. Voltage regulator (3.3V). Power input options: USB, battery (Li-Po), or external DC source. Decoupling capacitors. USB-to-serial converter for programming and debugging. Integrated or external antenna for Wi-Fi/Bluetooth. Place the ESP32 module centrally.Position the power supply components close to the power input.Place the USB-to-serial converter near the USB connector.Arrange GPIO headers around the edges for easy access.Ensure adequate space around the antenna for signal integrity. When designing a custom PCB for an ESP32-based system, there are several steps and considerations to ensure the final board meets the specific requirements of your application.

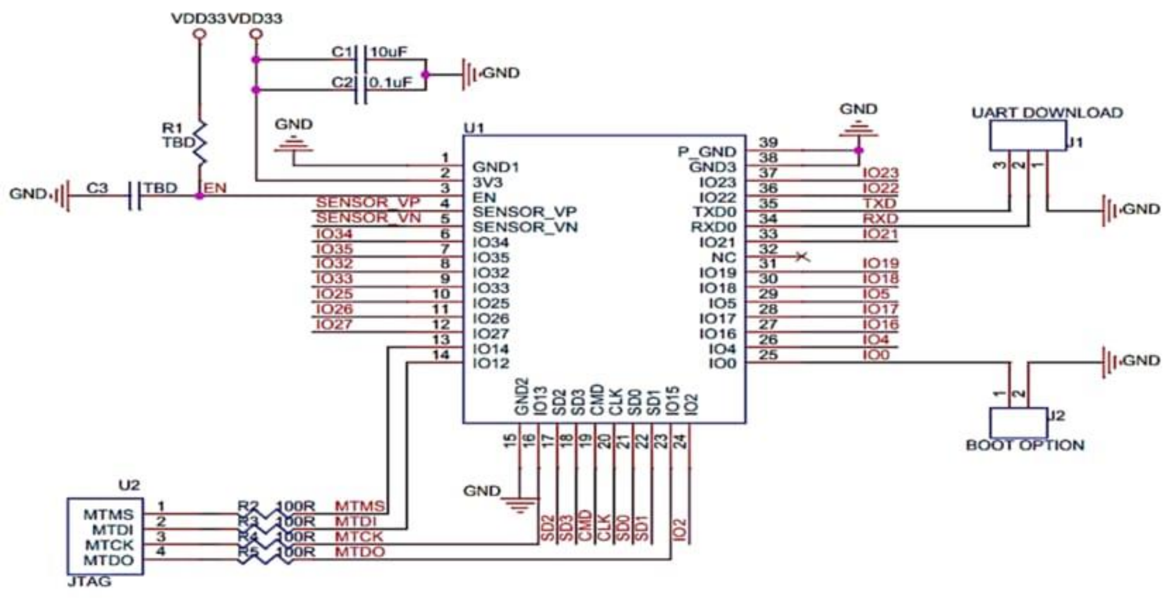

Figure 4.1: Proposed System Block Diagram

Below is a proposed system design for an ESP32 PCB board, highlighting key components, design choices, and steps. To integrate the ESP32 microcontroller into a PCB design effectively, follow a structured approach that encompasses planning, design, verification, and optimization. Here’s a proposed method. Define the purpose of your PCB and the specific functionalities required from the ESP32 (e.g., Wi-Fi connectivity, Bluetooth communication, sensor interfacing).Below is a detailed guide to creating a custom ESP32 PCB board. Voltage regulator (3.3V). Power input options: USB, battery (Li-Po), or external DC source. Decoupling capacitors. USB-to-serial converter for programming and debugging. Integrated or external antenna for Wi-Fi/Bluetooth. Place the ESP32 module centrally. Position the power supply components close to the power input. Place the USB-to-serial converter near the USB connector. Arrange GPIO headers. Here’s a proposed method. Define the purpose of your PCB and the specific functionalities required from the ESP32 (e.g., Wi-Fi connectivity, Bluetooth communication, sensor interfacing).Below is a detailed guide to creating a custom ESP32 PCB board. Voltage regulator (3.3V).

CHAPTER 5

METHODOLOGY

5.1 BLOCK DIAGRAM

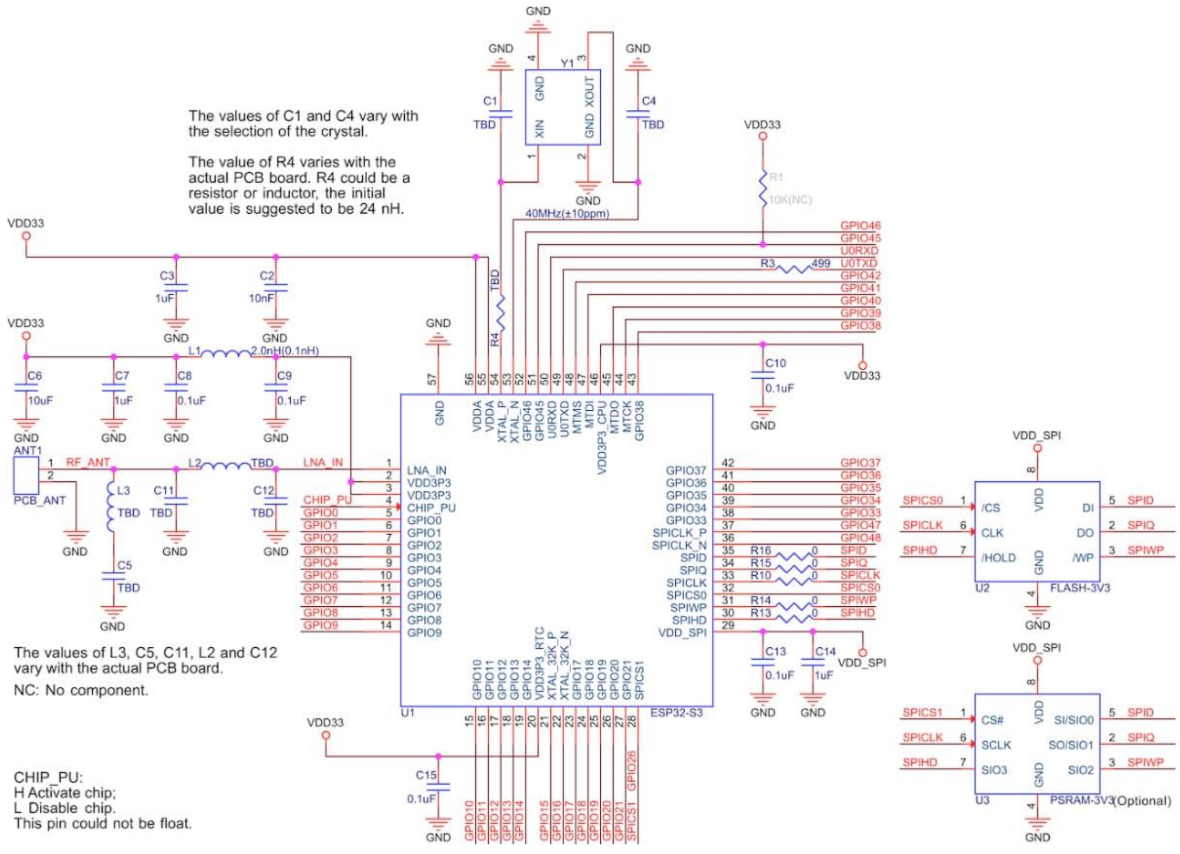

Figure 5.1: Block Diagram

The ESP32 Board's operating voltage is between 2.2V to 3.6V. But we can supply 5V from the Micro-USB port. For applying 3.3V there is already an LDO voltage regulator on the module to keep the voltage steady at 3.3V. ESP32 can be powered using Micro USB port and VIN pin (from external supply). ESP32 contains an on-board LED, which is connected to GPIO2 general purpose Digital In / Out pin.Connect the LEDs to GPIO pins 12 and 14 on the ESP32. Use a 220-ohm resistor to connect each LED's positive leg to the respective GPIO pin, and connect the negative leg to ground (GND) on the ESP32. Install the ESP board in the Arduino IDE. Copy the code provided into the Arduino IDE.20 5v can be applied to the 5V pin.

There are a few tips and recommendations to keep in mind when designing your setup with ESP32: ESP32 can handle up to ten strips at a time. As soon as installation is complete, select the LEDs type, pin numbers, length, and color order of your LED strips in the LED settings page.A user-led organisation is defined as “an organisation that is run and controlled by people who use support services including disabled people, people who use mental health services, people with learning disabilities, older people, and their families and carers.” Social Care Institute for Excellence, 2009.The ESP32-S2 routes the USB D+ and D- signals to GPIOs 20 and 19 respectively. For USB device functionality, these GPIOs should be connected to the bus in some way.Most of the ESP32 boards have at least one USB port, which is used for programming, debugging, serial communication and more. However, some ESP32 development boards manufacturers go the extra mile and offer multiple USB ports, especially the development boards from the ESP32 manufacturer itself.USB, or universal serial bus, is a mechanism used to connect peripheral devices to computers. Before the advent of USB technology, a PC typically included one or two serial connections, a parallel port, keyboard and mouse connectors, and in some instances, a joystick port.1Serial communication is a communication method that uses one or two transmission lines to send and receive data, and that data is continuously sent and received one bit at a time.

Universal serial bus (USB) is defined as a standard that mentions the specifications used by cables, ports, and protocols that enable simple and universally accepted connectivity between a host and peripheral device The result from testing the ESP32 base shield board show this prototype is a beginner-friendly design because it helps the beginner troubleshoot the coding and circuit also makes all the GPIO pins easily accessible through header pins.

5.2 COMPONENT DESCRIPTION

5.2.1 Power Supply

The ESP32 Board's operating voltage is between 2.2V to 3.6V. But we can supply 5V from the Micro-USB port. For applying 3.3V there is already an LDO voltage regulator on the module to keep the voltage steady at 3.3V. ESP32 can be powered using Micro USB port and VIN pin (from external supply).

5.2.2 Power Led

ESP32 contains an on-board LED, which is connected to GPIO2 general purpose Digital In / Out pin.Connect the LEDs to GPIO pins 12 and 14 on the ESP32. Use a 220-ohm resistor to connect each LED's positive leg to the respective GPIO pin, and connect the negative leg to ground (GND) on the ESP32. Install the ESP board in the Arduino IDE. Copy the code provided into the Arduino IDE.20 5v can be applied to the 5V pin.

5.2.3 User Led

There are a few tips and recommendations to keep in mind when designing your setup with ESP32: ESP32 can handle up to ten strips at a time. As soon as installation is complete, select the LEDs type, pin numbers, length, and color order of your LED strips in the LED settings page.A user-led organisation is defined as “an organisation that is run and controlled by people who use support services including disabled people, people who use mental health services, people with learning disabilities, older people, and their families and carers.” Social Care Institute for Excellence, 2009.

5.2.4 USB Connnection

The ESP32-S2 routes the USB D+ and D- signals to GPIOs 20 and 19 respectively. For USB device functionality, these GPIOs should be connected to the bus in some way.Most of the ESP32 boards have at least one USB port, which is used for programming, debugging, serial communication and more. However, some ESP32 development boards manufacturers go the extra mile and offer multiple USB ports, especially the development boards from the ESP32 manufacturer itself.USB, or universal serial bus, is a mechanism used to connect peripheral devices to computers. Before the advent of USB technology, a PC typically included one or two serial connections, a parallel port, keyboard and mouse connectors, and in some instances, a joystick port1.

5.2.5 Serial Connection

Serial communication is a communication method that uses one or two transmission lines to send and receive data, and that data is continuously sent and received one bit at a time.

Universal serial bus (USB) is defined as a standard that mentions the specifications used by cables, ports, and protocols that enable simple and universally accepted connectivity between a host and peripheral device.

5.2.6 Conculsion

The result from testing the ESP32 base shield board show this prototype is a beginner-friendly design because it helps the beginner troubleshoot the coding and circuit also makes all the GPIO pins easily accessible through header pins.

CHAPTER 6

SOFTWARE

This section outlines the software requirements necessary for designing a smartwatch using EASYEDA, an online Electronic Design Automation (EDA) tool. EASYEDA provides an integrated environment for schematic capture, PCB layout, and simulation. A registered account on the EASYEDA platform for project creation, management, and cloud storage. The schematic capture tool in EASYEDA is used for designing and documenting the circuit diagrams of the smartwatch. It should support Creation of new components and symbols, importing existing components from the library, Annotating and labelling components and connections, Netlist generation for PCB layout.

The PCB layout tool is used for arranging components on the PCB and defining electrical connections. It should support Multi-layer PCB design (at least 2 layers), Automated and manual routing options, Design rule checks (DRC) to ensure compliance with manufacturing standards, Importing netlists from the schematic capture tool**.** Component Library is used to access Microcontrollers (e.g., ARM Cortex-M series), Sensors (e.g., accelerometers, gyroscopes, heart rate monitors), Communication modules (e.g., Bluetooth, Wi-Fi), Power management components (e.g., voltage regulators, batteries), Display units (e.g., OLED, LCD).

Built-in simulation capabilities are used to verify circuit functionality before physical prototyping. This includes SPICE simulation for analog circuits, Digital simulation for microcontroller-based designs**.** Collaboration Features includes tools for team collaboration such as Real-time editing and commenting, Version control to track changes and revert to previous versions, Sharing projects with team members and external stakeholders.

File Import/Export Options enhances the ability to import and export files in various formats including Gerber files for manufacturing, BOM (Bill of Materials) for component procurement, PDF/PNG for documentation and presentations. Manufacturing Integration includes Direct integration with PCB manufacturers is used to streamline the production process. This includes Instant quotes for PCB manufacturing, Order placement and tracking.

EasyEDA is a popular, user-friendly online PCB design tool that allows you to design schematics, PCB layouts, and simulate circuits. Here's a step-by-step guide on how to use EasyEDA for integrating an ESP32 into your PCB design.

EasyEDA is an online Electronic Design Automation (EDA) tool that provides an integrated platform for circuit design, simulation, PCB layout, and PCB manufacturing. It offers various features to support hobbyists, makers, and professionals in creating electronic projects. Here's a brief overview of what EasyEDA offers:

1.Schematic Capture: EasyEDA allows users to create electronic circuit schematics easily with an intuitive interface, a wide range of electronic components, and a comprehensive symbol library.
2.Simulation: The software provides circuit simulation capabilities to test and validate designs before physical implementation, helping to identify and correct errors.
3.PCB Layout: Users can design PCB layouts with multiple layers, auto-routing features, and design rule checks to ensure manufacturability and functionality.
4.Component Libraries: EasyEDA offers extensive libraries of components, including symbols and footprints, to streamline the design process.
5.Collaboration and Sharing: The platform supports collaboration by allowing multiple users to work on the same project and share designs easily with others.

6.Manufacturing Services: EasyEDA is integrated with JLCPCB, a PCB manufacturer, providing seamless transitions from design to manufacturing, including component sourcing and assembly services.

7.Cross-Platform Access: As a web-based tool, EasyEDA can be accessed from any device with an internet connection, making it versatile and convenient for users.

EasyEDA is an integrated browser-based tool for schematic capture, SPICE circuit simulation (based on Ngspice) and PCB layout.Import from Altium Designer, CircuitMaker, Eagle, Kicad and LTspice file formats as well as generic SPICE netlists is supported. SPICE netlists can be exported to third party simulation tools and export of PCB netlists in Altium, PADS and FreePCB formats is also supported.The ability to import LTspice schematics and symbols provides a useful way to port schematics to PCB layout without having to redraw them from scratch.

Once Gerber files of a completed PCB design have been downloaded and checked - using a third party Gerber viewer - the user is free to choose a PCB manufacturer or, for a fee, they can submit the Gerbers directly to EasyEDA for manufacture. Alternatively, printable PCB layer image output is also supported in PDF, PNG and SVG formats for home PCB etching.

CHAPTER 7

RESULT AND DISCUSSION

Start a new project in EasyEDA software then add ESP32 into schematic into the EasyEDA software and next add CP2102N, AMS1117-3.3, USB connector, ESD, Transistors, Buttons, Capacitor, Resistor, LED, Drawing schematic: Buttons + ESP32,Connecting: USB to UART, Connecting: LED, Power, Connecting: Series resistors, Connectors,ESP32 vs S2 reference schematic,CP2102N Errata, Adding titles, Annotating schematic, Fixing errors in schematic, Importing schematic to PCB, Component placement, Start PCB Layout: setup rules, stack up and route it Updating schematic and importing.

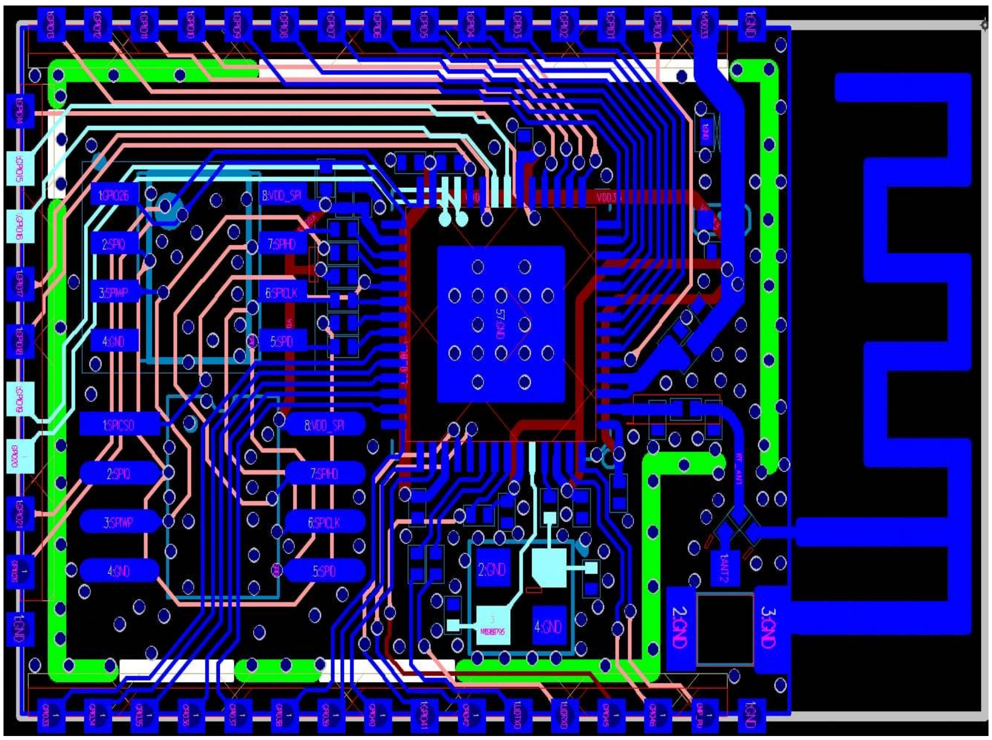

Figure 7.1: Layout of ESP32 board

Designing a PCB (Printed Circuit Board) for an ESP32 involves several steps to ensure the board functions correctly and efficiently. Here's an overview of the process:Include the ESP32 module, power supply components, capacitors, resistors, and any additional sensors or peripherals. Ensure all components are connected correctly according to the ESP32 datasheet and your specific design requirements. Strategically place components on the PCB. The ESP32 should be placed centrally or in a location that optimizes signal routing and minimizes interference. Route the connections (traces) between components. Ensure to follow best practices for signal integrity.

Avoid sharp corners in traces (use 45-degree angles). Ensure proper grounding by having a solid ground plane.Use decoupling capacitors close to the power pins of the ESP32.Ensure a stable power supply to the ESP32, typically 3.3V. Include voltage regulators if necessary. Place decoupling capacitors close to the power pins of the ESP32 to filter out noise.For optimal wireless performance, ensure the antenna area of the ESP32 module is free from obstructions and has a clear line of sight.Follow the manufacturer's guidelines for antenna placement and PCB design to maximize signal strength.Consider the heat dissipation of the ESP32 and other components. Place thermal vias and pads if necessary to dissipate heat. Run a DRC to ensure there are no design violations, such as spacing errors or unconnected nets.Generate a BOM that lists all the components needed for the PCB. Once the design is complete, create a prototype PCB and test it thoroughly to ensure it meets all design specifications and operates as intended.Popular for its extensive library and ease of use.Open-source software with a robust set of features.Professional-grade software with advanced capabilities. Position the ESP32 module in a way that the antenna is clear from other components, preferably at the edge of the PCB.

CHAPTER 8

CONCLUSION

The ESP32 is a versatile and powerful microcontroller that has been widely adopted in various applications, including those involving Printed Circuit Boards (PCBs). Here are some key points that summarize the use of ESP32 in PCB projects.The ESP32 is known for its wide range of features, including Wi-Fi and Bluetooth connectivity, making it suitable for IoT applications. Its dual-core processor allows for efficient multitasking.Integrating the ESP32 into a PCB design can significantly enhance the functionality of the board. Its built-in peripherals, such as ADC, DAC, UART, and SPI, reduce the need for additional components.Despite its advanced features, the ESP32 is relatively affordable, making it a cost-effective choice for many projects. This affordability, combined with its capabilities, makes it a popular choice for both hobbyists and professionals.The ESP32 has a large community of developers and extensive documentation, which can be very helpful during the design and implementation phases of PCB projects. Numerous libraries and example codes are available to simplify development.The ESP32 offers various power-saving modes, which can be crucial for battery-powered devices. This makes it suitable for applications where power consumption is a critical factor.The availability of development boards, like the ESP32 DevKit, allows for easy prototyping and testing. Once the design is validated, the ESP32 can be incorporated into custom PCB designs for production. In conclusion, the ESP32 is a robust and feature-rich microcontroller that enhances the capabilities of PCB designs. Its combination of connectivity options, processing power, cost-effectiveness, and community support makes it an excellent choice for a wide range of applications.

User-centric design considerations were also pivotal. The placement of push-button switches at the top of the PCB made them easily accessible, enhancing user interaction and convenience. The central battery placement ensured balanced power distribution, contributing to stable performance and extended battery life. Utilizing EasyEDA software streamlined the entire design process, from schematic capture to PCB layout. The software's comprehensive features, including precise component placement, efficient routing tools, and thorough design rule checks, ensured a high-quality final product.

This project demonstrates the feasibility of designing a sophisticated PCB using accessible tools and methods. The final design balances aesthetic appeal with practical functionality, providing a strong foundation for further enhancements. Future iterations could explore additional features such as wireless connectivity, sensor integration, and improved power management. In summary, this project has successfully achieved its objectives, resulting in a well-designed PCB that is both functional and visually appealing. The use of EasyEDA software proved to be instrumental in this process, offering the necessary tools to bring the design from concept to reality. This project lays the groundwork for future developments in wearable technology, showcasing the potential for innovative and user-friendly devices.

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