Smart Digital Clock

Electronic Design Realization

EN2160

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Contents

1 General Information

1.1 Overview

Digital clocks are electronic devices that display time numerically. They use digital circuitry and display technologies. This Digital clock can have additional features like alarms, timers, and time zone adjustments,stopwatch and power bank.

1.2 Functionality

In this clock LCD display is used and real time clock is shown. The clocks rely on a stable time base, such as RTC module to generate accurate time. The time is divided into units like hours, minutes, and seconds using digital counting techniques. The time and date can be set by users as well according to their country. In the clock there are two USB female jacks for devices such as charging phones, smartwatches. The clock is powered by three Li-ion batteries which are charged using battery management system(BMS). When power is low, it is charged using 12V power pack. In charging mode clock is directly powered by power pack. Buck converter is used as main power regulator. Overall, digital clocks provide precise timekeeping and offer various functionalities in different settings.

2 Product Goals

"A digital clock that shows time and date accurately is used where at Working tables, Bedrooms, Offices so on. The users can charge their smart devices by the clock which is near to them."

2.1 Functionality

- Clock shows time and date as user set
- Time and date is continuously updating,although power is OFF.
- Alarm can be set and buzzers are loudly ringing.
- Stopwatch and Timer are there in clock.
- There are setting menu to change brightness of screen, sound track of alarm and alarm sound.

2.2 Price

- Approximated cost of Rs.16500 per unit

2.3 User needs list

- Add stopwatch and timer to digital clock.
- The clock can be used as power bank.
- The clock has large display size to highlight the time.
- The clock appearance looks more attractive.
- Change the time and date according to country living.
- Settings menu of the clock should be more user friendly.

3 Conceptual Design

3.1 Enclosure View

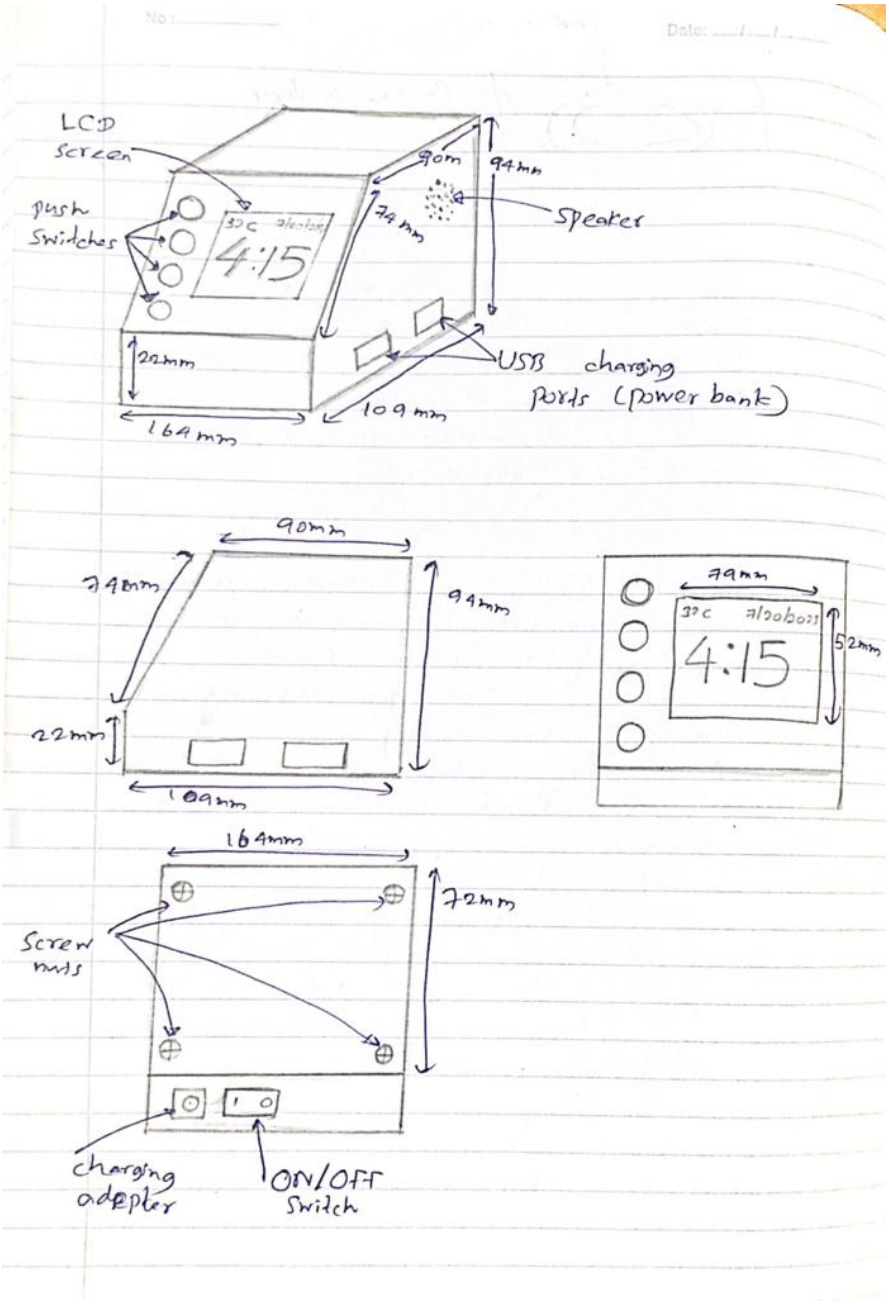

Figure 1: Design Enclosure View.

3.2 Circuit Block Diagram

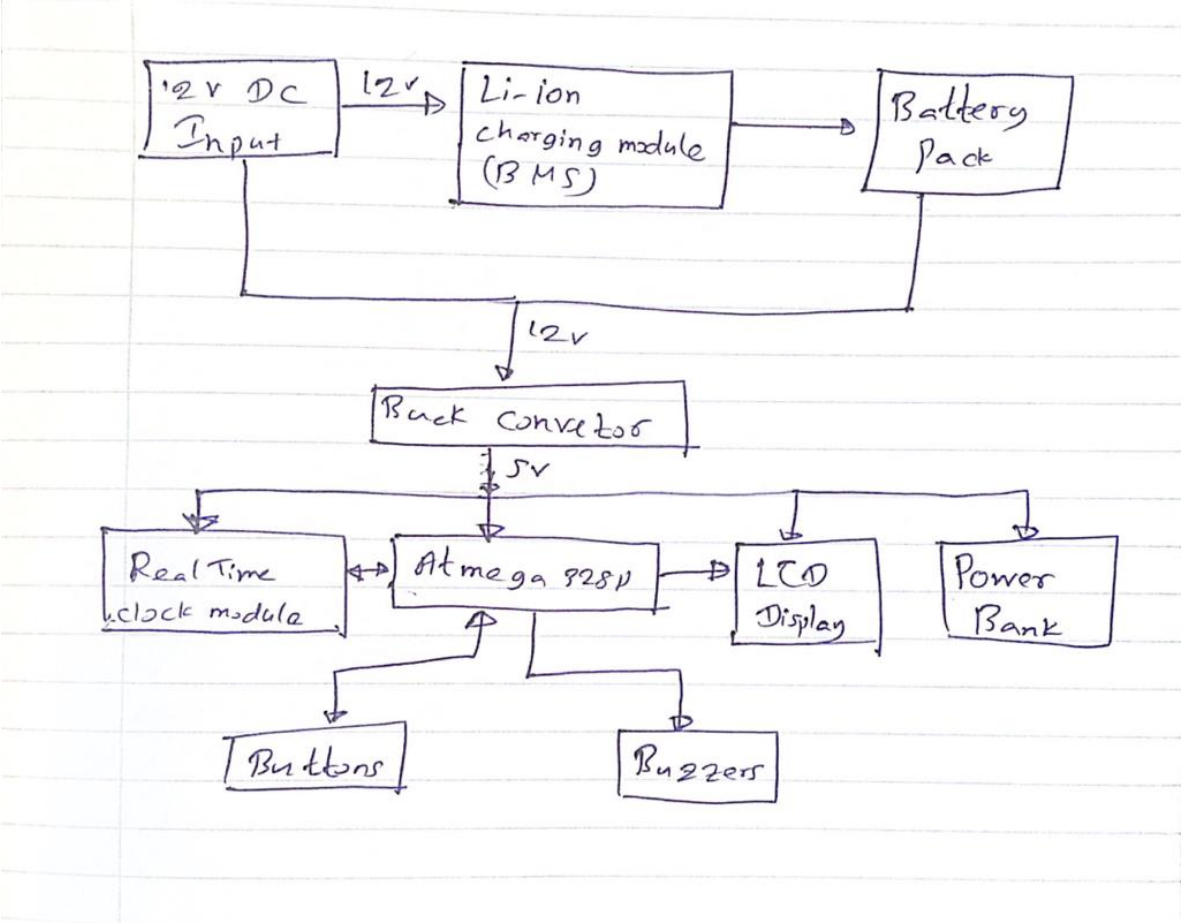

Figure 2: Circuit Block Diagram.

4 Schematic Design

4.1 Control Circuit

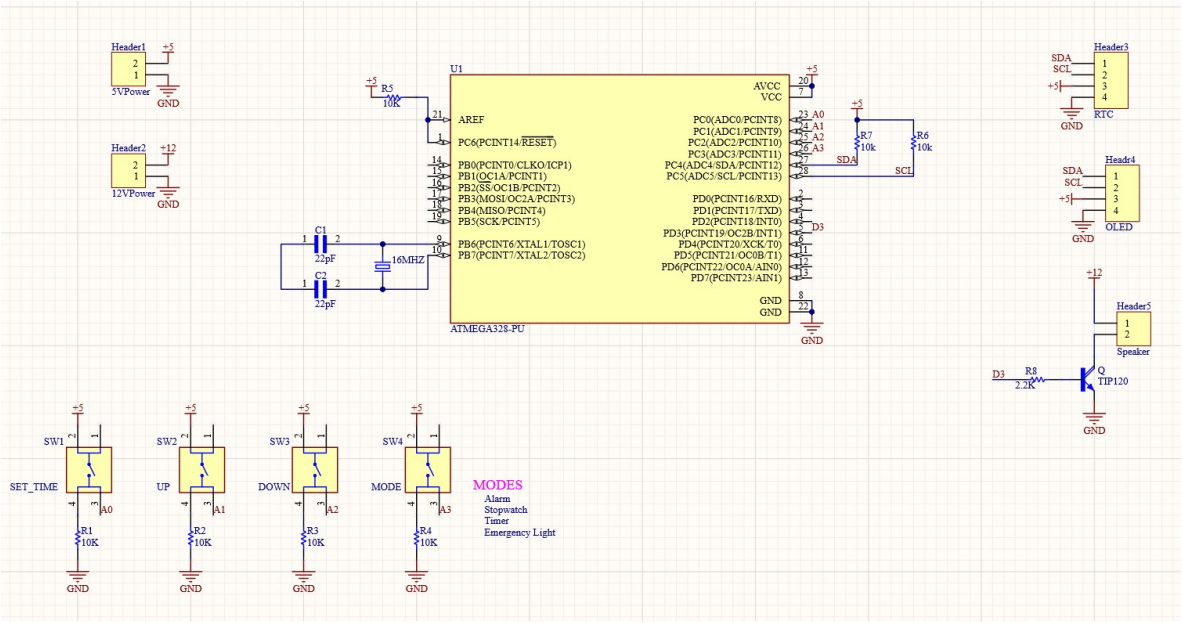

Figure 3: Control Circuit.

4.2 Modules Used in Product

In this section, there are brief description about modules have been used for the product. Those modules are available in the market.

4.2.1 Battery Management System(3S 12V 25A BMS)

The protection board has over charge protection function, over discharge protection function, over current protection function and short circuit protection function. Board charging and discharging are the same port, board is included balanced circuit.When the charge balance, the board will be a bit warm, even after disconnecting the charger, some are still in balance, will continue to warm for a while until below the equilibrium break threshold.

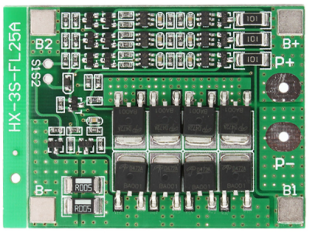

Figure 4: Battery Management System.

4.2.2 Real Time Clock(DS3231)

Real time clock generator seconds, minutes, hours, day, date, month and year timing and provide valid until the year 2100 leap year compensation.Chip temperature sensor comes with an accuracy of ± 3 ℃. I2C bus interface, the maximum transmission speed of 400KHz (working voltage of 5V).It can be cascaded with other I2C device, 24C32 addresses can be shorted A0/A1/A2 modify default address is 0x57.

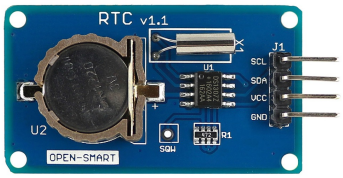

Figure 5: Real Time Clock.

4.2.3 Power Bank Charger Module(5V 2A Charging Circuit Board)

18650 Dual Micro USB 3.7V to 5V 2A Boost Mobile Power Bank DIY 18650 Lithium Battery Charger PCB Board Step Up Module With Led. LED lights show the power, non-working state of intelligent automatic shutdown.Dual USB output and built-in lithium battery protection IC, over-current, overvoltage, undervoltage protection.

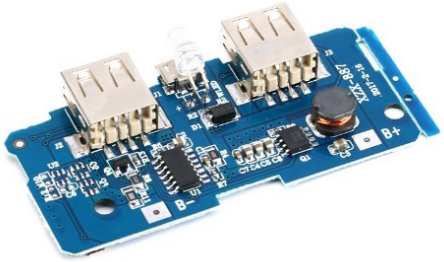

Figure 6: Power Bank Charger Module.

5 PCB Layout

5.1 PCB Design

Printed circuit board was designed with Altium Designer 23.3.1. It was a two-layer design.

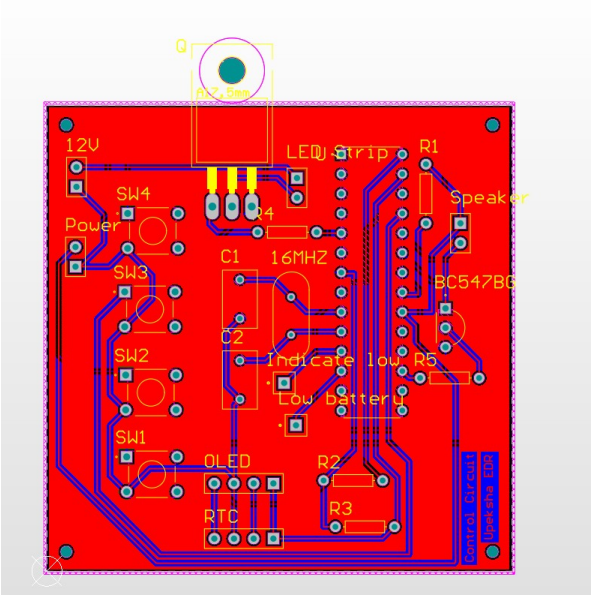

Figure 7: Top Layer.

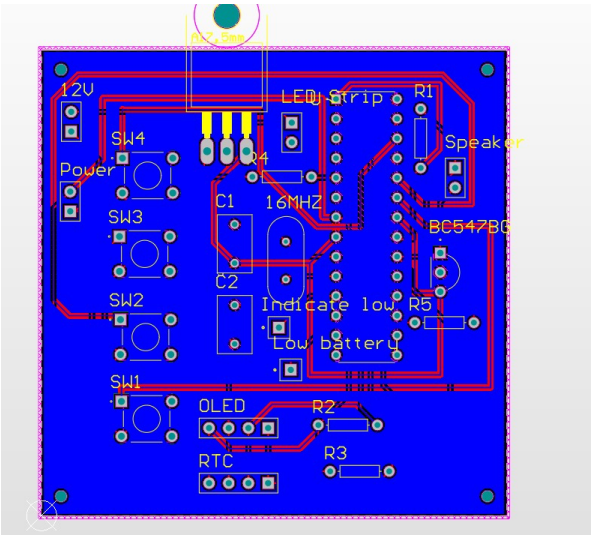

Figure 8: Bottom Layer.

5.2 Printed Circuit

Manufacturing was done at JLCPCB in China. Therefore, online available JLCPCB design rules were imported to Altium Designer. It was a two-layer design.

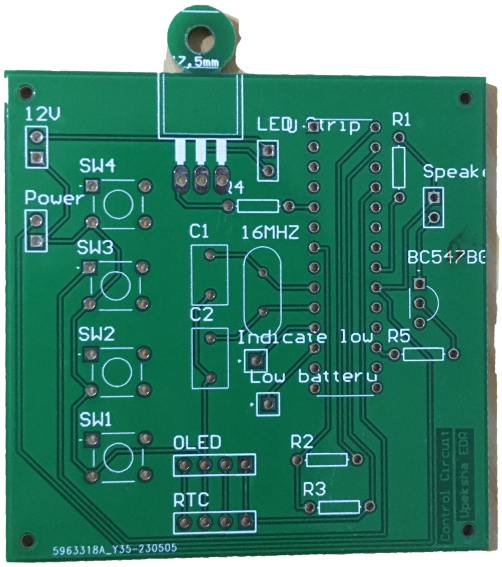

Figure 9: Top of the PCB.

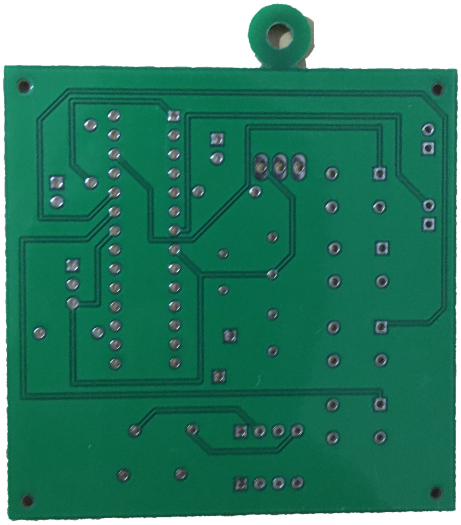

Figure 10: Bottom of the PCB.

6 Solidworks Design

Enclosure design was designed with SOLIDWORKS 2020.enclosure consist of Lid and the Body. Plastic is used in the enclosure.All of them can be mounted on the body by means of 3mmx 5mm screws.

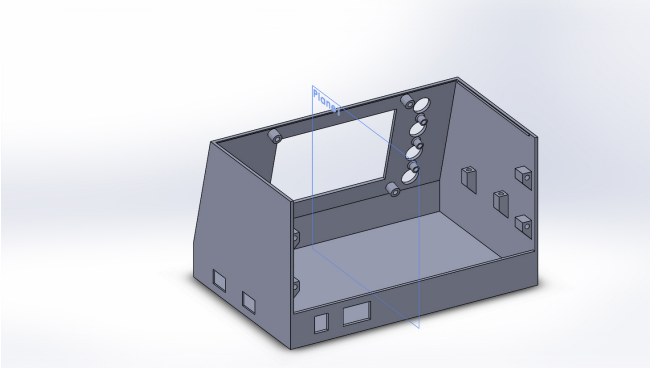

Figure 11: Base Part

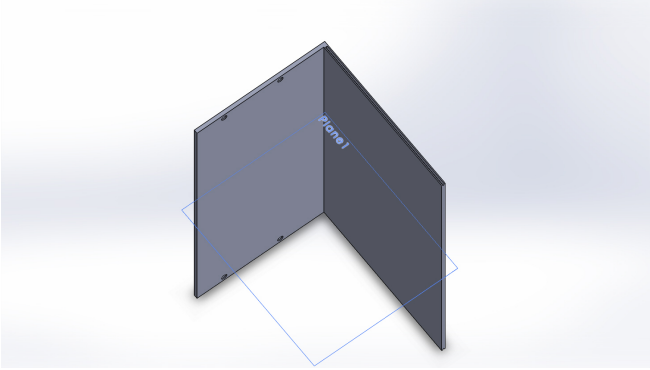

Figure 12: Lid Part

Figure 13: View1

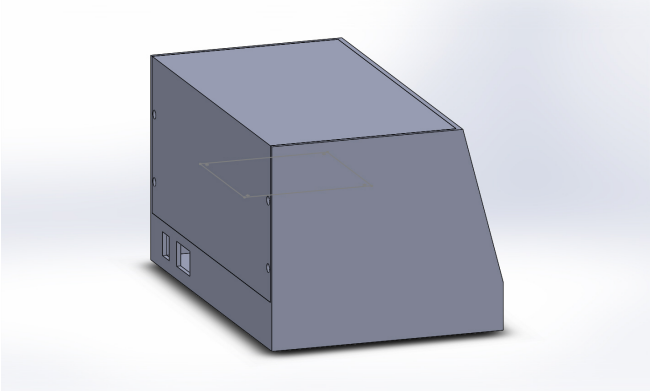

Figure 14: View2

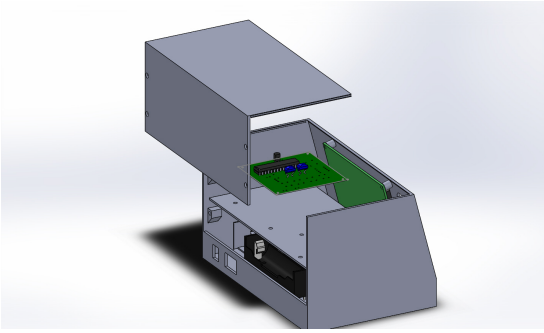

Figure 15: Explore view

Figure 16: Final Product

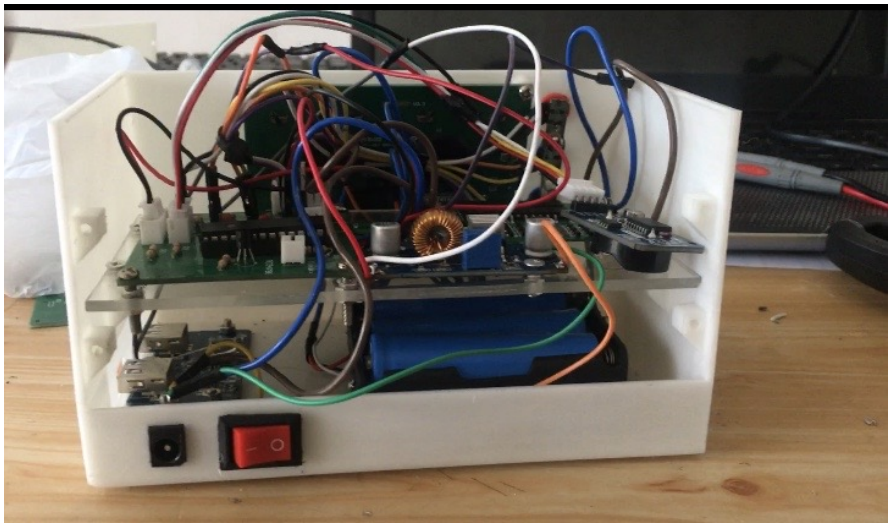

Figure 17: Final Product

7 Instruction for Assembly

This comprehensive guide is designed to assist you in assembling your own smart digital clock. Prior to commencing the assembly process, it is crucial to ensure that you have gathered all the necessary components and tools. By proceeding methodically and attentively adhering to the instructions provided, you will increase the likelihood of a successful assembly. Take your time throughout the process to ensure accurate and precise workmanship. Following these steps will ultimately lead to the completion of your frequency counter project.

1. **Checking Modules:** RTC module, Power Bank Module and Battery Management System should be checked separately by giving required voltage each of these. It is very important to know that modules have no errors before cascading.

2. **Soldering: To commence the assembly process of the provided printed circuit board (PCB), adhere to the following guidelines**

   - Start by soldering the low-profile components, which include resistors and capacitors. Progress to taller components as you proceed with the assembly
   - Exercise caution while soldering polarized components, like diodes and electrolytic capacitors. Verify their correct orientation on the PCB by referring to the markings or assembly instructions.
   - Employ an adjustable temperature soldering iron for optimum results. This will ensure that the soldering iron's temperature is set appropriately for different components. Additionally, use lead-free solder to comply with environmental standards.
   - Strive for clean and solid solder joints. When soldering, make sure the solder flows smoothly and adheres firmly to both the component lead and the PCB pad. Avoid creating solder bridges or excess solder on the joints.

3. **Connect Batteries:** Li-iron batteries should be connected to relevant pins of 3S BMS carefully because if wrong pins were connected BMS may be suddenly burn.

4. **Buck Converter:** Output of BMS is given to input of buck converter and output of buck converter is set to 5V. This 5V is main power for all the modules and Control PCB.

5. **Power-up circuits:** Regulated 5V output of buck converter is given Real Time Clock module, Power Bank Module, LCD display, push buttons and control pcb. Always have to be mindful about plus and minus of the terminals.

6. **Connect to Controller:**

   - RTC module is connected to **SDA(A4), SCL(A5)** of control pcb. It uses I2C protocol to communicate with atmega328.
   - Pins of LCD display is connected to control pcb like below.

Table 1: LCD pins and Control Pins

Control PCB	**LCD**
PB2(D10)	RS
PB3(D11)	R/W
PB5(D13)	E
GND	PSB
PB0(D8)	RST
PD6(D6)	BLA
GND	BLK

   - Buttons are connected to **PC0(A0), PC1(A1), PC2(A2), PC3(A3)** of the control pcb through pull-up resistors.
   - Buzzers are connected to control pcb of **PB5(D5) and GND** pins.

7. **Connect Power Pack** 12V dc power is used for charging Li-Iron batteries. 12V dc power is directly given to input of the BMS through a ON/OFF switch which is the power switch of the clock.

8 Testing the Product Functionality

Ensuring the functionality and performance of the Smart Digital Clock is a critical phase in its product development process. Rigorous testing is conducted to verify that the clock meets its specifications and provides accurate and reliable timekeeping, as well as various smart features. Here's an overview of the testing process:

8.1 Timekeeping Accuracy:

- Set the smart digital clock to the correct time and date.
- Monitor the clock's timekeeping accuracy over a period (e.g., 24 hours) and compare it against a reliable time source.
- Check for any time drift or discrepancies between the clock's display and the reference time source.

8.2 Alarm Functionality:

- Set multiple alarms at different times and verify that the clock activates the alarms at the specified times.
- Ensure that the alarm sound is loud enough to be heard and has the desired duration.
- Test the snooze feature, allowing the alarm to be temporarily silenced and then reactivated after a few minutes.

8.3 User Interface (UI) and Controls:

- Test all buttons and controls on the clock to ensure they respond correctly.
- Verify that the display shows the appropriate information, including time, date, and alarm settings.
- Check the screen's visibility and readability under different lighting conditions.

8.4 Temperature Display:

- Verify that the clock's temperature display is accurate and consistent with the actual room temperature.
- Compare the temperature reading with a reliable thermometer.

8.5 Brightness Adjustment:

- Test the brightness adjustment feature to ensure it works smoothly and changes the display brightness accordingly.

8.6 Power Supply and Backup:

- est the clock's performance when connected to the main power supply.
- Check if the clock maintains its settings and timekeeping during power outages when using a backup power source (batteries).

8.7 Compliance and Safety:

- Ensure that the clock complies with relevant safety standards and regulations for electronic devices.
- Verify that the clock does not pose any safety hazards, such as electrical or fire risks.

8.8 Quality Assurance:

- Conduct a comprehensive quality assurance review to check for any defects, errors, or malfunctions.
- Address and resolve any identified issues to achieve a high-quality product.

8.9 Durability and Robustness:

- Subject the clock to stress tests, including vibration and temperature variations, to ensure its robustness.
- Verify that the clock remains operational and undamaged under normal usage conditions.

By thoroughly testing the smart digital clock, manufacturers can ensure that the product meets customers' expectations and delivers reliable performance, contributing to its success in the market.

9 Bill of Materials(BOM)

9.1 Cost for the product

Table 2: BOM

Component or Module	**Quantity**	**Price(Rs)**
Power Bank Module	1	225
LCD display	1	2800
Real Time Clock Module	1	450
Buck Converter	1	250
BMS	1	975
Li-iron(18605)	3	600
3 cell battery pack	1	210
Buzzers	2	30
ON/OFF switch	1	10
Push buttons	4	20
Push button covers	4	10
Printing PCB	1	600
Resistors 10k	15	20
Oscillator	1	10
22pf capacitors	2	5
4 JST connectors	1	20
2 JST connectors	3	40
Atmega328	1	1200
10uf	1	5
wiring(wire and heat sleeve)	-	300
Enclosure(3D printing)	1	4500
	Total	**16320**

9.2 Suppliers

- Mouser Electronics
- Tronic.lk
- JCLPCB
- Hexidelab(3D printing)
- Nilabara Eletronics
- Aliexpress.com