

**DEPARTMENT OF ELECTRONIC AND TELECOMMUNICATION
ENGINEERING**

UNIVERSITY OF MORATUWA



EN2160 - Electronic Design Realization

Design Report

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Abstract

This project aims to design and develop a customized solar-powered battery charger transformed into a versatile power bank, tailored to charge Li-ion batteries efficiently. Originally conceived as a solar charger for lead-acid batteries, the focus shifted to address the practical needs of everyday users, opting for Li-ion battery compatibility and low-cost solar cells. The charger incorporates current and voltage regulation, along with an overvoltage cut-off function, ensuring optimal and safe charging. With an input voltage of 18V and an output of 12V DC, the charger supports a maximum output current of 1A. The integration of a microcontroller-based smart charging algorithm, USB output, battery protection, and an LCD display enhances its user experience. This project presents a sustainable and eco-friendly charging solution, reducing dependence on conventional power sources and promoting environmental sustainability. The customized solar-powered Li-ion battery charger power bank serves as a versatile and reliable charging companion for various devices, making it an ideal solution for diverse applications and outdoor use.

Introduction

This solar-powered battery charger transformed into a versatile power bank, designed to efficiently charge Li-ion batteries. Originally conceived as a solar charger for lead-acid batteries, the project evolved to cater to the practical needs of everyday users, focusing on Li-ion battery compatibility and low-cost solar cells.

With current and voltage regulation, the charger maintains a constant output voltage, crucial for proper and safe Li-ion battery charging. Overvoltage cut-off capabilities ensure protection against battery damage due to overcharging.

The charger's technical specifications include an 18V input voltage, 12V DC output, and a maximum output current of 1A. These features enable widespread compatibility with a variety of Li-ion battery-powered devices, making it an ideal charging solution.

Extra features, such as a microcontroller-based smart charging algorithm, battery protection, USB output, and an LCD display, enhance user experience and device performance.

Harnessing renewable solar energy, this eco-friendly charging solution reduces dependence on conventional power sources and promotes environmental sustainability.

In conclusion, the customized solar-powered Li-ion battery charger power bank is a groundbreaking innovation, offering an eco-conscious and versatile charging companion for a multitude of devices and outdoor applications.

Product Overview

Appearance, Design, and Dimensions:

The customized power bank exhibits an elegant and modern design, meticulously crafted to offer both aesthetics and functionality. Encased in a sleek and durable housing, the power bank exudes a professional and stylish appearance, making it a desirable accessory for users seeking a blend of performance and sophistication.

The overall design prioritizes user convenience, with strategically placed charging ports and indicator lights for intuitive operation. Ergonomically rounded edges ensure a comfortable grip, and the compact form factor allows for easy portability, fitting seamlessly into pockets, bags, or purses.

The dimensions of the power bank have been thoughtfully optimized, striking a balance between portability and charging capacity. Its slim profile and lightweight nature make it an ideal on-the-go companion for travel, outdoor activities, or daily commutes.

Capacity and Output Specifications:

The customized power bank boasts an impressive charging capacity, capable of storing substantial energy to keep devices powered throughout the day. Equipped with high-quality lithium-ion battery cells, the power bank offers reliable and long-lasting performance, ensuring uninterrupted power for various devices.

The power bank's capacity is measured in milliamperere-hours (mAh), reflecting the total amount of energy it can store. This capacity varies across different models, ranging from moderate capacities suitable for smartphones and wearables to high-capacity variants suitable for tablets and laptops.

Regarding output specifications, the power bank supports multiple charging ports to cater to a variety of devices simultaneously. The output voltage and current are optimized for seamless charging compatibility with a wide range of smartphones, tablets, cameras, and other portable electronics.

The power bank features advanced charging technology that ensures a consistent and stable output voltage, mitigating the risk of overcharging and maximizing the charging efficiency. Additionally, built-in protection mechanisms guard against overcurrent, short-circuiting, and overheating, providing a safe and reliable charging experience for connected devices.

The power bank's refined appearance, practical design, and optimal dimensions make it a stylish and portable charging solution. With its impressive charging capacity and versatile output specifications, the power bank accommodates the charging needs of a diverse array of devices, offering users a reliable and efficient power source to stay connected and empowered throughout their day.

Technical Specifications:

1. **Capacity:** 1800mAh (1 cell) , 3600mAh (2p cell), 7200mAh (4p cell)
2. **Input Voltage:** Up to 18V DC (By using solar panels or regular power supply)
3. **Output Voltage:** 5V – 12V DC
4. **Output Current:** Up to 1A DC
5. **Charging Time:** The power bank's charging time depends on its capacity and the input charging speed.
6. **Power Bank Dimensions:** 130mm × 91mm × 26mm
7. **Weight:** 200g
8. **Battery Type:** Rechargeable Li-ion Battery (3.7V)
9. **Charging Cables:** USB Type-C

Key Features:

1. **Sleek and Durable Design:** The power bank features a stylish and robust housing with an ergonomic design, ensuring comfort and durability during everyday use.
2. **High Charging Capacity:** With a substantial mAh rating, the power bank can store ample energy to charge multiple devices or a single device multiple times.
3. **Fast Charging Technology:** Equipped with advanced fast-charging technology, the power bank delivers rapid charging to compatible devices, reducing downtime significantly.
4. **Multiple Charging Ports:** The power bank offers multiple output ports, enabling simultaneous charging of multiple devices, making it convenient for users with multiple gadgets.

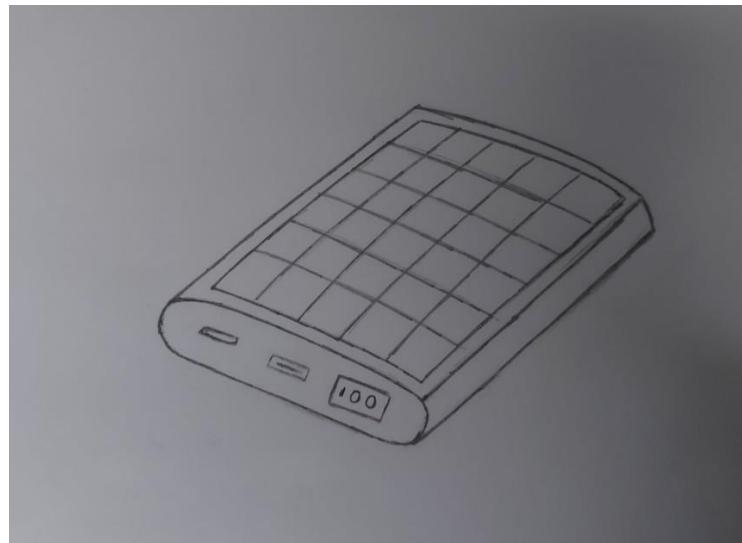
5. **Universal Compatibility:** Designed to be universally compatible, the power bank supports a wide range of devices, including smartphones, tablets, cameras, Bluetooth headphones, and more.
6. **Smart Charging Protection:** The power bank incorporates intelligent charging protection, guarding against overcharging, overcurrent, short-circuiting, and overheating, ensuring safe and efficient charging.
7. **LED Indicator Lights:** Convenient LED indicator lights display the power bank's remaining battery level, enabling users to monitor the charging status at a glance.
8. **LCD Display:** The LED display displays real-time charging status, capacity and source/device quality.
9. **Compact and Lightweight:** The power bank's compact form factor and lightweight design make it highly portable, fitting easily into pockets, purses, or travel bags.
10. **Pass-Through Charging:** The power bank allows for pass-through charging, enabling simultaneous charging of both the power bank and connected devices.
11. **High-Quality Battery Cells:** Utilizing premium lithium-ion battery cells, the power bank ensures reliable and long-lasting performance, providing consistent power delivery over time.

Design and Development Process

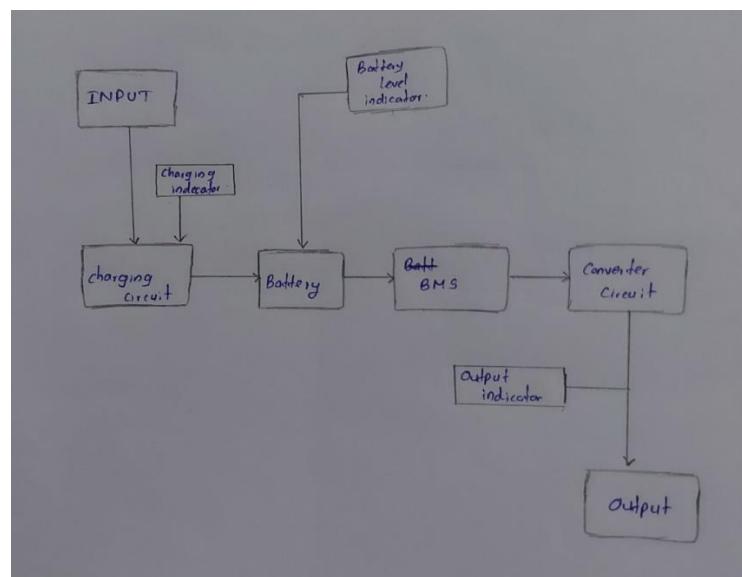
Conceptual Design Cycle

Initial design

Proposed Sketch



Functional block diagram



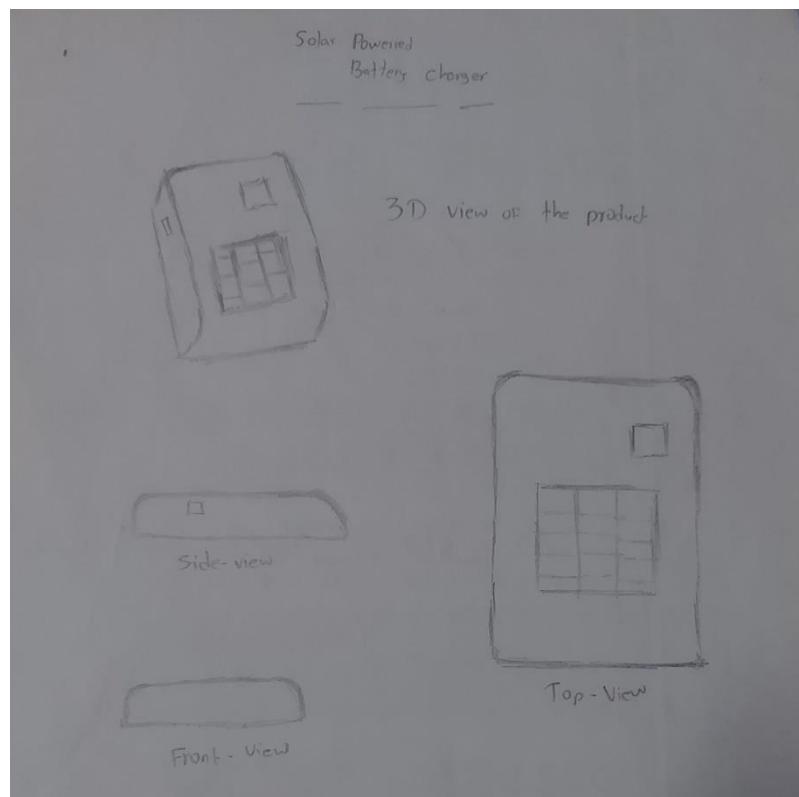
Product Specification

- 2 to 4-cell Li-ion batteries
- Can charge using solar panels and a normal power supply.
- Should indicate battery level.
- USB-A and USB-C output ports
- USB ports can use bi-directional.

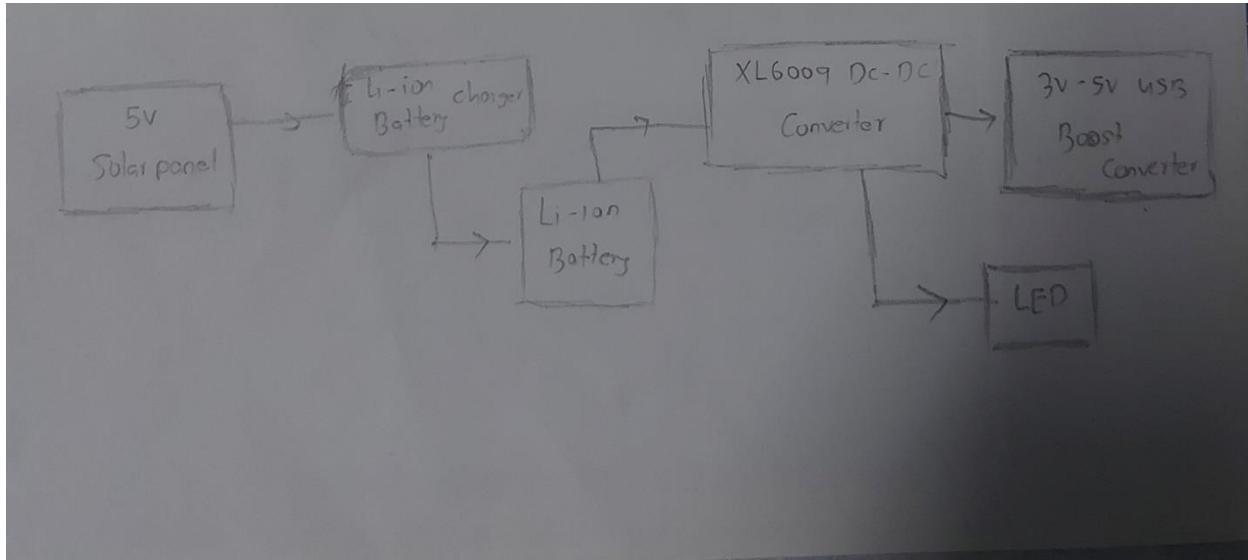
The design underwent three iterations of design-driven innovation cycles, resulting in three new designs that are presented in this report.

Design 1

This sketch and functional block diagram design by Vishagar A. (200686J) and here he is supposed to attach the solar panel within the power bank. And also, this design has the basic appearance, and the thickness of the design is somewhat higher.

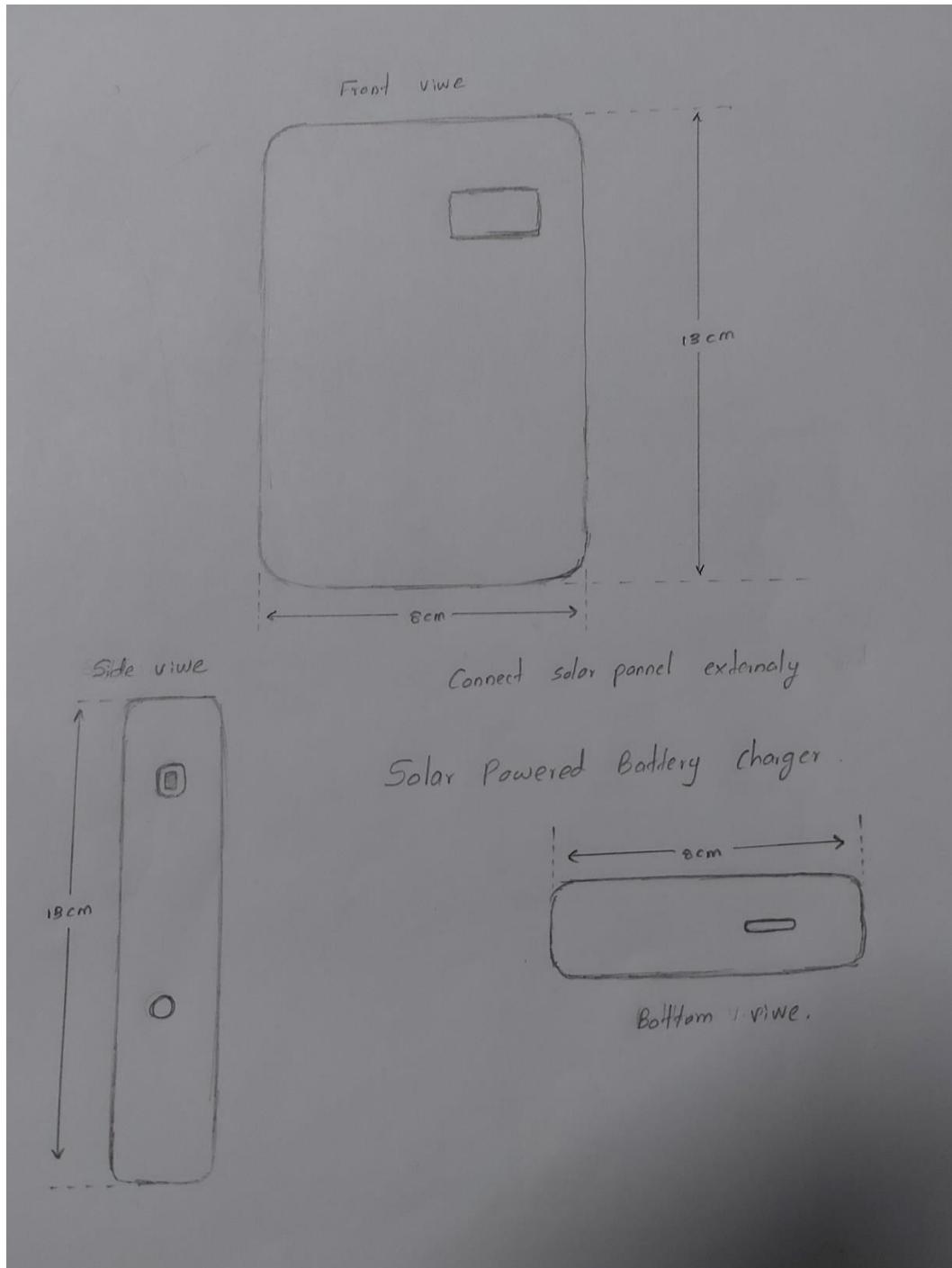


The functional block diagram that he supposed is contained Li-ion battery charger and it use to charge the battery. The only power source for the power bank is the solar panels.



Design 2

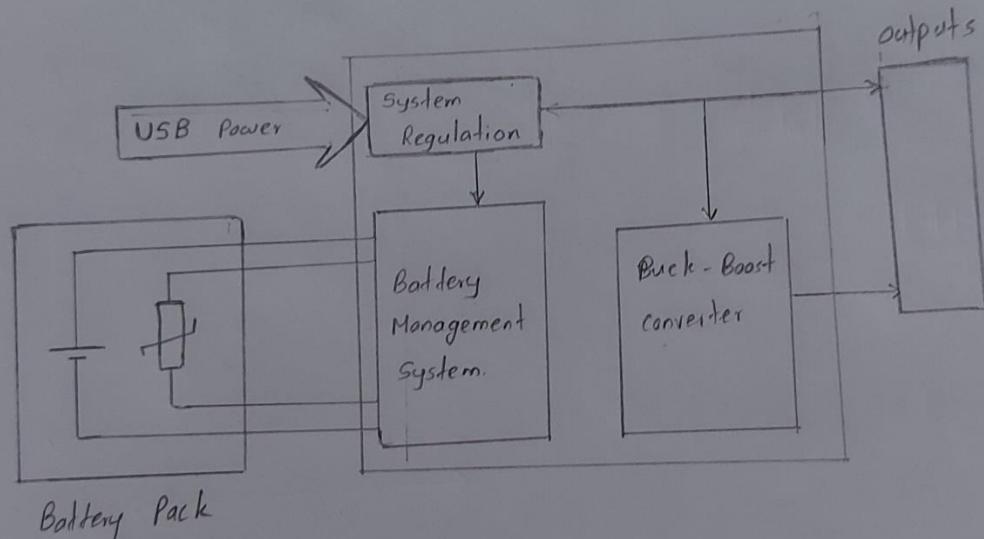
This design is proposed by Amarasinghe Y.E. (200029B) and here he designed this to connect solar panels externally. And the design of this one seems more attractive, and it has enough space to include all the PCB, Batteries, and other stuff.



This is the functional block diagram that he has proposed and here we should use different ports to charge and discharge the power bank. Here, he has used the Battery Management module to charge the battery and the buck-boost converter to create the necessary voltage when discharging the battery.

Functional Block Diagram

Solar Powered Battery charger.



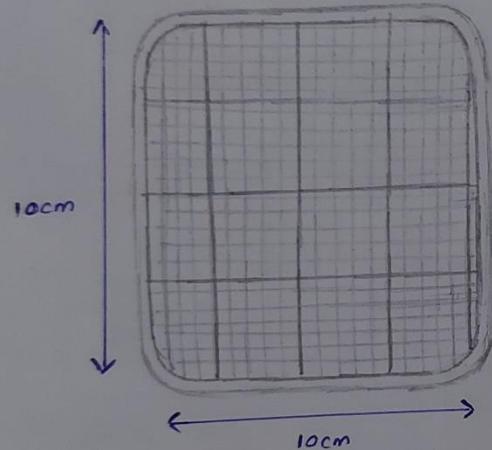
Design 3

This design is proposed by Liyanage P.H.S. (200352H) and this is seems to be like a square shape one and the solar panel already attached to the power bank.

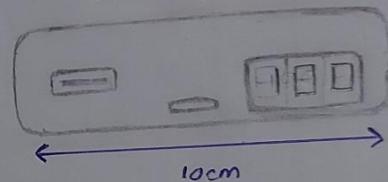
Solar Powered Battery charger & Power bank



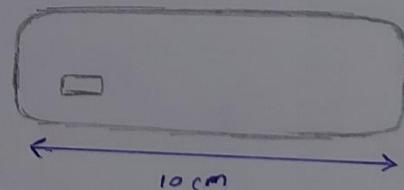
Top plan



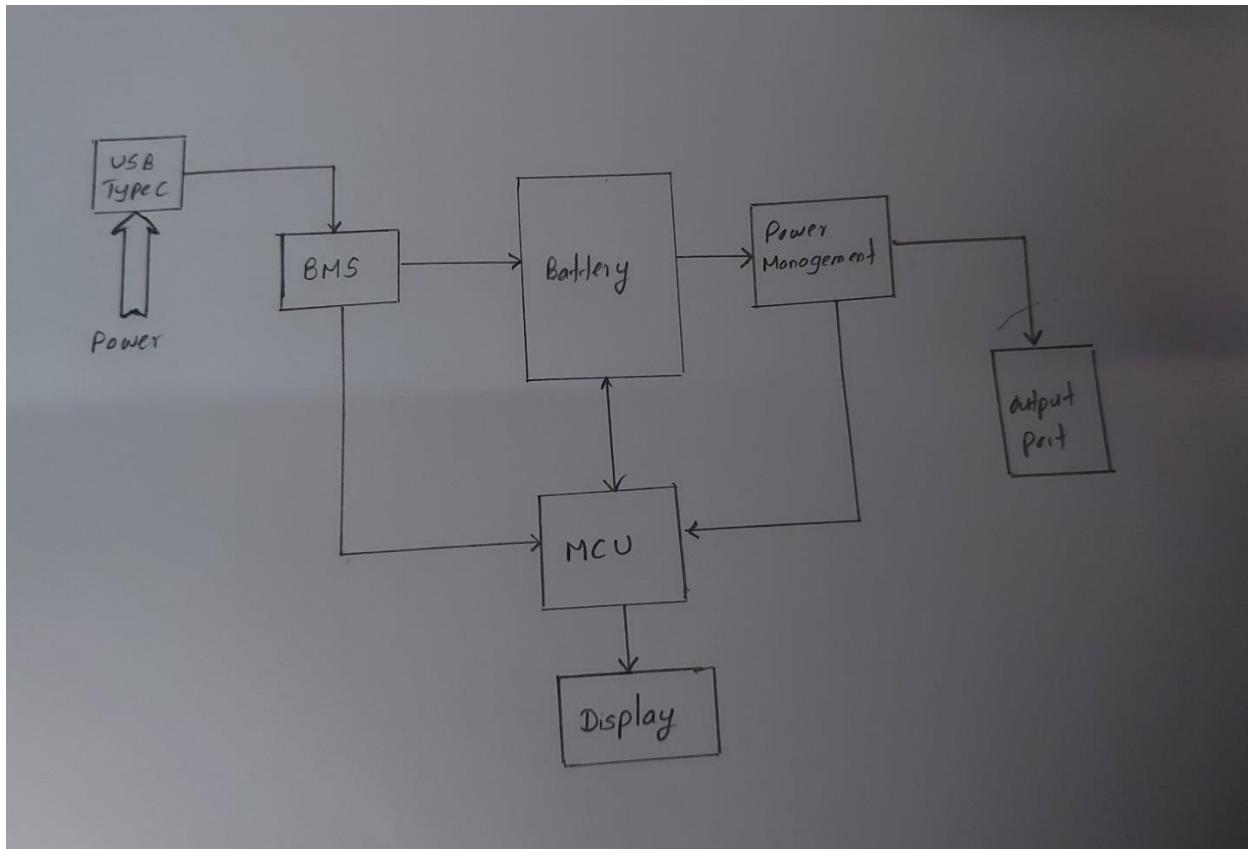
Front plan



Side plan



In the functional block diagram, BMS has use to charge the battery and it has separate power input and output ports.



User-centered design

User survey

To obtain diverse user feedback and identify potential areas for improvement, we conducted surveys among university undergraduates and external individuals regarding the initial design. To achieve this, we developed a questionnaire containing the following inquiries.

1. How frequently do you use a power bank and for what purposes?
2. What are the most critical features or capabilities you look for in a power bank?
3. What is your preferred battery capacity (mAh) for a power bank?

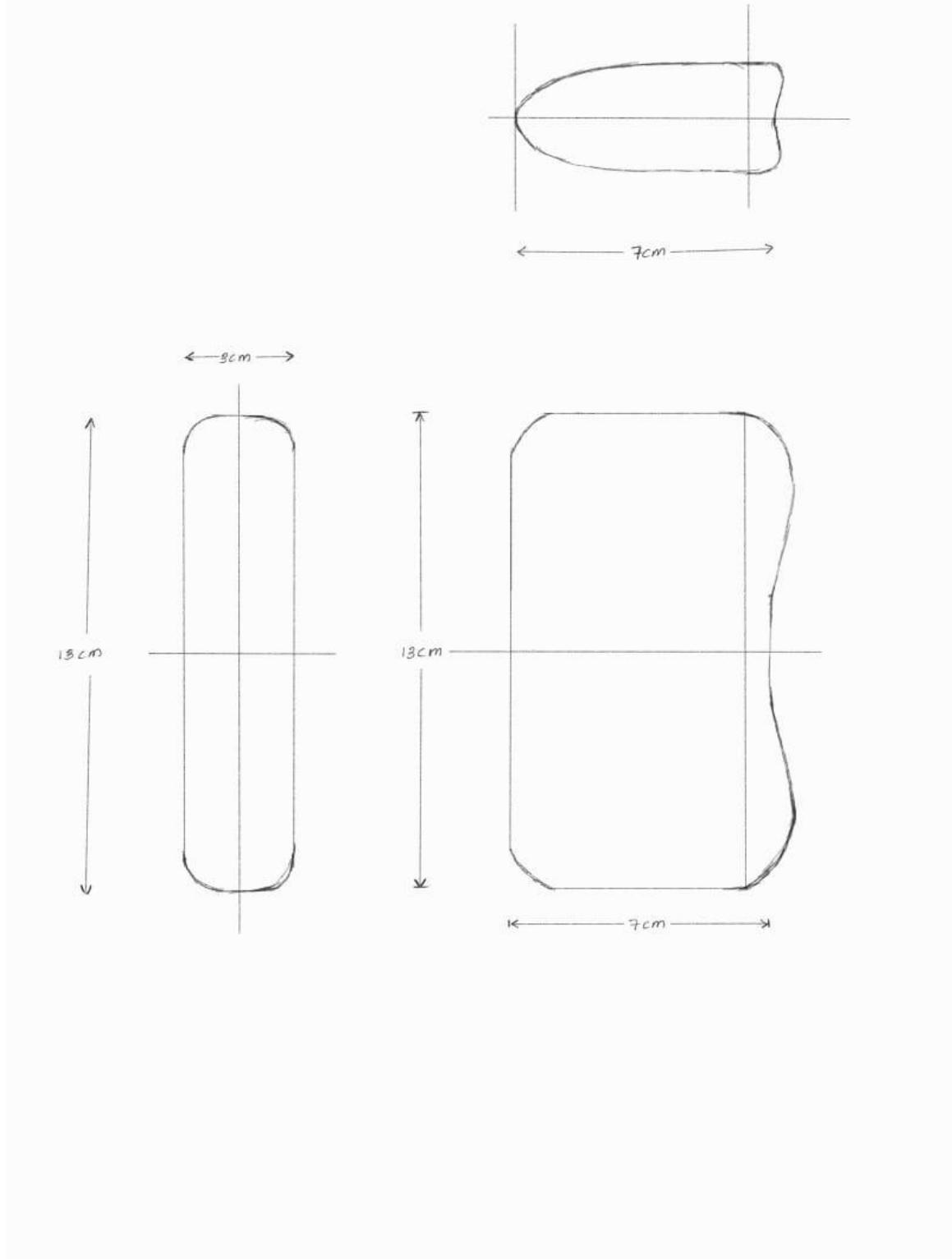
4. How important is the size and weight of a power bank to you?
5. Are there any specific charging ports or compatibility requirements you need the power bank to have?

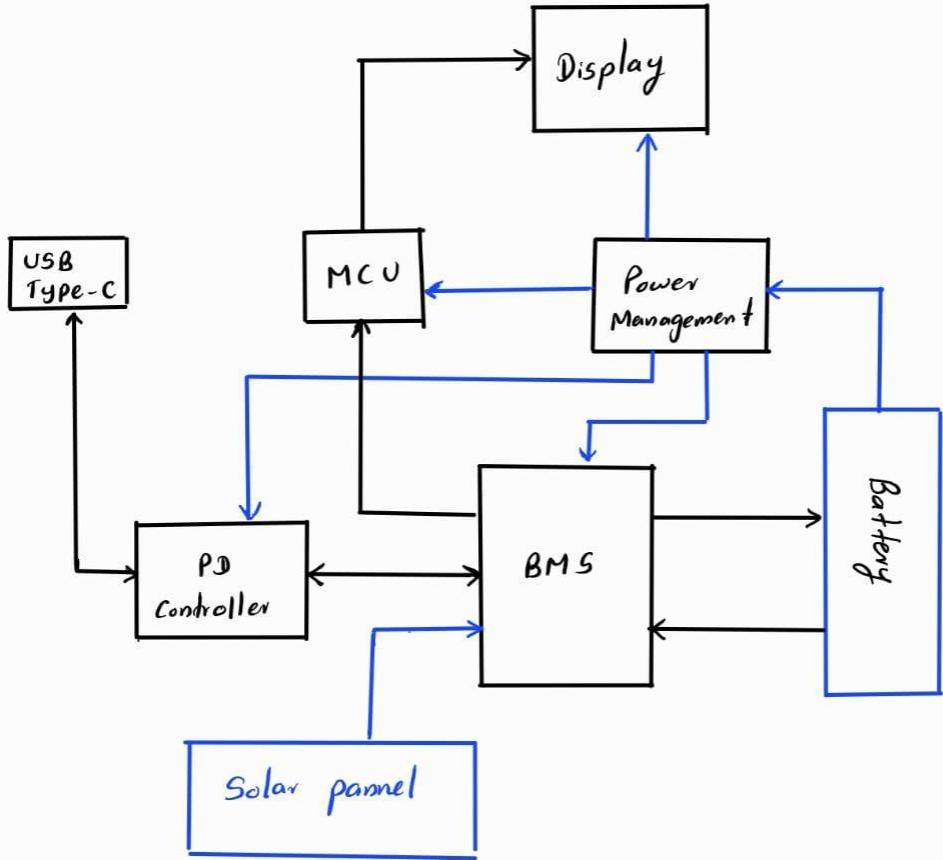
User Feedback

1. I use a power bank at least once a week when I'm traveling or in situations where I can't access a power outlet.
2. Fast charging, multiple USB ports, and a compact design are important features for me.
3. I prefer a power bank with a battery capacity of around 10,000mAh. That's usually enough to charge my phone multiple times.
4. I value a compact and lightweight power bank that I can easily carry in my pocket or bag without adding much weight.
5. It would be great if the power bank has both USB-A and USB-C ports to charge different devices. Compatibility with both Android and iPhone devices is also important.

Therefore, by considering above needs, we designed a new power bank

Design 4





Selection Matrix

I decided to use the following criteria to create my performance matrix for choose the best **sketch** out of these things.

1. Aesthetics: Assess the overall visual appeal and design of each power bank sketch. Factors such as the shape, color, texture, and overall attractiveness of the design.
2. Ergonomics: Evaluate the ergonomics of each power bank sketch, considering factors such as the size, weight, and comfort of holding and handling the power bank.
3. Port Accessibility: Assess the accessibility and placement of ports on each power bank sketch. Factors such as the ease of plugging and unplugging devices into the power bank are considered.
4. Button/Control Placement: Evaluate the placement and functionality of buttons or controls on each power bank sketch. Factors such as the ease of use and accessibility of the power bank's controls are considered.
5. Durability: Assess the perceived durability of each power bank sketch. I considered factors such as the material quality and construction of the power bank's outer design.
6. Branding/Logo Placement: Evaluate the positioning and visibility of branding elements or logos on each power bank sketch. Considered factors such as the prominence and alignment of branding on the power bank's design.

7. Versatility/Compatibility: Assess the versatility and compatibility of each power bank sketch with different devices. Considered factors such as the size and shape of the power bank's design, may impact its compatibility with various devices.

8. User Feedback/Preference: Consideration of user feedback or preferences when evaluating the power bank sketches. This could be gathered through surveys, interviews, or focus groups to understand user preferences for power bank designs.

In the performance matrix, I will give marks from 1 to 4. Because when we put marks from 1 to 4, I have not mid mark and it will help avoid receiving same marks for two products.

And also I added a weight for each criteria according to the importance of each one.

Criteria	Weight	Design 1	Design 2	Design 3	Design 4
Aesthetics	3	2*3	3*3	2*3	4*3
Ergonomics	2	3*2	3*2	3*2	4*2
Port Accessibility	2	3*2	2*2	4*2	3*2
Button/Control Placement	1	2*1	2*1	3*1	2*1
Durability	4	2*4	3*4	2*4	2*4
Branding/Logo Placement	2	2*2	4*2	3*2	3*2
Versatility/Compatibility	3	2*3	3*3	3*3	3*3
User Feedback/Preference	3	1*3	2*3	2*3	4*3
Total		41	56	52	63

When creating a selection matrix for the **functional block diagram**, I considered the following seven evaluation criteria:

1. Functionality: Evaluate how well the functional block diagram fulfills the required functions and meets the system requirements. Assess the completeness and effectiveness of the proposed solution in achieving the desired outcomes.
2. Modularity: Assess the degree to which the functional block diagram allows for modular design and integration. Consider the ease of adding, removing, or modifying functional blocks without causing significant disruptions or requiring extensive rework.
3. Interoperability: Evaluate the compatibility and interoperability of the functional blocks within the diagram. Consider whether the blocks can seamlessly communicate and exchange information with each other and with external systems, ensuring smooth integration into the overall system.
4. Scalability: Assess the ability of the functional block diagram to scale up or down, depending on the system requirements. Consider whether it can accommodate future expansion, additional functionalities, or changes in system size without significant redesign or reconfiguration.
5. Reliability: Evaluate the reliability and robustness of the functional block diagram. Consider factors such as fault tolerance, error handling, and the ability to recover from failures. Assess the impact of failures in one functional block on the overall system performance.
6. Performance: Assess the performance characteristics of the functional block diagram, such as speed, throughput, latency, and efficiency. Evaluate whether the diagram meets the required performance metrics and whether it optimizes

resource utilization, minimizes bottlenecks, and achieves acceptable levels of responsiveness.

7. Maintainability: Consider the ease of maintaining and updating the functional block diagram throughout its lifecycle. Evaluate factors such as documentation, clarity of design, ease of troubleshooting, and the availability of tools and resources for maintenance and support.

Criteria	Weight	Design 1	Design 2	Design 3	Design 4
Functionality	3	3*3	3*3	3*3	4*3
Modularity	2	1*2	2*2	4*2	3*2
Interoperability	2	1*2	2*2	3*2	3*2
Scalability	1	2*1	3*1	3*1	3*1
Reliability	4	3*4	3*4	3*4	4*4
Performance	3	2*2	3*2	3*2	4*2
Maintainability	2	2*3	3*3	3*3	3*3
Total		37	47	53	60

Conclusion

Therefore, according to the selection matrix that we have created above, the most suitable sketch and the most suitable functional block diagram are the sketch and the functional block diagram that are in **Design 4**.

Preliminary Design Cycle

Problems/Improvements identified/proposed in preliminary Design Cycle.

Problems:

- The enclosure is not attractive.
- Most of the devices have USB Type-A output.
- The design is not moldable.
- The thickness of the design is somewhat higher.

Improvement:

- Design enclosure by using hand-drawn sketches and user-attractive way.
- Add another Type-A USB port.
- Improve the design that includes draft angles.
- Change the dimensions of the design such that users can grip that easily.

Problems/Improvements identified/proposed by users.

To conduct the user need survey, I choose the following questionnaire.

1. How often do you use portable power banks?
2. What devices do you typically charge with a power bank? (e.g., smartphones, tablets, laptops, cameras)
3. How important is it for you to have a power bank that can be charged using solar power?
4. Are you familiar with using solar power to charge electronic devices?
5. What features do you value the most in a power bank? (e.g., battery capacity, fast charging, multiple ports)
6. How long do you usually expect a power bank to last before needing to be recharged?

7. In what outdoor activities or situations would you use a solar-powered power bank?
8. What is your primary reason for considering a solar-powered power bank? (e.g., environmental impact, convenience, emergency backup)
9. Are you willing to pay a premium price for a power bank with solar charging capabilities compared to a regular power bank?
10. What is the ideal size and weight of a power bank for your needs?
11. How important is it for the power bank to have multiple charging ports to simultaneously charge multiple devices?
12. Would you prefer the solar panel to be built-in or detachable?
13. What is the typical duration of sunlight exposure you can expect in your location during a typical day?
14. What is your level of concern about the environmental impact of the products you use?
15. Have you used any solar-powered devices in the past? If so, please describe your experience.
16. Would you be interested in additional features, such as a built-in flashlight or a rugged design for outdoor use?
17. What is your preferred method of connecting the power bank to devices? (e.g., USB-A, USB-C, wireless)
18. Are you interested in monitoring the charging progress and battery level through a mobile app or LED indicators?
19. Do you have any concerns or requirements regarding the compatibility of the power bank with different devices or operating systems?
20. Is there any specific design or functionality requirement you would like to see in a solar-powered power bank?

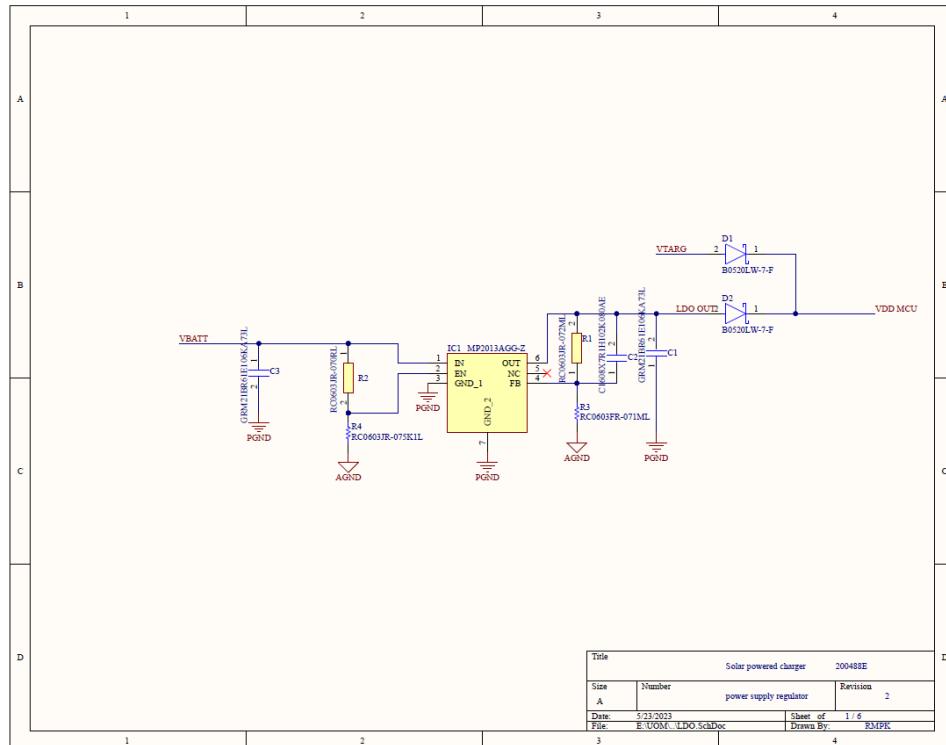
Users proposed things:

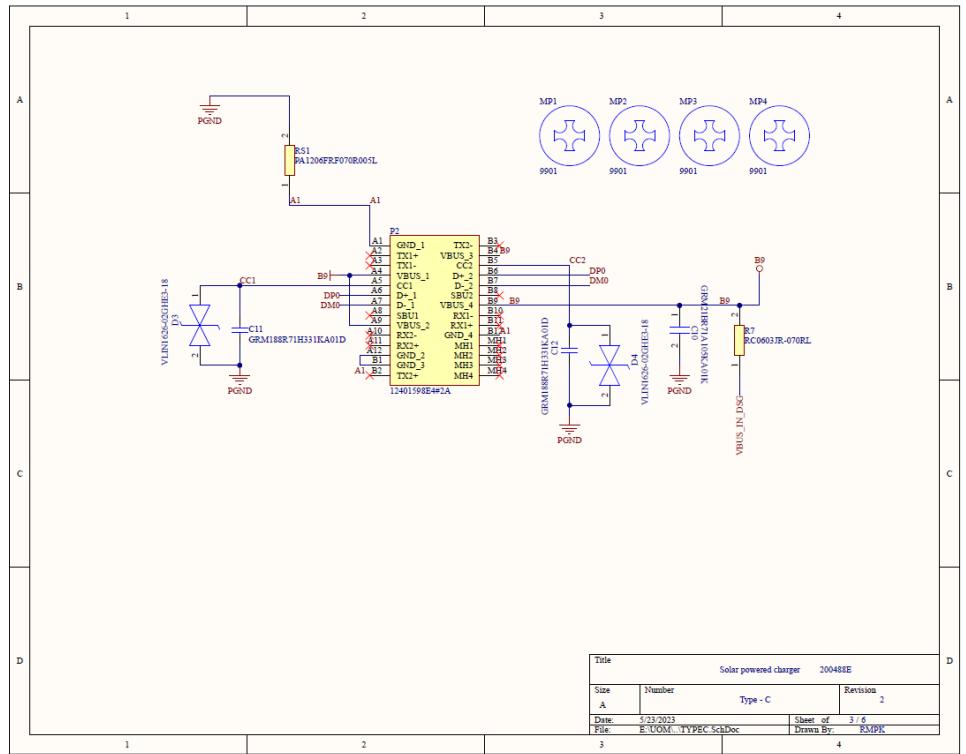
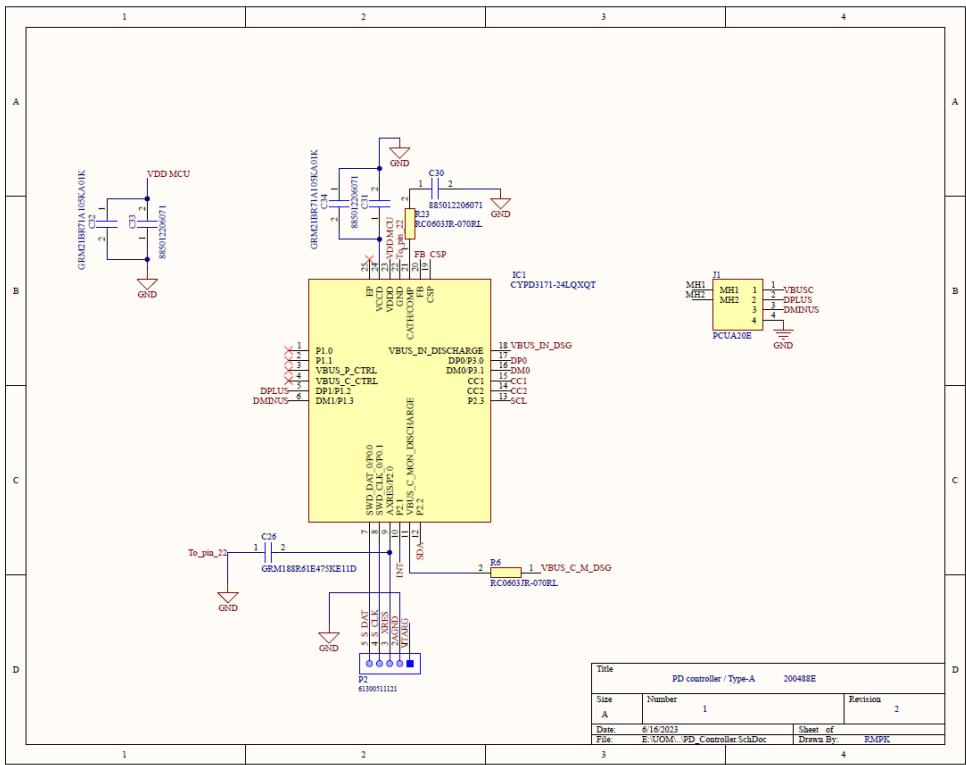
1. Sleek and modern designs
2. Clear branding options
3. Options can help attract customers.
4. Durable construction that can withstand occasional rough handling.
5. Smart power management system
6. Advanced safety features

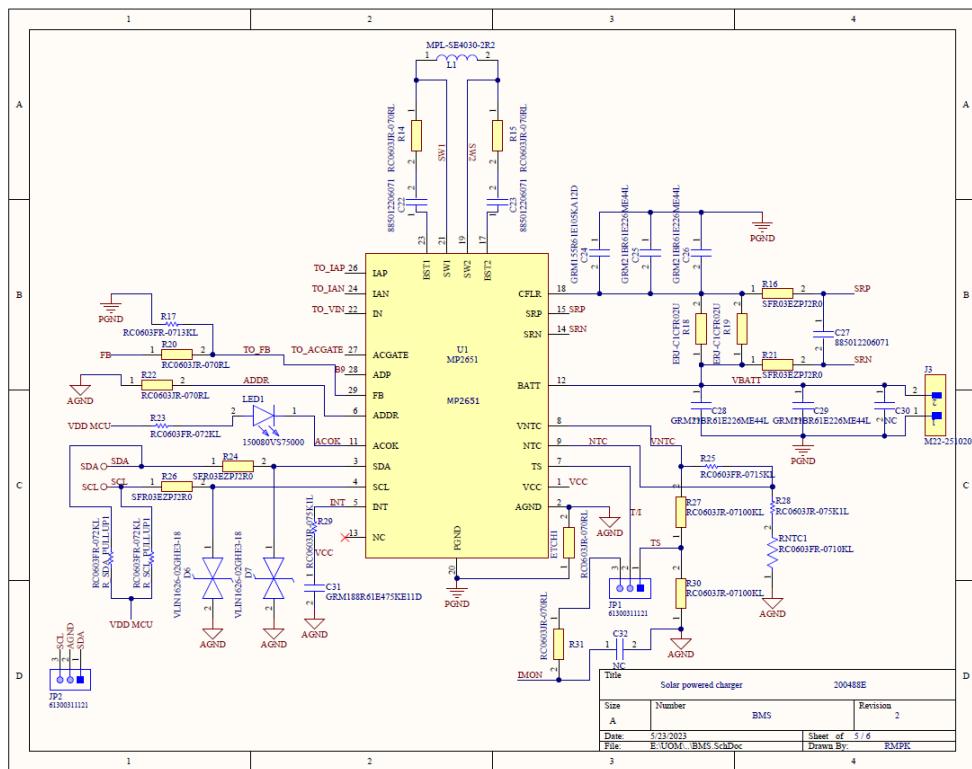
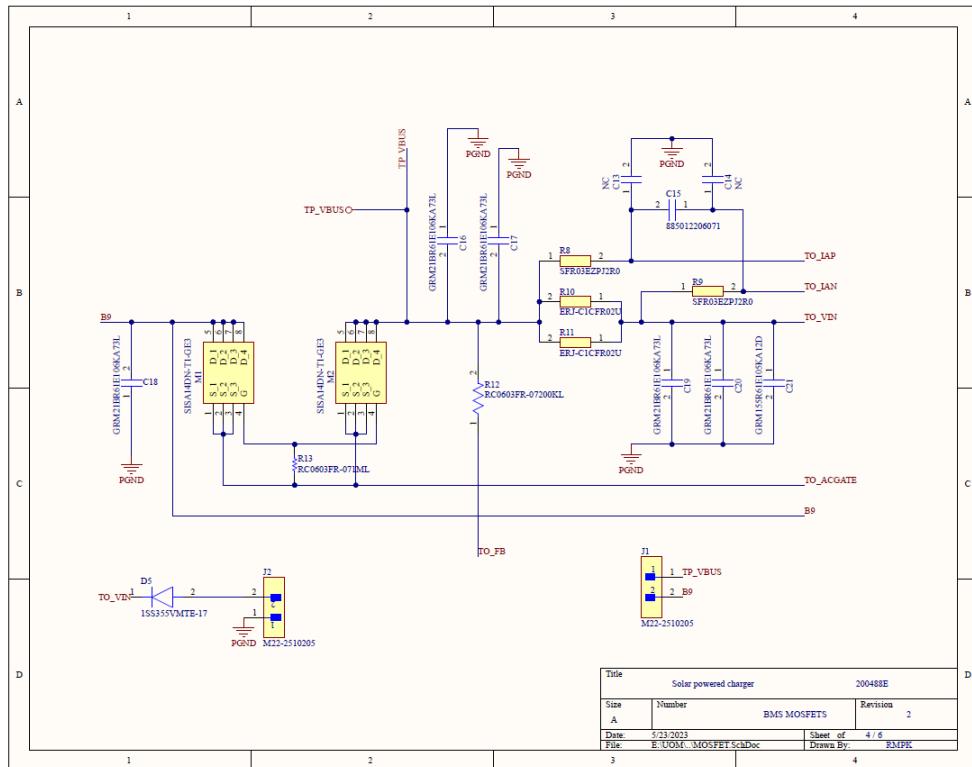
Improved design

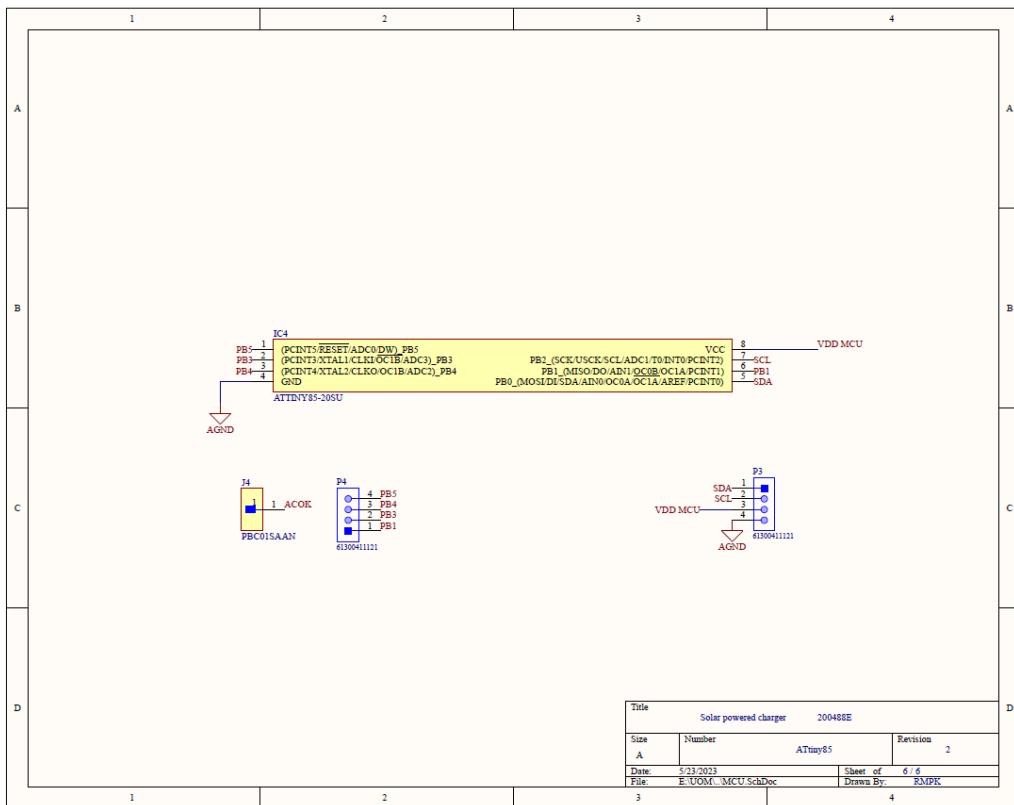
Schematic

I added USB-Type A port. Because all other features already had in my design.

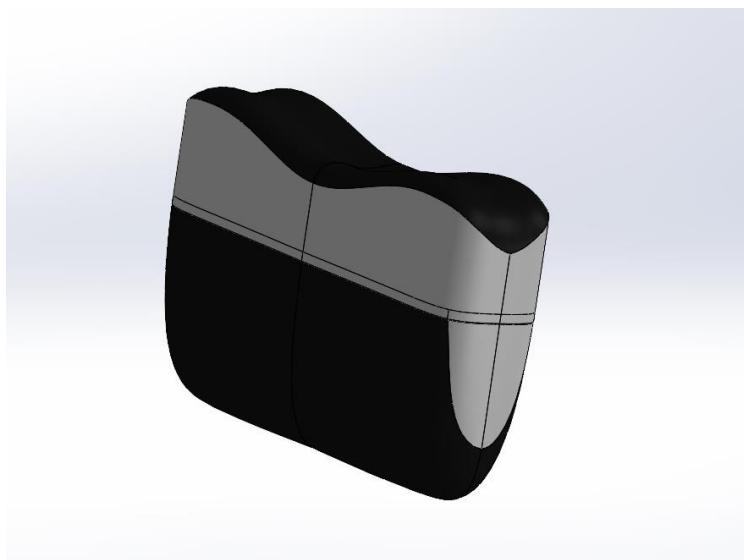
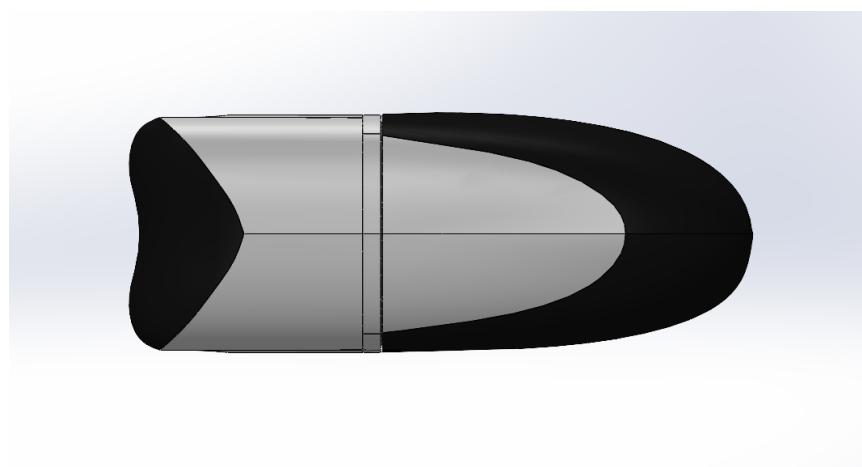
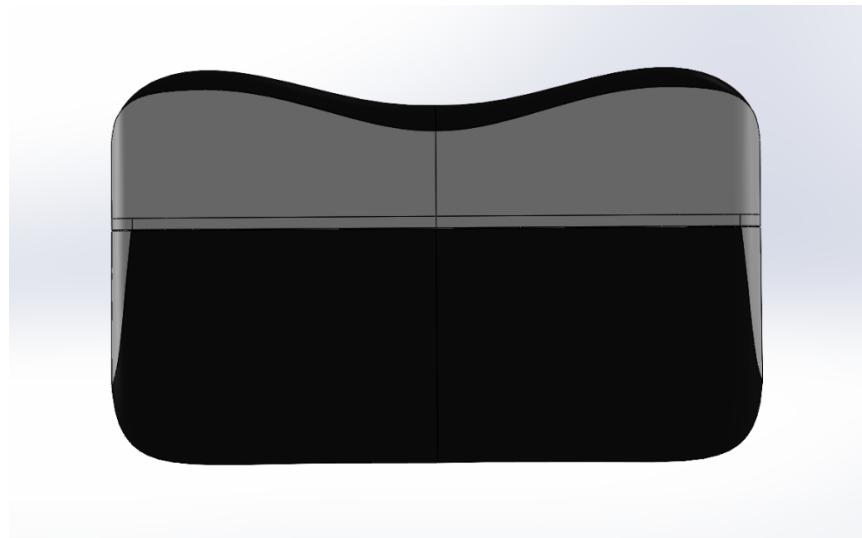


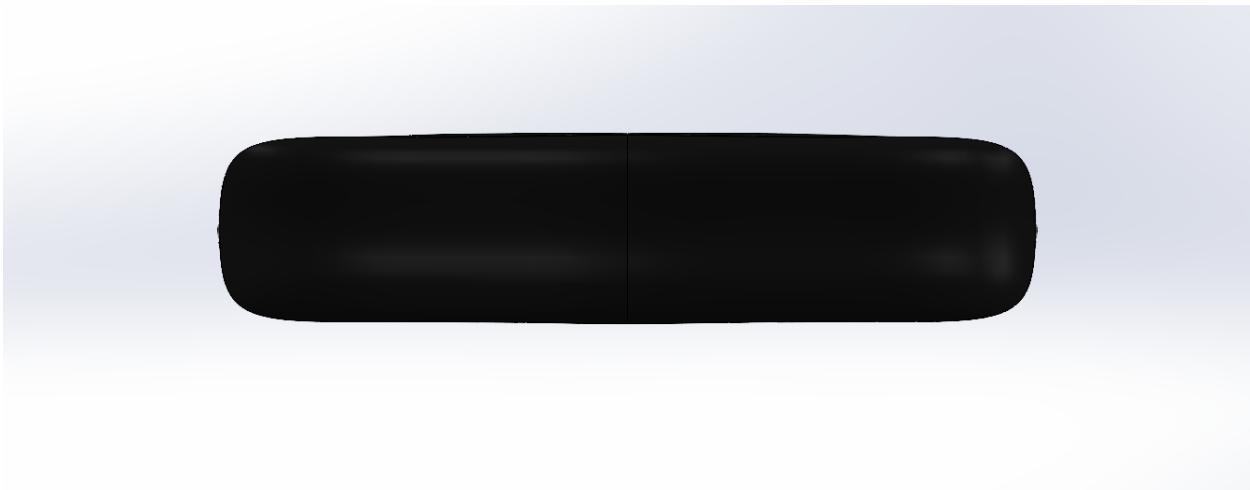
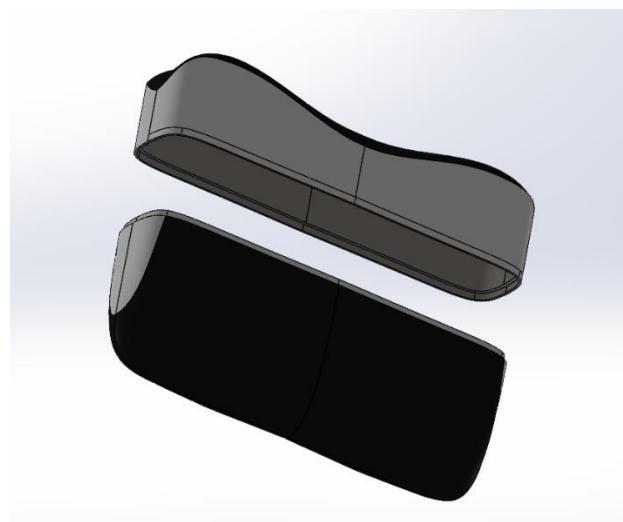




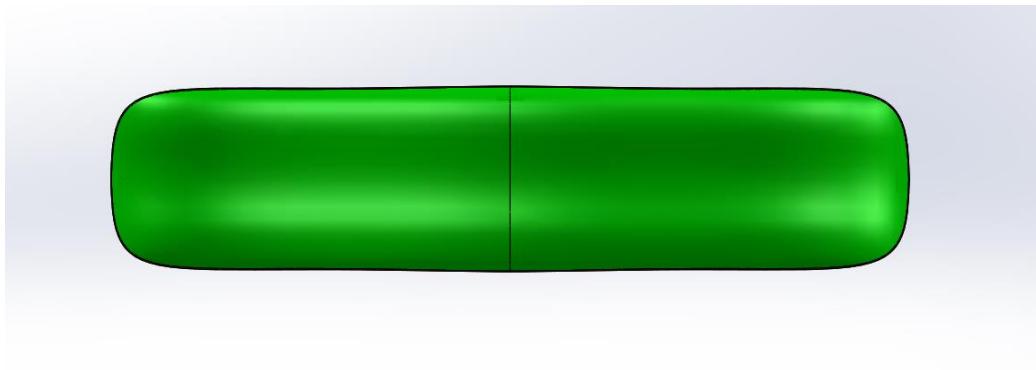
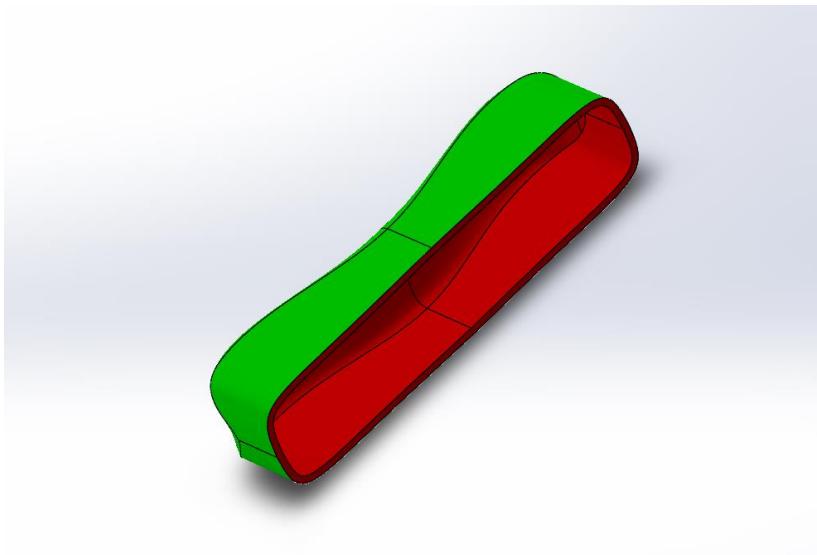
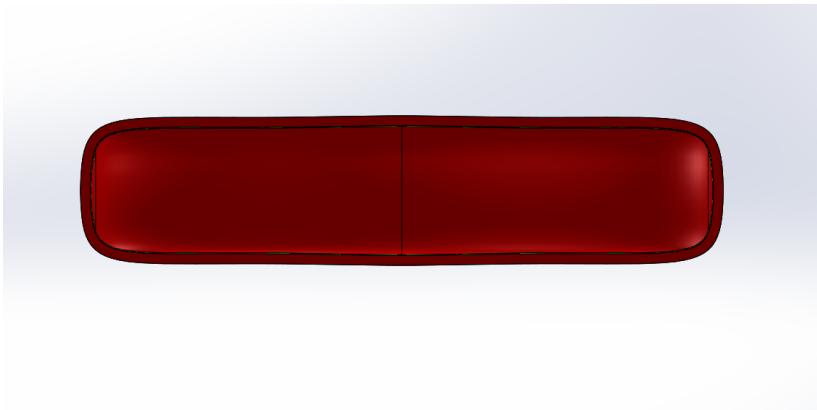


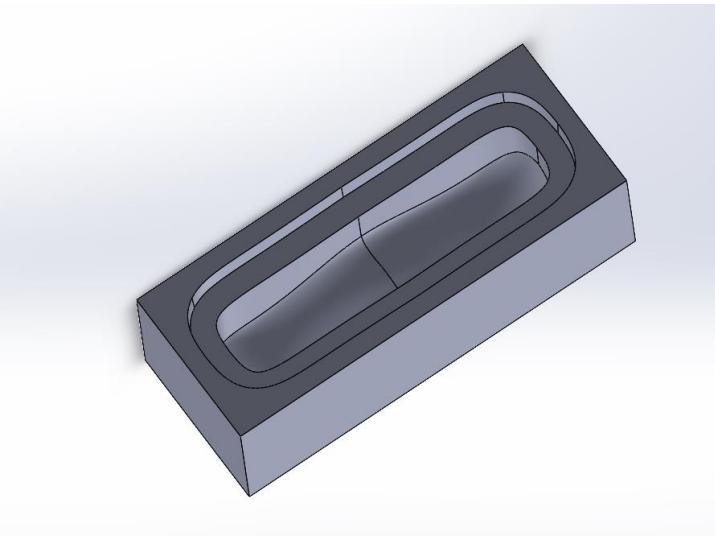
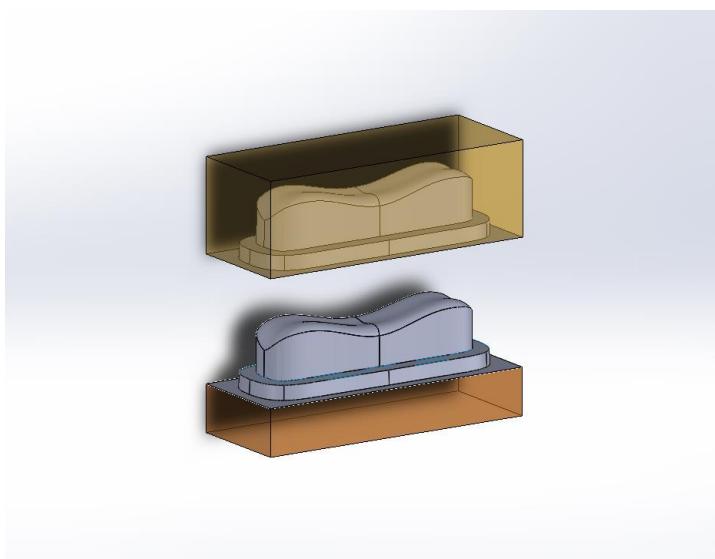
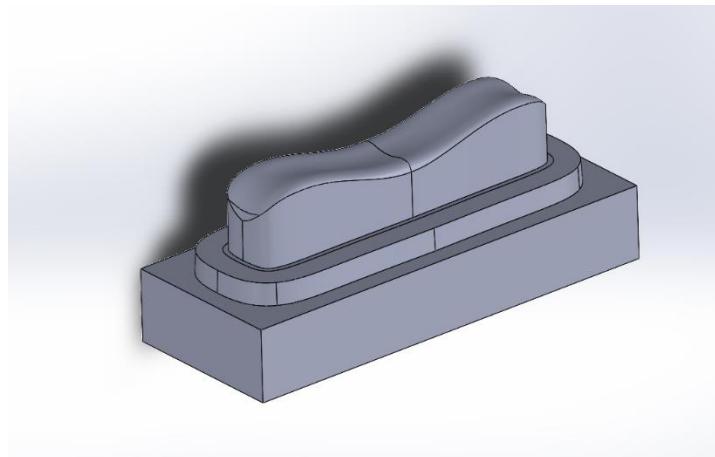
Solidworks Design





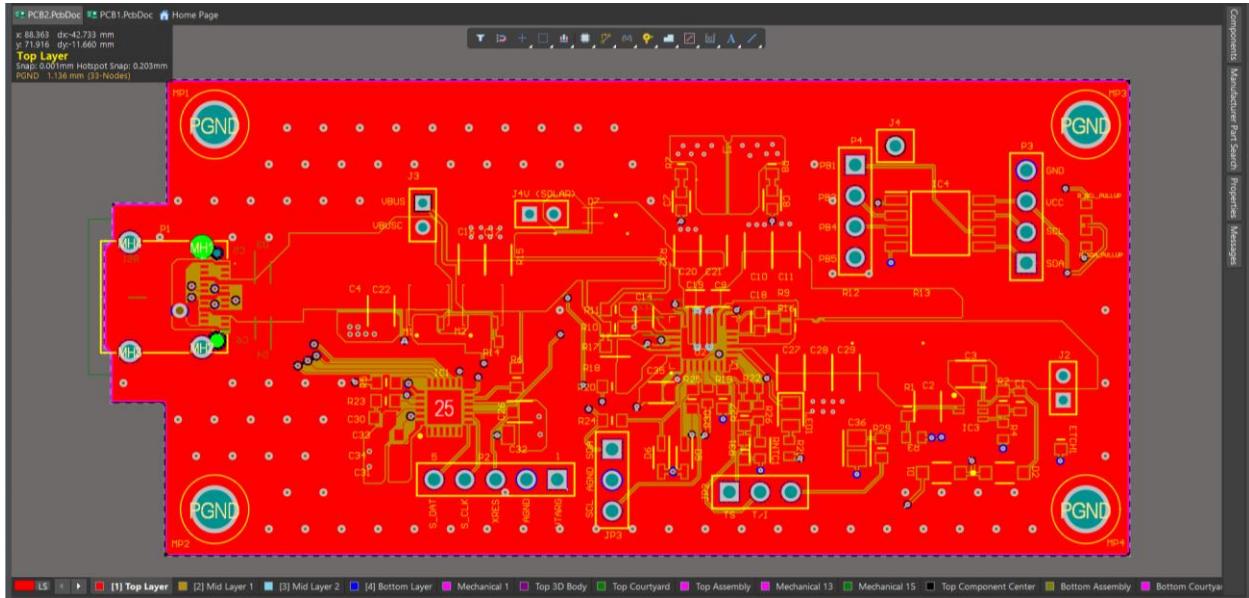
Draft analysis and mold design.



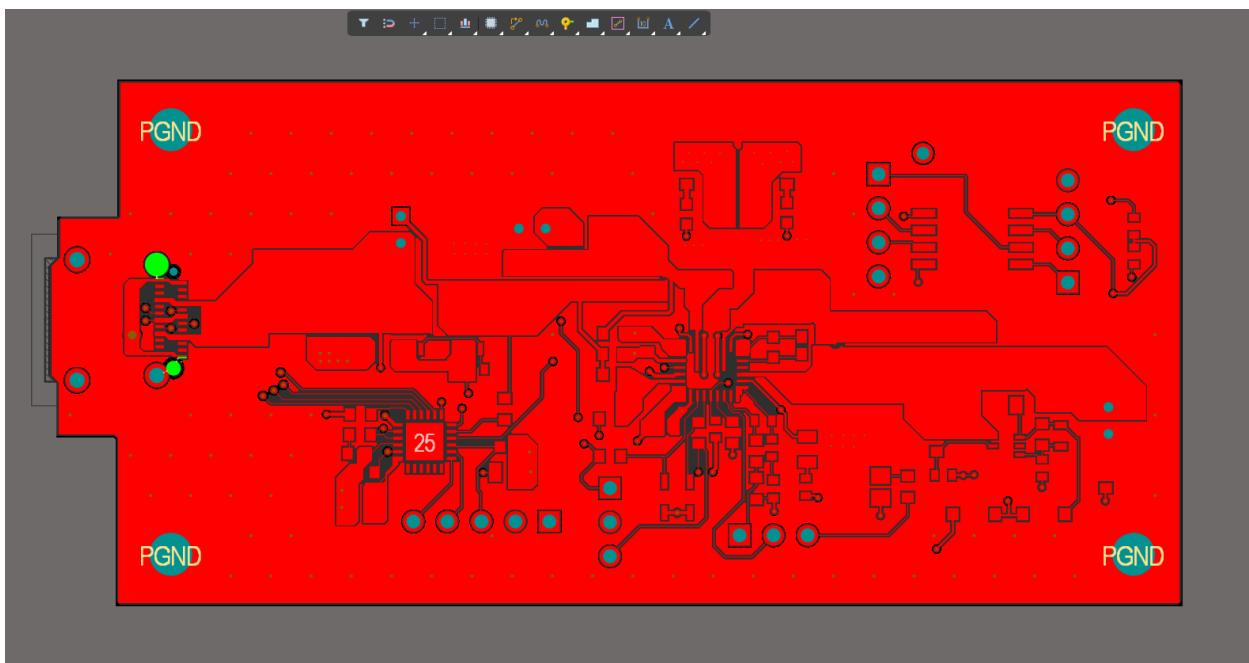


Final Implemented Design

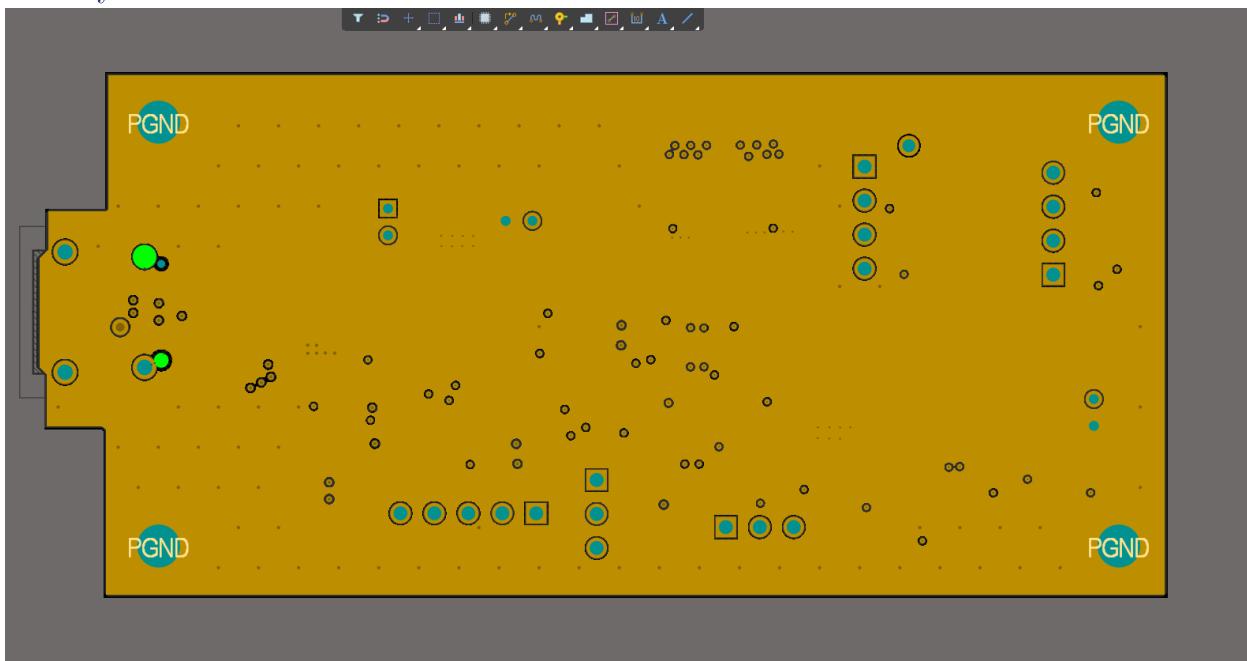
PCB Design & PCB



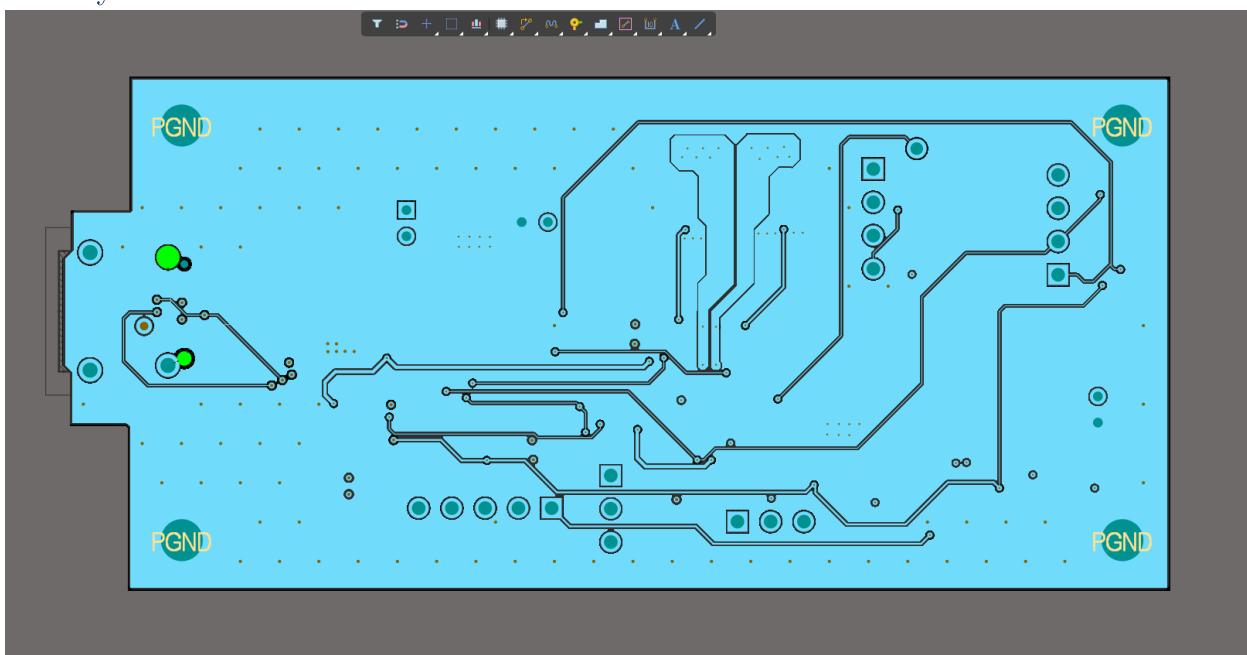
Top layer



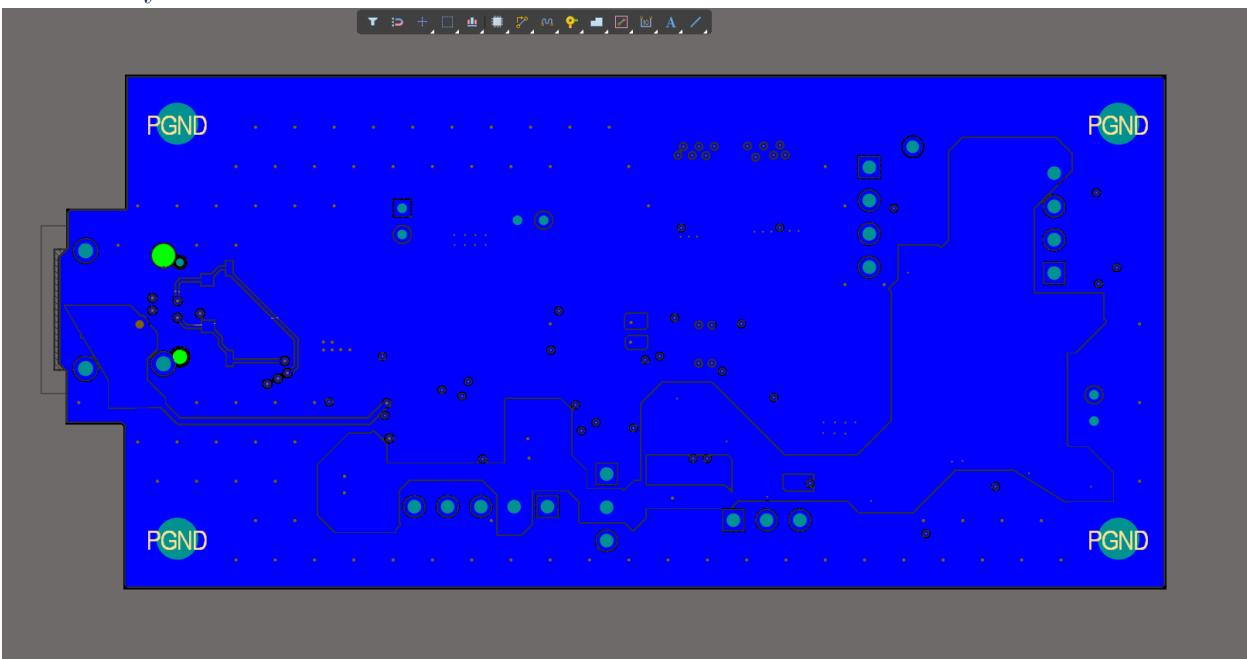
Mid layer – 1



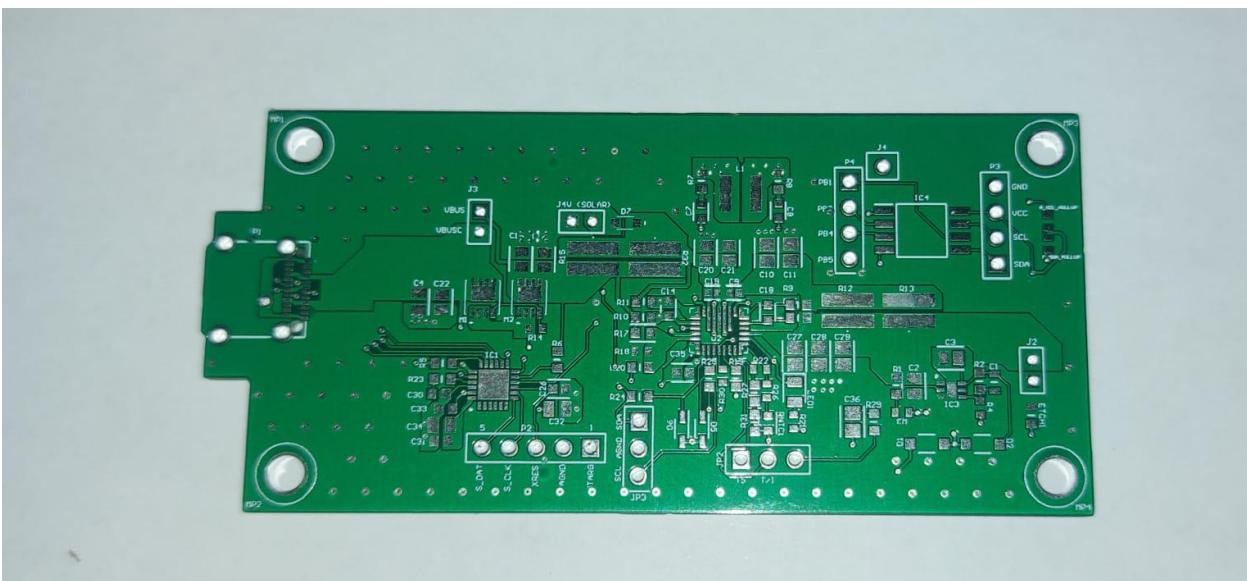
Mid layer – 2

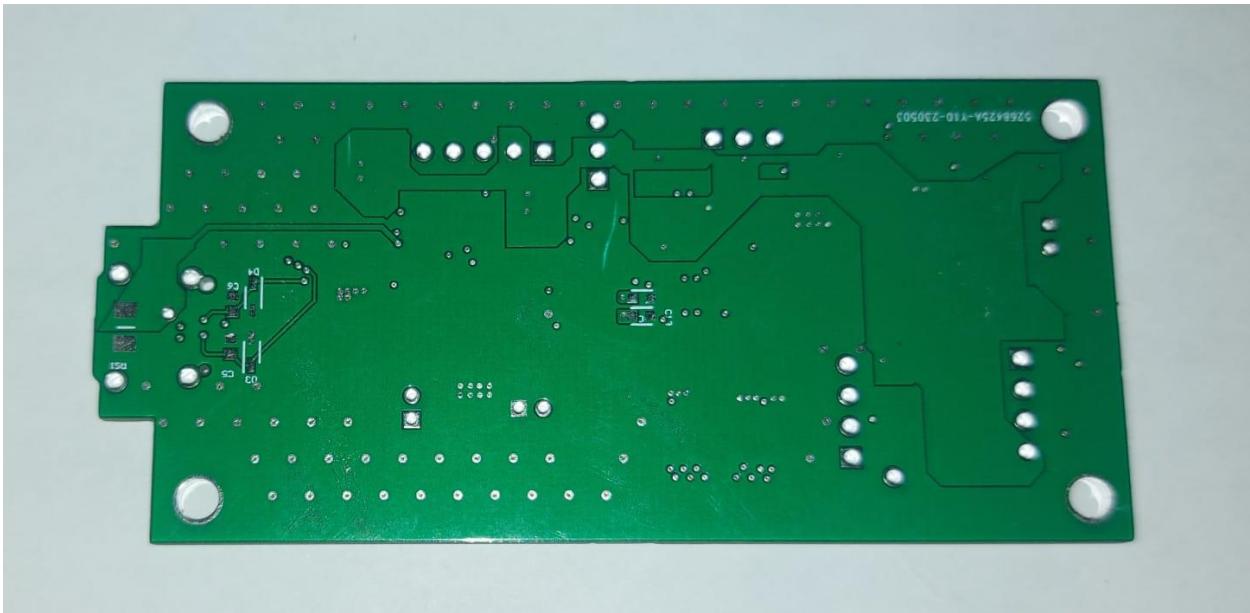


Bottom layer



Printed PCB





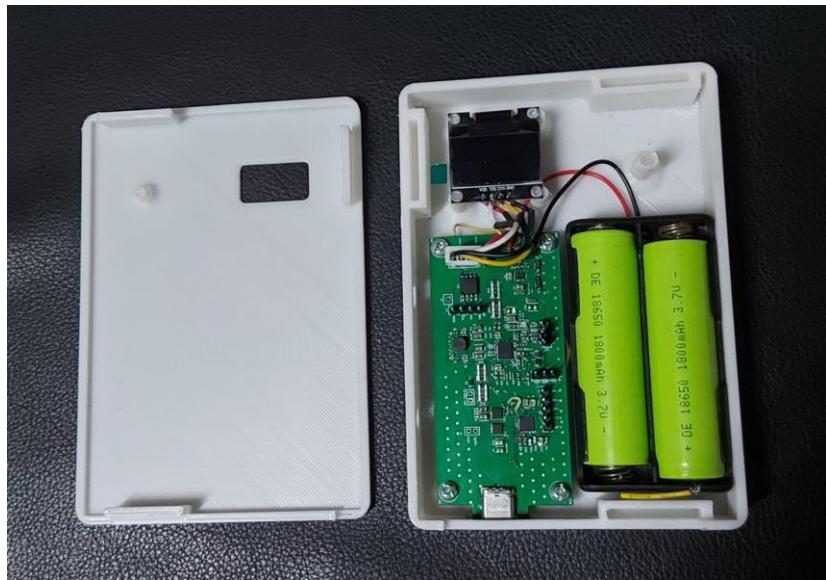
Enclosure Design & Enclosure

Since molding is not possible with small quantities, I selected 3D printable design for this.





Final assembly



Market Analysis

1. Market Overview:

The market for portable power banks has experienced significant growth in recent years, driven by the rising adoption of smartphones, tablets, wearables, and other portable devices. As consumers increasingly seek reliable and eco-friendly charging solutions, solar-powered battery chargers have gained traction due to their sustainability and environmental benefits. The demand for customized power banks that can efficiently charge Li-ion batteries is expected to witness substantial growth, catering to the needs of environmentally-conscious consumers.

2. Growing Environmental Awareness:

The increasing awareness of environmental issues and the need for sustainable solutions have created a growing market for eco-friendly products. Solar-powered battery chargers align with this trend, appealing to consumers who are conscious of their ecological footprint. As more people seek greener alternatives, the demand for customized solar-powered Li-ion battery charger power banks is likely to rise.

3. Expanding Mobile Device Market:

The global market for smartphones, tablets, and other portable devices continues to expand rapidly. With the proliferation of these devices, the need for portable charging solutions has become crucial. Customized power banks that support Li-ion batteries offer compatibility with a wide range of modern gadgets, making them highly appealing to the tech-savvy consumer base.

4. Outdoor Enthusiasts and Travelers:

Outdoor enthusiasts, frequent travelers, and adventurers often find themselves in locations without access to traditional power sources. Customized solar-powered battery charger power banks become invaluable companions in these situations, providing a

reliable and sustainable source of energy to keep their devices charged during their adventures.

5. Emergencies and Disaster Preparedness:

Power outages and emergencies can leave people without access to electricity for extended periods. In such scenarios, solar-powered chargers become essential for keeping communication devices operational and ensuring access to emergency information. This need for reliable power during emergencies contributes to the demand for customized power banks with solar charging capabilities.

6. Technological Advancements:

Advancements in solar technology and battery efficiency have significantly improved the performance of solar-powered chargers. Higher conversion rates, better energy storage, and faster charging times make customized solar-powered Li-ion battery charger power banks more appealing to consumers seeking convenient and efficient charging solutions.

7. Competitive Landscape:

The market for portable power banks is competitive, with several established brands and emerging players offering a variety of charging solutions. Differentiation through customization and unique features, such as smart charging algorithms, LCD displays, and battery protection mechanisms, can help products stand out in the market.

8. Price and Affordability:

While customized power banks with advanced features may attract tech enthusiasts, ensuring affordability remains essential for broader market penetration. The availability of low-cost solar cells and efficient manufacturing processes can play a significant role in making these chargers competitive in the market.

Conclusion:

The market for customized solar-powered Li-ion battery charger power banks is poised for growth, driven by the increasing demand for eco-friendly and versatile charging solutions. With the expanding mobile device market, rising environmental consciousness, and the need for reliable power in outdoor settings and emergencies, these chargers offer an appealing and sustainable solution for modern consumers. Technological advancements and a competitive landscape present an opportunity for innovative products to thrive, capturing a significant share in this dynamic and evolving market.

Manufacturing and Cost Analysis

Manufacturing process:

The manufacturing process for the customized solar-powered Li-ion battery charger power bank involves several key stages:

Component Sourcing: The first step is to procure the necessary components, including high-quality lithium-ion battery cells, solar panels, voltage regulators, microcontrollers, LED indicators, charging ports, and other electronic components. Except batteries, all other components ordered from **Mouser Electronics**.

PCB: The PCB was designed by using Altium designer software and printed from JLC PCB. I assembled the PCB locally by my self.

Enclosure Design and Manufacturing: The power bank's housing is designed using computer-aided design (CAD) software (Solidworks) to achieve an optimal combination of aesthetics and functionality. The enclosure is then manufactured using 3D printing in locally.

Solar Panel Integration: Solar panels are integrated into the power bank's design, ensuring efficient solar energy harvesting. The panels are mounted securely onto the enclosure, allowing them to capture sunlight effectively.

Quality Control and Testing: Throughout the manufacturing process, stringent quality control measures are implemented to identify and rectify any defects or issues. Each power bank undergoes rigorous testing to verify its functionality, safety, and compliance with industry standards.

Cost Analysis:

The prototype's production cost of approximately \$80 provides a baseline for estimating the overall manufacturing cost for the solar-powered Li-ion battery charger power bank.

Bill of Materials

Bill of Materials

Item	Unit Price (Rs.)	Amount	Total (Rs.)
Resistors, Capacitors and ICs	Attached separately		12800
OLED Display	900	1	900
Li-ion Battery	600	2	1200
Battery Casing	150	1	150
Headers	75	2	150
Wires and heat shrink	100		100
Enclosure	5000	1	5000
	Sub Total		20300



SHOPPING CART

This is not an invoice.

Sort	Product Detail	Description	Quantity	Availability	Unit Price (USD)	Ext. Price (USD)
1	Mouser #: 810-C1608X7R1H102KAE Mfr. #: C1608X7R1H102K080AE Mfr.: TDK Customer #: Customer #	Multilayer Ceramic Capacitors MLCC - SMD/SMT SOFT 0603 50V 1000pF XTR 10% T: 0.8mm RoHS Compliant	1	1 Ships Now	\$0.15	\$0.15
2	Mouser #: 81-GRM21BR61E106KA3L Mfr. #: GRM21BR61E106KA73L Mfr.: Murata Customer #: Customer #	Multilayer Ceramic Capacitors MLCC - SMD/SMT 10 uF 25 VDC 10% 0805 X5R RoHS Compliant	7	7 Ships Now	\$0.21	\$1.47
3	Mouser #: 81-GRM40X105K10K Mfr. #: GRM21R71A105KA01K Mfr.: Murata Customer #: Customer #	Multilayer Ceramic Capacitors MLCC - SMD/SMT 1 uF 10 VDC 10% 0805 X7R RoHS Compliant	3	3 Ships Now	\$0.17	\$0.51
4	Mouser #: 710-885012206080 Mfr. #: 885012206080 Mfr.: Würth Elektronik Customer #: Customer #	Multilayer Ceramic Capacitors MLCC - SMD/SMT WCAP-CSGP 330pF 0603 10% 50V MLCC RoHS Compliant	2	2 Ships Now	\$0.10	\$0.20
5	Mouser #: 710-885012206071 Mfr. #: 885012206071 Mfr.: Würth Elektronik Customer #: Customer #	Multilayer Ceramic Capacitors MLCC - SMD/SMT WCAP-CSGP 0.1uF 0603 10% 25V MLCC RoHS Compliant	7	7 Ships Now	\$0.10	\$0.70
6	Mouser #: 81-GRM15R61E105KE1J Mfr. #: GRM15R61E105KE1J Mfr.: Murata Customer #: Customer #	Multilayer Ceramic Capacitors MLCC - SMD/SMT 1 uF 25 VDC 10% 0402 X5R RoHS Compliant	2	2 Ships Now	\$0.10	\$0.20
7	Mouser #: 81-GRM21BR61E226ME4L Mfr. #: GRM21BR61E226ME4L Mfr.: Murata Customer #: Customer #	Multilayer Ceramic Capacitors MLCC - SMD/SMT 22 uF 25 VDC 10% 0805 X5R RoHS Compliant	4	4 Ships Now	\$0.36	\$1.44
8	Mouser #: 81-GRM188R61E475KE1D Mfr. #: GRM188R61E475KE1D Mfr.: Murata Customer #: Customer #	Multilayer Ceramic Capacitors MLCC - SMD/SMT 4.7 uF 25 VDC 10% 0603 X5R RoHS Compliant	2	2 Ships Now	\$0.24	\$0.48
	Mouser #: 621-B0520LW-F					
9	Mfr. #: B0520LW-7-F Mfr.: Diodes Incorporated Customer #: Customer #	Schottky Diodes & Rectifiers 20V 410mW RoHS Compliant	2	0 Ships Now 2 Backordered	\$0.34	\$0.68
10	Mouser #: 78-VLIN1626-02GHE318 Mfr. #: VLIN1626-02GHE-18 Mfr.: Vishay Customer #: Customer #	ESD Suppressors / TVS Diodes Low Cap Sgle ESD AEC-Q101 Qualified RoHS Compliant	4	4 Ships Now	\$0.47	\$1.88
11	Mouser #: 755-1SS355VMTE-17 Mfr. #: 1SS355VMTE-17 Mfr.: ROHM Semiconductor Customer #: Customer #	Diodes - General Purpose, Power, Switching DIODE SWITCHING RoHS Compliant	2	2 Ships Now	\$0.20	\$0.40

12		Mouser #: 603-RC0603JR-070RL Mfr. #: RC0603JR-070RL Mfr.: YAGEO Customer #: Customer #	Thick Film Resistors - SMD 0 Ohms 100 mW 0603 5% RoHS Compliant By Exemption	<input type="button" value="10"/> Packaging: **Cut Tape	10 Ships Now	\$0.009	\$0.09
13		Mouser #: 727-CYPD3171-24LQXQ Mfr. #: CYPD3171-24LQXQ Mfr.: Infineon Customer #: Customer #	USB Interface IC USB Type-C Port Controller RoHS Compliant	<input type="button" value="1"/> Packaging:	1 Ships Now	\$2.81	\$2.81
14		Mouser #: 946-MP2013AGG-Z Mfr. #: MP2013AGG-Z Mfr.: Monolithic Power Systems (MPS) Customer #: Customer #	LDO Voltage Regulators 40V,150mA,Low Quiescent Current Linear Regulator RoHS Compliant	<input type="button" value="1"/> Packaging:	1 Ships Now	\$1.36	\$1.36
15		Mouser #: 556-ATTINY85-20SU Mfr. #: ATTINY85-20SU Mfr.: Microchip Customer #: Customer #	8-bit Microcontrollers - MCU AVR 8K FLASH 512B EE 512B SRAM ADC 5V RoHS Compliant	<input type="button" value="1"/> Packaging:	0 Ships Now 1 Backordered	\$1.50	\$1.50
<i>Long lead time reported on this product.</i>							
16		Mouser #: 946-MPL-SE4030-2R2 Mfr. #: MPL-SE4030-2R2 Mfr.: Monolithic Power Systems (MPS) Customer #: Customer #	Power Inductors - SMD SemiShielded Series, size dimension: 4030, Inductance value: 2.2uH RoHS Compliant	<input type="button" value="1"/> Packaging:	1 Ships Now	\$0.57	\$0.57
17		Mouser #: 523-12401598E4#2A Mfr. #: 12401598E4#2A Mfr.: Amphenol Customer #: Customer #	USB Connectors USB TYPE C RCPT R/A HYBRID DUAL SMT RoHS Compliant	<input type="button" value="1"/> Packaging: **Cut Tape	0 Ships Now 1 Backordered	\$1.56	\$1.56
18		Mouser #: 710-150080V-S75000 Mfr. #: 150080V- Mfr.: Würth Elektronik Customer #: Custom	Standard LEDs - SMD WL-	<input type="button" value="2"/> <input type="button" value="4"/> <input type="button" value="3"/> <input type="button" value="4"/> <input type="button" value="5"/> <input type="button" value="6"/> <input type="button" value="7"/> <input type="button" value="8"/> <input type="button" value="9"/> <input type="button" value="10"/> <input type="button" value="11"/> <input type="button" value="12"/> <input type="button" value="13"/> <input type="button" value="14"/> <input type="button" value="15"/> <input type="button" value="16"/> <input type="button" value="17"/> <input type="button" value="18"/> <input type="button" value="19"/> <input type="button" value="20"/> <input type="button" value="21"/> <input type="button" value="22"/> <input type="button" value="23"/> <input type="button" value="24"/> <input type="button" value="25"/> <input type="button" value="26"/> <input 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26		Mouser #: 603-RC0603FR-0713KL Mfr. #: RC0603FR-0713KL Mfr.: YAGEO Customer #: Customer #	Thick Film Resistors - SMD 13 kOhms 100mW 0603 1% RoHS Compliant By Exemption	<input type="button" value="1"/>	Packaging: **Cut Tape	1 Ships Now	\$0.10	\$0.10														
27		Mouser #: 603-RC0603FR-072KL Mfr. #: RC0603FR-072KL Mfr.: YAGEO Customer #: Customer #	Thick Film Resistors - SMD 2 kOhms 100mW 0603 1% RoHS Compliant By Exemption	<input type="button" value="3"/>	Packaging: **Cut Tape	3 Ships Now	\$0.10	\$0.30														
28		Mouser #: 603-RC0603FR-0715KL Mfr. #: RC0603FR-0715KL Mfr.: YAGEO Customer #: Customer #	Thick Film Resistors - SMD 15 kOhms 100mW 0603 1% RoHS Compliant By Exemption	<input type="button" value="1"/>	Packaging: **Cut Tape	1 Ships Now	\$0.10	\$0.10														
29		Mouser #: 603-RC0603JR-07100KL Mfr. #: RC0603JR-07100KL Mfr.: YAGEO Customer #: Customer #	Thick Film Resistors - SMD 100 kOhms 100 mW 0603 5% RoHS Compliant By Exemption	<input type="button" value="3"/>	Packaging: **Cut Tape	3 Ships Now	\$0.10	\$0.30														
30		Mouser #: 603-RC0603FR-0710KL Mfr. #: RC0603FR-0710KL Mfr.: YAGEO Customer #: Customer #	Thick Film Resistors - SMD 10 kOhms 100mW 0603 1% RoHS Compliant By Exemption	<input type="button" value="1"/>	Packaging: **Cut Tape	1 Ships Now	\$0.10	\$0.10														
31		Mouser #: 603-PA1206FRF070R005 Mfr. #: PA1206FRF070R005L Mfr.: YAGEO Customer #: Customer #	Current Sense Resistors - SMD 5 mOhms 250 mW 1% 100 ppm/C AEC-Q200 RoHS Compliant	<input type="button" value="1"/>	Packaging: **Cut Tape	1 Ships Now	\$0.64	\$0.64														
32		Mouser #: 946-MP2651GVT-0000-P Mfr. #: MP2651GVT-0000-P Mfr.: Monolithic Power Systems (MPS) Customer #: Customer #	Battery Management I2C-Controlled, USB PD 6A Buck-Boost Charger with OTG/Source Mode for 1-Cell to 4-Cell Series Battery Applications RoHS Compliant	<input type="button" value="1"/>		1 Ships Now	\$4.72	\$4.72														
<p>By submitting your order you agree to these terms and conditions. For additional information on availability, click on the Mouser Part #.</p> <p>**All MouseReel™ items are non-cancellable and non-returnable.</p>																						
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Future Improvements

I hope to integrate more smart features to this product in future.

Wireless Charging: Integrate wireless charging technology into the power bank, allowing compatible devices to charge without the need for cables, offering added convenience to users.

Enhanced Smart Charging Algorithm: Further optimize the microcontroller-based smart charging algorithm to adapt to various device types and battery conditions, maximizing charging efficiency and prolonging battery life.

Mobile App Compatibility: Develop a companion mobile app that provides insights into solar charging performance, battery health, and charging history, offering a seamless user experience.

High-Efficiency Solar Panels: Utilize advanced and high-efficiency solar panels to maximize solar energy conversion, ensuring faster charging times and improved overall performance even in low-light conditions.

Foldable Solar Panels: Incorporate foldable or flexible solar panels into the design, making the power bank more portable and space-efficient during travel or outdoor activities.

Multi-Functional LCD Display: Enhance the LCD display to provide real-time information on solar charging status, battery health, and estimated charging time, empowering users with insightful data.

Conclusion

The solar-powered Li-ion battery charger power bank stands as a testament to innovation and sustainability, offering a groundbreaking solution to the ever-growing demand for eco-friendly and efficient charging options. Originally designed to charge lead-acid batteries, the project evolved to cater to the practical needs of the modern consumer, focusing on Li-ion battery compatibility and leveraging cost-effective solar cells.

The power bank's core principle lies in its current and voltage regulation, ensuring a stable and optimal output voltage critical for efficient and safe charging. The integration of an overvoltage cut-off function further protects batteries from potential damage due to overcharging, enhancing the power bank's reliability.

With an impressive 18V input voltage and 12V DC output, the power bank caters to a wide range of Li-ion battery-powered devices, making it a versatile charging companion for smartphones, tablets, wearables, cameras, and more.

The incorporation of advanced features, such as a microcontroller-based smart charging algorithm, USB output, battery protection, and an LCD display, enhances user experience and optimizes device performance, providing unparalleled convenience and efficiency.

The power bank's sustainable design embraces renewable solar energy, contributing to a greener and more sustainable future. By reducing dependence on conventional power sources, it promotes environmental consciousness and aligns with the global movement towards eco-friendly solutions.

In conclusion, the customized solar-powered Li-ion battery charger power bank embodies the fusion of technological advancement and environmental responsibility. Its adaptability, efficiency, and user-centric features make it a standout product in the competitive market. As further improvements continue to refine its performance and versatility, this charging solution is poised to meet the evolving needs of tech-savvy and environmentally conscious consumers alike. With its commitment to sustainability and commitment to efficient charging, the power bank paves the way for a brighter and more sustainable future.

References

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[https://www.mouser.com/datasheet/2/196/Infineon EZ PD TM CCG3PA Datasheet USB Type C Por-3162221.pdf](https://www.mouser.com/datasheet/2/196/Infineon_EZ_PD_TM_CCG3PA_Datasheet_USB_Type_C_Por-3162221.pdf)

Appendices

OLED display controlled code

```
#include <SPI.h>
#include <Wire.h>
#include <LiFuelGauge.h>      //https://github.com/nlamprian/LiFuelGauge
#include <Adafruit_GFX.h>
#include <Adafruit_SSD1306.h>

#define SCREEN_WIDTH 128 // OLED display width, in pixels
#define SCREEN_HEIGHT 64 // OLED display height, in pixels
#define OLED_RESET 4 // Reset pin # (or -1 if sharing Arduino reset pin)
#define SCREEN_ADDRESS 0x3C // 0x3D for 128x64, 0x3C for 128x32
Adafruit_SSD1306 display(SCREEN_WIDTH, SCREEN_HEIGHT, &Wire, OLED_RESET);

void lowPower();
LiFuelGauge gauge(MAX17043, 0, lowPower);
volatile boolean alert = false;

void setup()
{
    Serial.begin(9600); // Initializes serial port
    if (!display.begin(SSD1306_SWITCHCAPVCC, SCREEN_ADDRESS))
    {
        Serial.println(F("SSD1306 allocation failed"));
        for (;;) // Don't proceed, loop forever
    }
    display.clearDisplay();

    // Waits for serial port to connect. Needed for Leonardo only
    while ( !Serial ) ;

    gauge.reset(); // Resets MAX17043
    delay(200); // Waits for the initial measurements to be made

    // Sets the Alert Threshold to 10% of full capacity
    gauge.setAlertThreshold(10);
    Serial.println(String("Alert Threshold is set to ") +
                  gauge.getAlertThreshold() + '%');
}

void loop()
```

```

{
Serial.print("SOC: ");
Serial.print(gauge.getSOC()); // Gets the battery's state of charge
Serial.print("%, VCELL: ");
Serial.print(gauge.getVoltage()); // Gets the battery voltage
Serial.println('V');

display.setCursor(0, 10); //oled display
display.setTextSize(2);
display.setTextColor(WHITE);
display.print("SOC:");
display.print(gauge.getSOC());
display.print("%");

display.setCursor(0, 40); //oled display
display.setTextSize(2);
display.setTextColor(WHITE);
display.print("VOL:");
display.print(gauge.getVoltage());
display.print("V");

display.display();
display.clearDisplay();

if ( alert )
{
  Serial.println("Beware, Low Power!");
  Serial.println("Finalizing operations... ");
  gauge.clearAlertInterrupt(); // Resets the ALRT pin
  alert = false;
  Serial.println("Storing data...");
  Serial.println("Sending notification...");
  Serial.println("System operations are halted...");
  gauge.sleep(); // Forces the MAX17043 into sleep mode
  while ( true );
}
delay(2000);
}

void lowPower()
{
  alert = true;
}

```