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# Design and Development of a Fast Charging and Protection System for HEARNU Band

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**ABSTRACT:** This project focuses on improving the performance, safety, and reliability of WeHear Innovations flagship wearable device through the replacement of the existing battery charging integrated circuit (IC) and the integration of a battery protection circuit. The objective is to enhance user experience by increasing charging speed and efficiency while ensuring the longevity and safety of the device's battery. Key tasks include prototype testing, schematic and PCB design updates, procurement of components, and rigorous testing and validation of the updated device to ensure compliance with performance standards and safety regulations. By defining a clear scope of work and adhering to a structured timeline, this project aims to deliver tangible outcomes that significantly enhance the overall performance, reliability, and user satisfaction of WeHear Innovations wearable device.

**KEYWORDS:** Fast Charging, Battery protection, Thermal regulation, Battery management system, tp4056.

## I. INTRODUCTION

As WeHear Innovations embarked on its journey of innovation and product development, it encountered a critical challenge concerning the battery charging IC integrated into its flagship wearable device. The existing battery charging IC, while functional, presented limitations that hindered the device's performance and user experience. As technology evolved and consumer expectations shifted, it became evident that upgrading this crucial component was imperative to meet the demands of a dynamic market landscape.

The main issues with the current battery charging IC are its efficiency and safety. In the fast-paced world of wearable tech, users want quick charging that fits their lifestyle, but the current IC doesn't meet these expectations. Safety is also a concern due to reports of overheating and potential burnout. WeHear Innovations prioritizes addressing these issues to ensure user satisfaction and trust. Additionally, they recognize the need for a more adaptable solution to support future product enhancements and scalability.

The project "Enhancing Battery Charging and Protection for WeHear Innovations Wearable Device" aims to upgrade the performance and safety features of their flagship wearable technology. This involves replacing the existing battery charging IC with a more efficient one and integrating a battery protection circuit. The project begins with thorough research to find suitable components, followed by prototype development and testing. After successful testing, production begins, focusing on quality assurance and compliance. Throughout the project, documentation and communication are key to ensure timely completion and address any challenges. The goal is to deliver improved performance, reliability, and user satisfaction. The scope also includes developing and implementing a Battery Management System (BMS) based on the TP4056 charging circuit for various products and components within WeHear Innovations' portfolio to meet diverse needs and ensure compatibility and performance across applications.

Paper is organized as follows: Section II describes the emergence of fast charging technology, introduction of the TP4056 Integrated Circuit (IC), converged with advancements in Battery Management Systems (BMS) to revolutionize charging speed, efficiency, and device performance. Project focuses on upgrading the HEARNU Band's charging system with the TP4056 charging IC and battery protection IC which is given in Section III. Section IV presents experimental results showing results of images tested also, the flow diagram represents the step of the algorithm. Finally, Section V presents conclusion.

## II. RELATED WORK

The concept of fast charging, revolutionizing battery charging processes, has seen significant advancements over the years. It was in the early 2000s that the first iterations of fast charging technology emerged, driven by the need for quicker and more efficient charging solutions for portable electronic devices. Researchers and engineers delved into the development of innovative charging algorithms and circuit designs to facilitate rapid replenishment of battery power.

One pioneering innovation in this realm was the introduction of the TP4056 Integrated Circuit (IC). Developed by leading semiconductor manufacturers, the TP4056 IC represented a breakthrough in charging technology, offering a compact and efficient solution for charging Lithium-Ion and Lithium-Polymer batteries. With its integrated constant current/constant voltage (CC/CV) charging mechanism, thermal regulation features, and under-voltage lockout functionality, the TP4056 IC paved the way for faster and safer charging processes in a wide range of applications.

Advancements in Battery Management Systems (BMS) were underway, aiming to address critical aspects of battery protection, monitoring, and optimization. Various components, including battery protection ICs, temperature sensors, and charge termination circuits, were integrated into BMS designs to safeguard batteries against overcharge, overdischarge, and thermal runaway events. This approach to battery management ensured the longevity, safety, and reliability of rechargeable batteries across industries.

The convergence of fast charging technology and BMS innovations culminated in the integration of the TP4056 IC within wearable devices. By harnessing the fast-charging capabilities of the TP4056 IC and leveraging advanced BMS functionalities, wearable technology developers were able to deliver efficient, reliable, and user-friendly charging solutions. This integration not only optimized charging speed and efficiency but also enhanced battery protection and overall device performance.

## III. METHODOLOGY

Project involves a systematic approach to upgrading the HEARNU Band's charging system with the TP4056 charging IC. The process begins with comprehensive research and analysis to identify the limitations of the current charging system and explore potential solutions. Once the TP4056 IC is selected as the optimal solution, schematic diagrams and PCB layouts were developed to seamlessly integrate the new IC into the HEARNU Band's design. Fabrication and assembly of the prototype follows, with meticulous testing and optimization to ensure functionality and reliability. Throughout each phase, close attention was paid to compatibility, efficiency, and safety considerations. The methodology concludes with validation tests to confirm the performance and effectiveness of the upgraded charging system, ultimately delivering a solution that meets the project's objectives and requirements.

This outlines a rigorous yet systematic approach to enhancing the charging system of the HEARNU Band through the integration of the TP4056 charging IC. By combining thorough research, meticulous design, and comprehensive testing, this process ensures the seamless implementation of advanced charging technology while prioritizing compatibility, efficiency, and safety. Through these efforts, the project aims to deliver a reliable and efficient charging solution that meets the evolving needs of wearable technology users.

### 1. TP4056 Charging IC:

The TP4056 charging IC is a cornerstone component in the charging system of the HEARNU Band, responsible for efficiently and safely charging the device's battery. Through comprehensive characterization, the performance and functionality of the TP4056 can be evaluated to ensure optimal charging efficiency and battery health preservation.

### 2. DW01A Battery Protection IC:

The DW01A Battery Protection IC plays a crucial role in safeguarding the battery of the HEARNU Band against overcharging, overdischarging, and short circuit events. Through comprehensive characterization, the functionality and reliability of the DW01A IC can be assessed to ensure optimal battery protection and longevity.

### 3. 8205 Dual MOSFET:

The 8205 Dual MOSFET serves as a critical component in the battery protection circuitry of the HEARNU Band, playing a pivotal role in managing battery discharge and providing short circuit protection. Through thorough

characterization, the performance and reliability of the 8205 MOSFET can be evaluated to ensure effective battery protection and circuitry integrity.

#### IV. EXPERIMENTAL RESULTS

The results and insights obtained from the testing of the HEARNU Band with the integrated TP4056 charging IC unveil significant advancements in charging efficiency, battery protection, and overall performance. Through rigorous testing and analysis, valuable insights were gleaned, reaffirming the effectiveness and reliability of the TP4056 charging IC integration.

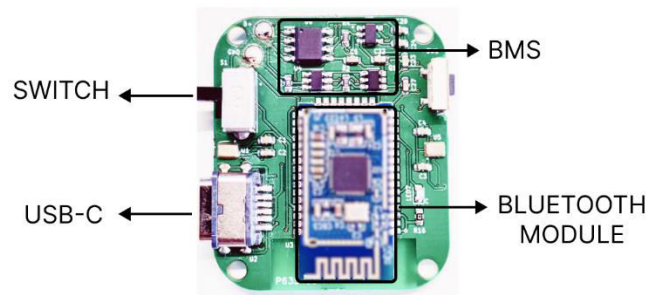


Fig. 1. TP4056 IC integrated HearNU PCB

#### Flow Chart:

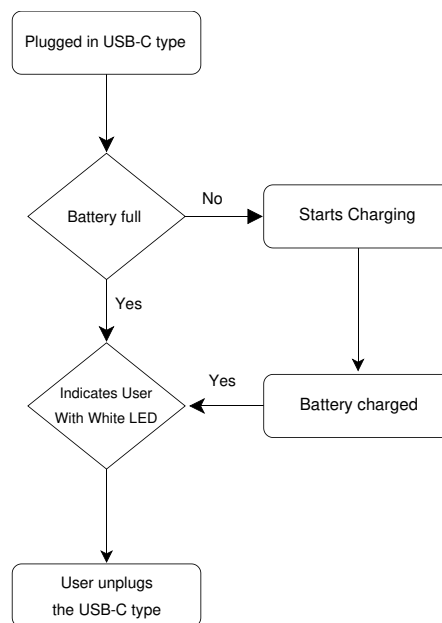


Fig. 2. Flow chart of the HEARNU Band working.

#### Testing:

Further validating the performance of the HEARNU Band with the integrated TP4056 charging IC, Digital Storage Oscilloscope (DSO) output readings were obtained during charging cycles. The following parameters were measured:

#### Fast Charging Current:

The DSO recorded the charging current output during fast charging cycles, providing insights into the efficiency and consistency of charging current delivered and charged the battery within expected time.



**Charged Capacity (mAh):**

The DSO measured the total capacity charged during fast charging sessions, indicating the amount of energy transferred to the battery within a specified time period.

**Charging Voltage:**

Voltage readings were captured throughout the charging process to monitor voltage stability and regulation, ensuring safe and optimal charging conditions.

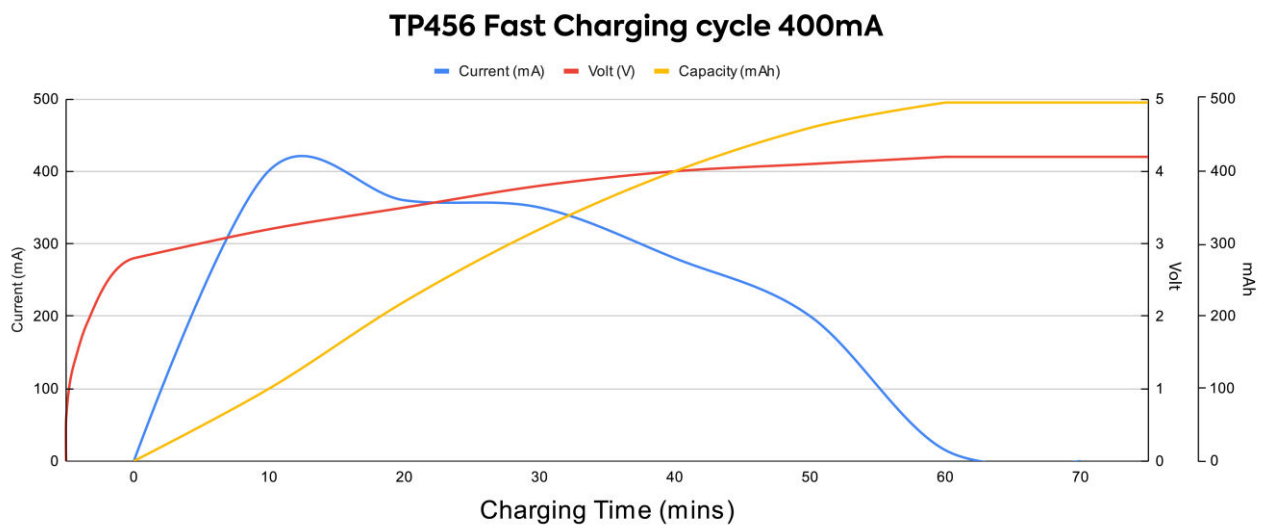


Fig. 3. DSO reading output for fast charging current, capacity of battery charged and voltage measures at charging time.

**Results:**

The results and insights obtained from the comprehensive testing of the HEARNU Band with the integrated TP4056 charging IC unveil significant advancements in charging efficiency, battery protection, and overall performance. Through rigorous testing and analysis, valuable insights were gleaned, reaffirming the effectiveness and reliability of the TP4056 charging IC integration. By successfully completing the design validation phase, confidence is instilled in the integrity, functionality, and performance of the HEARNU Band with the integrated TP4056 charging IC. This validation serves as a crucial milestone in the product development lifecycle.

**V. CONCLUSION**

The integration of the TP4056 charging IC within the HEARNU Band represents a significant milestone in the evolution of wearable technology, marking a paradigm shift towards enhanced charging efficiency, battery protection, and overall device performance. Through meticulous design, testing, and optimization, the project has successfully addressed the critical challenges associated with the previous charging system, delivering tangible improvements in charging speed, temperature management, and reliability.

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