Wireless Bluetooth Microphone

EN2160 Electronic Design Realization

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Contents

1 Abstract

The Bluetooth Microphone Device for Enhanced Wireless Communication project aimed at developing a cutting-edge wireless microphone system that utilizes Bluetooth technology to enable seamless and high-quality audio communication. The primary objective of this project is to design a versatile, user-friendly, and reliable microphone device, eliminating the constraints of wired connections and facilitating efficient communication across various applications.

The proposed Bluetooth microphone device will be equipped with advanced features, including low-latency audio transmission, noise cancellation, and robust connectivity. It will be compatible with a wide range of devices, such as smartphones, tablets, laptops, and Bluetooth-enabled professional audio equipment. This will make it suitable for diverse use cases, such as public speaking, live performances, virtual meetings, and mobile vlogging.

2 Introduction

A Bluetooth microphone operates on the principles of Bluetooth technology, which allows for short-range wireless data exchange between devices. This innovation has liberated users from the constraints of tangled wires, providing them with greater mobility and flexibility. The elimination of physical connections not only simplifies setup but also enhances the overall user experience, making it an ideal choice for professionals, hobbyists, and everyday users alike.

In an increasingly wireless world, the demand for seamless communication solutions has grown exponentially. The Bluetooth microphone has emerged as a revolutionary technology that addresses the need for convenient, cable-free audio transmission in various applications. Whether it's facilitating hands-free communication during virtual meetings, empowering performers on stage, or enhancing the audio experience during leisure activities, Bluetooth microphones have become an integral part of modern communication and entertainment.

As the world continues to embrace wireless connectivity, Bluetooth microphones have emerged as a transformative tool, ushering in a new era of convenient and reliable audio communication. From corporate boardrooms to concert stages, classrooms to content creation, the versatility and accessibility of Bluetooth microphones have redefined the way we interact with sound.

3 Product Specifications

1. Bluetooth Technology: The device will integrate the latest Bluetooth protocols, ensuring stable and secure connections over short distances. It will support Bluetooth versions with low energy consumption to optimize battery life.
2. High-Quality Audio Processing: The microphone will feature state-of-the-art audio processing algorithms to deliver crisp, clear, and noise-free sound reproduction. Adaptive noise cancellation will enable users to communicate effectively even in noisy environments.
3. High-fidelity wireless audio with support for 24-bit/96 kHz audio formats.
4. Advanced Audio Processing Wireless Connectivity: Voice processing such as Wide-Band (WB) speech, Acoustic Echo Cancellation (AEC) and Noise Reduction (NR).
5. Bluetooth 5.0 certified dual mode audio module that offers high-quality wireless audio.
6. User-Friendly: The device will be designed with a user-friendly interface, allowing quick pairing and intuitive controls muting functions.
7. Rechargeable Battery: Battery can be recharged using micro-USB cable with mobile phone adapters.

8. Long Battery Life: Emphasis will be placed on power efficiency to maximize the device's battery life, making it suitable for extended use without frequent recharging. (Battery Capacity = 3200mAh)
9. Compact and Ergonomic Design: The microphone will boast a sleek and lightweight design, making it portable and comfortable to use for prolonged periods.

4 Selection of components

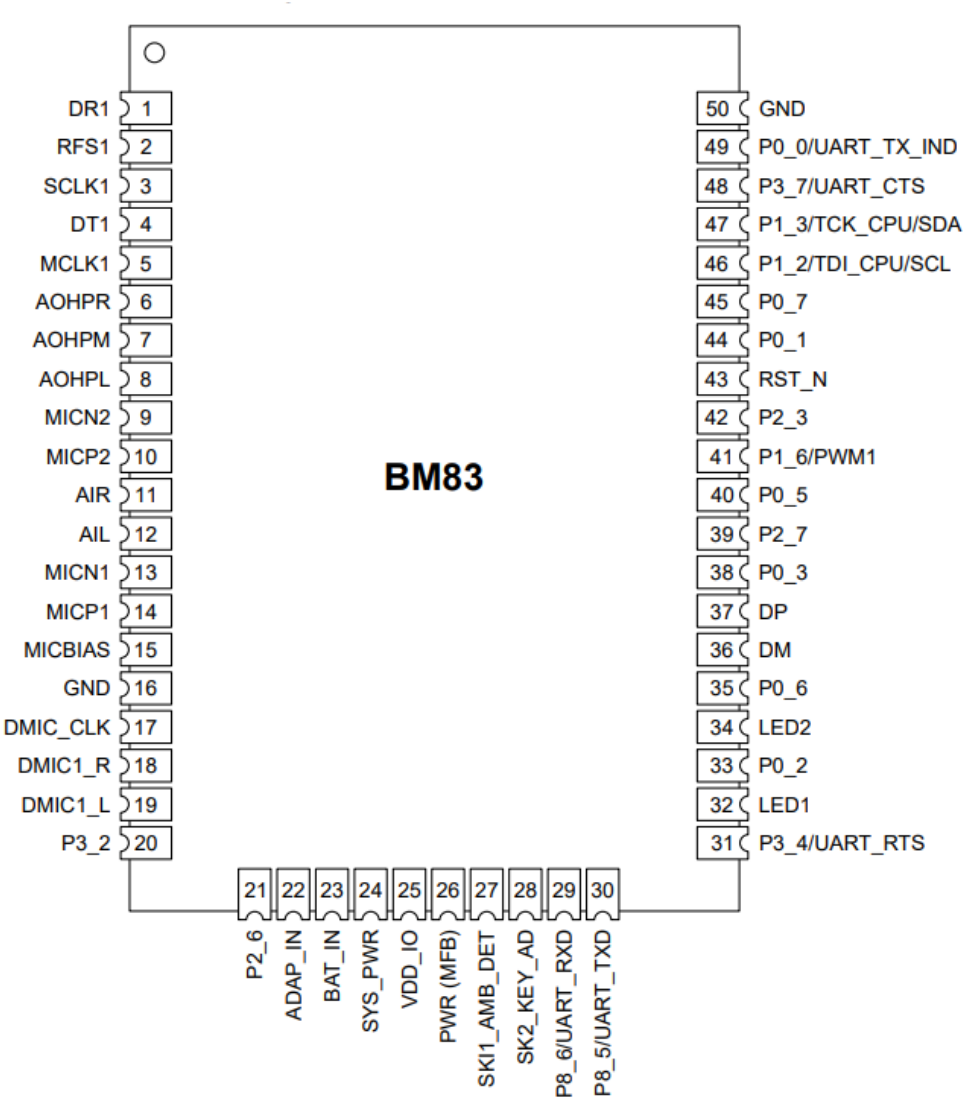
- BM83SM1
- Microphone - 4 mmx1.5mm, electret condenser, noise cancelling, solder pads, 1 V-DC
- LED - Green
- Switch
- Resistors 1kΩ
- Capacitors 0.1uF

5 BM83SM1

The BM83SM1 is a Bluetooth module manufactured by Microchip Technology Inc. The BM83SM1 is part of the BM83 series of Bluetooth audio modules, which are designed for implementing Bluetooth audio solutions in various applications.

The BM83SM1 module is typically used in applications like wireless speakers, headphones, and other audio devices where Bluetooth connectivity is required for audio streaming and control. These modules are pre-certified to comply with various international standards, making it easier for manufacturers to integrate them into their products without the need for additional Bluetooth certifications.

5.1 Pinout Diagram



5.2 Pinout Description

Pin Number	Pin Name	Pin Type	Description
1	DR1	I	I2S interface: digital left/right data
2	RFS1	I/O	I2S interface: digital left/right clock
3	SCLK1	I/ O	I2S interface: bit clock
4	DT1	O	I2S interface: digital left/right data
5	MCLK1	O	I2S interface: master clock
6	AOHPR	O	R-channel analog headphone output
7	AOHPM	O	Headphone common mode output/sense input
8	AOHPL	O	L-channel analog headphone output
9	MICN2	I	MIC 2 mono differential analog negative input
10	MICP2	I	MIC 2 mono differential analog positive input
11	AIR	I	R-channel single-ended analog input
12	AIL	I	L-channel single-ended analog input
13	MICN1	I	MIC 1 mono differential analog negative input
14	MICP1	I	MIC 1 mono differential analog positive input
15	MICBIAS	P	Electric microphone biasing voltage
16	GND	P	Ground reference
17	DMIC_CLK	O	Digital MIC clock output
18	DMIC1_R	I	Digital MIC right input
19	DMIC1_L	I	Digital MIC left input
20	P3_2	I/O	• General purpose I/O port P3_2 • By default, this is configured as AUX_IN DETECT
21	P2_6	I/O	General purpose I/O port P2_6
22	ADAP_IN	P	• 5V power adapter input • To charge the battery in the Li-ion battery powered applications • To be used for USB Device Firmware Upgrade (DFU) • Otherwise it can be left floating
23	BAT_IN	P	• Power supply input; voltage range: 3.2V to 4.2V • Source can either be a Li-ion battery or any other power rail on the host board
24	SYS_PWR	P	• System power output derived from the ADAP_IN or BAT_IN input • Only for internal use • Do not connect to any other devices • LED1 and LED2 can be connected to SYS_PWR
25	VDD_IO P	I/O	power supply, do not connect, for internal use only (connected to LDO31_VO)
26	PWR(MFB)	I	Multi-function push button and Power On key
27	SK1_AMB_DET	I	Temperature sense channel 1
28	SK2_KEY_AD	I	Temperature sense channel 2

Pin Number	Pin Name	Pin Type	Description
29	P8_6/ UART_RXD	I/O	• General purpose I/O port P8_6 • UART RX data
30	P8_5 / UART_TXD	I/O	• General purpose I/O port P8_5 • UART TX data
31	P3_4 / UART_RTS	I/O	• General purpose I/O port P3_4 • System configuration pin (Application mode or Test mode) • UART RTS
32	LED1	I	LED driver 1
33	P0_2	I/O	• General purpose I/O port P0_2 • By default, this is configured as play/pause button (user configurable button)
34	LED2	I	LED driver 2
35	P0_6	I/O	• General purpose I/O port P0_6
36	DM	I/O	USB data minus data line
37	DP	I/O	USB data positive data line
38	P0_3	I/O	• General purpose I/O port P0_3 • By default, this is configured as reverse button (user configurable button)
39	P2_7	I/O	• General purpose I/O port P2_7 • By default, this is configured as volume up button (user configurable button)
40	P0_5	I/O	• General purpose I/O port P0_5 • By default, this is configured as volume down button (user configurable button)
41	P1_6 / PWM1	I/O	• General purpose I/O port P1_6 • PWM1 output
42	P2_3	I/O	General purpose I/O port P2_3
43	RST_N	I	System Reset pin (active-low)
44	P0_1	I/O	• General purpose I/O port P0_1 • By default, this is configured as forward button (user configurable button)
45	P0_7	I/O	General purpose I/O port P0_7
46	P1_2 / TDI_CPU / SCL	I/O	• General purpose I/O port P1_2 • CPU 2-wire debug data • I2C SCL

Pin Number	Pin Name	Pin Type	Description
47	P1_3/ TCK_CPU/ SDA	I/O	• General purpose I/O port P1_3 • CPU 2-wire debug clock • I2C SDA
48	P3_7/ UART_CTS	I/O	• General purpose I/O port P3_7 • UART_CTS
49	P0_0/UART_TX_IND	I/O	• General purpose I/O port P0_0 • By default, this is configured as an external codec reset (Embedded mode) • UART_TX_IND (active-high) used to wake-up the host MCU (Host mode)
50	GND	P	Ground reference

5.3 Specifications

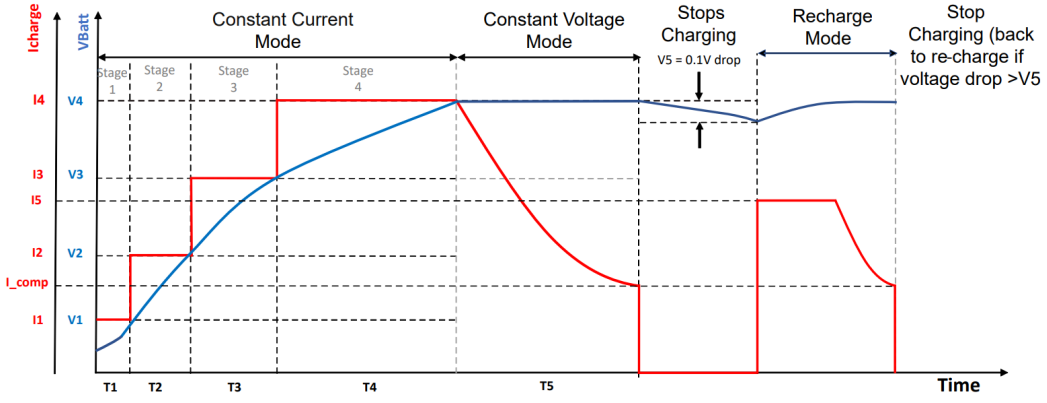
- **Power Management Unit**

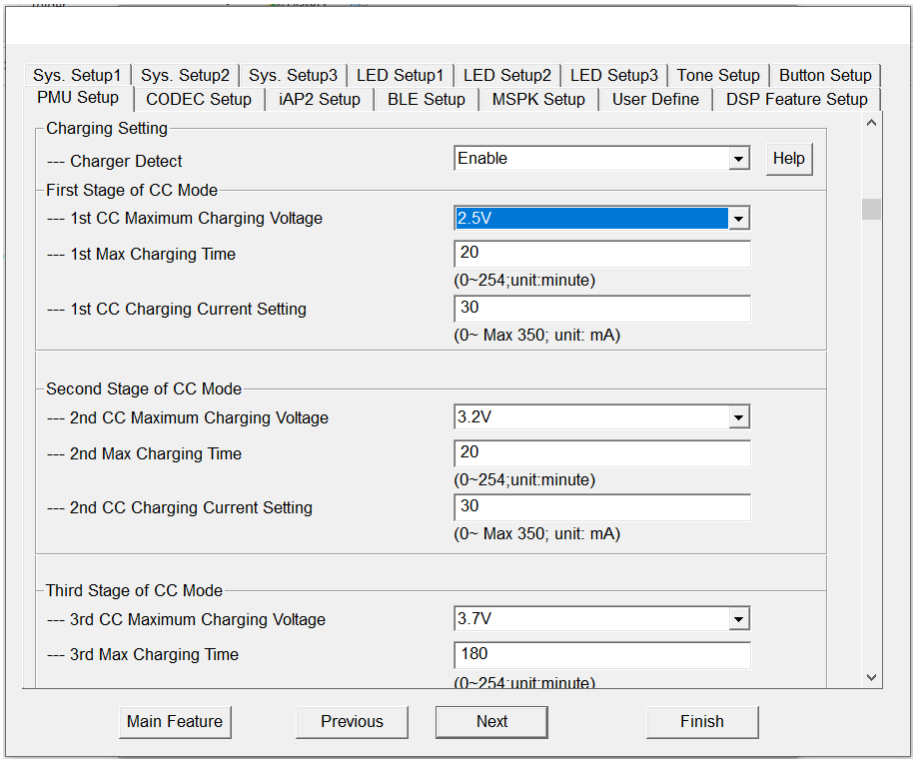
  The on-chip PMU integrates the battery (lithium-ion and lithium-polymer) charger, and voltage regulator. A power switch is used to switch over the power source between the battery (BAT_IN) and an adapter (ADAP_IN).

  The battery charger supports various modes with features listed below:

  – Charging control using current sensor
  – User-programmable current regulation
  – High accuracy voltage regulation
  – Constant current and constant voltage modes
  – Stop charging and re-charging modes

  The following figure illustrates the charging curve of a battery.





- **Audio Codecs**

  It supports both SBC and AAC Bluetooth audio codecs.

  16-bit/24-bit I2S Digital Audio: – 8 kHz, 16 kHz, 44.1 kHz and 48 kHz sampling frequency for SBC and AAC.

  16-bit Audio Stereo Analog-to-Digital Converter (ADC) with SNR 90 dB.

  SBC and AAC are the two common codecs that you'll find support for on most Bluetooth earphones. They're also called lossy codecs because they significantly compress the data, with the goal being stability and speed over audio quality.

- **Bluetooth 5.0 certified dual mode audio module that offers high-quality wireless audio.**

- **High-fidelity wireless audio with support for 24-bit/96 kHz audio formats.**

- **Two Modes of Operation**

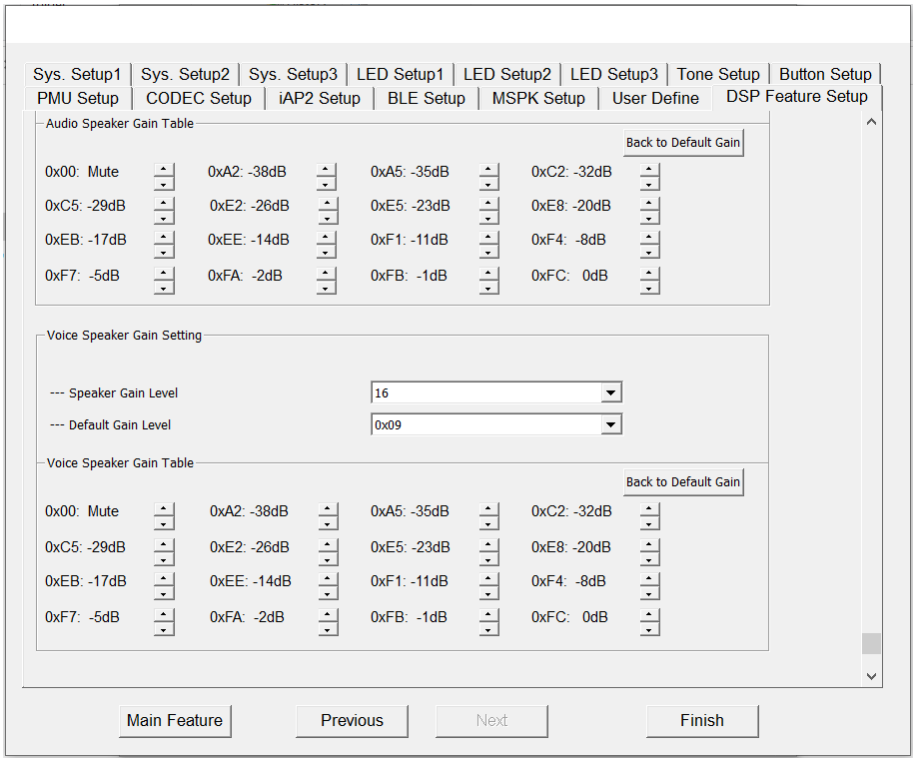
  It can be operated in two modes either in embedded mode or in host mode.

  Host mode requires an external MCU to control the BM83SM1 module but in host mode it takes control of every peripheral device itself and controls everything as master device. In host mode, it does not require an external MCU.

  Here we are oprating in Embedded Mode

- **Voice processing such as WideBand (WB) speech, Acoustic Echo Cancellation (AEC) and Noise Reduction (NR).**

  Here in this module we can adjust the voice band processing through firmware.



- **Automatic Call answering option while connected with mobile phones**
- **Programmable Using Firmware via USB, UART or Over-The-Air**

6 Implementation

The BM83 module can be configured using the Config Tool, and the firmware is programmed by using the isUpdate tool. The BM83 module provides Test mode, which allows customers to use existing module manufacturing and testing equipment and flow to test the BM83 modules without reinvesting in new test equipment. New customers are encouraged to use the new RF test modes defined for this device. Test mode is entered by pulling the PORT3_4 pin to low during start-up/Reset when powered by the ADAP_IN 5V supply. Test mode allows an external UART host to communicate with the BM83 module using Bluetooth vendor commands over the UART interface. The host can interface with the driver firmware on the BM83 module to perform TX/RX operations and to collect/report Bit Error Rate (BER) and other RF performance parameters. These values can, then, be used to accept/reject the device and/or calibrate the module.

It supports easy firmware upgrades via UART, USB and Over-the-Air (OTA). This turn-key solution module is pre-programmed with firmware that enables Bluetooth audio playback for a plug-and-play solution, and an audio transceiver solution for A2DP source/sink. Control settings for LED drivers and other peripherals can be set via the Configuration Tool.

6.1 Programming Via USB

To program a BM83 module via USB, you'll need a USB-to-UART converter or an evaluation board that has USB connectivity or using damaged USB cable. The BM83 module is a Bluetooth audio module made by Microchip Technology.

Here are the general steps to program the BM83 module via USB:

1. Prepare the Hardware:

   Obtain a BM83 module and make sure it is properly connected to your USB-to-UART converter or evaluation board that supports USB connectivity. Connect the USB-to-UART converter or evaluation board to your computer via a USB cable.

2. Install the USB-to-UART Driver:

   If you are using a USB-to-UART converter, you might need to install the appropriate driver for it to work with your computer. Most USB-to-UART converters will come with instructions on how to install the driver.

3. Download BM83 Programming Software:

   Visit the Microchip Technology website or the website of the manufacturer that produces the BM83 module and look for the BM83 programming software or tools. Download the software to your computer.

4. Open BM83 Programming Software:

   Launch the BM83 programming software on your computer.

5. Connect to the BM83 Module:

   In the programming software, there should be an option to connect to the BM83 module. Choose the appropriate COM port or USB device to which the BM83 module is connected.

6. Configure the BM83 Module:

   With the BM83 module connected, you can now configure its settings using the programming software. This may include Bluetooth settings, audio profiles, and other parameters specific to your application.

7. Program the BM83 Module:

   Once you have configured the settings, use the programming software to program the BM83 module. This step will flash the necessary firmware and settings onto the module.

8. Verify the Programming:

   After programming, you can verify that the BM83 module has been programmed correctly. The programming software should have options to read back the configuration from the module to ensure the data matches the programmed values.

9. Testing and Troubleshooting:

   Once the programming is complete, you can test the BM83 module to see if it behaves as expected. If there are any issues, refer to the documentation and support resources provided by Microchip Technology or the module manufacturer to troubleshoot and resolve them.

Please note that the specific steps and software tools may vary depending on the manufacturer of the BM83 module and the USB-to-UART converter or evaluation board you are using. Always refer to the official documentation and resources provided by the module manufacturer for the most accurate and up-to-date information.

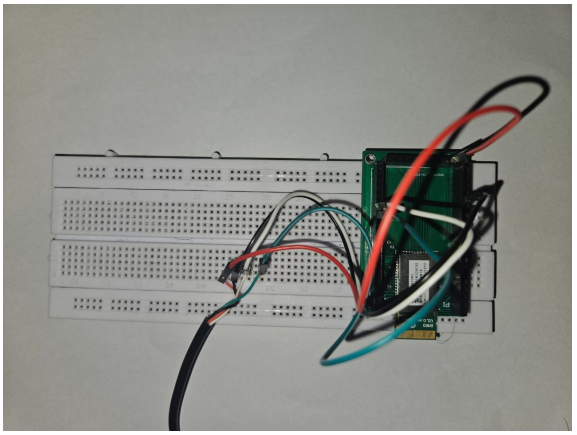
7 How to upload Firmware

Connect the pins of the bottom PCB as below

- BM83's 16 GND to USB's Ground Brown Cable
- BM83's 22 ADAP_IN to USB's 5V Red Cable
- BM83's 36 DM to USB's Data Minus White Cable
- BM83's 37 DP to USB's Data Plus Green Cable

Now connect to your PC, which you are using to program the module. Using the isUpdate tool which you can download from microchip.com, can upoload the firmware to the module.

Link to Download the software
https://www.microchip.com/en-us/product/bm83#Software

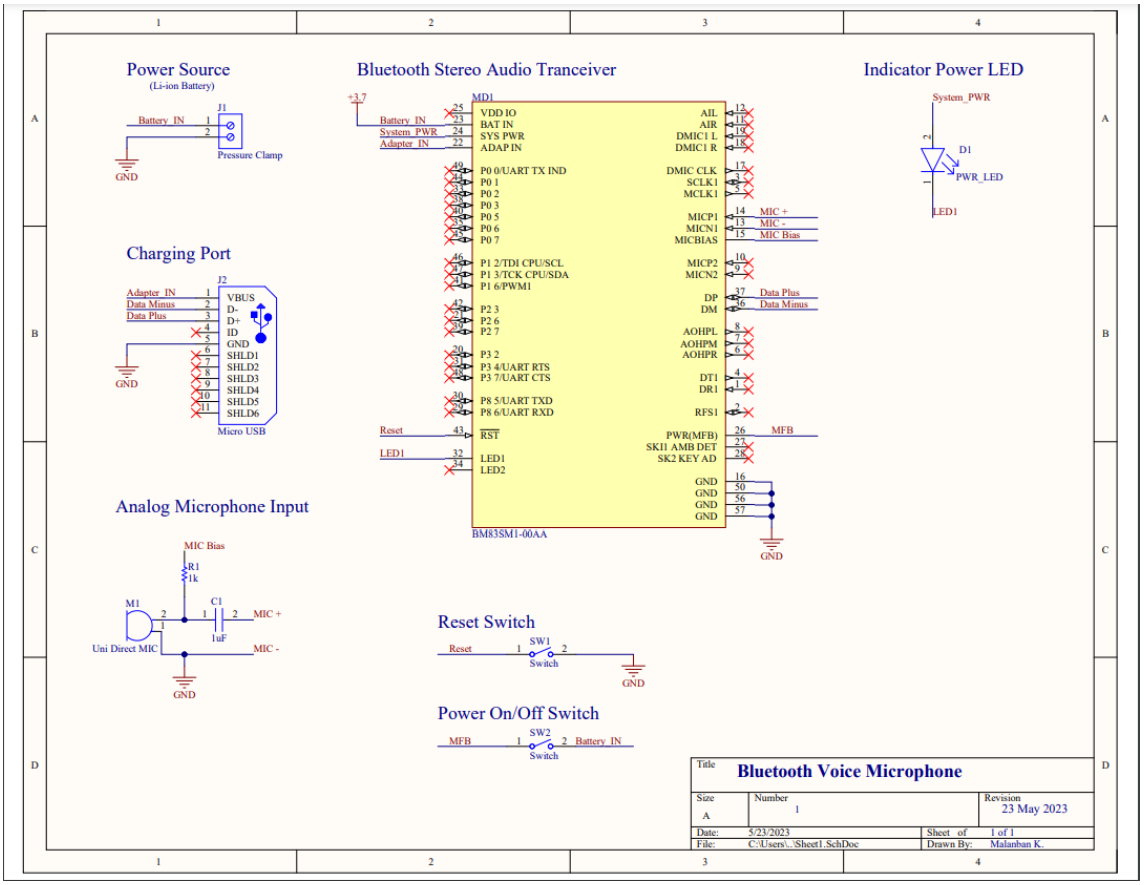


8 Assembly

- Easy to assemble, only few steps to go.
- There are two casing bottom and top casing in the enclosure, and both of them can be attached using two screws.
- PCB is attached with the bottom casing using two screws and two PCB's are stacked upon each other to compact the size of device.

9 Product Design

9.1 Schematics



9.2 PCB design

The PCB was designed using Altium software for the final implementation. The output Gerber files were generated and sent to China (JLCPCB) for printing.

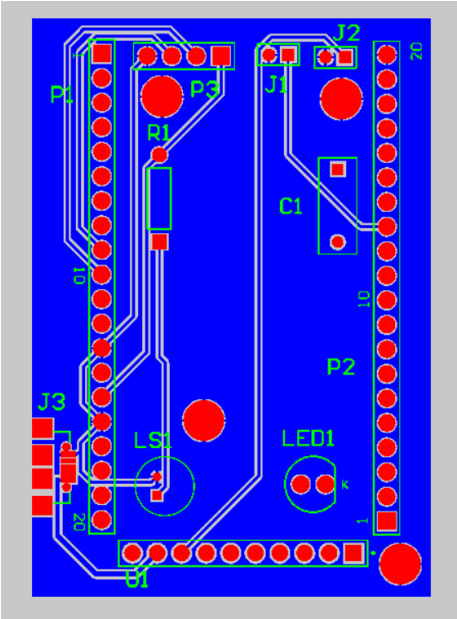


Figure 1: Top PCB

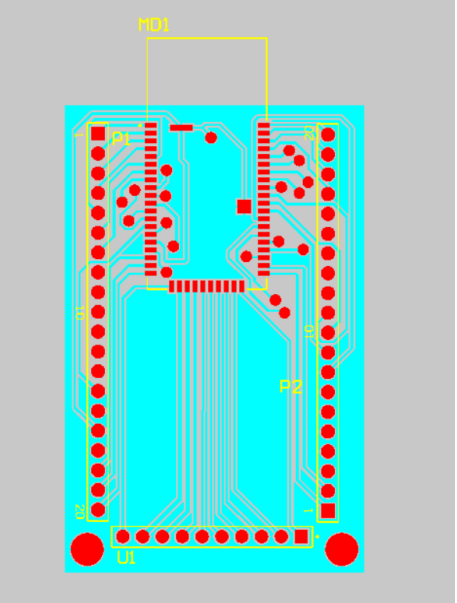


Figure 2: Bottom PCB

Two PCB are stacked upon each other, so that we can reduce the size of the device. Hence the deice will be easy to handle and portable.

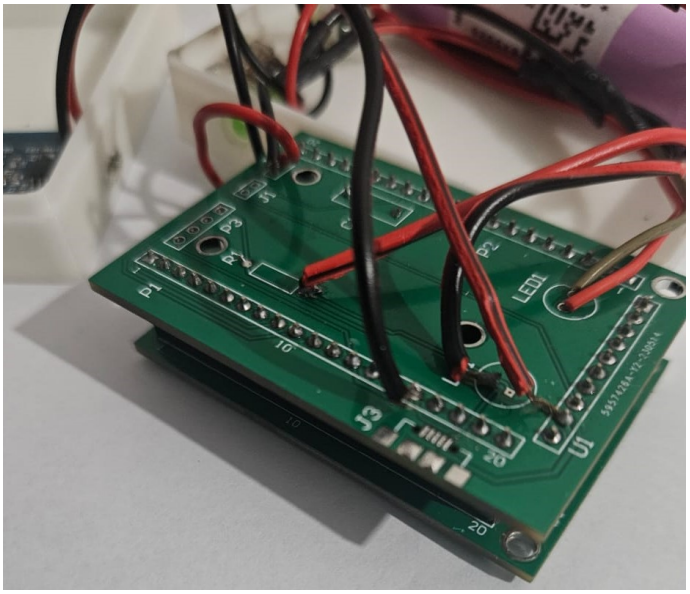


Figure 3: Stacked PCB

9.3 Enclosure Design

Designing an enclosure for a product involves creating a protective and aesthetically pleasing casing that houses the electronic product.

9.3.1 Hand Sketch

Before directly get in to designing enclosures using computer aided design software (CAD Software), we need to roughly handsketch the design.

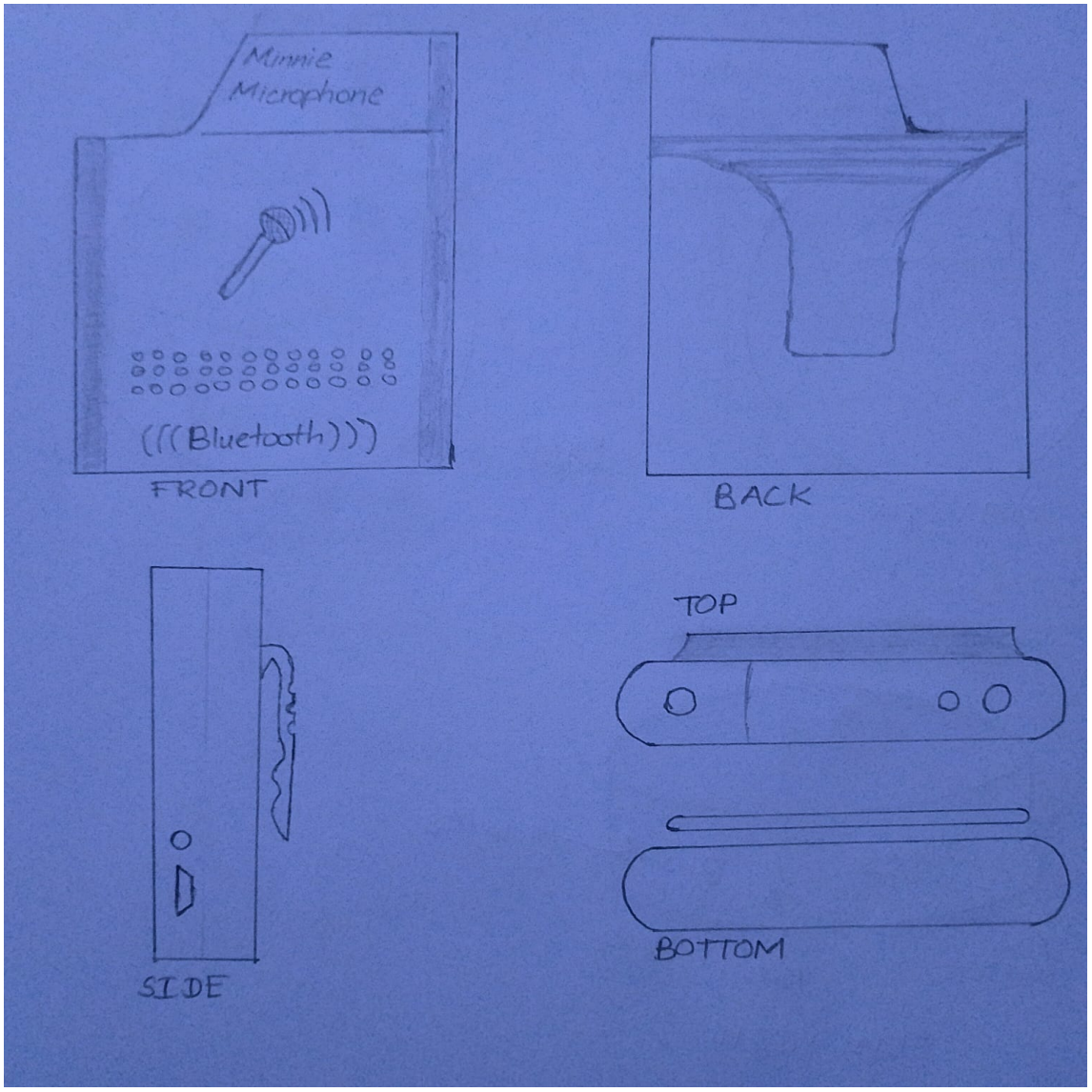


Figure 4: Hand Sketch

9.3.2 SOLIDWORKS Design

I have transferred the above design concept into computer-aided design (CAD) software. Created a 3D model of the enclosure, ensuring accurate dimensions and detailing.

Figure 5: Design 1

Then I have updated my design as in figure below **(Design 2)** to reduce cost in 3D printing.

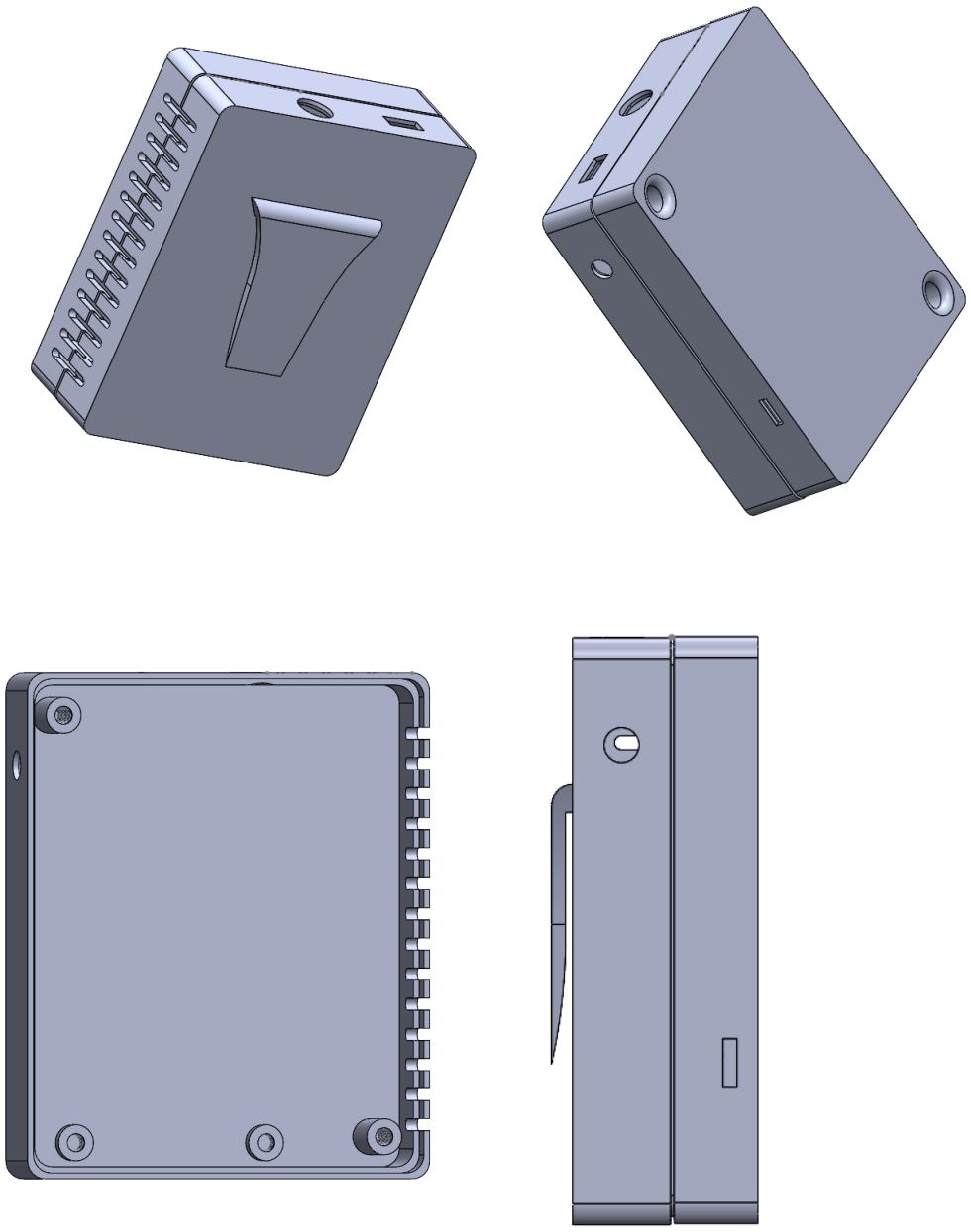


Figure 6: Design 2

If we are manufacture in a large scale then we can go for **design 1**. Because in large scale manufacturing process we need to go for injection moulding and once you made the mould then you can make as per your need with the low cost.

9.3.3 Physical Design

This is the 3D printed physical design of the product.

10 Bill of Materials

Item Number	Name	Supplier	Quantity	Price
01	BM83SM1-00TB	Mouser	1	$13.41
02	Noise Cancelling Microphone (CMR-4015-44-SP)	Mouser	1	$1.72
03	Li-ion Battery	Tronics	1	$2.56
04	Micro-USB female pin	Tronics	1	$0.17
05	LED	Tronics	1 Pckt	$0.12
06	Resistor (1 KOhm / 0.25W)	Tronics	1 Pckt	$0.18
07	Capacitor (1 uF)	Tronics	1	$0.046
08	Switch	Tronics	2	$0.12
Total				$18.326

Total Cost in Sri Lankan Rupees = LKR 6024.03
(1 USD = 328.71 LKR)

11 Conclusion and Future Works

11.0.1 Conclusion

The Bluetooth microphone project has been successfully completed, achieving its primary objectives and delivering a functional and reliable product. Throughout the development process, I worked diligently to design, build, and test the Bluetooth microphone with the aim of providing a high-quality audio solution for various applications. The Bluetooth microphone is designed to be compatible with a wide range of devices across different platforms and operating systems. It has been tested with major Bluetooth-enabled devices, ensuring broad usability.

11.0.2 Future Works

I have planned to further develop this Bluetooth microphone by adding a small speaker giving sound feedback to users as it is more comfortable to users than having different blinking in LED.

Also, a method can be developed to update the firmware of the device through micro-USB same port which is currently being used for only charging purposes.

Instead of having an automatic call answering option, I will add a button in my device to answer the call if needed.

12 *Appendix I User Manual*

1. Power on the device using the switch on top.
2. After power on the green LED on top will turn on with long breeze blinking.
3. Turn on Bluetooth on your mobile phone.
4. Scan for this device and connect.
5. Go to the voice recording application in your mobile and enjoy.
6. While recording via this device you can see the Green LED on top will have fast rate of blinking.
7. Charge your device through micro-USB port in side.

13 *References*

https://www.microchip.com/en-us/product/bm83#Software
https://www.alldatasheet.com/datasheet-pdf/pdf/1176944/MICROCHIP/BM83.html
https://www.mouser.com/datasheet/2/670/cmr_4015_44_sp-3011537.pdf