

Bluetooth Low Energy (BLE) Module

HM-BT2401DA

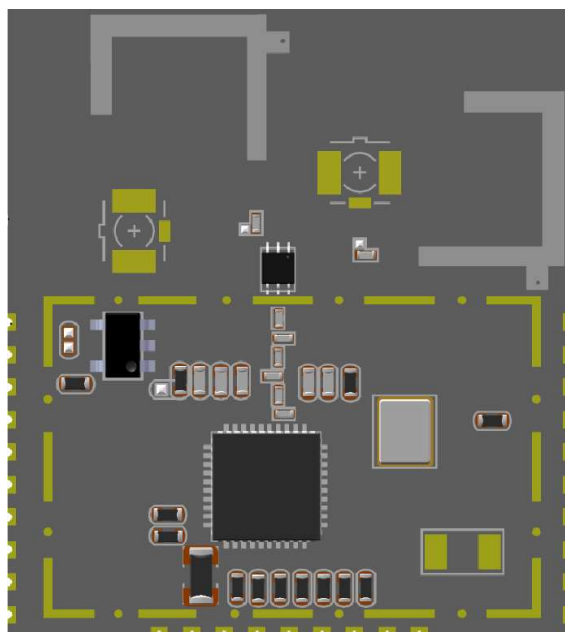


Table of Contents

1 Product Overview	3
2 Module Features	3
3 Electrical Characteristics	4
4 Module Functional Description	4
5 Application Diagram	5
6 Module Pinout	5
6.1 Module Pin Layout	5
6.2 Module Pin Definition	6
7 Package Specifications	8
8 Design Guidelines	8
9 Soldering Recommendations	10
10 Electrostatic Discharge Warning	10
11 Version History	11

1 Product Overview

The HM-BT2401DA is a high-performance BLE 6.0 Channel Sounding module based on SoC chip design. It supports both Initiator and Reflector roles for ranging and integrates dual PCB antennas with optional external dual antennas for high-precision distance measurement. Featuring a high-performance 2.4 GHz RF, low current consumption, AI/ML hardware accelerators, and secure vault capabilities, the module is also an ideal choice for low-power Bluetooth and mesh wireless communication. IoT device manufacturers can create smart, robust, and energy-efficient products resistant to remote and local network attacks. With rich resources and powerful performance, the module supports secondary development. Based on specific firmware, it can easily configure the module and enable wireless data transparent transmission through communication with an external MCU. It supports both BLE master and slave roles, allowing it to act as a master to scan and connect to slave BLE devices or as a slave to quickly establish wireless connections and data communication with BLE masters like smart phones and tablets. The module requires very few external MCU resources, simplifying the development process.

2 Module Features

- High Performance 32-bit 78 MHz ARM Cortex®-M33 with DSP instruction and floating-point unit for efficient signal processing.
- Up to 1024 KB Flash program memory and 128 KB RAM data memory.
- Multi-protocol support including Bluetooth Low Energy, Bluetooth Mesh, proprietary 2.4G protocols and Channel Sounding.
- Bluetooth Channel Sounding functionality supporting RTT (Round-Trip Time) and PBR (Phase-Based Ranging) modes.
- Supports both Initiator and Reflector roles for ranging.
- Supports up to 72 channels for standard and random frequency hopping modes.

- Onboard dual-antenna path support.

3 Electrical Characteristics

- Operating voltage: 1.71V–3.8V
- Operating temperature: -40°C to +85°C
- Modulation mode: GFSK (Gaussian Frequency Shift Keying)
- Modulation frequency: 2400 MHz–2483.5 MHz
- Maximum transmit power: +10 dBm
- 4.4 mA RX current@1 Mbps
- 5.0 mA TX current@0 dBm
- 19.1 mA TX current@10 dBm
- -97.6 dBm sensitivity @ 1 Mbps GFSK
- 33.4 μ A/MHz in Active Mode (EM0) at 39.0 MHz
- 1.3 μ A EM2 DeepSleep current (16 kB RAM retention and RTC running from LFRCO)

4 Module Functional Description

The module will start advertising automatically when it is powered. The mobile device running a specific APP can scan and connect to the module. When a connection has been established, the module can be operated through the BLE protocol. The external MCU can carry out wireless communication with the mobile device through the serial port of the module, and the external MCU can also send the control commands to change the communication parameters through the serial port of the module.

The user's data package format is defined by the upper application. The mobile device can send data to the module through the APP, and then the data will be sent to the external MCU through the serial port of the module. After the module receives the

data packet from the external MCU, it will automatically forward it to the connected mobile device. The user needs to complete the source code development of the external host MCU and APP running on the mobile device.

5 Application Diagram

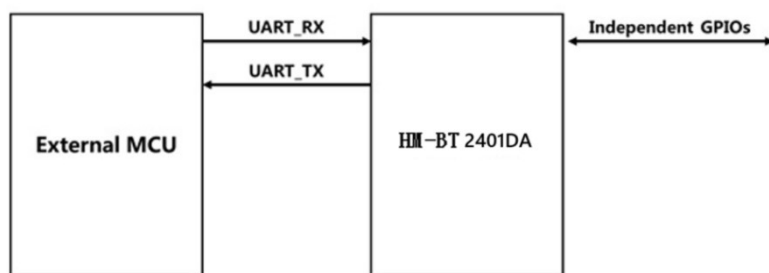


Figure 1: Application Diagram

6 Module Pinout

6.1 Module Pin Layout

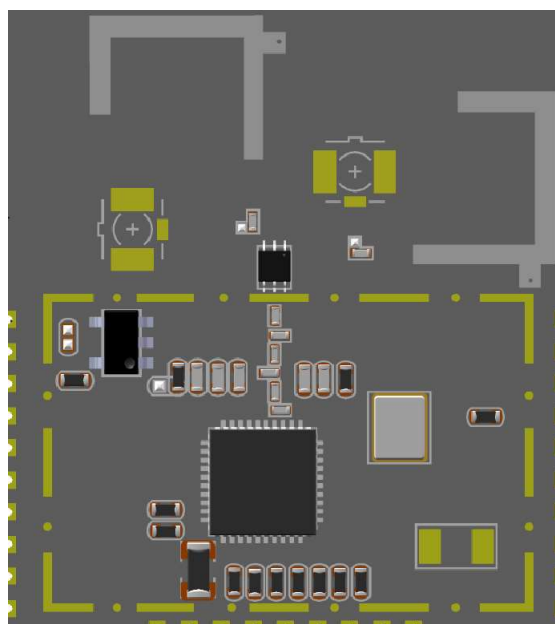


Figure 2: TopView



6.2 Module Pin Definition

Pin No	Pin Name	Type	Description
1	GND	DG	Power ground
2	PB4	I/O	General GPIO
3	PB3	I/O	General GPIO
4	PB2	I/O	General GPIO
5	PB1	I/O	General GPIO
6	PB0	I/O	General GPIO
7	PA1	I/O	SWCLK: Serial Clock for Debugging and Programming
8	PA2	I/O	SWDIO: Serial Data for Debugging and Programming
9	PA3	I/O	General GPIO
10	PA4	I/O	General GPIO
11	PA5	DO	PA5; UART TXD
12	PA6	DI	PA6; UART RXD
13	PA7	I/O	General GPIO

14	PA8	I/O	General GPIO
15	PD3	I/O	General GPIO
16	PD2	I/O	General GPIO
17	PD1	I/O	General GPIO
18	PD0	I/O	General GPIO
19	VCC	DV	3.3V power supply
20	GND	DG	Power ground
21	PC0	I/O	General GPIO
22	PC1	I/O	General GPIO
23	PC2	I/O	General GPIO
24	PC3	I/O	General GPIO
25	PC4	I/O	General GPIO
26	PC5	I/O	General GPIO
27	PC6	I/O	General GPIO
28	PC7	I/O	General GPIO
29	RES	I/O	Reset pin; active low

Table 1: Module Pin Definition

7 Package Specifications

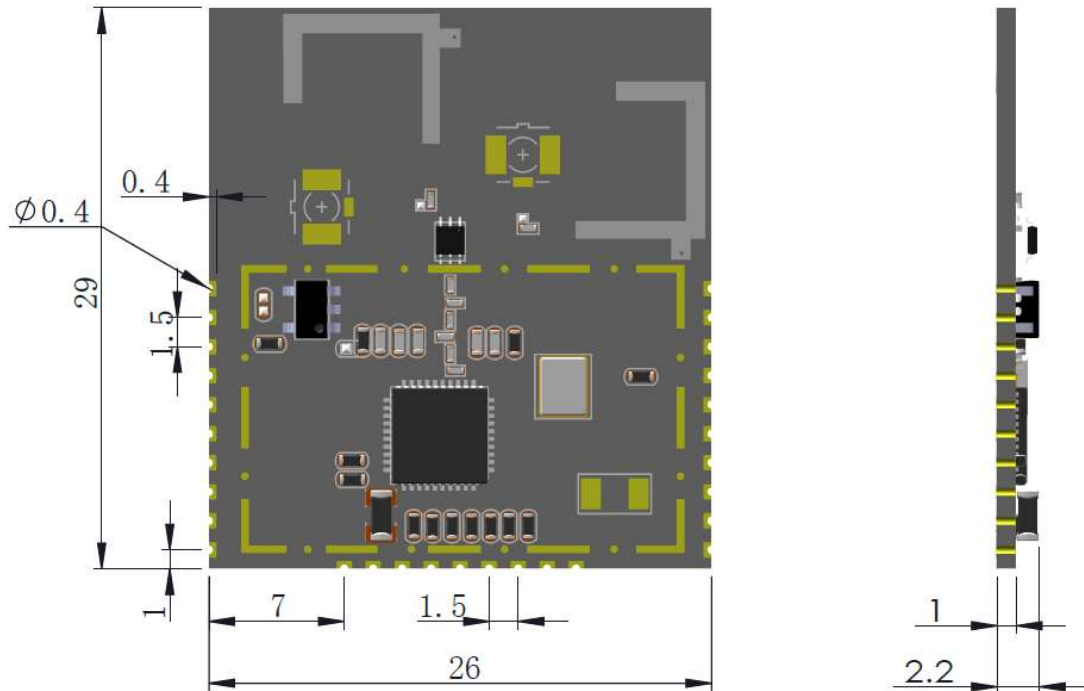


Figure 4: Mechanical Dimensions (Unit: mm)

8 Design Guidelines

1. Use a DC regulated power supply for the module with minimal ripple. Ensure proper grounding. Incorrect polarity may cause permanent damage.
2. Ensure the power supply voltage is within the recommended range. Exceeding the maximum value may permanently damage the module. Avoid frequent voltage fluctuations.
3. Design the power circuit with at least 30% margin for long-term stability. Keep the module away from high EMI sources like power supplies and transformers.
4. Avoid routing high-frequency digital/analog traces or power lines under the module. If unavoidable, ensure the Top Layer is grounded, and route traces on the

Bottom Layer near the digital section.

5. Avoid arbitrary routing on the Bottom Layer or other layers, as it may affect spurious emissions and receiver sensitivity.
6. Keep high-EMI components away from the module. Implement isolation or shielding if necessary.
7. Maintain distance from high-EMI traces (high-frequency digital/analog, power lines). Use isolation or shielding if needed.
8. Use level-shifting circuits for 5V communication lines.
9. Avoid protocols operating in the 2.4 GHz band, such as USB 3.0.
10. For antenna layout, refer to the following figures:

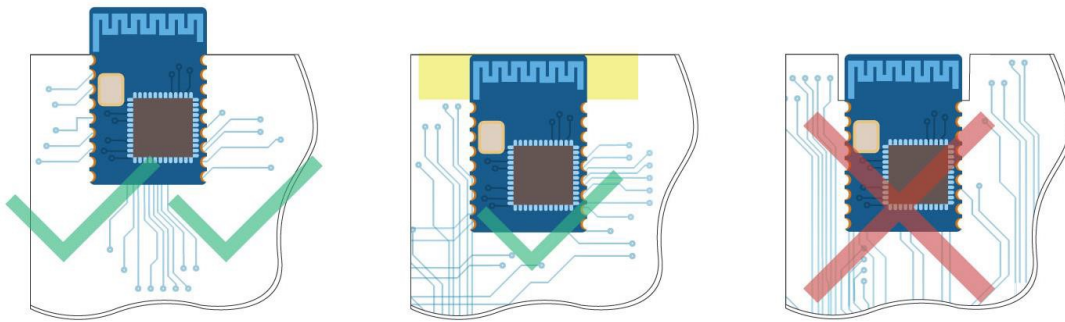


Figure 5: PCB Routing Recommendations

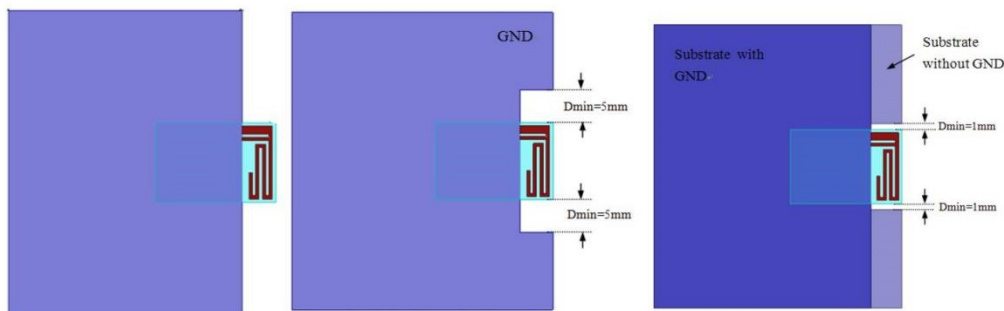


Figure 6: PCB Layout Recommendations

9 Soldering Recommendations

It is recommended that final PCB assembly of the module follows the industry standard as identified by the Institute for Printed Circuits (IPC). Sometimes a PCB must be reflowed multiple times based on the nature of the design and components used or limitations of the assembly line. During a single reflow cycle, every component is exposed to and stressed with high temperature. Exposing parts to high temperature for multiple times can damage the parts. It is always recommended to avoid more than two reflow cycles of the parts. The figure below illustrates the recommended reflow profile that follows IPC / JEDEC-020, and the peak temperature should not exceed 245°C.

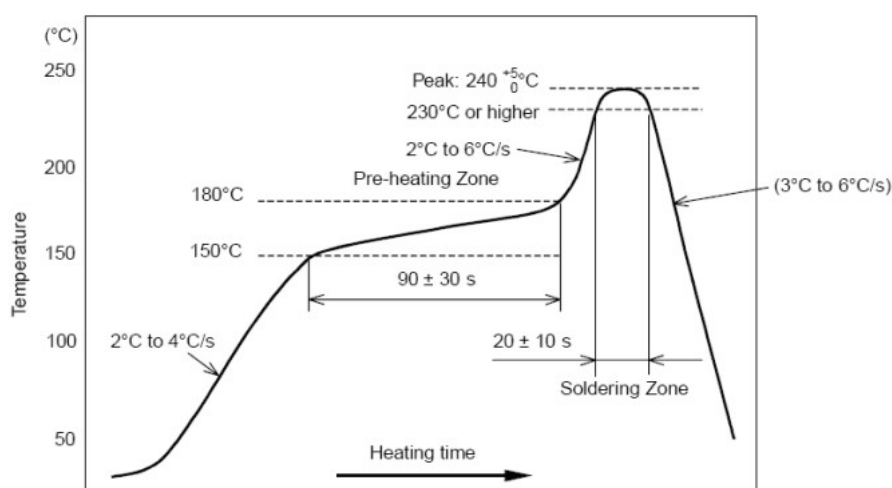


Figure 7: Soldering Thermal Profile (Solder Joint)

10 Electrostatic Discharge Warning

The module is susceptible to ESD damage. Follow these precautions:

1. Always use ESD-safe handling (avoid bare hands).
2. Include ESD protection circuits in high-voltage or high-frequency inputs.

ESD may cause performance degradation or complete failure. Minor parameter shifts can render the module non-compliant with certified specifications.

11 Version History

Table 2. Version History

Version	Modification	Date
V1.0	Initial Version	2025.7.14

Liability Disclaimer

Shenzhen Hope Microelectronics Co., Ltd reserves the right to make changes without further notice to the product to improve reliability, function or design. Shenzhen Hope Microelectronics Co., Ltd does not assume any liability arising out of the application or use of any product or circuits described herein.

Life Support Applications

Shenzhen Hope Microelectronics Co., Ltd's products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Shenzhen Hope Microelectronics Co., Ltd customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Shenzhen Hope Microelectronics Co., Ltd for any damages resulting from such improper use or sale.

Contact Information

Shenzhen Hope Microelectronics Co., Ltd.

Address: 30th floor of 8th Building, C Zone, Vanke Cloud City, Xili Sub-district, Nanshan, Shenzhen, GD, P.R. China

Tel: +86-755-82973805

Post Code: 518055

Email: sales@hoperf.com

Website: www.hoperf.com