

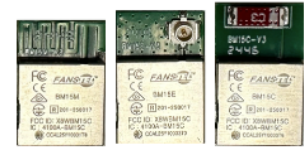
Bluetooth 6.0, 802.15.4 Module BM15C, BM05C

Ver. 1.00 Jan. 2025

BM15C Series are powerful, highly flexible, ultra low power Bluetooth Low Energy (BLE) modules using Nordic nRF54L15 or nRF54L05 SoC. With an ARM Cortex™ M33 MCU at 128 MHz, up to 1.524MB flash, up to 256KB RAM, embedded 2.4GHz multi-protocol transceiver, and an integrated PCB trace antenna or a connection for an external antenna. It allows faster time to market with reduced development cost.

BM15C are designed to minimize PCB cost and to maximize efficiency in production line dedicated for Bluetooth modules. The cost of using BM15C modules can be lower than designing-in SoC at any quantity.

BM15Cs are footprint upgradeable to nRF54H20 BLE module BMH20Cs.



BM15C Specifications

BLE 6.0, IEEE 802.15.4-2006 Transceiver

- Complete RF solution with integrated antenna
 - BLE: 2Mbps, 1Mbps (-98 dBm sensitivity), 500kbps, 125kbps (-106 dBm sensitivity).
 - IEEE 802.15.4-2006: 250 kbps (-102 dBm sensitivity).
 - Proprietary: 4Mbps, 2Mbps, 1Mbps.
- Programmable TX power, -8 dBm +8 dBm.
- AoA and AoD direction finding using BLE.
- 128 bit AES/ECB/CCM/AAR co-processor (on-the-fly operation).
- 12.0 mW TX current at 0 dBm, 1Mbps, 1.8V VDD.
- 7.5 mW RX current, 1Mbps, 1.8V VDD.
- RSSI, 1 dB resolution

Platform Security

- Secure/non-secure memory protection.
- Symmetric and asymmetric key crypto accelerator.
- Secure key management.
- Tamper detection.
- Immutable boot partition.
- Debug access port protection.
- Two watchdog timers for secure and non-secure context.

MCU

- Nordic nRF54L with ARM Cortex M33, 128 MHz.
- Flash/RAM: 1524KB/256KB, or 500KB/96KB.
- 505 EEMAC CoreMark score running from non-volatile memory, 3.95 CoreMark per MHz.
- Single precision floating point unit (FPU).
- Memory protection unit (MPU).
- Digital signal processing (DSP) instructions.
- Serial Wire Debug (SWD)

- Data watchpoint and trace (DWT), embedded trace macrocell (ETM), instrumentation trace macrocell (ITM), and cross trigger interface (CTI).
- Trace port interface unit (TPIU), 4-bit parallel trace of ITM and ETM trace data; Serial wire output (SWO) trace of ITM data.

Peripherals

- Two realtime counters (RTC), and one global RTC (GRTC) that can run in System OFF mode and implement a shared system timer.
- Seven 32-bit timers with counter mode.
- Five fully featured serial interfaces with EasyDMA, supporting I²C, SPI controller/peripheral, and UART.
- Three pulse width modulator (PWM) units with Easy DMA.
- I²S two channel inter-IC sound interface.
- 14-bit at 20KS/s, 12 bit at 250KS/s, or 10-bit at 2MS/s ADC with up to eight programmable gain channels.
- Near field communication (NFC).
- Two quadrature decoders (QDEC).
- 38 LGA pins, 31 GPIOs.
- Embedded inductors for DCDC converter
- 1.7V to 3.6V supply.
- An external 32.768 KHz crystal is not required.
- Operation temperature: -40°C to +105°C

Certifications

- FCC ID: X8WBM15C
- ISED ID: 4100A-BM15C
- CE, RCM: Compliant
- TELEC ID: 201-250017
- Taiwan NCC ID: See below
- QDID:

Model Summaries

| module | BM15M | BM15C | BM15E | BM05M | BM05C |
|--------------------|-------------------------------------|----------------|-------------------|-----------------------------------|-------------|
| SoC | nRF54L15, 1524 KB flash; 256 KB RAM | | | nRF54L05, 500 KB flash; 96 KB RAM | |
| Size | 10.0x14.0mm | 10.0x15.8mm | 10.0x15.0mm | 10.0x14.0mm | 10.0x15.8mm |
| Antenna | PCB Trace | Chip | U.FL for external | PCB Trace | Chip |
| Peak TX, conducted | +7.71 dBm | +7.71 dBm | +7.71 dBm | | |
| Peak TX, radiated | +7.15 dBm | +12.01 dBm | +13.71 dBm | | |
| BLE range,1Mbps | 300M est. | 900M, est. | | 300M est. | 900M, est. |
| Certifications | BLE+802.15.4 | BLE+802.15.4 | BLE+802.15.4 | BLE | BLE |
| Taiwan NCC ID | CCAL25Y10031T8 | CCAL25Y10030T6 | CCAL25Y10032T0 | | |
| Availability | Production | Production | Production | Q2, 2025 | Q2, 2025 |

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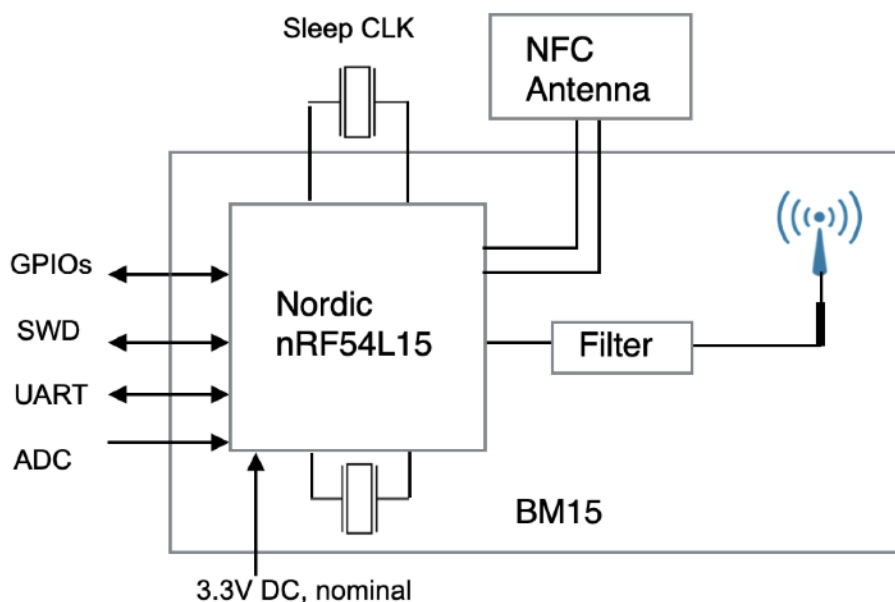
1. Introduction

BM15C module is powerful, highly flexible, ultra low power Bluetooth Low Energy (BLE) modules using Nordic nRF54L15 SoCs. With an ARM Cortex™ M33 MCU at 128 MHz, up to 1.524MB flash, 256KB RAM, embedded 2.4GHz multi-protocol transceiver, and an integrated antenna, it allows faster time to market with reduced development cost.

The following is a block diagram of BM15C. Antenna circuit and main clock are integrated. All 31 GPIOs of nRF54L15 can be accessed from main board. For lower power consumption at idle state, a 32.768 kHz crystal is added on the host board. Connection to an external NFC (Near Field Communication) antenna is provided.

In this data sheets, BM05C, BM05M, BM15C, BM15E, and BM15M are referred as BM15C.

BM15C Block Diagram



Summaries of BM15C Series modules.

BM15M

- BM15M: uses an nRF54L15 SoC.
- Cortex M33 MCU at 128 MHz, 1524KB flash, 256 KB RAM
- Integrated PCB trace antenna
- Size: 10.0x14.0mm



BM15E

- BM15E: uses an nRF54L15 SoC.
- Cortex M33 MCU at 128 MHz, 1524KB flash, 256 KB RAM
- An u.FL connector for external antenna
- Size: 10.0x15.0mm.



BM15C

- BM15C: uses an nRF54L15 SoC.

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- Cortex M33 MCU at 128 MHz, 1524KB flash, 256 KB RAM
- Integrated high performance chip antenna
- Size: 10.0x15.8mm



BM05C

- BM05C: uses an nRF54L05 SoC.
- Cortex M33 MCU at 128 MHz, 500KB flash, 96 KB RAM
- Integrated high performance chip antenna
- Size: 10.0x15.8mm

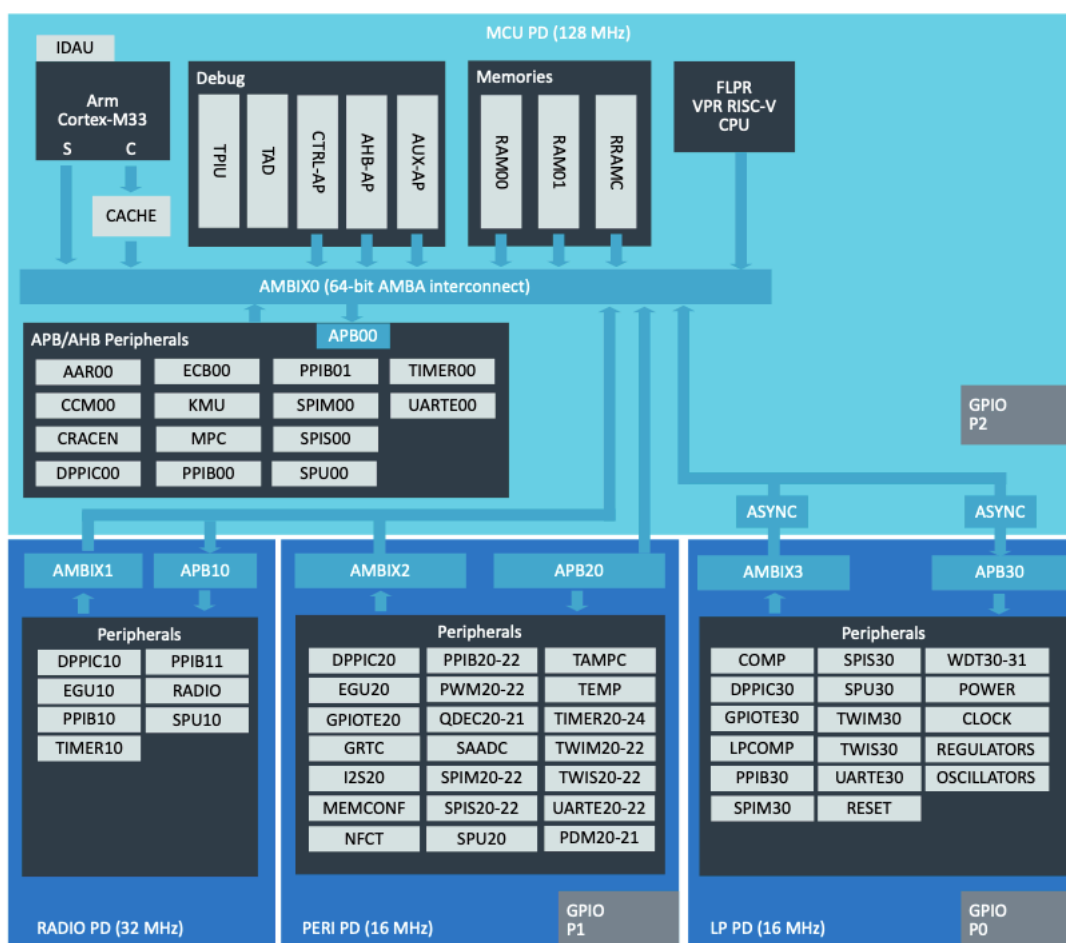
BM05M

- BM05M: uses an nRF54L05 SoC.
- Cortex M33 MCU at 128 MHz, 500KB flash, 96 KB RAM
- Integrated PCB trace antenna
- Size: 10.0x14.0mm

2. BM15C Specifications

Nordic SoCs

A block diagram of nRF54L15 is below. This is an ultra-low power SoC with advanced security features, a range of peripherals, and a multiple protocol 2.4 GHz transceiver. It supports Bluetooth Low Energy (BLE), IEEE 802.15.4 for Thread and Zigbee protocols, and allows for the implementation of proprietary 2.4 GHz protocols.



The main processing unit is an ARM Cortex M33 processor running at up to 128 MHz, supported by nonvolatile RRAM and RAM memory. The ARM Cortex M33 has a full set of digital processing (DSP) instructions and a memory protection unit (MPU) for application security. The full-featured single-precision floating-point unit (FPU) supports all single-precision instructions.

The peripheral set offers a variety of analog and digital functionality enabling single chip implementation of a wide range of applications. Hardware isolation between the secure and non-secure resources, as defined by ARM TrustZone, is implemented in the device. The hardware peripherals can be configured as secure or non-secure.

A key management unit (KMU) provides key storage, that when combined with a cryptographic accelerator (CRACEN), ensures discretion of encryption keys even within the secure world. The cryptographic accelerator has protection against differential power analysis (DPA) attacks.

The device has measures to protect against physical security attacks. It can detect and report fault injection attacks such as voltage glitching or electromagnetic fault injection. An external active shield I/O interface provides PCB or product level security for the detection of a product's encapsulation being opened, or product tampering.

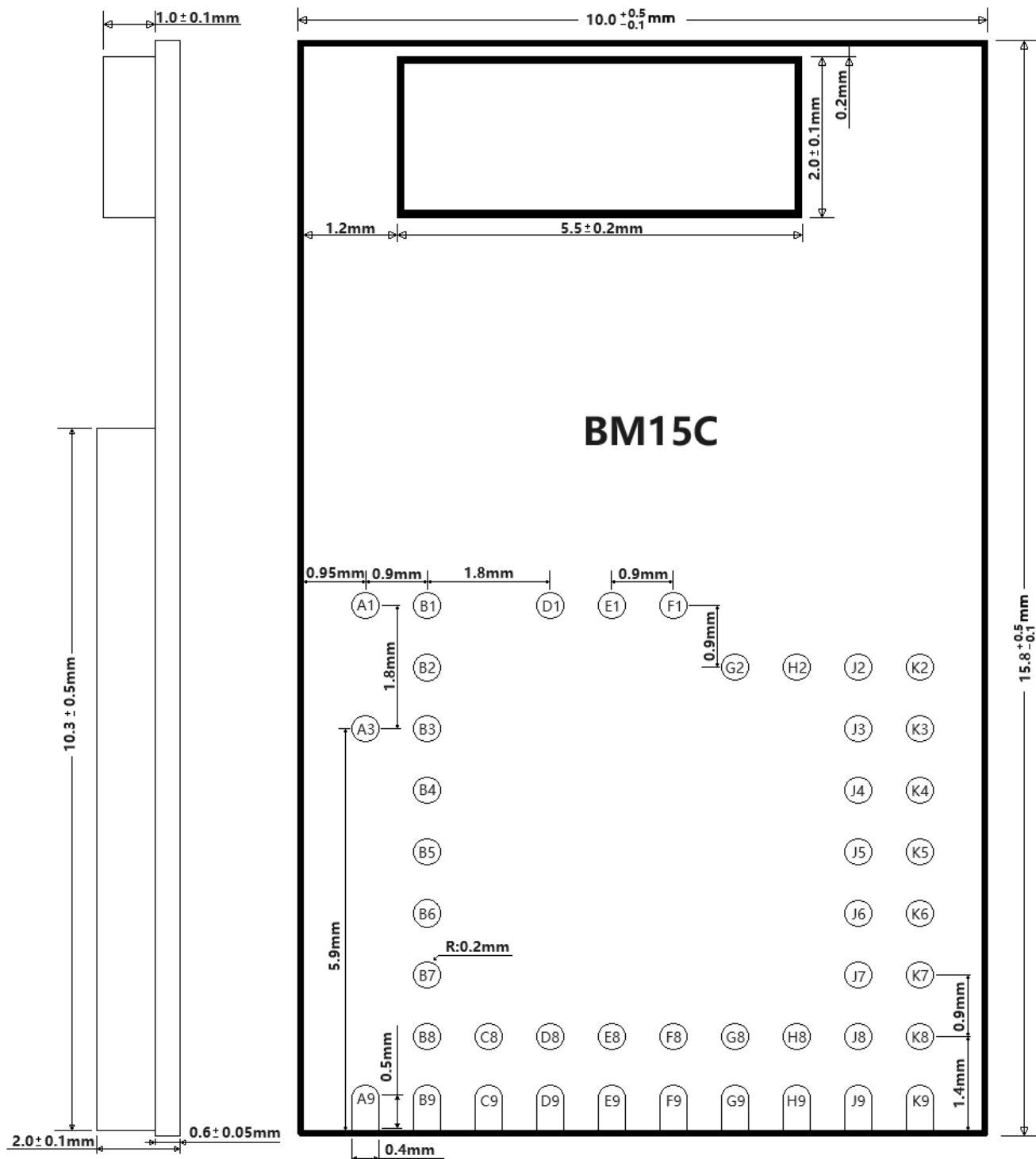
The device non-volatile memory has a boot region that can be made immutable before the CPU starts up. Boot initiated from an immutable source allows subsequent boot steps to be performed by authenticated code.

The debug access port can be enabled or disabled to allow either non-intrusive or intrusive debugging, from secure or non secure worlds. The non volatile memory can be protected against erasing, providing protection from unauthenticated repurposing. Authenticated debug access control, such as facilitating the ARM ADAC architecture, is supported through a hardware mailbox. The mailbox allows on-chip firmware to authenticate the debug host before enabling the device debug interface.

The device has a dedicated RISC-V CPU (VPR), which is a fast, lightweight peripheral processor (FLPR) dedicated for software defined peripherals.

Mechanical Drawings

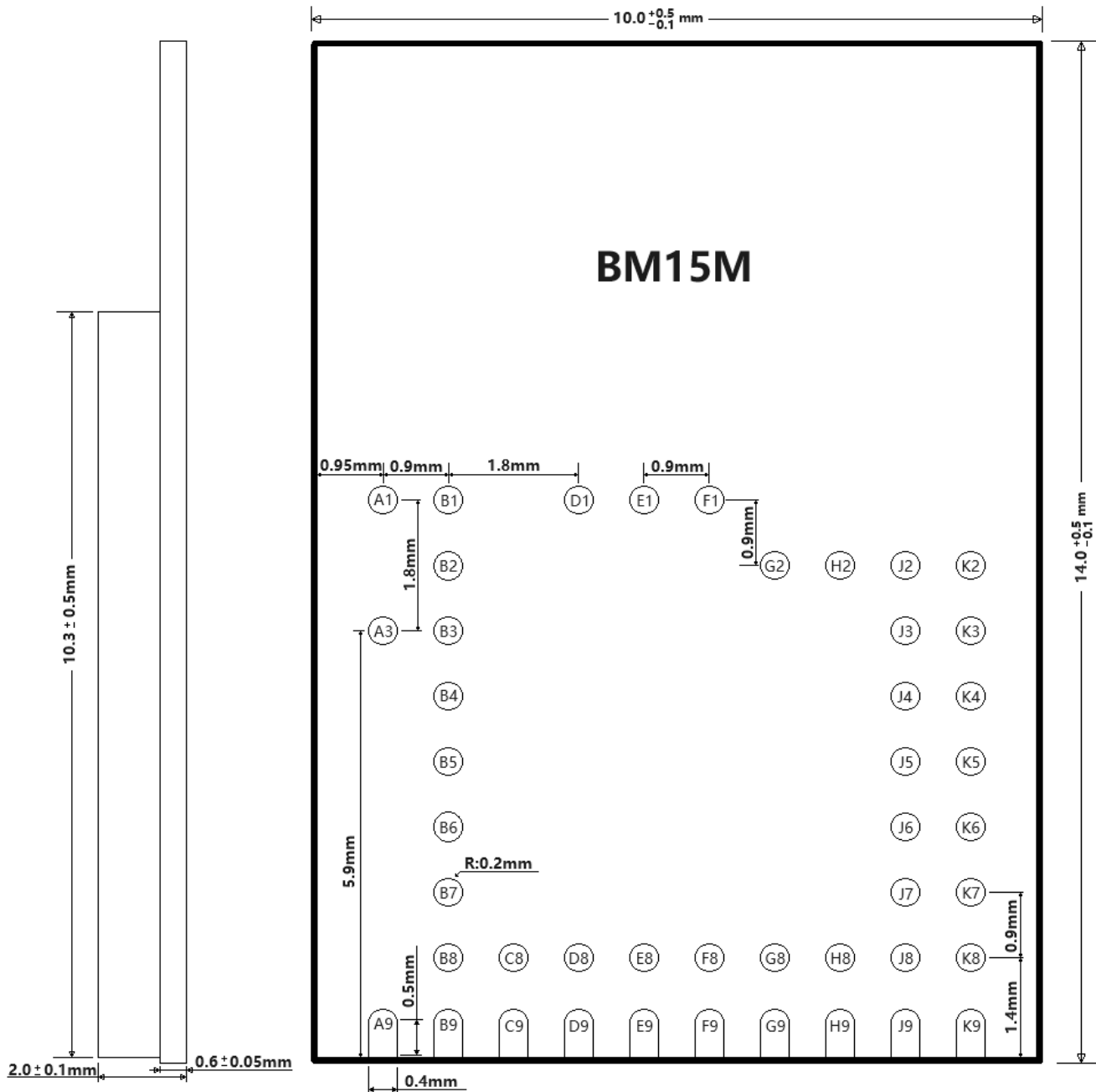
The following is mechanical drawings of BM15C and BM05C, top view.



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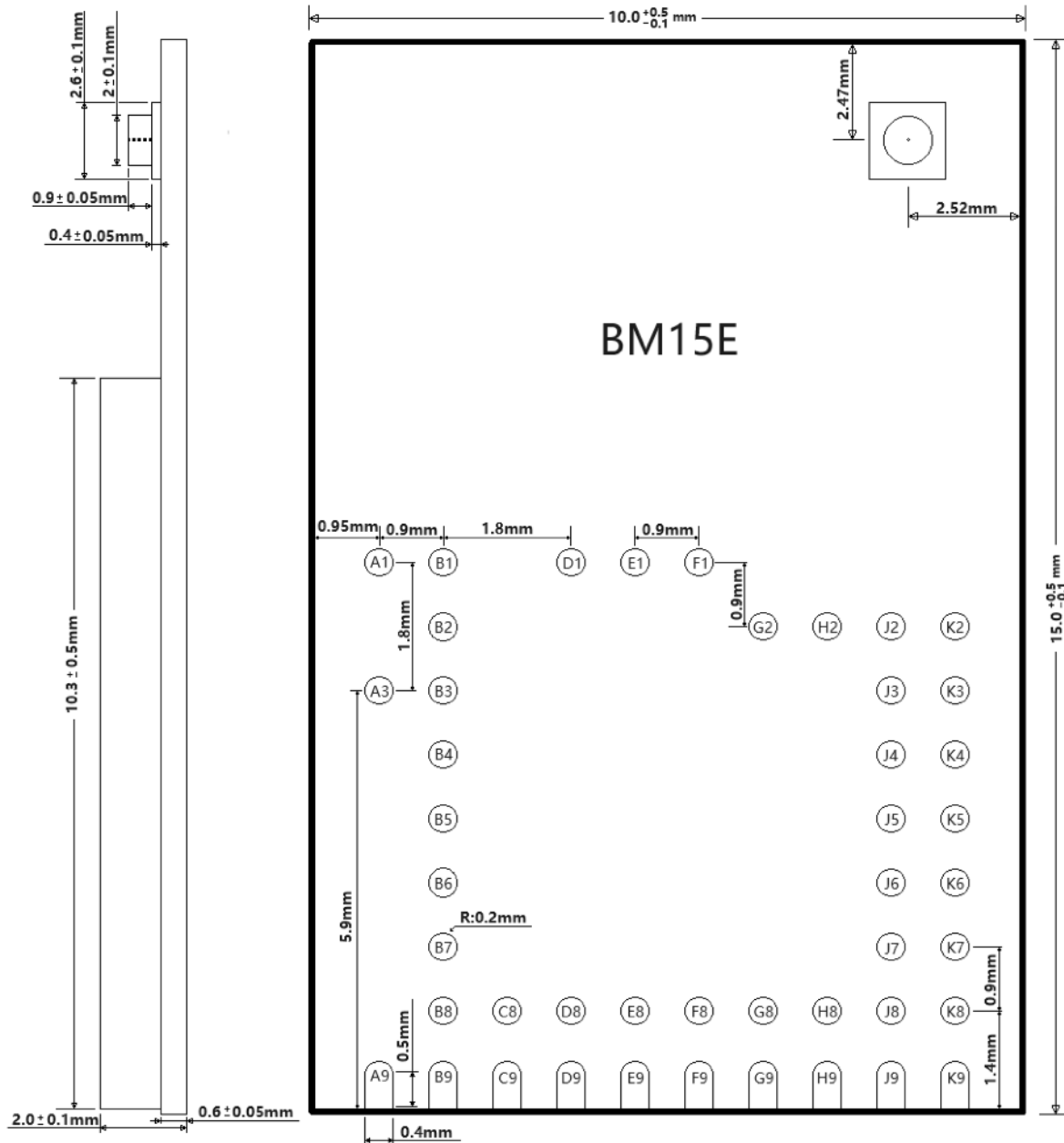
The following is mechanical drawings of BM15M and BM05M, top view.



Bluetooth 6.0, 802.15.4 Module BM15C, BM05C

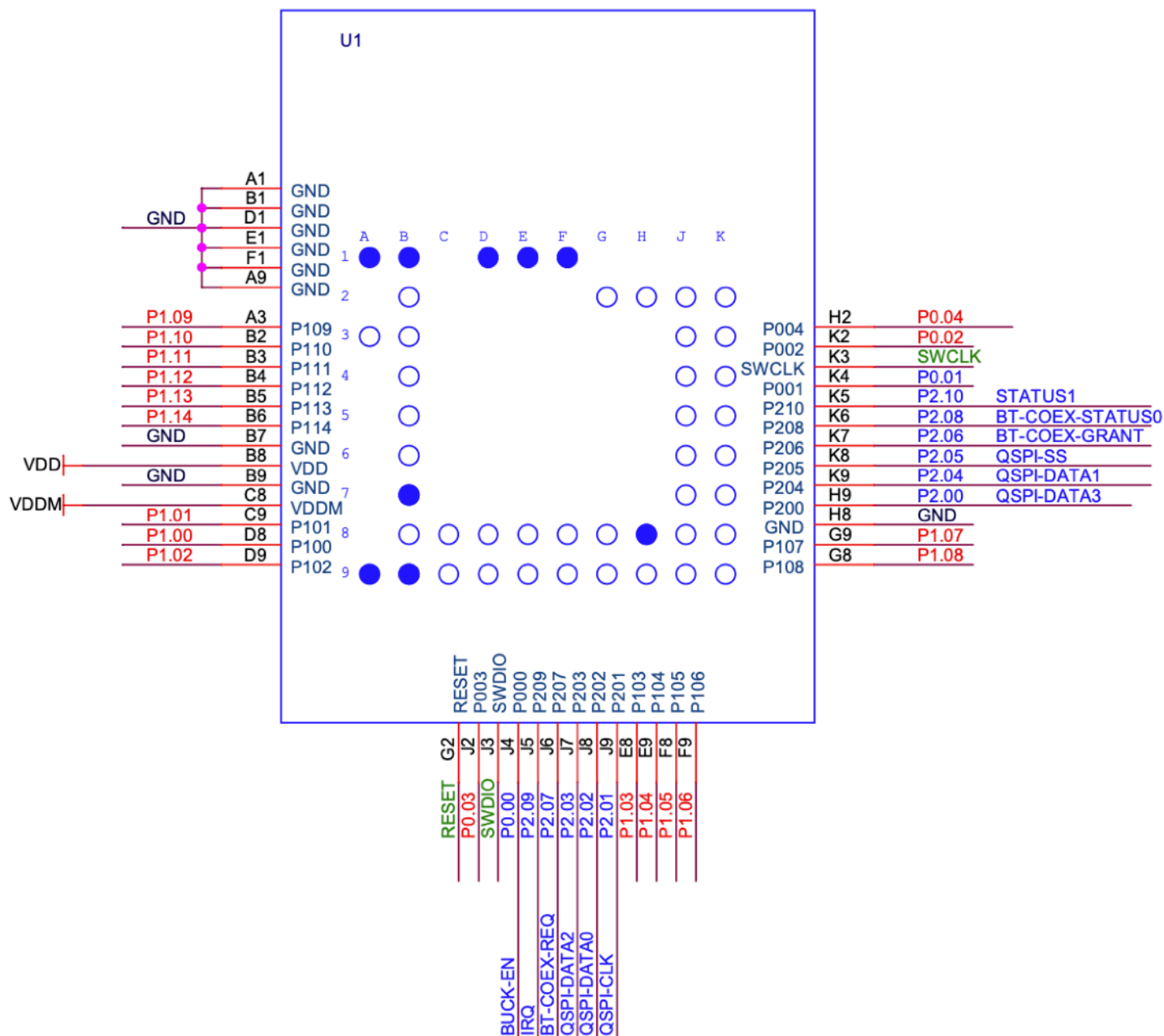
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The following is mechanical drawings of BM15E, top view.



BM15C Pin Map

The following is a pin map of BM15C Series modules.



Pin Function Table

In this section, the following abbreviations are used.

- BM15, an nRF54L15 Bluetooth module representing BM15M, BM15C, BM15E, BM05C, BM05M.
- L15, nRF54L15 or nRF54L05.

| BM15 pin# | L15 pin# | Name | Descriptions |
|--------------|-------------|--------|--|
| A1 | | GND | Ground |
| A3 | 37 | P109 | GPIO |
| A9 | | GND | Ground |
| B1 | | GND | Ground |
| B2 | 38 | P110 | GPIO |
| B3 | 39 | P111 | GPIO, Analog input AIN4; |
| B4 | 40 | P112 | GPIO, Analog input AIN5; |
| B5 | 41 | P113 | GPIO, Analog input AIN6; |
| B6 | 42 | P114 | GPIO, Analog input AIN7; |
| B7 | 49 | GND | Ground |
| B8 | 36 | VDD | 1.7V to 3.6V; |
| B9 | 49 | GND | Ground |
| C8 | 48 | VDD | Main power supply, 3V nominal, 1.7V to 3.6V. |
| C9 | 2 | P101 | GPIO, connection for 32.768 kHz crystal |
| D1 | | GND | Ground |
| D8 | 1 | P100 | GPIO, connection for 32.768 kHz crystal |
| D9 | 3 | P102 | GPIO, NFC pin. |
| E1 | | GND | Ground |
| E8 | 4 | P103 | GPIO |
| E9 | 5 | P104 | GPIO, Analog input AIN0; |
| F1 | | GND | Ground |
| F8 | 6 | P105 | GPIO, Analog input AIN1; |
| F9 | 7 | P106 | GPIO, Analog input AIN2; |
| G2 | 30 | /Reset | /Reset, active low. |
| G8 | 9 | P108 | GPIO |
| G9 | 8 | P107 | GPIO, Analog input AIN3 |
| H2 | 29 | P004 | GPIO |
| H8 | 49 | GND | Ground |
| H9 | 11 | P200 | GPIO |
| J2 | 28 | P003 | GPIO |
| J3 | 25 | SWDIO | Serial Wire Debug data. |
| J4 | 23 | P000 | GPIO; |
| J5 | 20 | P209 | GPIO; |
| J6 | 18 | P207 | GPIO; |
| J7 | 14 | P203 | GPIO; |
| J8 | 13 | P202 | GPIO; |
| J9 | 12 | P201 | GPIO; |
| K2 | 27 | P002 | GPIO |

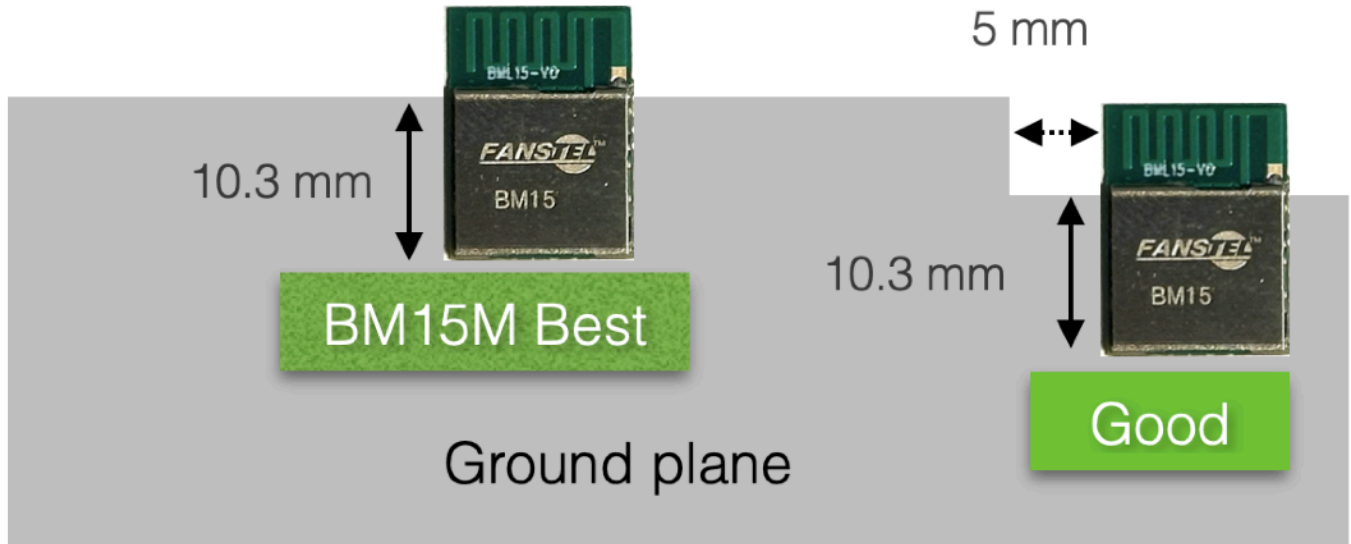
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| | | | |
|----|----|--------|-------------------------|
| K3 | 26 | SWDCLK | Serial Wire Debug clock |
| K4 | 24 | P001 | GPIO; |
| K5 | 21 | P210 | GPIO; |
| K6 | 19 | P208 | GPIO; |
| K7 | 17 | P206 | GPIO; |
| K8 | 16 | P205 | GPIO; |
| K9 | 15 | P204 | GPIO; |

Mounting BM15M on the Host PCB

BM15C or BM15M with an integrated antenna is referred as BM15M in this section. It shall follow these mounting guidelines. There is no mounting restriction for BM15E with an u.FL connector.



The length of the RFI shield is 10.3 mm. The RFI shield area is the main body of module. The rest of the module is called antenna area.

- The main body area can be on a host board ground plane. The antenna area must be extended outside of the host board or in an area without ground or signal trace.
- The length of BM15C antenna area is 5.5 mm.
- The length of BM15M antenna area is 3.7mm.
- We don't recommend mounting BM15M module in the middle of a host PCB.

For the best Bluetooth range performance, keep all external metal at least 30mm from the antenna area.

Suggestion for Battery Power Application

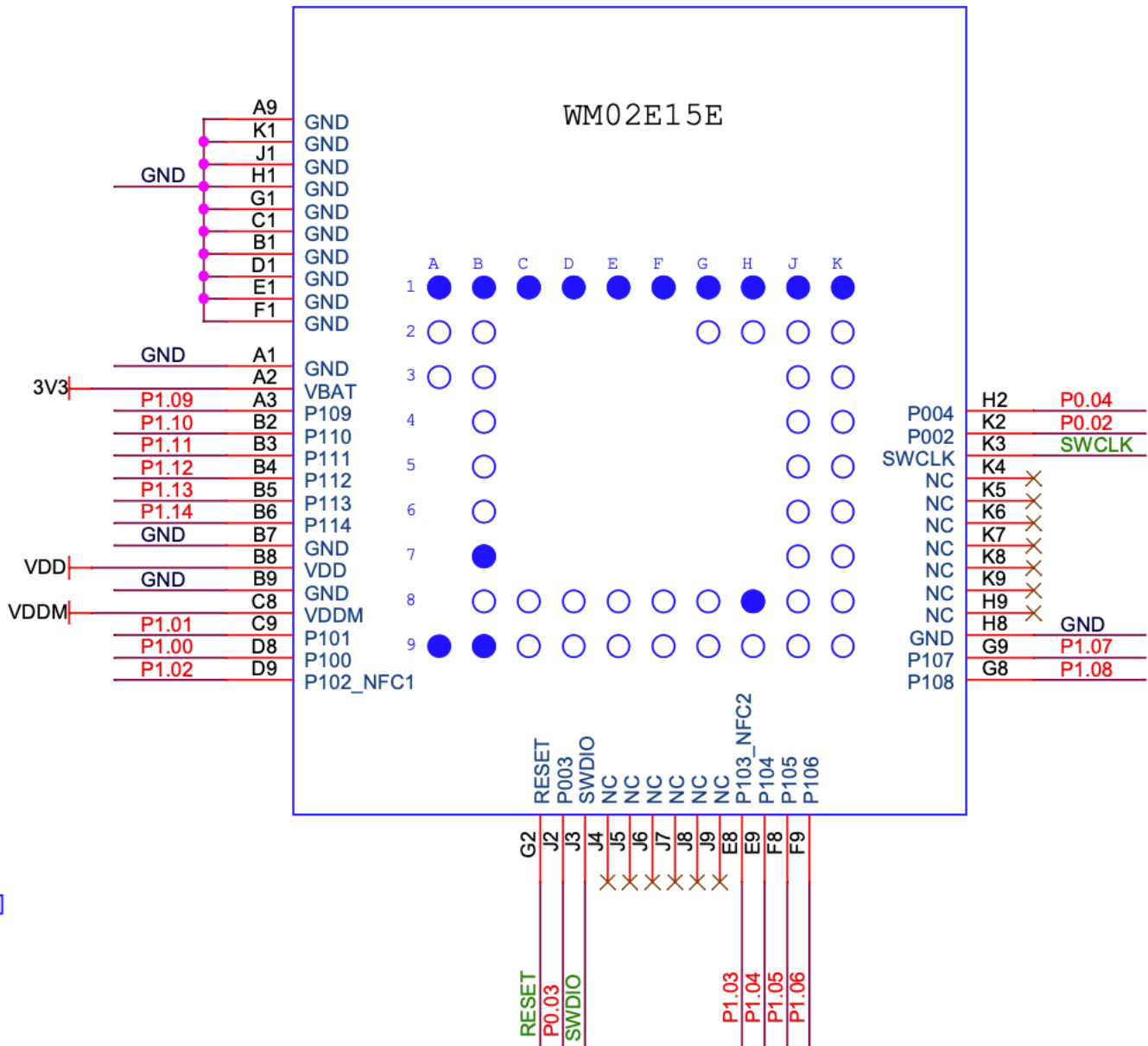
Standby current consumption is important for battery-powered product. We suggest adding a 32.768 kHz crystal as shown in the evaluation board schematics. The 32MHz main clock won't be active at idle state to save power. Two inductors required for DCDC converter are inside BM15 module. You can enable DCDC to lower power consumption.

3. Upgrading to BMH20C or WiFi 6 Combo

Use information in this section to design a host PCB that is upgradeable to support an nRF54H20 module, an nRF54H20 + nRF7002 combo module, or an nRF54L15 + nRF7002 combo module.

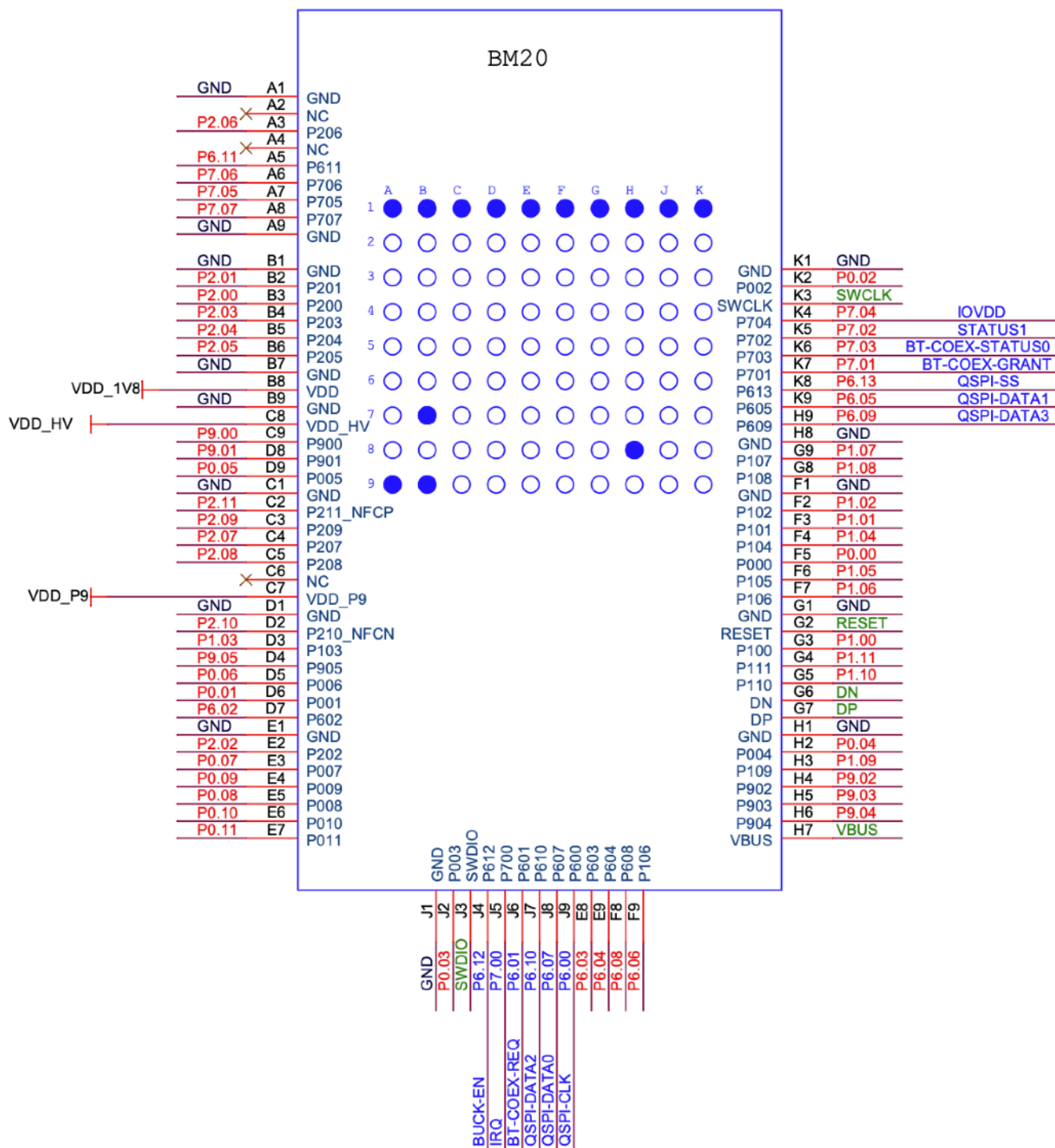
WM02C15C pin map

The pin map of WM02C15C, an nRF7002 + nRF54L15 combo module is below. Use this pin map to design-in BM15C for possible upgrade to support WiFi 6.



BMH20C pin map

BMH20C is an nRF54H20 module with 64 GPIO pins. Use this pin map to design-in BM15C for possible upgrade to BMH20C.



WM02CH20C pin map.

WM02E20E

Pinout diagram for the WM02E20E microcontroller. The diagram shows the connections for the 14 pins (A1 through P11) and the internal pin connections for the WM02E20E chip.

Pin Connections:

- A1:** GND
- A2:** 3V3
- A3:** P2.06
- A4:** P6.11
- A5:** P7.06
- A6:** P7.05
- A7:** P7.07
- A8:** P2.01
- A9:** P2.00
- B1:** P2.03
- B2:** P2.04
- B3:** P2.05
- B4:** P9.00
- B5:** P9.01
- B6:** P0.05
- B7:** P2.11
- B8:** P2.09
- B9:** P2.07
- B10:** P2.08
- B11:** P2.10
- B12:** P1.03
- B13:** P9.05
- B14:** P0.06
- B15:** P0.01
- B16:** P6.02
- B17:** P2.02
- B18:** P0.07
- B19:** P0.09
- B20:** P0.08
- B21:** P0.10
- B22:** P0.11
- B23:** P0.03
- B24:** SWDIO
- B25:** P6.03
- B26:** P6.04
- B27:** P6.08
- B28:** P6.06
- B29:** P0.02
- B30:** SWCLK
- B31:** P1.07
- B32:** P1.08
- B33:** P1.02
- B34:** P1.01
- B35:** P1.04
- B36:** P0.00
- B37:** P1.05
- B38:** P1.06
- B39:** RESET
- B40:** P1.00
- B41:** P1.11
- B42:** P1.10
- B43:** DN
- B44:** DP
- B45:** P0.04
- B46:** P1.09
- B47:** P9.02
- B48:** P9.03
- B49:** P9.04
- B50:** VBUS

Internal Pin Connections:

- A1:** GND
- A2:** 3V3
- A3:** P206
- A4:** NC
- A5:** P611
- A6:** P706
- A7:** P705
- A8:** P707
- A9:** GND
- B1:** GND
- B2:** P201
- B3:** P200
- B4:** P203
- B5:** P204
- B6:** P205
- B7:** GND
- B8:** VDD
- B9:** GND
- B10:** VDD_HV
- B11:** P900
- B12:** P901
- B13:** P005
- B14:** GND
- B15:** P211_NFCP
- B16:** P209
- B17:** P207
- B18:** P208
- B19:** NC
- B20:** VDD_P9
- B21:** GND
- B22:** P210_NFCN
- B23:** P103
- B24:** P905
- B25:** P006
- B26:** P001
- B27:** P602
- B28:** GND
- B29:** P202
- B30:** P007
- B31:** P009
- B32:** P008
- B33:** P010
- B34:** P011
- B35:** GND
- B36:** P003
- B37:** SWDIO
- B38:** NC
- B39:** NC
- B40:** NC
- B41:** NC
- B42:** NC
- B43:** NC
- B44:** NC
- B45:** P603
- B46:** P604
- B47:** P608
- B48:** P606
- B49:** GND
- B50:** P002
- B51:** SWCLK
- B52:** NC
- B53:** NC
- B54:** NC
- B55:** NC
- B56:** NC
- B57:** NC
- B58:** NC
- B59:** NC
- B60:** GND
- B61:** P107
- B62:** P108
- B63:** GND
- B64:** P102
- B65:** P101
- B66:** P104
- B67:** P105
- B68:** P106
- B69:** GND
- B70:** RESET
- B71:** P100
- B72:** P111
- B73:** P110
- B74:** DN
- B75:** DP
- B76:** GND
- B77:** P004
- B78:** P109
- B79:** P902
- B80:** P903
- B81:** P904
- B82:** VBUS

Pin Function Table

In this section, the following abbreviations are used.

- BM15, an nRF54L15 Bluetooth module representing BM15M, BM15C, BM15E.
- WM15, an nRF54L15 + nRF7002 Bluetooth and WiFi 6 combo module representing WM02C15C, WM02E15M, WM02E15E, and WM02P15P.
- BM20, an nRF54H20 Bluetooth module representing BMH20M, BMH20C, BMH20E.
- WM20, an nRF54H20 + nRF7002 Bluetooth and WiFi 6 combo module representing WM02CH20C, WM02EH20C, WM02EH20E, and WM02PH20P.
- L15, nRF54L15.
- H20, nRF54H20.

| BM15 pin# | L15 pin# | Name | BM20 pin# | H20 pin# | Name | Descriptions |
|--------------|-------------|------|--------------|-------------|--------|--|
| A1 | | GND | A1 | | | Ground |
| A2 | | 3V3 | A2 | | 3V3 | BM15,BM20,NC; WM15,WM20 3.3V power to nRF7002. |
| A3 | 37 | P109 | A3 | J2 | P206 | BM20,WM20, GPIO |
| | | | A4 | | | |
| | | | A5 | M7 | P611 | BM20,WM20, DQ2 |
| | | | A6 | J10 | P706 | BM20,WM20, GPIO |
| | | | A7 | J11 | P705 | BM20,WM20, GPIO |
| | | | A8 | J9 | P707 | BM20,WM20, GPIO |
| A9 | | GND | A9 | | GND | Ground |
| B1 | | GND | B1 | | GND | Ground |
| B2 | 38 | P110 | B2 | G3 | P201 | GPIO |
| B3 | 39 | P111 | B3 | F3 | P200 | GPIO, BM15,WM15,Analog input AIN4; |
| B4 | 40 | P112 | B4 | H3 | P203 | GPIO, BM15,WM15,Analog input AIN5; |
| B5 | 41 | P113 | B5 | H2 | P204 | GPIO, BM15,WM15,Analog input AIN6; |
| B6 | 42 | P114 | B6 | J3 | P205 | GPIO, BM15,WM15,Analog input AIN7; |
| B7 | 49 | GND | B7 | | GND | Ground |
| B8 | 36 | VDD | B8 | L4 | VDD | BM15,WM15, 1.7V to 3.6V; BM20,WM20, 1.8V supply to GPIOs except port 9, 1.7V to 1.98V. |
| B9 | 49 | GND | B9 | | GND | Ground |
| C1 | | | C1 | | GND | BM15,NC; WM15,BM20,WM20 ground; |
| | | | C2 | J1 | P211 | GPIO, BM20,WM20 NFC-P; |
| | | | C3 | K1 | P209 | BM20,WM20, GPIO |
| | | | C4 | K3 | P207 | BM20,WM20, GPIO |
| | | | C5 | K2 | P208 | BM20,WM20, GPIO |
| | | | C6 | | NC | |
| | | | C7 | A12 | VDD_P9 | BM20,WM20, DC power supply to set port 9 GPIO voltage, 3.3V nominal, 1.62V to 3.6V. |
| C8 | 48 | VDDM | C8 | L1 | VDD_HV | Main power supply; BM15,WM15, 3V nominal, 1.8V to 3.6V; BM20,WM20, 3V nominal, 1.9V to 5.5V. |
| C9 | 2 | P101 | C9 | A11 | P900 | GPIO, BM15,WM15,connection for 32.768 kHz crystal |
| D1 | | GND | D1 | | GND | Ground |

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| | | | | | | |
|----|----|--------|----|-----|--------|--|
| | | | D2 | H1 | P210 | GPIO, BM20,WM20,NFC-N. |
| | | | D3 | E5 | P103 | BM20,WM20, GPIO |
| | | | D4 | C10 | P905 | BM20,WM20, GPIO |
| | | | D5 | E10 | P006 | BM20,WM20, GPIO |
| | | | D6 | D11 | P001 | BM20,WM20, GPIO |
| | | | D7 | M11 | P602 | GPIO, BM20,WM20,RWDS. |
| D8 | 1 | P100 | D8 | A10 | P901 | GPIO, BM15,WM15, connection for 32.768 kHz crystal |
| D9 | 3 | P102 | D9 | E11 | P005 | GPIO, BM15,WM15,NFC pin. |
| E1 | | GND | E1 | | GND | Ground |
| | | | E2 | G2 | P202 | BM20,WM20, GPIO |
| | | | E3 | E9 | P007 | BM20,WM20, GPIO |
| | | | E4 | F10 | P009 | BM20,WM20, GPIO |
| | | | E5 | F11 | P008 | BM20,WM20, GPIO |
| | | | E6 | F9 | P010 | BM20,WM20, GPIO |
| | | | E7 | G8 | P011 | BM20,WM20, GPIO |
| E8 | 4 | P103 | E8 | K12 | P603 | GPIO, BM15,WM15,NFC pin; BM20,WM20,CS0 |
| E9 | 5 | P104 | E9 | L11 | P604 | GPIO, BM15,WM15,Analog input AIN0; BM20,WM20,DQ7 |
| F1 | | GND | F1 | | GND | Ground |
| | | | F2 | E4 | P102 | BM20,WM20, GPIO |
| | | | F3 | D4 | P101 | BM20,WM20, GPIO |
| | | | F4 | D5 | P104 | BM20,WM20, GPIO |
| | | | F5 | C9 | P000 | BM20,WM20, GPIO |
| | | | F6 | C5 | P105 | BM20,WM20, GPIO |
| | | | F7 | B5 | P106 | BM20,WM20, GPIO |
| F8 | 6 | P105 | F8 | L9 | P608 | GPIO, BM15,WM15,Analog input AIN1; BM20,WM20,DQ5 |
| F9 | 7 | P106 | F9 | L10 | P606 | GPIO, BM15,WM15,Analog input AIN2; BM20,WM20,DQ6 |
| G1 | | GND | G1 | | GND | BM15,NC; WM15,BM20,WM20, ground; |
| G2 | 30 | /Reset | G2 | L7 | /Reset | /Reset, active low. |
| | | | G3 | B4 | P100 | BM20,WM20, GPIO |
| | | | G4 | C6 | P111 | BM20,WM20, GPIO |
| | | | G5 | B6 | P110 | BM20,WM20, GPIO |
| | | | G6 | B8 | DN | BM20,WM20, USB port Data |
| | | | G7 | B7 | DP | BM20,WM20, USB port Data |
| G8 | 9 | P108 | G8 | D6 | P108 | BM20,WM20, GPIO |
| G9 | 8 | P107 | G9 | A5 | P107 | GPIO, Analog input AIN3 |
| H1 | | GND | H1 | | GND | BM15,NC; WM15,BM20,WM20, ground; |
| H2 | 29 | P004 | H2 | D8 | P004 | BM20,WM20, GPIO |
| | | | H3 | A6 | P109 | BM20,WM20, GPIO |
| | | | H4 | B11 | P902 | BM20,WM20, GPIO |
| | | | H5 | B10 | P903 | BM20,WM20, GPIO |
| | | | H6 | C11 | P904 | BM20,WM20, GPIO |
| | | | H7 | A9 | VBUS | BM20,WM20, USB power supply, 5V nominal, 4.4V to 5.5V. |
| H8 | 49 | GND | H8 | | GND | Ground |
| H9 | 11 | P200 | H9 | M8 | P609 | GPIO, BM20,WM20,DQ3 |
| J1 | | GND | J1 | | GND | BM15,NC; WM15,BM20,WM20, ground; |

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| | | | | | | |
|----|----|--------|----|-----|--------|---|
| J2 | 28 | P003 | J2 | D9 | P003 | GPIO |
| J3 | 25 | SWDIO | J3 | G12 | SWDIO | Serial Wire Debug data. |
| J4 | 23 | P000 | J4 | L7 | P612 | GPIO; WM15,WM20, NC, internal, BUCK-EN to 7002; BM20, /Reset for QSPI memory. |
| J5 | 20 | P209 | J5 | G11 | P700 | GPIO; WM15,WM20, NC, internal, IRQ to 7002; |
| J6 | 18 | P207 | J6 | L12 | P601 | GPIO; WM15,WM20, NC, internal BT-COEX-REQ; |
| J7 | 14 | P203 | J7 | L8 | P610 | GPIO; WM15,WM20, NC, internal QSPI DATA2 |
| J8 | 13 | P202 | J8 | M9 | P607 | GPIO; WM15,WM20, NC, internal QSPI DATA0 |
| J9 | 12 | P201 | J9 | M12 | P600 | GPIO; WM15,WM20, NC, internal QSPI CLK; |
| K1 | | GND | K1 | | GND | BM15,NC; WM15,BM20,WM20, ground; |
| K2 | 27 | P002 | K2 | D10 | P002 | GPIO |
| K3 | 26 | SWDCLK | K3 | F12 | SWDCLK | Serial Wire Debug clock |
| K4 | 24 | P001 | K4 | H9 | P704 | GPIO; WM15,WM20, NC, internal control power IOVDD to 7002. |
| K5 | 21 | P210 | K5 | H11 | P702 | GPIO; WM15,WM20, NC, internal STATUS1 |
| K6 | 19 | P208 | K6 | H10 | P703 | GPIO; WM15,WM20, NC, internal STATUS0 |
| K7 | 17 | P206 | K7 | G10 | P701 | GPIO; WM15,WM20, NC, internal COEX GRANT |
| K8 | 16 | P205 | K8 | K7 | P613 | GPIO; WM15,WM20, NC, internal QSPI SS; |
| K9 | 15 | P204 | K9 | M10 | P605 | GPIO; WM15,WM20, NC, internal QSPI DATA1; |

4. Bluetooth Range Measurements

Bluetooth range measurement hex codes can be downloaded from **Bluetooth Range Measurements** section of this webpage.

To be provided.

Description of measurement site, measurement methods, and range raw data are available at:

<https://www.fanstel.com/testreport/>

Measurement Results

To be provided.

5. Evaluation Board

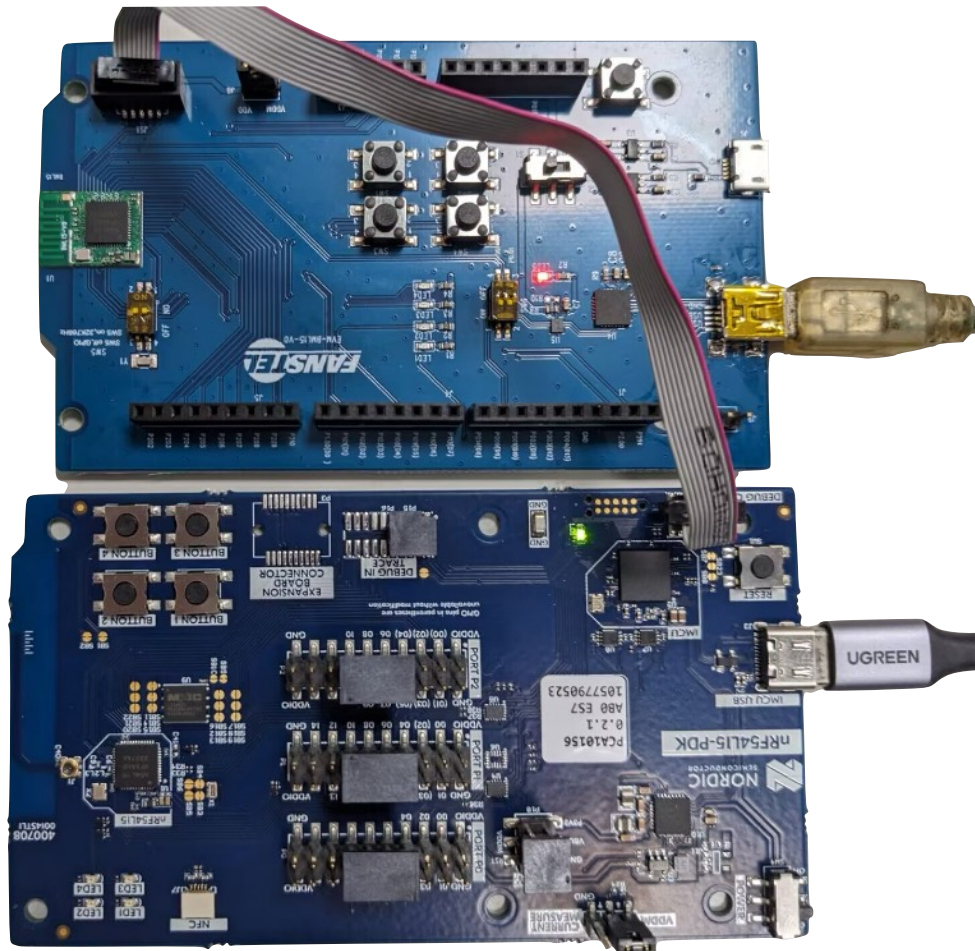
An evaluation board can be used to evaluate performance of module and to develop and test your firmware before an application-specific host board is developed.

Loading Firmware into Evaluation Board Through a Nordic DK

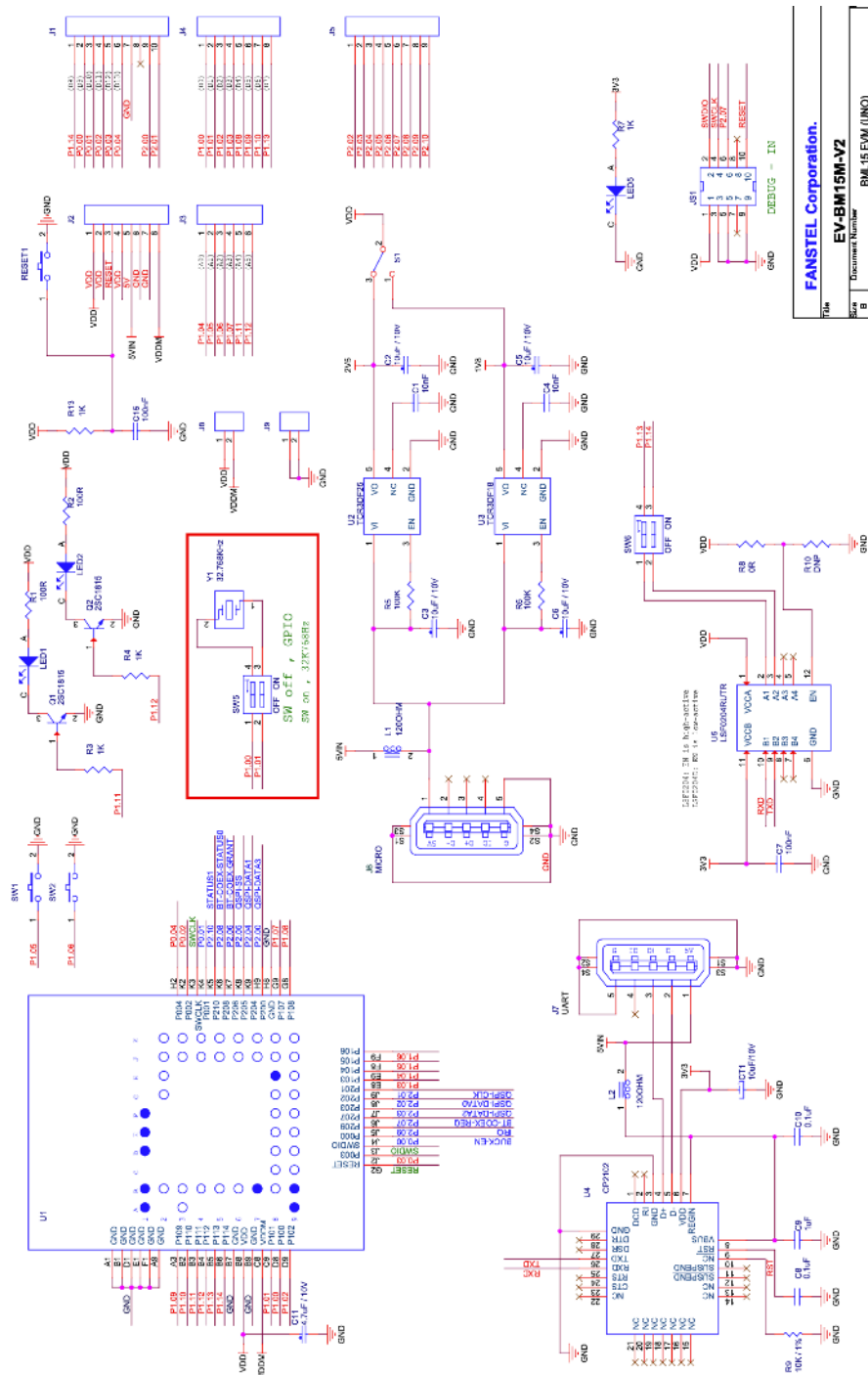
A Nordic nRF54L15 PDK or DK is required to load firmware into EV-BM15.

Procedures to connect a Nordic DK to a Fanstel nRF54 module evaluation board.

- Connect Nordic nRF54L15 DK debug out to Fanstel evaluation board debug in using the 10-pin flat cable as shown below.
- Connect Nordic nRF54L15 DK to PC.
- Connect a DC power source to micro or mini USB port of evaluation board.



Evaluation Board Schematics



6. Firmware Development

Procedures to Load Firmware

[EV-BM15 hex codes and source codes](#) can be downloaded from the Fanstel website.

Open command line tool and execute the programming commands.

```
nrfjprog -f NRF54L --recover
```

```
nrfjprog -f NRF54L --program BML15_231129.hex --chiperase --verify --reset
```

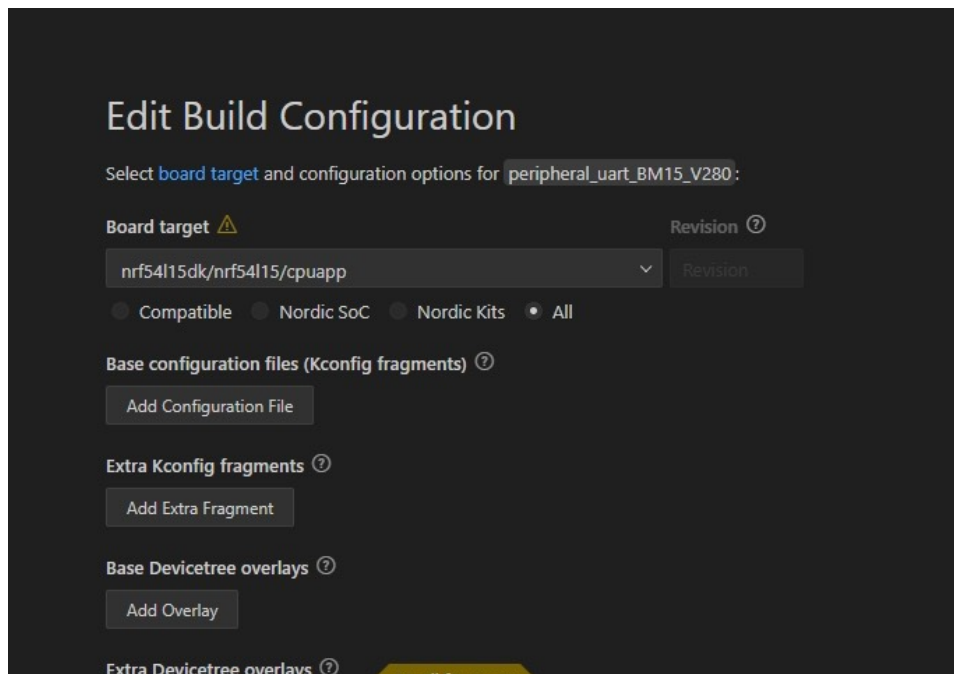
```
C:\Users\Leo\Desktop\Nordic_Firmware\BML15_231129\HEX>nrfjprog -f NRF54L --recover
Recovering device. This operation might take 30s.
Erasing user code and UICR flash areas.

C:\Users\Leo\Desktop\Nordic_Firmware\BML15_231129\HEX>nrfjprog -f NRF54L --program BML15_231129.hex --chiperase --verify
--reset
[ ##### ] 0.261s | Erase file - Done erasing
[ ##### ] 3.951s | Program file - Done programming
[ ##### ] 1.720s | Verify file - Done verifying
Applying system reset.
Run.

C:\Users\Leo\Desktop\Nordic_Firmware\BML15_231129\HEX>
```

Setting Up Firmware Development Environment

Please use nRF Connect SDK version 2.8.0 or newer for development. The previous versions of nRF Connect SDK do not support the BM15C. Please select the board nrf54l15dk/nrf54l15/cupapp. nRF54L15 silicon.



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Create an overlay file to configure the hardware peripherals to match your specific hardware. The following is an example setup for the nrf54l15dk/nrf54l15.overlay file.

```

20 //-----
21 //OSC32KRC.INTCAP 0x50120904
22 //nordic,nrf-1fxo".yaml([4000:18000] ,step 500)
23 &1fxo {
24     load-capacitors = "internal";
25     load-capacitance-femtofarad = <15500>;
26 };
27
28 &pinctrl {
29     /omit-if-no-ref/ uart20_default: uart20_default {
30         group1 {
31             psels = <NRF_PSEL(UART_TX, 1, 13)>;
32         };
33         group2 {
34             psels = <NRF_PSEL(UART_RX, 1, 14)>;
35             bias-pull-up;
36         };
37     };
38
39     /omit-if-no-ref/ uart20_sleep: uart20_sleep {
40         group1 {
41             psels = <NRF_PSEL(UART_TX, 1, 13)>,
42                 <NRF_PSEL(UART_RX, 1, 14)>;
43             low-power-enable;
44         };
45     };
46 };
47
48 &uart20 {
49     status = "okay";
50     current-speed = <115200>;
51     pinctrl-0 = <&uart20_default>;
52     pinctrl-1 = <&uart20_sleep>;
53     pinctrl-names = "default", "sleep";

```

After completing the setup, build and flash the code. Ensure that the code is running properly.

```

Restore: CONFIG_MBEDTLS_PSA_CRYPTO_C: True
Restore: CONFIG_MBEDTLS_PSA_CRYPTO_KEY_ID_ENCODES_OWNER: False
Restore: CONFIG_MBEDTLS_PSA_CRYPTO_SPM: False
Restore: CONFIG_MBEDTLS_USE_PSA_CRYPTO: True
Restore: CONFIG_MBEDTLS_PLATFORM_PRINTF_ALT: False
Restore: CONFIG_MBEDTLS_THREADING: False
Restore: CONFIG_MBEDTLS_THREADING_ALT: True
===== End psa_crypto_library_config =====
CMake Warning at C:/nRF91_241105_V280/v2.8.0/zephyr/CMakeLists.txt:2134 (message):
  __ASSERT() statements are globally ENABLED

-- Configuring done
-- Generating done
-- Build files have been written to: C:/MyNordicTestV280/peripheral_uart_BM15_V280/build/peripheral_uart_BM15_V280
-- Configuring done
-- Generating done
-- Build files have been written to: C:/MyNordicTestV280/peripheral_uart_BM15_V280/build
[68/68] Linking C executable zephyr\zephyr.elf
Memory region      Used Size  Region Size  %age Used
  FLASH:         240056 B      1420 KB    16.51%
    RAM:          37044 B       188 KB    19.24%
   IDT_LIST:         0 GB         32 KB     0.00%
Generating files from C:/MyNordicTestV280/peripheral_uart_BM15_V280/build/peripheral_uart_BM15_V280/zephyr/zephyr.elf for
[5/5] Generating ../merged.hex
Terminal will be reused by tasks, press any key to close it.

```


Use RTT Viewer or UART to monitor the logs and confirm that the code is functioning as expected.

```
00> 40 c2 f3 32 |@..2
00> [00:00:00.021,489] <inf> bt_hci_core: HW Platform: Nordic Semiconductor (0x0002)
00> [00:00:00.021,505] <inf> bt_hci_core: HW Variant: nRF54Lx (0x0005)
00> [00:00:00.021,520] <inf> bt_hci_core: Firmware: Standard Bluetooth controller (0x00) Version 254.63788 Build 573996906
00> [00:00:00.021,954] <inf> bt_hci_core: No ID address. App must call settings_load()
00> [00:00:00.021,962] <inf> peripheral_uart: Bluetooth initialized
00> [00:00:00.022,481] <inf> bt_hci_core: Identiom
00> [0m
```

Using Internal Load Capacitors for the High Frequency Oscillator

The external load capacitors for the 32MHz crystal are not mounted. An Epson or equivalent +/-10 PPM crystal is connected to XC1 and XC2 pins. The Bluetooth signal frequencies are within specifications if the internal load capacitors are not enabled. Use the following procedures to set the internal load capacitors to:

The internal load capacitors can be programmed from 4.0 pF to 17pF in 0.5 pF steps. The addresses and description of registers for programming the value of load capacitors are from the nRF54L15 product specifications.

To set up the internal capacitance, please configure it in the overlay file.

```
XOSC32M.CONFIG.INTCAP step 0.25 pf
&hfxo {
    load-capacitors = "internal";
    load-capacitance-femtofarad = <17000>;
};
```

```
XOSC32KI.INTCAP step 0.5 pf
&lfxo {
    load-capacitors = "internal";
    load-capacitance-femtofarad = <7000>;
};
```

Read the memory back to confirm.

```
nrfjprog --memrd 0x5012071C
```

The internal load capacitance shall be set to 17 pF for BM15C, BM15E, and BM15M modules.

Preloaded Firmware

The module is preloaded with firmware designed for factory testing purposes. The firmware is based on the Nordic NUS example. The preloaded source codes can be downloaded from the following link:

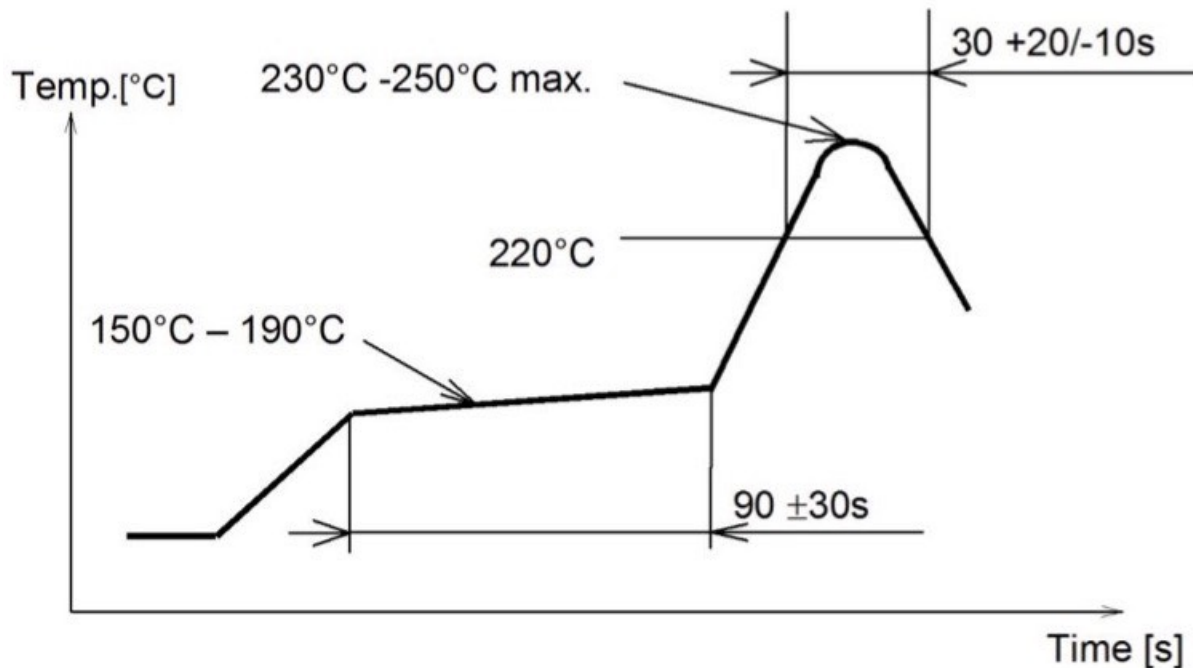
https://www.dropbox.com/scl/fo9jebdh7hfmvn1c wd769m/32M_CL-8pF-32K_CL-9pF-BlueNor_v280_BM15M_241119.7z?rlkey=ox0p6udd3mzsdz1djjvs1u09g&st=umimp4wm&dl=0

We suggest erasing the preloaded firmware before loading your own codes.

7. Miscellaneous

Soldering Temperature-Time Profile for Re-Flow Soldering

Maximum number of cycles for re-flow is 2. No opposite side re-flow is allowed due to module weight.



Cautions, Design Notes, and Installation Notes

Failure to follow the guidelines set forth in this document may result in degrading of the product's functions and damage to the product.

Design Notes

- (1) Follow the conditions written in this specification, especially the control signals of this module.
- (2) The supply voltage has to be free of AC ripple voltage (for example from a battery or a low noise regulator output). For noisy supply voltages, provide a decoupling circuit (for example a ferrite in series connection and a bypass capacitor to ground of at least 47uF directly at the module).
- (3) This product should not be mechanically stressed when installed.
- (4) Keep this product away from heat. Heat is the major cause of decreasing the life of these products.
- (5) Avoid assembly and use of the target equipment in conditions where the products' temperature may exceed the maximum tolerance.
- (6) The supply voltage should not be exceedingly high or reversed. It should not carry noise and/or spikes.
- (7) this product away from other high frequency circuits.

Notes on Antenna and PCB Layout

- (1) Don't use a module with internal antenna inside a metal case.
- (2) For PCB layout:
 - Avoid running any signal line below module whenever possible,
 - No ground plane below antenna,
 - If possible, cut-off the portion of main board PCB below antenna.

Installation Notes

- (1) Reflow soldering is possible twice based on the time-temperature profile in this data sheets. Set up the temperature at the soldering portion of this product according to this reflow profile.
- (2) Carefully position the products so that their heat will not burn into printed circuit boards or affect the other components that are susceptible to heat.
- (3) Carefully locate these products so that their temperatures will not increase due to the effects of heat generated by neighboring components.
- (4) If a vinyl-covered wire comes into contact with the products, then the cover will melt and generate toxic gas, damaging the insulation. Never allow contact between the cover and these products to occur.
- (5) This product should not be mechanically stressed or vibrated when reflowed.
- (6) If you want to repair your board by hand soldering, please keep the conditions of this chapter.
- (7) Do not wash this product.
- (8) Refer to the recommended pattern when designing a board.
- (9) Pressing on parts of the metal cover or fastening objects to the metal will cause damage to the unit.
- (10) For more details on LGA (Land Grid Array) soldering processes refer to the application note.

Usage Condition Notes

- (1) Take measures to protect the unit against static electricity. If pulses or other transient loads (a large load applied in a short time) are applied to the products, check and evaluate their operation before assembly on the final products.
- (2) Do not use dropped products.
- (3) Do not touch, damage or soil the pins.
- (4) Follow the recommended condition ratings about the power supply applied to this product.
- (5) Electrode peeling strength: Do not add pressure of more than 4.9N when soldered on PCB
- (6) Pressing on parts of the metal cover or fastening objects to the metal cover will cause damage.
- (7) These products are intended for general purpose and standard use in general electronic equipment, such as home appliances, office equipment, information and communication equipment.

Storage Notes

- (1) The module should not be stressed mechanically during storage.
- (2) Do not store these products in the following conditions or the performance characteristics of the product, such as RF performance will be adversely affected:

- Storage in salty air or in an environment with a high concentration of corrosive gas.
- Storage in direct sunlight
- Storage in an environment where the temperature may be outside the range specified.
- Storage of the products for more than one year after the date of delivery storage period.

(3) Keep this product away from water, poisonous gas and corrosive gas.

(4) This product should not be stressed or shocked when transported.

(5) Follow the specification when stacking packed crates (max. 10).

Safety Conditions

These specifications are intended to preserve the quality assurance of products and individual components. Before use, check and evaluate the operation when mounted on your products. Abide by these specifications, without deviation when using the products. These products may short-circuit. If electrical shocks, smoke, fire, and/or accidents involving human life are anticipated when a short circuit occurs, then provide the following failsafe functions, as a minimum.

(1) Ensure the safety of the whole system by installing a protection circuit and a protection device.

(2) Ensure the safety of the whole system by installing a redundant circuit or another system to prevent a dual fault causing an unsafe status.

Other Cautions

(1) This specification sheet is copyrighted. Reproduction of this data sheet is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices.

(2) Do not use the products for other purposes than those listed.

(3) Be sure to provide an appropriate failsafe function on your product to prevent an additional damage that may be caused by the abnormal function or the failure of the product.

(4) This product has been manufactured without any ozone chemical controlled under the Montreal Protocol.

(5) These products are not intended for other uses, other than under the special conditions shown below. Before using these products under such special conditions, check their performance and reliability under the said special conditions carefully to determine whether or not they can be used in such a manner.

- In liquid, such as water, salt water, oil, alkali, or organic solvent, or in places where liquid may splash.
- In direct sunlight, outdoors, or in a dusty environment
- In an environment where condensation occurs.
- In an environment with a high concentration of harmful gas.

(6) If an abnormal voltage is applied due to a problem occurring in other components or circuits, replace these products with new products because they may not be able to provide normal performance even if their electronic characteristics and appearances appear satisfactory.

(7) When you have any question or uncertainty, contact Fanstel.

Packaging

Production modules are delivered in reel, 1000 modules in each reel.

FCC LABEL

The Original Equipment Manufacturer (OEM) must ensure that the OEM modular transmitter must be labeled with its own FCC ID number. This includes a clearly visible label on the outside of the final product enclosure that displays the contents shown below. If the FCC ID is not visible when the equipment is installed inside another device, then the outside of the device into which the equipment is installed must also display a label referring to the enclosed equipment

The end product with this module may subject to perform FCC part 15 unintentional emission test requirement and be properly authorized.

This device is intended for OEM integrator only.

8. Revision History

- May 2024, Ver. 0.50: The first draft copy
- July 2024, Ver. 0.51: Draft revision.
- Aug. 2024, Ver. 0.52: Add module mechanical drawings.
- Aug. 2024, Ver. 0.53: Revise module mechanical drawings.
- Nov. 2024, Ver. 0.70: Revision for rev B silicon.
- Nov. 2024, Ver.0.71: Add BM05C and BM05M.
- Jan. 2025, Ver. 1.00: Initial release.

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