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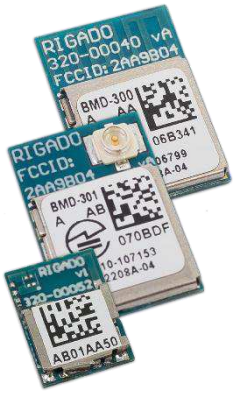
www.rigado.com/modules

BMD-300 Series Module for Bluetooth 4.2 LE

The **BMD-300 Series** from Rigado is a line of powerful, highly flexible, ultra-low power *Bluetooth* Smart modules based on the nRF52832 SoC from Nordic Semiconductor. With an ARM® Cortex™ M4F CPU, embedded 2.4GHz transceiver, and integrated antenna, they provide a complete RF solution with no additional RF design, allowing faster time to market. Providing full use of the nRF52832's capabilities and peripherals, the **BMD-300 Series** can power the most demanding applications, all while simplifying designs and reducing BOM costs. With an internal DC-DC converter and intelligent power control, the **BMD-300 Series** provide class-leading power efficiency, enabling ultra-low power sensitive applications. Regulatory pre-approvals reduce the burden to enter the market, and the included **BMD Software Suite** provides access to great features like a secure BLE & UART bootloader, iOS & Android Bluetooth libraries, and more. Available in three variants: internal antenna (**BMD-300**), U.FL connector (**BMD-301**), and ultra-miniature (**BMD-350**).



1. Features

- Based on the Nordic nRF52832 SoC
- Complete RF solution with integrated antenna (**BMD-300** & **BMD-350**) or U.FL connector (**BMD-301**)
- Integrated DC-DC converter
- No external components required
- ARM® Cortex™-M4F 32-bit processor
- Serial Wire Debug (SWD)
- Nordic SoftDevice ready
- Over-the-Air (OTA) firmware updates
- 512kB embedded flash memory
- 64kB RAM
- 32 General Purpose I/O Pins
- 12-bit/200KSPS ADC
- -40C to +85 Temperature Range
- BMD Software Suite included
- FCC: **2AA9B04** (BMD-300/BMD-301) **2AA9B05** (BMD-350)
- Three SPI Master/Slave (8 Mbps)
- Low power comparator
- Temperature sensor
- Random Number Generator
- Two 2-wire Master/Slave (I2C compatible)
- I2S audio interface
- UART (w/ CTS/RTS and DMA)
- 20 channel CPU independent Programmable Peripheral Interconnect (PPI)
- Quadrature Demodulator (QDEC)
- 128-bit AES HW encryption
- 5 x 32bit, 3 x 24bit Real Timer Counters (RTC)
- NFC-A tag interface for OOB pairing
- **BMD-300/301** Dimensions: 14 x 9.8 x 1.9mm
- **BMD-350** Dimensions: 8.7 x 6.4 x 1.5mm
- IC: **12208A-04** (BMD-300/BMD-301) **12208A-05** (BMD-350)
- Japan: **210-106799** (BMD-300) **210-107153** (BMD-301) **210-108944** (BMD-350)

2. Applications

- App-cessories
- Beacons – iBeacon™, AltBeacon, Eddystone, etc.
- Low-Power Sensors
- Lighting Products
- Fitness devices
- Wearables

3. Ordering Information

Email modules@rigado.com for quotes and ordering or visit www.rigado.com/BMD-300

Part Number	Description
BMD-300-A-R	BMD-300 module, Rev A, Tape & Reel, 1000 piece multiples
BMD-301-A-R	BMD-301 module, Rev A, Tape & Reel, 1000 piece multiples
BMD-350-A-R	BMD-350 module, Rev A, Tape & Reel, 1000 piece multiples
BMD-300-EVAL	BMD-300 Evaluation Kit with Segger J-Link programmer
BMD-301-EVAL	BMD-301 Evaluation Kit with Segger J-Link programmer w/antennas
BMD-350-EVAL	BMD-350 Evaluation Kit with Segger J-Link programmer

Table 1 – Ordering Part Numbers

4. Block Diagram

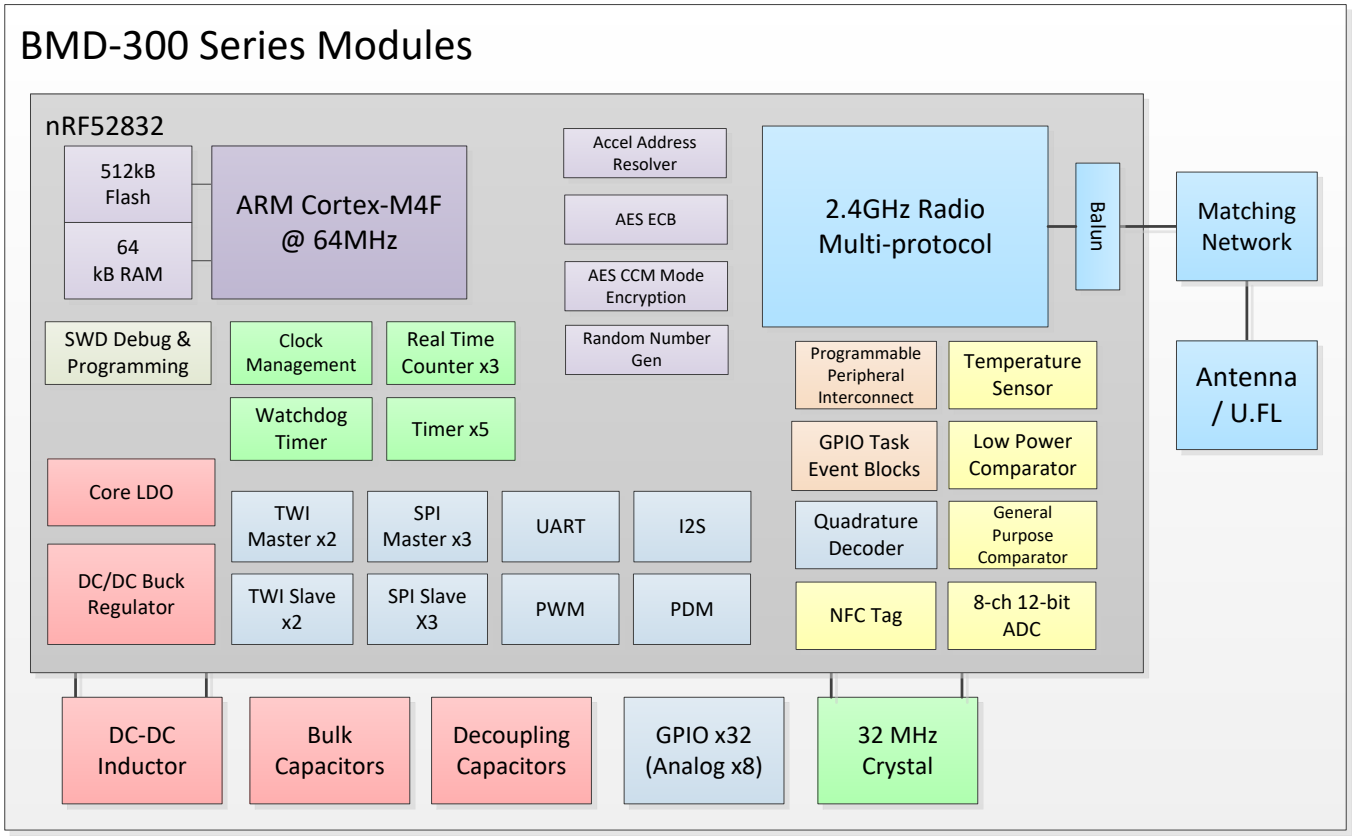


Figure 1 – Block Diagram

Table of Contents

5. Quick Specifications

Bluetooth		
Version	4.2 (*Bluetooth* Smart) Concurrent Central & Peripheral (S132)	
Security	AES-128	
LE connections	Up to 8 as Central, 1 as Peripheral, Observer, Broadcaster (S132)	
Radio		
Frequency	2.360GHz to 2.500GHz	
Modulations	GFSK at 1 Mbps, 2 Mbps data rates	
Transmit power	+4 dBm	
Receiver sensitivity	-96 dBm (BLE mode)	
Antenna	Integrated	
Current Consumption		
TX only @ +4 dBm, 0 dBm @ 3V, DCDC enabled		7.5 mA, 5.3 mA
TX only @ +4 dBm, 0 dBm		16.6 mA, 11.6 mA
RX only @ 1 Mbps @ 3V, DCDC enabled		5.4 mA
RX only @ 1 Mbps		11.7 mA
CPU @ 64MHz from flash, from RAM		7.4 mA, 6.7 mA
CPU @ 64MHz from flash, from RAM @ 3V, DCDC		3.7 mA, 3.3 mA
System Off, On		0.3 µA, 1.2 µA
Additional current for RAM retention		30 nA / 4KB block
Dimensions		
BMD-300 BMD-301	Length Width Height	14.0 mm ± 0.3mm 9.8 mm ± 0.3mm 1.9 mm ± 0.1mm
BMD-350	Length Width Height	8.7 mm ± 0.2mm 6.4 mm ± 0.2mm 1.5 mm ± 0.1mm
Hardware		
Interfaces	SPI Master/Slave x 3 UART Two-Wire Master/Slave (I2C) x 2 GPIO x 32	I2S PWM PDM
Power supply	1.7V to 3.6V	
Temperature Range	-40 to +85°C	
Certifications		
FCC	FCC part 15 modular certification BMD-300/BMD-301 FCC ID: 2AA9B04 BMD-350 FCC ID: 2AA9B05	
IC	Industry Canada RSS-210 modular certification BMD-300/BMD-301 IC: 12208A-04 BMD-350 IC: 12208A-05	
CE	EN 60950-1: 2011-01 EN 301 489-1 V1.9.2 & EN 301 489-17 V2.2.1 EN 300 328 V1.9.1	3.1 (a): Health and Safety of the User 3.1 (b): Electromagnetic Compatibility 3.2: Effective use of spectrum allocated
Japan (MIC)	Ministry of Internal Affairs and Communications (MIC) of Japan pursuant to the Radio Act of Japan BMD-300: 210-106799 BMD-301: 210-107153 BMD-350: 210-108944	
Australia / New Zealand	AS/NZS 4268 :2012+AMDT 1:2013, Radio equipment and systems – Short range devices	
Bluetooth	BMD-300/301 RF-PHY Component (Tested) – DID: D030629; QDID: 81876	

Table 2 – Quick Specifications

6. Pin Descriptions

6.1 BMD-300 / BMD-301

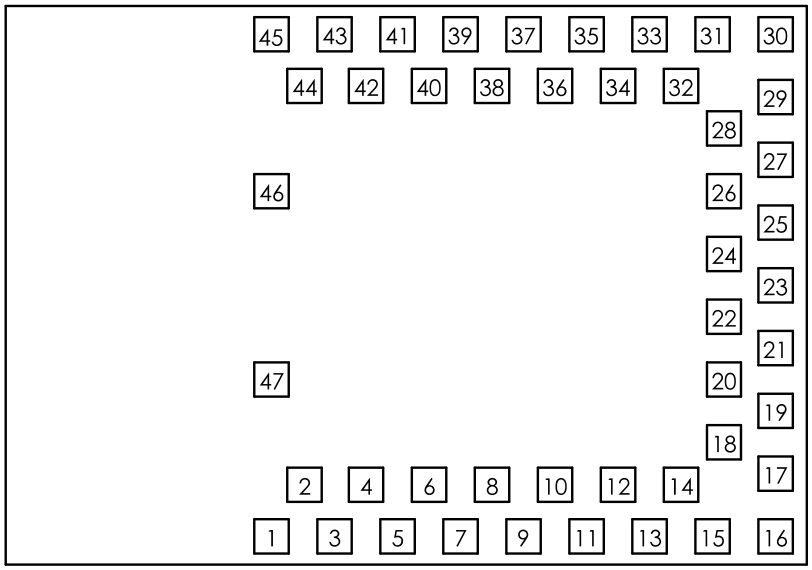


Figure 2 – BMD-300/301 Pin out (Top View)

Pin description

Pin	Name	Direction	Description
6	P0.25	In/Out	GPIO[2]
7	P0.26	In/Out	GPIO[2]
8	P0.27	In/Out	GPIO[2]
9	P0.28	In/Out	GPIO/AIN4[2]
10	P0.29	In/Out	GPIO/AIN5[2]
11	P0.30	In/Out	GPIO/AIN6[2]
12	P0.31	In/Out	GPIO/AIN7[2]
13	P0.00	In/Out	GPIO/XTAL1 (32.768kHz)
14	P0.01	In/Out	GPIO/XTAL2 (32.768kHz)
15	P0.02	In/Out	GPIO/AIN0
19	P0.03	In/Out	GPIO/AIN1
20	P0.04	In/Out	GPIO/AIN2
21	P0.05	In/Out	GPIO/AIN3
22	P0.06	In/Out	GPIO
23	P0.07	In/Out	GPIO
24	P0.08	In/Out	GPIO
25	P0.09	In/Out	GPIO/NFC1
26	P0.10	In/Out	GPIO/NFC2
27	P0.11	In/Out	GPIO
28	P0.12	In/Out	GPIO
31	P0.13	In/Out	GPIO
32	P0.14	In/Out	GPIO/TRACEDATA[3]
33	P0.15	In/Out	GPIO/TRACEDATA[2]

Pin	Name	Direction	Description
34	P0.16	In/Out	GPIO/TRACEDATA[1]
35	P0.17	In/Out	GPIO
36	P0.18	In/Out	GPIO/TRACEDATA[0]/SWO
37	P0.19	In/Out	GPIO
38	P0.20	In/Out	GPIO/TRACECLK
39	P0.21	In/Out	GPIO/$\overline{\text{RESET}}$
40	P0.22	In/Out	GPIO[2]
41	P0.23	In/Out	GPIO[2]
42	P0.24	In/Out	GPIO[2]
43	SWCLK	In	SWD Clock
44	SWDIO	In/Out	SWD IO
17	VCC	Power	+1.7V to +3.6V[1]
1, 2, 3, 4, 5, 16, 18, 29, 30, 45, 46, 47	GND	Power	Electrical Ground

Note 1: An internal 4.7µF bulk capacitor is included on the module. However, it is good design practice to add additional bulk capacitance as required for your application, i.e. those with heavy GPIO usage and/or current draw.

Note 2: These pins are in close proximity to the nRF52 radio power supply and antenna pins. Radio performance parameters, such as sensitivity, may be affected by high frequency digital I/O with large sink/source current on these pins. Nordic recommends using only low frequency, low-drive functions when possible.

Table 3 – BMD-300/301 Pin Descriptions

6.2 BMD-350

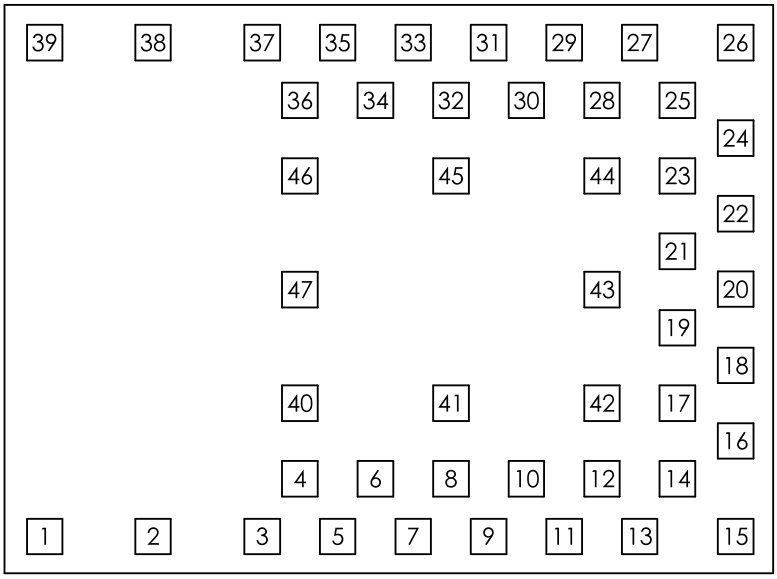


Figure 3 – BMD-350 Pin out (Top View)

Pin description

Pin	Name	Direction	Description
4	SWCLK	In	SWD Clock
5	SWDIO	In/Out	SWD IO
6	P0.20	In/Out	GPIO/TRACECLK
7	P0.21	In/Out	GPIO/$\overline{\text{RESET}}$

Pin	Name	Direction	Description
8	P0.18	In/Out	GPIO/TRACEDATA[0]/SWO
9	P0.16	In/Out	GPIO/TRACEDATA[1]
10	P0.17	In/Out	GPIO
11	P0.15	In/Out	GPIO/TRACEDATA[2]
12	P0.13	In/Out	GPIO
13	P0.12	In/Out	GPIO
14	P0.14	In/Out	GPIO/TRACEDATA[3]
16	P0.09	In/Out	GPIO/NFC1
17	P0.10	In/Out	GPIO/NFC2
18	P0.11	In/Out	GPIO
19	P0.06	In/Out	GPIO
20	P0.08	In/Out	GPIO
21	P0.05	In/Out	GPIO/AIN3
22	P0.07	In/Out	GPIO
23	P0.01	In/Out	GPIO/XTAL2 (32.768kHz)
24	P0.00	In/Out	GPIO/XTAL1 (32.768kHz)
27	P0.04	In/Out	GPIO/AIN2
28	P0.02	In/Out	GPIO/AIN0
29	P0.30	In/Out	GPIO/AIN6[2]
30	P0.31	In/Out	GPIO/AIN7[2]
31	P0.29	In/Out	GPIO/AIN5[2]
32	P0.27	In/Out	GPIO[2]
33	P0.25	In/Out	GPIO[2]
34	P0.26	In/Out	GPIO[2]
35	P0.23	In/Out	GPIO[2]
36	P0.24	In/Out	GPIO[2]
41	P0.22	In/Out	GPIO[2]
42	P0.19	In/Out	GPIO
44	P0.03	In/Out	GPIO/AIN1
45	P0.28	In/Out	GPIO/AIN4[2]
25	VCC	Power	+1.7V to +3.6V[1]
1, 2, 3, 15, 26, 37, 38, 39, 40, 43, 46, 47	GND	Power	Electrical Ground

Note 1: An internal 4.7µF bulk capacitor is included on the module. However, it is good design practice to add additional bulk capacitance as required for your application, i.e. those with heavy GPIO usage and/or current draw.

Note 2: These pins are in close proximity to the nRF52 radio power supply and antenna pins. Radio performance parameters, such as sensitivity, may be affected by high frequency digital I/O with large sink/source current on these pins. Nordic recommends using only low frequency, low-drive functions when possible.

Table 4 – BMD-350 Pin Descriptions

6.3 RigDFU Pin Functions

Rigado RigDFU is programmed on the BMD-300 Series at the factory. Two GPIO pins are configured as UART pins for transferring new firmware images to the BMD-300. Pins are configured only when bootloader is running, and are fully available to the application firmware. RigDFU can be removed from the BMD-300 by performing a full-chip erase.

BMD-300/1 Pin	BMD-350 Pin	Name	Direction	RigDFU Functions
22	19	P0.06	Out	UART TX for bootloader *Hi-Z until bootloader activation message received on UART RX.*
24	20	P0.08	In	UART RX for bootloader *Internal 12kΩ pull-down enabled*

Table 5 – RigDFU Functions

6.4 BMDware Pin Functions

Rigado BMDware is programmed on the BMD-300 Series at the factory. BMDware provides UART-to-BLE Bridge, beaconing, and Direct Test Mode (DTM) functionality. The pins in Table 6 below describe the pin functionality in BMDware. DTM Mode, Beacon-Only Mode, and AT Command Mode pin states are checked at BMDware start-up to configure BMDware as required by the user, and are then set to Hi-Z to conserve power. For further details on BMDware operation, please see the BMDware Datasheet that can be found at www.rigado.com. BMDware can be overwritten by RigDFU with custom application firmware, or removed along with RigDFU by a full chip erase.

BMD-300/1 Pin	BMD-350 Pin	Name	Direction	BMDware Functions
21	21	P0.05	Out	Bridge UART RTS Disabled in Beacon-Only & DTM modes, N/C if not used.
22	19	P0.06	Out	Bridge UART TX Disabled in Beacon-Only & DTM modes, N/C if not used.
23	22	P0.07	In	Bridge UART CTS Disabled in Beacon-Only & DTM modes, N/C if not used.
24	20	P0.08	In	Bridge UART RX Disabled in Beacon-Only & DTM modes, N/C if not used.
27	18	P0.11	Out	DTM UART TX Only enabled in DTM mode; N/C if not used.
28	13	P0.12	In	DTM UART RX / DTM Mode Only enabled in DTM mode; N/C if not used. On BMDware Start-up: **High** = Enter DTM mode; **Low** = Enter Normal Operation *Internal 12kΩ pull-down during BMDware start-up, then Hi-Z*
31	12	P0.13	In	Beacon Only Mode On BMDware Start-up: **High** = Bridge UART enabled; **Low** = Bridge UART disabled *Internal 12kΩ pull-up during BMDware start-up, then Hi-Z*
32	14	P0.14	In	UART AT Command Mode On BMDware Start-up: **High** = Full pass-through mode; **Low** = AT command mode *Internal 12kΩ pull-up during BMDware start-up, then Hi-Z*

Table 6 – BMDware Functions at Start-up

7. Electrical Specifications

7.1 Absolute Maximum Ratings

Symbol	Parameter	Min.	Max.	Unit
V_{CC_MAX}	Voltage on supply pin	-0.3	3.9	V
V_{IO_MAX}	Voltage on GPIO pins (V_{CC} > 3.6V)	-0.3	3.9	V
V_{IO_MAX}	Voltage on GPIO pins (V_{CC} ≤ 3.6V)	-0.3	V_{CC} + 0.3V	V
T_S	Storage Temperature Range	-40	125	°C

Table 7 – Absolute Maximum Ratings

7.2 Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC}	Operating supply voltage	1.7	3.0	3.6	V
T_{R_VCC}	Supply rise time (0V to 1.7V)	-	-	60	ms
T_A	Operating Ambient Temperature Range	-40	25	85	°C

Table 8 – Operating Conditions

7.3 General Purpose I/O

The general purpose I/O is organized as one port enabling access and control of the 32 available GPIO pins through one port. Each GPIO can be accessed individually with the following user configurable features:

- Input/output direction
- Output drive strength
- Internal pull-up and pull-down resistors
- Wake-up from high or low level triggers on all pins
- Trigger interrupt on all pins
- All pins can be used by the PPI task/event system; the maximum number of pins that can be interfaced through the PPI at the same time is limited by the number of GPIOTE channels
- All pins can be individually configured to carry serial interface or quadrature demodulator signals

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{IH}	Input High Voltage	0.7 x V_{CC}	-	V_{CC}	V
V_{IL}	Input Low Voltage	V_{SS}	-	0.3 x V_{CC}	V
V_{OH}	Output High Voltage	V_{CC} – 0.4	-	V_{CC}	V
V_{OL}	Output Low Voltage	V_{SS}	-	V_{SS} + 0.4	V
R_{PU}	Pull-up Resistance	11	13	16	kΩ
R_{PD}	Pull-down Resistance	11	13	16	kΩ

Table 9 – GPIO

7.4 Module RESET

GPIO pin P0.21 may be used for a hardware reset. In order to utilize P0.21 as a hardware reset, the UICR registers PSELRESET[0] and PSELRESET[1] must be set alike, to the value of 0x7FFFFF15. When P0.21 is programmed as $\overline{\text{RESET}}$, the internal pull-up is automatically enabled. Rigado and Nordic example applications and development kits program P0.21 as $\overline{\text{RESET}}$.

7.5 Debug & Programming

The BMD-300 Series supports the two pin Serial Wire Debug (SWD) interface and offers flexible and powerful mechanism for non-intrusive debugging of program code. Breakpoints, single stepping, and instruction trace capture of code execution flow are part of this support.

The BMD-300 also supports ETM and ITM trace. Trace data from the ETM and the ITM is sent to an external debugger via a 4-bit wide parallel trace port. In addition to parallel trace, the TPIU supports serial trace via the Serial Wire Output (SWO) trace protocol.

7.6 Clocks

The BMD-300 Series requires two clocks, a high frequency clock and a low frequency clock.

The high frequency clock is provided on-module by a high-accuracy 32-MHz crystal as required by the nRF52832 for radio operation.

The low frequency clock can be provided internally by an RC oscillator or synthesized from the fast clock; or externally by a 32.768 kHz crystal. An external crystal provides the lowest power consumption and greatest accuracy. Using the internal RC oscillator with calibration provides acceptable performance for BLE applications at a reduced cost and slight increase in power consumption. Note: the ANT protocol requires the use of an external crystal.

32.768 kHz Crystal (LFXO)

Symbol	Parameter	Typ.	Max.	Unit
F_{NOM_LFXO}	Crystal frequency	32.768	-	kHz
$F_{TOL\_LFXO\_BLE}$	Frequency tolerance, BLE applications	-	±250	ppm
C_{L_LFXO}	Load Capacitance	-	12.5	pF
C_{0_LFXO}	Shunt Capacitance	-	2	pF
R_{S_LFXO}	Equivalent series resistance	-	100	kΩ
C_{pin}	Input Capacitance on XL1 & XL2 pads	4	-	pF

Table 10 – 32.768 kHz Crystal

32.768 kHz Oscillator Comparison

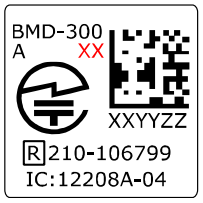
Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{LFXO}	Current for 32.768kHz Crystal Oscillator	-	0.25	-	µA
I_{LFRC}	Current for 32.768kHz RC Oscillator	-	0.6	1	µA
I_{LFSYNT}	Current for 32.768kHz Synthesized Oscillator	-	100	-	µA
$f_{TOL\_LFXO\_BLE}$	Frequency Tolerance, 32.768kHz Crystal Oscillator (BLE Stack)[1]	-	-	±250	ppm
$f_{TOL\_LFXO\_ANT}$	Frequency Tolerance, 32.768kHz Crystal Oscillator (ANT Stack)[1]	-	-	±50	ppm
f_{TOL_LFRC}	Frequency Tolerance, 32.768kHz RC Oscillator	-	-	±2	%
$f_{TOL\_CAL\_LFRC}$	Frequency tolerance, 32.768kHz RC after calibration	-	-	±250	ppm
f_{TOL_LFSYNT}	Frequency Tolerance, 32.768kHz Synthesized Oscillator	-	-	±48	ppm
Note 1: $f_{TOL\_LFXO\_BLE}$ and $f_{TOL\_LFXO\_ANT}$ are the max allowed for BLE and ANT applications. Actual tolerance depends on the crystal used.					

Table 11 – 32.768 kHz Oscillator

8. Firmware

8.1 Factory Image

All modules are shipped with factory programmed firmware. The factory programmed firmware version is indicated on the label.



Factory Firmware Version Code: XX

8.1.1 Firmware Version 'AA'

Factory firmware version 'AA' contains the Rigado RigDFU OTA and Serial bootloader v3.2.0 (42), Nordic S132 SoftDevice v2.0.0, and Rigado BMDware v3.1.0 (50). Modules can be programmed with customer code via BLE and UART interfaces using the bootloader and Rigado provided tools, or with a full-chip erase via the SWD interface. Examples apps for iOS and Android are provided that utilize the Rigablue Library for easy OTA updates. Visit the BMD Software Suite page at www.rigado.com for more information.
Note: A full chip erase will clear the Rigado assigned MAC address from memory; see section 8.3 "MAC Address Info" on how to retain it.

8.1.2 Firmware Version 'AB'

Factory firmware version 'AB' contains the Rigado RigDFU OTA and Serial bootloader v3.2.1 (43), Nordic S132 SoftDevice v2.0.0, and Rigado BMDware v3.1.1 (51). Modules can be programmed with customer code via BLE and UART interfaces using the bootloader and Rigado provided tools, or with a full-chip erase via the SWD interface. Examples apps for iOS and Android are provided that utilize the Rigablue Library for easy OTA updates. Visit the BMD Software Suite page at www.rigado.com for more information.
Note: A full chip erase will clear the Rigado assigned MAC address from memory; see section 8.3 "MAC Address Info" on how to retain it.

8.1.3 Module Programming and Read-Back Protection

RigDFU allows for UART and OTA updates to RigDFU, the SoftDevice and application firmware. Read-back protection of the BMD-300 Series modules is enabled which prevents unauthorized access to the firmware and optional encryption keys through the SWD debug port.

If the SWD port is required, for example when developing custom firmware, the nRF52 must be erased and recovered. This is accomplished with the Rigado BMD-300 Eraser and Recovery Utility at www.rigado.com, or with nrfjprog, which is provided with the Nordic Semiconductor command line utilities:

```
nrfjprog -f NRF52 --recover
```

A full chip erase is performed, so all components will need re-loaded (RigDFU Bootloader, SoftDevice and application Firmware). The rigado/bootloader-tools repository on GitHub contains the utilities to load these items. Procedures are described in the RigDFU Datasheet at www.rigado.com for programming, firmware preparation, and update procedures.

The BMD-300 Series modules may also be restored to the factory firmware versions noted above with the utilities available at the rigado/programming repository on GitHub.

Access to the Rigado BMD Software Suite may be requested on the Rigado Website.

8.2 SoftDevices

Nordic Semiconductor protocol stacks are known as SoftDevices. SoftDevices are pre-compiled, pre-linked binary files. SoftDevices can be programmed in nRF52 series SoCs and are downloadable from the Nordic website. The BMD-300 with the nRF52832 SoC supports the S132 (BLE Central & Peripheral), S212 (ANT) and S312 (ANT and BLE) SoftDevices.

8.2.1 S132

The S132 SoftDevice is a Bluetooth® low energy (BLE) Central and Peripheral protocol stack solution supporting up to eight connections with an additional Observer and a Broadcaster role all running concurrently. The S132 SoftDevice integrates a BLE Controller and Host, and provides a full and flexible API for building Bluetooth Smart nRF52 System on Chip (SoC) solutions.

Key Features

- *Bluetooth 4.2 compliant low energy single-mode protocol stack suitable for Bluetooth Smart products*
- *Concurrent Central, Observer, Peripheral, and Broadcaster roles with up to eight concurrent connections along with one observer and one broadcaster*
  - *Configurable number of connections and bandwidth per connection to optimize memory and performance*
  - *Configurable attribute table size*
  - *Custom UUID support*
  - *Link layer*
  - *LL Privacy*
  - *LE Data Packet Length Extension*
  - *L2CAP, ATT, and SM protocols*
  - *LE Secure Connections pairing model*
  - *GATT and GAP APIs*
  - *GATT Client and Server*
  - *Configurable ATT MTU*
- *Complementary nRF5 SDK including Bluetooth profiles and example applications*
- *Master Boot Record for over-the-air device firmware update*
  - *SoftDevice, application, and bootloader can be updated separately*
- *Memory isolation between the application and the protocol stack for robustness and security*
- *Thread-safe supervisor-call based API*
- *Asynchronous, event-driven behavior*
- *No RTOS dependency*
  - *Any RTOS can be used*
- *No link-time dependencies*
  - *Standard ARM® Cortex®-M4 project configuration for application development*
- *Support for concurrent and non-concurrent multiprotocol operation*
  - *Concurrent with the Bluetooth stack using Radio Timeslot API*
  - *Alternate protocol stack in application space*
- *Support for control of external Power Amplifiers and Low Noise Amplifiers*

8.2.2 S212

The S212 SoftDevice is an ANT protocol stack solution that provides a full and flexible Application Programming Interface (API) for building ANT System on Chip (SoC) solutions for the nRF52832 chip. The S212 SoftDevice simplifies combining the ANT protocol stack and an application on the same CPU.

Key Features

Advanced ANT stack

- *Simple to complex network topologies:*
  - *Peer-to-peer, Star, Tree, Star-to-star and more*
- *Up to 15 logical channels, each with configurable:*
  - *Channel type, ID and period*
  - *RF frequency*
  - *Networks*
- *Broadcast, Acknowledged, and Burst Data modes*
- *Device search, pairing and proximity support*
- *Enhanced ANT features:*
  - *Advanced Burst Transfer mode (up to 60 kbps)*
  - *Up to 15 channels encryption (AES-128) support*
  - *Additional networks – up to 8*
  - *Event Filtering and Selective Data Updates*
  - *Asynchronous Transmission*
  - *Fast Channel Initiation*

SoftDevice features

- *Built-in NVM access and radio coexistence management*
- *Master Boot Record for over-the air device firmware update*
- *Memory isolation between application and protocol stack for robustness and security*
- *Thread-safe supervisor-call based API*
- *Asynchronous, event-driven behavior*
- *No RTOS dependency*
  - *Any RTOS can be used*
  - *No link-time dependencies*
  - *Standard ARM® Cortex™ -M4F project configuration for application development*
- *Support for concurrent and non-concurrent multiprotocol operation*
- *Concurrent multiprotocol timeslot API*
- *Alternate protocol stack running in application space*

8.2.3 S332

The S332 SoftDevice is a combined ANT™ and Bluetooth® low energy (BLE) protocol stack solution. It supports all four Bluetooth low energy roles (central, peripheral, observer, broadcaster) and ANT.

The S332 SoftDevice provides a full and flexible Application Programming Interface (API) for building concurrent ANT and BLE System on Chip (SoC) solutions. It simplifies combining an ANT and BLE protocol stack and an application on the same CPU, therefore eliminating the need for an added device to support concurrent multiprotocol.

8.3 MAC Address Info

The BMD-300 Series modules comes preprogrammed with a unique MAC address from the factory. The MAC address is also printed on a 2D barcode on the top of the module.

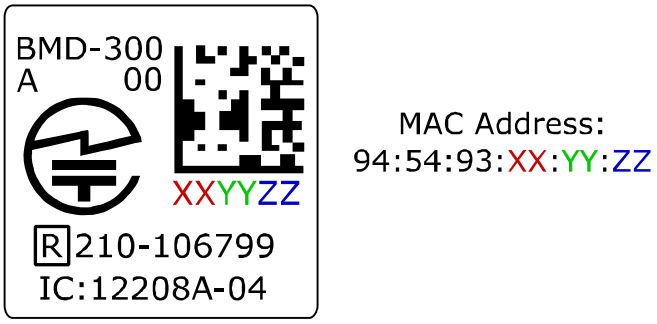


Figure 4 – BMD-300/301 MAC Address on Label

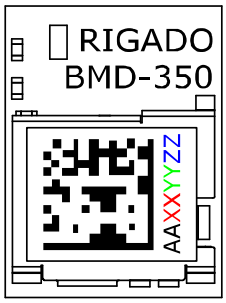


Figure 5 – BMD-350 MAC Address on Label

The 6-byte BLE Radio MAC address is stored in the nRF52832 UICR at NRF_UICR_BASE+0x80 LSB first. Please read the MAC Address Provisioning application note if you are not using the built in bootloader to avoid erasing/overwriting the MAC address during programming. **Important:** The BMD-300 comes with full memory protection enabled, not allowing the UICR to be read via the SWD interface. If performing a full-erase, the MAC can then only be recovered from the 2D barcode and human-readable text.

UICR Register:
NRF_UICR + 0x80 (0x10001080): MAC_Addr [0] (0xZZ)
NRF_UICR + 0x81 (0x10001081): MAC_Addr [1] (0xYY)
NRF_UICR + 0x82 (0x10001082): MAC_Addr [2] (0xXX)
NRF_UICR + 0x83 (0x10001083): MAC_Addr [3] (0x93)
NRF_UICR + 0x84 (0x10001084): MAC_Addr [4] (0x54)
NRF_UICR + 0x85 (0x10001085): MAC_Addr [5] (0x94)

9. Mechanical Data

9.1 Mechanical Dimensions

9.1.1 BMD-300 Dimensions

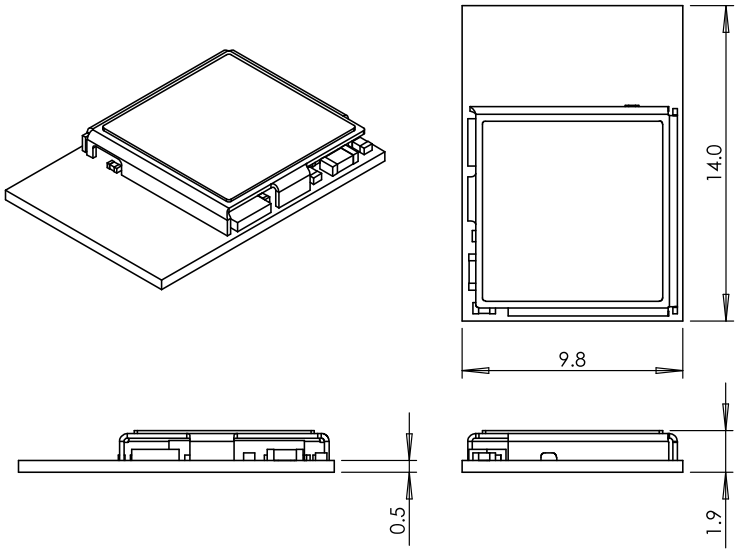


Figure 6 – BMD-300 Module Dimensions

(All dimensions are in mm)

9.1.2 BMD-301 Dimensions

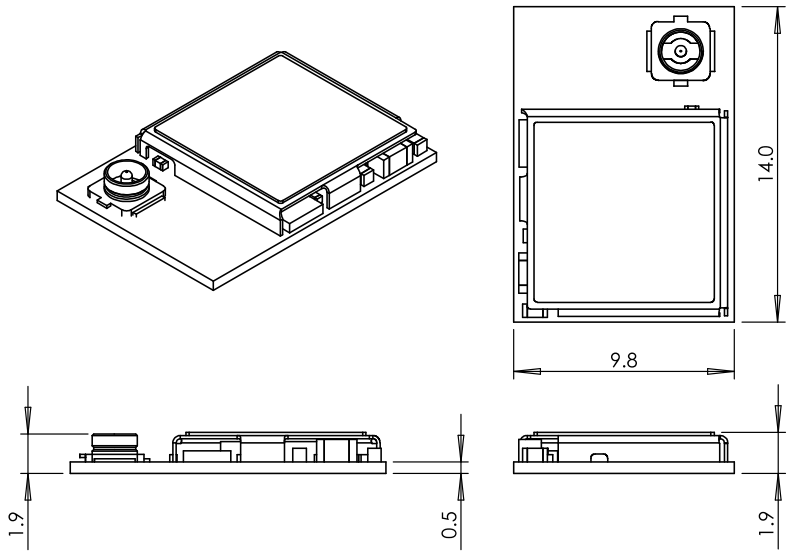


Figure 7 – BMD-301 Module Dimensions

(All dimensions are in mm)

9.1.3 BMD-350 Dimensions

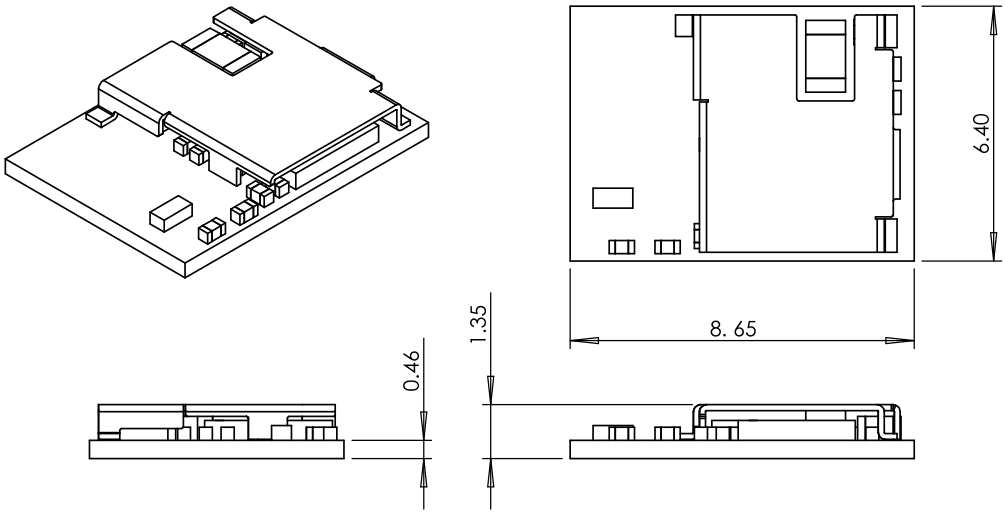


Figure 8 – BMD-350 Module Dimensions

(All dimensions are in mm)

9.2 Recommended PCB Land Pads

9.2.1 BMD-300/301

The BMD-300 and BMD-301 have identical PCB layout footprints. **Note**: RF keep-out not required when using the BMD-301.

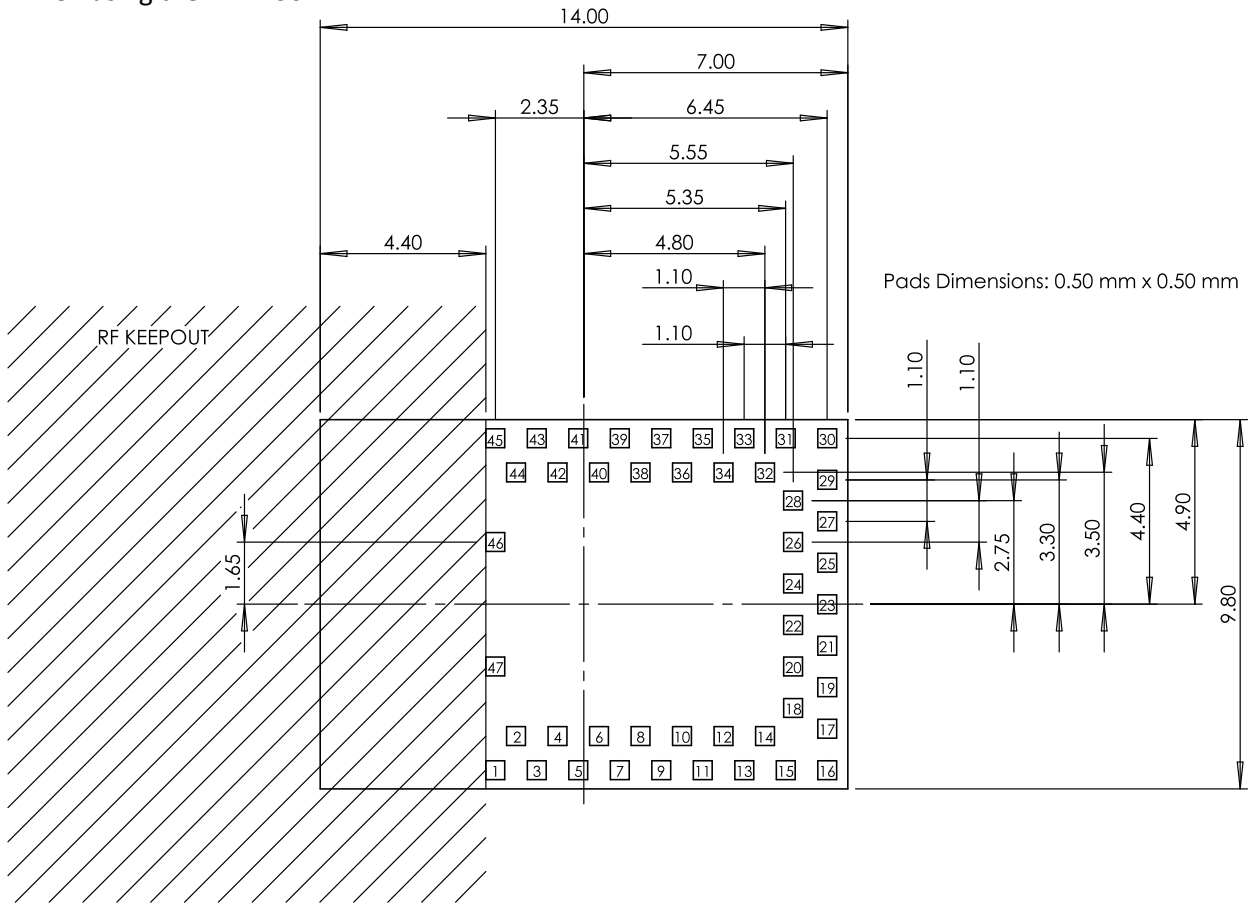


Figure 9 – BMD-300/301 Dimensions (Top View)

(All dimensions are in mm)

9.2.2 BMD-350

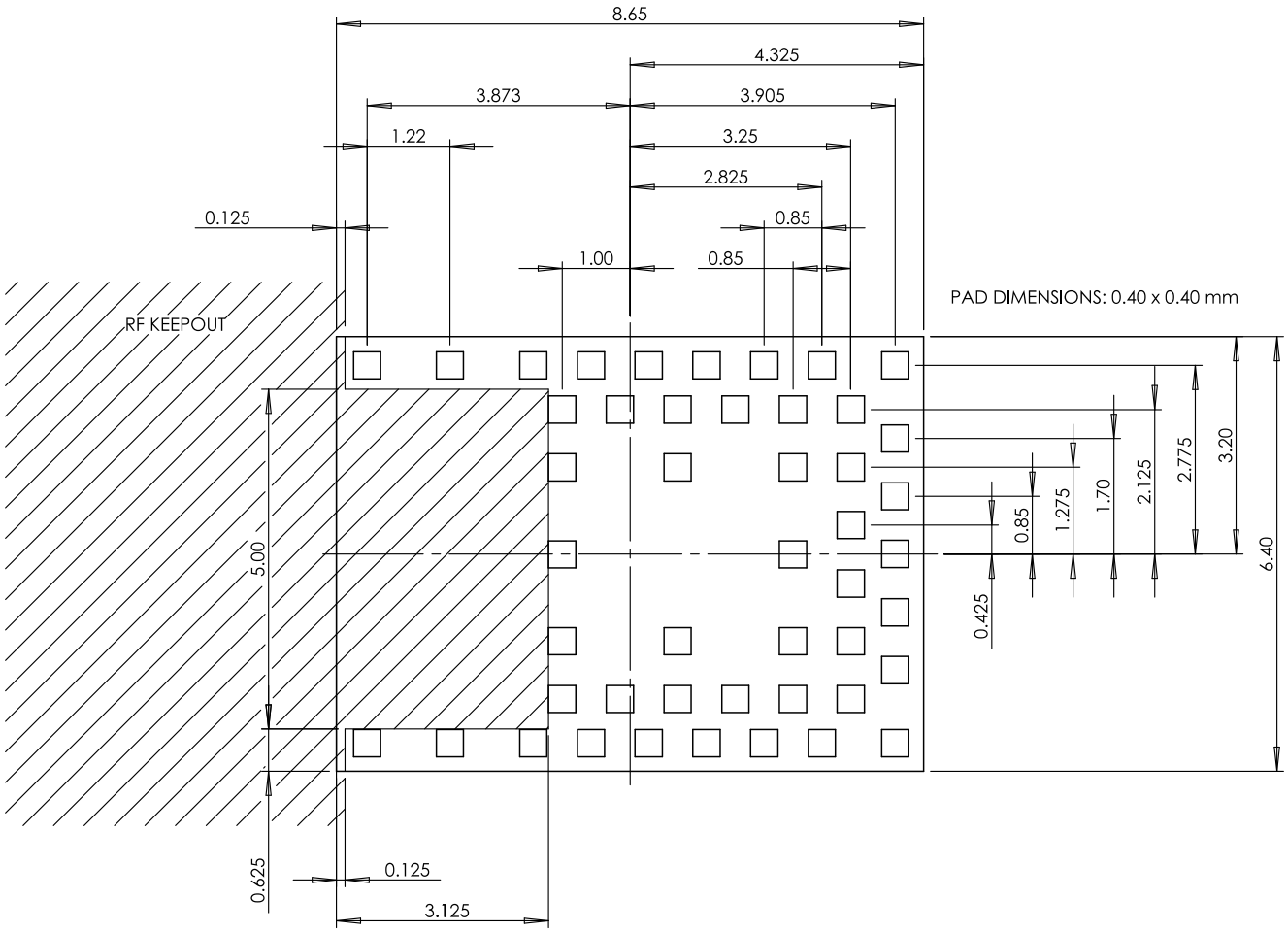


Figure 10 – BMD-350 Dimensions (Top View)

(All dimensions are in mm)

10. Module Marking

10.1 BMD-300 Module Marking

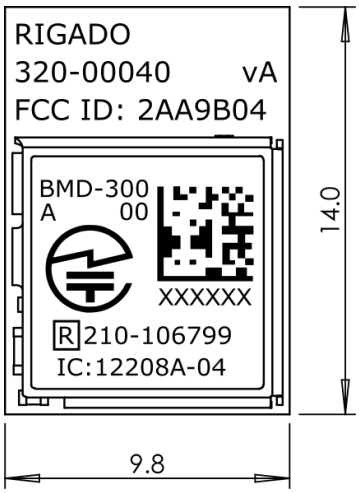


Figure 11 – BMD-300 Module Marking – Rev A

10.2 BMD-301 Module Marking

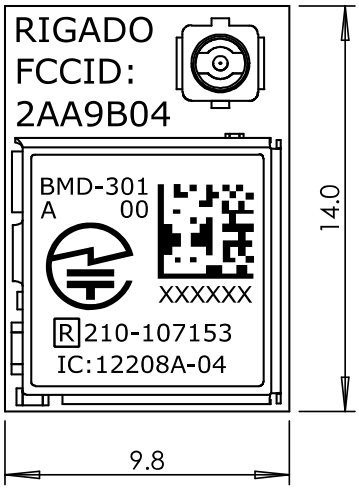


Figure 12 – BMD-301 Module Marking – Rev A

10.3 BMD-350 Module Marking

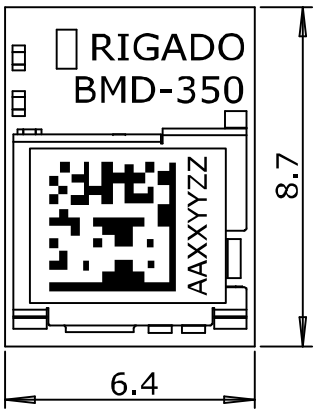


Figure 13 – BMD-350 Module Marking – Rev A

11. RF Design Notes

11.1 Recommended RF Layout & Ground Plane

11.1.1 BMD-300

For the BMD-300, the integrated antenna requires a suitable ground plane to radiate effectively.
The area under and extending out from the antenna portion of the module should be kept clear of copper and other metal. The module should be placed at the edge of the PCB with the antenna edge facing out. Reducing the ground plane from that shown in Figure 14 will reduce the effective radiated power. For example, a 27mm x 29mm board (about the size of a coin cell) has approximately 3dB lower output than the BMD-300 Evaluation Board.

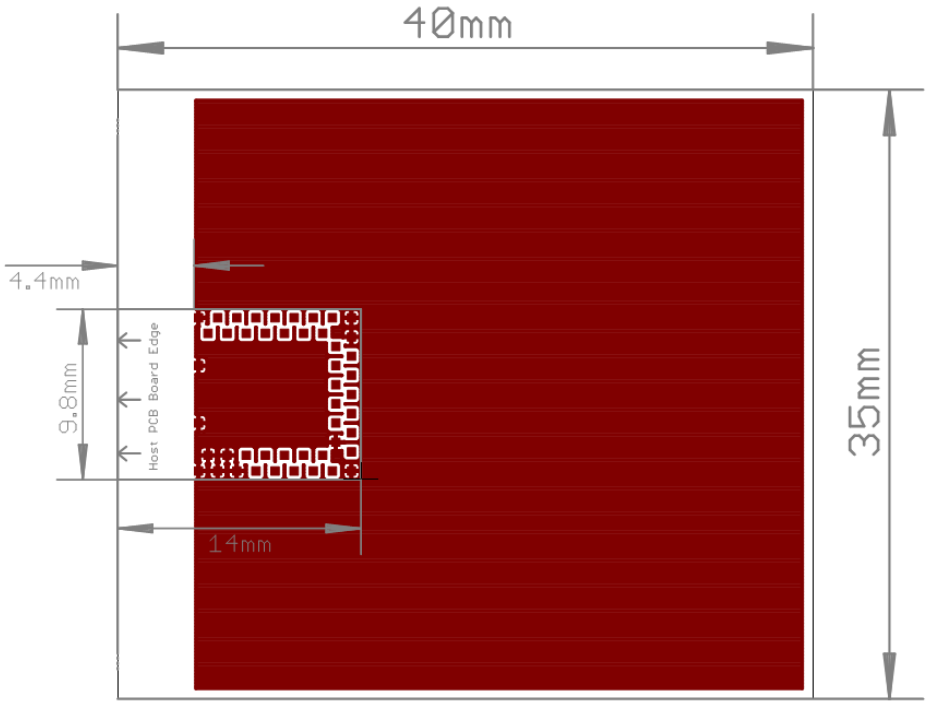


Figure 14 – BMD-300 Recommended RF Layout

11.1.2 BMD-301

For the BMD-301, refer to the external antenna datasheet for antenna placement and grounding recommendations.

11.1.3 BMD-350

For the BMD-350, the integrated chip antenna requires a suitable ground plane to radiate effectively.
The area under and extending out from the antenna portion of the module should be kept clear of copper and other metal. The module should be placed at the edge of the PCB with the antenna edge facing out.

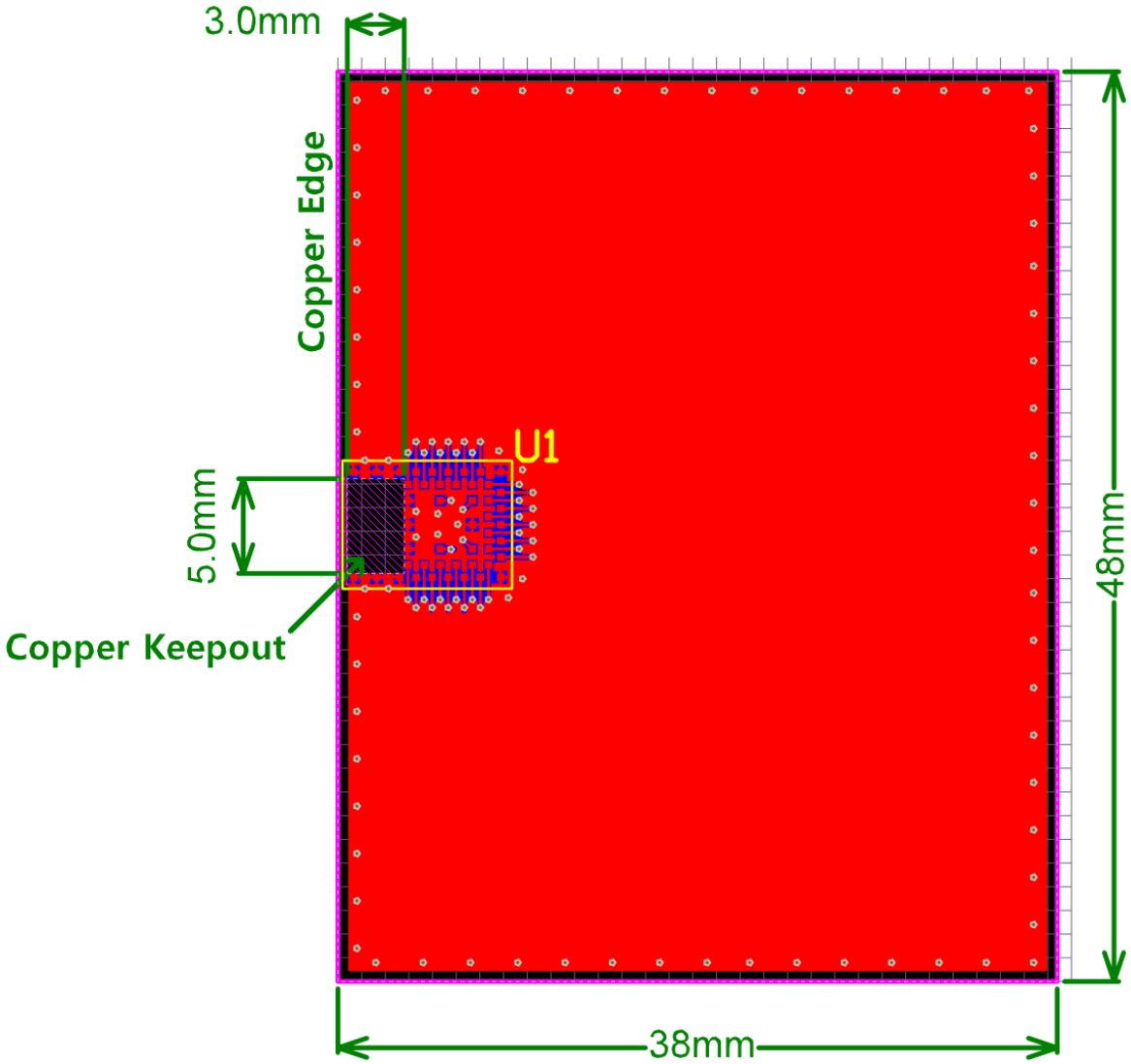


Figure 15 – BMD-350 Recommended RF Layout

11.2 Mechanical Enclosure

For the BMD-300 and BMD-350, care should be taken when designing and placing the module into an enclosure. Metal should be kept clear from the antenna area, both above and below. Any metal around the module can negatively impact RF performance.
The module is designed and tuned for the antenna and RF components to be in free air. Any potting, epoxy fill, plastic over-molding, or conformal coating can negatively impact RF performance and must be evaluated by the customer.

For the BMD-301, refer to the external antenna datasheet for placement in or on a mechanical enclosure.

11.3 Antenna Patterns

11.3.1 BMD-300

Antenna patterns are based on the BMD-300 Evaluation Kit vA with a ground plane size of 82mm x 56mm. X-Y-Z orientation is shown in Figure 16:

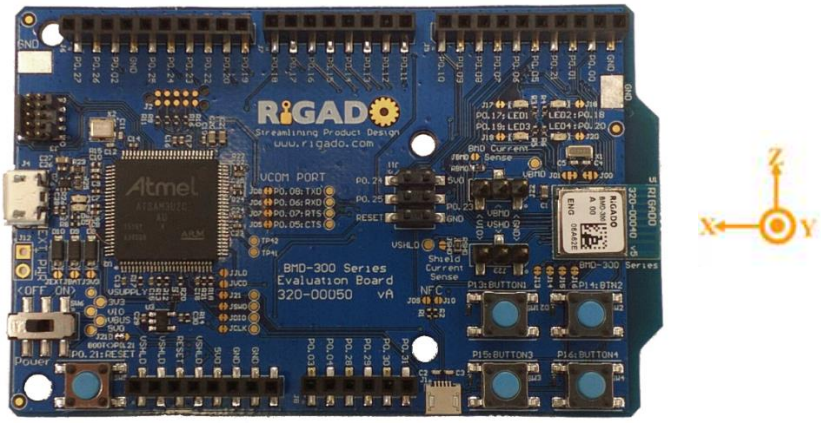


Figure 16 – X-Y-Z Antenna Orientation

11.3.1.1 X-Y Plane

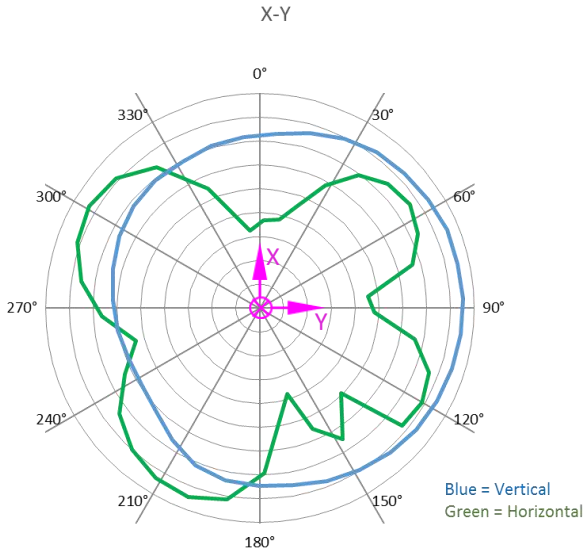


Figure 17 – X-Y Plane Antenna Pattern

11.3.1.2 Y-Z Plane

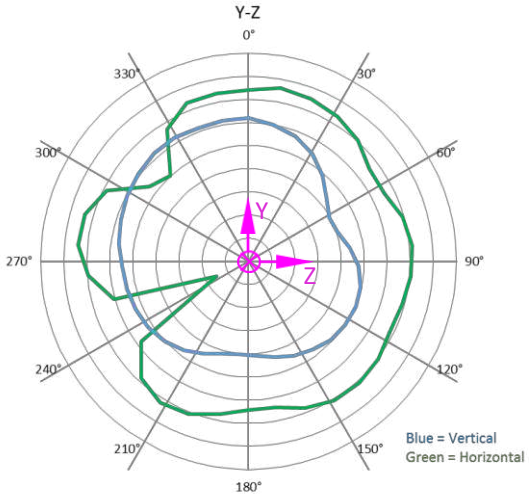


Figure 18 – Y-Z Plane Antenna Pattern

11.3.1.3 Z-X Plane

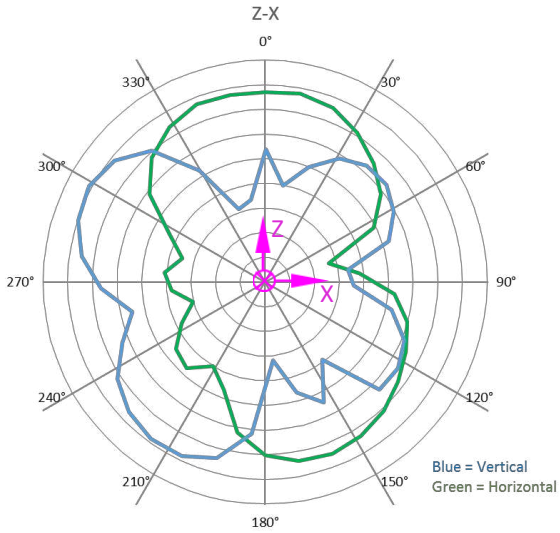


Figure 19 – Z-X Plane Antenna Pattern

11.3.2 BMD-350

11.3.2.1 X-Y Plane

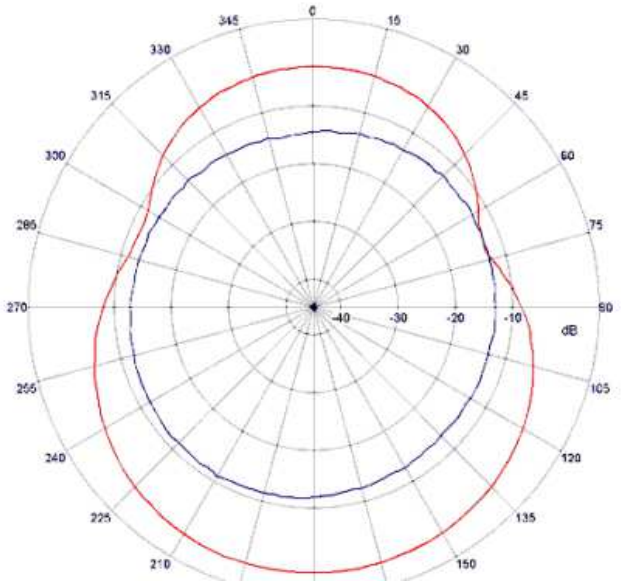


Figure 20 – X-Y Plane Antenna Pattern

11.3.2.2 Y-Z Plane

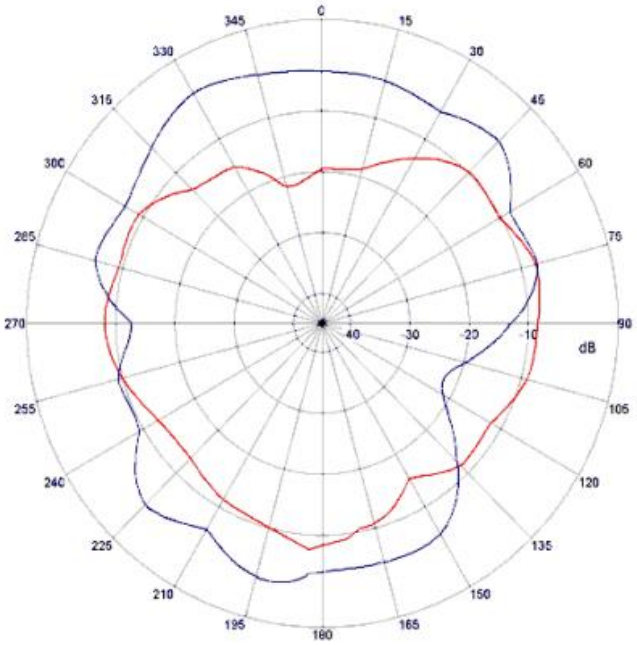


Figure 21 – Y-Z Plane Antenna Pattern

11.3.2.3 Z-X Plane

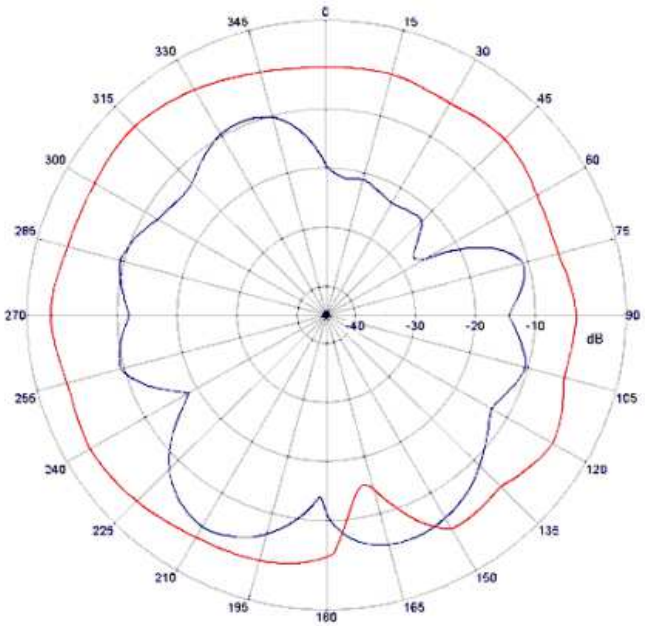


Figure 22 – Z-X Plane Antenna Pattern

12. Evaluation Boards

Rigado has developed full featured evaluation boards that provide a complete I/O pin out to headers, on-board programming and debug, 32.768 kHz crystal, power & virtual COM port over USB, 4 user LEDs, and 4 user buttons. The evaluation boards also provide the option to be powered from a CR2032 coin cell battery, and have current sense resistors and headers to allow for convenient current measurements. An Arduino Uno R3 style header is provided for easy prototyping of additional functions. The evaluation boards also support programming off-board BMD-300 Series modules.

13. Custom Development

Rigado is a full-service design house offering end-to-end product development from concept to manufacturing. We can provide custom modules and do electrical and mechanical design, end product manufacturing, firmware and mobile development, and web and cloud integration. Please contact Rigado at info@rigado.com or 1-866-6-RIGADO for custom engineering options and fees.