BMD-340 Data Sheet

Version 2.1

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2 Introduction

The BMD-340 is an advanced, highly flexible, ultra-low power multiprotocol SoM that enables Bluetooth 5 (BLE) and IEEE 802.15.4 (Thread and Zigbee) connectivity for portable, extremely low power embedded systems. With an ARM® Cortex™-M4F CPU, integrated 2.4GHz transceiver, and an integrated antenna, the BMD-340 provides a complete RF solution allowing faster time to market with reduced development costs. Providing full use of the Nordic nRF52840's capabilities and peripherals, the BMD-340 can power the most demanding applications, all while simplifying designs and reducing BOM costs. The BMD-340 is an ideal solution for designs that require the latest Bluetooth 5 features or 802.15.4 based networking for Thread. Increased integration with built in USB and 5.5V compatible DC/DC supply reduces design complexity and BOM cost, while expanding possible applications. BMD-340 designs are footprint compatible with the BMD-300/301/BMD-330, providing low-cost flexibility for tiered product lineups.

3 Features

- Based on the Nordic nRF52840 SoC
- Bluetooth 5 2M LE, Advertising Extensions, CSA #2, Coded PHY (Long Range)
- Bluetooth Mesh
- IEEE 802.15.4 with Thread and Zigbee support
- Complete RF solution with integrated antenna
- Integrated DC-DC converter
- No external components required
- ARM® Cortex™-M4F 32-bit processor
- ARM® TrustZone® Cryptocell 310 security
- True Random Number Generator
- Serial Wire Debug (SWD)
- Nordic SoftDevice ready
- 1MB embedded flash memory
- 256kB RAM
- 48 General Purpose I/O Pins
- 12-bit/200KSPS ADC
- One Full-Speed USB (12Mbps)
- Four SPI Master/Slave (8 Mbps)
- Quad SPI with Execute in Place (XIP)
- Low power comparator
- Temperature sensor
- Two 2-wire Master/Slave (I2C compatible)
- I2S audio interface
- Two UARTs (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
- Dimensions: 15.0 x 10.2 x 1.9mm
- USA (FCC): 2AA9B10
- Canada (IC): 12208A-10

4 Applications

- Climate Control
- Lighting Products
- Safety and Security
- Home Appliances
- Access Control
- Home Appliances
- Internet of Things
- Home Health Care
- Advanced Remote Controls
- Smart Energy Management
- Low-Power Sensor Networks
- Interactive Entertainment Devices
- Environmental Monitoring
- Hotel Automation
- Office Automation

5 Ordering Information

Part Number	Description
BMD-340-A-R	BMD-340 module, Rev A, nRF52840-QIAA, Tape & Reel, 1000-piece multiples
BMD-340-EVAL	BMD-340-A Evaluation Kit w/ SEGGER J-Link-OB debug probe

Table 1 – Ordering Information

6 Block Diagram

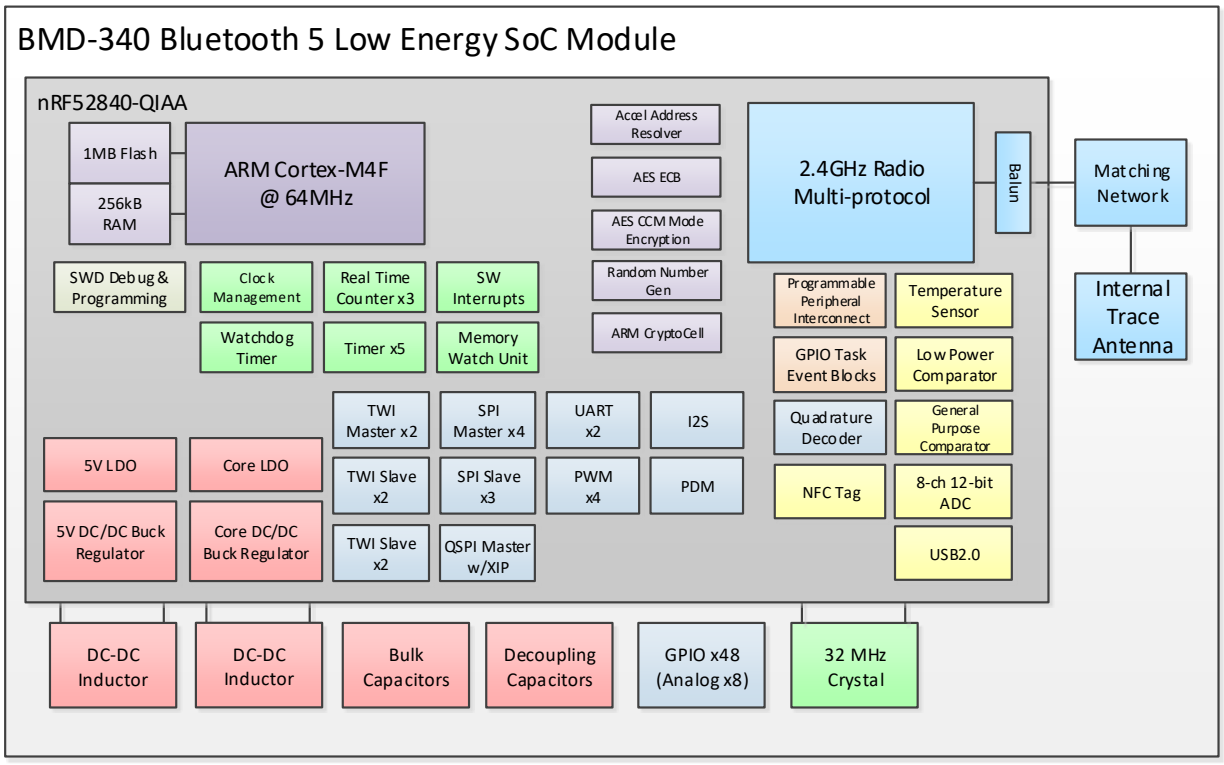


Figure 1 – Block Diagram

7 Quick Specifications

Bluetooth		
Version	Bluetooth 5 Low Energy, Concurrent Central & Peripheral (S140) Coded PHY (Long Range), 2Mbps & 1Mbps PHY, Advertising Extensions, Improved Coexistence	
Security	AES-128	
LE connections	Concurrent central, observer, peripheral, and broadcaster roles with up to twenty concurrent connections along with one Observer and one Broadcaster (S140)	
IEEE 802.15.4		
Thread Stack	OpenThread, Thread 1.1 certified	
Thread Security	Thread Security AES-128, ARM® Cryptocell accelerated	
Zigbee Stack	Zigbee 3.0	
Radio		
Frequency	2.360GHz to 2.500GHz	
Modulations	GFSK at 1 Mbps and 2Mbps, QPSK at 250kbps	
Transmit power	+8 dBm maximum	
Receiver sensitivity	-96 dBm (BLE mode)	
Antenna	Integrated (-1dBi max gain)	
Current Consumption		
TX only @ +8 dBm, 0 dBm @ 3V, DCDC enabled		14.8 mA, 4.8 mA
TX only @ +8 dBm, 0 dBm		32.7 mA, 10.6 mA
RX only @ 1 Mbps @ 3V, DCDC enabled		4.6 mA
RX only @ 1 Mbps		9.9 mA
CPU @ 64MHz from flash, from RAM		6.3 mA, 5.2mA
CPU @ 64MHz from flash, from RAM @ 3V, DCDC enabled		3.3 mA, 2.8mA
System Off, On (Supply on VDD), no RAM retention		0.4 µA, 0.97 µA
System Off, On (Supply on VDD), full 256kB RAM retention		1.86 µA, 2.35µA
Dimensions		
BMD-340	Length Width Height	15.0 mm ± 0.3 mm 10.2 mm ± 0.3 mm 1.9 mm ± 0.1 mm
Hardware		
Interfaces	SPI Master/Slave x4 Quad SPI x1 UART x2 Two-Wire Master/Slave (I2C) x2 GPIO x48	I2S x1 PWM x12 PDM x1 USB 2.0 x1 Analog input x8
Power supply	VDD: 1.7V to 3.6V, 1.75V required to start DCDC VDDH: 2.5V to 5.5V VBUS: 4.35V to 5.5V (For USB operation)	
Temperature Range	-40°C to +85°C	
Certifications		
USA (FCC)	FCC part 15 modular certification FCC ID: 2AA9B10	
Canada (IC)	Industry Canada RSS-210 modular certification IC: 12208A-11	
Europe (CE)	EN 60950-1: A2:2013 3.1 (a): Health and Safety of the User EN 301 489-1 V2.1.1 & 3.1 (b): Electromagnetic Compatibility EN 301 489-17 V3.1.1 EN 300 328 V2.1.1 3.2: Effective use of spectrum allocated	
Australia / New Zealand (RCM)	AS/NZS 4268:2017, Radio equipment and systems – Short range devices	
Bluetooth	BMD-340 RF-PHY Component (Tested) – DID: D040773; QDID: 95452	
Export		
BMD-350	ECCN: 5A992.C, Exception 740.17(b)(1) HTS: 8473.30.1180	
Nordic Semiconductor nRF52840		
Additional details	nRF52840 Product Specification Software Development Kit	

Table 2 – Quick Specifications

8 Pin Descriptions – BMD-340

8.1 Pin-out

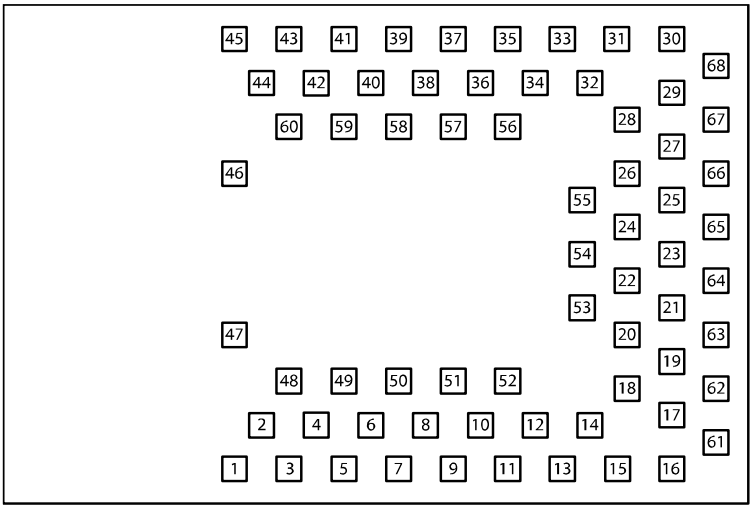


Figure 2 – BMD-340 Pin-out (Top View)

8.2 Pin Descriptions

Pin	Name	Direction	Description
6	P0.25	In/Out	GPIO
7	P0.26	In/Out	GPIO
8	P0.27	In/Out	GPIO
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[2]
19	P0.03	In/Out	GPIO/AIN1[2]
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/TRACECLK
24	P0.08	In/Out	GPIO
25	P0.09	In/Out	GPIO/NFC1[2]
26	P0.10	In/Out	GPIO/NFC2[2]
27	P0.11	In/Out	GPIO/TRACEDATA[2]
28	P0.12	In/Out	GPIO/TRACEDATA[1]
31	P0.13	In/Out	GPIO
32	P0.14	In/Out	GPIO
33	P0.15	In/Out	GPIO
34	P0.16	In/Out	GPIO

Pin	Name	Direction	Description
35	P0.17	In/Out	GPIO
36	P0.21	In/Out	GPIO
37	P0.19	In/Out	GPIO
38	P0.20	In/Out	GPIO
39	P0.18	In/Out	GPIO/$\overline{\text{RESET}}$
40	P0.22	In/Out	GPIO
41	P0.23	In/Out	GPIO
42	P0.24	In/Out	GPIO
43	SWCLK	In	SWD Clock
44	SWDIO	In/Out	SWD IO
48	P1.05	In/Out	GPIO[2]
49	P1.06	In/Out	GPIO[2]
50	P1.07	In/Out	GPIO[2]
51	P1.08	In/Out	GPIO
52	P1.09	In/Out	GPIO/TRACEDATA[3]
53	P1.10	In/Out	GPIO[2]
54	P1.11	In/Out	GPIO[2]
56	P1.00	In/Out	GPIO/TRACEDATA[0]/SWO
57	P1.01	In/Out	GPIO[2]
58	P1.02	In/Out	GPIO[2]
59	P1.03	In/Out	GPIO[2]
60	P1.04	In/Out	GPIO[2]
61	P1.12	In/Out	GPIO[2]
62	P1.13	In/Out	GPIO[2]
63	P1.14	In/Out	GPIO[2]
64	P1.15	In/Out	GPIO[2]
67	USB-D-	In/Out	USB Data -
68	USB-D+	In/Out	USB Data +
66	VBUS	Power	USB PHY supply: 4.35V to 5.5V in Connect to USB Host device 5V supply
17	VCC1	Power In/Out	LV Mode: 1.7V to 3.6V in HV Mode: 1.8V to 3.3V supply out3
65	VCCH1	Power	LV Mode: Connect to VCC HV Mode: 2.5V to 5.5V in
1, 2, 3, 4, 5, 16, 18, 29, 30, 45, 46, 47, 55	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.

Note 3: In HV mode, VCC acts as a regulated supply that can power other external devices. The voltage output of VCC can be configured in software but is limited to no more than VCCH-0.3V. In System Off mode VCC can supply no more than 1mA.

Table 3 – Pin Descriptions

8.3 Peripheral Pins

The BMD-340 features a pin multiplexing system that allows most internal peripherals, such as UART and SPI, to be used on any GPIO pin. This freedom in pin choice enables better optimization of designs and PCB layout. Note that only one peripheral signal can be multiplexed to a GPIO pin at a time. Some functions are restricted to certain pins due to additional internal circuitry required by the interface. These include: Trace signals, analog inputs, XTAL signals, USB signals, SWD interface, and reset. See Table 4 below for details:

Peripheral	Signal	Pin Options
UART0, UART1 I2C0, I2C1 SPI0, SPI1, SPI2, SPI3 I2S0 QSPI0 PWM0, PWM1, PWM2, PWM3 PDN0	All	P0.00-P0.31, P1.00-P1.15
ADC, COMP, LPCOMP	All	P0.02-P0.05, P0.28-P0.31 (AIN0-AIN7)
NFC	NFC1 NFC2	P0.09 P0.10
Reset	$\overline{\text{RESET}}$	P0.18
Trace	TRACECLK SWO/TRACEDATA[0] TRACEDATA[1] TRACEDATA[2] TRACEDATA[3]	P0.07 P1.00 P0.12 P0.11 P1.09
SWD	SWD Clock SWD IO	SWCLK SWDIO
32.768kHz Crystal	XTAL1 XTAL2	P0.00 P0.01
USB	USB Data + USB Data -	USB-D+ USB-D-

Table 4 – Peripheral Pin Options

Note: Some peripherals on the BMD-340 share the same memory location for their registers. This means that only one of these peripherals can be used at a time. It is possible to switch between peripherals that share the same register location by clearing and reinitializing the associated configuration registers. See the Nordic Semiconductor nRF52840 Product Specification for details.

Peripheral ID	Base Address	Shared Peripherals	
3	0x40003000	SPI0	I2C0
4	0x40004000	SPI1	I2C1

Table 5 – Peripherals with Shared Registers

8.4 BMD-300 Series Footprint Compatibility and Migration

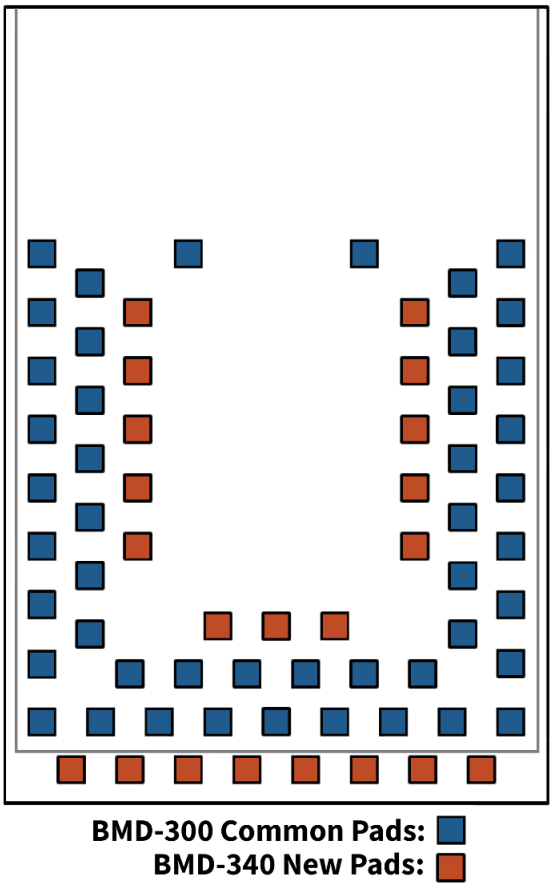


Figure 3 – BMD-340 and BMD-300/301/330 Footprint Comparison

The BMD-340 footprint has been designed to allow for backwards compatibility with the BMD-300, BMD-301, and BMD-330 modules with pins 1 through 47 of the BMD-340 directly mapping to the same pin numbers on the BMD-300/301/330. This allows BMD-300, BMD-301, and BMD-330 modules to be placed directly onto the BMD-340 footprint for easy migration and enabling tiered product design. Generally, all pin names and functions remain the same, except for some differences noted below. Pins 48 through 68 of the BMD-340 footprint are new pads used for new features that are not present on the BMD-300/301/330 modules, such as USB interface and additional GPIO and power connections.

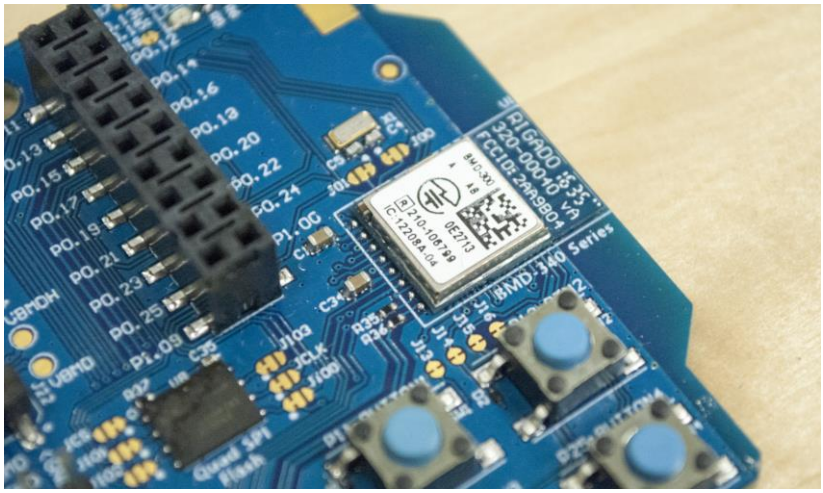


Figure 4 – BMD-300 Module Soldered to BMD-340 Footprint

8.4.1 BMD-300/301/330 to BMD-340 Pad Differences

Due to changes in the nRF52840 SoC used by the BMD-340, not all functions (such as SWO/TRACE signals) are found on the same pins as on the BMD-300/301/330. Particularly of note is the reset pin function which on the BMD-340 is now available on P0.18 instead of P0.21 as on the BMD-300/301. To maintain pin for pin compatibility of the reset signal, P0.18 and P0.21 have swapped pad locations on the BMD-340 footprint. These differences are detailed in Table 6 below:

Pin	BMD-300/301 Name	BMD-300/301 Function	BMD-340 Name	BMD-340 Function
39	**P0.21**	GPIO/$\overline{\text{RESET}}$	**P0.18**	GPIO/$\overline{\text{RESET}}$
38	P0.20	GPIO/**TRACECLK**	P0.20	GPIO
36	**P0.18**	GPIO/**TRACEDATA[0]/SWO**	**P0.21**	GPIO
34	P0.16	GPIO/**TRACEDATA[1]**	P0.16	GPIO
33	P0.15	GPIO/**TRACEDATA[2]**	P0.15	GPIO
32	P0.14	GPIO/**TRACEDATA[3]**	P0.14	GPIO
23	P0.07	GPIO	P0.07	GPIO/**TRACECLK**
56	N/A	N/A	P1.00	GPIO/**TRACEDATA[0]/SWO**
28	P0.12	GPIO	P0.12	GPIO/**TRACEDATA[1]**
27	P0.11	GPIO	P0.11	GPIO/**TRACEDATA[2]**
52	N/A	N/A	P1.09	GPIO/**TRACEDATA[3]**

Table 6 – BMD-300/301/330 to BMD-340 Pad Differences

8.4.2 BMD-300/301/330 to BMD-340 Design Migration

Existing designs incorporating the BMD-300, BMD-301, or BMD-330 module can be migrated over to the BMD-340 with the addition of a single footprint pad for VCCH (pin 65). This migration option is only suitable for applications that do not require the new USB interface, additional GPIO, or higher supply voltage functionality. The VCCH pad must be present and electrically connected to the same supply as VCC for the module to operate correctly. Vias underneath the BMD-340 should be tented to avoid shorts to unused module pads. Firmware written for the BMD-300/301/330 can generally be ported to the BMD-340 with minimal effort. See the Nordic Semiconductor SDK documentation for details.

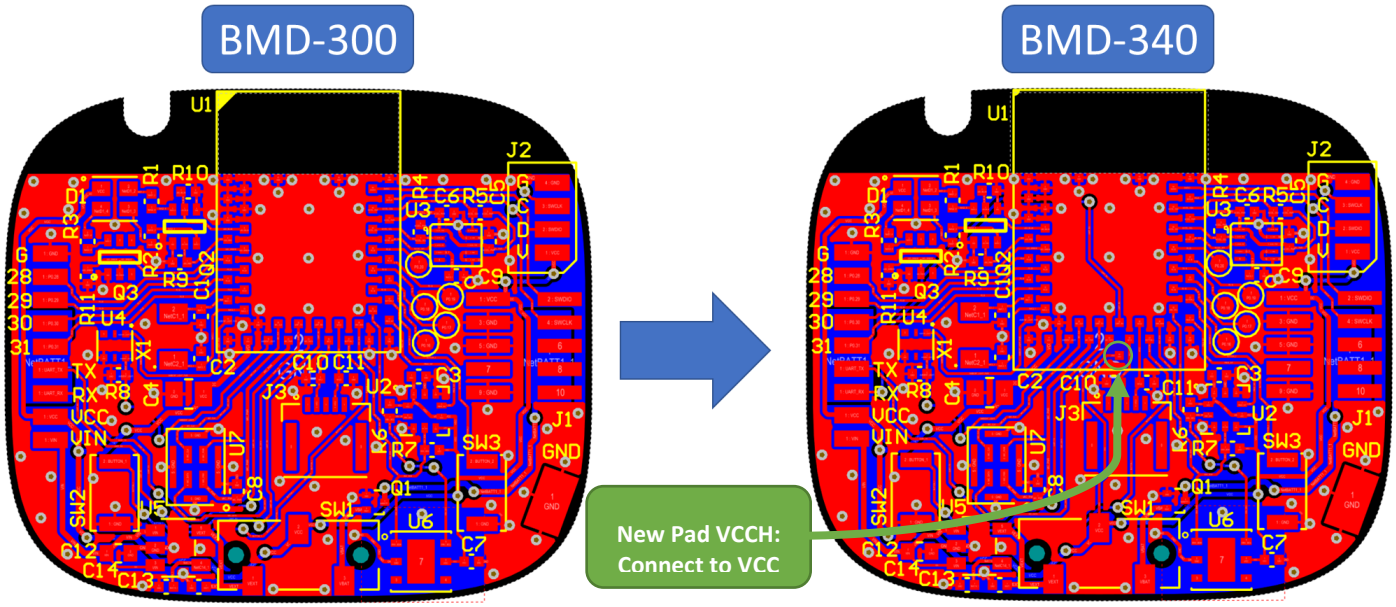


Figure 5 – BMD-300 to BMD-340 Migration Example

Using the BMD-340 minimal footprint, with only the additional VCCH pad added, allows BMD-300 designs to gain the following BMD-340 features with typically minor layout re-work:

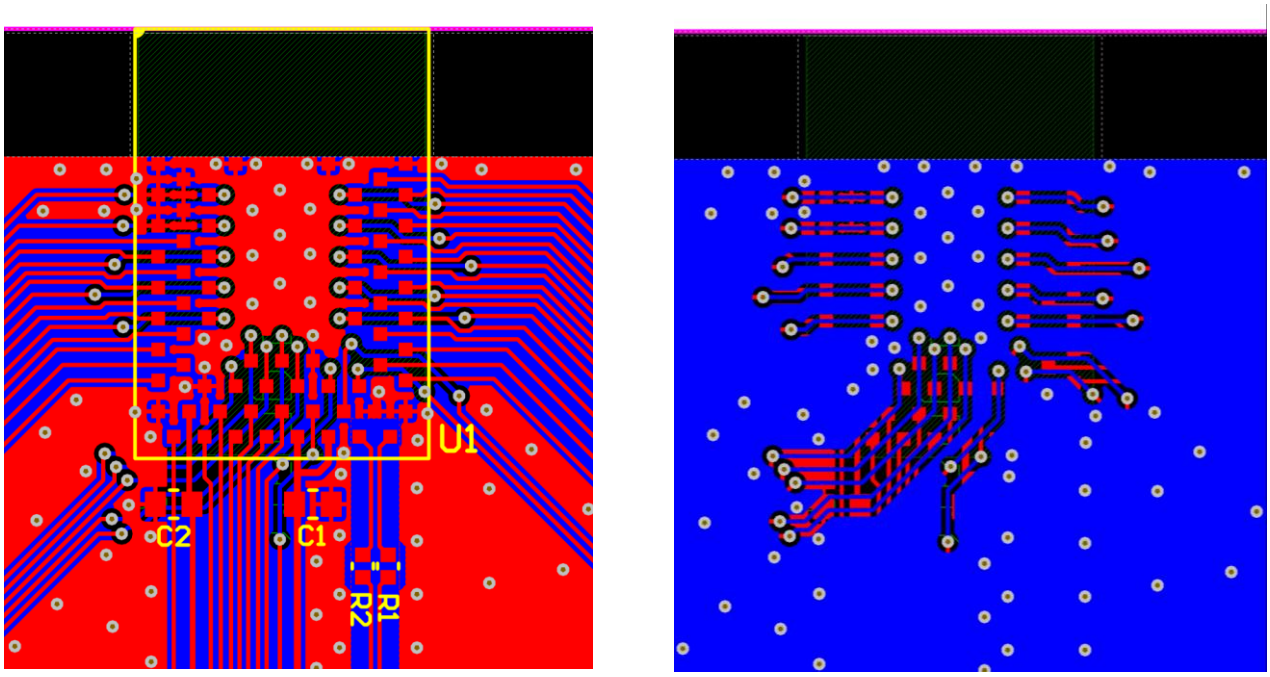
- Bluetooth 5 long range modes
- IEEE 802.15.4 (Thread and Zigbee) connectivity
- Doubled Flash memory (1MB vs. 512kB)
- Quadrupled RAM (256kB vs. 64kb)
- ARM® TrustZone® Cryptocell 310 security co-processor

To take advantage of new hardware features, such as the additional UART and Quad SPI interface, the full BMD-340 footprint should be used. Designs that require the 5V DCDC converter, trace interface, USB interface, or the additional GPIO (P1.00-P1.15) must use the full BMD-340 footprint.

Note: Since the BMD-300/330 can be soldered to the full BMD-340 footprint, it is highly recommended that all new BMD-300 and BMD-340 projects use the full BMD-340 footprint. When migrating designs, the full BMD-340 footprint should be used whenever possible as it is better suited for use with mass production SMT processing.

8.5 BMD-340 Fanout Example

The following figure is a BMD-340 fanout example on a simple 2-layer PCB. This example is powered via VCCH from a USB connection. See Section 9.3 for details on power and DCDC operation.



Top Layer **Bottom Layer**

Figure 6 – BMD-340 2 Layer Fanout Example

9 Electrical Specifications

9.1 Absolute Maximum Ratings

Symbol	Parameter	Min.	Max.	Unit
V_{CC_MAX}	Voltage on VCC supply pin	-0.3	3.9	V
V_{CCH_MAX}	Voltage on VCCH supply pin	-0.3	5.8	V
V_{BUS_MAX}	Voltage on VBUS Supply pin	-0.3	5.8	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

9.2 Operating Conditions

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{CC_IN}	VCC operating supply voltage in	1.7	3.0	3.6	V
V_{CC_START}	VCC DCDC starting voltage	1.75	-	-	V
V_{CCH_HV}	VCCH operating supply voltage in	2.5	5.0	5.5	V
V_{BUS_IN}	VBUS operating supply voltage in	4.35	5.0	5.5	V
T_{R_VCC}	VCC Supply rise time (0V to 1.7V)	-	-	60	ms
T_{R_VCCH}	VCCH Supply rise time (0V to 3.7V)[1]	-	-	1	ms
T_A	Operating Ambient Temperature Range	-40	25	85	°C
Note 1: Applies when module is configured to use HV mode. When using LV mode T_{R_VCC} applies. See Nordic nRF52840 Rev 1 errata [202] for details on T_{R_VCCH} requirement.					

Table 8 – Operating Conditions

9.3 Power and DCDC Configuration

Important Note Regarding REG0: Initial mass production silicon (Nordic Rev 1) for the nRF52840 includes some errata that affect the REG0 regulator. The REG0 DC-DC converter mode cannot be used reliably. The LDO mode of REG0 can be used in High Voltage mode but when applying power, the input voltage must have a rise time of 1ms or less. Due to the rise time constraint and higher current consumption of LDO mode compared to DCDC, High Voltage mode should be considered non-functional for most applications and should not be used on ES2 and Revision A BMD-340 modules. See Nordic nRF52840 errata 197 and 202 for more details. These errata are expected to be corrected in future production silicon releases and subsequent revisions of the BMD-340 module. Contact Rigado for timing and details.

The BMD-340 has two internal regulator stages that each contain an LDO and DCDC regulator. The first regulator, REG0, is fed by the VCCH pin and can accept a source voltage of 2.5V to 5.5V. The output of REG0 is connected to the VCC pin and the input of the second regulator stage REG1. REG1 supplies power to the module core and can accept an input source voltage of 1.7V to 3.6V. Depending on how the VCC and VCCH pins are connected, the module will operate in one of two modes: Normal/Low Voltage (LV) or High Voltage (HV). The voltage present on the VCC pin is always the GPIO high logic level voltage, regardless of power mode.

To enter LV Mode, the same source voltage is applied to both the VCC and VCCH pins causing REG0 to automatically shut down leaving only the REG1 stage active. To enter HV, the source voltage is only applied to VCCH causing the VCC pin to become an output source supplied by REG0.

Mode	Pin	Name	Connection
Normal (LV)	17 65	VCC VCCH	1.7V to 3.6V source in Same source as VCC
High Voltage (HV)	17 65	VCC VCCH	1.8V to 3.3V supply out 2.5V to 5.5V source in

Table 9 – Power Mode Pin Connections

Important: in both LV and HV mode, the GPIO logic level voltage is determined by the VCC pin. In HV mode, all external devices that are connected to the BMD-340's GPIO must either be powered by the module (from VCC) or use level translation.

REG0 can supply a maximum current of ~50mA for the module and external circuits in System On Mode and 1mA in System Off Mode. External circuits powered from VCC in HV mode should be limited to no more than 20mA to ensure stability.

9.3.1 USB Power

The USB interface on the BMD-340 can be used when the module is in either Normal (LV) or High Voltage (HV) mode. The BMD-340 USB PHY is powered by a dedicated, internal LDO regulator that is fed by the VBUS pin (66). This means that applying power to only the VBUS pin will not power the rest of the module. In order for the USB PHY to operate, VBUS must be externally powered.

9.3.2 Normal (LV) Power Mode Examples

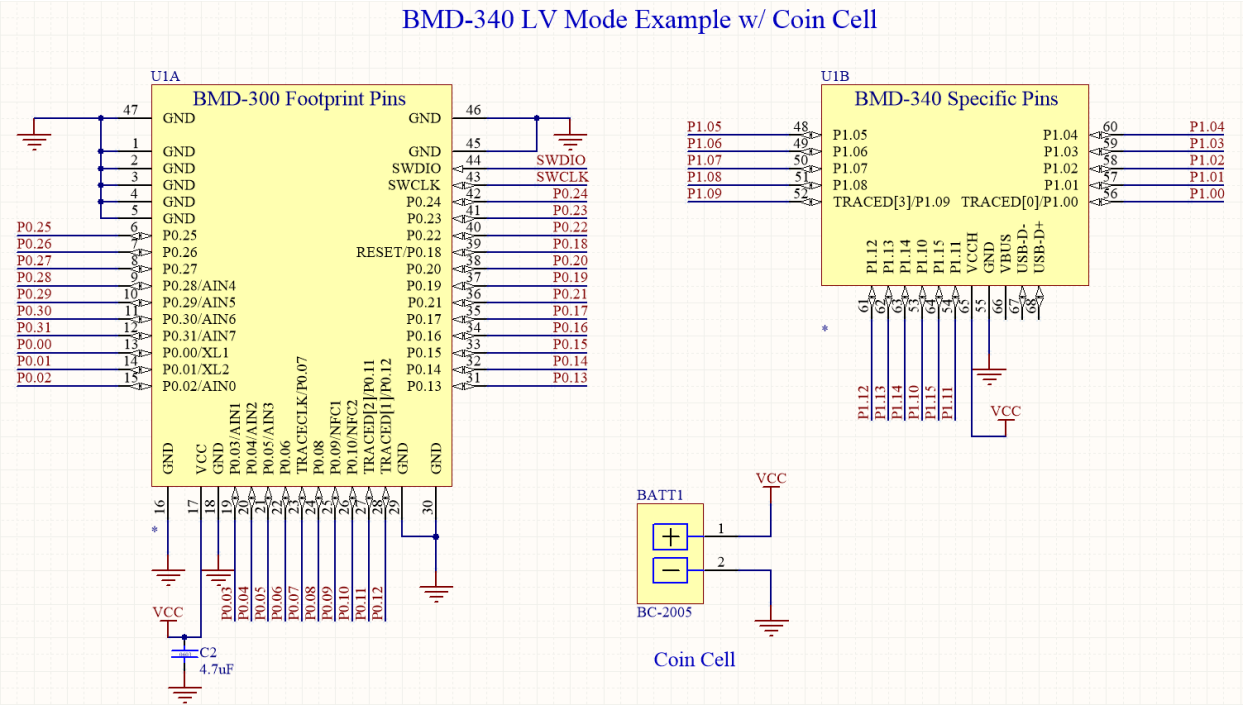


Figure 7 – LV Mode w/ Coin Cell Example

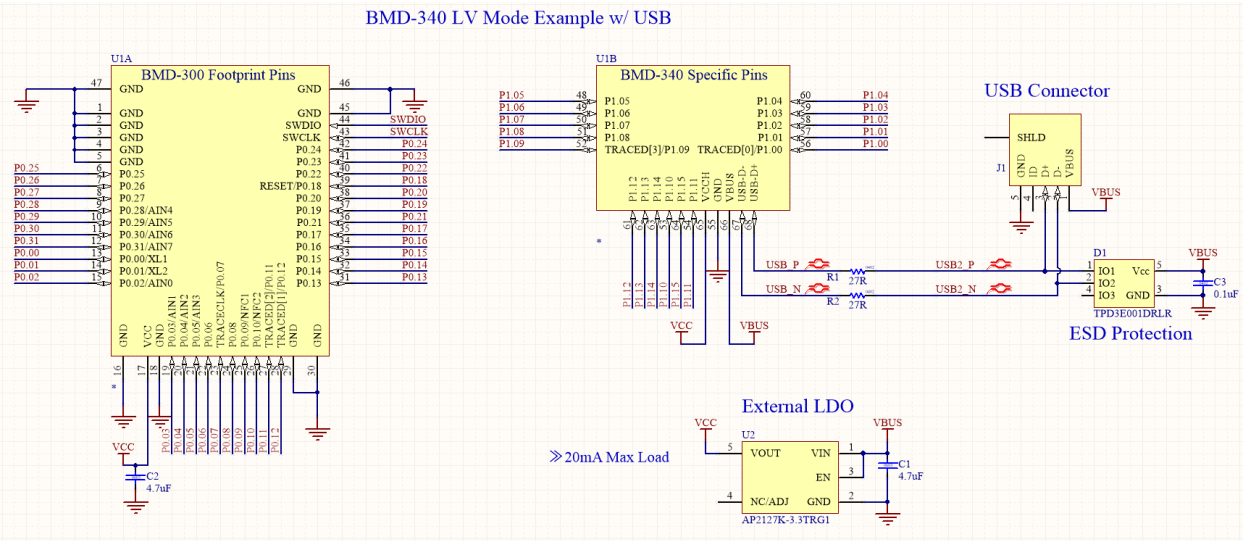


Figure 8 – LV Mode Example w/ USB and External Regulator

9.3.3 High Voltage (HV) Power Mode Examples

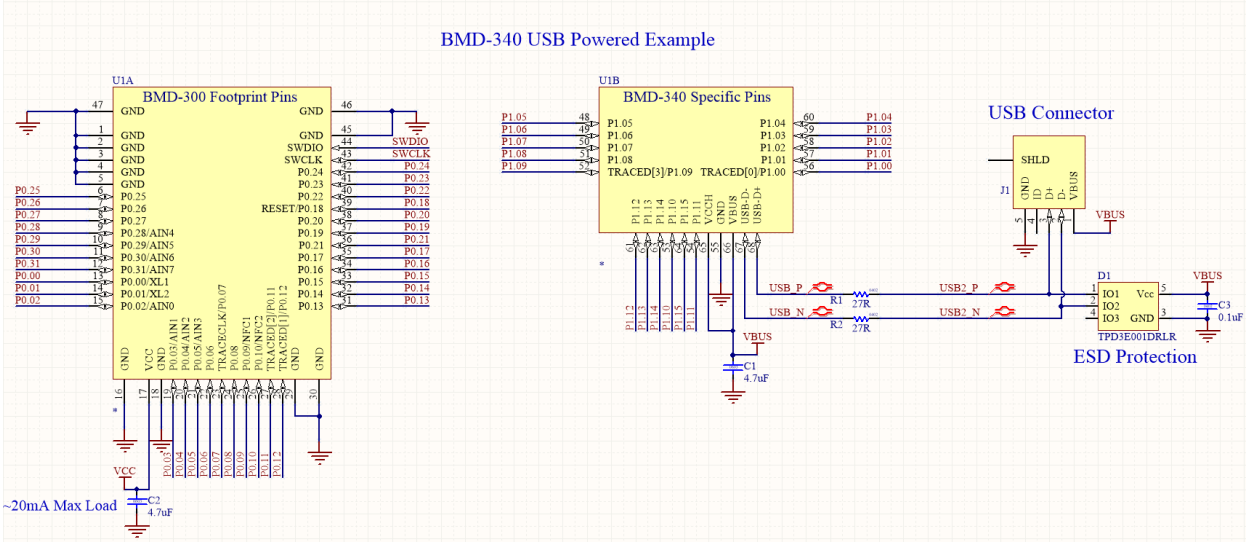


Figure 9 – USB Powered HV Mode Example

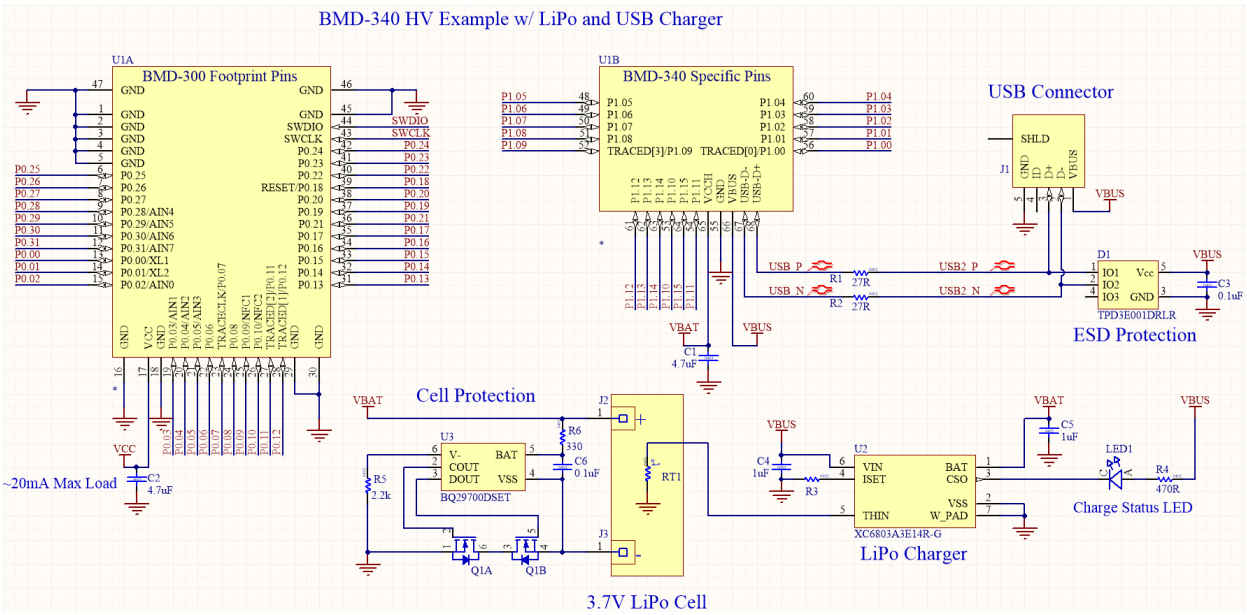


Figure 10 – LiPo Powered HV Example w/ USB Charger

Important: the LiPo circuit above is meant to be a generic example of how the BMD-340's power modes can be used. Great care must be taken when integrating Lithium-Ion batteries into a design. Protection circuits suitable for the type of battery used and the application must always be implemented.

9.4 General Purpose I/O

The general purpose I/O is organized as two ports enabling access and control of the 48 available GPIO pins. The first port allows access of P0.00 to P0.31, similar to the one port available on the BMD-300/301. The second port, new to the BMD-340, allows access to P1.00 to P1.15. 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 VCC	-	VCC	V
V_{IL}	Input Low Voltage	VSS	-	0.3 x VCC	V
V_{OH}	Output High Voltage	VCC – 0.4	-	VCC	V
V_{OL}	Output Low Voltage	VSS	-	VSS + 0.4	V
R_{PU}	Pull-up Resistance	11	13	16	kΩ
R_{PD}	Pull-down Resistance	11	13	16	kΩ

Table 10 – GPIO

9.5 Module RESET

GPIO pin P0.18 may be used for a hardware reset. In order to utilize P0.18 as a hardware reset, the UICR registers PSELRESET[0] and PSELRESET[1] must be set alike, to the value of 0x7FFFFFD2. When P0.18 is programmed as $\overline{\text{RESET}}$, the internal pull-up is automatically enabled. Rigado and Nordic example applications and development kits program P0.18 as $\overline{\text{RESET}}$.

9.6 Debug & Programming

The BMD-340 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-340 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.

9.7 Clocks

The BMD-350 requires two clocks, a high frequency clock and a low frequency clock.

The high frequency clock is provided on-module by a high-accuracy 32MHz crystal as required by the nRF528340for radio operation.

The low frequency clock can be provided internally by an RC oscillator or synthesized from the fast clock, or externally by a 32.768kHz 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.

9.7.1 32.768kHz Crystal (LFXO)

Symbol	Parameter	Typ.	Max.	Unit
F_{NOM_LFXO}	Crystal frequency	32.768	-	kHz
$F_{TOL\_LFXO\_BLE}$	Frequency tolerance, BLE applications[1]	-	±250	ppm
$f_{TOL\_LFXO\_ANT}$	Frequency Tolerance, ANT applications[1]	-	±50	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
Note 1: $f_{TOL\_LFXO\_BLE}$ and $f_{TOL\_LFXO\_ANT}$ are the maximum allowed for BLE and ANT applications. Actual tolerance depends on the crystal used.				

Table 11 – 32.768kHz Crystal (LFXO)

9.7.2 32.768kHz Clock Source Comparison

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{LFXO}	Current for 32.768kHz Crystal Oscillator	-	0.23	-	µA
I_{LFRC}	Current for 32.768kHz RC Oscillator	-	0.7	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 maximum allowed for BLE and ANT applications. Actual tolerance depends on the crystal used.					

Table 12 – 32.768kHz Clock Source Comparison

10 Firmware

Rigado recommends that projects for the BMD-340 utilize Nordic SDK and the nRF52840 tools for any new development. This will allow access to the very latest Bluetooth support from Nordic and provide an ongoing path as new features are released.

10.1 Factory Image

The BMD-340 module is not loaded with a factory firmware image. The unique Rigado MAC address is printed on the module label and is also programmed into the UICR.

10.2 SoftDevices

Nordic Semiconductor protocol stacks for Bluetooth and ANT 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-340 with the nRF52840 SoC supports the S140 (BLE Central & Peripheral) SoftDevice.

10.2.1 S140

The S140 SoftDevice is a Bluetooth® low energy (BLE) Central and Peripheral protocol stack solution supporting up to twenty connections with an additional Observer and a Broadcaster role all running concurrently. The S140 SoftDevice integrates a BLE Controller and Host and provides a full and flexible API for building Bluetooth Smart nRF52 System on Chip (SoC) solutions. The S140 SoftDevice is an extension of the S132 SoftDevice adding support for Bluetooth 5.

10.3 IEEE 802.15.4 (Thread and Zigbee)

IEEE 802.15.4 based protocols, such as Thread and Zigbee, on the BMD-340 are not implemented using a SoftDevice. Nordic Semiconductor provides an IEEE 802.15.4 compliant MAC stack which does not require a SoftDevice to be loaded to operate. Nordic Semiconductor also provides pre-compiled Thread and Zigbee stacks. See the Nordic SDKfor more information on developing applications that utilize IEEE 802.15.4. Both allow for concurrent operation with BLE SoftDevices.

10.4 MAC Address Info

Figure 11 – BMD-340 MAC Address

The BMD-340 module 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.

The 6-byte BLE Radio MAC address is stored in the nRF52840 UICR at NRF_UICR_BASE+0x80 LSB first. Please read the MAC Address Provisioning application note to avoid erasing/overwriting the MAC address during programming.

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)

11 Mechanical Data

11.1 Dimensions

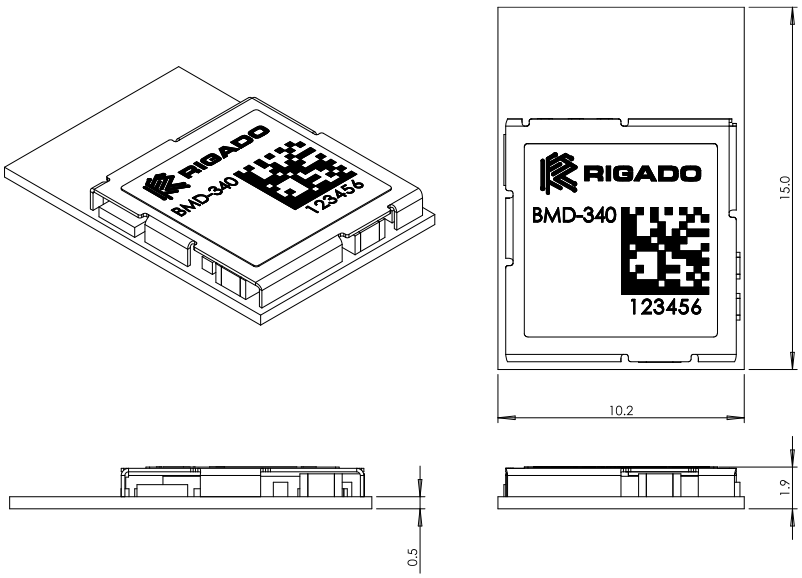


Figure 12 – Mechanical Drawing

11.2 Recommended PCB Land Pads

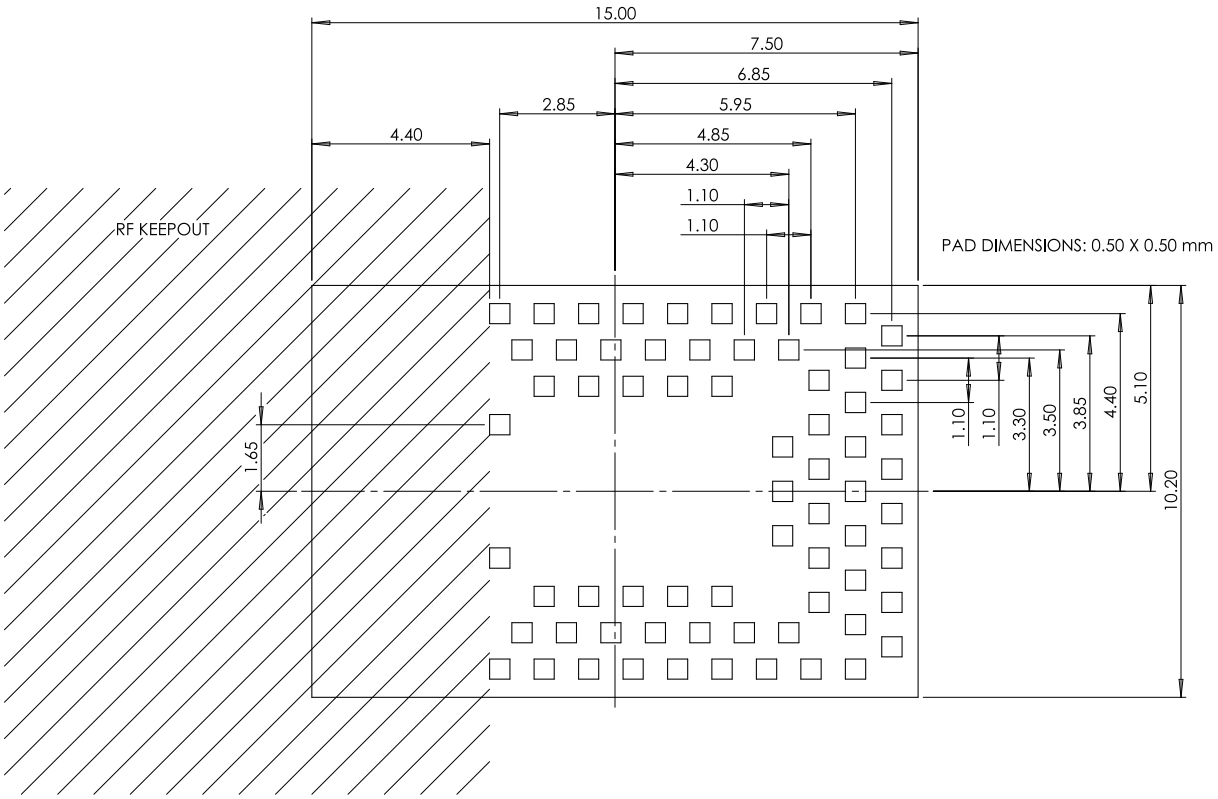


Figure 13 – Recommended PCB Land Pads

11.3 Module Marking

Figure 14 – Module Marking

12 RF Design Notes

12.1 Recommended RF Layout & Ground Plane

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 15 will reduce the effective radiated power.

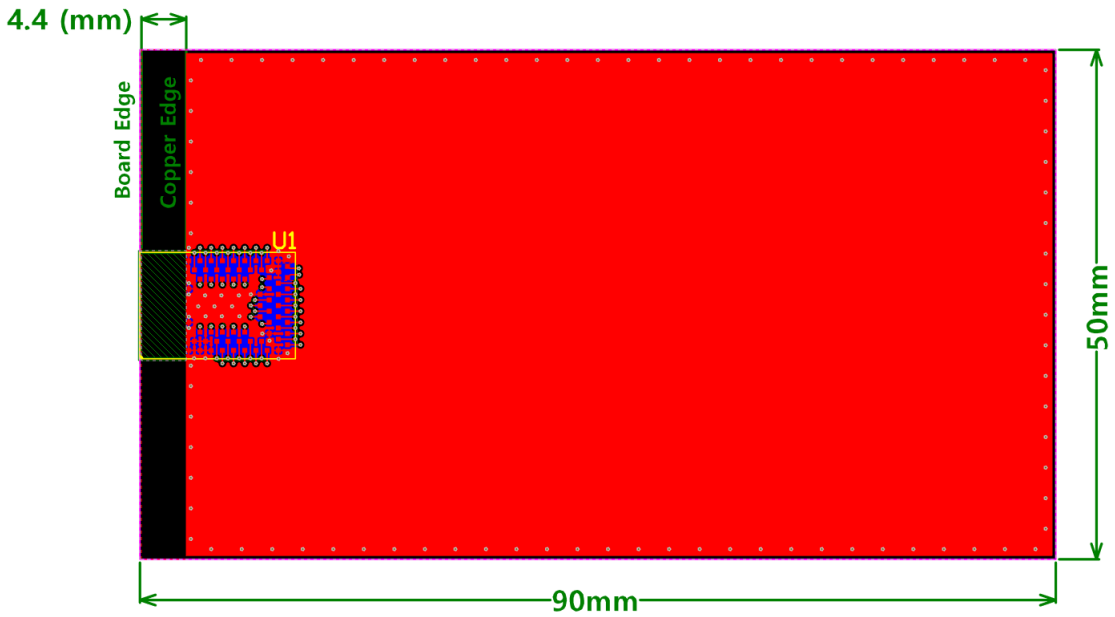


Figure 15 – BMD-340 RF Example based on EVAL Board

12.2 Mechanical Enclosure

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.

12.3 Antenna Patterns

Antenna patterns are based on the BMD-340 Evaluation Kit with a ground plane size of 109mm x 56mm. X-Y-Z orientation is shown in Figure 16:

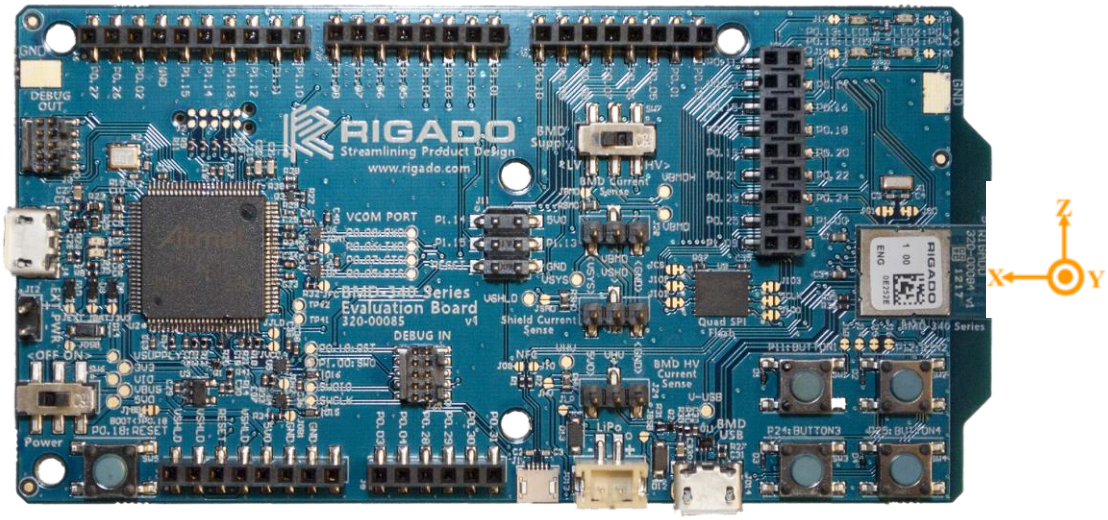
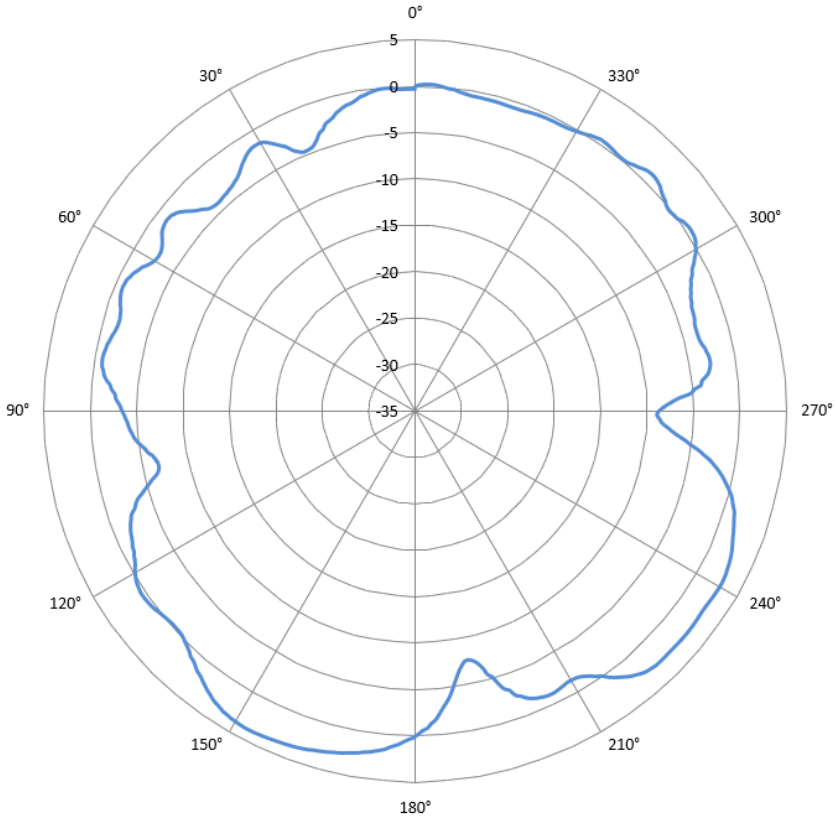
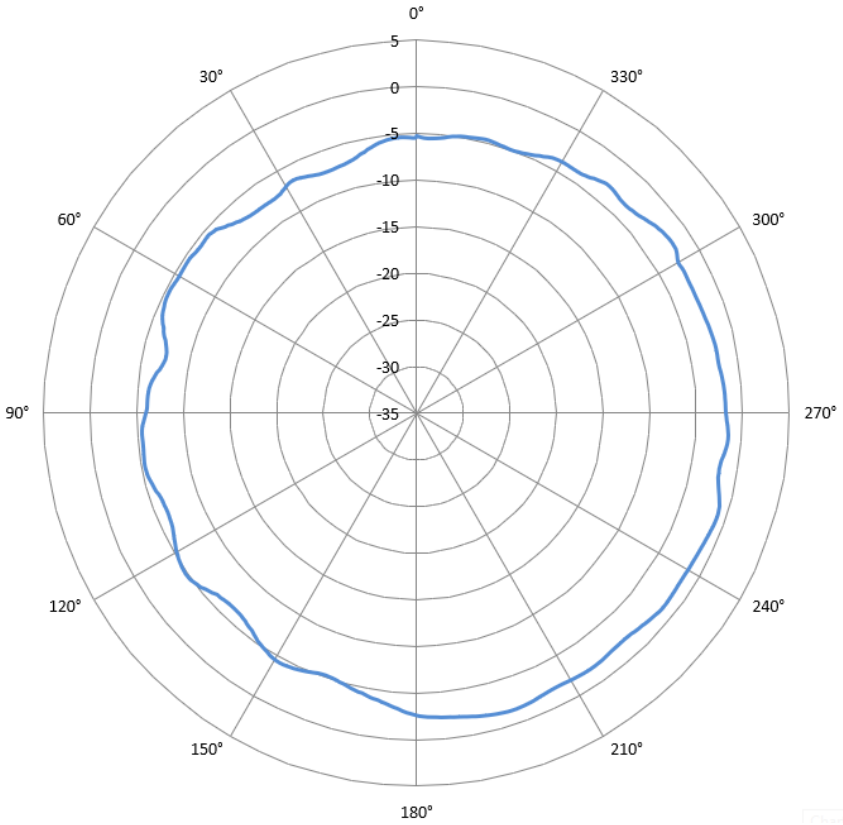


Figure 16 – X-Y-Z Antenna Orientation

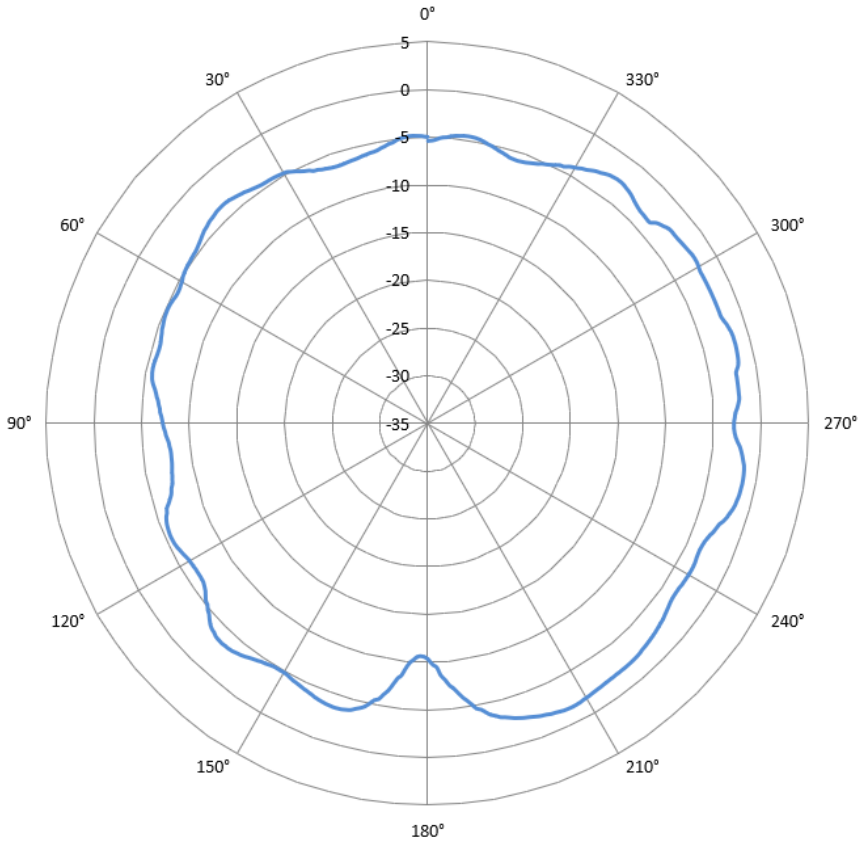
X-Z Plane



Y-Z Plane



X-Y Plane



13 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, BMD-340 USB connector, 64Mb quad SPI Flash, 4 user LEDs, and 4 user buttons. The evaluation boards also provide the option to be powered from a CR2032 coin cell battery or a LiPo battery through a JST-PH connecter and have current sense resistors and headers to allow for convenient current measurements. Arduino Mega style headers are provided for easy prototyping of additional functions. The evaluation boards also support programming off-board BMD-300/301 and BMD-340 Series modules.

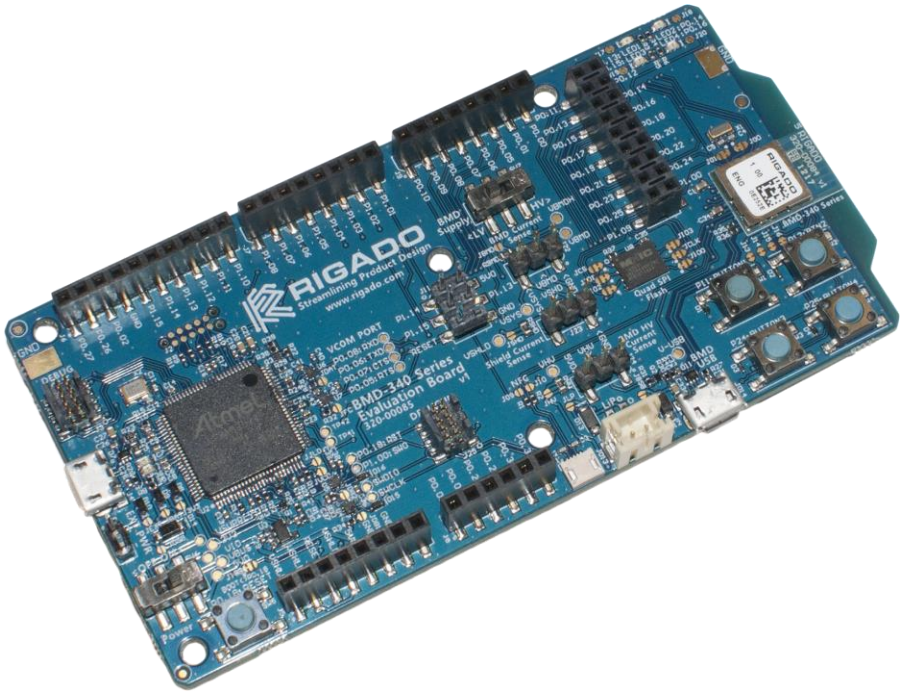


Figure 17 – BMD-340 Evaluation Board

14 Bluetooth Qualification

- The Bluetooth SIG maintains the Bluetooth Specification, and ensures that products are properly tested and comply with the Bluetooth license agreements. Companies that list products with the Bluetooth SIG are required to be members of the SIG and submit the listed fees. Refer to this link for details: https://www.bluetooth.com/develop-with-bluetooth/qualification-listing
- The Rigado Bluetooth Low Energy modules based on Nordic Semiconductor SoCs are listed as a "Tested Component". This allows an end-product based on a Rigado module to inherit the component listings without the need to run through all of the tests again. The end-product will often inherit several different listings, known as Qualified Design IDs (QDID), and are identified on a "Declaration of Compliance". Refer to this Help Center article for creating a Declaration of Compliance: https://rigado.zendesk.com/hc/en-us/articles/360002645694-Bluetooth-SIG-Launch-Studio-Product-Declaration
- The list of Qualified Products is found here: https://launchstudio.bluetooth.com/Listings/Search
- The BMD-340 primarily utilizes the S140 SoftDevice
- A list of current QDIDs used by Rigado is maintained at the Rigado Help Center

15 Regulatory Agency Approvals

15.1 United States (FCC):

Rigado's modules have received Federal Communications Commission (FCC) CFR47 Telecommunications, Part 15 Subpart C "Intentional Radiators" modular approval in accordance with Part 15.212 Modular Transmitter approval. Modular approval allows the end user to integrate the module into a finished product without obtaining subsequent and separate FCC approvals for intentional radiation, provided no changes or modifications are made to the module circuitry. Changes or modifications could void the user's authority to operate the equipment. The end user must comply with all of the instructions provided by the Grantee, which indicate installation and/or operating conditions necessary for compliance.

The finished product is required to comply with all applicable FCC equipment authorizations regulations, requirements and equipment functions not associated with the transmitter module portion. For example, compliance must be demonstrated to regulations for other transmitter components within the host product; to requirements for unintentional radiators (Part 15 Subpart B "Unintentional Radiators"), such as digital devices, computer peripherals, radio receivers, etc.; and to additional authorization requirements for the non-transmitter functions on the transmitter module (i.e., Verification, or Declaration of Conformity) (e.g., transmitter modules may also contain digital logic functions) as appropriate.

Note: Modification to this product will void the users' authority to operate this equipment.

Caution! **The OEM is still responsible for verifying end-product compliance with FCC Part 15, subpart B limits for unintentional radiators through an accredited test facility.**

15.1.1 Labeling & User Information Requirements

The BMD-340 is assigned the FCC ID number: 2AA9B10

If the FCC ID is not visible when the module is installed inside another device, then the outside of the finished product into which the module is installed must also display a label referring to the enclosed module. This exterior label can use the following or similar wording:

Contains FCC ID: 2AA9B10

In addition to marking the product with the appropriate FCC ID, the end-product user manual may also require specific information based on the digital device classification. Refer to the FCC Rules, Title 47, Subchapter A, Part 15, Subpart B, Chapter §15.105 for specific wording of the notices.

15.1.2 RF Exposure

All transmitters regulated by FCC must comply with RF exposure requirements. KDB 447498 General RF Exposure Guidance provides guidance in determining whether proposed or existing transmitting facilities, operations or devices comply with limits for human exposure to Radio Frequency (RF) fields adopted by the Federal Communications Commission (FCC).

This module is approved for installation into mobile and/or portable host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with FCC multi-transmitter guidelines. End users must be provided with transmitter operating conditions for satisfying RF Exposure compliance.

15.2 Canada (IC)

Rigado's modules have been certified for use in Canada under Industry Canada (IC) Radio Standards Specification (RSS) RSS-210 and RSSGen. Modular approval permits the installation of a module in a host device without the need to recertify the device.

15.2.1 Labeling & User Information Requirements

The BMD-340 is assigned the IC ID number: 12208A-10

Labeling Requirements for the Host Device (from Section 3.2.1, RSS-Gen, Issue 3, December 2010): The host device shall be properly labeled to identify the module within the host device. The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labeled to display the Industry Canada certification number of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

> Contains transmitter module IC: 12208A-10

User Manual Notice for License-Exempt Radio Apparatus (from Section 7.1.3 RSS-Gen, Issue 3, December 2010): User manuals for license-exempt radio apparatus shall contain the following or equivalent notice in a conspicuous location in the user manual or alternatively on the device or both:

> This device complies with Industry Canada license exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.
>
> Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.
>
> Transmitter Antenna (from Section 7.1.2 RSS-Gen, Issue 3, December 2010): User manuals for transmitters shall display the following notice in a conspicuous location:
>
> Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication.
>
> Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante.

15.2.2 RF Exposure

All transmitters regulated by IC must comply with RF exposure requirements listed in RSS-102 - Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands). This module is approved for installation into mobile and/or portable host platforms and must not be co-located or operating in conjunction with any other antenna or transmitter except in accordance with Industry Canada's multi-transmitter guidelines. End users must be provided with transmitter operating conditions for satisfying RF Exposure compliance.

15.3 Europe (CE)

The BMD-340 is a Radio Equipment Directive assessed radio module that is CE complaint and have been manufactured and tested with the intention of being integrated into a final product.

The BMD-340 has been tested to current Radio Equipment Directives

EU - Radio Equipment Directive 2014/53/EU

- ETSI EN 300 328 V 2.1.1
- ETSI EN 301 489-1 V2.1.1
- ETSI EN 301 489-17 V3.1.1

The Radio Equipment Directive – Compliance Association (RED-CA) provides guidance on modular devices at the RED-CA website: http://www.redca.eu/Pages/Documents%201.htm.

15.3.1 Labeling & User Information Requirements

The label on the final products which contain a Rigado module must follow CE marking requirements. The "R&TTE Compliance Association Technical Guidance Note 01" provides guidance on final product CE marking.

15.4 Australia / New Zealand (RCM)

The BMD-350 has been tested to comply with the AS/NZS 4268:2017, Radio equipment and systems – Short range devices – Limits and methods of measurement. The report may be downloaded from www.rigado.com, and may be used as evidence in obtaining permission to use the Regulatory Compliance Mark (RCM).

Information on registration as a Responsible Party, license and labeling requirements may be found at the following websites:

Australia: http://www.acma.gov.au/theACMA/radiocommunications-short-range-devices-standard-2004

New Zealand: http://www.rsm.govt.nz/compliance

Only Australian-based and New Zealand-based companies who are registered may be granted permission to use the RCM. An Australian-based or New Zealand-based agent or importer may also register as a Responsible Party to use the RCM on behalf of a company not in Australia or New Zealand.

15.5 Environmental

15.5.1 RoHS

Rigado's modules are in compliance with Directive 2011/65/EU, 2015/863/EU of the European Parliament and the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment. The declaration may be found here: https://go.rigado.com/RoHS-Modules

15.5.2 REACH

Rigado's modules listed below do not contain the 191 SVHC (Substance of Very High Concern), as defined by Directive EC/1907/2006 Article according to REACH Annex XVII. The compliance statement may be found here: https://go.rigado.com/REACH-Modules

15.5.3 California Proposition 65 (P65)

This product can expose you to Nickel (metallic), which is known to the State of California to cause cancer. For more information go to www.P65Warnings.ca.gov. Warnings are not required where the listed chemical is inaccessible to the average user of the end-product.

16 Solder Reflow Temperature-Time Profile

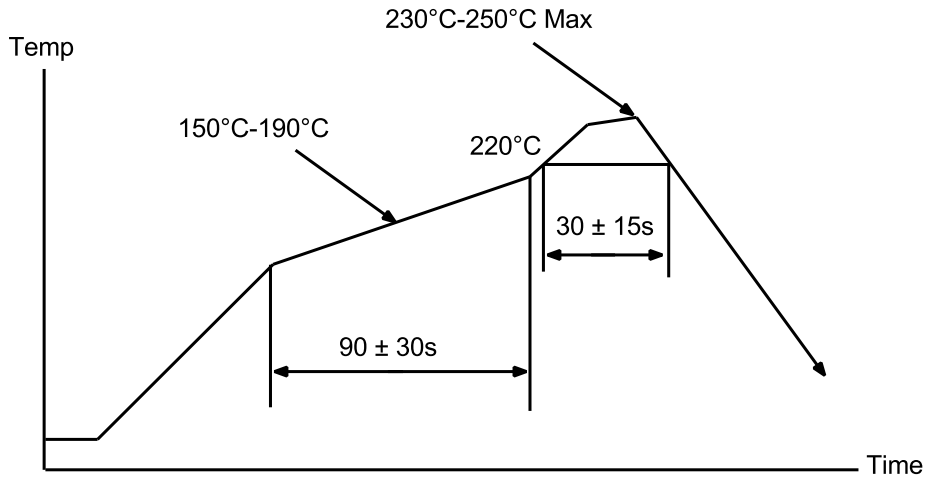


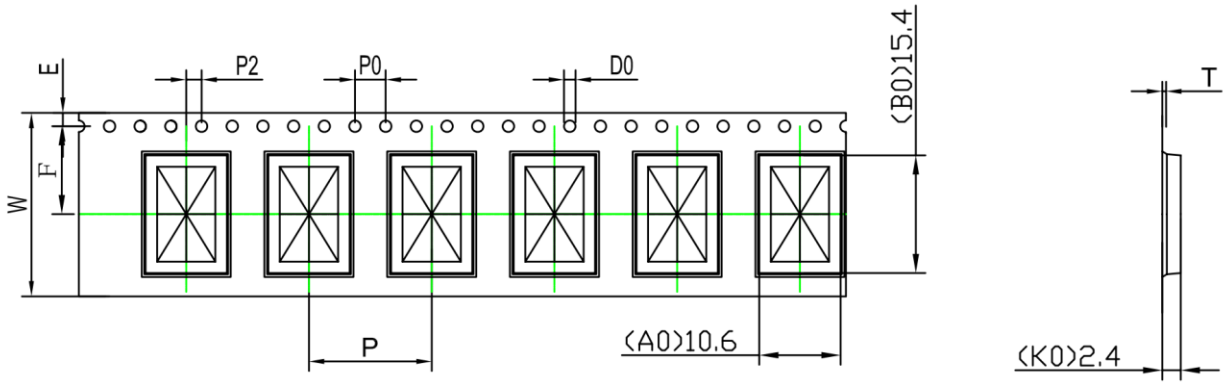
Figure 18 – Reflow Profile for Lead Free Solder

16.1 Moisture Sensitivity Level

The BMD-340 is rated for MSL 3, 168-hour floor life after opening.

17 Packaging and Labeling

17.1 Carrier Tape Dimensions



ITEM	W	A_0	B_0	K_0	K_1	P	F	E	D_0	D_1	P_0	P_2	T
DIM	$24.0^{+0.30}_{-0.30}$	$10.60^{+0.10}_{-0.10}$	$15.4^{+0.10}_{-0.10}$	$2.40^{+0.10}_{-0.10}$	$0.00^{+0.00}_{-0.00}$	$16.0^{+0.10}_{-0.10}$	$11.5^{+0.10}_{-0.10}$	$1.75^{+0.10}_{-0.10}$	$1.50^{+0.10}_{-0.00}$	$0.00^{+0.10}_{-0.00}$	$4.00^{+0.10}_{-0.10}$	$2.00^{+0.10}_{-0.10}$	$0.30^{+0.05}_{-0.05}$
ALTERNATE													

Figure 19 – Carrier Tape Dimensions

17.2 Reel Packaging

Modules are packaged on 330mm reels loaded with 1000 modules. Each reel is placed in an antistatic bag with a desiccant pack and humidity card and placed in a 340x350x65mm box. An antistatic warning and reel label are adhered to the outside of the bag.

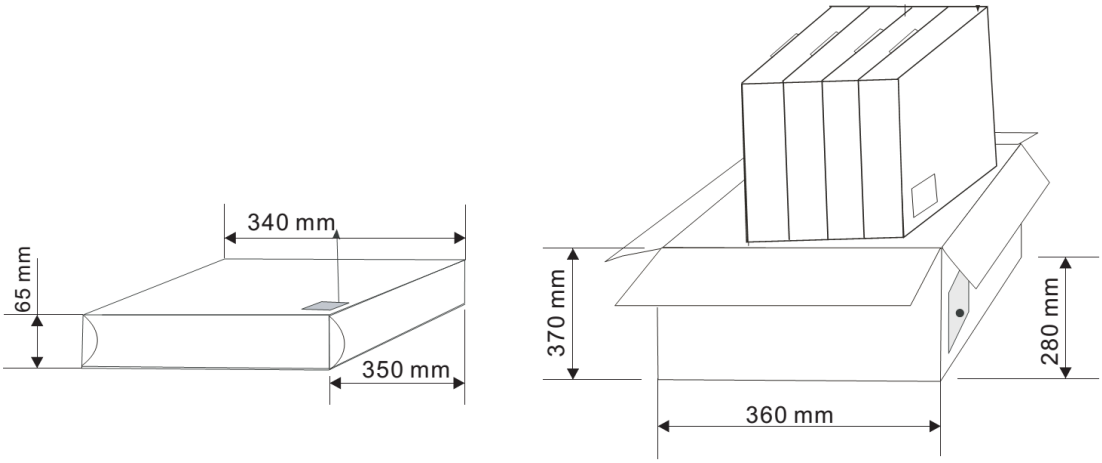


Figure 20 – Reel Cartons

17.3 Packaging Label

Figure 21 – Packaging Label

18 Cautions

1. The guidelines of this document should be followed in order to assure proper performance of the module.
2. This product is intended for use in office, business, and residential applications and not designed for medical applications. See the life support policy below for use in medical applications.
3. This module may short-circuit. If a short circuit can result in serious damage or injury, then failsafe precautions should be used. This could be accomplished by redundant systems and protection circuits.
4. Supply voltage to the module should not be higher than the specified inputs or reversed. Additionally, it should not contain noise, spikes, or AC ripple voltage.
5. Avoid use with other high frequency circuits.
6. Use methods to eliminate static electricity when working with the module as it can damage the components.
7. Contact with wires, the enclosure, or any other objects should be avoided.
8. Refer to the recommended land pattern when designing for this module.
9. If hand soldering is used, be sure to use the precautions outlined in this document.
10. This module should be kept away from heat, both during storage and after installation.
11. Do not drop or physically shock the module.
12. Do not damage the interface surfaces of the module.
13. The module should not be mechanically stressed at any time (storage, handling, installation).
14. Do not store or expose this module to:
    - Humid or salty air conditions
    - High concentrations of corrosive gasses.
    - Long durations of direct sunlight.
    - Temperatures lower than -40°C or higher than 125°C.

19 Life Support and other High-Risk Use Warning

This product is not designed nor intended for use in a life support device or system, nor for use in other fault-intolerant, hazardous or other environments requiring fail-safe performance, such as any application in which the failure or malfunction of the product could lead directly or indirectly to death, bodily injury, or physical or property damage (collectively, “High-Risk Environments”). RIGADO EXPRESSLY DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR USE IN HIGH-RISK ENVIRONMENTS. The customer using this product in a High-Risk Environment agrees to indemnify and defend Rigado from and against any claims and damages arising out of such use.

20 Related Documents

Rigado Documents:

Visit the Rigado File Downloads page for BMD-301 documentation.

- BMD-340-EVAL User Guide
- BMD-340-EVAL Reference Design

Nordic Documents:

Visit the Nordic Document Library for a comprehensive library of Nordic technical documentation.

- nRF52840 Product Specification
- nRF52840 S140 Soft Device Specification

21 Contact Information

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Support: https://rigado.zendesk.com/hc

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24 Document History

Revision	Date	Changes / Notes
0.8	2017-07-05	Initial Release
1.0	2018-05-21	Production Release. Updated power specifications. Added details on REG0 related silicon errata. Updated certification information. Added Zigbee information. Removed outdated factory firmware information.
1.1	2018-07-24	Added Antenna data and updated certification information.
2.0	2019-02-01	Updated to new format Updated Life Support and other High-Risk Use Warning
2.1	2019-02-28	Corrected output power in Table 7 to +8dBm Corrected superscript note on low-frequency GPIO pins

Table 13 – Document History