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Version: A
Issued Date: 2020/07/20

Approval Sheet

(產品承認書)

產品名稱 (Product): Bluetooth Low Energy Module

產品型號 (Model No.): **MDBT50 Series** (Chip Antenna)

MDBT50 – P Series (PCB Antenna)

Index

1. Overall Introduction

Raytac's MDBT50 & MDBT50-P is a BT 5.0 & BT 5.1 stack (Bluetooth low energy or BLE) module designed based on **Nordic nRF SoC solution**, which incorporates: **GPIO**, **SPI**, **UART**, **I2C** and **USB** interfaces for connecting peripherals and sensors.

Features:

1. Embedded 2.4GHz transceiver supports Bluetooth 5.1 (Bluetooth®), IEEE 802.15.4 (THREAD & Zigbee) & 2.4Ghz RF & ANT+ upon customer's preference.
2. Compact size with **(L) 13.2 x (W) 8.4 x (H) 2.1 mm**.
3. Low power requirements, ultra-low peak, average and idle mode power consumption.
4. Be compatible with a large installed base of mobile phones, tablets and computers.
5. Fully coverage of BLE software stack.
6. BLE & RF transmission switching helps products fit all operation system and most hardware.

1.1. Application

- IoT Networks
  - Smart home sensors and controllers
  - Industrial IoT sensors and controllers
- Interactive entertainment devices
  - Remote controls
  - Gaming controller
- Advanced computer peripherals and I/O devices
  - Mouse
  - Keyboard
  - Multi-touch trackpad

1.2. Features

- Bluetooth 5.1, IEEE 802.15.4, 2.4 GHz transceiver
    - -95 dBm sensitivity in 1 Mbps Bluetooth low energy (BLE) mode
    - -103 dBm sensitivity in 125 Kbps BLE mode (long range)
    - +8 dBm TX power (down to -20 dBm in 4 dB steps)
    - On-air compatible with nRF52, nRF51, nRF24L and nRF24AP Series
    - Programmable output power from +8dBm to -20dB
    - RSSI (1 dB resolution)
    - Supported data rates:
        - Bluetooth 5.1: 2 Mbps, 1 Mbps, 500 kbps, 125 kbps
        - IEEE 802.15.4-2006: 250 kbps
        - Proprietary 2.4 GHz: 2 Mbps, 1 Mbps
    - Angle-of-arrival (AoA) and angle-of-departure (AoD) direction finding using Bluetooth®.
- ARM Cortex –M4 32-bit processor with FPU, 64 MHz
- Memory: 256KB flash / 32KB RAM
- HW accelerated security
    - 128 bit AES / ECB / CCM / AAR co-processor (on-the-fly packet encryption)
- Advanced on-chip interfaces
    - USB 2.0 full speed (12 Mbps) controller
    - 8MHz SPI
    - Programmable peripheral interconnect (PPI)
    - 18 general purpose I/O pins
    - EasyDMA automated data transfer between memory and peripherals
- 4 X 32-bit timers with counter mode
- Up to 2 x SPI masters / 2 x SPI slaves with EasyDMA
- Up to 2 x I2C compatible 2-wire master / slave
- 1 x UART(CTS/RTS) with EasyDMA
- Quadrature decoder (QDEC)
- 2 x real-time counters (RTC)

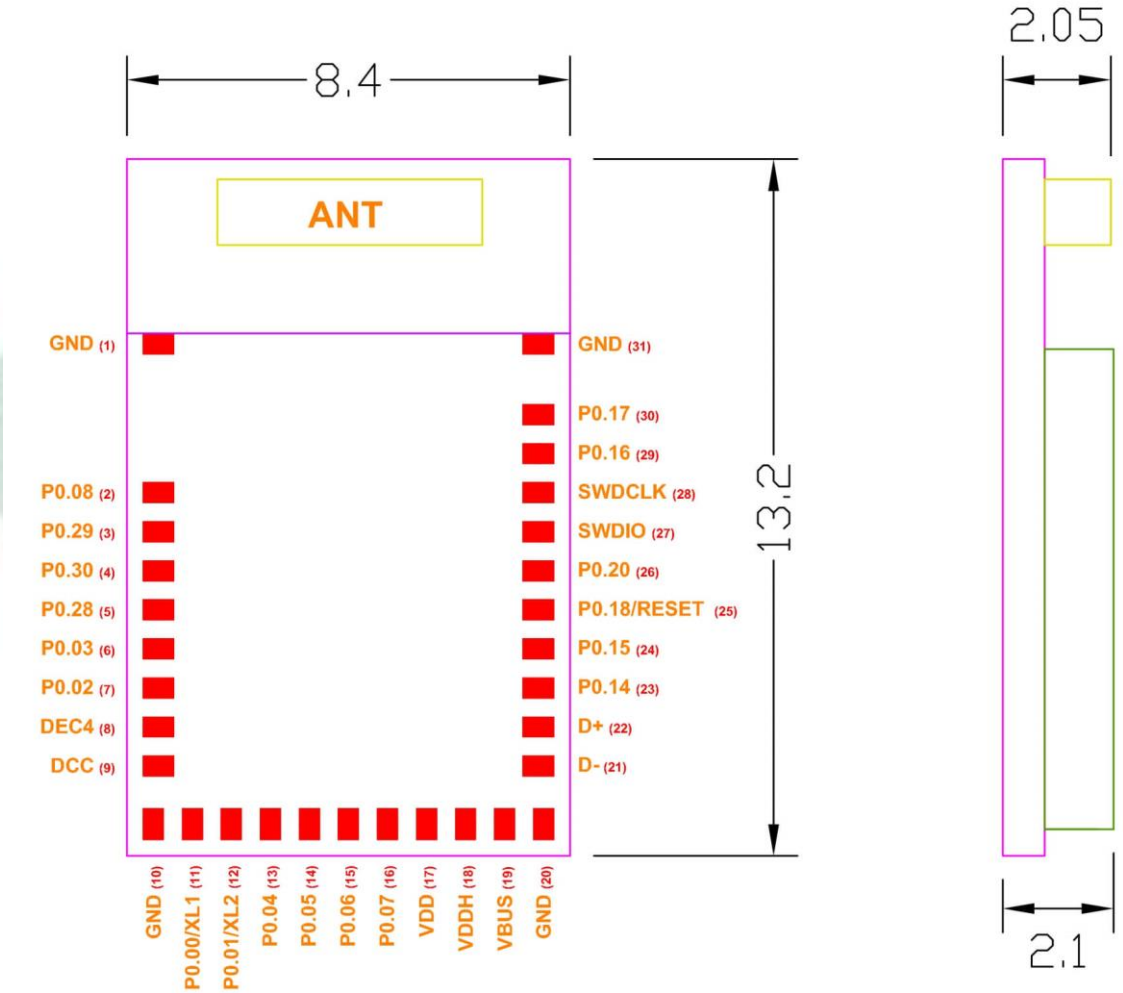
- Flexible power management
    - Supply voltage range 1.7V to 5.5V
    - On-chip DC/DC and LDO regulators with automated low current modes
    - Automated peripheral power management
    - Fast wake-up using 64MHz internal oscillator
    - 0.3uA at 3V in System OFF mode, no RAM retention
    - 1.2uA at 3V in System ON mode, no RAM retention, wake on RTC
- Nordic SoftDevice ready with support for concurrent multi-protocol
- Operating temperature from -40 to 105 °C

2. Product Dimension

2.1. PCB Dimensions & Pin Indication

- **MDBT50**

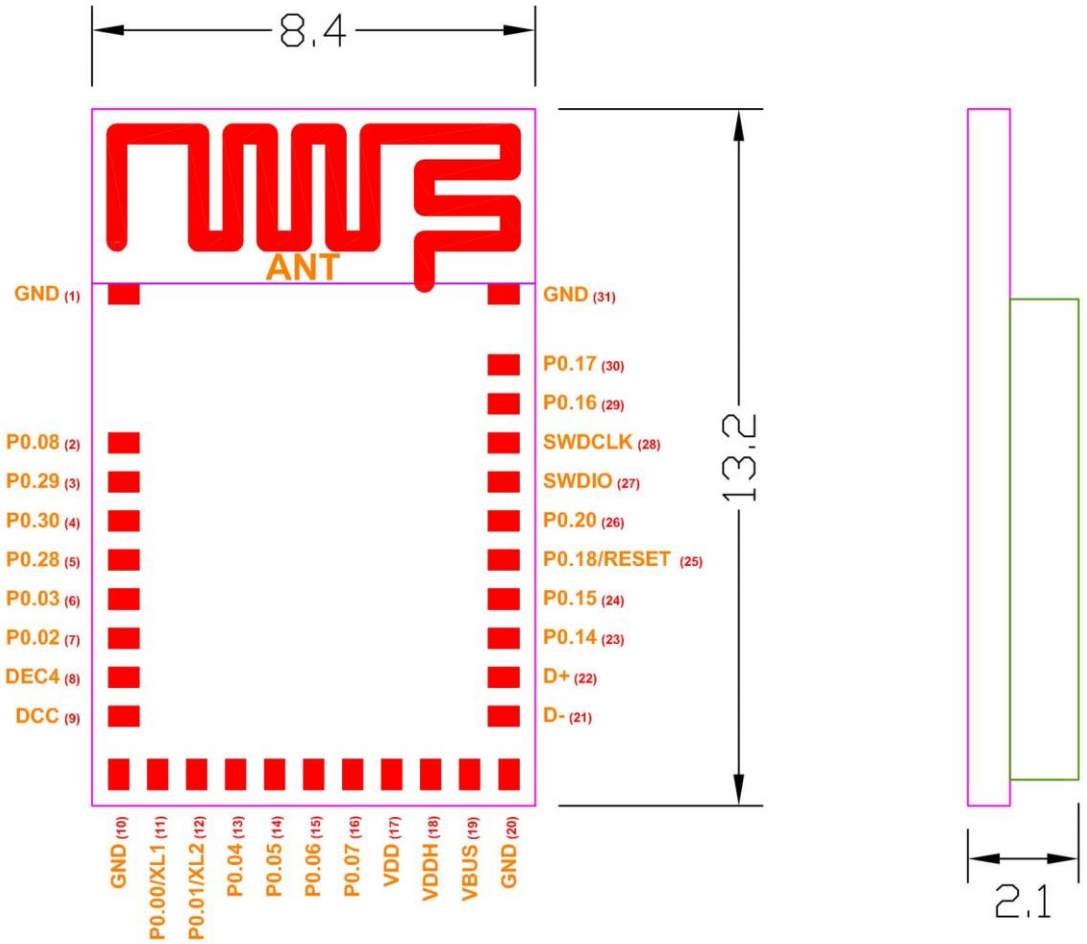
PCB Size (in mm)			
	Min.	Norm	MAX.
L		13.2	
W	- 0.15	8.4	+ 0.2
H		2.1	



Top (Unit: mm)

- **MDBT50-P**

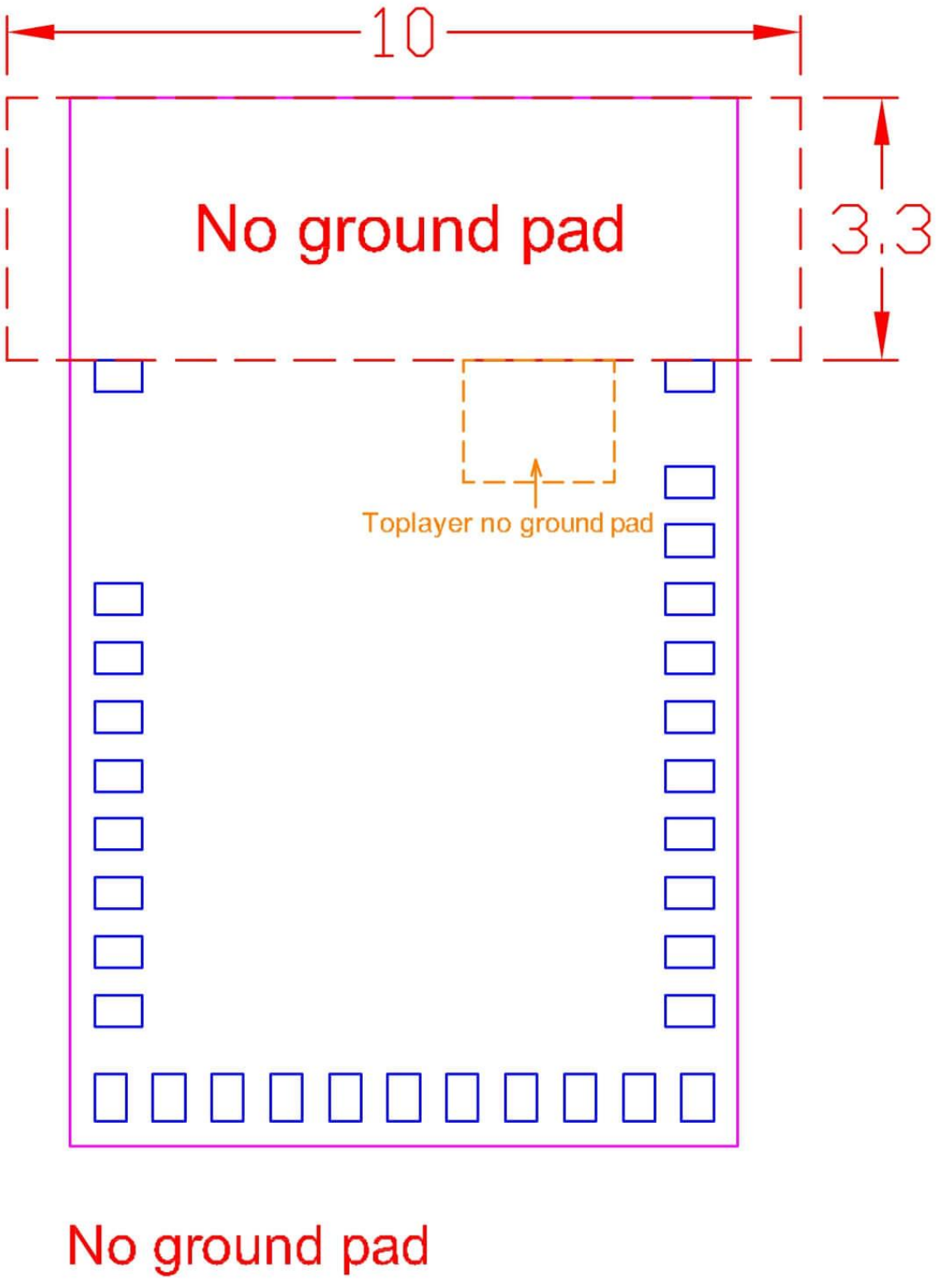
PCB Size (in mm)			
	Min.	Norm	MAX.
L		13.2	
W	- 0.15	8.4	+ 0.2
H		2.1	

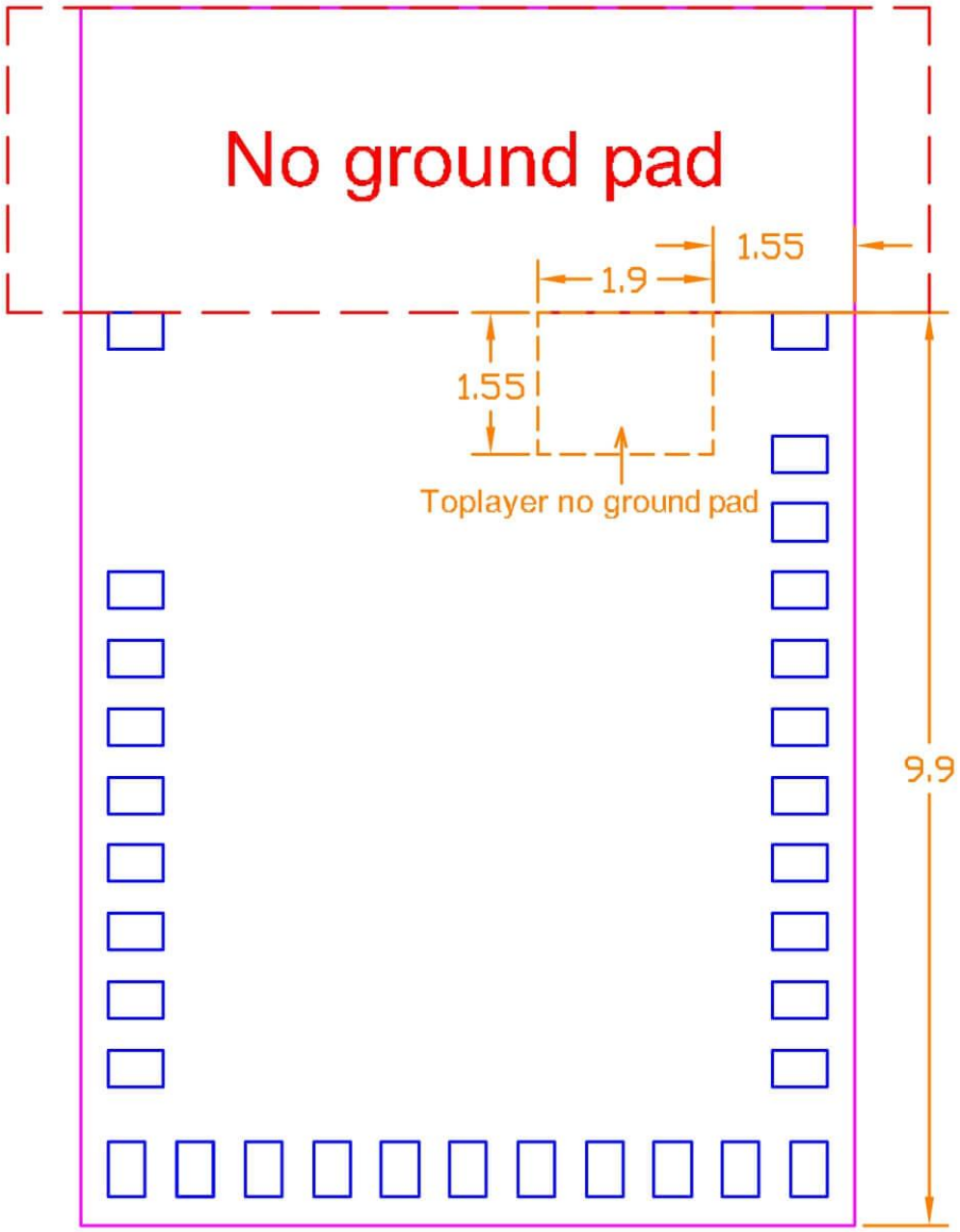


Top (Unit: mm)

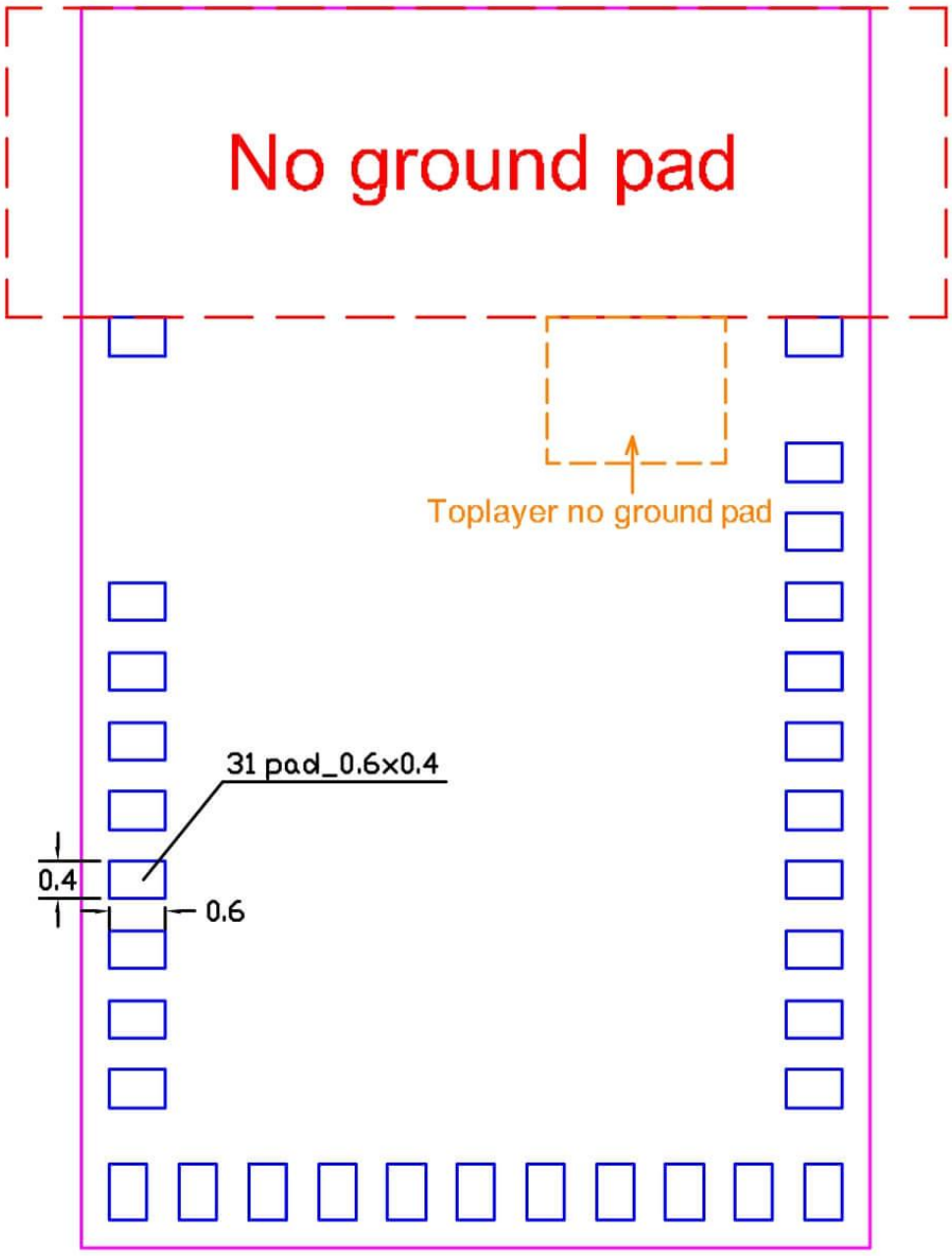
2.2. Recommended Layout of Solder Pad

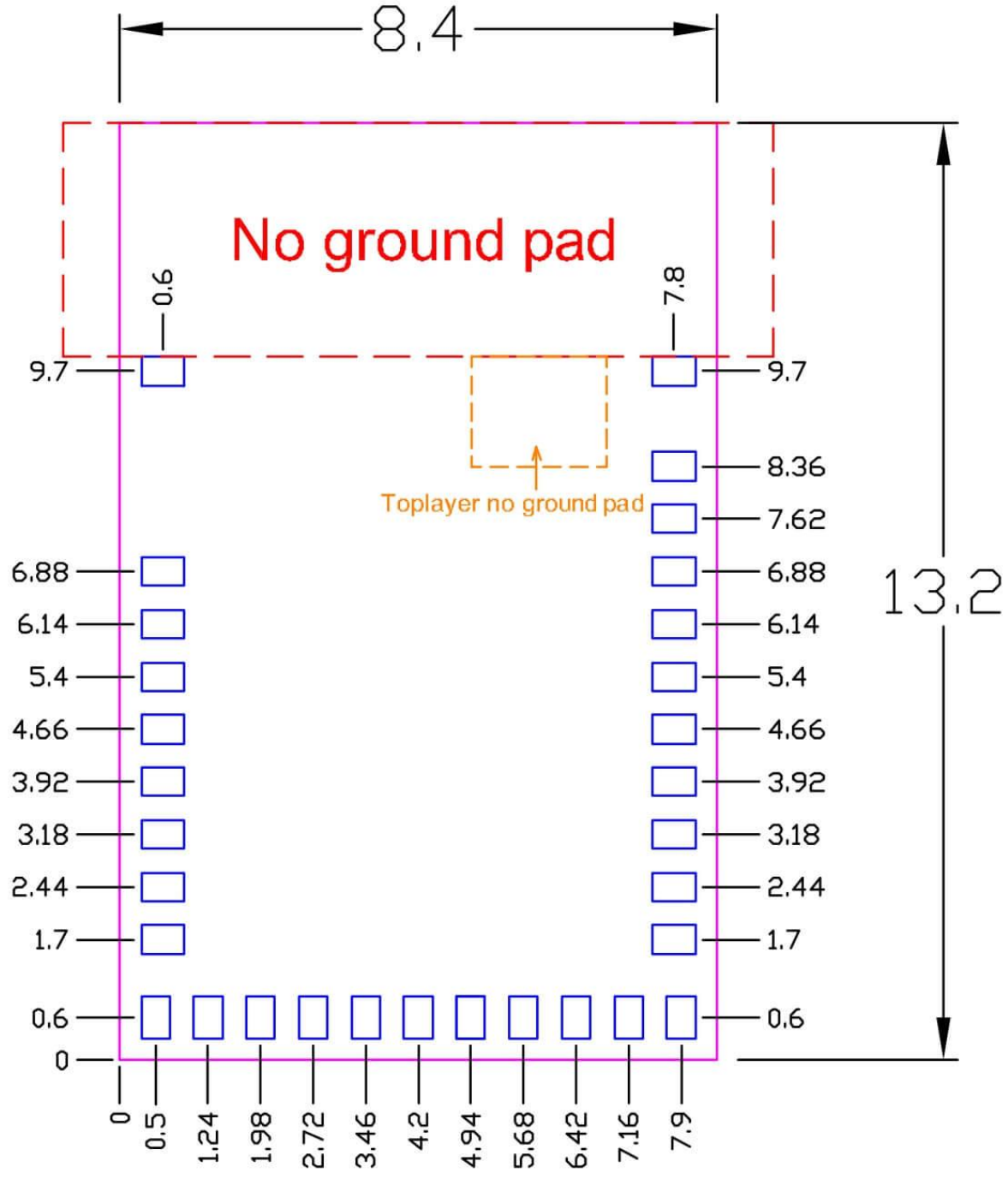
Graphs are all in Top View, Unit in mm.





Toplayer no ground pad


No ground pad
Toplayer no ground pad
31 pad_0.6x0.4
0.4
0.6



Top View (Unit ： mm)

recommended solder pad layout

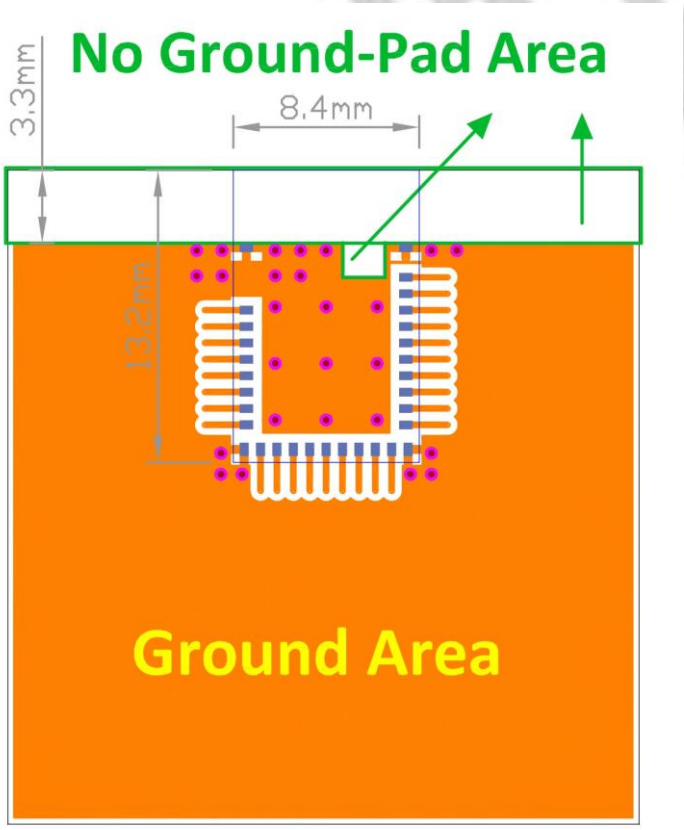
2.3. RF Layout Suggestion (aka Keep-Out Area)

Please follow below instruction to have better wireless performance. Make sure to keep the "No-Ground-Pad" as wider as you can when there is not enough space in your design.

No Ground Pad should be included in the corresponding position of the antenna in **EACH LAYER**.

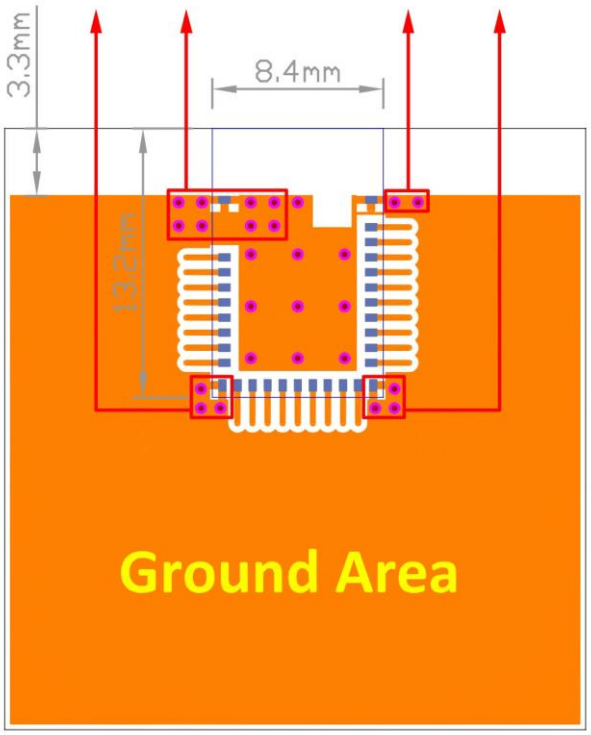
Place the module towards the edge of PCB to have better performance than placing it on the center.

Welcome to send us your layout in PDF for review at service@raytac.com or your contact at Raytac with title "Layout reviewing – Raytac Model No. – YOUR company's name".

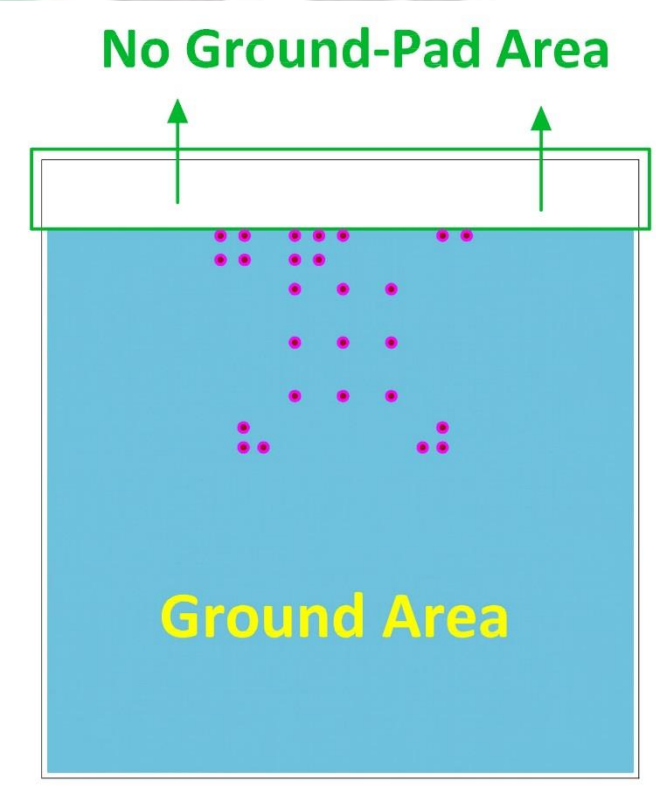


Top layer

Please add via holes in GROUND area as many as possible, especially around the four corners.

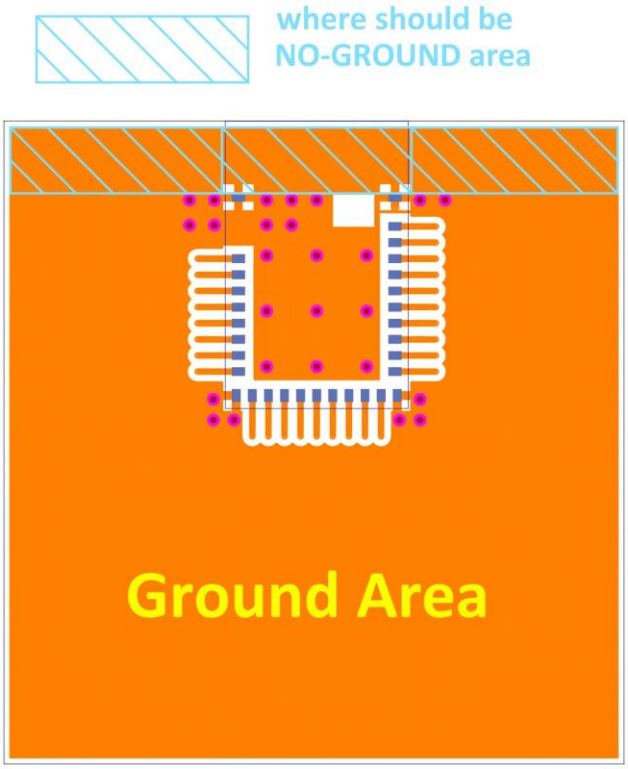


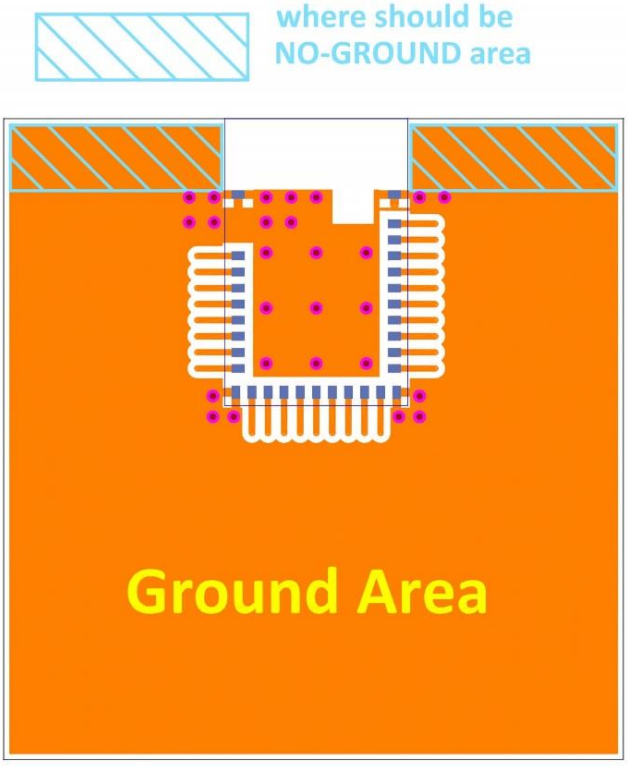
Top layer



Bottom layer

Examples of “**NOT RECOMMENDED**” layout





2.4. Footprint & Design Guide

Please visit “Support” page of our website to download. The package includes footprint, 2D/3D drawing, reflow graph/solder profile and recommended spec for external 32.768khz.

2.5. Pin Assignment

Pin No.	Name	Pin function	Description
(1)	GND	Power	Ground
(2)	P0.08	Digital I/O	General-purpose I/O (standard drive, low frequency I/O only)
(3)	P0.29	Digital I/O	General-purpose I/O (standard drive, low frequency I/O only)
(4)	P0.30	Digital I/O	General-purpose I/O (standard drive, low frequency I/O only)
(5)	P0.28	Digital I/O	General-purpose I/O (standard drive, low frequency I/O only)
(6)	P0.03	Digital I/O	General-purpose I/O (standard drive, low frequency I/O only)
	AIN1	Analog input	Analog input
(7)	P0.02	Digital I/O	General-purpose I/O
	AIN0	Analog input	Analog input
(8)	DEC4	Power	1.3V regulator supply decoupling
(9)	DCC	Power	DC/DC converter output
(10)	GND	Power	Ground
(11)	P0.00	Digital I/O	General-purpose I/O
	XL1	Analog input	Connection for 32.768 kHz crystal
(12)	P0.01	Digital I/O	General-purpose I/O
	XL2	Analog input	Connection for 32.768 kHz crystal
(13)	P0.04	Digital I/O	General-purpose I/O
	AIN2	Analog input	Analog input
(14)	P0.05	Digital I/O	General-purpose I/O
	AIN3	Analog input	Analog input
(15)	P0.06	Digital I/O	General-purpose I/O
(16)	P0.07	Digital I/O	General-purpose I/O
(17)	VDD	Power	Power supply
(18)	VDDH	Power	High voltage power supply

Pin No.	Name	Pin Function	Description
(19)	VBUS	Power	5V input for USB 3.3V regulator
(20)	GND	Power	Ground
(21)	D–	Digital I/O	USB D-
(22)	D+	Digital I/O	USB D+
(23)	P0.14	Digital I/O	General-purpose I/O
(24)	P0.15	Digital I/O	General-purpose I/O
(25)	P0.18	Digital I/O	General-purpose I/O
	nRESET		Configurable as system RESET
(26)	P0.20	Digital I/O	General-purpose I/O
(27)	SWDIO	Debug	Debug serial debug I/O for debug and programming
(28)	SWDCLK	Debug	Debug serial debug clock input for debug and programming
(29)	P0.16	Digital I/O	General-purpose I/O (standard drive, low frequency I/O only)
(30)	P0.17	Digital I/O	General-purpose I/O (standard drive, low frequency I/O only)
(31)	GND	Power	Ground

3. Main Chip Solution

RF IC	Crystal Frequency
Nordic NRF52820/52833	32MHZ

32MHz crystal is already inside the module.

4. Specification

Any technical spec shall refer to Nordic's official documents as final reference.

4.1. Absolute Maximum Ratings

	Note	Min.	Max.	Unit
Supply voltages				
VDD		-0.3	+3.9	V
VDDH		-0.3	+5.8	V
VBUS		-0.3	+5.8	V
VSS			0	V
I/O pin voltage				
$V_{I/O}$, VDD ≤3.6 V		-0.3	VDD + 0.3	V
$V_{I/O}$, VDD >3.6 V		-0.3	3.9	V
Environmental QFN40 package				
Storage temperature		-40	+125	°C
MSL	Moisture Sensitivity Level		2	
ESD HBM	Human Body Model		3	kV
ESD HBM Class	Human Body Model Class		2	
ESD CDM	Charged Device Model		1	kV
Flash memory				
Endurance		10 000		write/erase cycles
Retention at 85 °C		10		years
Retention at 105 °C	Limited to 1000 write/erase cycles	3		years
Retention at 105 °C-85 °C, execution split	Limited to 1000 write/erase cycles 75% execution time at 85 °C or less	6.7		years

4.2. Operating Conditions

Symbol	Parameter	Min.	Nom.	Max.	Units
VDD	VDD supply voltage, independent of DCDC enable	1.7	3.0	3.6	V
VDD_{POR}	VDD supply voltage needed during power-on reset	1.75			V
VDDH	VDDH supply voltage	2.5	3.7	5.5	V
VBUS	VBUS USB supply voltage	4.35	5.0	5.5	V
t_{R_VDD}	Supply rise time (0 V to 1.7 V)			60	ms
t_{R_VDDH}	Supply rise time (0 V to 3.7 V)			100	ms
TA	Operating temperature	-40	25	85	°C
TA_{EXT}	Extended operating temperature	85		105	°C
T_J	Junction temperature			110	°C

4.3. Electrical Specifications

4.3.1. General Radio Characteristics

Symbol	Description	Min.	Typ.	Max.	Units
f_{OP}	Operating frequencies	2360		2500	MHz
$f_{PLL,CH,SP}$	PLL channel spacing		1		MHz
$f_{DELTA,1M}$	Frequency deviation @ 1 Mbps		±170		kHz
$f_{DELTA,BLE,1M}$	Frequency deviation @ BLE 1 Mbps		±250		kHz
$f_{DELTA,2M}$	Frequency deviation @ 2 Mbps		±320		kHz
$f_{DELTA,BLE,2M}$	Frequency deviation @ BLE 2 Mbps		±500		kHz
fsk_{BPS}	On-the-air data rate	125		2000	kbps
$f_{chip,\ IEEE\ 802.15.4}$	Chip rate in IEEE 802.15.4 mode		2000		kchips

4.3.2. Radio Current Consumption (Transmitter)

Symbol	Description	Min.	Typ.	Max.	Units
$I_{TX,PLUS8dBM,DCDC}$	TX only run current (DC/DC, 3 V) P_{RF} = +8 dBm		14.0		mA
$I_{TX,PLUS8dBM}$	TX only run current P_{RF} = +8 dBm		30.0		mA
$I_{TX,PLUS4dBM,DCDC}$	TX only run current (DC/DC, 3 V) P_{RF} = +4 dBm		9.4		mA
$I_{TX,PLUS4dBM}$	TX only run current P_{RF} = +4 dBm		20.4		mA
$I_{TX,0dBM,DCDC}$	TX only run current (DC/DC, 3 V)P_{RF} = 0 dBm		4.9		mA
$I_{TX,0dBM}$	TX only run current P_{RF} = 0 dBm		10.4		mA
$I_{TX,MINUS4dBM,DCDC}$	TX only run current DC/DC, 3 V P_{RF} = -4 dBm		3.8		mA
$I_{TX,MINUS4dBM}$	TX only run current P_{RF} = -4 dBm		8.1		mA
$I_{TX,MINUS8dBM,DCDC}$	TX only run current DC/DC, 3 V P_{RF} = -8 dBm		3.4		mA
$I_{TX,MINUS8dBM}$	TX only run current P_{RF} = -8 dBm		7.1		mA
$I_{TX,MINUS12dBM,DCDC}$	TX only run current DC/DC, 3 V P_{RF} = -12 dBm		3.1		mA
$I_{TX,MINUS12dBM}$	TX only run current P_{RF} = -12 dBm		6.4		mA
$I_{TX,MINUS16dBM,DCDC}$	TX only run current DC/DC, 3 V P_{RF} = -16 dBm		2.9		mA
$I_{TX,MINUS16dBM}$	TX only run current P_{RF} = -16 dBm		6.0		mA
$I_{TX,MINUS20dBM,DCDC}$	TX only run current DC/DC, 3 V P_{RF} = -20 dBm		2.7		mA
$I_{TX,MINUS20dBM}$	TX only run current P_{RF} = -20 dBm		5.6		mA
$I_{TX,MINUS40dBM,DCDC}$	TX only run current DC/DC, 3 V P_{RF} = -40 dBm		2.3		mA
$I_{TX,MINUS40dBM}$	TX only run current P_{RF} = -40 dBm		4.6		mA
$I_{START,TX,DCDC}$	TX start-up current DC/DC, 3 V, P_{RF} = 4 dBm		4.2		mA
$I_{START,TX}$	TX start-up current, P_{RF} = 4 dBm		8.8		mA

4.3.3. Radio Current Consumption (Receiver)

Symbol	Description	Min.	Typ.	Max.	Units
$I_{RX,1M,DCDC}$	RX only run current (DC/DC, 3 V) 1 Mbps/1 Mbps BLE		4.7		mA
$I_{RX,1M}$	RX only run current (LDO, 3 V) 1 Mbps/1 Mbps BLE		9.8		mA
$I_{RX,2M,DCDC}$	RX only run current (DC/DC, 3 V) 2 Mbps/2 Mbps BLE		5.2		mA
$I_{RX,2M}$	RX only run current (LDO, 3 V) 2 Mbps/2 Mbps BLE		10.9		mA
$I_{START,RX,1M,DCDC}$	RX start-up current (DC/DC, 3 V) 1 Mbps/1 Mbps BLE		3.4		mA
$I_{START,RX,1M}$	RX start-up current 1 Mbps/1 Mbps BLE		6.8		mA

4.3.4. Transmitter Specification

Symbol	Description	Min.	Typ.	Max.	Units
P_{RF}	Maximum output power		8		dBm
P_{RFC}	RF power control range		28		dB
P_{RFCR}	RF power accuracy			±4	dB
$P_{RF1,1}$	1st Adjacent Channel Transmit Power 1 MHz (1 Mbps)		-25		dBc
$P_{RF2,1}$	2nd Adjacent Channel Transmit Power 2 MHz (1 Mbps)		-54		dBc
$P_{RF1,2}$	1st Adjacent Channel Transmit Power 2 MHz (2 Mbps)		-26		dBc
$P_{RF2,2}$	2nd Adjacent Channel Transmit Power 4 MHz (2 Mbps)		-54		dBc
E_{vm}	Error vector magnitude in IEEE 802.15.4 mode (Offset EVM)		2		%rms
$P_{harm2nd,\ IEEE\ 802.15.4}$	2nd harmonics in IEEE 802.15.4 mode		-49		dBm
$P_{harm3rd,\ IEEE\ 802.15.4}$	3rd harmonics in IEEE 802.15.4 mode		-54		dBm

4.3.5. RSSI Specifications

Symbol	Description	Min.	Typ.	Max.	Units
$RSSI_{ACC}$	RSSI accuracy valid range -90 to -30 dBm		±2		dB
$RSSI_{RESOLUTION}$	RSSI resolution		1		dB
$RSSI_{PERIOD}$	RSSI sampling time from RSSI_START task		0.25		µs
$RSSI_{SETTLE}$	RSSI settling time after signal level change		15		µs

4.3.6. Receiver Operation

Symbol	Description	Min.	Typ.	Max.	Units
$P_{RX,MAX}$	Maximum received signal strength at < 0.1% PER		0		dBm
$P_{SENS,IT,1M}$	Sensitivity, 1 Mbps nRF mode ideal transmitter [1]		-92		dBm
$P_{SENS,IT,2M}$	Sensitivity, 2 Mbps nRF mode ideal transmitter [1]		-89		dBm
$P_{SENS,IT,SP,1M,BLE}$	Sensitivity, 1 Mbps BLE ideal transmitter, packet length ≤ 37 bytes BER=1E-3 [2]		-95		dBm
$P_{SENS,IT,LP,1M,BLE}$	Sensitivity, 1 Mbps BLE ideal transmitter, packet length ≥ 128 bytes BER=1E-4 [3]		-94		dBm
$P_{SENS,IT,SP,2M,BLE}$	Sensitivity, 2 Mbps BLE ideal transmitter, packet length ≤ 37 bytes		-92		dBm
$P_{SENS,IT,BLE\ LE125k}$	Sensitivity, 125 kbps BLE mode		-103		dBm
$P_{SENS,IT,BLE\ LE500k}$	Sensitivity, 500 kbps BLE mode		-98		dBm
$P_{SENS,IEEE\ 802.15.4}$	Sensitivity in IEEE 802.15.4 mode		-99		dBm

Remark:
1. Typical sensitivity applies when ADDR0 is used for receiver address correlation. When ADDR[1...7] are used for receiver address correlation, the typical sensitivity for this mode is degraded by 3 dB.
2. As defined in the Bluetooth Core Specification v4.0 Volume 6: Core System Package (Low Energy Controller Volume).
3. Equivalent BER limit < 10E-04.

4.3.7. RX Selectivity

Symbol	Description	Min.	Typ.	Max.	Units
$C/I_{1M,co\text{-}channel}$	1Mbps mode, co-channel interference		10		dB
$C/I_{1M,-1MHz}$	1 Mbps mode, Adjacent (-1 MHz) interference		-5		dB
$C/I_{1M,+1MHz}$	1 Mbps mode, Adjacent (+1 MHz) interference		-14		dB
$C/I_{1M,-2MHz}$	1 Mbps mode, Adjacent (-2 MHz) interference		-25		dB
$C/I_{1M,+2MHz}$	1 Mbps mode, Adjacent (+2 MHz) interference		-45		dB
$C/I_{1M,-3MHz}$	1 Mbps mode, Adjacent (-3 MHz) interference		-40		dB
$C/I_{1M,+3MHz}$	1 Mbps mode, Adjacent (+3 MHz) interference		-46		dB
$C/I_{1M,\pm6MHz}$	1 Mbps mode, Adjacent (≥6 MHz) interference		-52		dB
$C/I_{1MBLE,co\text{-}channel}$	1 Mbps BLE mode, co-channel interference		6		dB
$C/I_{1MBLE,-1MHz}$	1 Mbps BLE mode, Adjacent (-1 MHz) interference		-2		dB
$C/I_{1MBLE,+1MHz}$	1 Mbps BLE mode, Adjacent (+1 MHz) interference		-10		dB
$C/I_{1MBLE,-2MHz}$	1 Mbps BLE mode, Adjacent (-2 MHz) interference		-28		dB
$C/I_{1MBLE,+2MHz}$	1 Mbps BLE mode, Adjacent (+2 MHz) interference		-45		dB
$C/I_{1MBLE,>3MHz}$	1 Mbps BLE mode, Adjacent (≥3 MHz) interference		-54		dB
$C/I_{1MBLE,image}$	Image frequency interference		-28		dB
$C/I_{1MBLE,image,1MHz}$	Adjacent (1 MHz) interference to in-band image frequency		-37		dB

Symbol	Description	Min.	Typ.	Max.	Units
$C/I_{2M,co\text{-}channel}$	2 Mbps mode, co-channel interference		10		dB
$C/I_{2M,-2MHz}$	2 Mbps mode, Adjacent (-2 MHz) interference		-4		dB
$C/I_{2M,+2MHz}$	2 Mbps mode, Adjacent (+2 MHz) interference		-16		dB
$C/I_{2M,-4MHz}$	2 Mbps mode, Adjacent (-4 MHz) interference		-22		dB
$C/I_{2M,+4MHz}$	2 Mbps mode, Adjacent (+4 MHz) interference		-46		dB
$C/I_{2M,-6MHz}$	2 Mbps mode, Adjacent (-6 MHz) interference		-39		dB
$C/I_{2M,+6MHz}$	2 Mbps mode, Adjacent (+6 MHz) interference		-48		dB
$C/I_{2M,\geq 12MHz}$	2 Mbps mode, Adjacent (≥12 MHz) interference		-52		dB
$C/I_{2MBLE,co\text{-}channel}$	2 Mbps BLE mode, co-channel interference		7		dB
$C/I_{2MBLE,-2MHz}$	2 Mbps BLE mode, Adjacent (-2 MHz) interference		-2		dB
$C/I_{2MBLE,+2MHz}$	2 Mbps BLE mode, Adjacent (+2 MHz) interference		-12		dB
$C/I_{2MBLE,-4MHz}$	2 Mbps BLE mode, Adjacent (-4 MHz) interference		-25		dB
$C/I_{2MBLE,+4MHz}$	2 Mbps BLE mode, Adjacent (+4 MHz) interference		-46		dB
$C/I_{2MBLE,\geq 6MHz}$	2 Mbps BLE mode, Adjacent (≥6 MHz) interference		-54		dB
$C/I_{2MBLE,image}$	Image frequency interference		-25		dB
$C/I_{2MBLE,image,\ 2MHz}$	Adjacent (2 MHz) interference to in-band image frequency		-37		dB
$C/I_{125k\ BLE\ LR,co\text{-}channel}$	125 kbps BLE LR mode, co-channel interference		3		dB
$C/I_{125k\ BLE\ LR,-1MHz}$	125 kbps BLE LR mode, Adjacent (-1 MHz) interference		-9		dB
$C/I_{125k\ BLE\ LR,+1MHz}$	125 kbps BLE LR mode, Adjacent (+1 MHz) interference		-16		dB
$C/I_{125k\ BLE\ LR,-2MHz}$	125 kbps BLE LR mode, Adjacent (-2 MHz) interference		-28		dB
$C/I_{125k\ BLE\ LR,+2MHz}$	125 kbps BLE LR mode, Adjacent (+2 MHz) interference		-54		dB
$C/I_{125k\ BLE\ LR,>3MHz}$	125 kbps BLE LR mode, Adjacent (≥3 MHz) interference		-60		dB
$C/I_{125k\ BLE\ LR,image}$	Image frequency interference		-28		dB
$C/I_{IEEE\ 802.15.4,-5MHz}$	IEEE 802.15.4 mode, Adjacent (-5 MHz) rejection		-33		dB
$C/I_{IEEE\ 802.15.4,+5MHz}$	IEEE 802.15.4 mode, Adjacent (+5 MHz) rejection		-38		dB
$C/I_{IEEE\ 802.15.4,\pm 10MHz}$	IEEE 802.15.4 mode, Alternate (±10 MHz) rejection		-49		dB

Desired signal level at PIN = -67 dBm. One interferer is used, having equal modulation as the desired signal. The input power of the interferer where the sensitivity equals BER = 0.1% is presented.

4.3.8. RX Intermodulation

Symbol	Description	Min.	Typ.	Max.	Units
$P_{IMD,5TH,1M}$	IMD performance, 1 Mbps, 5th offset channel, packet length ≤ 37 bytes		-34		dBm
$P_{IMD,5TH,1M,BLE}$	IMD performance, BLE 1 Mbps, 5th offset channel, packet length ≤ 37 bytes		-32		dBm
$P_{IMD,5TH,2M}$	IMD performance, 2 Mbps, 5th offset channel, packet length ≤ 37 bytes		-33		dBm
$P_{IMD,5TH,2M,BLE}$	IMD performance, BLE 2 Mbps, 5th offset channel, packet length ≤ 37 bytes		-32		dBm

Remark: Desired signal level at PIN = -64 dBm. Two interferers with equal input power are used. The interferer closest in frequency is not modulated, the other interferer is modulated equal with the desired signal. The input power of the interferers where the sensitivity equals BER = 0.1% is presented.

4.3.9. Radio Timing Parameters

Symbol	Description	Min.	Typ.	Max.	Units
$t_{TXEN,BLE,1M}$	Time between TXEN task and READY event after channel FREQUENCY configured (1 Mbps BLE and 150 µs TIFS)		140		µs
$t_{TXEN,FAST,BLE,1M}$	Time between TXEN task and READY event after channel FREQUENCY configured (1 Mbps BLE with fast ramp-up and 150 µs TIFS)		40		µs
$t_{TXDIS,BLE,1M}$	When in TX, delay between DISABLE task and DISABLED event for MODE = Nrf_1Mbit and MODE = Ble_1Mbit		6		µs
$t_{RXEN,BLE,1M}$	Time between the RXEN task and READY event after channel FREQUENCY configured (1 Mbps BLE)		140		µs
$t_{RXEN,FAST,BLE,1M}$	Time between the RXEN task and READY event after channel FREQUENCY configured (1 Mbps BLE with fast ramp-up)		40		µs
$t_{RXDIS,BLE,1M}$	When in RX, delay between DISABLE task and DISABLED event for MODE = Nrf_1Mbit and MODE = Ble_1Mbit		0		µs
$t_{TXDIS,BLE,2M}$	When in TX, delay between DISABLE task and DISABLED event for MODE = Nrf_2Mbit and MODE = Ble_2Mbit		4		µs
$t_{RXDIS,BLE,2M}$	When in RX, delay between DISABLE task and DISABLED event for MODE = Nrf_2Mbit and MODE = Ble_2Mbit		0		µs
$t_{TXEN,IEEE\ 802.15.4}$	Time between TXEN task and READY event after channel FREQUENCY configured (IEEE 802.15.4 mode)		130		µs
$t_{TXEN,FAST,IEEE\ 802.15.4}$	Time between TXEN task and READY event after channel FREQUENCY configured (IEEE 802.15.4 mode with fast ramp- up)		40		µs
$t_{TXDIS,IEEE\ 802.15.4}$	When in TX, delay between DISABLE task and DISABLED event (IEEE 802.15.4 mode)		21		µs
$t_{RXEN,IEEE\ 802.15.4}$	Time between the RXEN task and READY event after channel FREQUENCY configured (IEEE 802.15.4 mode)		130		µs
$t_{RXEN,FAST,IEEE\ 802.15.4}$	Time between the RXEN task and READY event after channel FREQUENCY configured (IEEE 802.15.4 mode with fast ramp-up)		40		µs
$t_{RXDIS,IEEE\ 802.15.4}$	When in RX, delay between DISABLE task and DISABLED event (IEEE 802.15.4 mode)		0.5		µs
$t_{RX\text{-}to\text{-}TX\ turnaround}$	Maximum TX-to-RX or RX-to-TX turnaround time in IEEE 802.15.4 mode		40		µs

4.3.10. CPU

Symbol	Description	Min.	Typ.	Max.	Units
W_{FLASH}	CPU wait states, running CoreMark from flash			2	
W_{RAM}	CPU wait states, running CoreMark from RAM			0	
CM_{FLASH}	CoreMark, running CoreMark from flash		144		CoreMark
$CM_{FLASH/MHz}$	CoreMark per MHz, running CoreMark from flash		2.3		CoreMark/MHz
$CM_{FLASH/mA}$	CoreMark per mA, running CoreMark from flash, DCDC 3V		68.6		CoreMark/mA

4.3.11. Power Management

Symbol	Description	Min.	Typ.	Max.	Units
$I_{ON\_RAMOFF\_EVENT}$	System ON, no RAM retention, wake on any event		0.4		µA
$I_{ON\_RAMON\_EVENT}$	System ON, full 32 kB RAM retention, wake on any event		0.6		µA
$I_{ON\_RAMON\_POF}$	System ON, full 32 kB RAM retention, wake on any event, power-fail comparator enabled		0.8		µA
$I_{ON\_RAMON\_GPIOTE}$	System ON, full 32 kB RAM retention, wake on GPIOTE input (event mode)		2.5		µA
$I_{ON\_RAMON\_GPIOTEPORT}$	System ON, full 32 kB RAM retention, wake on GPIOTE PORT event		0.6		µA
$I_{ON\_RAMOFF\_RTC}$	System ON, no RAM retention, wake on RTC (running from LFRC clock)		1.2		µA
$I_{ON\_RAMON\_RTC}$	System ON, full 32 kB RAM retention, wake on RTC (running from LFRC clock)		1.4		µA
$I_{OFF\_RAMOFF\_RESET}$	System OFF, no RAM retention, wake on reset		0.3		µA
$I_{OFF\_RAMON\_RESET}$	System OFF, full 32 kB RAM retention, wake on reset		0.5		µA
$I_{ON\_RAMOFF\_EVENT\_5V}$	System ON, no RAM retention, wake on any event, 5 V supply on VDDH, REG0 output = 3.3 V		0.9		µA
$I_{OFF\_RAMOFF\_RESET\_5V}$	System OFF, no RAM retention, wake on reset, 5 V supply on VDDH, REG0 output = 3.3 V		0.7		µA

5. FCC Compliance

This equipment has been tested and found to comply with the limits for a Class digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to the radio communications. However, there are no guarantees that interference will not occur in a particular installation.

Troubleshooting

If this equipment does cause harmful interference to radio reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one or more of the following instructions.

・Reorient or relocate the receiving antenna.
・Increase the separation between the equipment and receiver.
・Consult dealer or an experienced radio technician.

Conditions

Operation is subject to the following conditions

・This device may not cause harmful interference.
・This device must accept any interference received, including interference that may cause undesired operation.

FCC Caution

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any changes or modifications not expressly approved by the party responsible for compliance could void the authority to operate equipment.

RF Exposure

FCC RF Radiation Exposure Statement:

1. This Transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.
2. For body worn operation, this device has been tested and meets FCC RF exposure guidelines. When used with an accessory that contains metal may not ensure compliance with FCC RF exposure guidelines.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1) this device may not cause harmful interference and
2) this device must accept any interference received, including interference that may cause undesired operation.

Required End Product Labeling

Any device incorporating this module must include an external, visible, permanent marking or label which states: “Contains FCC ID: SH6MDBT50”

Applicable FCC Rules

This module has been tested and found to comply with the following requirements for Modular Approval.

- Part 15.247 - Operation within the bands 902-928 MHz, 2400-2483.5 MHz, and 5725-5850 MHz.

Additional testing, Part 15 Subpart B disclaimer

The modular transmitter is only FCC authorized for the specific rule parts (i.e., FCC transmitter rules) listed on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

The final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Test Modes

This device uses various test mode programs for test set up which operate separate from production firmware. Host integrators should contact the grantee for assistance with test modes needed for module/host compliance test requirements.

Antennas

The following external antenna type have been approved for use with this module.

Radio	Model	Antenna Type	Freq. (MHz)	Max. Peak Antenna Gain (dBi)
BLE	MDBT50	Chip	2402-2480	-3.05
BLE	MDBT50-P	PCB	2402-2480	-3.24

In the end product, the antenna(s) used with this transmitter must be installed and must not be co-located or operation in conjunction with any other antenna or transmitter except in

accordance with FCC multi-transmitter product procedures.

End Product Labeling

This transmitter module is authorized only for use in device where the antenna may be installed such that 5mm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following:

Contains FCC ID: SH6MDBT50

Manual Information to the End User

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warming as shown in this manual.

6. IC Caution

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

1. *This device may not cause interference.*
2. *This device must accept any interference, including interference that may cause undesired operation of the device.*

Avis Canadien

L'émetteur/récepteur exempt de licence contenu dans le présent appareil est conforme aux CNR d'Innovation, Sciences et Développement économique 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;*
2. *L'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.*

RF Radiation Exposure Statement:

1. To comply with the Canadian RF exposure compliance requirements, this device and its antenna must not be co-located or operating in conjunction with any other antenna or transmitter.

2. For body worn operation, this phone has been tested and meets RF exposure guidelines when used with an accessory that contains no metal. Use of other accessories may not ensure compliance with RF exposure guidelines.

Déclaration de l'exposition aux radiations RF:

1. Pour se conformer aux exigences de conformité RF canadienne l'exposition, cet appareil et son antenne ne doivent pas être co-localisés ou fonctionnant en conjonction avec une autre antenne ou transmetteur.
2. Pour le fonctionnement du corps, ce téléphone a été testé et répond aux directives d'exposition RF lorsqu'il est utilisé avec un accessoire qui ne contient pas de métal. Utilisation d'autres accessoires peut ne pas assurer le respect des directives d'exposition RF.

Required End Product Labeling

Any device incorporating this module must include an external, visible, permanent marking or label which states: "Contains IC : 8017A-MDBT50"

Obligation d'étiquetage du produit final:

Tout dispositif intégrant ce module doit comporter un externe, visible, marquage permanent ou une étiquette qui dit: "Contient IC : 8017A-MDBT50"

Antennas

This radio transmitter has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Antennes

Cet émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci-dessous avec le gain maximal admissible indiqué . types d'antennes non inclus dans cette liste , ayant un gain supérieur au gain maximum indiqué pour ce type , sont strictement interdits pour une utilisation avec cet appareil.

Radio	ISED HVIN	Antenna Type	Freq. (MHz)	Max. Peak Antenna Gain (dBi)
BLE	MDBT50	Chip	2402-2480	-3.05
BLE	MDBT50-P	PCB	2402-2480	-3.24

7. NCC 警語

根據 NCC 低功率電波輻射性電機管理辦法規定

LP0002 低功率射頻器材技術規範_章節 3.8.2

取得審驗證明之低功率射頻器材，非經核准，公司、商號或使用者均不得擅自變更頻率、加大功率或變更原設計之特性及功能。

低功率射頻器材之使用不得影響飛航安全及干擾合法通信;經發現有干擾現象時,應立即停用，並改善至無干擾時方得繼續使用。

前述合法通信，指依電信管理法規定作業之無線電通信。

低功率射頻器材須忍受合法通信或工業、科學及醫療用電波輻射性電機設備之干擾。

此模組於取得認證後將依規定於模組本體標示審驗合格標籤，並要求平台廠商於平台上標示。

「本產品內含射頻模組：ID 編號 XXXXX」字樣