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Version: A
Issued Date: 2020/09/01

Approval Sheet

(產品承認書)

產品名稱 (Product): Bluetooth Low Energy Module

解決方案 (Solution): Nordic nRF52820 QFN Package

產品型號 (Model No.): **MDBT50 – 256R** (Chip Antenna)

MDBT50 – P256R (PCB Antenna)

Index

1. Overall Introduction

Raytac's MDBT50-256R & MDBT50-P256R is a BT 5.0 & BT 5.1 stack (Bluetooth low energy or BLE) module designed based on **Nordic nRF52820 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)

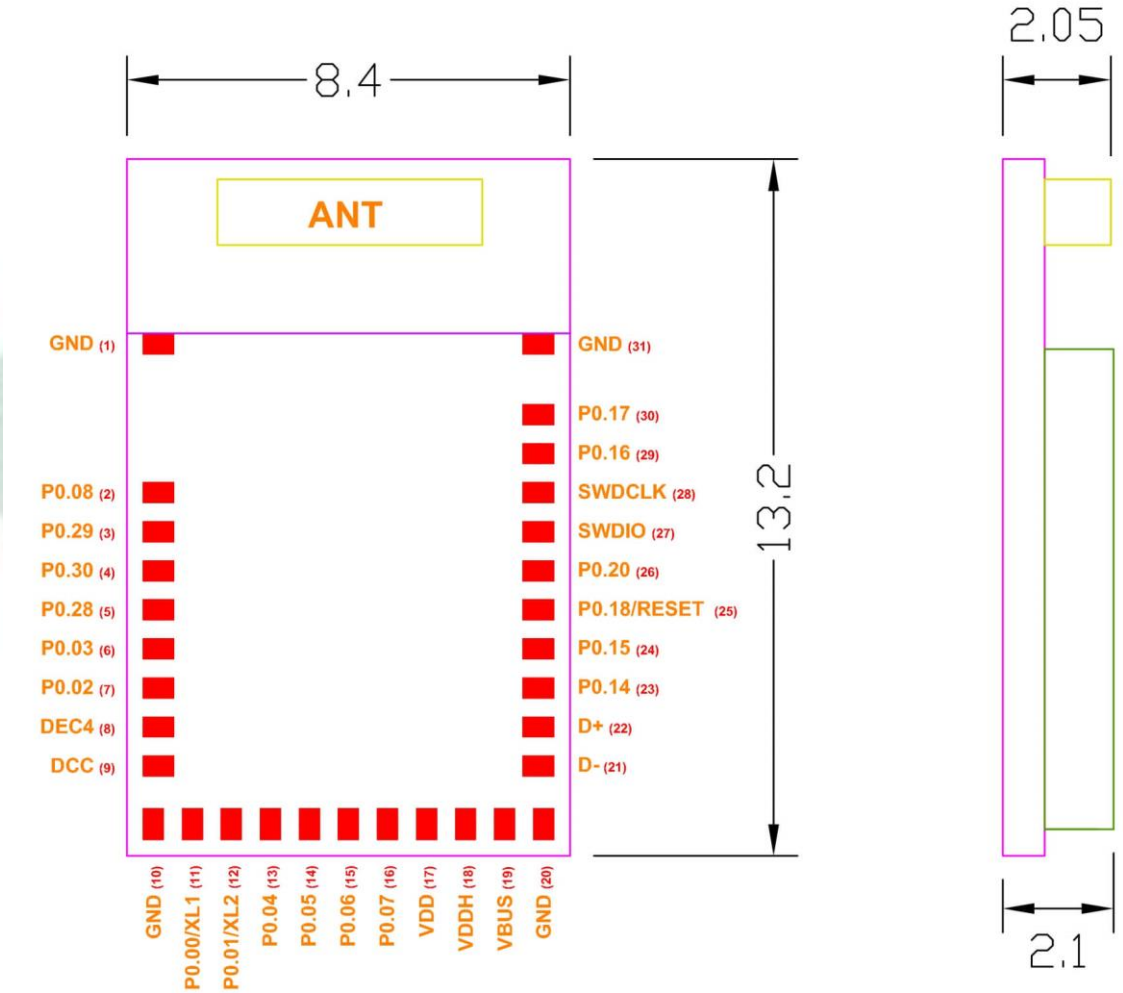
- Flexible power management
    - Supply voltage range 1.7V to 5.5V
    - On-chip DC/DC and LDO regulators with automated low current modes
    - Automated peripheral power management
    - Fast wake-up using 64MHz internal oscillator
    - 0.3uA at 3V in System OFF mode, no RAM retention
    - 1.2uA 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**

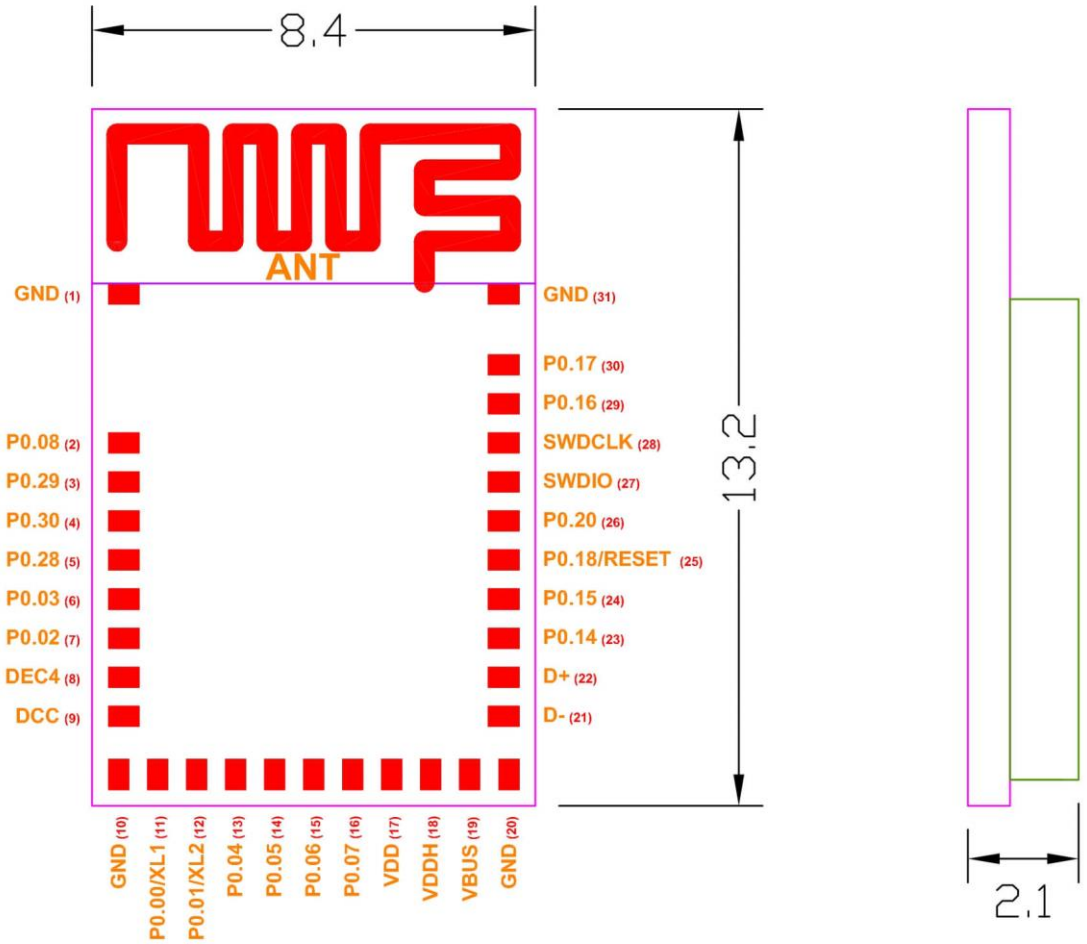
PCB Size (in mm)			
	Min.	Norm	MAX.
L		13.2	
W	- 0.15	8.4	+ 0.2
H		2.1	



Top (Unit: mm)

- **MDBT50-P**

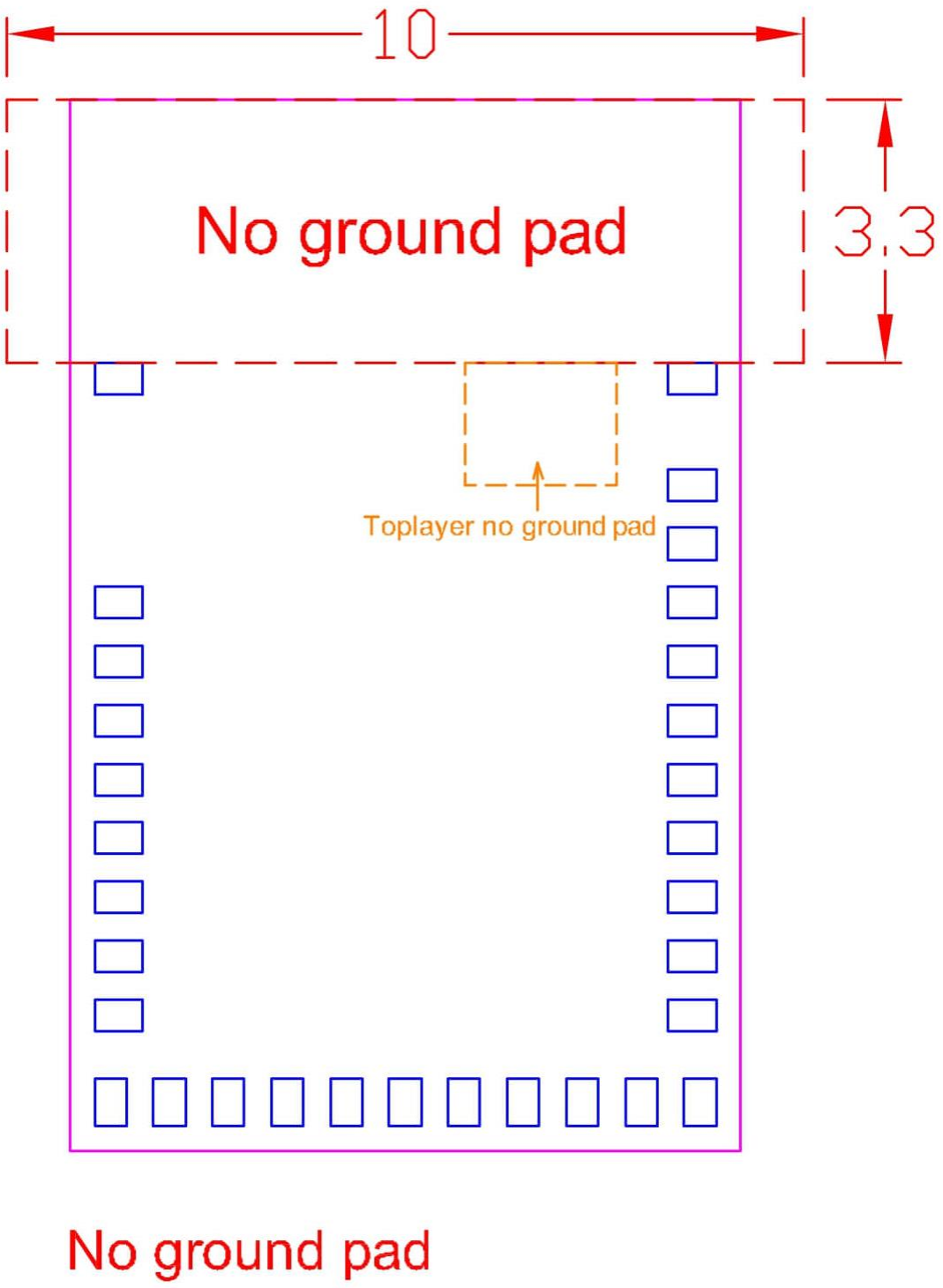
PCB Size (in mm)			
	Min.	Norm	MAX.
L		13.2	
W	- 0.15	8.4	+ 0.2
H		2.1	

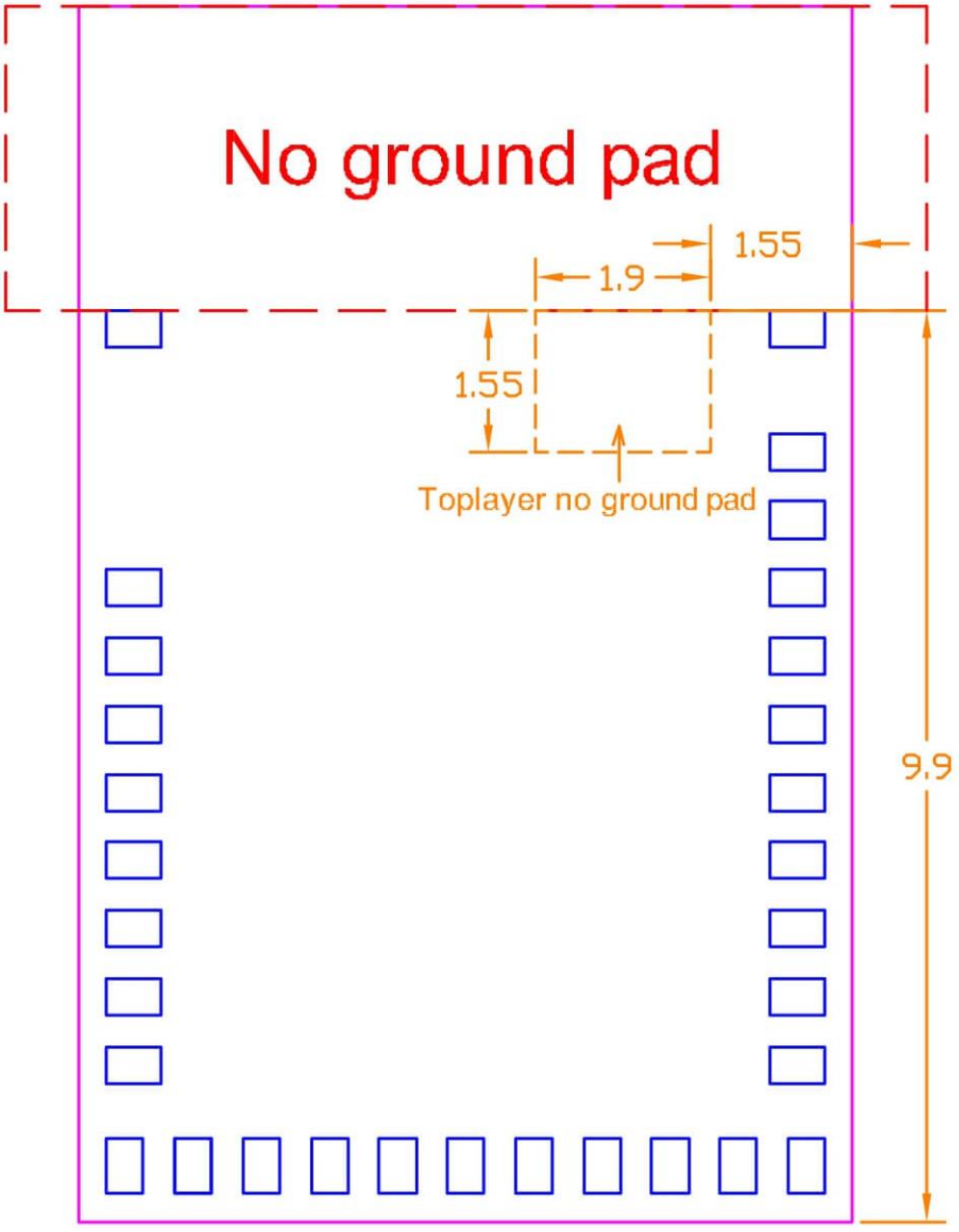


Top (Unit: mm)

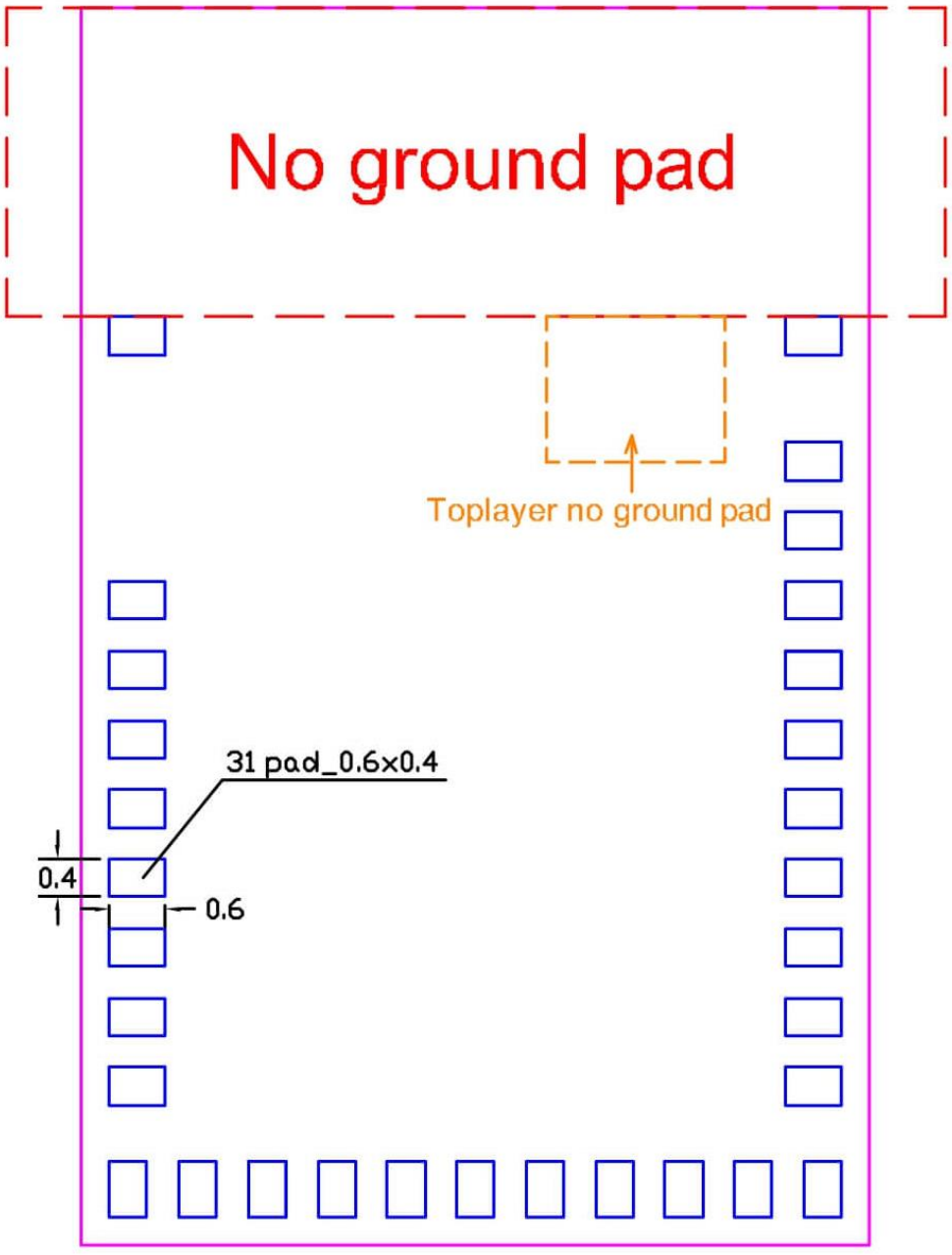
2.2. Recommended Layout of Solder Pad

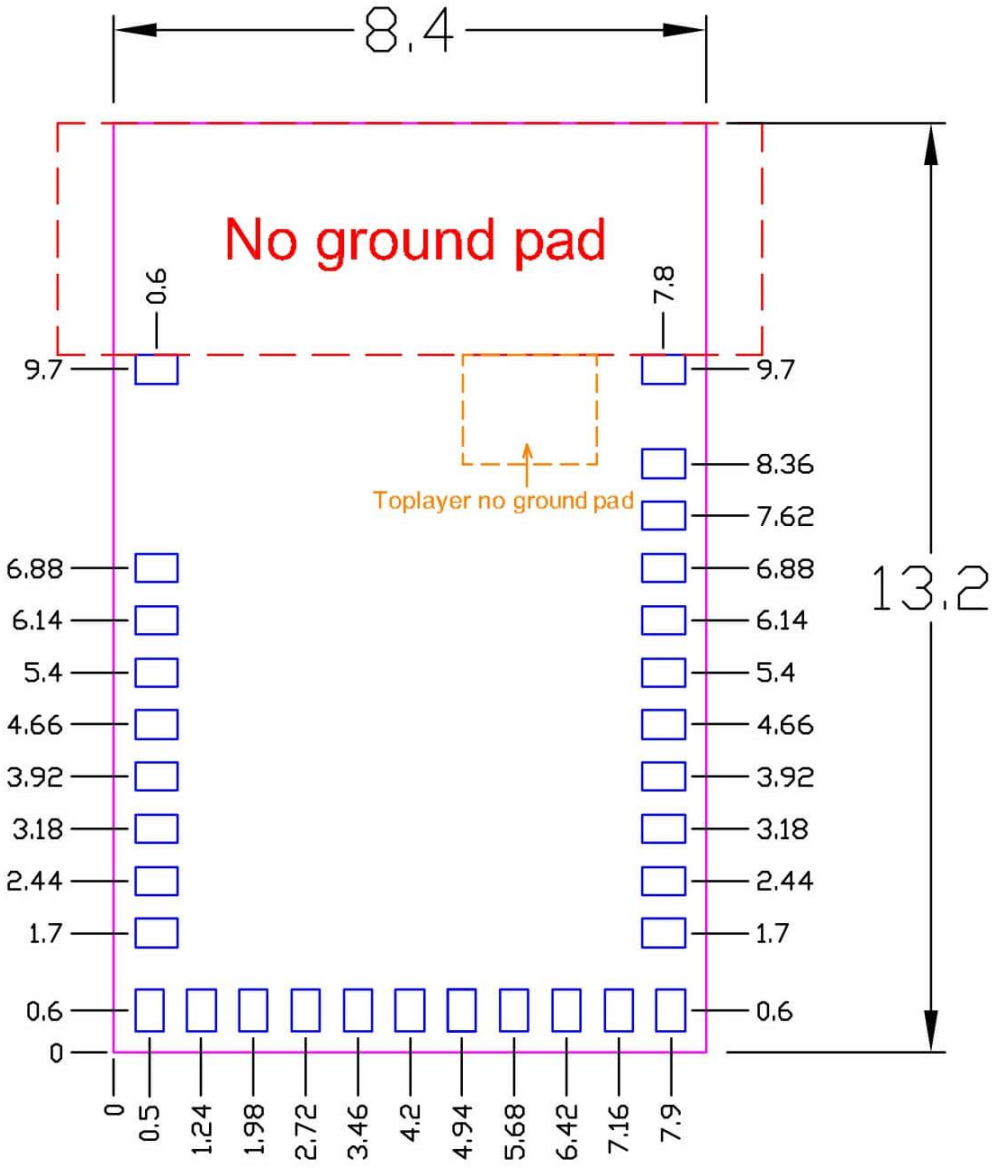
Graphs are all in Top View, Unit in mm.





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

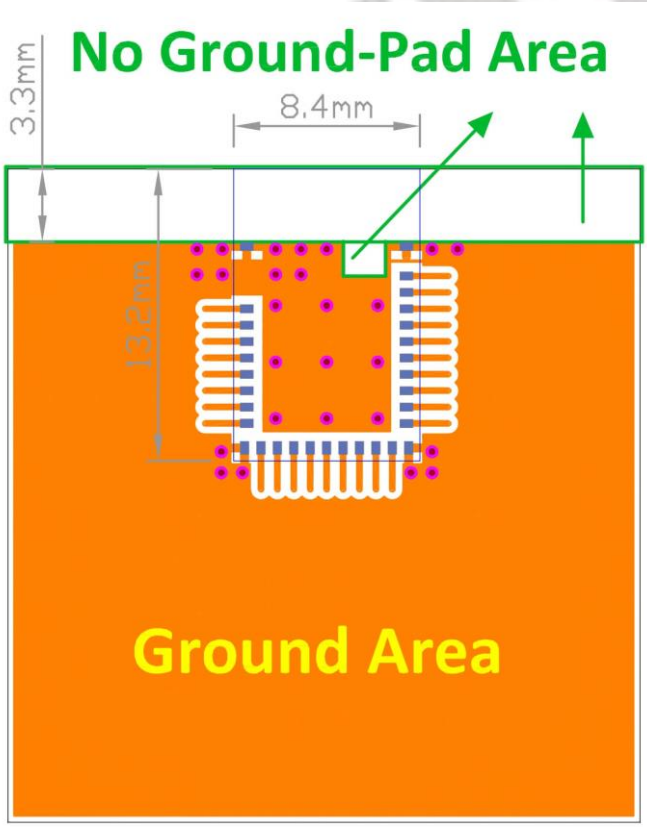
2.3. RF Layout Suggestion (aka Keep-Out Area)

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**.

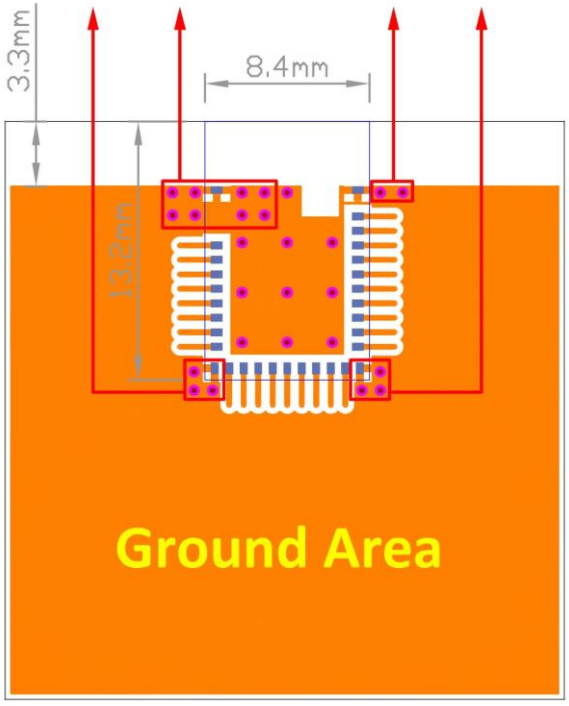
Place the module towards the edge of PCB to have better performance than placing it on the center.

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".

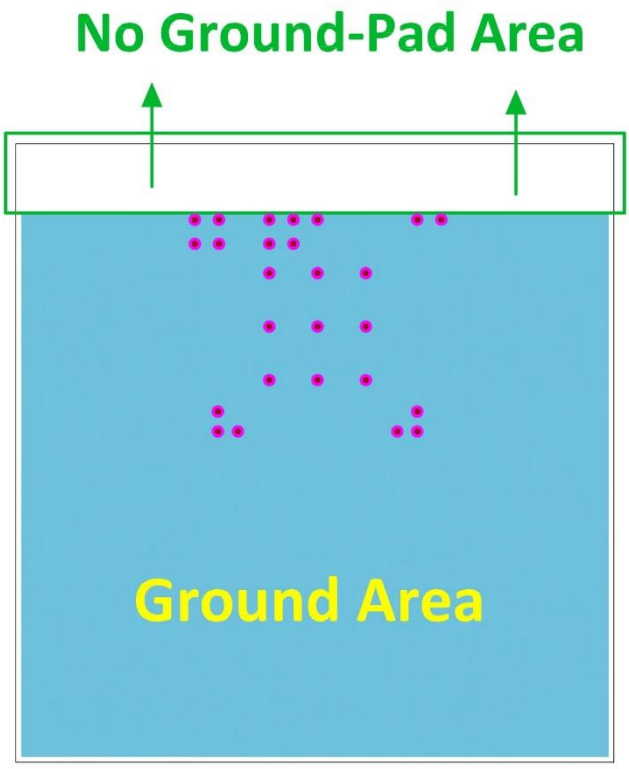


Top layer

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

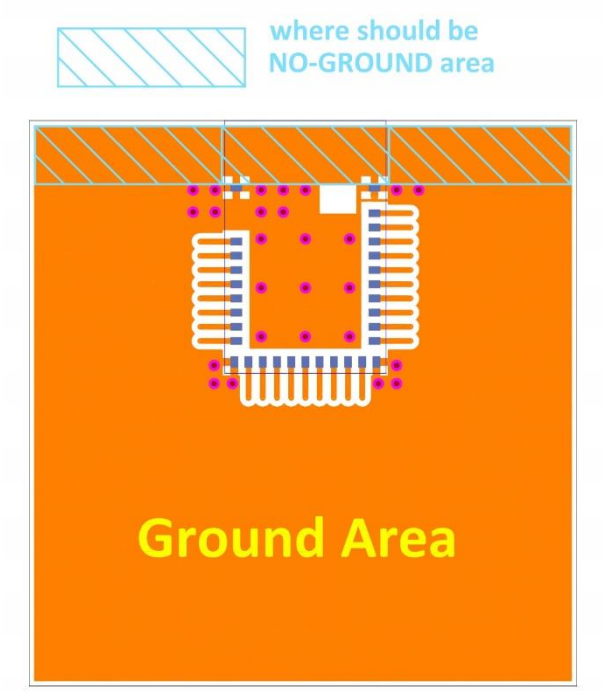


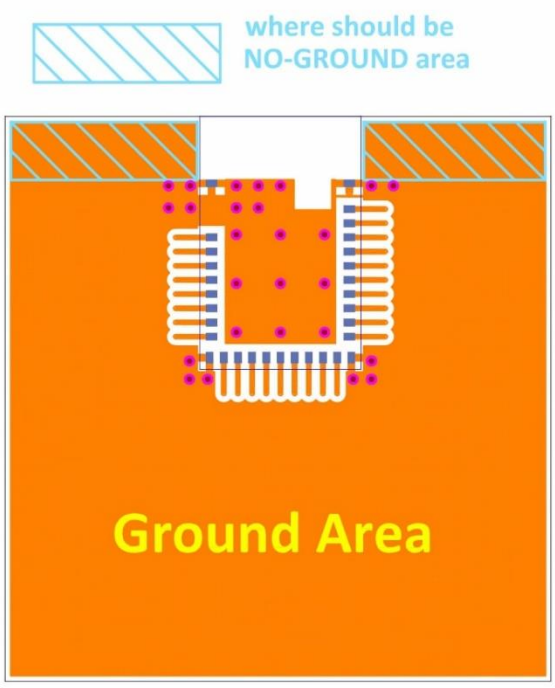
Top layer



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

2.6. GPIO Located Near the Radio

Please refer to *2.5 Pin Assignment* on page 14 to 16 where identifies some GPIO that have recommended usage. To maximize RF performance, these GPIO are only available to use under standard drive, low frequency I/O only, wrong usage may lead to undesirable performance.

Low frequency I/O is a signal with a frequency up to 10 kHz. SPI, I2C, UART, PWM are NOT low frequency I/O.

3. Main Chip Solution

RF IC	Crystal Frequency
Nordic NRF52820	**32MHZ**

32MHz crystal is already inside the module.

4. Shipment Packaging Information

Model	Antenna	Photo
MDBT50-256R	Chip/Ceramic	
MDBT50-P256R	PCB/Printed	

5. Specification

Any technical spec shall refer to Nordic's official documents as final reference. Contents below are from "nRF52820 Production Specification v1.0", please click to download full spec.

5.1. 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

5.2. 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

5.3. Electrical Specifications

5.3.1. 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

5.3.2. 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

5.3.3. 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

5.3.4. 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

5.3.5. 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

5.3.6. 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.

5.3.7. 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.

5.3.8. 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.

5.3.9. 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

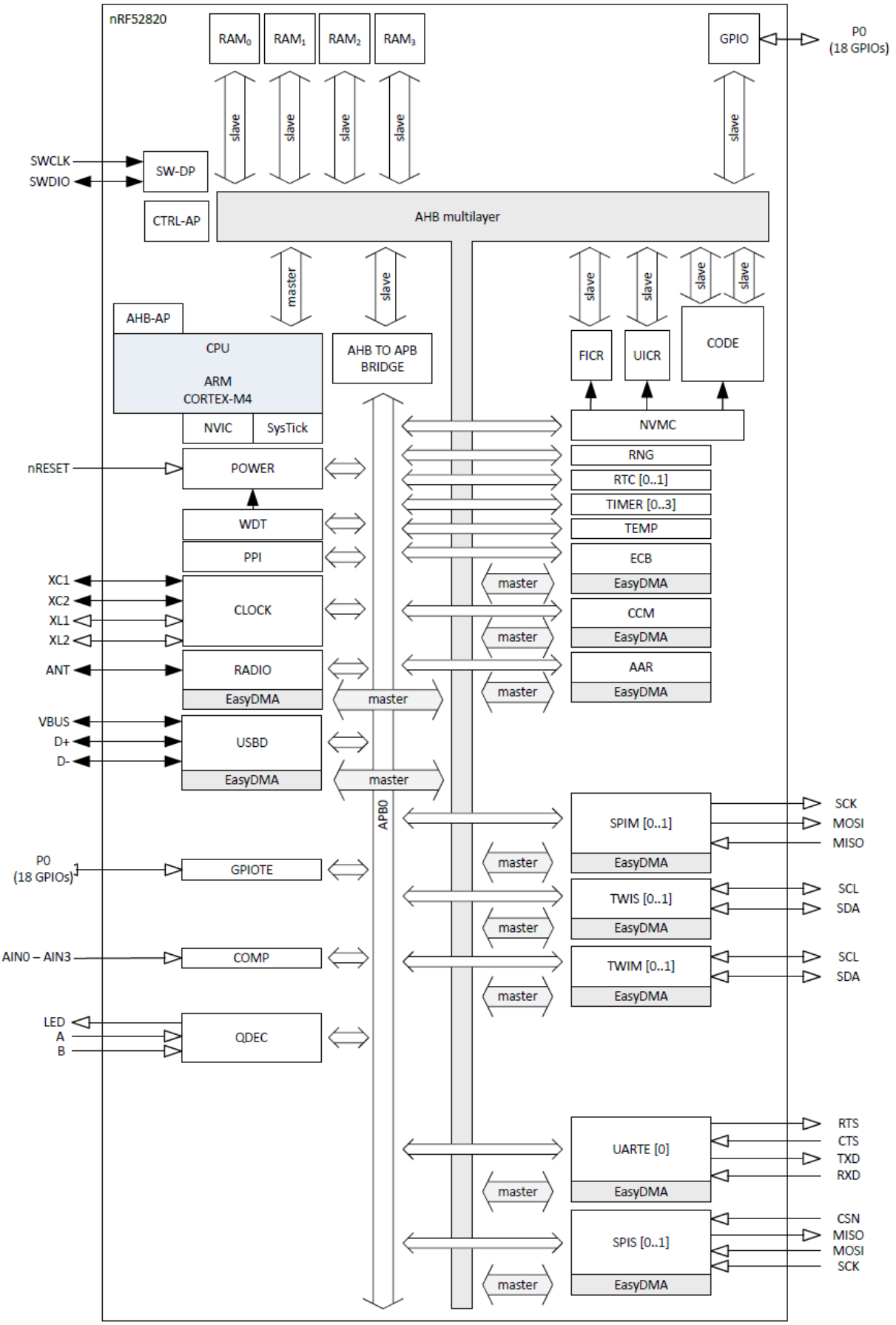
5.3.10. CPU

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

5.3.11. 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

6. Block Diagram

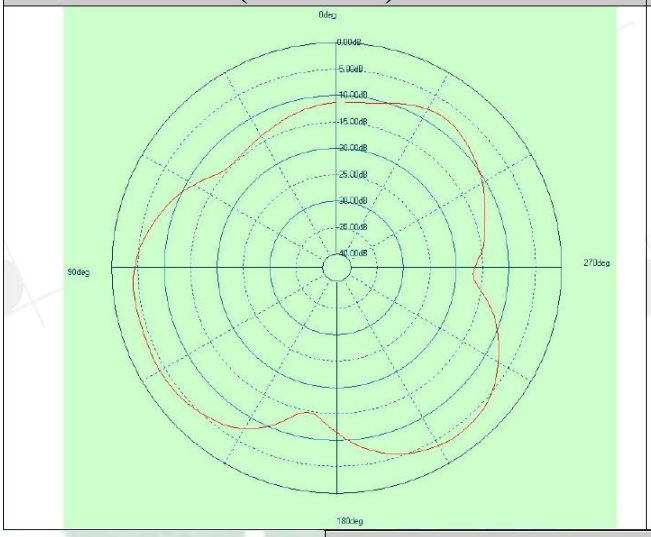


7. Antenna

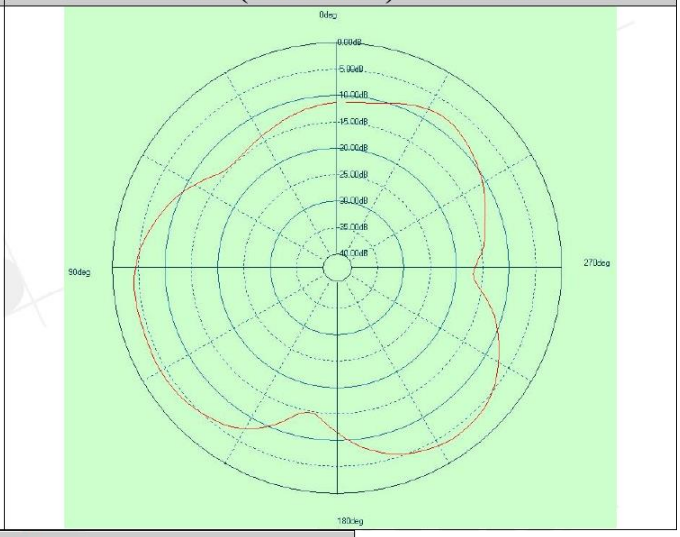
7.1. MDBT50

Freq(MHz)	Peak. dBi	Efficiency	Average . dBi
2400.00	-3.90	14.14%	-8.50
2410.00	-3.52	15.66%	-8.05
2420.00	-3.34	16.67%	-7.78
2430.00	-3.05	17.48%	-7.58
2440.00	-3.06	17.60%	-7.54
2450.00	-3.32	16.58%	-7.80
2460.00	-3.73	14.27%	-8.46
2470.00	-4.22	12.85%	-8.91
2480.00	-4.58	12.38%	-9.07
2490.00	-4.87	11.78%	-9.29
2500.00	-5.59	9.40%	-10.27

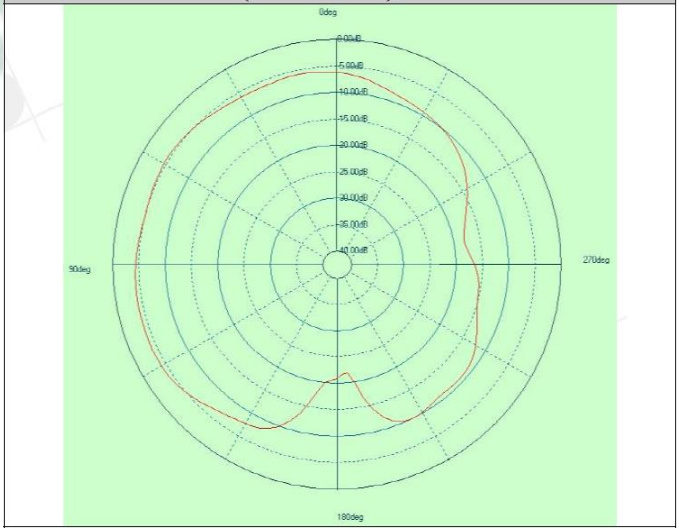
Free Space
EIRP (2450MHz) – XY cut



Free Space
EIRP (2450MHz) – XY cut



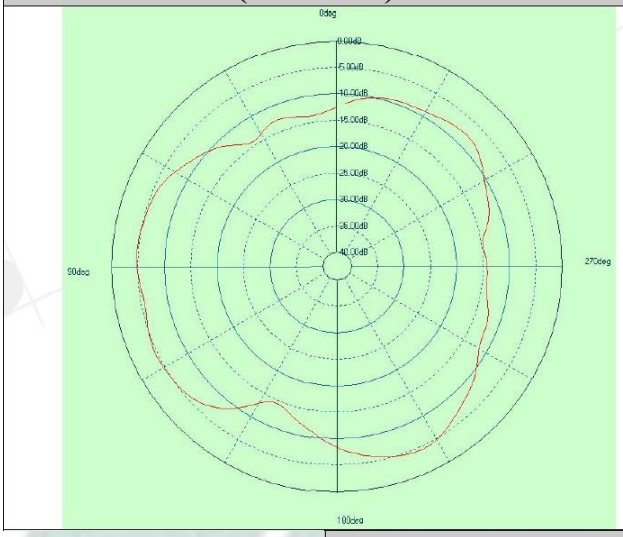
Free Space
EIRP (2450MHz) – YZ cut



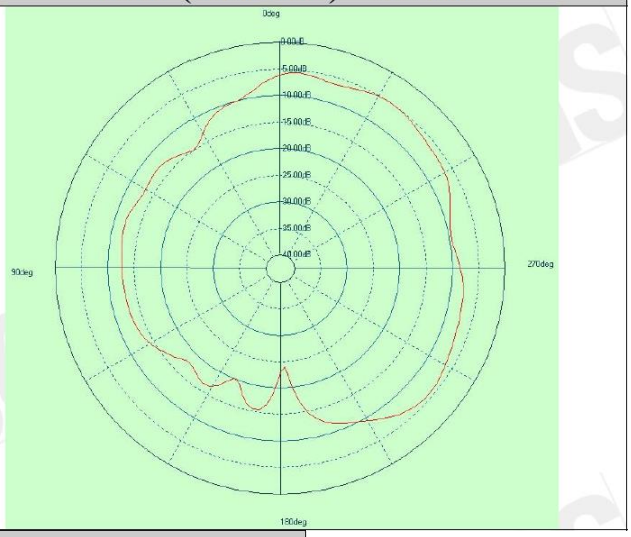
7.2. MDBT50-P

Freq(MHz)	Peak. dBi	Efficiency	Average . dBi
2400.00	-3.55	15.01%	-8.24
2410.00	-3.51	15.35%	-8.14
2420.00	-3.43	15.65%	-8.05
2430.00	-3.24	16.26%	-7.89
2440.00	-3.34	15.89%	-7.99
2450.00	-3.72	14.62%	-8.35
2460.00	-4.19	13.32%	-8.76
2470.00	-4.31	13.08%	-8.83
2480.00	-4.46	12.79%	-8.93
2490.00	-4.83	11.71%	-9.32
2500.00	-5.62	9.66%	-10.15

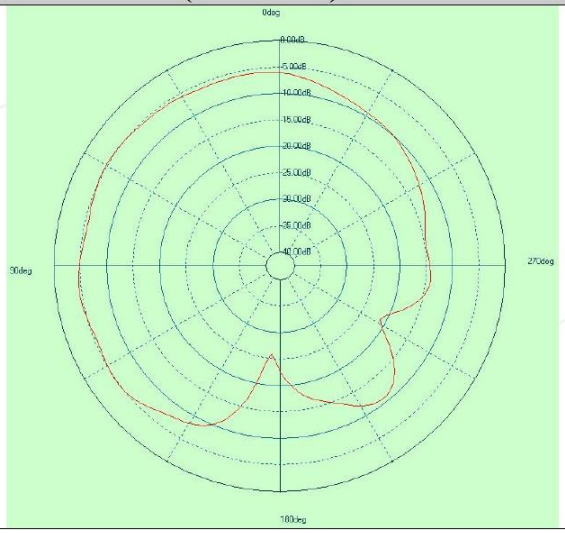
Free Space
EIRP (2450MHz) – XY cut



Free Space
EIRP (2450MHz) – XZ cut



Free Space
EIRP (2450MHz) – YZ cut



8. Reference Circuit

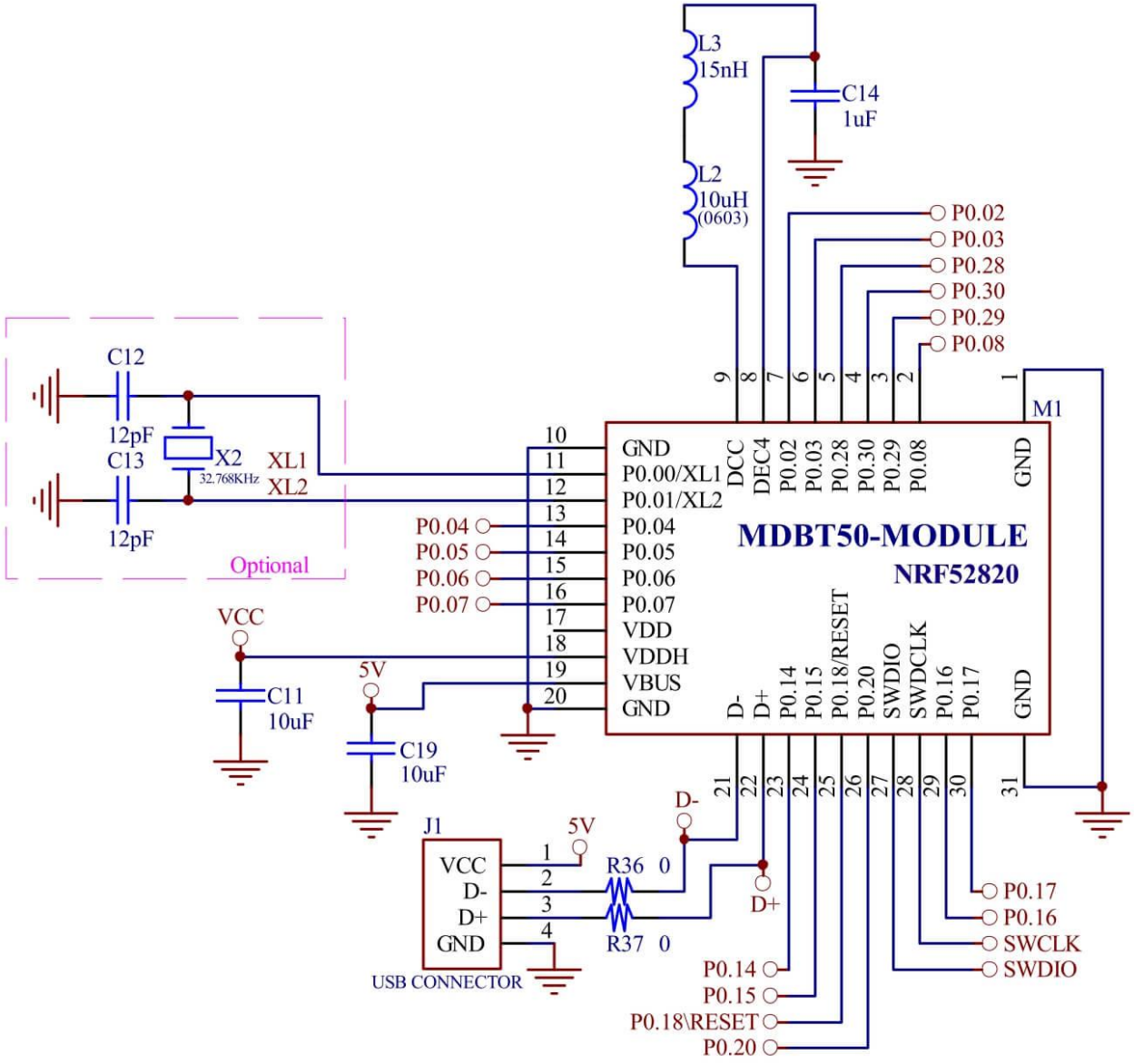
This chapter shows a different combination of reference circuits. **Before getting started, please read below notes carefully because it is applied to all the reference circuits.**

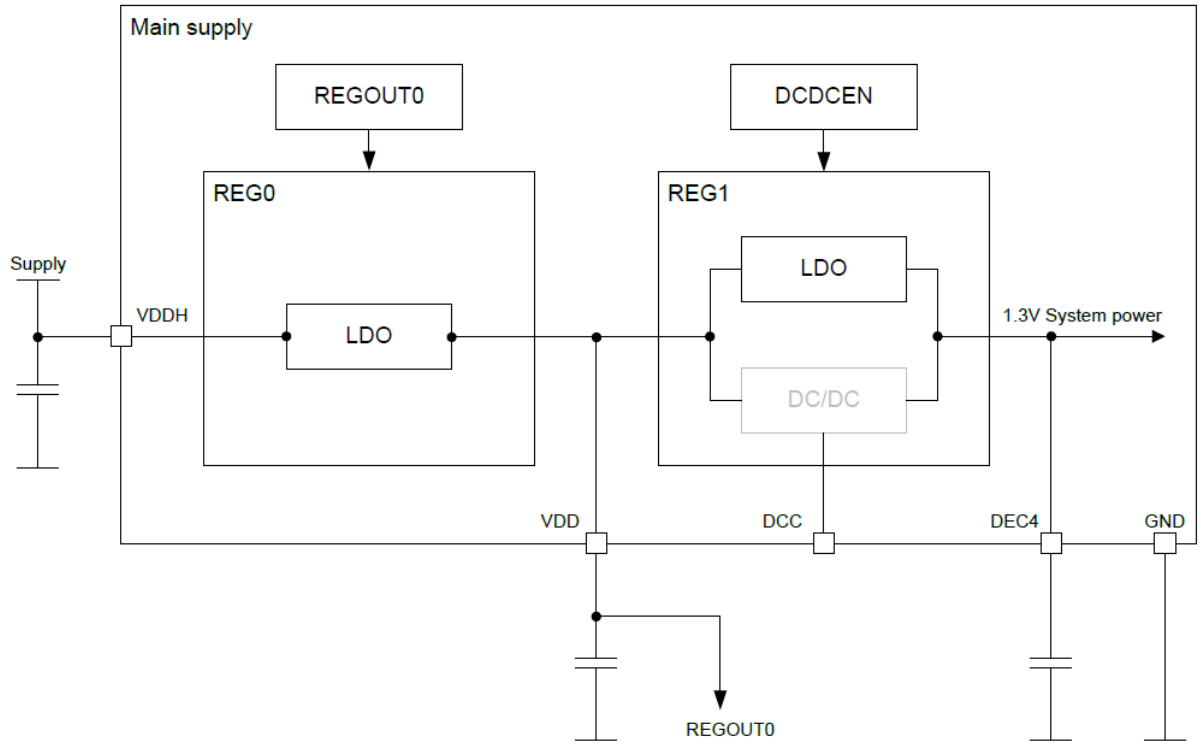
- **32MHz crystal is already inside the module.**
- **Please add L2, L3 and C14 of RF (VDD) DC/DC inductor (Reg1) when using DC-DC mode.**
- **Module is pre-programmed with Raytac testing code. Default is using LDO mode and need to add external 32.768khz to work.**

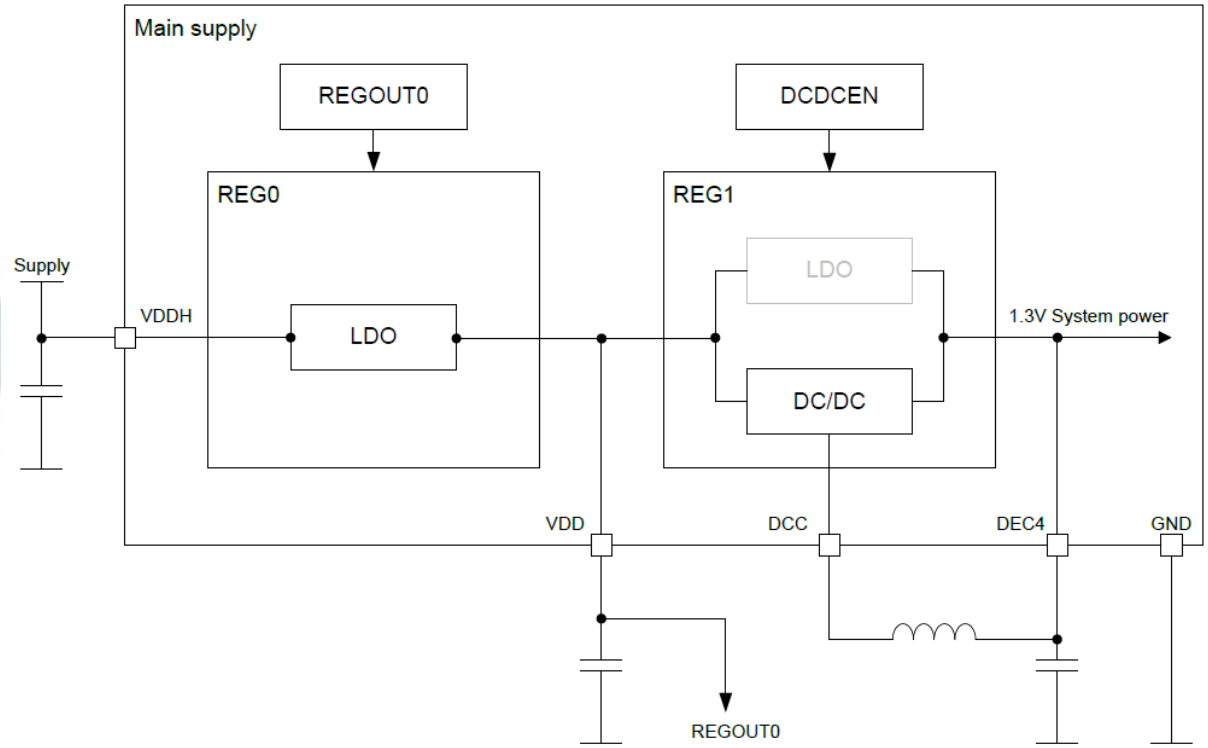
  You can use DC-DC mode *without* adding external 32.768khz, they are NOT related events.
- **When using internal 32.768khz RC oscillator, please remove X2 / C12 / C13.**
- **When NOT using NFC, please remove NFC1 / C19 / C21.**

8.1. Reg0 LDO Mode

Recommend using when *the highest* input voltage is equal or greater than 3.6V. Supply power from VCC (VDDH).

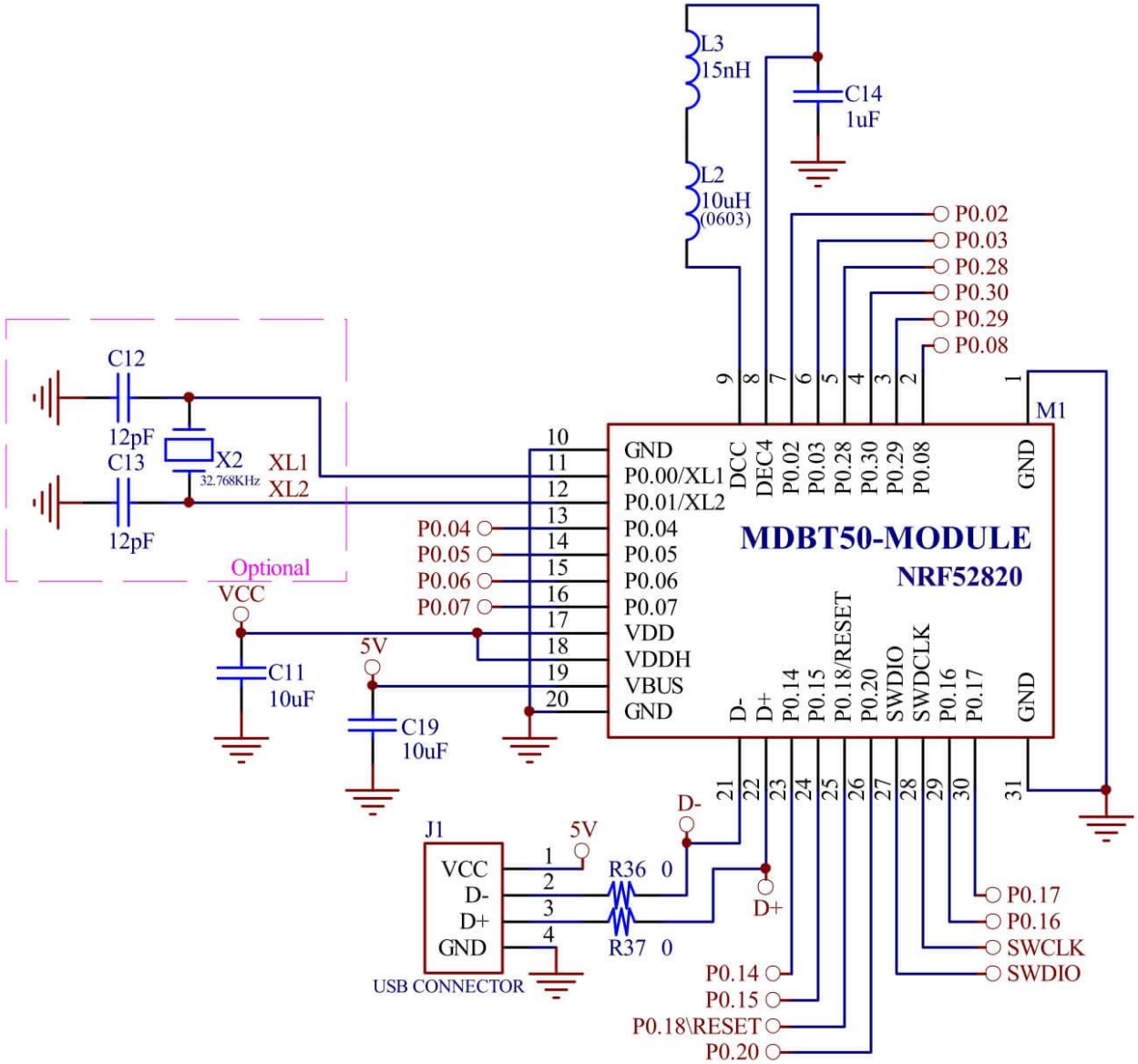


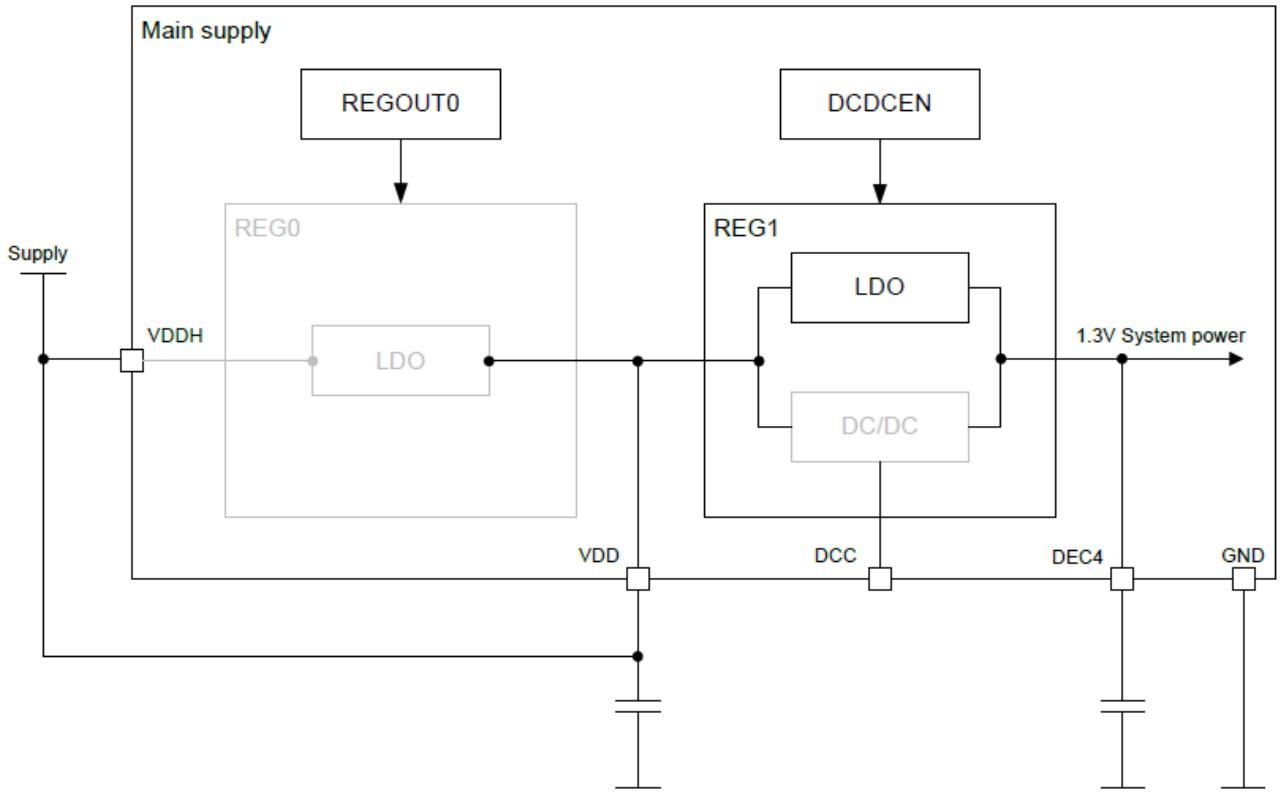

Main supply
REGOUT0
DCDCEN
REG0
REG1
LDO
Supply
VDDH
LDO
1.3V System power
DC/DC
VDD
DCC
DEC4
GND
REGOUT0

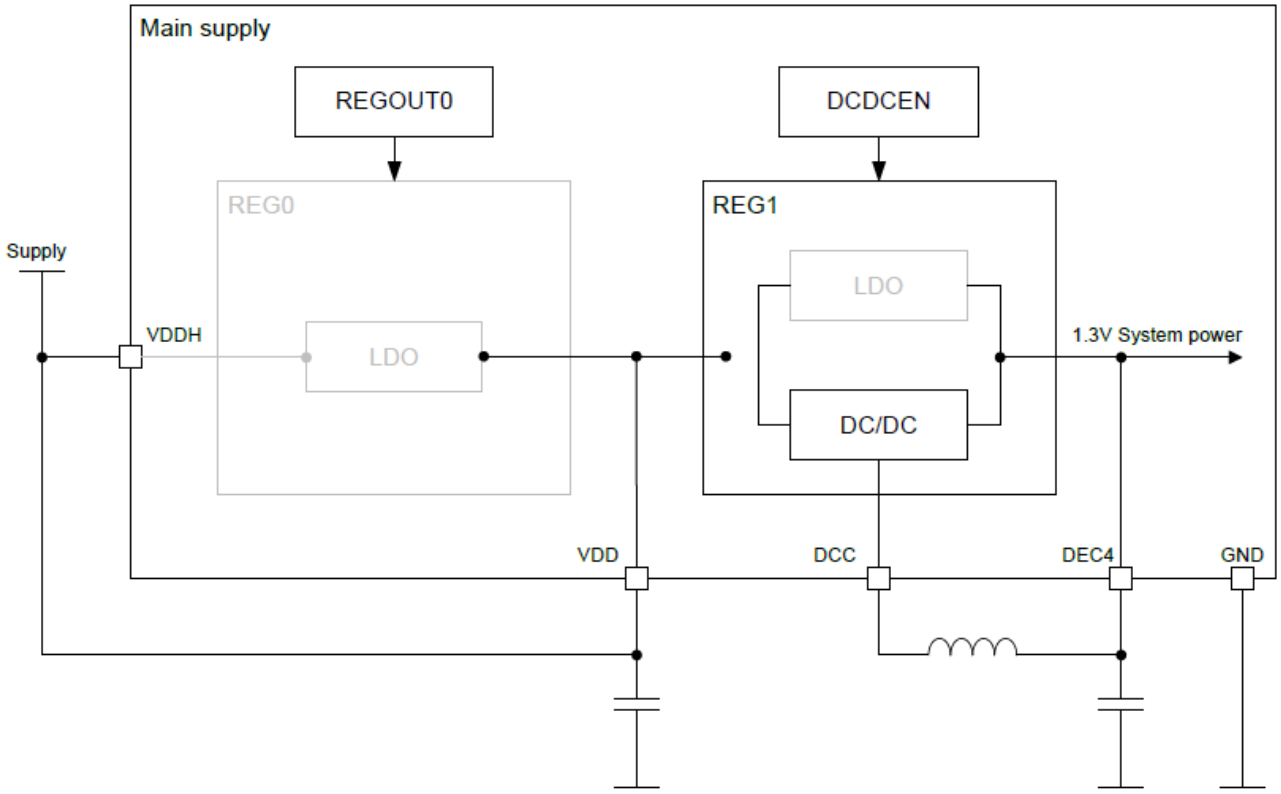

Main supply
REGOUT0
DCDCEN
REG0
REG1
LDO
Supply
VDDH
LDO
1.3V System power
DC/DC
VDD
DCC
DEC4
GND
REGOUT0

8.2. Reg0 LDO Mode Disabled

Recommend using when *the highest* input voltage is less than 3.6V.

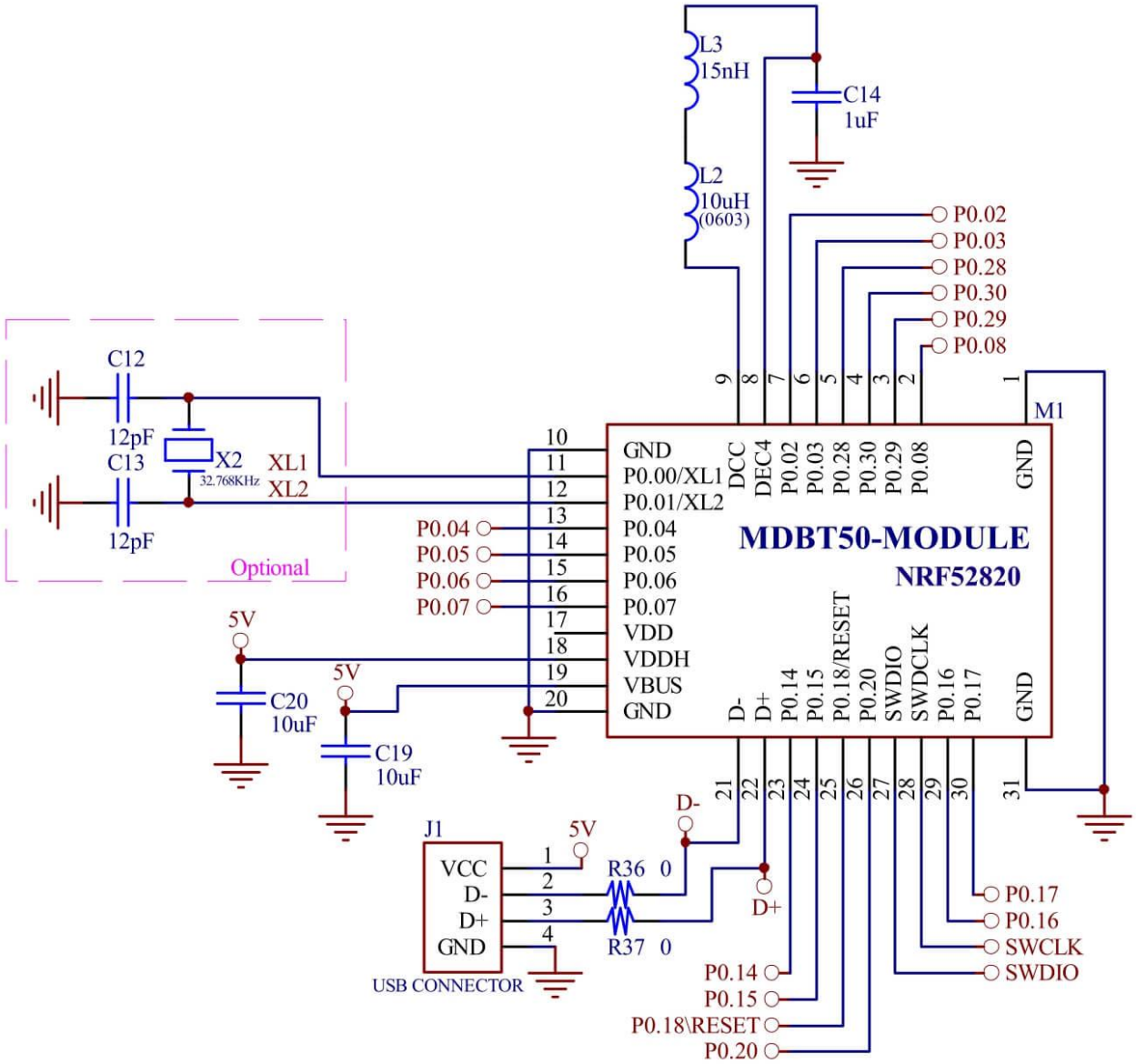


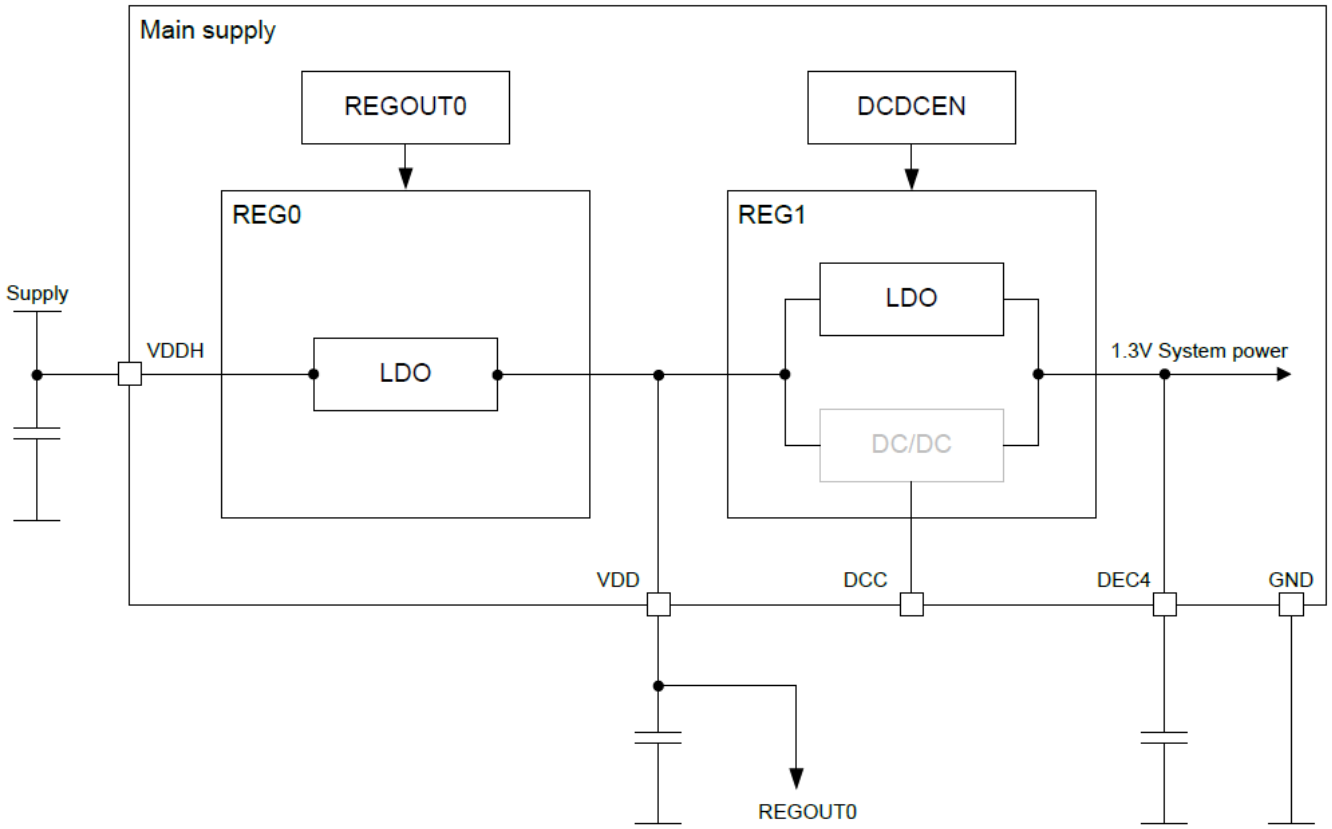

Main supply
REGOUT0
DCDCEN
REG0
REG1
LDO
Supply
VDDH
LDO
1.3V System power
DC/DC
VDD
DCC
DEC4
GND

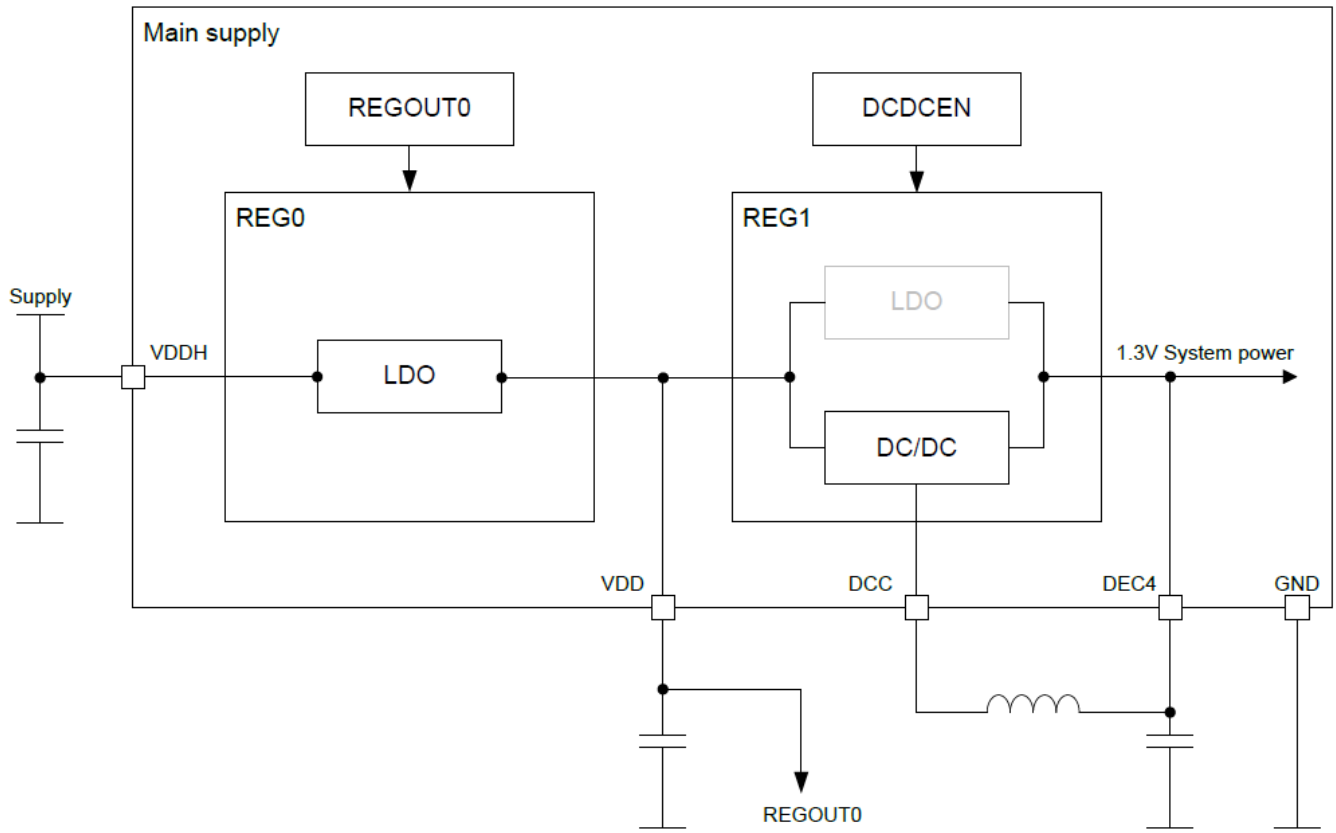

Main supply
REGOUT0
DCDCEN
REG0
REG1
LDO
Supply
VDDH
LDO
1.3V System power
DC/DC
VDD
DCC
DEC4
GND

8.3. USB Powered

Recommend using when power the device via USB

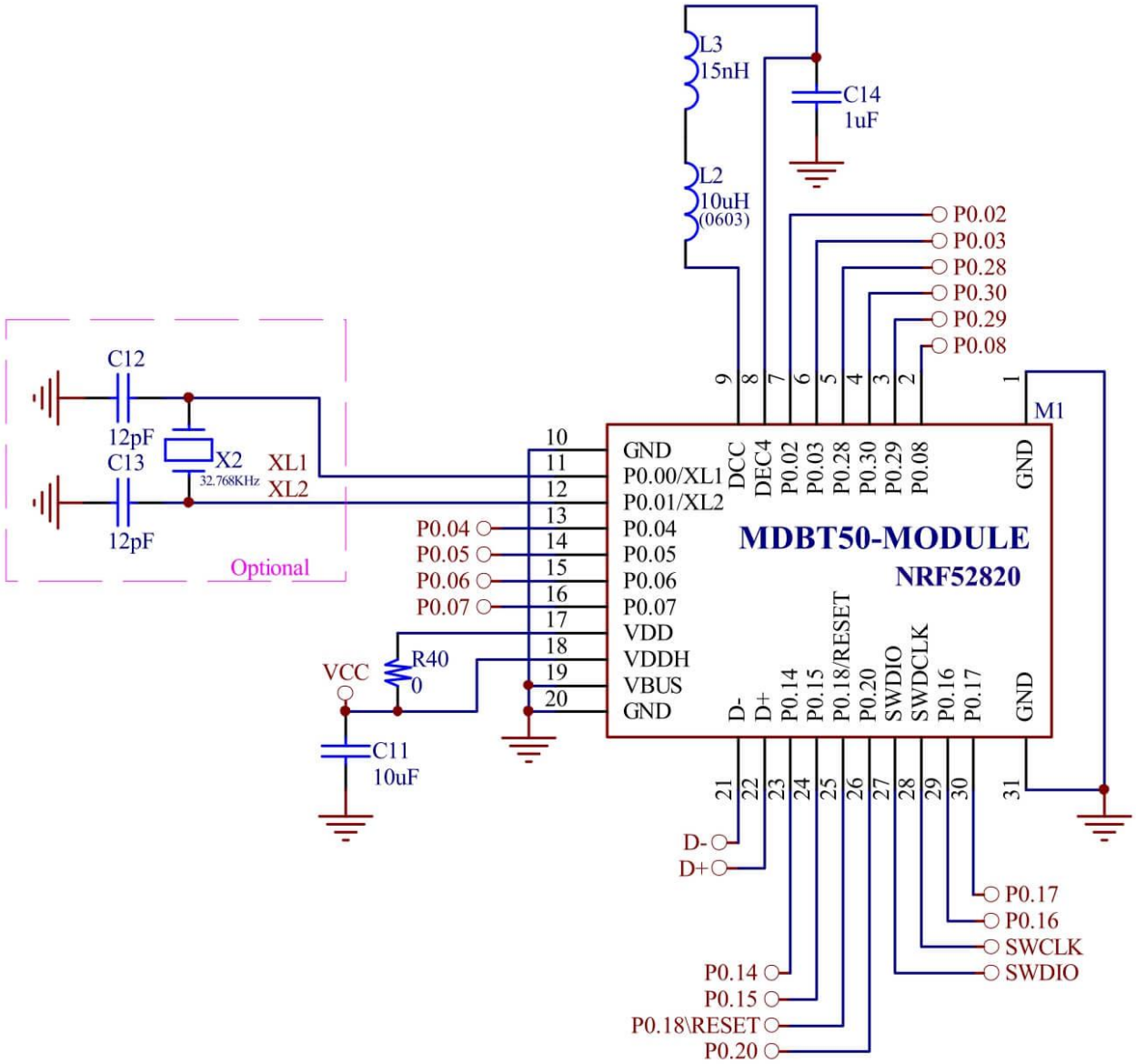


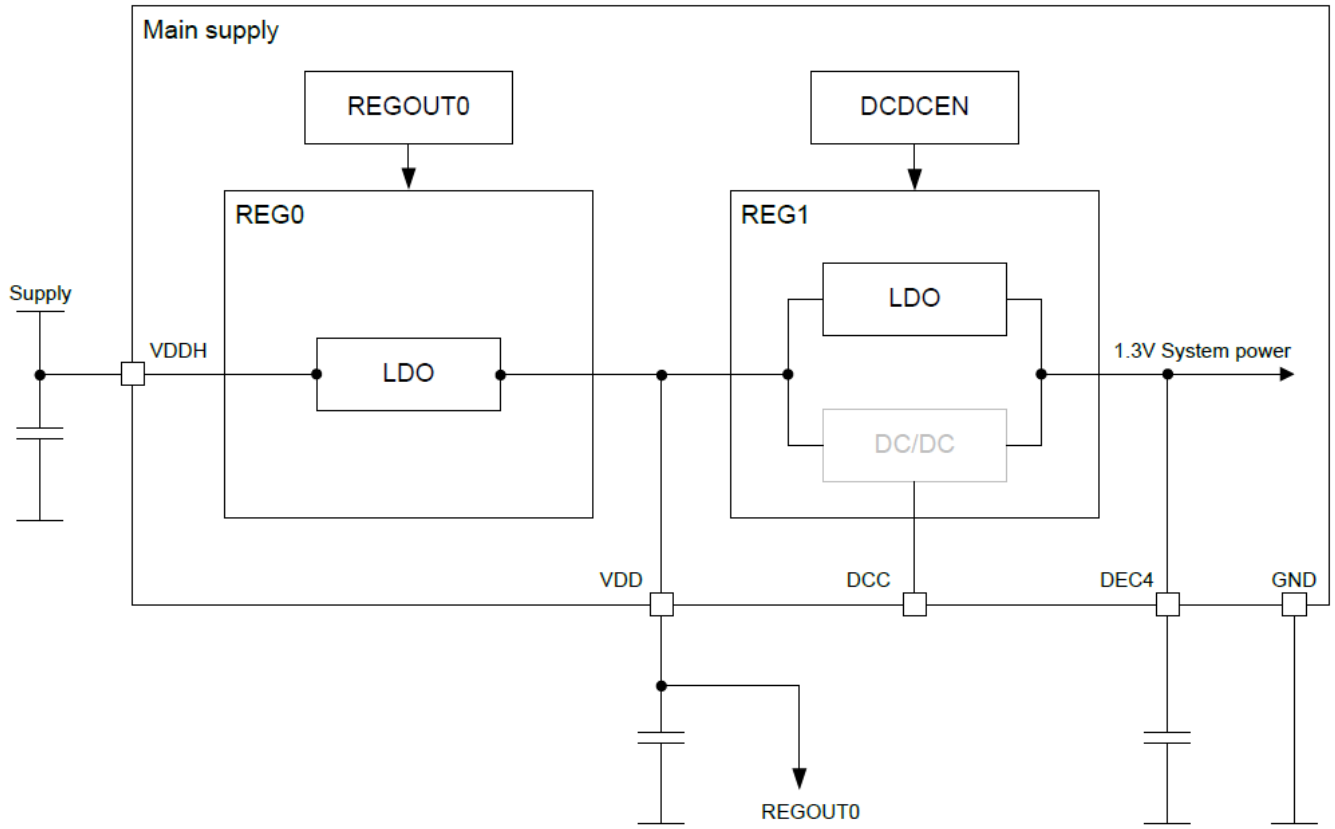

Main supply
REGOUT0
DCDCEN
REG0
REG1
LDO
Supply
VDDH
LDO
1.3V System power
DC/DC
VDD
DCC
DEC4
GND
REGOUT0

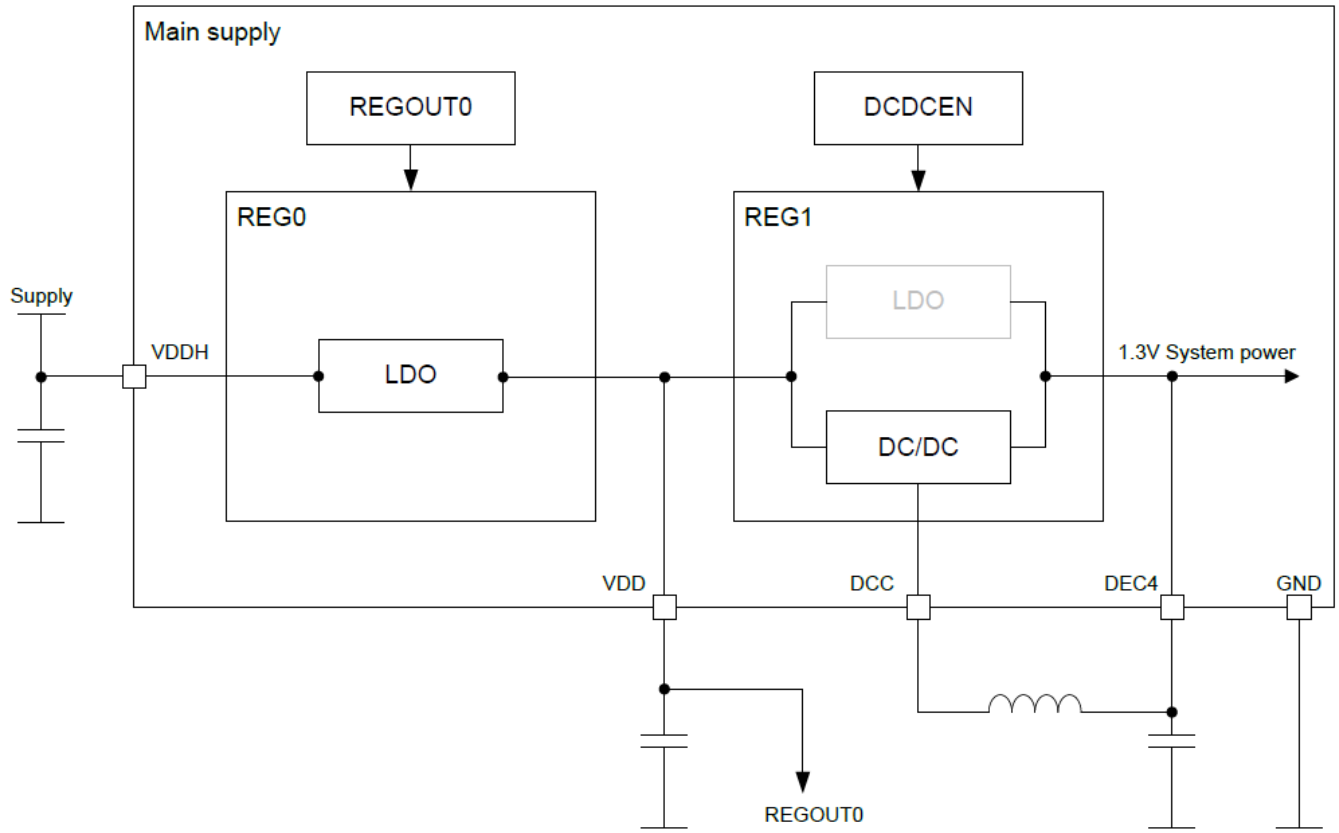

Main supply
REGOUT0
DCDCEN
REG0
REG1
LDO
Supply
VDDH
LDO
1.3V System power
DC/DC
VDD
DCC
DEC4
GND
REGOUT0

8.4. USB Disabled

This circuit only focuses on USB disabled. **Please leave D^+ & D^- as NC when USB is disabled.**




Main supply
REGOUT0
DCDCEN
REG0
REG1
LDO
Supply
VDDH
LDO
1.3V System power
DC/DC
VDD
DCC
DEC4
GND
REGOUT0


Main supply
REGOUT0
DCDCEN
REG0
REG1
LDO
Supply
VDDH
LDO
1.3V System power
DC/DC
VDD
DCC
DEC4
GND
REGOUT0

9. Notes and Cautions

Module is not designed to last for a lifetime. Like general products, it is expected to be worn out after continuous usage through the years. To assure that product will perform better and last longer, please make sure you:

- Follow the guidelines of this document while designing circuit/end-product. Any discrepancy of core Bluetooth technology and technical specification of IC should refer to definition of Bluetooth Organization and Nordic Semiconductor as final reference.

- Do not supply voltage that is not within range of specification.

- Eliminate static electricity at any cost when working with the module as it may cause damage. It is highly recommended adding anti-ESD components to circuit design to prevent damage from real-life ESD events. Anti-ESD methods can be also applied in mechanical design.

- Do not expose modules under direct sunlight for long duration. Modules should be kept away from humid and salty air conditions, and any corrosive gasses or substances. Store it within -40℃ to +125℃ before and after installation.

- Avoid any physical shock, intense stress to the module or its surface.

- Do not wash the module. No-Clean Paste is used in production. Washing it will oxidize the metal shield and have chemistry reaction with No-Clean Paste. Functions of the module are not guaranteed if it has been washed.

The module is not suitable for life support device or system and not allowed to be used in destructive device or systems in any direct or indirect ways. The customer agrees to indemnify Raytac for any losses when applying modules in applications such as the ones described above.

10. Basic Facts for nRF52 Family

Below chart shows basic spec for Nordic nRF52 family, which is helpful to understand the differences between each SoC. Any discrepancy shall refer to Nordic's technical document as final reference.

See *Full List of Raytac's BLE Modules* for complete model no. of each item.

Nordic Solution	nRF52840	nRF52833	nRF52820	nRF52832	nRF52810	nRF52811	nRF52805
RAYTAC Model No. (MDBTXX)	50Q series	50Q series 50 series	50 series	42Q series 42 series 42V series	42Q series	42Q Series	42T series 42TV series
Bluetooth Direction Finding		V	V			V	
Bluetooth 5 Long Range (125kbps)	V	V	V			V	
Bluetooth 5 High Speed	V	V	V	V	V	V	V
Bluetooth 5 Ad. Extention (x8)	V	V	V	V	V	V	V
Flash (kBytes)	1024	512	256	512	192	192	192
RAM (kBytes)	256	128	32	64	24	24	24
ANT Plus	V	V	V	V	V	V	
IEEE 802.15.4	V	V	V			V	
ARM® TrustZone® Cryptocell	V						
USB	V	V	V				
QSPI	V						
NFC	V	V		V			
I2S	V	V		V			
SPI, TWI, UART, PWM	V	V	V	V	V	V	without PWM
PDM	V	V		V	V	V	
ADC, Comparators	V	V	without ADC	V	V	V	without comparators
Supply Range (V)	1.7 to 5.5	1.7 to 5.5	1.7 to 5.5	1.7 to 3.6	1.7 to 3.6	1.7 to 3.6	1.7 to 3.6

11. Useful Links

- Nordic Infocenter: https://infocenter.nordicsemi.com/index.jsp
  All the necessary technical files and software development kits of Nordic's chip are on this website.

- Nordic DevZone: https://devzone.nordicsemi.com/questions/
  A highly recommended website for firmware developer. Interact, discuss and consult with other fellow developers and Nordic's employees to get answers to your questions. The site also includes tutorials in detail to help you get started.

- Official Page of nRF52820 :
  https://www.nordicsemi.com/Products/Low-power-short-range-wireless/nRF52820
  A brief introduction to nRF52820 and download links for Nordic's developing software and SoftDevices.

Full List of Raytac's BLE Modules

MDBT40 Series

Series	Nordic Solution	Raytac No.	IC Ver.	Antenna	RAM	Flash Memory
MDBT40	nRF51822	MDBT40-256V3	3	Chip Antenna	16 kb	256 K
		MDBT40-256RV3			32 kb	256 K
MDBT40-P	nRF51822	MDBT40-P256V3	3	PCB Antenna	16 kb	256 K
		MDBT40-P256RV3			32 kb	256 K

MDBT42Q Series (QFN Package IC)

Series	Nordic Solution	Raytac No.	IC Ver.	Antenna	RAM	Flash Memory
MDBT42Q	nRF52832	MDBT42Q-512KV2	2	Chip Antenna	64 kb	512 K
	nRF52810	MDBT42Q-192KV2	2		24 kb	192 K
	nRF52811	MDBT42Q-192KL	1			
MDBT42Q-P	nRF52832	MDBT42Q-P512KV2	2	PCB Antenna	64 kb	512 K
	nRF52810	MDBT42Q-P192KV2	2		24 kb	192 K
	nRF52811	MDBT42Q-P192KL	1			
MDBT42Q-U	nRF52832	MDBT42Q-U512KV2	2	u.FL Connector	64 kb	512 K

MDBT42 Series (WLCSP Package IC)

Series	Nordic Solution	Raytac No.	IC Ver.	Antenna	RAM	Flash Memory
MDBT42	nRF52832	MDBT42-512KV2	2	Chip Antenna	64 kb	512 K
MDBT42-P		MDBT42-P512KV2		PCB Antenna		

MDBT42V Series (WLCSP Package IC)

Series	Nordic Solution	Raytac No.	IC Ver.	Antenna	RAM	Flash Memory
MDBT42V	nRF52832	MDBT42V-512KV2	2	Chip Antenna	64 kb	512 K
MDBT42V-P		MDBT42V-P512KV2		PCB Antenna		

MDBT42T Series (WLCSP Package IC)

Series	Nordic Solution	Raytac No.	IC Ver.	Antenna	RAM	Flash Memory
MDBT42T	nRF52805	MDBT42T-192K	1	Chip Antenna	24 kb	192 K
MDBT42T-P		MDBT42T-P192K		PCB Antenna		

MDBT42TV Series (WLCSP Package IC)

Series	Nordic Solution	Raytac No.	IC Ver.	Antenna	RAM	Flash Memory
MDBT42TV	nRF52805	MDBT42TV-192K	1	Chip Antenna	24 kb	192 K
MDBT42TV-P		MDBT42TV-P192K		PCB Antenna		

MDBT50Q Series (aQFN Package IC)

Series	Nordic Solution	Raytac No.	IC Ver.	Antenna	RAM	Flash Memory
MDBT50Q	nRF52840	MDBT50Q-1MV2	2	Chip Antenna	256 kb	1 MB
	nRF52833	MDBT50Q-512K	1		128 kb	512 kb
MDBT50Q-P	nRF52840	MDBT50Q-P1MV2	2	PCB Antenna	256 kb	1 MB
	nRF52833	MDBT50Q-P512K	1		128 kb	512 kb
MDBT50Q-U	nRF52840	MDBT50Q-U1MV2	2	u.FL Connector	256 kb	1 MB
	nRF52833	MDBT50Q-U512K	1		128 kb	512 kb
Dongle	nRF52840	MDBT50Q-RX	1, 2	PCB Antenna	256 kb	1 MB

MDBT50 Series (QFN Package IC)

Series	Nordic Solution	Raytac No.	IC Ver.	Antenna	RAM	Flash Memory
MDBT50	nRF52820	MDBT50-256R	1	Chip Antenna	32 kb	256 kb
	nRF52833	MDBT50-512K	1		128 kb	512 kb
MDBT50-P	nRF52820	MDBT50-P256R	1	PCB Antenna	32 kb	256 kb
	nRF52833	MDBT50-P512K	1		128 kb	512 kb

Release Note

- 2020/09/01 1ST release