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Approval Sheet

(產品承認書)

產品名稱 (Product): BT 4.1 Module (Nordic nRF51822)

產品型號 (Model No.): **MDBT40 Series & MDBT40-P Series**

Advantages of MDBT40 & MDBT40-P Series

1. Long Working Distance
MDBT40 Series: Over 80 meters in open space
MDBT40-P Series: Up to 60 meters in open space
2. Declaration ID already included all Nordic applied profiles.
3. FCC (USA) & TELEC (Japan) certificate & CE (EU) & NCC (Taiwan) report granted.

Index

List of Raytac's Model No.	3
1. Overall Introduction	4
1.1 Applications	4
1.2 Features	5
1.3 Profile & Service Information	6
2. Product Dimension	7
2.1 MDBT40 Series	7
2.2 MDBT40-P Series	9
2.3 Pin Assignment	11
3. Main Chip Solution	12
4. Shipment Packaging Information	13
5. Specification	14
5.1 Absolute Maximum Ratings	14
5.2 Operation Conditions	14
5.3 Electrical Specifications	15
6. Block Diagram	21
7. Antenna	22
7.1 MDBT40 Series	22
7.2 MDBT40-P Series	24
8. Reference Circuit	25
8.1 nRF51822 Schematic with Internal LDO	25
8.2 nRF51822 Schematic with 1.8V Low Voltage Mode	26
8.3 nRF51822 Schematic with Internal DC/DC Converter	27
9. Carrier Keep-Out Area	28
10. Certification	29
10.1 Declaration ID Certification	29
10.2 FCC Certification (USA)	30
10.3 TELEC Certification (Japanese)	32
10.4 NCC Certificate	33
10.5 End-Product Label	34
10.6 CE Test Report (EU)	35
10.7 RoHS Report	36
11. Current Consumption Reference Data (BT3.0 VS BT4.0)	38
12. BT 4.0 Product Certification Cost Comparison Chart	39
13. nRF51 IC Compatibility with SDK & SoftDevice	40
Release Note	41

List of Raytac's Model No.

Series	Nordic Solution	Raytac No.	IC Version	Antenna	RAM	Flash Memory
MDBT40	nRF51822	MDBT40-128V2	2	Chip Antenna	16 kb	128 K
		MDBT40-128V3	3			256 K
		MDBT40-256V2	2		32 kb	
		MDBT40-256V3	3			
		MDBT40-256RV3	3			

MDBT40-P	nRF51822	MDBT40-P128V2	2	PCB Antenna	16 kb	128 K
		MDBT40-P128V3	3			256 K
		MDBT40-P256V2	2		32 kb	
		MDBT40-P256V3	3			
		MDBT40-P256RV3	3			

MDBT40 - ANT	nRF51422	MDBT40-ANT-256V2	2	Chip Antenna	16 kb	256 K
		MDBT40-ANT-256V3	3		32 kb	
		MDBT40-ANT-256RV3	3			

MDBT40 -ANT-P	nRF51422	MDBT40-ANT-P256V2	2	PCB Antenna	16 kb	256 K
		MDBT40-ANT-P256V3	3		32 kb	
		MDBT40-ANT-P256RV3	3			

MDBT40 Nano	nRF51822	MDBT40-n256V2	2	N / A	16 kb	256 K
		MDBT40-n256V3	3		32 kb	
		MDBT40-n256RV3	3			

MDBT40 -ANT-Nano	nRF51422	MDBT40-ANT-n256V2	2	N / A	16 kb	256 K
		MDBT40-ANT-n256V3	3		32 kb	
		MDBT40-ANT-n256RV3	3			

Remark:

- Operating temperature in Version 3 IC is -40°C to 85°C; Version 2 IC is -25°C to 75°C.
- Version 3 IC supports Internal DC/DC Converter, which is not suggested to use in Version 2 IC.

1. Overall Introduction

Raytac's MDBT40 is a BT 4.0 & BT 4.1 stack (Bluetooth low energy or BLE) module designed based on **Nordic nRF51822 SoC solution**, which incorporates: **GPIO, UART, I2C** and **ADC interfaces** for connecting peripherals and sensors.

The feature of the module:

1. Dual Transmission Mode of BLE & RF 2.4G upon customer preference.
2. Compact size with **(L) 18 x (W) 10 x (H) 3.2 or 2.7 mm**
3. Low power requirements, ultra-low peak, average and idle mode power consumption.
4. Compatible with a large installed based of mobile phones, tablets and computers.
5. Fully coverage of BLE software stack including:
Proximity Profile; Heart Rate Profile; Health Thermometer Profile;
Blood Pressure Profile; Running Speed & Cadence Profile;
HID Over GATT Profile; Alert Notification Profile; Glucose Profile;
Cycling Speed & Cadence Profile
6. BLE & RF transmission switching may help products to fit all operation system
7. BLE & RF transmission switching may help products fit all kinds of hardware.

1.1 Applications

- . Computer peripherals and I/O devices
 - . Mouse
 - . Keyboard
 - . Multi-touch track pad
- . Interactive entertainment devices
 - . Remote control
 - . 3D Glasses
 - . Gaming controller
- . Personal Area Networks
 - . Health/fitness sensor and monitor devices
 - . Medical devices
 - . Key-fobs + wrist watch
 - . Remote control toys

1.2 Features

- . 2.4GHZ transceiver
 - . -93dbm sensitivity in Bluetooth low energy mode
 - . TX Power -20 to +4dbm
 - . RSSI (1db resolution)
- . ARM Cortex – M0 32 bit processor
 - . Serial Wire Debug (SWD)
- . S100 series SoftDevice ready
- . Memory
 - . 256kb or 128kb embedded flash programmed memory
 - . 16kb RAM or 32kb RAM
- . Support for non-concurrent multiprotocol operation
 - . On-air compatibility with nRF24L series
- . Flexible Power Management
 - . Supply voltage range 1.8V to 3.6V
 - . 2.5us wake-up using 16MHz RCOSC
 - . 0.6uA @ 3V mode
 - . 1.2uA @ 3V in OFF mode + 1 region RAM retention
 - . 2.6uA @ 3V ON mode, all blocks IDLE
- . 8/9/10 bit ADC- 8 configurable channels
- . 31 General Purpose I/O Pins
- . One 32 bit and two 16 bit timers with counter mode
- . SPI Master
- . Two-wire Master (I2C compatible)
- . UART (CTS/RTS)
- . CPU independent Programmable Peripheral Interconnect (PPI)
- . Quadrature Decoder (QDEC)
- . AES HW encryption
- . Real Timer Counter (RTC)

1.3 Profile & Service Information

Profile & Service below are supported by MDBT40.

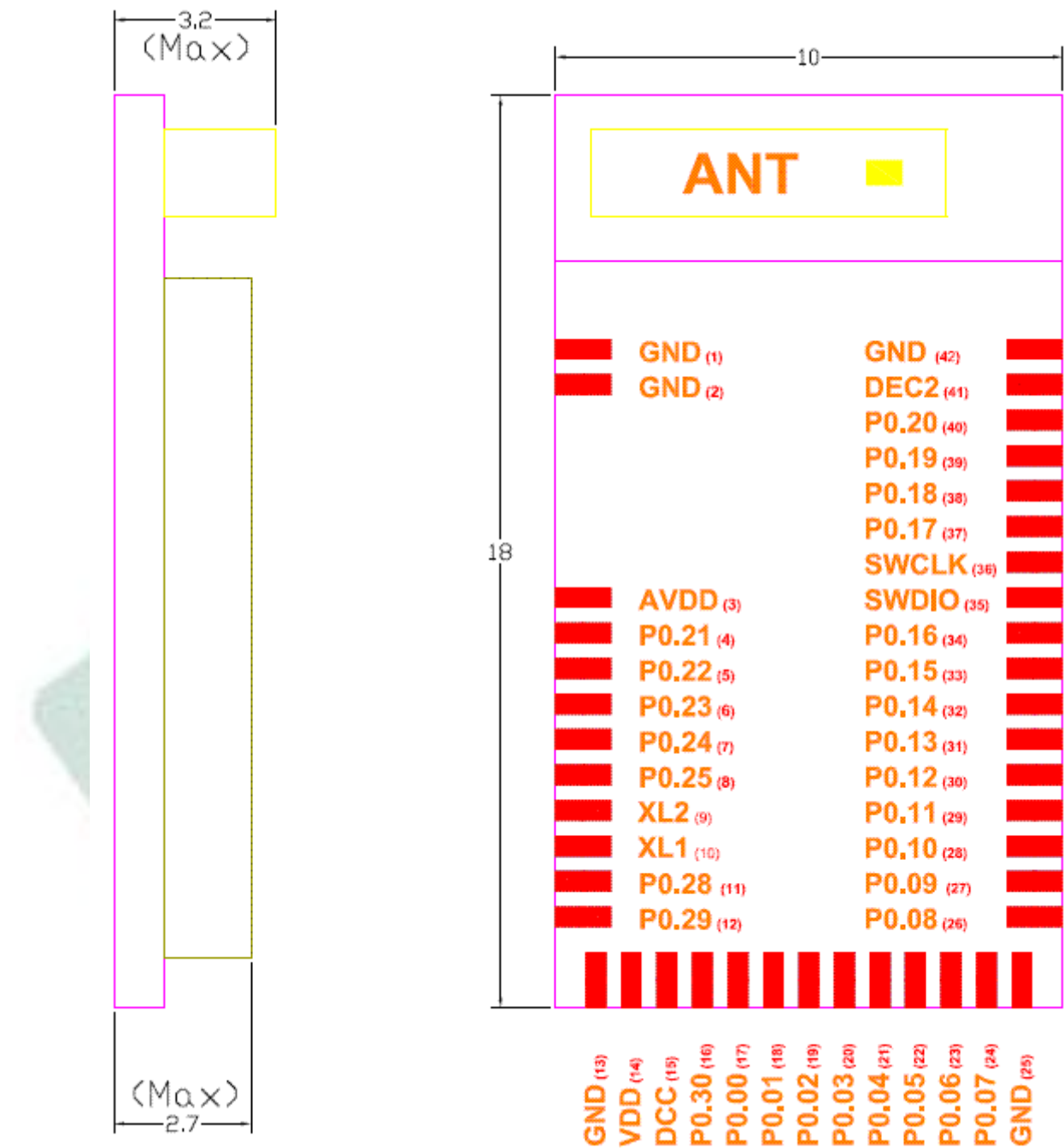
Profile Description	Service Description
Alert Notification Profile	Alert Notification Service
Blood Pressure Profile	Blood Pressure Service
	Device Information Service
Cycling Speed & Cadence Profile	Cycling Speed & Cadence Service
	Device Information Service
Glucose Profile	Glucose Service
	Device Information Service
Health Thermometer Profile	Health Thermometer Service
	Device Information Service
Heart Rate Profile	Heart Rate Service
	Device Information Service
HID over GATT Profile	HID Service
	Battery Service
Proximity Profile	Link Loss Service
	Immediate Alert Service
	TX Power Service
Running Speed & Cadence Profile	Running Speed & Cadence Service
	Device Information Service

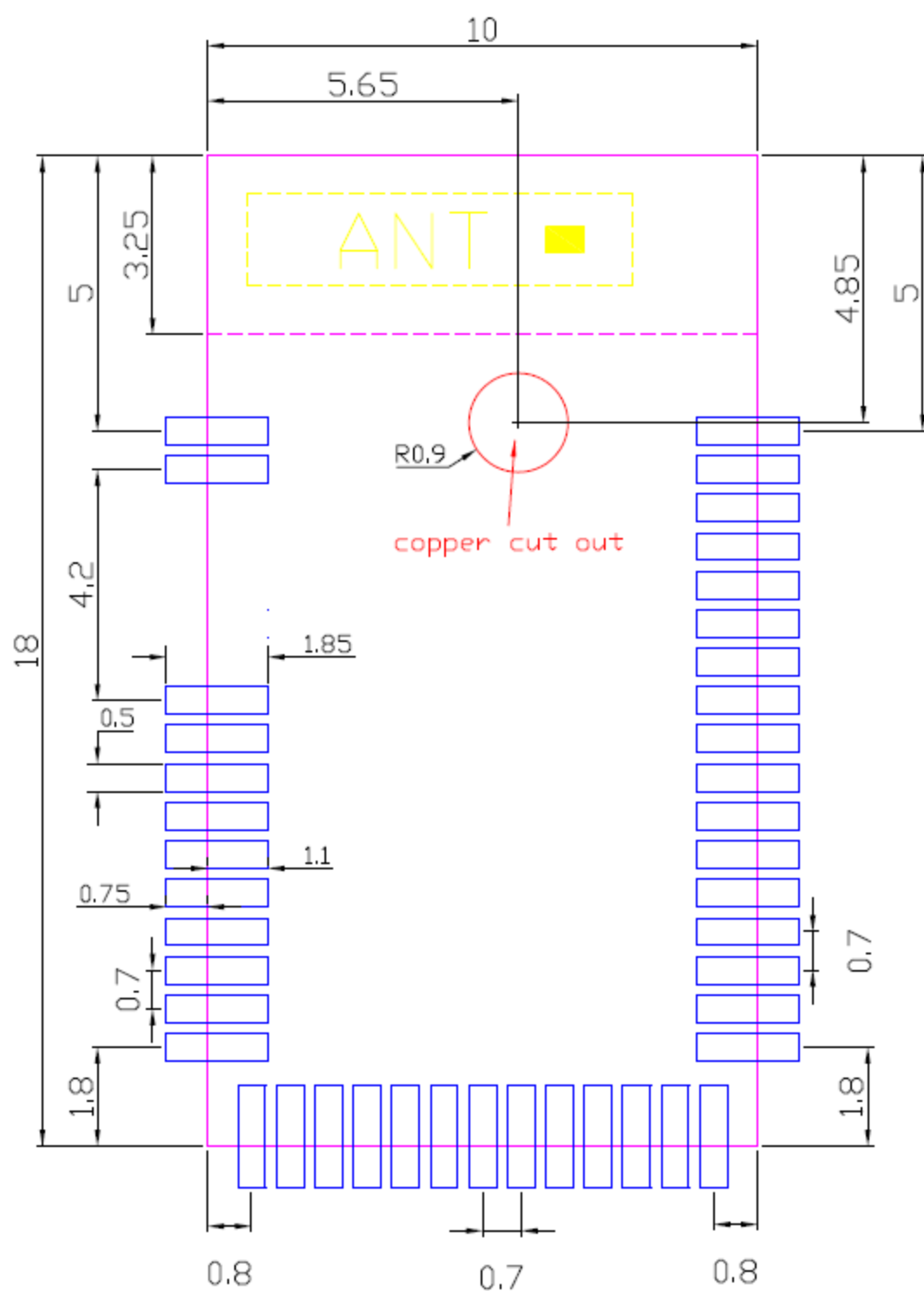
2. Product Dimension

2.1 MDBT40 Series

PCB Dimensions, & Pin Indication & Layout Guide

PCB SIZE : (L) 18 x (W) 10 mm





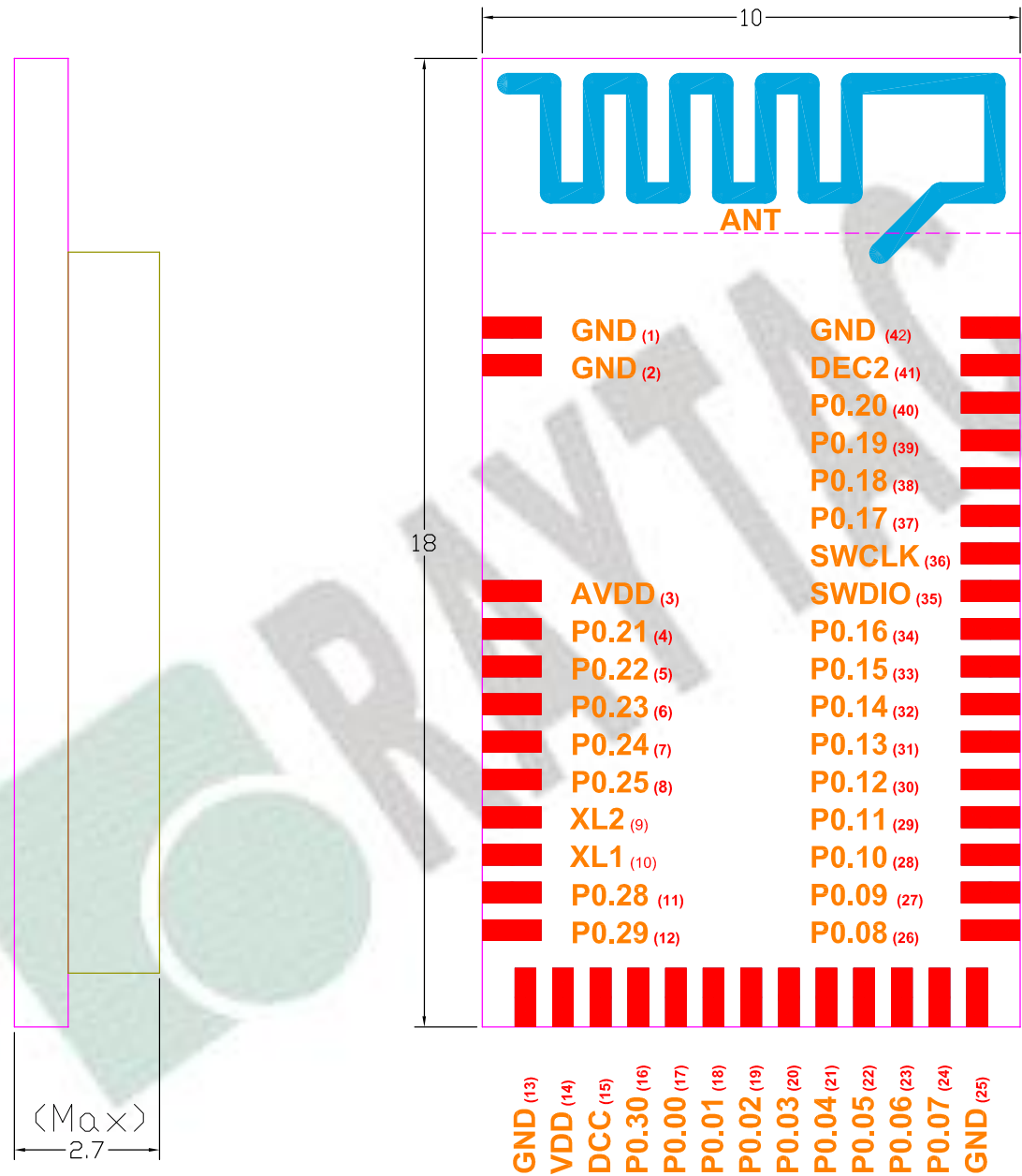
Top View (單位:mm)

recommended solder pad layout

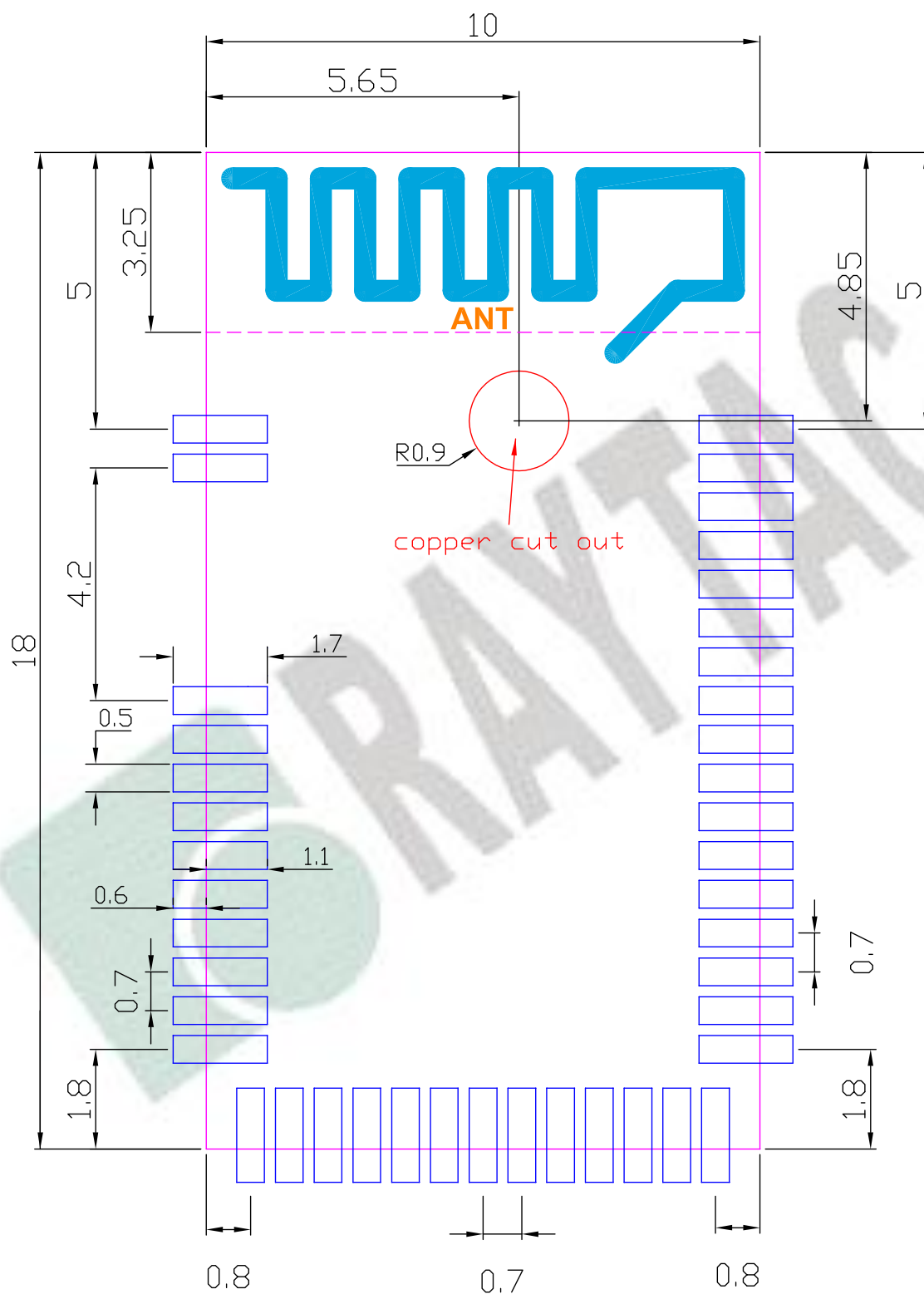
2.2 MDBT40-P Series

PCB Dimensions, & Pin Indication & Layout Guide

PCB SIZE : (L) 18 x (W) 10 mm



TOP 單位:(mm)



2.3 Pin Assignment

Pin No.	Name	Pin function	Description
(1)(2)	GND	Ground	The pad must be connected to a solid ground plane
(3)	AVDD	Power	Analog power supply
(4)	P0.21	Digital I/O	General-purpose digital I/O
(5)	P0.22	Digital I/O	General-purpose digital I/O
(6)	P0.23	Digital I/O	General-purpose digital I/O
(7)	P0.24	Digital I/O	General-purpose digital I/O
(8)	P0.25	Digital I/O	General-purpose digital I/O
(9)	P0.26	Digital I/O	General-purpose digital I/O
	AIN0	Analog input	ADC input 0
	XL2	Analog output	Connector for 32.768KHz crystal
(10)	P0.27	Digital I/O	General-purpose digital I/O
	AIN1	Analog input	ADC input 1
	XL1	Analog input	Connector for 32.768KHz crystal or external 32.768KHz clock reference
(11)	P0.28	Digital I/O	General-purpose digital I/O
(12)	P0.29	Digital I/O	General-purpose digital I/O
(13)	GND	Ground	The pad must be connected to a solid ground plane
(14)	VDD	Power	Power supply
(15)	DCC	Power	DC/DC output voltage to external LC filter
(16)	P0.30	Digital I/O	General-purpose digital I/O
(17)	P0.00	Digital I/O	General-purpose digital I/O
	AREF0	Analog input	ADC Reference voltage
(18)	P0.01	Digital I/O	General-purpose digital I/O
	AIN2	Analog input	ADC input 2
(19)	P0.02	Digital I/O	General-purpose digital I/O
	AIN3	Analog input	ADC input 3
(20)	P0.03	Digital I/O	General-purpose digital I/O
	AIN4	Analog input	ADC input 4
(21)	P0.04	Digital Input	General-purpose digital I/O
	AIN5	Analog input	ADC input 5
(22)	P0.05	Digital I/O	General-purpose digital I/O
	AIN6	Analog input	ADC input 6




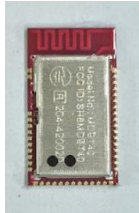

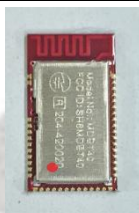

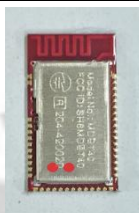


Pin No.	Name	Pin function	Description
(23)	P0.06	Digital I/O	General-purpose digital I/O
	AIN7	Analog input	ADC input 7
	AREF1	Analog input	ADC Reference voltage
(24)	P0.07	Digital I/O	General-purpose digital I/O
(25)	GND	Ground	The pad must be connected to a solid ground plane
(26)	P0.08	Digital I/O	General-purpose digital I/O
(27)	P0.09	Digital I/O	General-purpose digital I/O
(28)	P0.10	Digital I/O	General-purpose digital I/O
(29)	P0.11	Digital I/O	General-purpose digital I/O
(30)	P0.12	Digital I/O	General-purpose digital I/O
(31)	P0.13	Digital I/O	General-purpose digital I/O
(32)	P0.14	Digital I/O	General-purpose digital I/O
(33)	P0.15	Digital I/O	General-purpose digital I/O
(34)	P0.16	Digital I/O	General-purpose digital I/O
(35)	SWDIO/RESET	Digital I/O	System reset(active low).Also HW debug and flash Programming
(36)	SWDCLK	Digital input	HW debug and flash programming.
(37)	P0.17	Digital I/O	General-purpose digital I/O
(38)	P0.18	Digital I/O	General-purpose digital I/O
(39)	P0.19	Digital I/O	General-purpose digital I/O
(40)	P0.20	Digital I/O	General-purpose digital I/O
(41)	DEC2	Power	Power supply decoupling. Low voltage mode VCC
(42)	GND	Ground	The pad must be connected to a solid ground plane

¹ Digital I/O pad with 5mA source/sink capability.

3. Main Chip Solution

RF IC	Crystal Frequency
Nordic NRF51822/QFN48	16MHZ

4. Shipment Packaging Information

Model	Marking	Photo			
MDBT40-128 (left) MDBT40-P128 (right)	Black	Version 2 IC		Version 3 IC	
					
MDBT40-256 (left) MDBT40-P256 (right)	Red	Version 2 IC		Version 3 IC	
					
MDBT40-256R (left) MDBT40-P256R (right)	Yellow	Version 2 IC		Version 3 IC	
		N/A			

- Packaging Type: Tray only
- Minimum Package Quantity (MPQ): 88 pcs per Tray
- Carton Contents: 1760 pcs per Carton (20 Full Tray + 1 Empty Tray)
- Dimension of Carton: (L) 37 x (W) 20.5 x (H) 14 cm
- Gross Weight: approx. 3.5 kgs



Remark: Packaging may be subject to change without further notice.

5. Specification

5.1 Absolute Maximum Ratings

Symbol	Parameter	Min.	Max.	Unit
Supply voltages				
VDD		-0.3	+3.9	V
DEC2			2	V
VSS			0	V
I/O pin voltage				
VIO		-0.3	VDD + 0.3	V
Environmental QFN48 package				
Storage temperature		-40	+125	°C
MSL	Moisture Sensitivity Level		2	
ESD HBM	Human Body Model		4	kV
ESD CDM	Charged Device Model		750	V
Environmental WLCSP package				
Storage temperature		-40	+125	°C
MSL	Moisture Sensitivity Level		1	
ESD HBM	Human Body Model		4	kV
ESD CDM	Charged Device Model		500	V
Flash memory				
Endurance		20 000 ¹		write/erase cycles
Retention		10 years at 40 °C		
Number of times an address can be written between erase cycles			2	times

5.2 Operation Conditions

Symbol	Parameter	Notes	Min.	Typ.	Max.	Units
VDD	Supply voltage, normal mode		1.8	3.0	3.6	V
VDD	Supply voltage, normal mode, DC/DC converter output voltage 1.9 V		2.1	3.0	3.6	V
VDD	Supply voltage, low voltage mode	1	1.75	1.8	1.95	V
t _{R_VDD}	Supply rise time (0 V to 1.8 V)	2			60	ms
T _A	Operating temperature		-40	25	85	°C

Remark: Above operating temperature is applied in Version 3 IC. Operating temperature for Version 2 IC is -25°C to 75°C with typical 25°C.

5.3 Electrical Specifications

5.3.1 Radio Transceiver

. General Radio Characteristics

Symbol	Description	Note	Min.	Typ.	Max.	Units	Test level
f_{OP}	Operating frequencies.	1 MHz channel spacing.	2400		2483	MHz	N/A
PLL_{res}	PLL programming resolution.			1		MHz	N/A
Δf_{250}	Frequency deviation at 250 kbps.			± 170		kHz	2
Δf_{1M}	Frequency deviation at 1 Mbps.			± 170		kHz	2
Δf_{2M}	Frequency deviation at 2 Mbps.			± 320		kHz	2
Δf_{BLE}	Frequency deviation at BLE.		± 225	± 250	± 275	kHz	4
bps_{FSK}	On-air data rate.		250		2000	kbps	N/A

. Radio Current Consumption

Symbol	Description	Note	Min.	Typ.	Max.	Units	Test level
$I_{TX,+4dBm}$	TX only run current at $P_{OUT} = +4$ dBm.	1		16		mA	4
$I_{TX,0dBm}$	TX only run current at $P_{OUT} = 0$ dBm.	1		10.5		mA	4
$I_{TX,-4dBm}$	TX only run current at $P_{OUT} = -4$ dBm.	1		8		mA	2
$I_{TX,-8dBm}$	TX only run current at $P_{OUT} = -8$ dBm.	1		7		mA	2
$I_{TX,-12dBm}$	TX only run current at $P_{OUT} = -12$ dBm.	1		6.5		mA	2
$I_{TX,-16dBm}$	TX only run current at $P_{OUT} = -16$ dBm.	1		6		mA	2
$I_{TX,-20dBm}$	TX only run current at $P_{OUT} = -20$ dBm.	1		5.5		mA	2
$I_{TX,-30dBm}$	TX only run current at $P_{OUT} = -30$ dBm.	1		5.5		mA	2
$I_{START,TX}$	TX startup current.	2		7		mA	1
$I_{RX,250}$	RX only run current at 250 kbps.			12.6		mA	1
$I_{RX,1M}$	RX only run current at 1 Mbps.			13		mA	4
$I_{RX,2M}$	RX only run current at 2 Mbps.			13.4		mA	1
$I_{START,RX}$	RX startup current.	3		8.7		mA	1

1. Valid for data rates 250 kbps, 1 Mbps, and 2 Mbps.
2. Average current consumption (at 0 dBm TX output power) for TX startup (130 μ s), and when changing mode from RX to TX (130 μ s).
3. Average current consumption for RX startup (130 μ s), and when changing mode from TX to RX (130 μ s).

5.3.2. Transmitter Specifications

Symbol	Description	Min.	Typ.	Max.	Units	Test level
P _{RF}	Maximum output power.		4		dBm	4
P _{RFC}	RF power control range.	20	24		dB	2
PRFCR	RF power accuracy.			±4	dB	1
P _{WHISP}	RF power whisper mode.		-30		dBm	2
P _{BW2}	20 dB bandwidth for modulated carrier (2 Mbps).		1800	2000	kHz	2
P _{BW1}	20 dB bandwidth for modulated carrier (1 Mbps).		950	1100	kHz	2
P _{BW250}	20 dB bandwidth for modulated carrier (250 kbps).		700	800	kHz	2
P _{RF1.2}	1 st Adjacent Channel Transmit Power. ±2 MHz (2 Mbps).			-20	dBc	2
P _{RF2.2}	2 nd Adjacent Channel Transmit Power. ±4 MHz (2 Mbps).			-45	dBc	2
P _{RF1.1}	1 st Adjacent Channel Transmit Power. ±1 MHz (1 Mbps).			-20	dBc	2
P _{RF2.1}	2 nd Adjacent Channel Transmit Power. ±2 MHz (1 Mbps).			-40	dBc	2
P _{RF1.250}	1 st Adjacent Channel Transmit Power. ±1 MHz (250 kbps).			-25	dBc	2
P _{RF2.250}	2 nd Adjacent Channel Transmit Power. ±2 MHz (250 kbps).			-40	dBc	2
t _{TX,30}	Maximum consecutive transmission time, f _{TOL} < ±30 ppm.			16	ms	1
t _{TX,60}	Maximum consecutive transmission time, f _{TOL} < ±60 ppm.			4	ms	1

5.3.3 Receiver Specifications

Symbol	Description	Min.	Typ.	Max.	Units	Test level
Receiver operation						
PRX _{MAX}	Maximum received signal strength at < 0.1% PER.		0		dBm	1
PRX _{SENS,2M}	Sensitivity (0.1% BER) at 2 Mbps.		-85		dBm	2
PRX _{SENS,1M}	Sensitivity (0.1% BER) at 1 Mbps.		-90		dBm	2
PRX _{SENS,250k}	Sensitivity (0.1% BER) at 250 kbps.		-96		dBm	2
P _{SENS IT} 1 Mbps BLE	Receiver sensitivity: Ideal transmitter.		-93		dBm	2
P _{SENS DT} 1 Mbps BLE	Receiver sensitivity: Dirty transmitter. ¹		-91		dBm	2
RX selectivity - modulated interfering signal²						
2 Mbps						
C/I _{CO}	C/I co-channel.		12		dB	2
C/I _{1ST}	1 st ACS, C/I 2 MHz.		-4		dB	2
C/I _{2ND}	2 nd ACS, C/I 4 MHz.		-24		dB	2
C/I _{3RD}	3 rd ACS, C/I 6 MHz.		-28		dB	2
C/I _{6th}	6 th ACS, C/I 12 MHz.		-44		dB	2
C/I _{Nth}	N th ACS, C/I f _i > 25 MHz.		-50		dB	2
1 Mbps						
C/I _{CO}	C/I co-channel (1 Mbps).		12		dB	2
C/I _{1ST}	1 st ACS, C/I 1 MHz.		4		dB	2
C/I _{2ND}	2 nd ACS, C/I 2 MHz.		-24		dB	2
C/I _{3RD}	3 rd ACS, C/I 3 MHz.		-30		dB	2
C/I _{6th}	6 th ACS, C/I 6 MHz.		-40		dB	2
C/I _{12th}	12 th ACS, C/I 12 MHz.		-50		dB	2
C/I _{Nth}	N th ACS, C/I f _i > 25 MHz.		-53		dB	2

Symbol	Description	Min.	Typ.	Max.	Units	Test level
250 kbps						
C/I _{CO}	C/I co-channel.		4		dB	2
C/I _{1ST}	1 st ACS, C/I 1 MHz.		-10		dB	2
C/I _{2ND}	2 nd ACS, C/I 2 MHz.		-34		dB	2
C/I _{3RD}	3 rd ACS, C/I 3 MHz.		-39		dB	2
C/I _{6th}	6 th ACS, C/I $f_i > 6$ MHz.		-50		dB	2
C/I _{12th}	12 th ACS, C/I 12 MHz.		-55		dB	2
C/I _{Nth}	N th ACS, C/I $f_i > 25$ MHz.		-60		dB	2
Bluetooth Low Energy RX selectivity						
C/I _{CO}	C/I co-channel.		10		dB	2
C/I _{1ST}	1 st ACS, C/I 1 MHz.		1		dB	2
C/I _{2ND}	2 nd ACS, C/I 2 MHz.		-25		dB	2
C/I _{3+N}	ACS, C/I (3+n) MHz offset [n = 0, 1, 2, ...].		-51		dB	2
C/I _{Image}	Image blocking level.		-30		dB	2
C/I _{Image±1MHz}	Adjacent channel to image blocking level (±1 MHz).		-31		dB	2
RX intermodulation³						
P_IMD _{2Mbps}	IMD performance, 2 Mbps, 3rd, 4th, and 5th offset channel.		-41		dBm	2
P_IMD _{1Mbps}	IMD performance, 1 Mbps, 3rd, 4th, and 5th offset channel.		-40		dBm	2
P_IMD _{250kbps}	IMD performance, 250 kbps, 3rd, 4th, and 5th offset channel.		-36		dBm	2
P_IMD _{BLE}	IMD performance, 1 Mbps BLE, 3rd, 4th, and 5th offset channel.		-39		dBm	2

1. As defined in the *Bluetooth Core Specification v4.0 Volume 6: Core System Package (Low Energy Controller Volume)*.
2. Wanted signal level at $P_{IN} = -67$ dBm. One interferer is used, having equal modulation as the wanted signal. The input power of the interferer where the sensitivity equals BER = 0.1% is presented.
3. Wanted signal level at $P_{IN} = -64$ 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 wanted signal. The input power of interferers where the sensitivity equals BER = 0.1% is presented.

5.3.4 Radio Timing Parameters

Symbol	Description	250 k	1 M	2 M	BLE	Jitter	Units
t_{TXEN}	Time between TXEN task and READY event.	132	132	132	140	0	μs
$t_{TXDISABLE}$	Time between DISABLE task and DISABLED event when the radio was in TX.	10	4	3	4	1	μs
t_{RXEN}	Time between the RXEN task and READY event.	130	130	130	138	0	μs
$t_{RXDISABLE}$	Time between DISABLE task and DISABLED event when the radio was in RX.	0	0	0	0	1	μs
$t_{TXCHAIN}$	TX chain delay.	5	1	0.5	1	0	μs
$t_{RXCHAIN}$	RX chain delay.	12	2	2.5	3	0	μs

5.3.5 RSSI Specifications

Symbol	Description	Note	Min.	Typ.	Max.	Units	Test level
$RSSI_{ACC}$	RSSI accuracy.	Valid range -50 dBm to -80 dBm.			± 6	dB	2
$RSSI_{RESOLUTION}$	RSSI resolution.			1		dB	1
$RSSI_{PERIOD}$	Sample period.		8.8			μs	1
$RSSI_{CURRENT}$	Current consumption in addition to I_{RX} .			250		μA	1

5.3.6 CPU

Symbol	Description	Min.	Typ.	Max.	Units	Test level
$I_{CPU, Flash}$	Run current at 16 MHz. Executing code from flash memory.		4.4 ¹		mA	2
$I_{CPU, RAM}$	Run current at 16 MHz. Executing code from RAM.		2.4 ²		mA	1
$I_{START, CPU}$	CPU startup current.		600		μA	1
$t_{START, CPU}$	IDLE to CPU execute.	0 ³			μs	1

1. Includes CPU, flash, 1V2, 1V7, RC16M.
2. Includes CPU, RAM, 1V2, RC16M.
3. t_{1V2} if 1V2 regulator is not running already.

5.3.7 Power Management

Symbol	Description	Note	Min.	Typ.	Max.	Units	Test level
$t_{POR, 1\mu s}$	Time Reset is active from VDD reaches 1.7 V with 1 μs rise time.		0.2	2.7		ms	1
$t_{POR, 50 ms}$	Time Reset is active from VDD reaches 1.7 V with 50 ms rise time.		6.5	29		ms	1
I_{OFF}	Current in SYSTEM OFF, no RAM retention.			0.6 ¹		μA	2
$I_{OFF, 8 k}$	Current in SYSTEM OFF mode 8 kB SRAM retention.			1.2 ¹		μA	2
$I_{OFF, 16 k}$	Current in SYSTEM OFF mode 16 kB SRAM retention.			1.8 ¹		μA	2
I_{OFF2ON}	OFF to CPU execute transition current.			400		μA	1
t_{OFF2ON}	OFF to CPU execute.			9.6	10.6	μs	1
I_{ON}	SYSTEM-ON base current with 16 kB RAM enabled.			2.6 ¹		μA	2
t_{1V2}	Startup time for 1V2 regulator.			2.3		μs	1
$I_{1V2RC16}$	Current drawn by 1V2 regulator and 16 MHz RCOSC when both are on at the same time.	See Table 28 on page 39		880 ²		μA	1
$I_{1V2XO16}$	Current drawn by 1V2 regulator and 16 MHz XOOSC when both are on at the same time.	See Table 28 on page 39		810 ²		μA	1
$I_{1V2XO32}$	Current drawn by 1V2 regulator and 32 MHz XOOSC when both are on at the same time.	See Table 28 on page 39		840 ²		μA	1
t_{1V7}	Startup time for 1V7 regulator			2	3.6	μs	1
I_{1V7}	Current drawn by 1V7 regulator			105		μA	2
I_{DCDC}	Current drawn by DC/DC converter.			300		μA	1
F_{DCDC}	DC/DC converter current conversion factor.		0.65 ³		1.2 ³		1
$t_{START,DCDC}$	DC/DC converter startup time.		10 ³		425 ³	μs	1

1. Add 1 μA to the current value if the device is used in Low voltage mode.
2. This number includes the current used by the automated power and clock management system.
3. F_{DCDC} and $t_{START,DCDC}$ will vary depending on VDD and device internal current consumption (I_{DD}). The range of values stated in this specification is for VDD between 2.1 V and 3.6 V, and I_{DD} between 4 mA and 20 mA. Please refer to the *nRF51 Series Reference Manual*, v1.1 or later, for a method to calculate these numbers based on VDD and I_{DD} .

7. Antenna

7.1 MDBT40 Series



AT7020 Series **Multilayer Chip Antenna**

Features

- ❖ Monolithic SMD with small, low-profile and light-weight type.
- ❖ Wide bandwidth

Applications

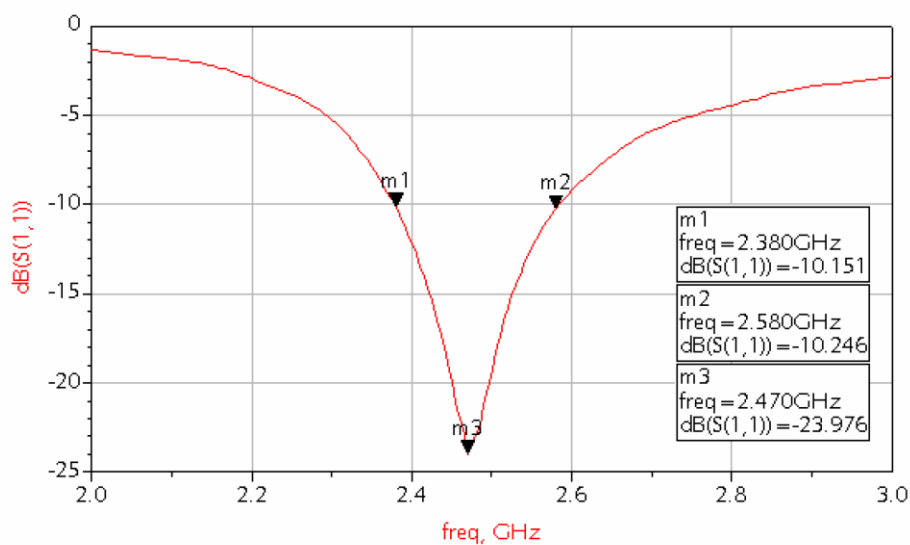
- ❖ 2.4GHz WLAN, Home RF, Bluetooth Modules, etc.



Specifications

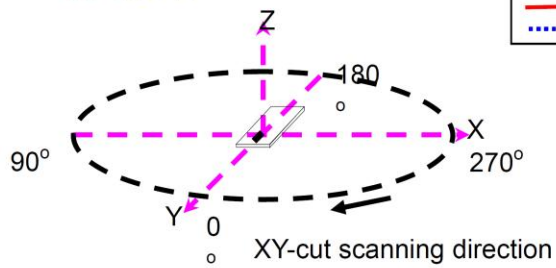
Part Number	Frequency Range (MHz)	Peak Gain (dBi typ.)	Average Gain (dBi typ.)	VSWR	Impedance
AT7020 -E3R0HBA_	2400~2500	1.3dBi (XZ-V)	-0.5dBi (XZ-V)	2 max.	50 Ω

- ❖ Return Loss/With Matching Circuits

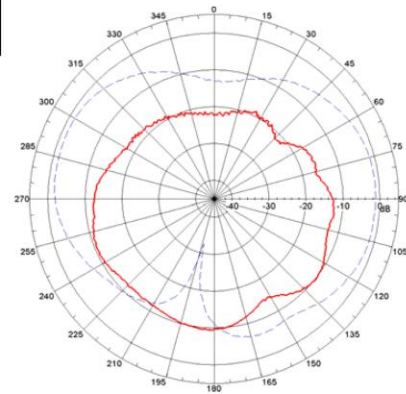


❖ Radiation Patterns

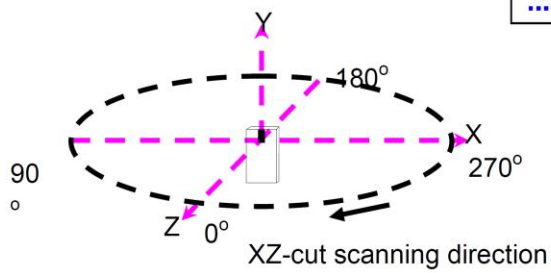
XY-V/XY-H



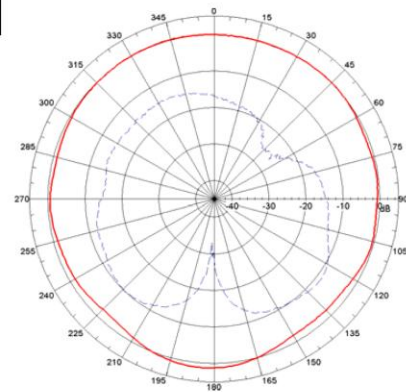
XY cut @2.45GHz
— Vertical
..... Horizontal



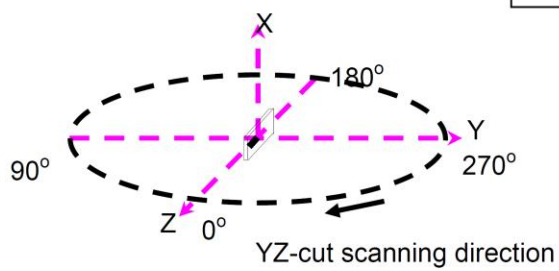
XZ-V/XZ-H



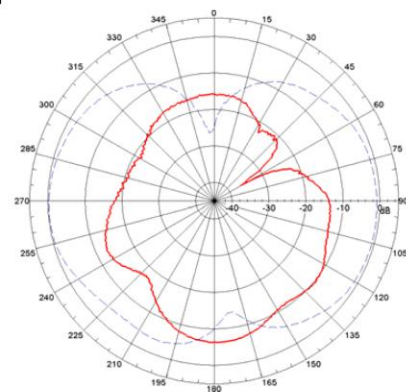
XZ cut @2.45GHz
— Vertical
..... Horizontal



YZ-V/YZ-H



YZ cut @2.45GHz
— Vertical
..... Horizontal

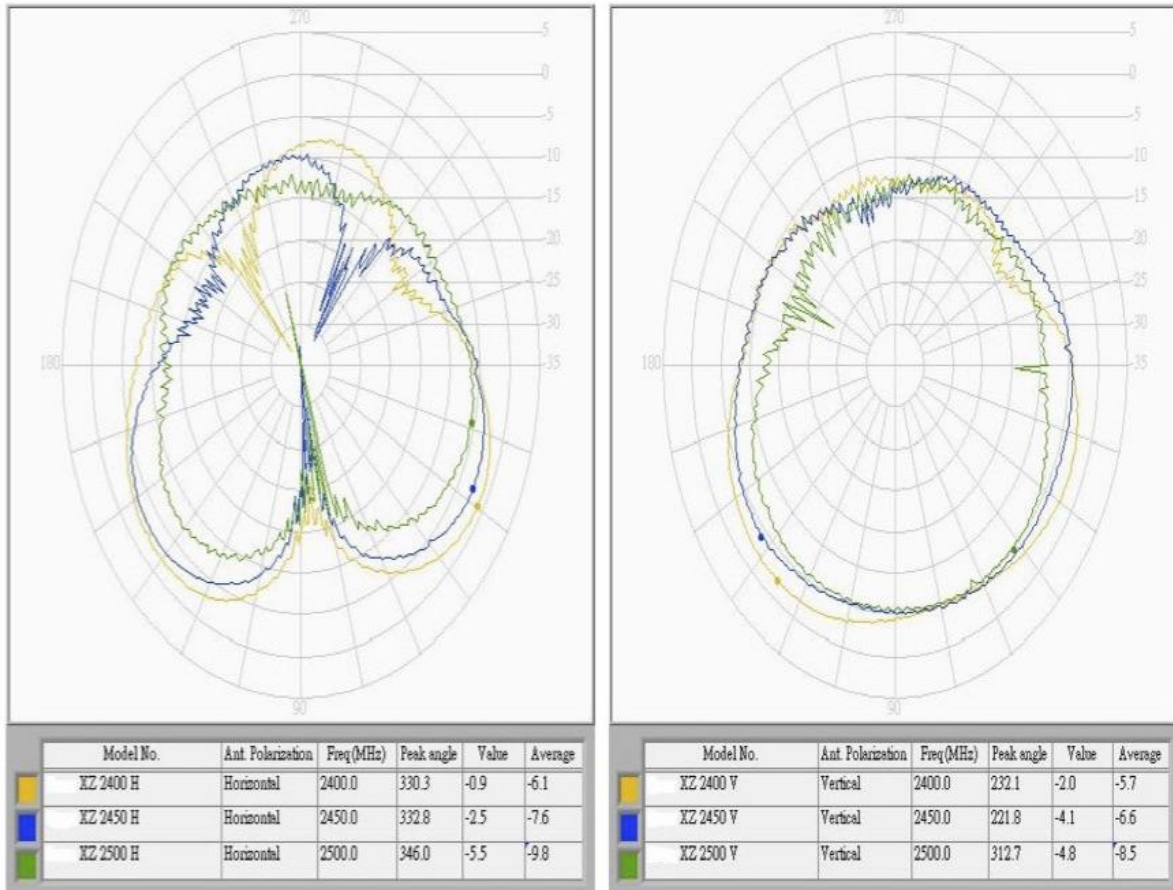


7.2 MDBT40-P Series

Antenna Manufacturer : Raytac Corporation.

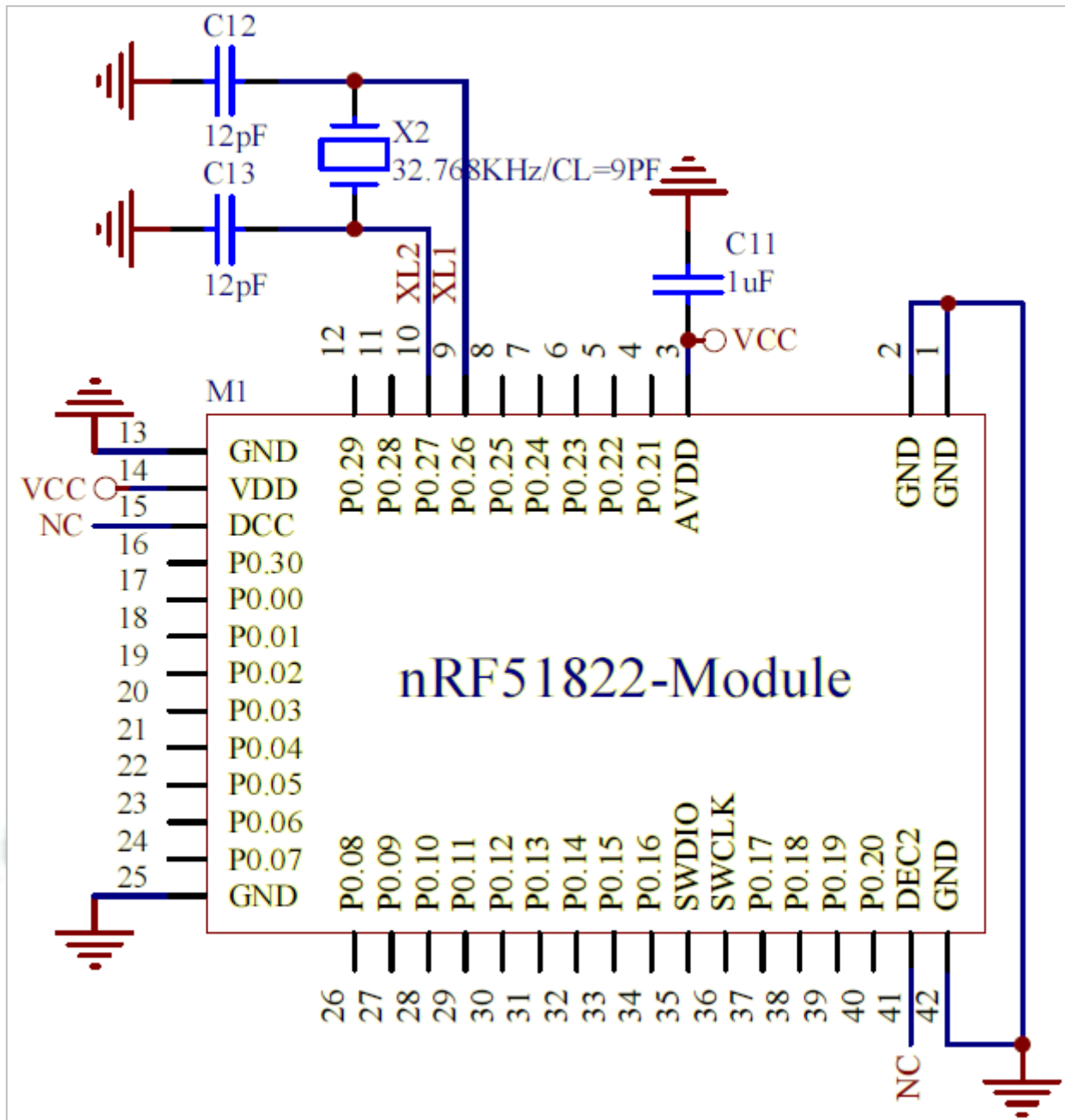
MODEL:Printed Trace Antenna

C. X-Z polarization scan

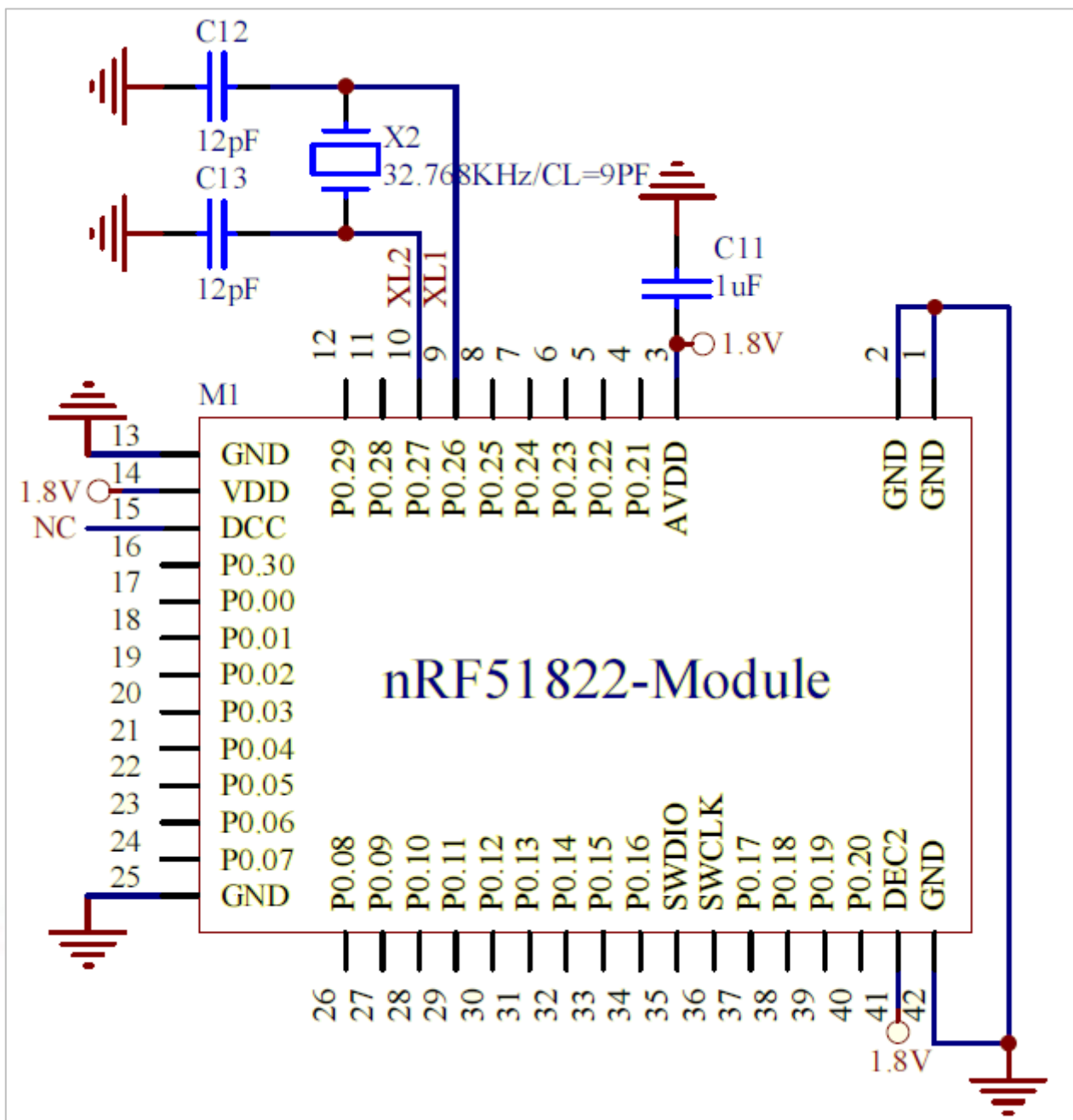


8. Reference Circuit

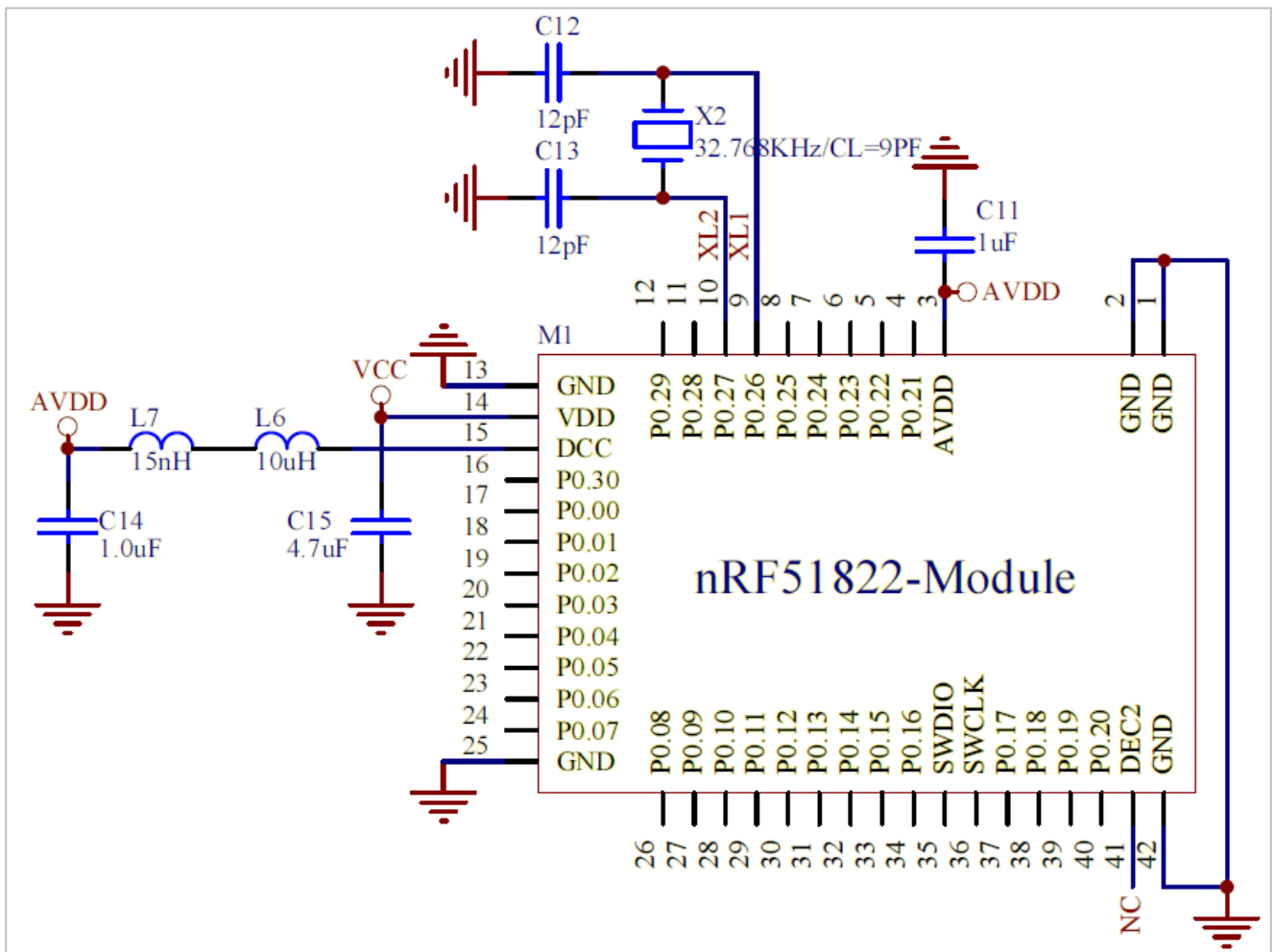
8.1 nRF51822 Schematic with Internal LDO



8.2 nRF51822 Schematic with 1.8V Low Voltage Mode



8.3 nRF51822 Schematic with Internal DC/DC Converter

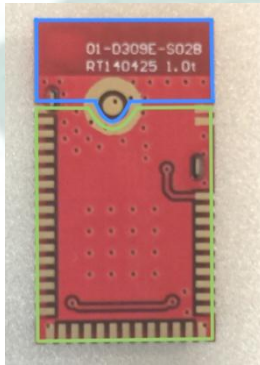
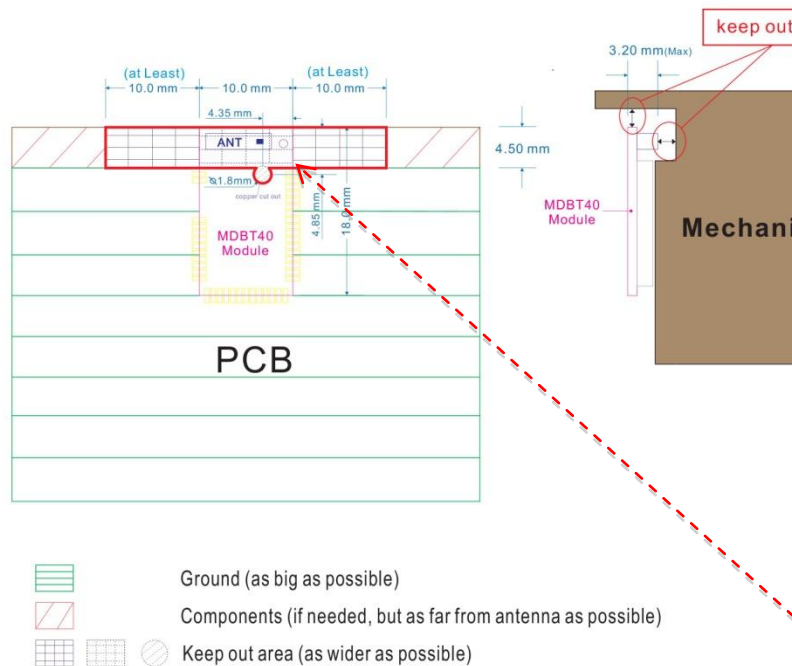


Remark:

Version 3 supports Internal DC/DC Converter, which is not suggested to use in Version 2 IC.

9. Carrier Keep-Out Area

Reference Item: MDBT40 / MDBT40ANT/MDBT40-P



1. Carrier Board under the **BLUE PART** (antenna and test pin pad)

Carrier Board **is not allowed** to have ground or circuit or components **in any layer**.

2. Carrier Board under the **GREEN PART**

- a. Suggest to equip ground full green area **in first layer**
- b. If first layer equipped ground, 2nd and 3rd layer can have circuit in this area.
- c. If first layer equipped ground, 4th layer can have components in this area.

10. Certification

10.1 Declaration ID Certification



Remark: Ginstar Corporation is one of subsidiaries of Raytac Corporation.

10.2 FCC Certification (USA)

TCB

GRANT OF EQUIPMENT AUTHORIZATION

TCB

Certification
Issued Under the Authority of the
Federal Communications Commission
By:

PHOENIX TESTLAB GmbH
Koenigswinkel 10
32825 Blomberg,
Germany

Date of Grant: 02/17/2014

Application Dated: 02/17/2014

Raytac Corp.
5F., No.3, Jiankang Rd., Zhonghe Dist.,
New Taipei City,, 23586
Taiwan

Attention: Venson Liao , R&D Manager

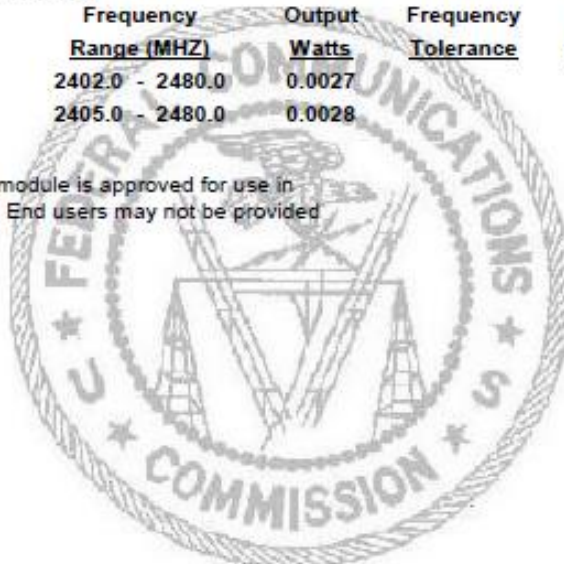
NOT TRANSFERABLE

EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE,
and is VALID ONLY for the equipment identified hereon for use under the
Commission's Rules and Regulations listed below.

FCC IDENTIFIER: SH6MDBT40
Name of Grantee: Raytac Corp.
Equipment Class: Digital Transmission System
Notes: Bluetooth Module
Modular Type: Single Modular

<u>Grant Notes</u>	<u>FCC Rule Parts</u>	<u>Frequency</u>	<u>Output</u>	<u>Frequency</u>	<u>Emission</u>
		<u>Range (MHZ)</u>	<u>Watts</u>	<u>Tolerance</u>	
	15C	2402.0 - 2480.0	0.0027		
	15C	2405.0 - 2480.0	0.0028		

Output power listed is peak conducted. This OEM module is approved for use in
products operating as portable transmitting device. End users may not be provided
with the module installation instructions.





Certificate Number: INF412101

This is to certify that the following products have been tested by us with the listed standards and found in conformity with the procedures given in ANSI C63.4-2009 and all tests are performed according to FCC Part 15 and Canada Standard ICES-003 Issue 5 Rules.

This Certificate applies to the tested sample below mentioned only and shall not imply an assessment of the whole production. It is only valid in connection with the test report number: FD412101.

Applicant : Raytac Corporation
 Product Name : BT4.0 module
 Model No. : MDBT40
 Brand Name : Raytac

Applied Standards : FCC Part 15, Subpart B, Class B
 ICES-003 Issue 5
 ANSI C63.4:2009




 Kent Chen / Assistant Manager
 February 12, 2014

International Certification Corp.

Address: No. 3-1, Lane 6, Wen San 3rd St., Kwei Shan Hsiang, Tao Yuan Hsien 333, Taiwan, R.O.C.
 Tel: 886-3-271-8666, Fax: 886-3-318-0155

Rev. 01

10.3 TELEC Certification (Japanese)

RCB Japan
Königswinkel 10
D-32625 Blomberg, Germany
Phone: +49 (0) 5235 9500-75
Fax: +49 (0) 5235 9500-28
www.phoenix-testlab.de



Certificate

No: 14-110771

of Technical Regulations Conformity for Specified Radio Equipment in Japan

PHOENIX TESTLAB GmbH, operating as a Registered Certification Body (RCB ID: 204) with respect to Japan, declares that the listed product complies with the Technical Regulations Conformity Certification of Specified Radio Equipment (ordinance of MPT N°. 37, 1981), Article 2, Paragraph 1, Item 19.

Product description: **BT4.0 module**
Trademark / model name: **Raytac / MDBT40**
Family name: --
Serial No: --
Software Release No: --
Type of emissions: **F1D/G1D**
Frequency and power: **2402-2480 MHz; 40 ch; 3.0 mW**
2405-2480 MHz; 16 ch; 3.0 mW

Manufacturer: **Raytac Corporation**
Address: **5F., No.3, Jiankang Rd.,**
Zhonghe Dist
City: **23586 New Taipei City**
Country: **Taiwan**

This certificate is granted to:

Certificate holder: **Raytac Corporation**
Address: **5F., No.3, Jiankang Rd.,**
Zhonghe Dist
City: **23586 New Taipei City**
Country: **Taiwan**

This certificate has 2 annexes.

Blomberg, 17 Feb. 2014
Place, Date

PHOENIX TESTLAB GmbH
Königswinkel 10
32625 Blomberg
Tel: 0 52 35 95 00 75
Fax: 0 52 35 95 00 28
Signature, Stamp

10.4 NCC Certificate

耕興股份有限公司

低功率射頻電機型式認證證明

- | | |
|----------------|---|
| (1) 申請者 | : 勁達國際電子有限公司
(臺北市大安區和平東路1段145號5樓之1) |
| (2) 製造廠商 | : 勁達國際電子有限公司 |
| (3) 器材名稱 | : BT4.0 module |
| (4) 廠牌/型號 | : Raytac / MDBT40 |
| (5) 發射功率(電場強度) | : 2.402-2.480 GHz: 4.38dBm |
| (6) 工作頻率 | : 2.402-2.480 GHz (GFSK 40CH, ChS-2MHz) |
| (7) 審驗日期 | : 104年02月04日 |
| (8) 審驗合格標籤式樣 | : |



CCAF15LP0280T1



說明:

1. 請依上列標籤式樣自製標籤，標貼或印鑄於器材本體明顯處，始得販賣或公開陳列。
2. 經型式認證合格之低功率射頻電機，其廠牌、型號、設計、射頻性能如有變更，應重新申請型式認證。
3. 違反低功率電波輻射性電機管理辦法之規定，擅自使用或變更無線電頻率、電功率者，除依電信法規定處罰外，驗證機關(構)並得廢止其型式認證證明或型式認證標籤。
4. 送審廠商應保留送審樣品供日後核對。
5. 本型式認證證明及其合格標籤使用權專屬取得本證明者。依電信管制射頻器材審驗辦法第15條規定，持有人得經由網際網路申請同意他人於同廠牌同型號之電信管制射頻器材使用型式認證標籤，並於次日起30天內，應檢具「電信管制射頻器材審驗合格標籤或符合性聲明標籤同意使用備查表」送國家通訊傳播委員會備查。

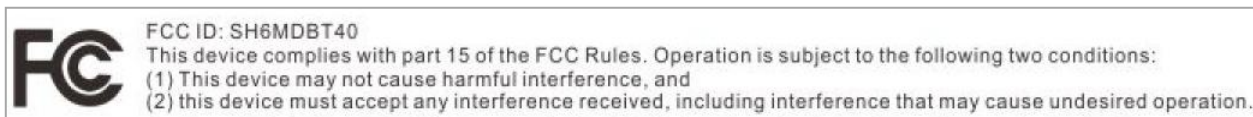
備註:

1. 本器材符合低功率射頻電機技術規範(第3.10.1章節)之規定。
2. 本器材使用 Chip 天線，天線增益 1.3dBi。
3. 本公司係經國家通訊傳播委員會委託之驗證機構(電信管制射頻器材驗證機構認證證書號碼：NCC-RCB-05/電信終端設備驗證機構認證證書號碼：NCC-RCB-05)，核發本型式認證證明。
4. 依「商品標示法」及「資訊、通信及消費性電子商品標示基準」規定，標示事項貼於商品或內外包裝上，以免違法而受處分。
5. 本案審驗模組為完全模組，適用於任何平台。「平台」定義如下：若器材不組裝本案審驗模組，消費者仍能正常使用該器材主要功能，該器材得視為平台。若器材不組裝本案審驗模組，消費者不能正常使用該器材主要功能，則該器材不能視為平台，該類不同廠牌型號器材組裝本案審驗模組後，須分別申請型式認證。

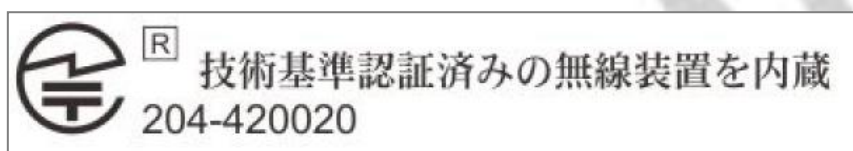
10.5 End-Product Label

Customers are suggested using following label content for FCC, TELEC and NCC certification.

FCC (USA)

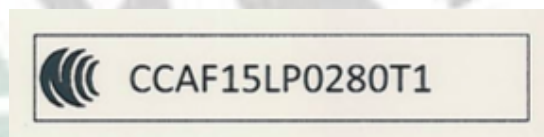


TELEC (Japan)



NCC (Taiwan)

MDBT40 Series



MDBT40-P Series



平台廠商需於平台上標示<本產品內含射頻模  CCAF15LP0280T1 字樣>

註：平台定義為若器材不組裝本模組，消費者仍能正常使用本器材之主要功能，該器材得視為平台。

10.6 CE Test Report (EU)

Produkte Products		 TÜVRheinland®	
Prüfbericht-Nr.: Test Report No.:	10047574 002	Auftrags-Nr.: Order No.:	114024339 Seite 1 von 26 Page 1 of 26
Kunden-Referenz-Nr.: Client Reference No.:	N/A	Auftragsdatum: Order date:	July 7, 2014
Auftraggeber: Client:	Raytac Corporation, 5F., No. 3, Jiankang Rd., TW-23586 Zhonghe Dist., New Taipei City, Taiwan, ROC		
Prüfgegenstand: Test item:	Bluetooth 4.1 Module		
Bezeichnung / Typ-Nr.: Identification / Type No.:	MDBT40		
Auftrags-Inhalt: Order content:	Test Report for CE compliance, R&TTE Directive		
Prüfgrundlage: Test specification:	EN 300 328 V 1.8.1 EN 62479:2010 Refer to section 1.1 Test Specifications for more details.		
Wareneingangsdatum: Date of receipt:	7/15/2014		
Prüfmuster-Nr.: Test sample No.:	A000085167-002 A000085167-001		
Prüfzeitraum: Testing period:	21-Jul-2014 - 24-Jul-2014		
Ort der Prüfung: Place of testing:	EMC/RF Laboratory Taipei		
Prüflaboratorium: Testing laboratory:	TUV Rheinland Taiwan Ltd.		
Prüfergebnis*: Test result*:	Pass		
geprüft von / tested by:		kontrolliert von / reviewed by:	
2014-08-04 Ryan W. T. Chen / Project Engineer Datum Name / Stellung Unterschrift Date Name / Position Signature		2014-08-04 René Charton / Senior Project Manager Datum Name / Stellung Unterschrift Date Name / Position Signature	
Sonstiges / Other:			
Zustand des Prüfgegenstandes bei Anlieferung: Condition of the test item at delivery:		Prüfmuster vollständig und unbeschädigt Test item complete and undamaged	
* Legende: 1 = sehr gut 2 = gut 3 = befriedigend 4 = ausreichend 5 = mangelhaft P(ass) = entspricht o.g. Prüfgrundlage(n) F(ail) = entspricht nicht o.g. Prüfgrundlage(n) N/A = nicht anwendbar N/T = nicht getestet Legend: 1 = very good 2 = good 3 = satisfactory 4 = sufficient 5 = poor P(ass) = passed a.m. test specification(s) F(ail) = failed a.m. test specification(s) N/A = not applicable N/T = not tested			
Dieser Prüfbericht bezieht sich nur auf das o.g. Prüfmuster und darf ohne Genehmigung der Prüfstelle nicht auszugsweise vervielfältigt werden. Dieser Bericht berechtigt nicht zur Verwendung eines Prüfzeichens. This test report only relates to the a. m. test sample. Without permission of the test center this test report is not permitted to be duplicated in extracts. This test report does not entitle to carry any test mark.			
V04			
TÜV Rheinland LGA Products GmbH · Tillystraße 2 · D - 90431 Nürnberg · Tel.: +49 911 655 5225 · Fax: +49 911 655 5226 Mail: service@de.tuv.com · Web: www.tuv.com			

10.7 RoHS Report



測試報告

號碼(No.) : CE/2014/93151

日期(Date) : 2014/09/23

頁數(Page): 2 of 6

Test Report

勁達國際電子有限公司

RAYTAC CORPORATION

新北市中和區建康路3號5樓

5F, NO. 3, JIANKANG RD., ZHONGHE DIST, NEW TAIPEI CITY 23586, TAIWAN (R. O. C.)



測試結果(Test Results)

測試部位(PART NAME)No.1 : 整體混測 (MIXED ALL PARTS)

測試項目 (Test Items)	單位 (Unit)	測試方法 (Method)	方法偵測 極限值 (MDL)	結果 (Result)
				No.1
鎘 / Cadmium (Cd)	mg/kg	參考 IEC 62321-5: 2013 方法, 以感應耦合電漿原子發射光譜儀檢測. / With reference to IEC 62321-5: 2013 and performed by ICP-AES.	2	n.d.
鉛 / Lead (Pb)	mg/kg	參考 IEC 62321-5: 2013 方法, 以感應耦合電漿原子發射光譜儀檢測. / With reference to IEC 62321-5: 2013 and performed by ICP-AES.	2	11
汞 / Mercury (Hg)	mg/kg	參考 IEC 62321-4: 2013 方法, 以感應耦合電漿原子發射光譜儀檢測. / With reference to IEC 62321-4: 2013 and performed by ICP-AES.	2	n.d.
六價鉻 / Hexavalent Chromium Cr(VI)	mg/kg	參考 IEC 62321: 2008 方法, 以 UV-VIS 檢測. / With reference to IEC 62321: 2008 and performed by UV-VIS.	2	n.d.
多溴聯苯總和 / Sum of PBBs	mg/kg	參考 IEC 62321: 2008 方法, 以氣相層析/質譜儀檢測. / With reference to IEC 62321: 2008 and performed by GC/MS.	-	n.d.
一溴聯苯 / Monobromobiphenyl	mg/kg		5	n.d.
二溴聯苯 / Dibromobiphenyl	mg/kg		5	n.d.
三溴聯苯 / Tribromobiphenyl	mg/kg		5	n.d.
四溴聯苯 / Tetrabromobiphenyl	mg/kg		5	n.d.
五溴聯苯 / Pentabromobiphenyl	mg/kg		5	n.d.
六溴聯苯 / Hexabromobiphenyl	mg/kg		5	n.d.
七溴聯苯 / Heptabromobiphenyl	mg/kg		5	n.d.
八溴聯苯 / Octabromobiphenyl	mg/kg		5	n.d.
九溴聯苯 / Nonabromobiphenyl	mg/kg		5	n.d.
十溴聯苯 / Decabromobiphenyl	mg/kg		5	n.d.

This document is issued by the Company subject to its General Conditions of Service printed overleaf, available on request or accessible at <http://www.sgs.com/en/Terms-and-Conditions.aspx> and, for electronic format documents, subject to Terms and Conditions for Electronic Documents at <http://www.sgs.com/en/Terms-and-Conditions/Termse-Documents.aspx>. Attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein. Any holder of this document is advised that information contained hereon reflects the Company's findings at the time of its intervention only and within the limits of client's instruction, if any. The Company's sole responsibility is to its Client and this document does not exonerate parties to a transaction from exercising all their rights and obligations under the transaction documents. This document cannot be reproduced, except in full, without prior written approval of the Company. Any unauthorized alteration, forgery or falsification of the content or appearance of this document is unlawful and offenders may be prosecuted to the fullest extent of the law. Unless otherwise stated the results shown in this test report refer only to the sample(s) tested.

SGS Taiwan Ltd. 台灣檢驗科技股份有限公司

33, Wu Chuan Rd., New Taipei Industrial Park, New Taipei City, Taiwan / 新北市新北產業園區五權路33號
t+886 (02)2299 3279 f+886 (02)2299 3237 www.sgs.tw

Member of the SGS Group



測試報告

Test Report

號碼(No.) : CE/2014/93151

日期(Date) : 2014/09/23

頁數(Page): 3 of 6

勁達國際電子有限公司

RAYTAC CORPORATION

新北市中和區建康路3號5樓

5F, NO. 3, JIANKANG RD., ZHONGHE DIST, NEW TAIPEI CITY 23586, TAIWAN (R. O. C.)



測試項目 (Test Items)	單位 (Unit)	測試方法 (Method)	方法偵測 極限值 (MDL)	結果 (Result)
				No.1
多溴聯苯醚總和 / Sum of PBDEs	mg/kg	參考 IEC 62321: 2008 方法, 以氣相層析/質譜儀檢測。 / With reference to IEC 62321: 2008 and performed by GC/MS.	-	n.d.
一溴聯苯醚 / Monobromodiphenyl ether	mg/kg		5	n.d.
二溴聯苯醚 / Dibromodiphenyl ether	mg/kg		5	n.d.
三溴聯苯醚 / Tribromodiphenyl ether	mg/kg		5	n.d.
四溴聯苯醚 / Tetrabromodiphenyl ether	mg/kg		5	n.d.
五溴聯苯醚 / Pentabromodiphenyl ether	mg/kg		5	n.d.
六溴聯苯醚 / Hexabromodiphenyl ether	mg/kg		5	n.d.
七溴聯苯醚 / Heptabromodiphenyl ether	mg/kg		5	n.d.
八溴聯苯醚 / Octabromodiphenyl ether	mg/kg		5	n.d.
九溴聯苯醚 / Nonabromodiphenyl ether	mg/kg		5	n.d.
十溴聯苯醚 / Decabromodiphenyl ether	mg/kg		5	n.d.

備註(Note) :

1. mg/kg = ppm; 0.1wt% = 1000ppm
2. n.d. = Not Detected (未檢出)
3. MDL = Method Detection Limit (方法偵測極限值)
4. "-" = Not Regulated (無規格值)
5. 樣品的測試是基於申請人要求混合測試, 報告中的混合測試結果不代表其中個別單一材質的含量。(The samples was/were analyzed on behalf of the applicant as mixing sample in one testing. The above results was/were only given as the informality value.)

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11. Current Consumption Reference Data (BT3.0 VS BT4.0)

Mouse Power Consumption			
	BT4.0 (Based on nRF51822)		BT3.0
	BT4.0 Mode	RF2.4GHz	
2 x AAA	9.5 Months	10 Months	2.9 Months
2 x AA	21 Months	22 Months	6.2 Months
Including Sensor	BT4.0 (Based on nRF51822)		BT3.0 @3V
	BT4.0 Mode @ 1.5V	RF2.4GHz @1.5V	
Active-Mouse moving (4.3%) (7.5ms report rate)	5.4 mA 8.1 mW	5.8 mA 8.7 mW	8.7 mA 26.1 mW
Rest 1>1s (4.1%) Link maintained Sensor latency: 20ms	900 uA 1.35 mW	350 uA No link 1.05 mW	1.24 mA 3.72 mW
Rest 2>10 sec (4.9%) Link maintained Sensor latency: 100ms	680 uA 1.02 mW	120 uA 198 uW	900 uA 2.7 mW
Rest 2d>60 sec Link maintained Sensor latency: 100ms	120 uA 180 uW	120 uA 198 uW	900 uA 2.7 mW
Rest 3>600s (86.3) Link disconnected Sensor latency: 500ms	90 uA 135 uW	90 uA 135 uW	797 uA 2.3 mW

Keyboard Power Consumption			
	BT4.0 (Based on nRF51822)		BT3.0 @3V
	BT4.0 Mode @3V	RF2.4GHz @3V	
Active 6 letters/s	200 uA	5.8 mA 8.7 mW	8.7 mA 26.1 mW
Rest 1 Maintain link	20 - 40 uA	NA	20 - 40 uA
Rest 2 after>1min, disconnected	0.8 uA	0.8 uA	2 uA Only when PC is off

12. BT 4.0 Product Certification Cost Comparison Chart

BT 4.1 Product Certification Cost Comparison List

(First Certification Application)			
	Chip-on-board Built Up Product	Apply Raytac Module MDBT40 to Build Product	Raytac Module Saving
Declaration ID	US\$8,000	US\$8,000	Every Single Customer & Every Single Product Certification Cost Saving
BQB Test	US\$7,000	US\$2,000 (*Note 1)	
USA FCC Test for BT4.0	US\$3,600	US\$0	
Japan Telec Test for BT4.0	US\$5,500	US\$0	
CE RF Certification	US\$4,500	US\$0	
IC (Canada) Certificate	US\$3,600	US\$0	
SRRC (China) Certificate	US\$8,500	US\$0	
Taiwan NCC	US\$3,600	US\$0	
CE & FCC Part 15B EMC Testing	US\$1,800	US\$1,800	
Total	US\$46,100	US\$11,800	US\$34,300

(2nd and Later Series Product Certification Application)			
	Chip-on-board Built Up Product	Apply Raytac Module MDBT40 to Build Product	Raytac Module Saving
Declaration ID	US\$8,000	US\$0	Every Single Customer & Every Single Product Certification Cost Saving
BQB Test	US\$7,000	US\$0	
USA FCC Test for BT4.0	US\$3,600	US\$0	
Japan Telec Test for BT4.0	US\$5,500	US\$0	
CE RF Certification	US\$4,500	US\$0	
IC (Canada) Certificate	US\$3,600	US\$0	
SRRC (China) Certificate	US\$8,500	US\$0	
Taiwan NCC	US\$3,600	US\$0	
CE & FCC Part 15B EMC Testing	US\$1,800	US\$1,800	
Total	US\$46,100	US\$1,800	US\$44,300
Note:	1. BQB test based on single profile 2. Declaration ID cost based on Adopter Membership	1. FCC & Telec applicant is Raytac (For the case of copy report to change the applicant, the cost is about US\$1800 for FCC & US\$2,800 for Telec)	

Above cost provided for reference, it may be varied according to different testing lab.

13. nRF51 IC Compatibility with SDK & SoftDevice

nRF51 IC rev.	nRF51 SDK	SoftDevices									
		nRF51422/nRF51822						nRF51422			
		S110		S120		S130		S210		S310	
		SD	SDS	SD	SDS	SD	SDS	SD	SDS	SD	SDS
1	4.4.2	5.2.1 ^a	1.1	-	-	-	-	2.0.0 ^b	1.0	-	-
2	4.4.2	5.2.1	1.1	-	-	-	-	3.0.0	1.2	-	-
	5.2.0	6.0.0 6.2.1	1.2					3.0.0	1.2	1.0.0	1.0
	6.1.0	7.0.0 7.1.0	1.3					3.0.0	1.2	1.0.0	1.0
	-	8.0.0	2.0					4.0.1	2.0	2.0.1	2.0
3	6.1.0	7.1.0	1.3	1.0.1	1.1	-	-	3.0.0	1.2	1.0.0	1.0
	7.0.1					0.5.0-1 alpha	0.5	4.0.1	2.0	-	-
	7.1.0							4.0.1	2.0	2.0.1	2.0
	7.2.0							4.0.1	2.0	2.0.1	2.0
	8.0.0	8.0.0	2.0	2.0.0	2.1	0.9.0-1 alpha	0.5	4.0.1	2.0	-	-
	-	-	-	-	-	1.0.0-3 alpha	0.5	-	-	-	-

a. Valid for nRF51822 only.
b. Preprogrammed in factory.

The SDK version must match with its corresponding softdevice version to make BLE work.

Remark: Above table is extracted from document “nRF51 Series Compatibility Matrix v2.0”. Any updates shall refer to Nordic’s official release as final reference.

Release Note

- 2015/2/13 Version. A1: NCC certificate in Chapter 10 added.
- 2015/4/29 Version A2:
 - (1) Added MDBT40-P Spec, RoHS Report, List of Raytac's Model No.
 - (2) Updated Chapter 8, 9, and 12, 13.

