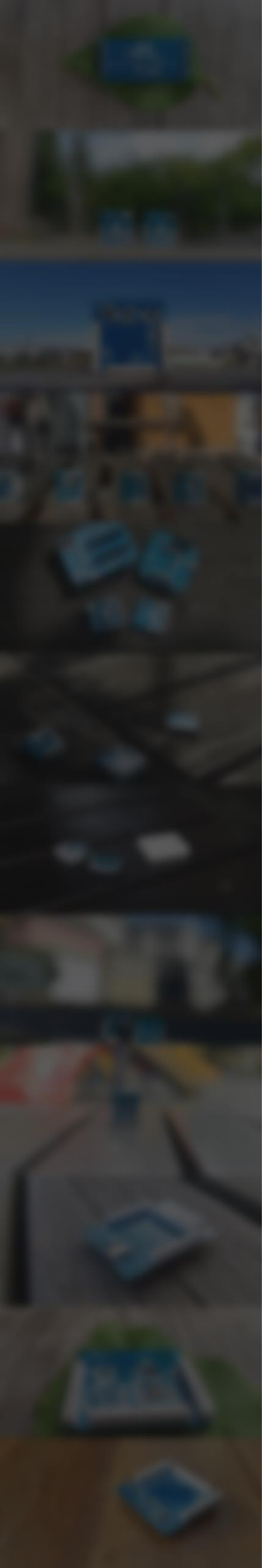


MtM+ Technology

M904

Bluetooth SiP Module

-BT 4.2 LE

Preliminary DATASHEET
26th April, 2018

Table of Contents

1 Product Brief

The SiP module M904 is a small size module with antenna inside. The module provides full function of Bluetooth 4.2 Low Energy in a tiny module via 48 pins LGA Foot Print. The M904 module provides everything required to create Bluetooth 4.2 Low Energy product with RF, baseband, MCU, qualified Bluetooth v4.2 stack and customer application running on a single IC.

M904 enables ultra-low power connectivity and basic data transfer for applications previously limited by the power consumption, size constraints and complexity of other wireless standards. The low power consumption and excellent radio performance make it the best solution for OEM /ODM customers who require embedded Bluetooth 4.2 Low Energy feature, such as, IP camera, car key, sport and fitness watch, mouse, led light bulb etc.

For the software and driver development, we provide extensive technical document and reference software code for the system integration.

Hardware evaluation kit and development utilities will be released base on listed OS and processors to OEM customers.

KEY FEATURES

- Bluetooth® Smart
- ARM® Cortex™-M0 32-bit processor
- Up to +4dBm output power
- 256kB flash
- 32kB RAM
- LGA-48 package, 6.5 x 6.5 mm
- I^2C/UART
- Built-in antenna

2 Features and Applications

Feature List

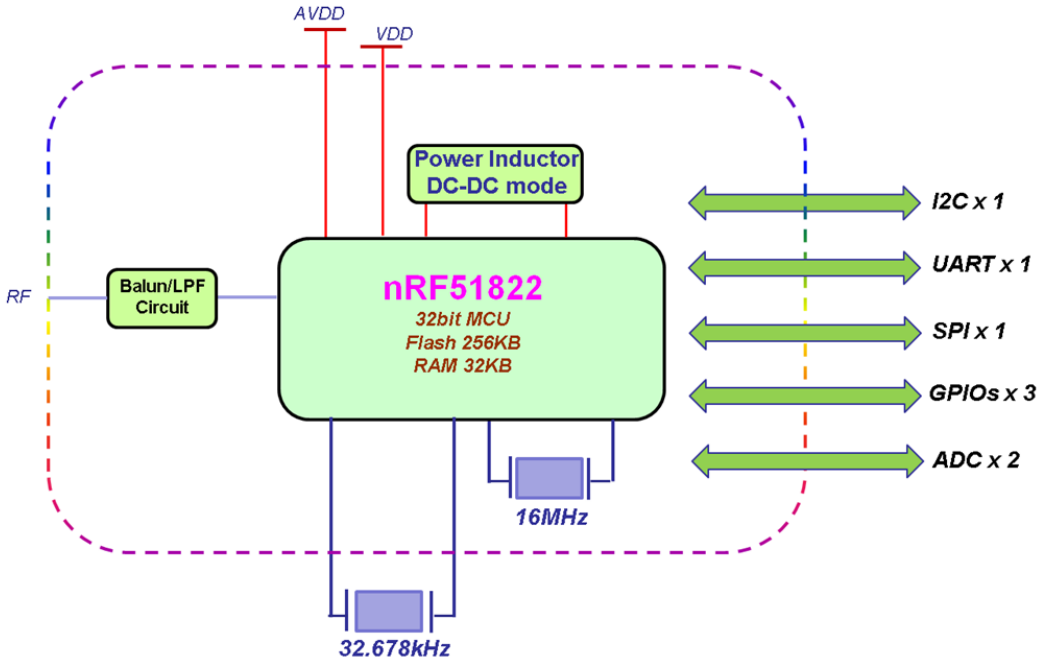
- Bluetooth® v4.2 LE radio technology
- -90 dBm sensitivity in Bluetooth® low energy mode
- 250kbps, 1 Mbps, 2 Mbps supported data rates
- TX Power -20 to +4 dBm in 4 dB steps
- TX Power -30 dBm Whisper mode
- 12 mA peak RX, 10 mA peak TX (0 dBm)
- 256 kB embedded flash program memory
- Supply voltage range: 1.8 ~ 3.6 V
- SPI master/slave
- Low power comparator
- Temperature sensor
- Two-wire master (I^2C compatible)
- UART (CTS/RTS)
- AES HW encryption
- Real Timer Counter (RTC)
- Antenna on Package (AoP)
- LGA-48 package, 6.5 x 6.5 mm

Applications

- IoT
  - Smart home
  - Sensor networks
  - Building automation
  - Industrial
  - Retail
  - Smart Lighting
- Personal area networks
  - Medical devices
  - Key-fobs and wrist watches
- Beacons
- Remote control toys

3 Block Diagram

M904 supports UART command line interface to connect to the host processor. The simplified block diagram is depicted in the figure as below.



4 Technical Specifications

Operation and storage condition

4.1 Absolute Maximum Ratings

Item	Description		Value	Unit
Ratings Over Operating Free-Air Temperature Range				
1	Supply voltage	All supply pins must have the same voltage	-0.3 ~ 3.9	V
2	Voltage on any pin		-0.3 ~ 3.9	V
3	Operating ambient temperature range		-25 ~ 75	℃
4	Storage temperature range		-35 ~ 75	℃
5	Bluetooth RF output (Typ.)		4±1	dBm

4.2 Voltage

Operating Condition	Min	Typical	Max	Unit
DVDD_3V3	1.8	3.3	3.6	V
I/O supply voltage (VDD_PADS)	1.2	3.3	3.6	V

4.3 Wireless Specifications

Features	Description
Bluetooth Standards	Bluetooth core v4.2 Low Energy
Antenna Port	Support Single Antenna for Bluetooth
Frequency Band	2.402 – 2.480 GHz

4.4 Radio Specifications – Bluetooth 4.2 Low Energy

Features	Description
Features	Bluetooth core v4.2 Low Energy
Frequency Band	2.402 – 2.480 GHz
Number of selectable sub channels	40 Channels
Modulation	GFSK
Support Rates	<2Mbps
Maximum receive level	-10dBm (with PER<30.8%)

Operating Condition	Min	Typical	Max	Unit
RX Sensitivity	--	-90	--	dBm
Maximum Input	--	--	-10	dBm
Frequency Range	2400	--	2483	MHz
Output Power Adjustment Ranger	-20	-	4	dBm
Output Power	--	2	--	dBm
Output Power Variation	--	4	--	dB

4.5 Power Consumption

Item	Typical	Unit
TX Mode 3.3V	10	mA
RX Mode 3.3V	12	mA
MCU ON, Bluetooth sleep	5.14	mA
MCU sleep, Bluetooth sleep	0.42	uA

Power Management

Symbol	Description	Note	Min.	Typ.	Max.	Units	Test level
I_{OFF}	Current in SYSTEM OFF, no RAM retention.			0.6[1]		µA	2
$I_{OFF, RET, 8k}$	Additional current in SYSTEM OFF per retained RAM block (8 kB)			0.6[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
$I_{ON,16k}$	SYSTEM-ON base current with 16 kB RAM enabled.			2.6[1]		µA	2
$I_{ON,32k}$	SYSTEM-ON base current with 32 kB RAM enabled.			3.8[1]		µA	2
t_{1V2}	Startup time for 1V2 regulator.			2.3		µs	1
$I_{1V2XO16}$	Current drawn by 1V2 regulator and 16 MHz XOSC when both are on at the same time.	See *Table 33* on page 48.		810[2]		µA	1

Symbol	Description	Note	Min.	Typ.	Max.	Units	Test level
t_{1V7}	Startup time for 1V7 regulator			2	3.6	µs	1
I_{1V7}	Current drawn by 1V7 regulator			105		µA	2
F_{DCDC}	DC/DC converter current conversion factor.		0.65[4]		1.2[4]		1

F_{DCDC} will vary depending on VDD and internal radio current consumption (I_{DD}). Please refer to the *nRF51 Series Reference Manual*, v3.0 or later, for a method to calculate $I_{DD,DCDC}$. See ***Figure 11*** on page 50 for a DC/DC conversion factor chart.

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 µs), and when changing mode from RX to TX (130 µs).
3. Average current consumption for RX startup (130 µs), and when changing mode from TX to RX (130 µs).

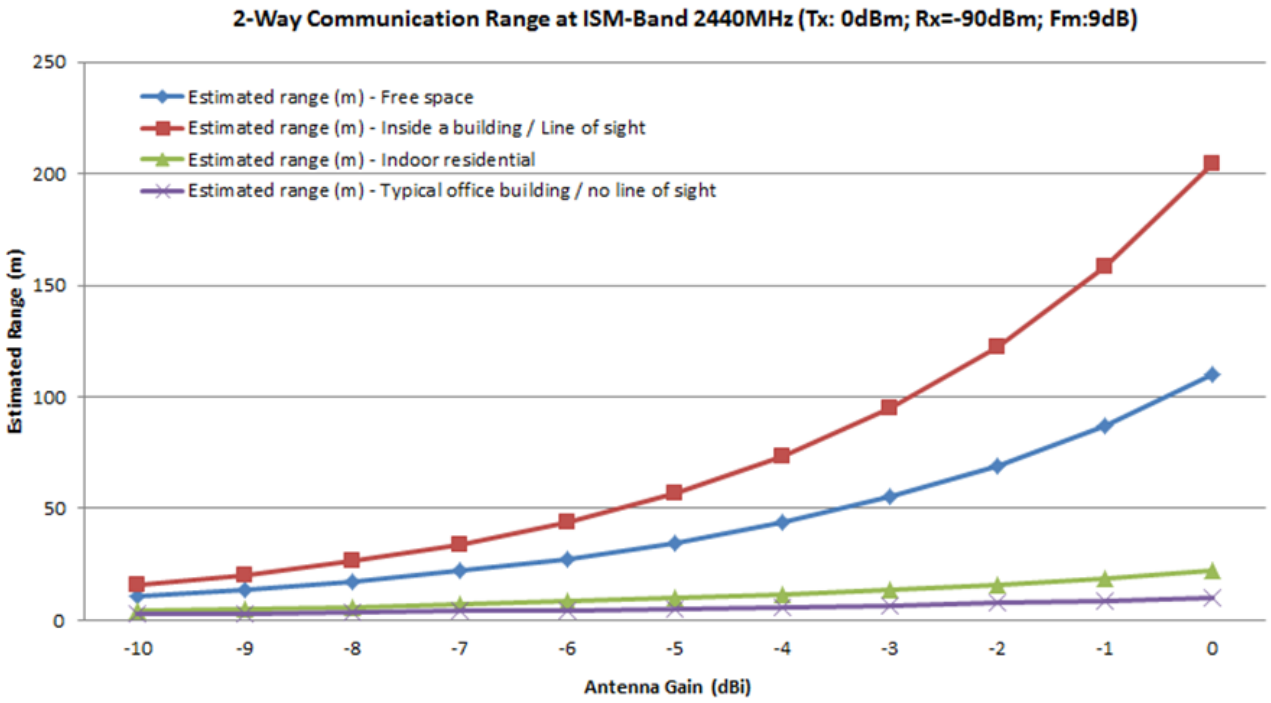
4.6 Transmitter Specification

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

4.7 Antenna Reference Specification

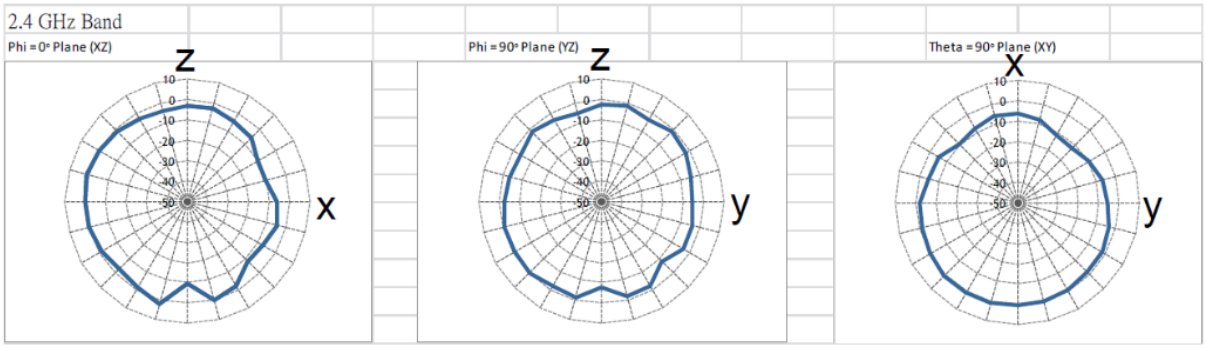
4.7.1 Built-In Antenna Performance

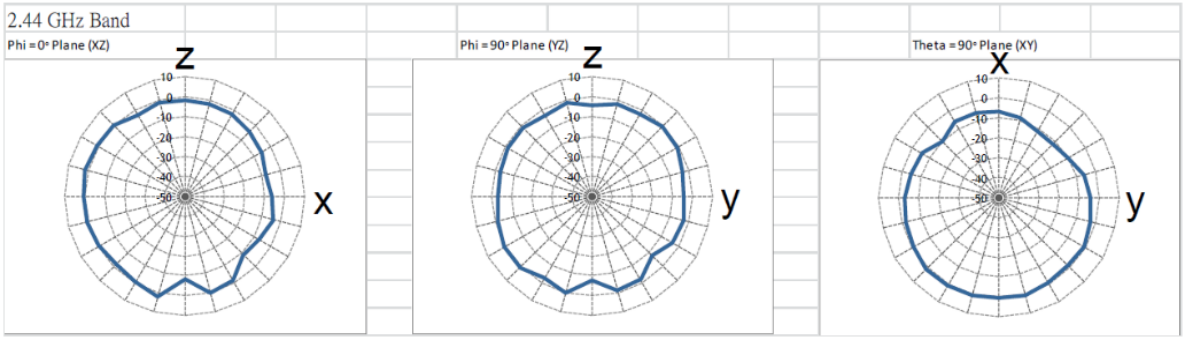
Item	Freq. Band	Gain	Return Loss	VSWR
Spec	2.4 ~ 2.5GHz	>-5dBi	<-8.5dB	2.2 max
Item	**Impedance**	**Polarization**	**Directivity**	**Efficiency**
Spec	50 ohm	Linear	Omni-directional	>30%

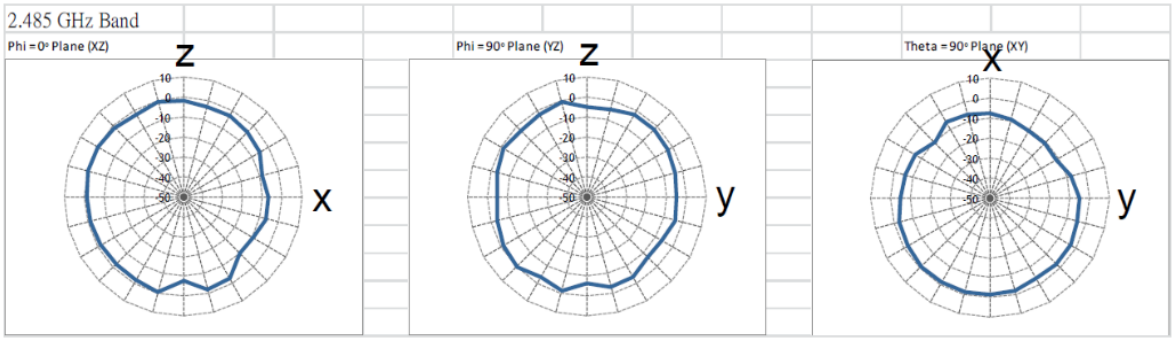


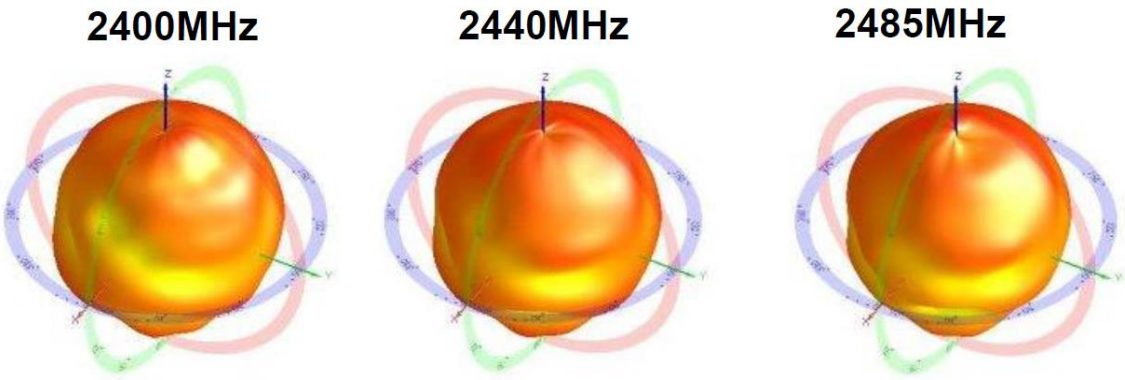
4.7.2 Antenna Pattern

Omnidirectional Radiation



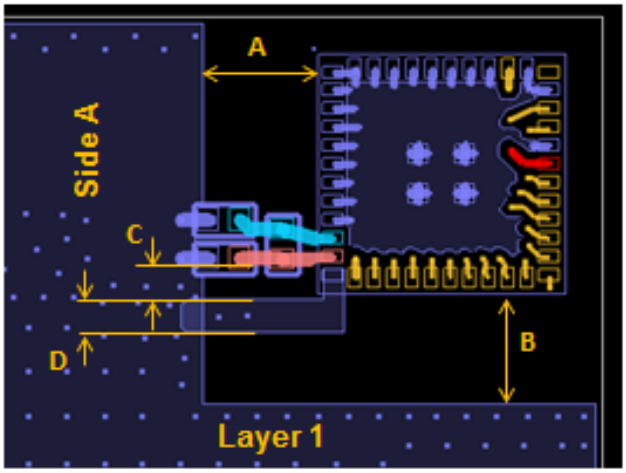


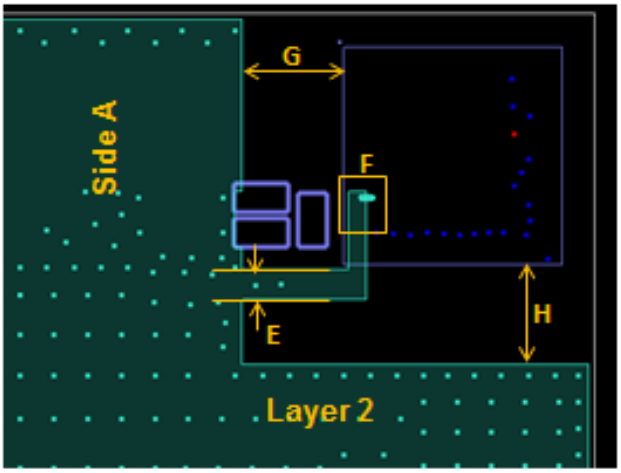


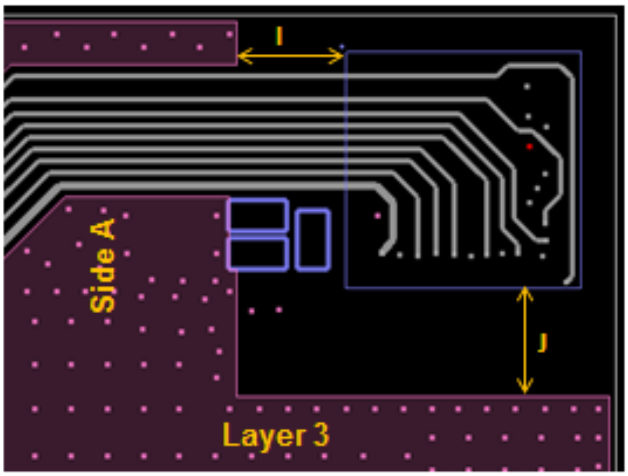


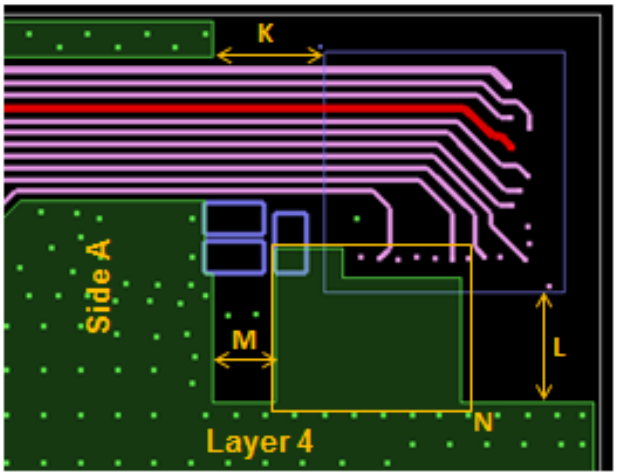
4.8 System Design Guide

Keep-Out area: As shown in following figures









EVB DESIGN GUIDE

Keep A, G, I & K = 3 mm

Keep B, H, J & L = 3 mm

Keep C = 0.8 mm

Keep D & E = 0.9 mm

Keep M = 1.7 mm

Connect to system ground from F (2nd layer)

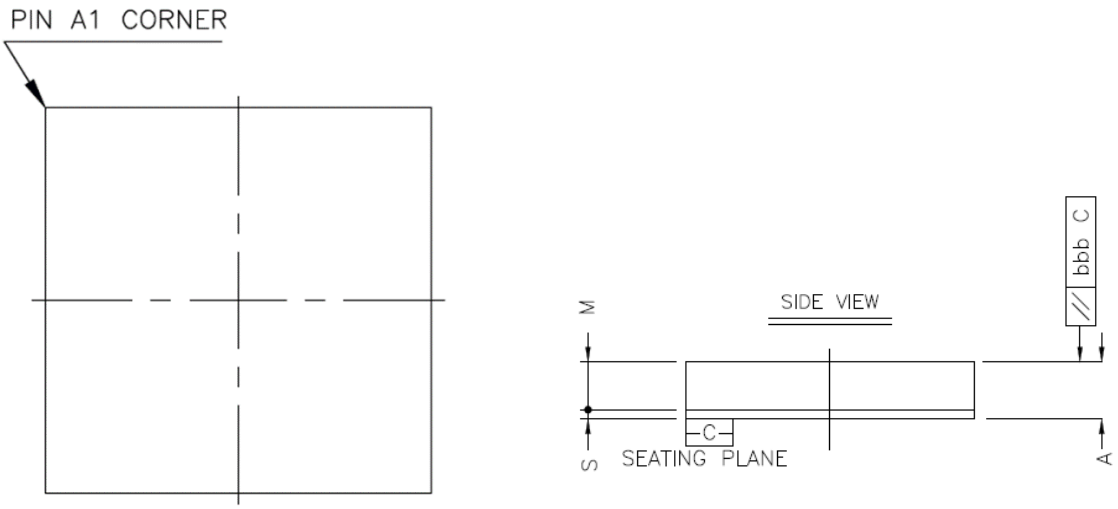
The L-shaped ground leg is required for antenna performance. Don't cut-off L-shaped ground leg and accommodate routes.

Route signal trace out of module from side A on 3rd layer to maintain 1st & 2nd layer system ground plan integrity.

5 Dimensions

The size and thickness of the M904 module 6.5mm (W) x 6.5mm (L) x 1.2mm (H):

Top View & Side View:



Dimension Detail

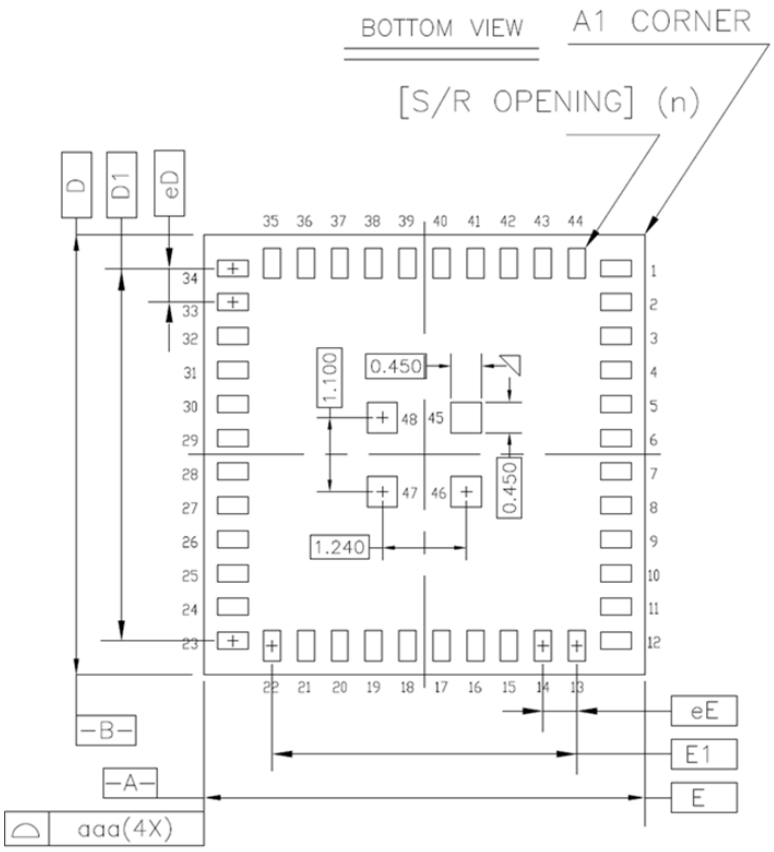
		Symbol	Common Dimensions
Package :			PIM
Body Size:	X	E	6.500
	Y	D	6.500
Ball Pitch :	X	eE	0.500
	Y	eD	0.500
Total Thickness :		A	1.300±0.100
Mold Thickness :		M	1.100 Ref.
Substrate Thickness :		S	0.200 Ref.
S/R Opening :			0.450*0.450/0.250*0.450
Stand Off :		A1	--- ~ ---
Ball Width :		b	--- ~ ---
Package Edge Tolerance :		aaa	0.100
Mold Flatness :		bbb	0.100
Coplanarity:		ddd	---
Ball Offset (Package) :		eee	---
Ball Offset (Ball) :		fff	---
Ball Count :		n	48
Edge Ball Center to Center :	X	E1	4.500
	Y	D1	5.500

6 Pin Assignments

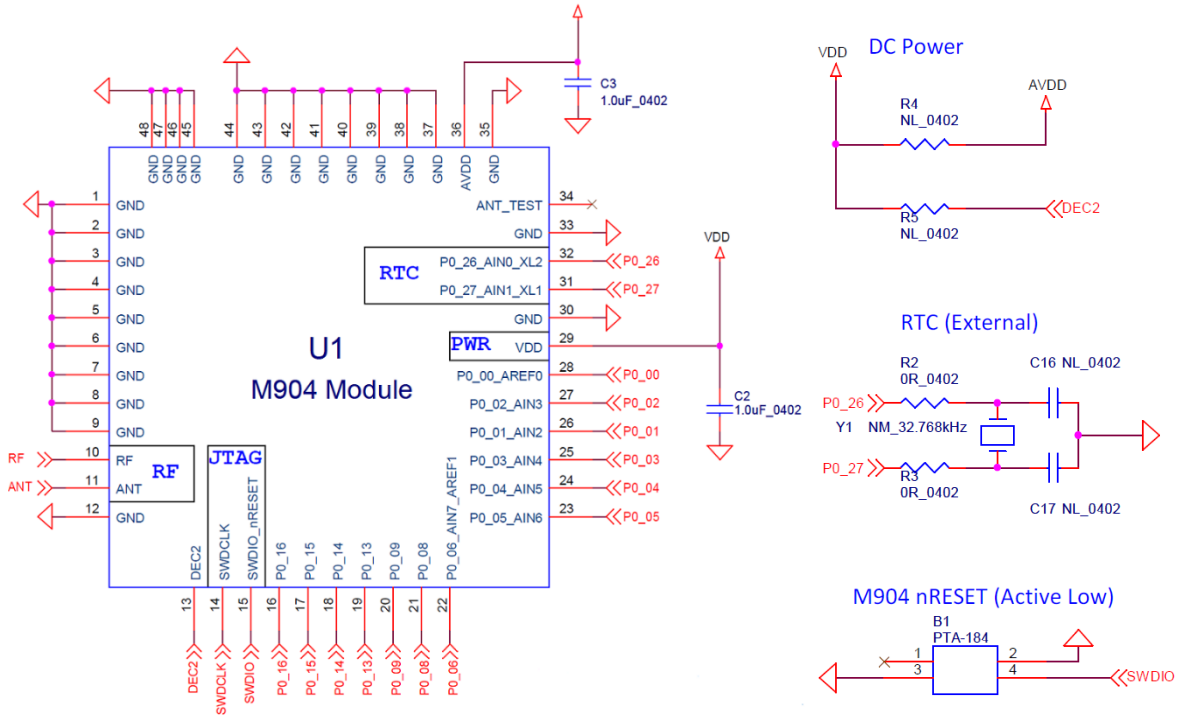
Pin number	Pin name	Pin function	Description
1 to 9	VSS	Power	Ground (0V)
10	RF	BLE RF (antenna connection)	BLE RF (antenna connection)
11	ANT	Antenna	Antenna feed
12	VSS	Power	Ground (0V)
13	DEC2	Power	Power supply decoupling
14	SWDCLK	Digital input	Hardware debug and flash programming I/O
15	SWDIO/ nRESET	Digital I/O	System reset (active low). Also hardware debug and flash programming I/O.
16	P0_16	Digital I/O	General purpose I/O pin.
17	P0_15	Digital I/O	General purpose I/O pin.
18	P0_14	Digital I/O	General purpose I/O pin.
19	P0_13	Digital I/O	General purpose I/O pin.
20	P0_09	Digital I/O	General purpose I/O pin.
21	P0_08	Digital I/O	General purpose I/O pin.
22	P0_06	Digital I/O	General purpose I/O pin.
23	AIN6	Analog input	ADC/LPCOMP input
24	AIN5	Analog input	ADC/LPCOMP input
25	AIN4	Analog input	ADC/LPCOMP input
26	AIN2	Analog input	ADC/LPCOMP input
27	AIN3	Analog input	ADC/LPCOMP input
28	AREF0	Analog input	ADC/LPCOMP reference input
29	PWR	Power	Power supply
30	VSS	Power	Ground (0V)
31	AIN1_XL1	Analog input Analog output	ADC/LPCOMP input Connection for 32.768 kHz crystal.
32	AIN0_XL2	Analog input Analog input	ADC/LPCOMP input 1 Connection for 32.768 kHz crystal or external 32.768 kHz clock reference.
33	VSS	Power	Ground (0V)
34	ANT_TEST	Antenna test	Antenna open/short test
35	VSS	Power	Ground (0V)
36	AVDD	Power	Analog power supply
37 to 48	VSS	Power	Ground (0V)

7 Recommended Footprint

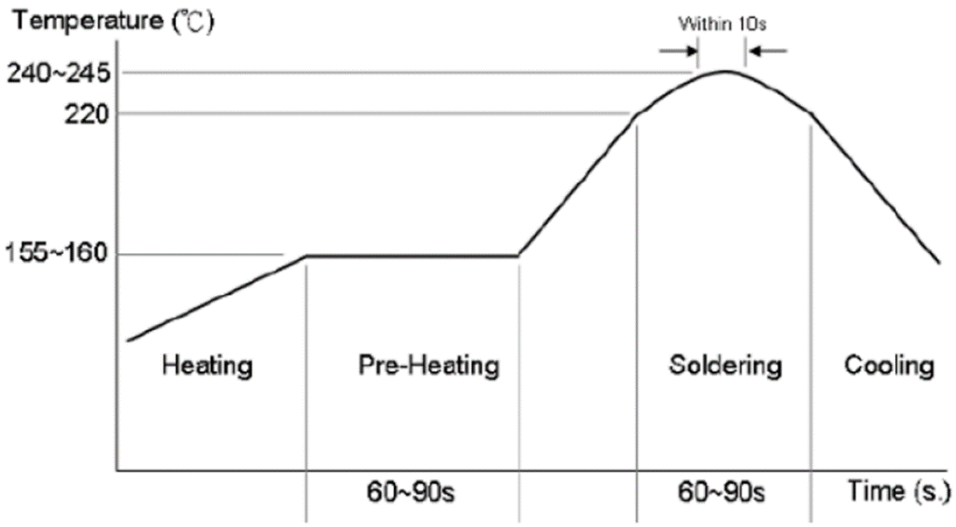
Suggest on PCB: SMD (1:1)



8 Reference Design Circuit



9 Recommended Reflow Profile



Profile Condition

a. Suitable for lead-free solder
b. Between 155 ~ 160°C: 60 ~ 90 sec.
c. Above 220°C: 60 ~ 90 sec.
d. Peak temperature: 240 ~ 245°C (<10 sec.)

10 SiP Module Preparation

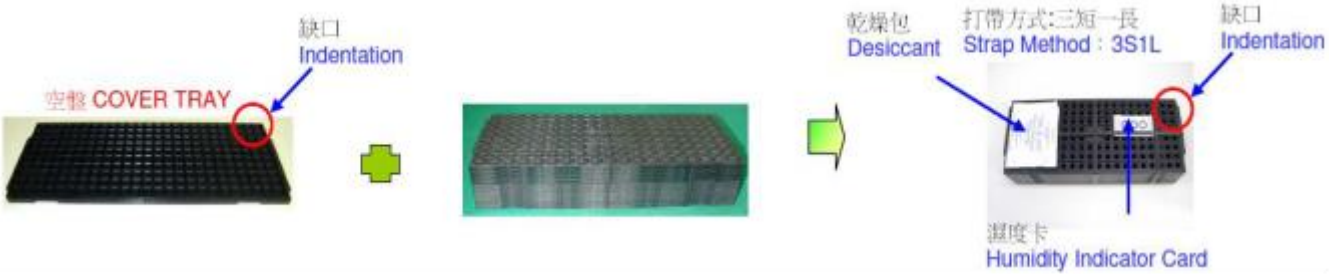
10.1 Handling

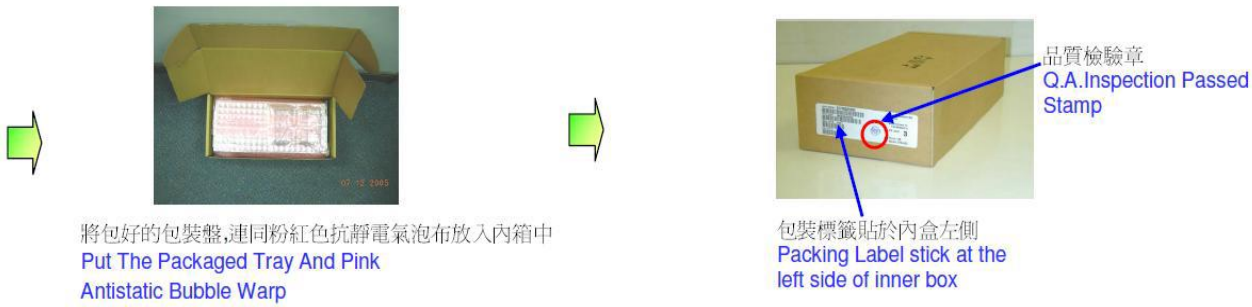
Handling the module must wear the anti-static wrist strap to avoid ESD damage. After each module is aligned and tested, it should be transport and storage with anti-static tray and packing. This protective package must be remained in suitable environment until the module is assembled and soldered onto the main board.

10.2 SMT Preparation

1. Calculated shelf life in sealed bag: 6 months at <40°C and <90% relative humidity (RH).
2. Peak package body temperature: 250°C.
3. After bag was opened, devices that will be subjected to reflow solder or other high temperature process must.
   a. Mounted within: 72 hours of factory conditions <30°C /60% RH.
   b. Stored at ≦10% RH with N2 flow box.
4. Devices require baking, before mounting, if:
   a. Package bag does not keep in vacuumed while first time open.
   b. Humidity Indicator Card is >10% when read at 23±5°C.
   c. Expose at 3A condition over 8 hours or Expose at 3B condition over 24 hours.
5. If baking is required, devices may be baked for 12 hours at 125±5°C.

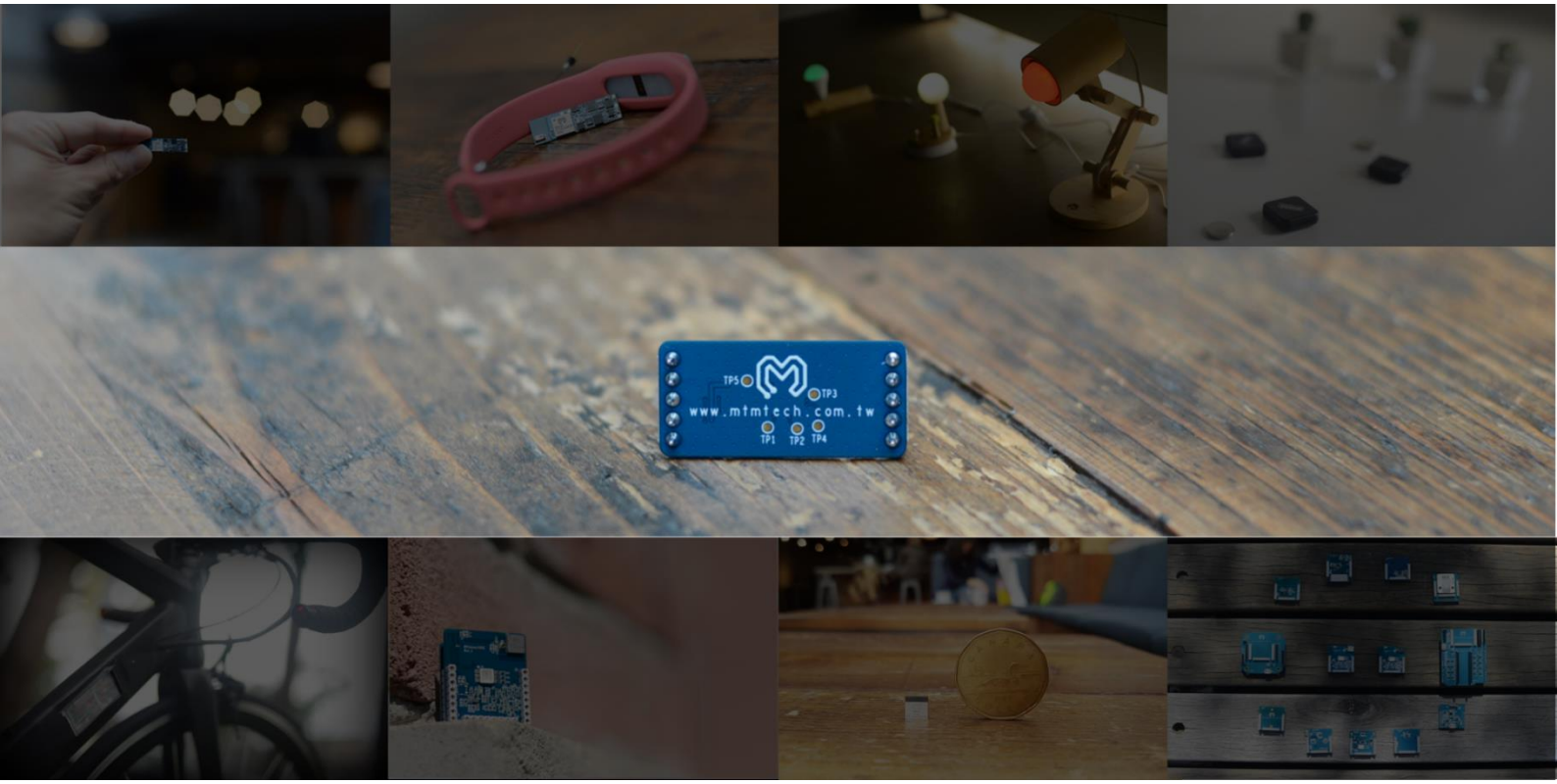
11 Package Information





12 Document History

Date	Modifications	Version
Jan. 23, 2014	Preliminary Version	1.0
Jun. 14, 2016	Add antenna design guide, and modify power consumption information	1.1
Nov. 24, 2016	Revise the reference scheme	1.2
Feb. 26, 2018	Renew format & Add the item “Voltage any pin" in 4.1	1.3
Apr. 26, 2018	Update datasheet to Bluetooth 4.2	1.4



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