



M905

Bluetooth 5.0 Low Energy SiP Module

with MCU and integrated antenna

DATASHEET
26th April, 2018

Table of Contents

1	Product Brief.....	1
2	Features and Applications	2
3	Block Diagram.....	3
4	Technical Specifications.....	4
4.1	Absolute Maximum Ratings	4
4.2	Operation Condition	4
4.3	Wireless Specifications	4
4.4	Radio Specifications – Bluetooth 5.0 Low Energy.....	4
4.5	Built-In Antenna Performance	5
4.5.1	Antenna Pattern	6
4.5.2	Antenna Design Guide.....	8
4.6	Power Consumption	12
5	Dimensions	13
6	Pin Assignments.....	14
7	Recommended Footprint	16
8	Reference Design Circuit	17
9	Recommended Reflow Profile	19
10	SiP Module Preparation.....	20
10.1	Handling	20
10.2	SMT Preparation	20
11	Package Information	21
11.1	Product Marking	21
11.2	Packaging	22
12	Document History.....	23

1 Product Brief

The SiP module M905 is a small size module with built-in antenna and EMI shielding performance. The module provides full function of Bluetooth 5.0 Low Energy in a tiny module via 52 pins LGA footprint. The M905 module provides everything required to create Bluetooth 5.0 Low Energy product with RF, baseband, MCU, qualified Bluetooth v5.0 stack and customer application running on a single IC.

M905 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 5.0 Low Energy feature, such as, Home Automation, PAN, 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 are ready to applied.

KEY FEATURES

- Bluetooth 5.0 Low Energy compliant
- ARM® Cortex™-M4 32-bit processor with FPU
- 512 kB programmable flash
- 64 kB RAM
- Built-in antenna
- RF range: up to 100m
- NFC-A tag interface for easy pairing
- TX Power -20 to +4 dBm in 4 dB steps
- RX Sensitivity: -93 dBm
- Ultra-compact package at 6.5 x 6.5 mm

2 Features and Applications

Feature List

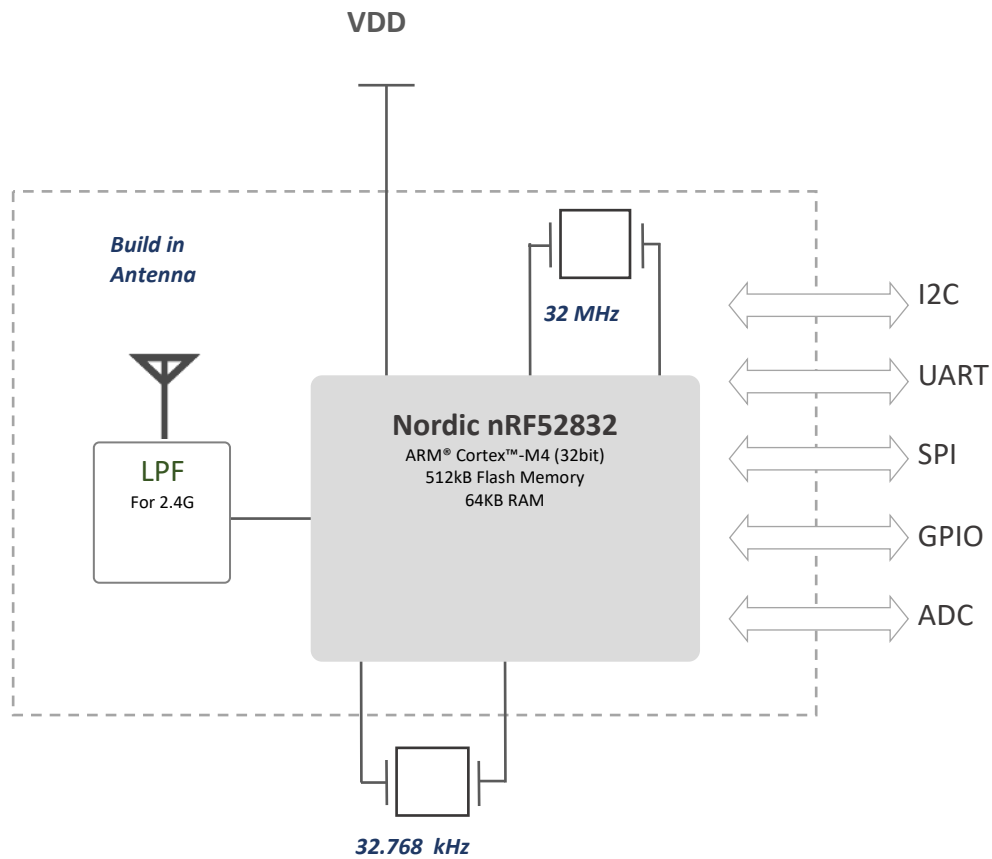
- Multi-protocol with Bluetooth low energy / ANT / 2.4G RF
- Built-in antenna
- 32-bit ARM Cortex M4F processor
- 512kB flash + 64kB RAM
- LGA-52 package, 6.5 x 6.5 x 1.1 mm
- Application development independent from protocol stack
- Programmable output power from -20dBm to +4dBm
- Flexible and configurable 26 pin GPIO
- Simple ON/OFF global power modes
- Digital interfaces including: SPI/2-wire/UART/PDM/I2S
- 12-bit/200KSPS ADC
- 128-bit AES ECB/CCM/AAR co-processor
- Quadrature demodulator
- Low power 32MHz crystal and RC oscillators
- Ultra-low power 32kHz crystal and RC oscillators
- Wide supply voltage range (1.7 V to 3.6 V)
- On-chip DC/DC buck converter
- Individual power management for all peripherals

Applications

- IoT
 - Smart home
 - Sensor networks
 - Building automation
 - Industrial
 - Retail
- Personal area networks
 - Health/fitness sensor and monitor devices
 - Medical devices
 - Key-fobs and wrist watches
- Interactive entertainment devices
 - Remote controls
 - Gaming controllers
- Beacons
- A4WP wireless chargers and devices
- Remote control toys
- Computer peripherals and I/O devices
 - Mouse
 - Keyboard
 - Multi-Touch-PAD

3 Block Diagram

There is fully integration module with nRF52832, 32MHz low power crystal. Especially, there is built-in antenna with compart coating.



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 to 3.9	V
2	Voltage on any pin		-0.3 to 3.9	V
3	Storage temperature range		-35 to 75	°C
4	Bluetooth RF output (Typ.)		4	dBm

4.2 Operation Condition

Operating Condition	Min	Typical	Max	Unit
VCC	1.7	3.3	3.6	V
Operation ambient temperature range	-20	--	70	°C

4.3 Wireless Specifications

The M905 module is compliant with the following features and standards:

Features	Description
Bluetooth Standards	Bluetooth core v5.0 Low Energy
Antenna Port	Built-in Antenna
Frequency Band	2.402 – 2.480 GHz

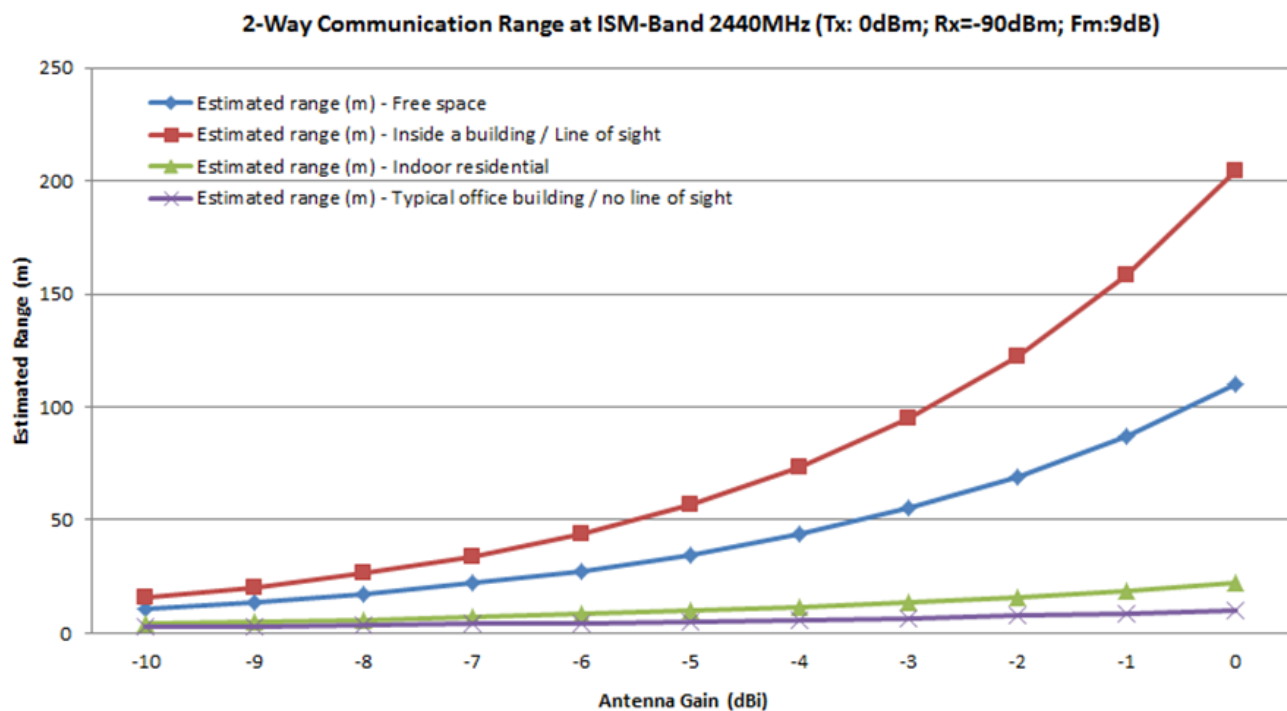
4.4 Radio Specifications – Bluetooth 5.0 Low Energy

Features	Description
Features	Bluetooth core v5.0 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%)

4.5 Built-In Antenna Performance

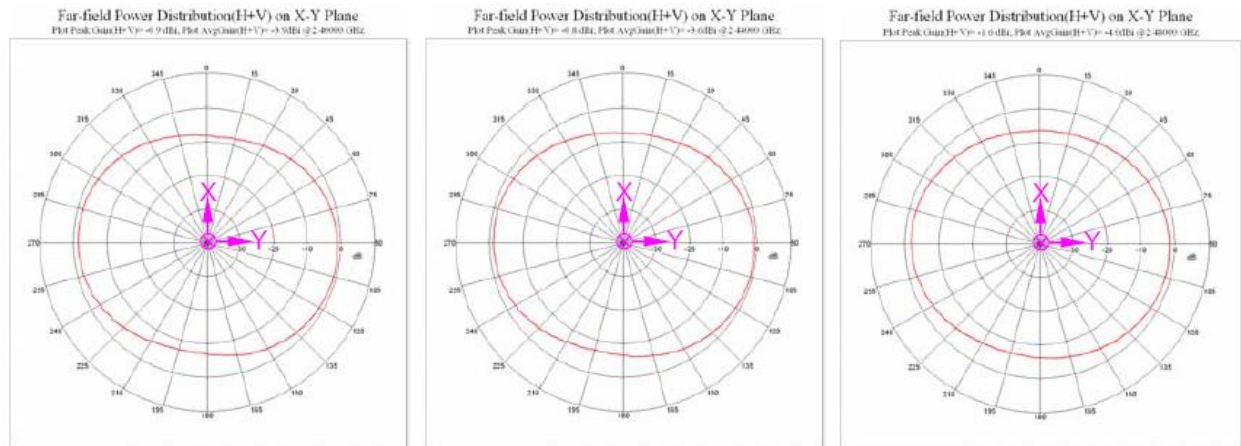
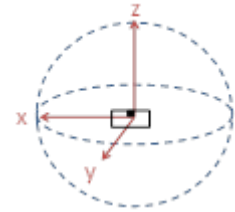
Item	Freq. Band	Gain	Return Loss	VSWR
Spec	2.4~2.5 GHz	>5dBi	<6dB	3 max
Item	Impedance	Polarization	Directivity	Efficiency
Spec	50 ohm	Linear	Omni-directional	>30%

Antenna Gain Reference

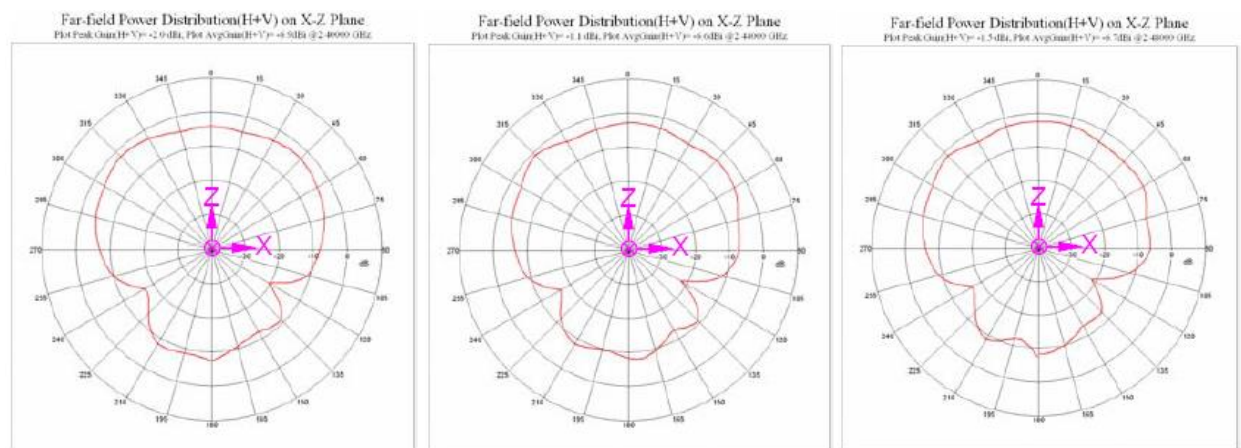


4.5.1 Antenna Pattern

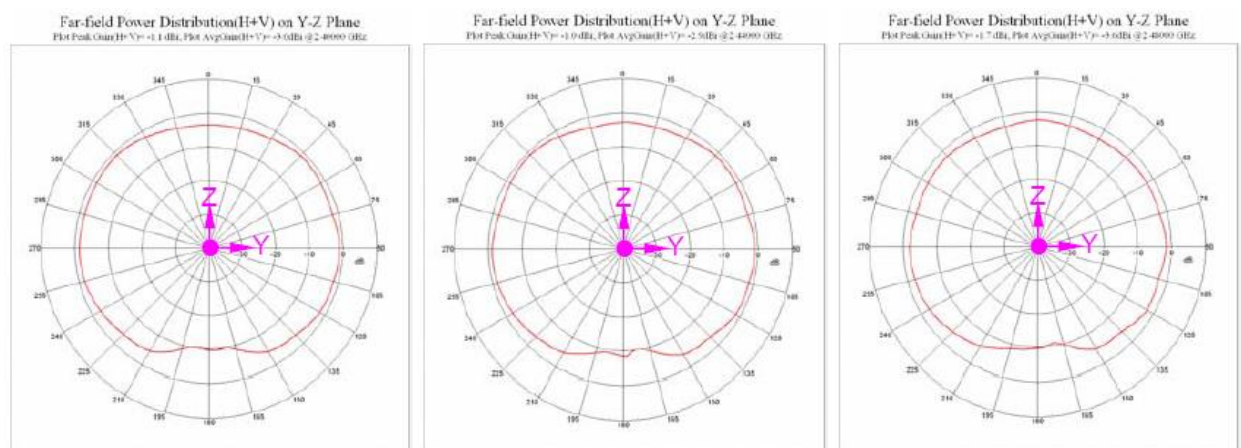
2D Radiation Pattern Plot (Centre Edge):



a. XY-plane radiation pattern at 2400MHz, 2440MHz and 2480MHz

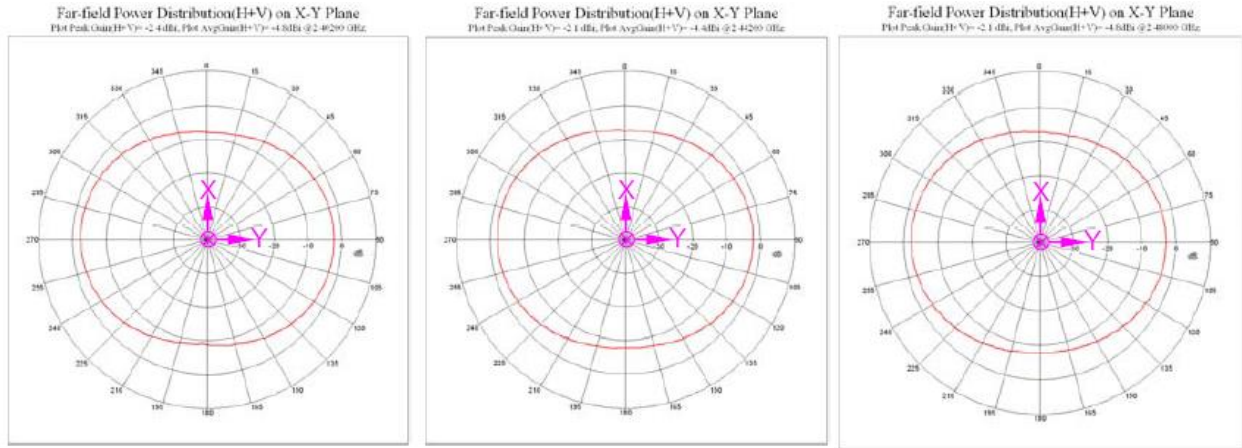
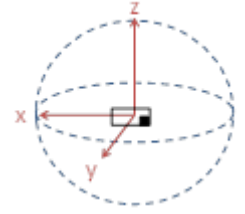


b. XZ-plane radiation pattern at 2400MHz, 2440MHz and 2480MHz

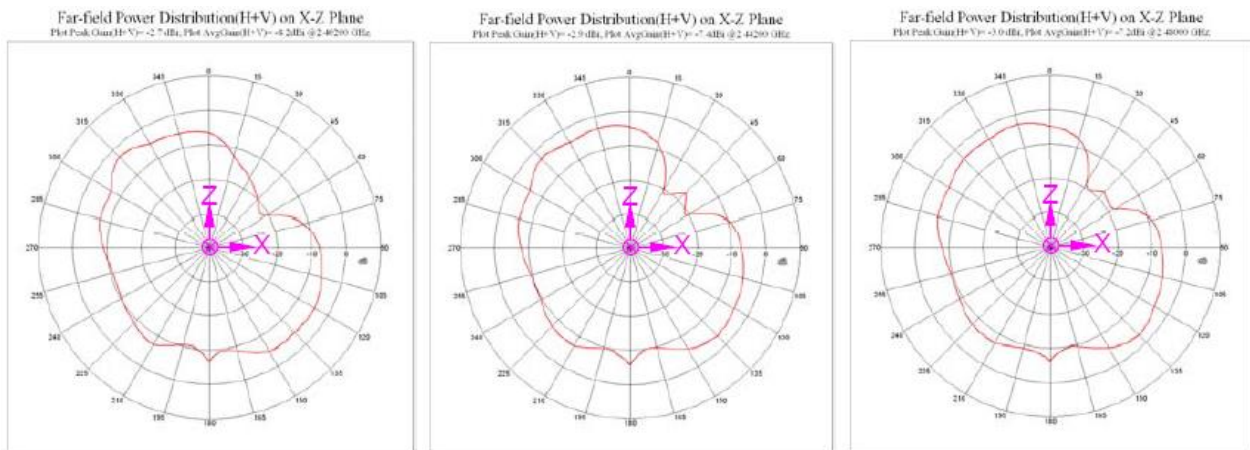


c. YZ-plane radiation pattern at 2400MHz, 2440MHz and 2480MHz

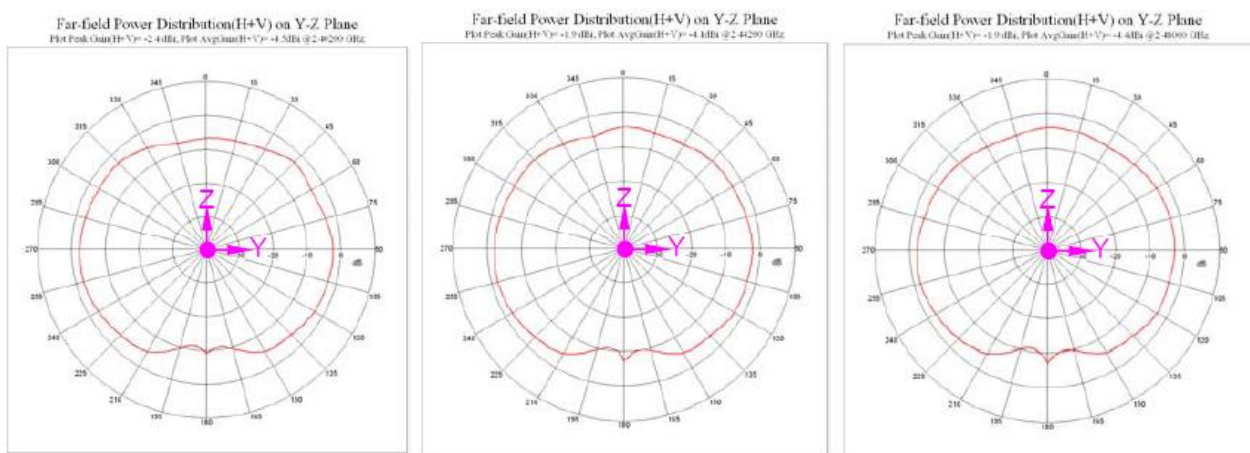
2D Radiation Pattern Plot (Corner Design):



a. XY-plane radiation pattern at 2400MHz, 2440MHz and 2480MHz



b. XZ-plane radiation pattern at 2400MHz, 2440MHz and 2480MHz

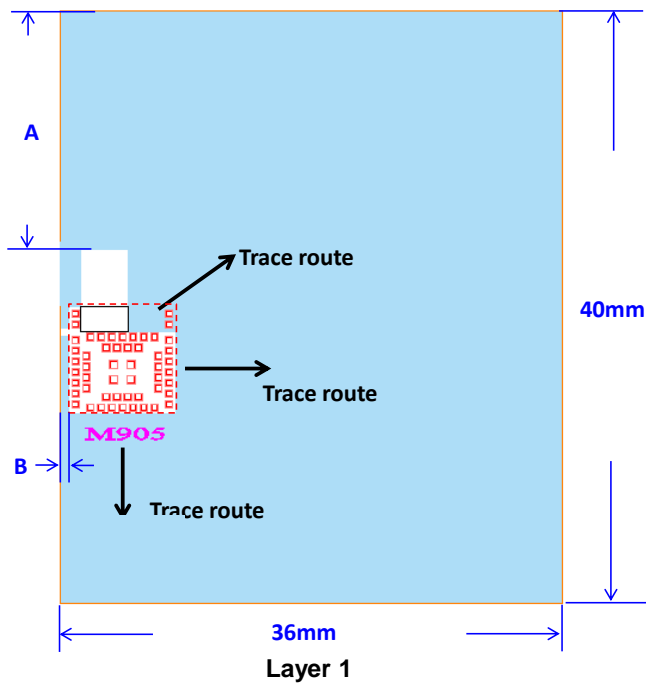


c. YZ-plane radiation pattern at 2400MHz, 2440MHz and 2480MHz

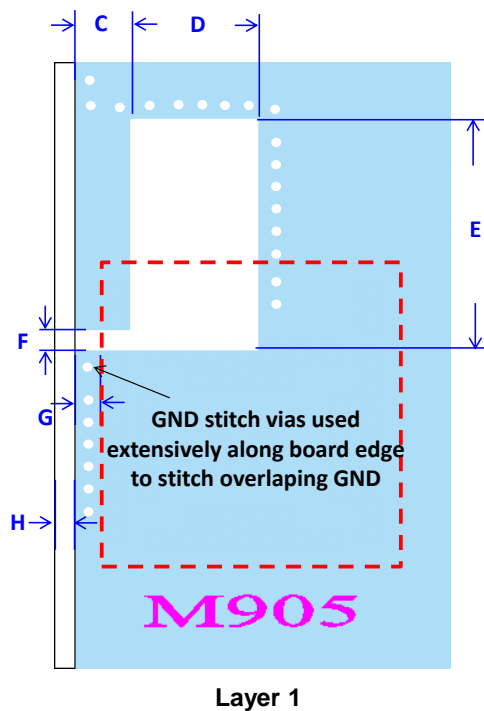
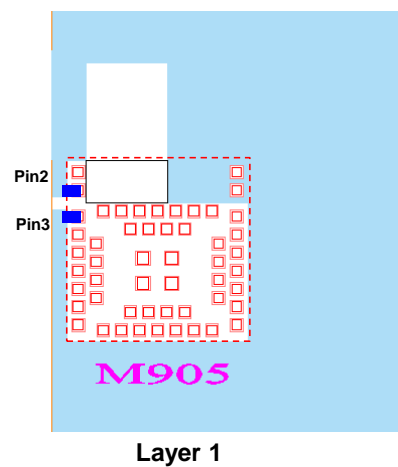
4.5.2 Antenna Design Guide

Option 1: Center Edge

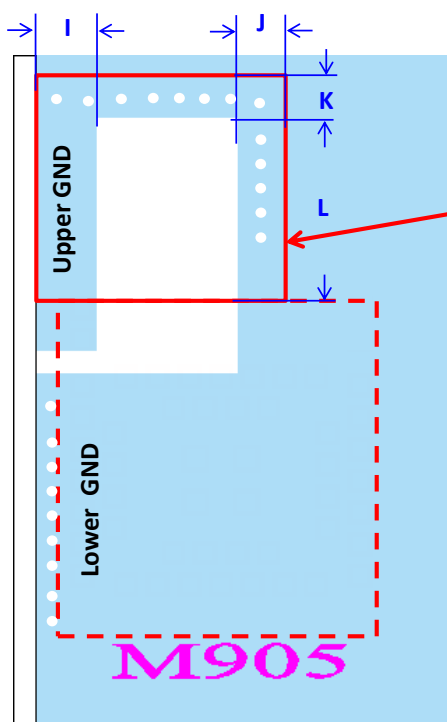
- Keep $A \geq 10.5\text{mm}$, $B \geq 0.55\text{mm}$
- Connect Pin 2 to Upper GND, Pin 3 to lower GND
- Don't route signal trace across antenna clearance area
- Recommend that module must be placed at long side.



Parameter	Units : mm
A	≥ 10.5
B	1.05



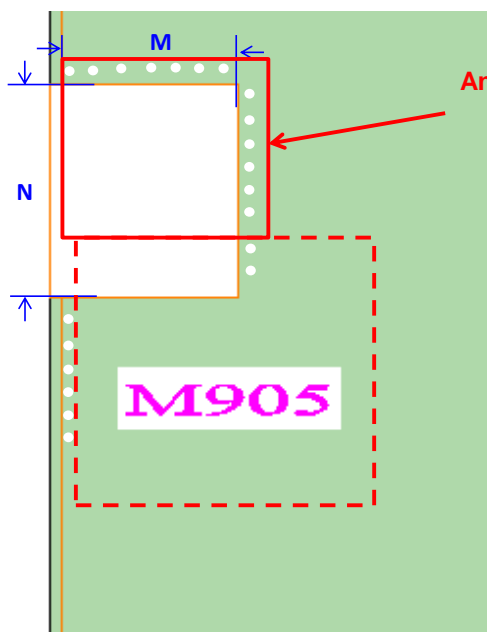
Parameter	Units : mm
C	1.25
D	2.9
E	5
F	0.45
G	1.05
H	0.25



Layer 1

Antenna Clearance Area

Parameter	Units : mm
I	1.25
J	0.5
K	0.5
L	3.5



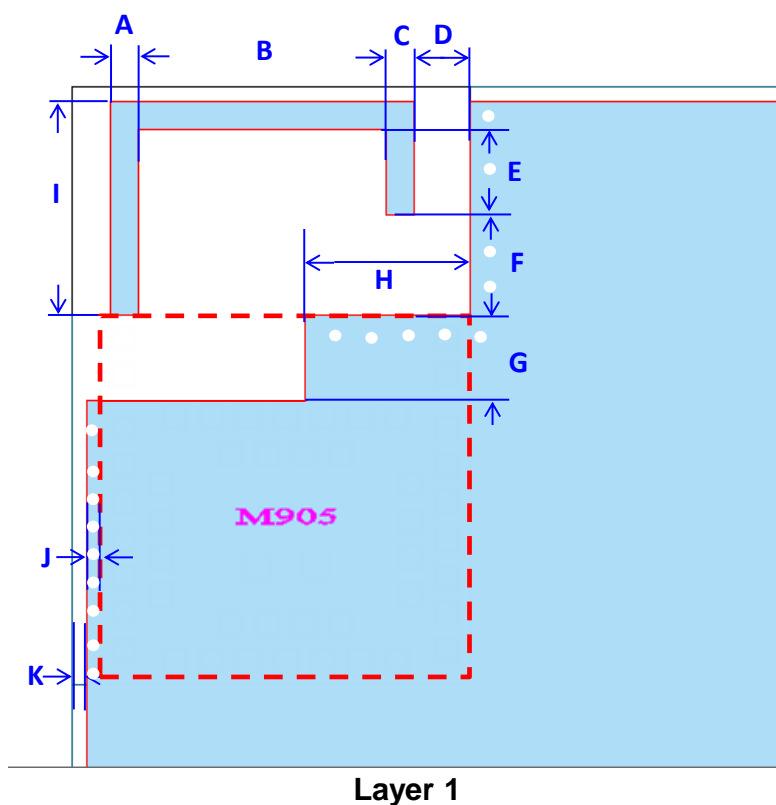
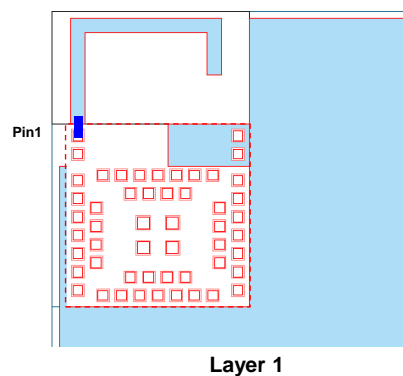
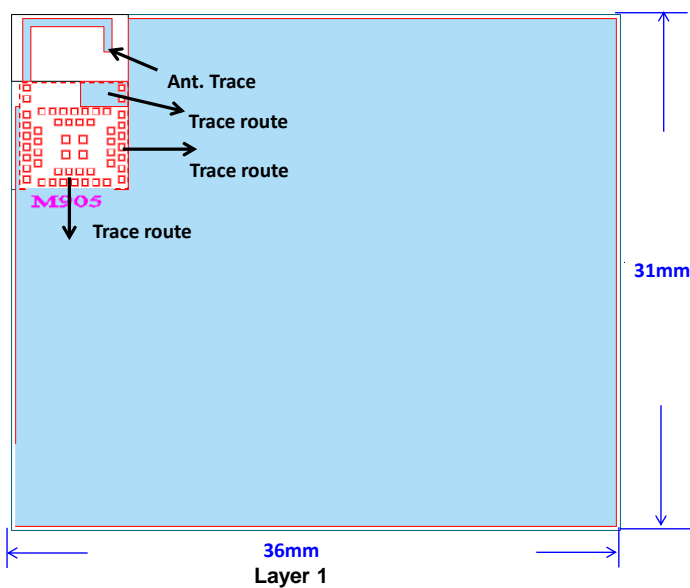
Layer 2,3,4

Antenna Clearance Area

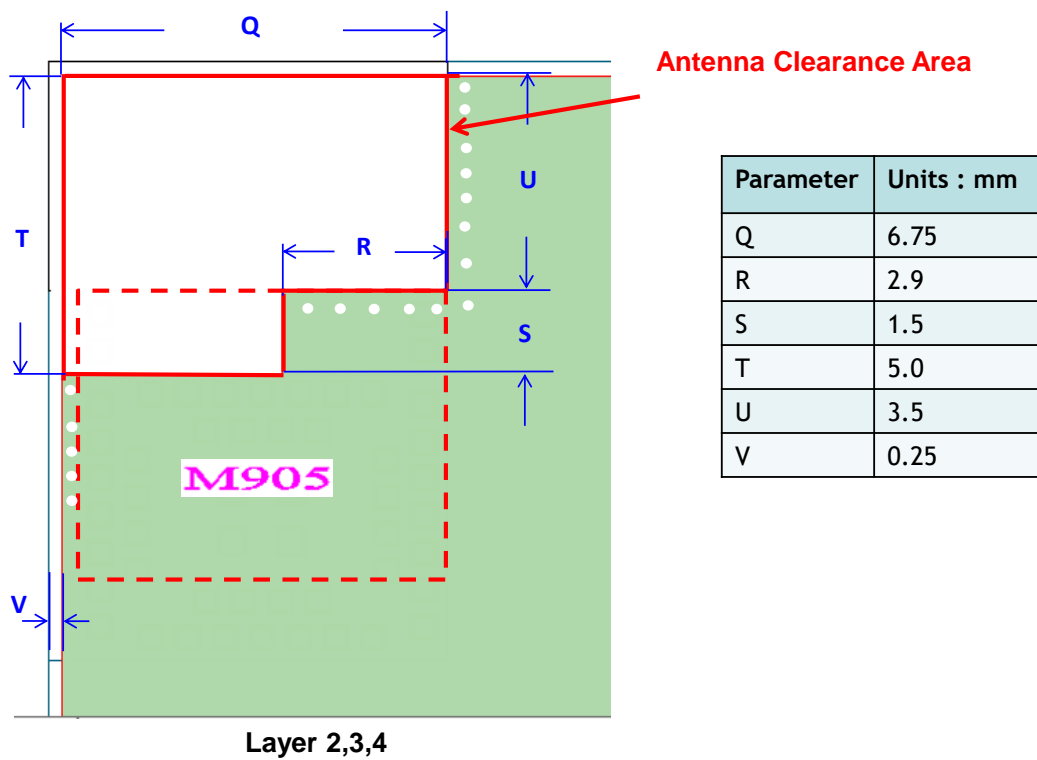
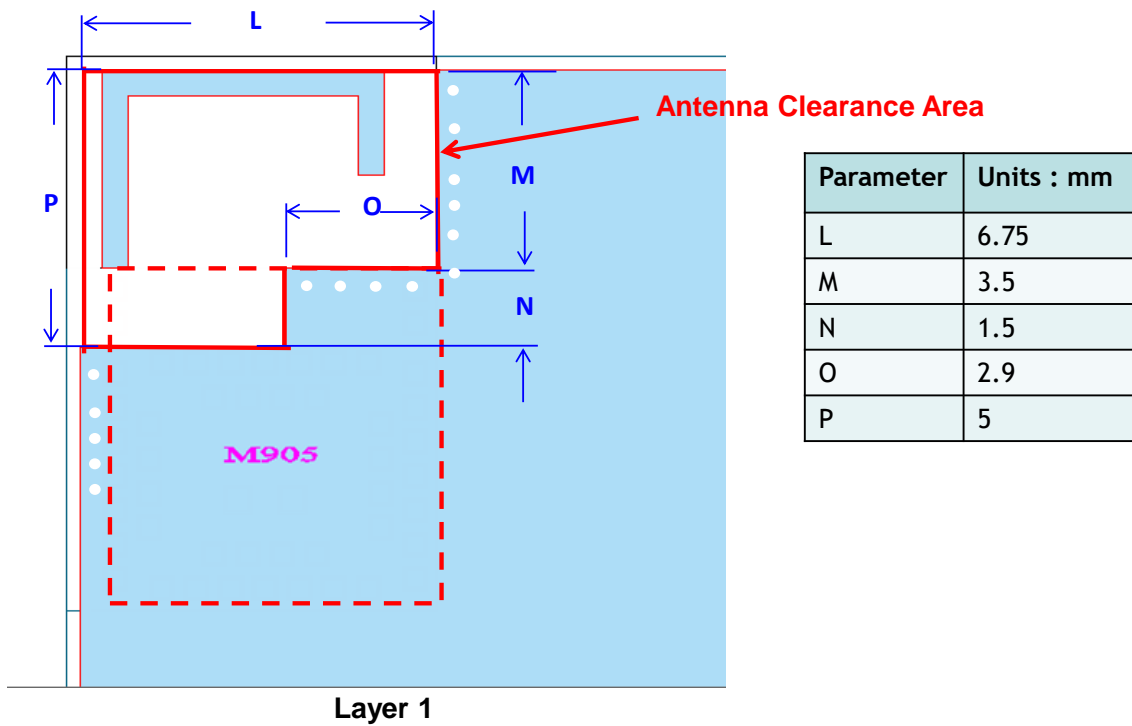
Parameter	Units : mm
M	4.15
N	5

Option 2: Corner

- Connect Pin 1 to Ant. Trace
- Don't route signal trace across antenna clearance area



Parameter	Units : mm
A	0.5
B	4.34
C	0.5
D	1
E	1
F	2
G	1.5
H	0.29
I	3.5
J	0.25
K	0.25



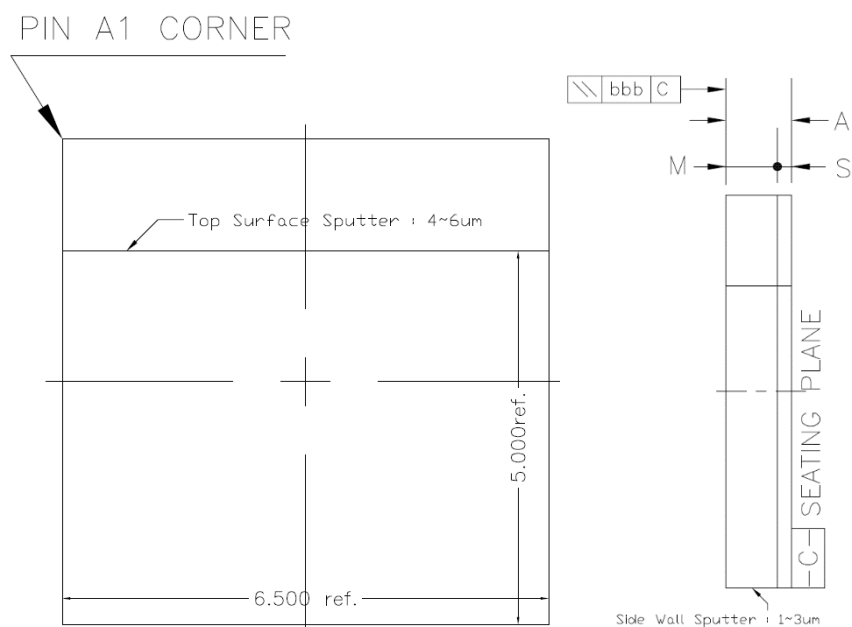
4.6 Power Consumption

Item	Typical	Units
TX Mode 0dBm	7.1	mA
RX Mode @ 1Mb/s	6.5	mA
System On, No RAM retention, Wake on any event	1.2	uA
System On, No RAM retention Wake on reset	1.5	uA
System OFF, Full 64 kB RAM retention, wake on reset	0.7	uA

5 Dimensions

The size and thickness of the M905 module are 6.5mm (W) x 6.5mm (L) x 1.2mm (H):

Top-view & Side-view



Dimension Details

		Symbol	Common Dimensions
Package :			PIM
Body Size:	X	E	6.500
	Y	D	6.500
Lead Pitch :	X	eE	0.650
	Y	eD	0.650
Total Thickness :		A	1.100±0.100
Mold Thickness :		M	0.860 Ref.
Substrate Thickness :		S	0.240 Ref.
S/R Opening :			0.350*0.350 / 0.420*0.420
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	---
Lead Count :		n	52
Edge Lead Center to Center :	X	E1	5.680
	Y	D1	5.680

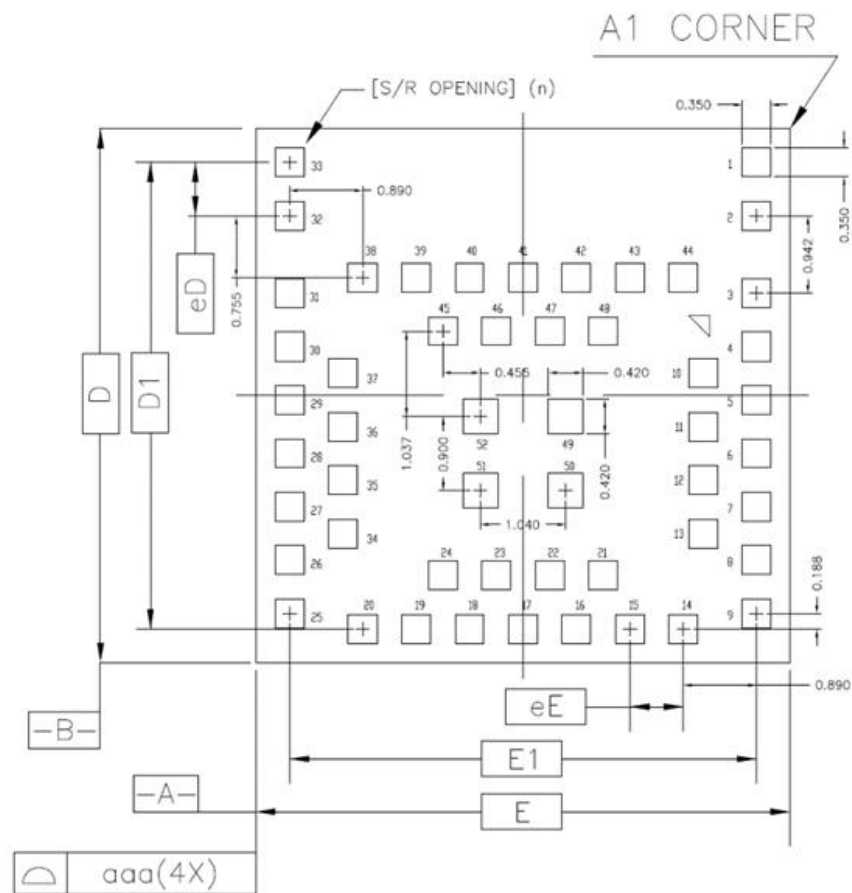
6 Pin Assignments

Pin Number	Pin Name	Pin Function	Description
1	Antenna Leg	RF	Antenna Option 2
2	GND A1	RF	Antenna Option 1
3	GND A2	RF	Antenna Option 1
4	GND	Power	Ground (0V)
5	ANT	RF	Signal-ended radio antenna connection
6	RF	RF	Conducted radio connection
7	GND	Power	Ground (0V)
8	GND	Power	Ground (0V)
9	VDD	Power	Power supply
10	GND	Power	Ground (0V)
11	GND	Power	Ground (0V)
12	P0.21/nRESET	Digital I/O	General purpose I/O pin. Configurable as system RESET pin
13	P0.14/TRACEDATA[3]	Digital I/O	General purpose I/O pin. Trace port output
14	P0.15/TRACEDATA[2]	Digital I/O	General purpose I/O pin. Trace port output
15	P0.16/TRACEDATA[1]	Digital I/O	General purpose I/O pin. Trace port output
16	P0.18/TRACEDATA[0]	Digital I/O	General purpose I/O pin. Trace port output
17	P0.00/XL1	Digital I/O Analog input	General purpose I/O pin. Connection for 32.768kHz crystal (LFXO)
18	P0.01/XL2	Digital I/O Analog input	General purpose I/O pin. Connection for 32.768kHz crystal (LFXO)
19	P0.03/AIN1	Digital I/O Analog input	General purpose I/O pin. SAADC/COMP/LPCOMP input
20	P0.02/AIN0	Digital I/O Analog input	General purpose I/O pin. SAADC/COMP/LPCOMP input
21	P0.09/NFC1	Digital I/O NFC input	General purpose I/O pin. NFC antenna connection
22	P0.10/NFC2	Digital I/O NFC input	General purpose I/O pin. NFC antenna connection
23	P0.05/AIN3	Digital I/O Analog input	General purpose I/O pin. SAADC/COMP/LPCOMP input
24	P0.04/AIN2	Digital I/O Analog input	General purpose I/O pin. SAADC/COMP/LPCOMP input
25	P0.31/AIN7	Digital I/O Analog input	General purpose I/O pin. SAADC/COMP/LPCOMP input
26	P0.30/AIN6	Digital I/O Analog input	General purpose I/O pin. SAADC/COMP/LPCOMP input
27	P0.29/AIN5	Digital I/O Analog input	General purpose I/O pin. SAADC/COMP/LPCOMP input
28	P0.28/AIN4	Digital I/O Analog input	General purpose I/O pin. SAADC/COMP/LPCOMP input
29	P0.27	Digital I/O	General purpose I/O pin
30	P0.25	Digital I/O	General purpose I/O pin
31	P0.26	Digital I/O	General purpose I/O pin
32	GND	Power	Ground (0V)
33	GND	Power	Ground (0V)
34	P0.11	Digital I/O	General purpose I/O pin
35	P0.19	Digital I/O	General purpose I/O pin
36	P0.22	Digital I/O	General purpose I/O pin
37	P0.23	Digital I/O	General purpose I/O pin
38	P0.24	Digital I/O	General purpose I/O pin
39	SWDCLK	Digital input	Serial wire debug clock input for debug and programming
40	SWDIO	Digital I/O	Serial wire debug I/O for debug and programming
41	GND	Power	Ground (0V)
42	GND	Power	Ground (0V)

43	GND	Power	Ground (0V)
44	GND	Power	Ground (0V)
45	P0.20/TRACECLK	Digital I/O	General purpose I/O pin. Trace port clock output
46	GND	Power	Ground (0V)
47	GND	Power	Ground (0V)
48	GND	Power	Ground (0V)
49	GND	Power	Ground (0V)
50	GND	Power	Ground (0V)
51	GND	Power	Ground (0V)
52	GND	Power	Ground (0V)

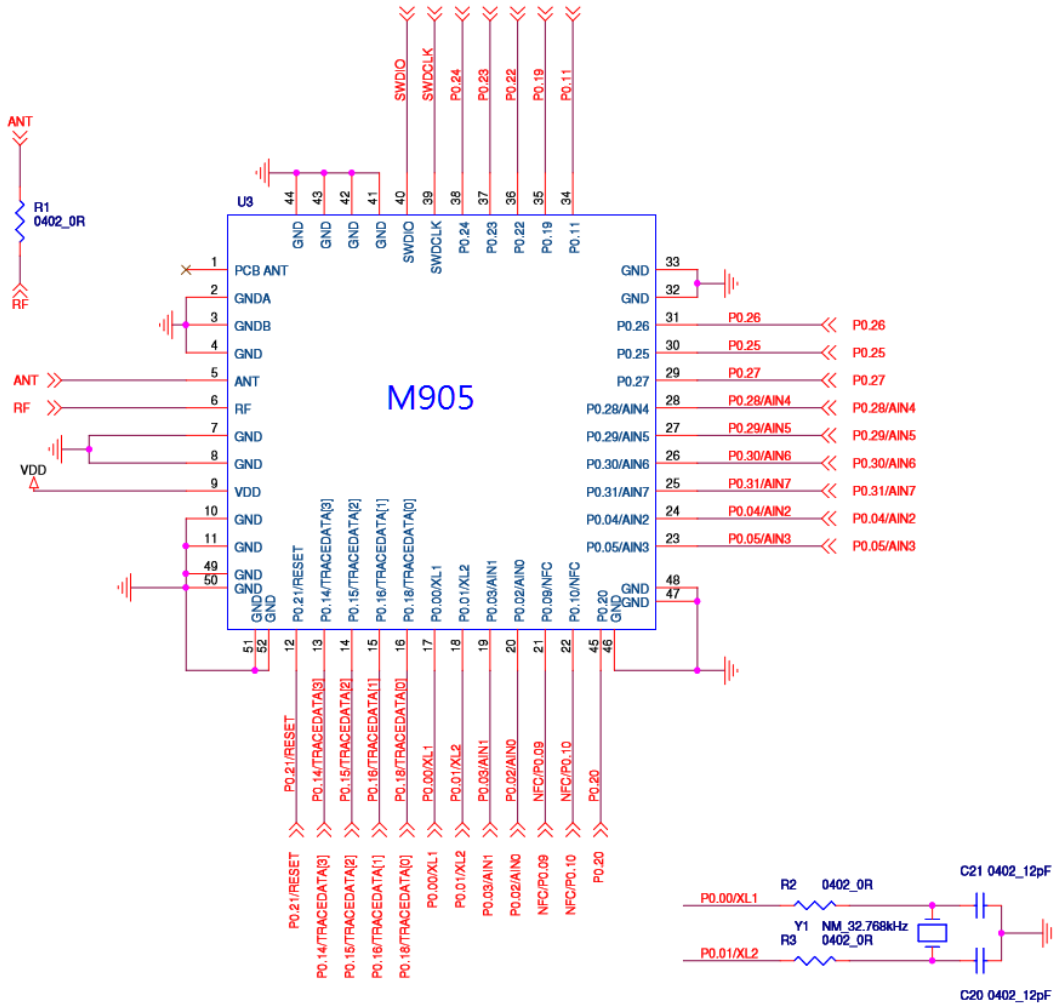
7 Recommended Footprint

Suggest on PCB: SMD (1:1)



8 Reference Design Circuit

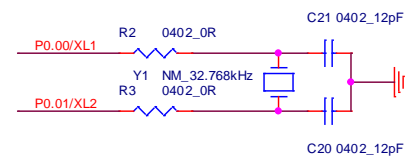
AoP Design



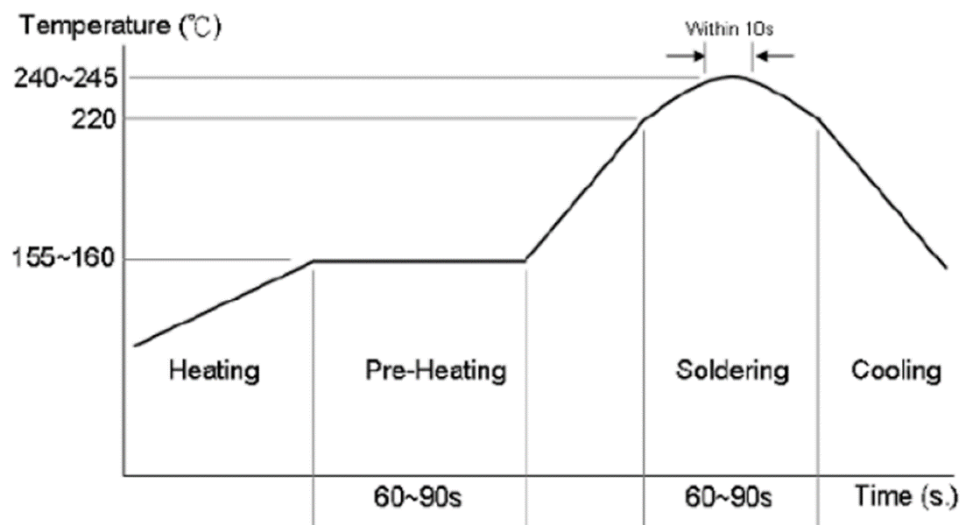
The diagram illustrates the PCB layout of the M905 module. The central component is the M905 chip, which is a square integrated circuit with numerous pins. The pins are labeled with their functions and corresponding pin numbers. The layout includes several external components and connections:

- Antenna:** A small antenna labeled "E1 ANTENNA" is connected to the RF pin (pin 6).
- RF Connectors:** Two RF connectors are shown, one labeled "RF" and the other "RF".
- Power and Ground:** The VDD pin (pin 9) is connected to a power source, and the GND pin (pin 8) is connected to ground. The GND pin (pin 10) is also connected to ground.
- Control Pins:** The RESET pin (pin 12) is connected to a reset signal. The TRACEDATA pins (pins 13-16) are connected to a data bus.
- Other Pins:** The XL1, XL2, AN1, AN0, P0.09, and P0.10 pins are connected to various signals.

The M905 chip is shown with its pins numbered 1 through 52. The pins are arranged in a grid, with the top row containing pins 1 through 12, the second row containing pins 13 through 22, and so on. The bottom row contains pins 51 through 52. The chip is labeled "M905" in the center.



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 $<40^{\circ}\text{C}$ 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 $<30^{\circ}\text{C}$ / 60% RH.
 - b. Stored at $\leq 10\%$ 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 $23\pm 5^{\circ}\text{C}$.
 - 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 $125\pm 5^{\circ}\text{C}$.

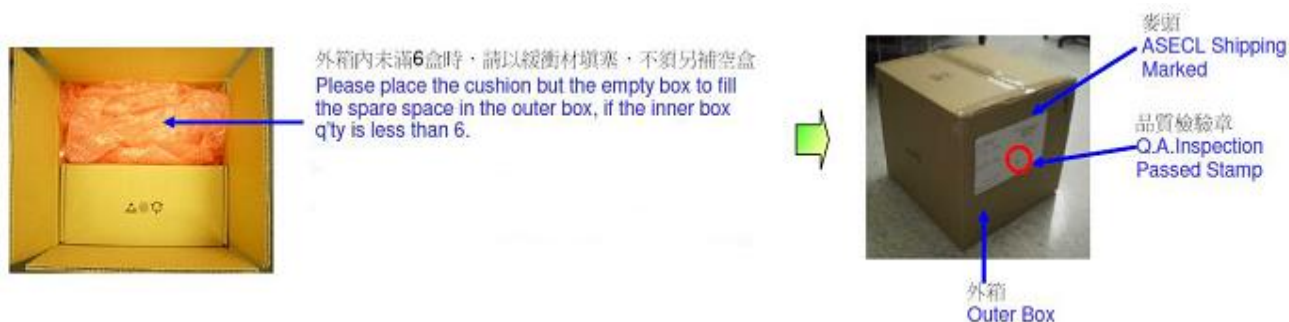
11 Package Information

11.1 Product Marking



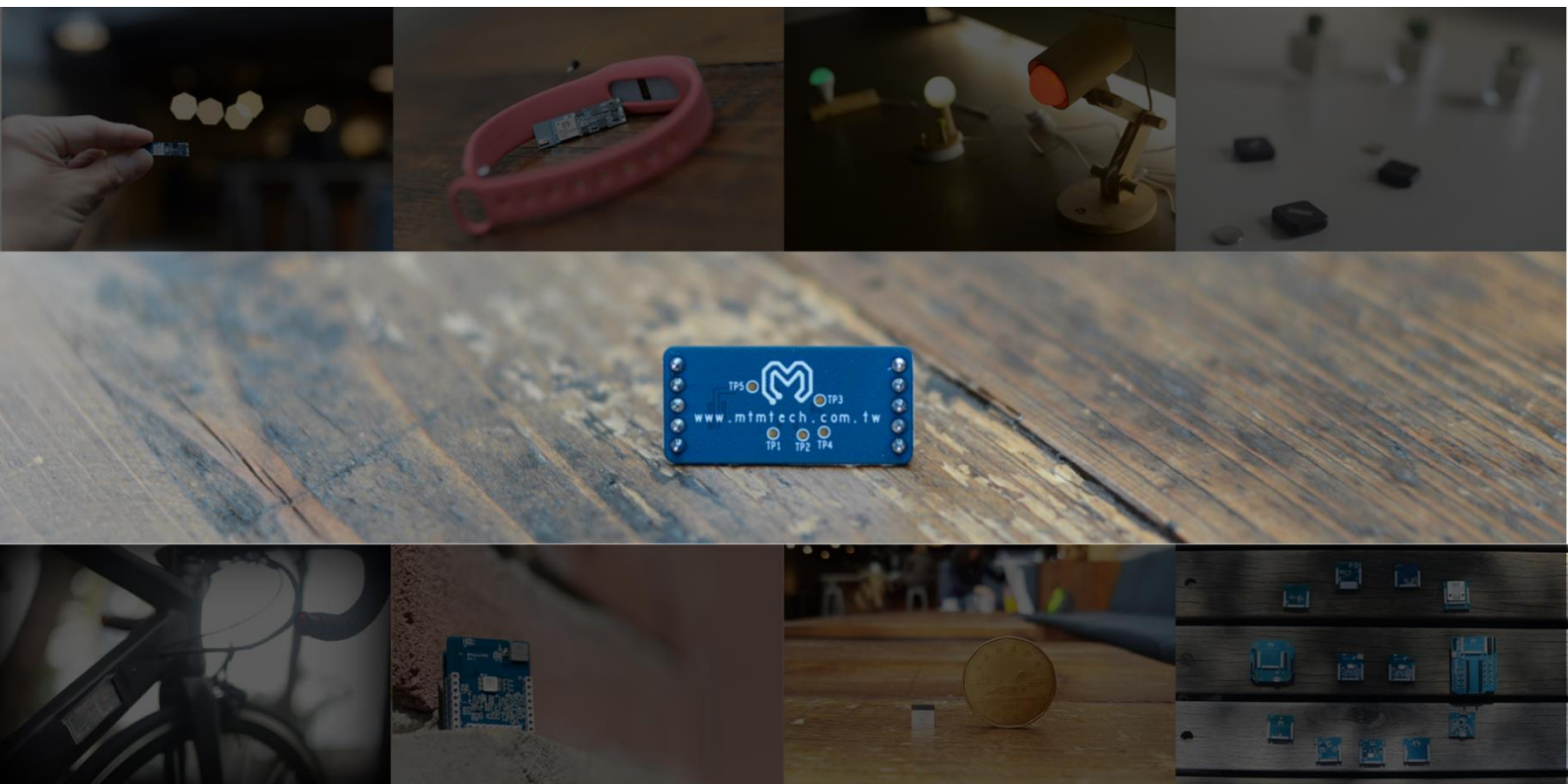
- Line 1: M905 (Model Name)
- Line 2: YYWW (Date Code)
- Line 3: 2AJ9P-M905 (FCC ID)

11.2 Packaging



12 Document History

Date	Modifications	Version
Jan. 23, 2016	Preliminary Version	1.0
May. 08, 2016	AoP Design Guide & Antenna Pattern Update	1.1
Sep. 05, 2017	Rebrand as MtM+ Technology	1.2
Feb. 13, 2018	Revise description detail	1.3
Apr. 26, 2018	Update datasheet to Bluetooth 5.0	1.4



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