



MtM+ Technology

M905

Bluetooth 5.0 Low Energy SiP Module

with MCU and integrated antenna

DATASHEET
28th May, 2018

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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

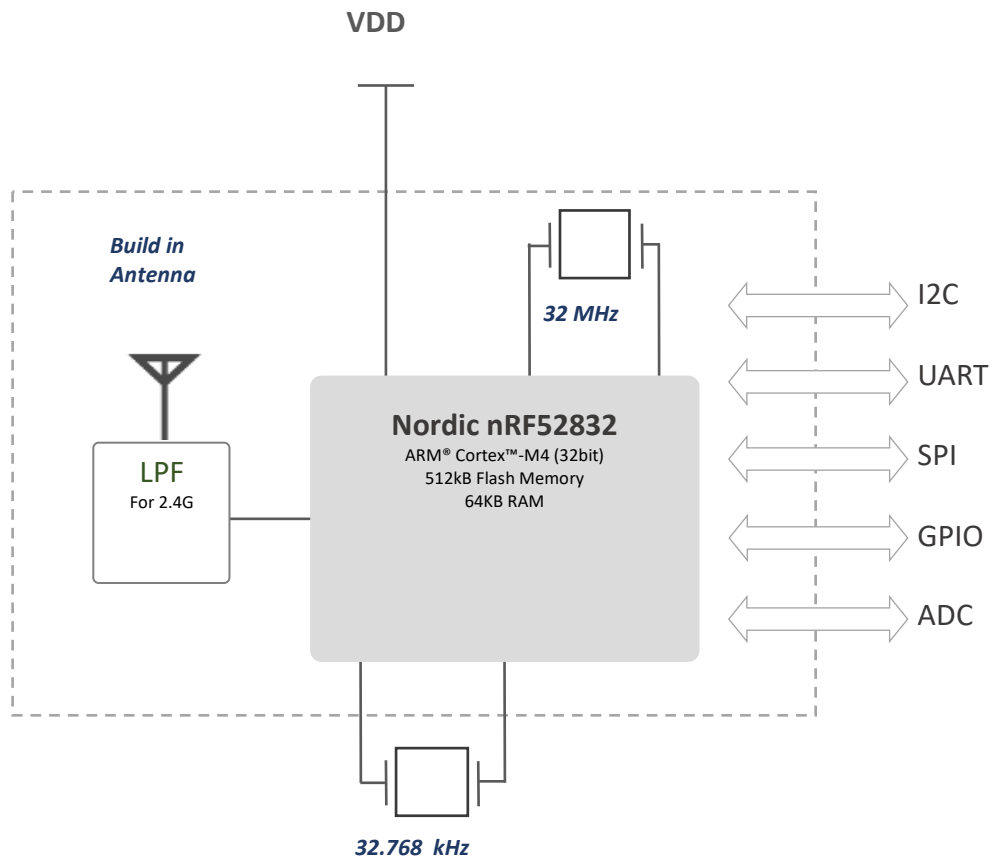
- Multi-protocol with Bluetooth low energy / ANT / 2.4G RF
- Built-in antenna
- 32-bit ARM Cortex M4F processor
- 512kB flash + 64kB RAM
- LGA-52 package, 6.5 x 6.5 x 1.1 mm
- Application development independent from protocol stack
- Programmable output power from -20dBm to +4dBm
- Flexible and configurable 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 compact 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 |

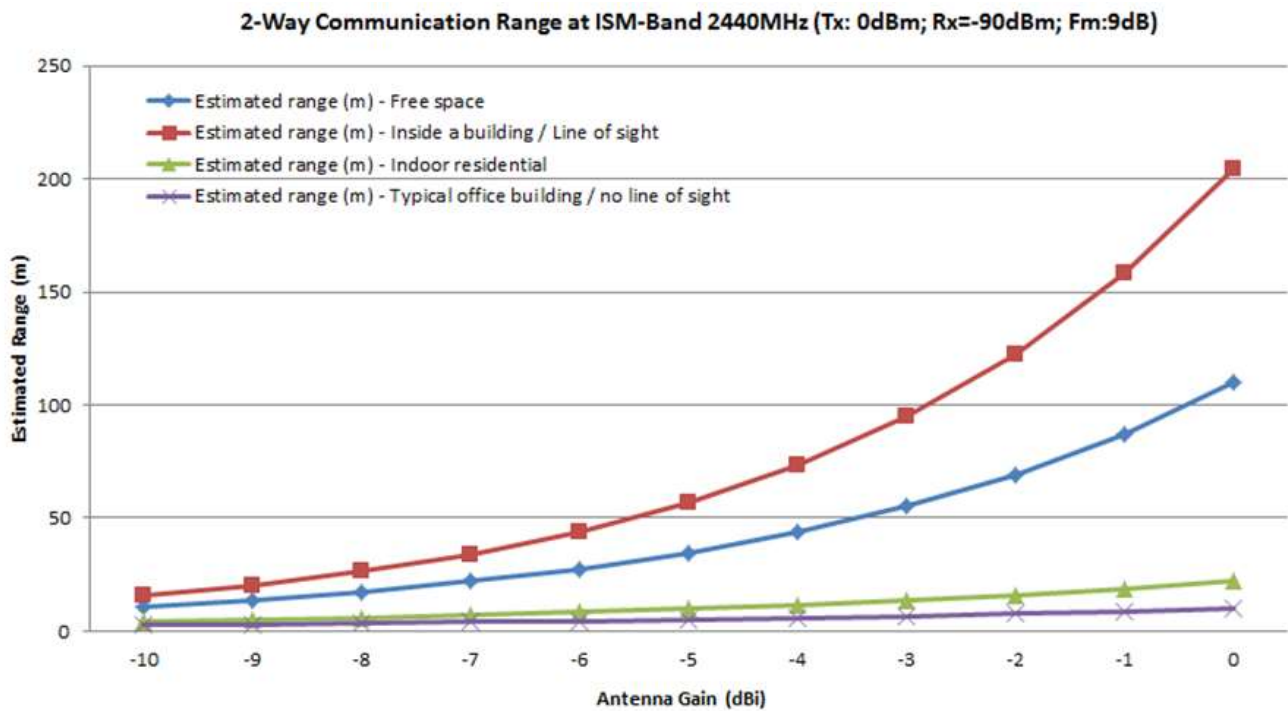
4.4 Radio Specifications – Bluetooth 5.0 Low Energy

| 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

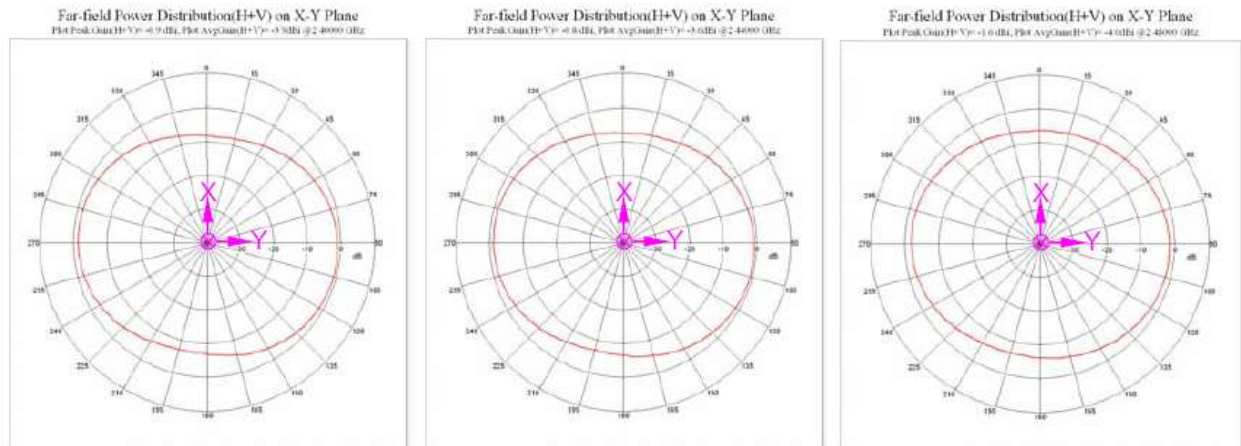
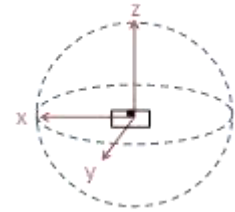
| Item | Freq. Band | Gain | Return Loss | VSWR |
|------|-------------|--------------|------------------|------------|
| Spec | 2.4~2.5 GHz | >5dBi | <6dB | 3 max |
| Item | Impedance | Polarization | Directivity | Efficiency |
| Spec | 50 ohm | Linear | Omni-directional | >30% |

Antenna Gain Reference

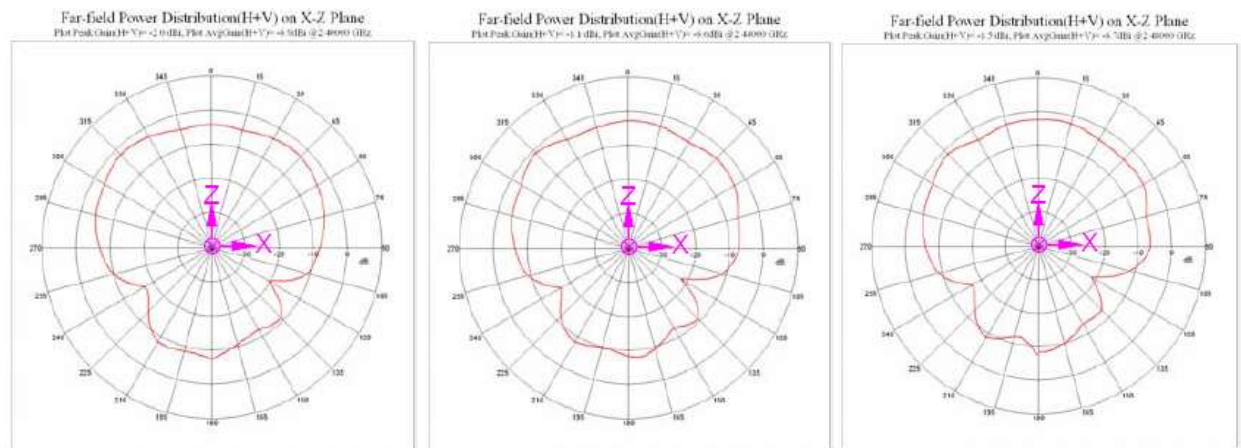


4.5.1 Antenna Pattern

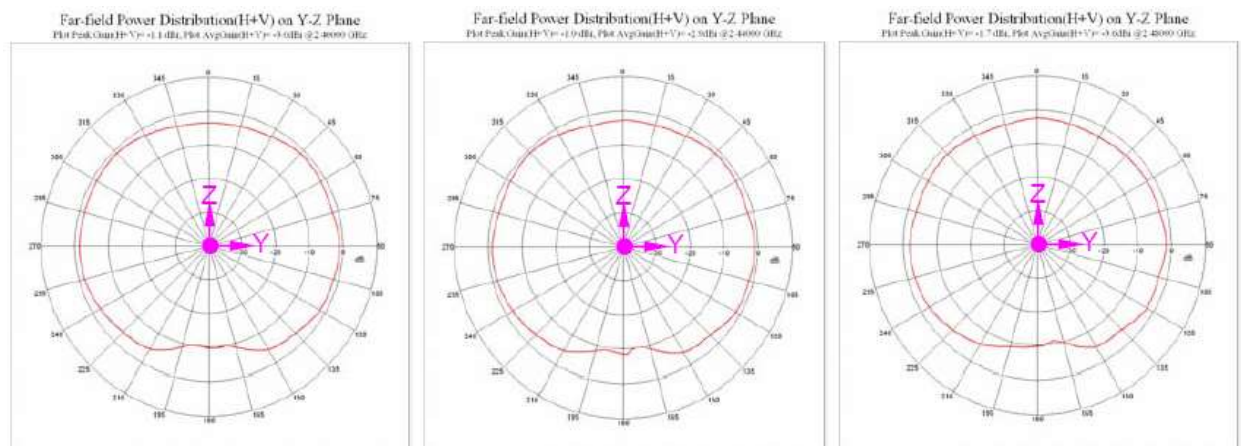
2D Radiation Pattern Plot (Centre Edge):



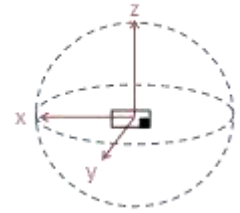
a. XY-plane radiation pattern at 2400MHz, 2440MHz and 2480MHz



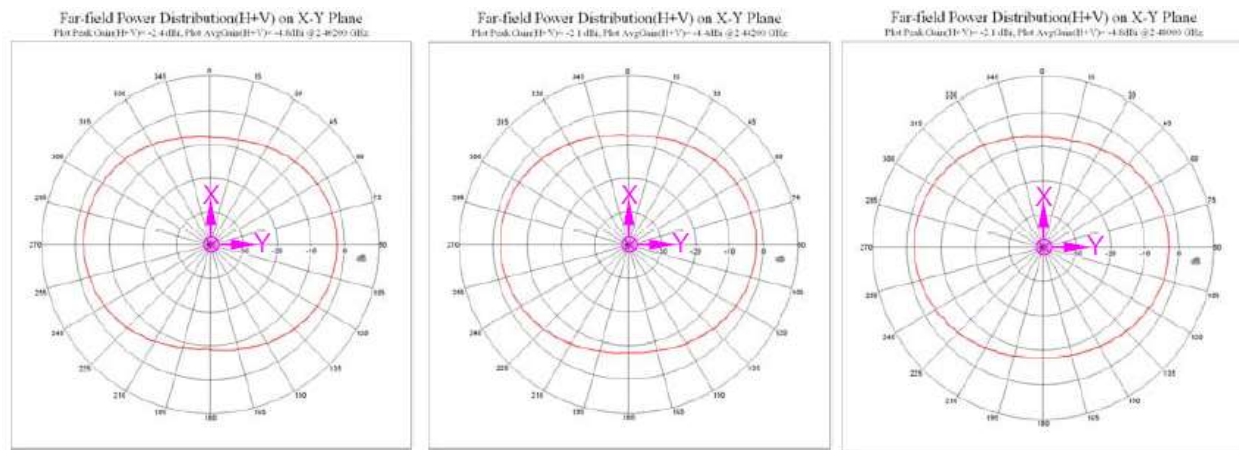
b. XZ-plane radiation pattern at 2400MHz, 2440MHz and 2480MHz



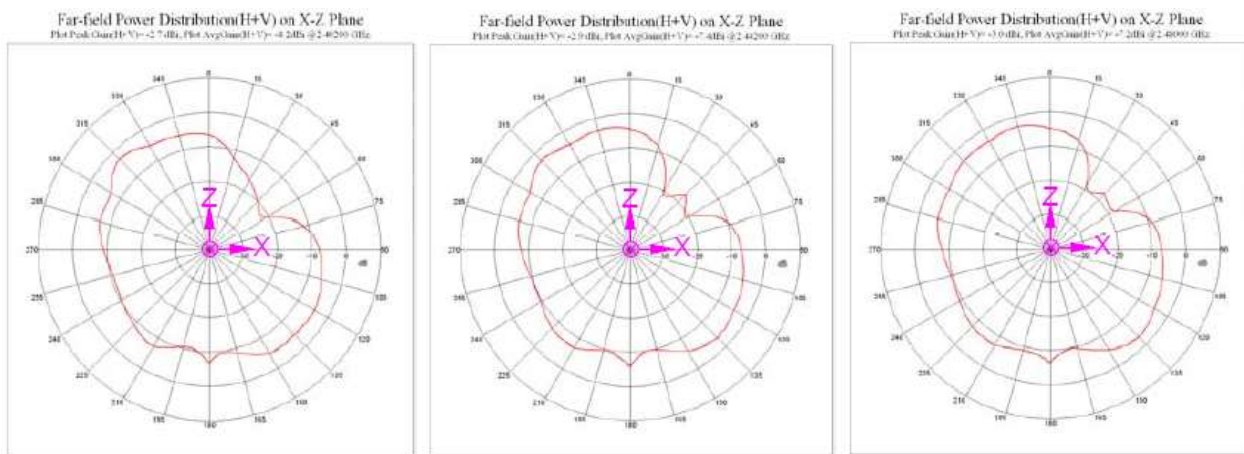
c. YZ-plane radiation pattern at 2400MHz, 2440MHz and 2480MHz



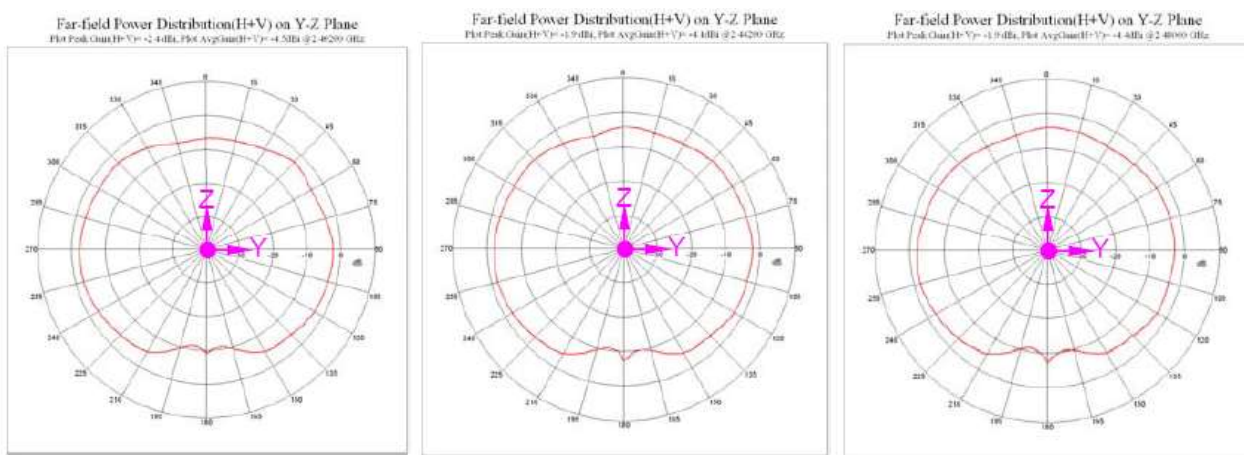
2D Radiation Pattern Plot (Corner Design):



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



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

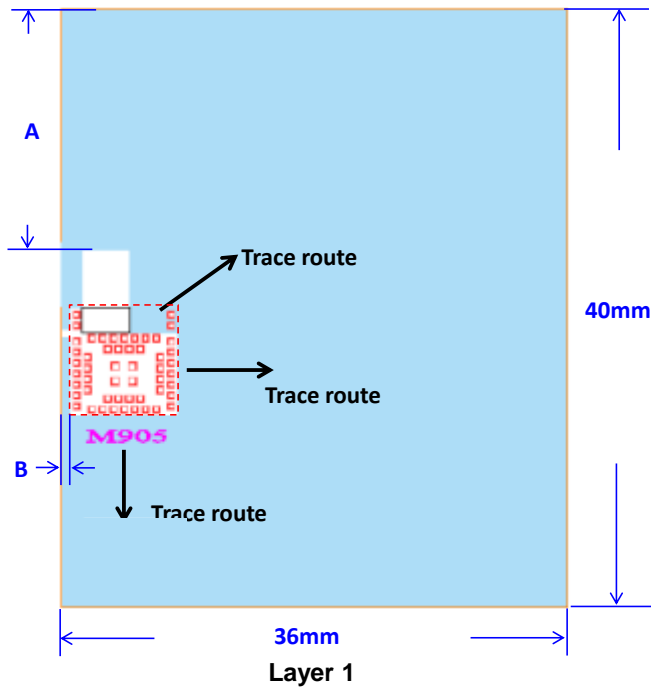


c. YZ-plane radiation pattern at 2400MHz, 2440MHz and 2480MHz

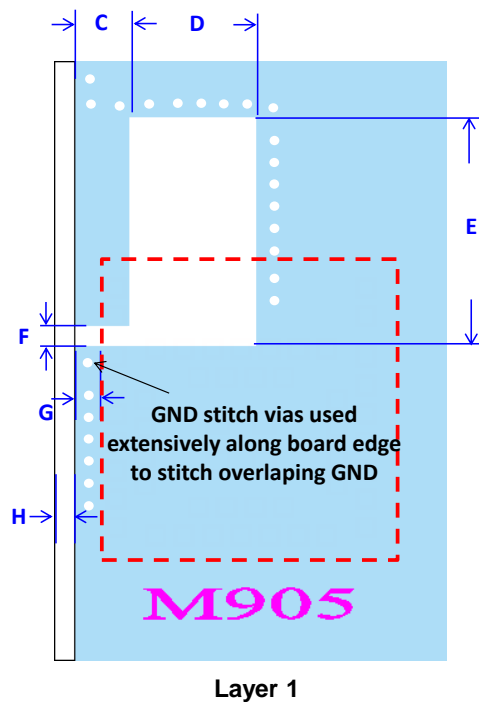
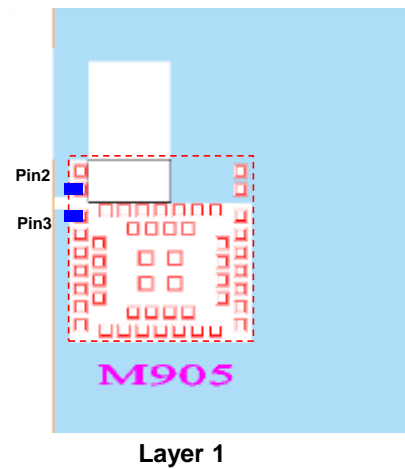
4.5.2 Antenna Design Guide

Option 1: Center Edge

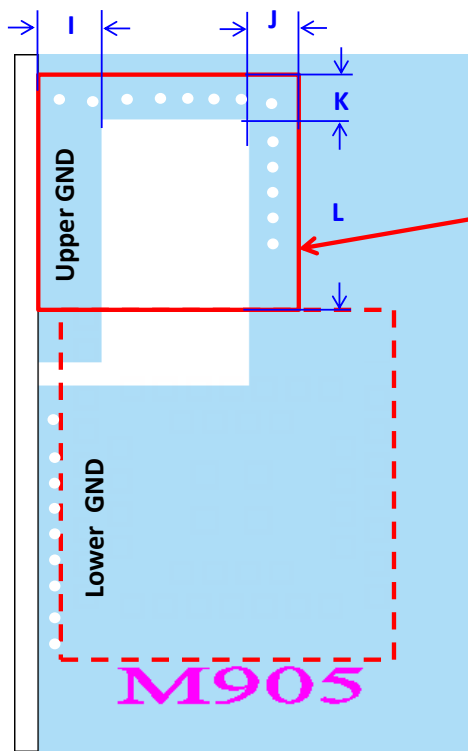
- Keep $A \geq 10.5\text{mm}$, $B \geq 0.55\text{mm}$
- Connect Pin 2 to Upper GND, Pin 3 to lower GND
- Don't route signal trace across antenna clearance area
- Recommend that module must be placed at long side.



| Parameter | Units : mm |
|-----------|-------------|
| A | ≥ 10.5 |
| B | 1.05 |



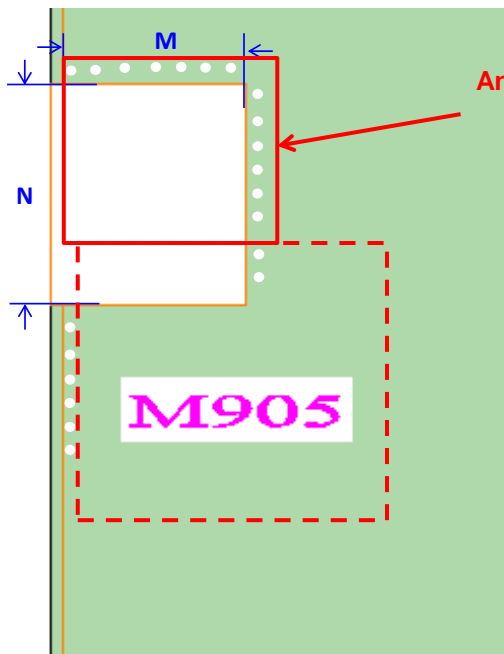
| Parameter | Units : mm |
|-----------|------------|
| C | 1.25 |
| D | 2.9 |
| E | 5 |
| F | 0.45 |
| G | 1.05 |
| H | 0.25 |



Layer 1

Antenna Clearance Area

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



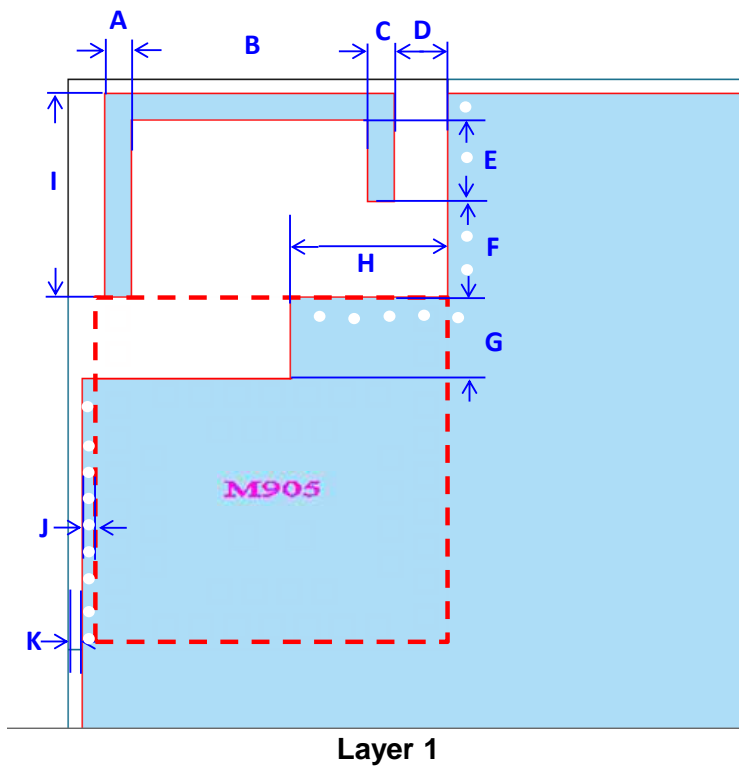
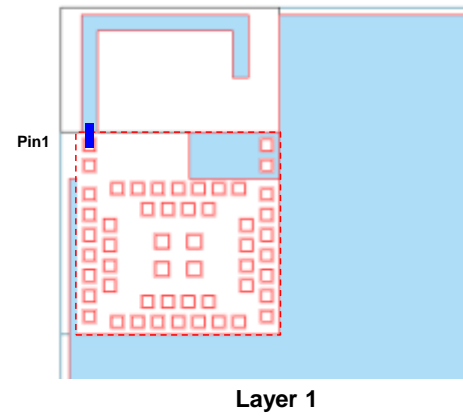
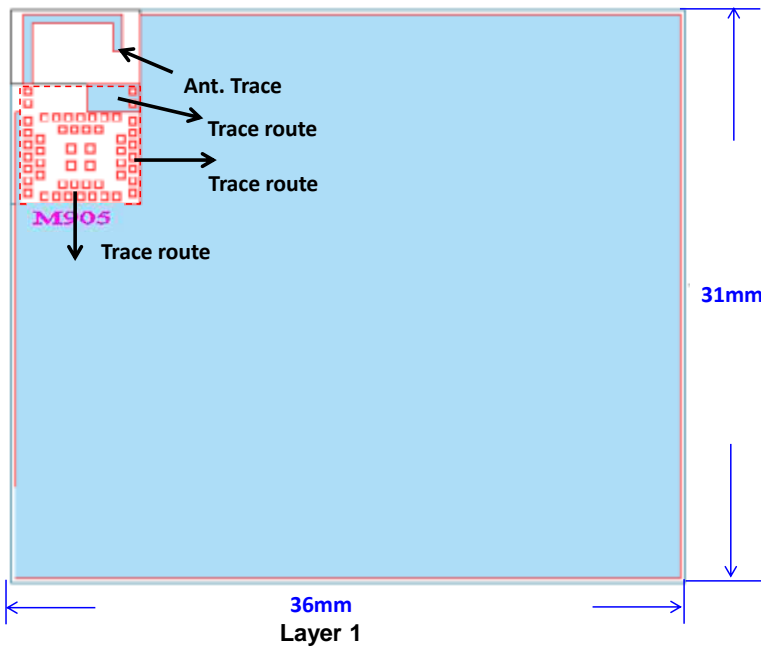
Layer 2,3,4

Antenna Clearance Area

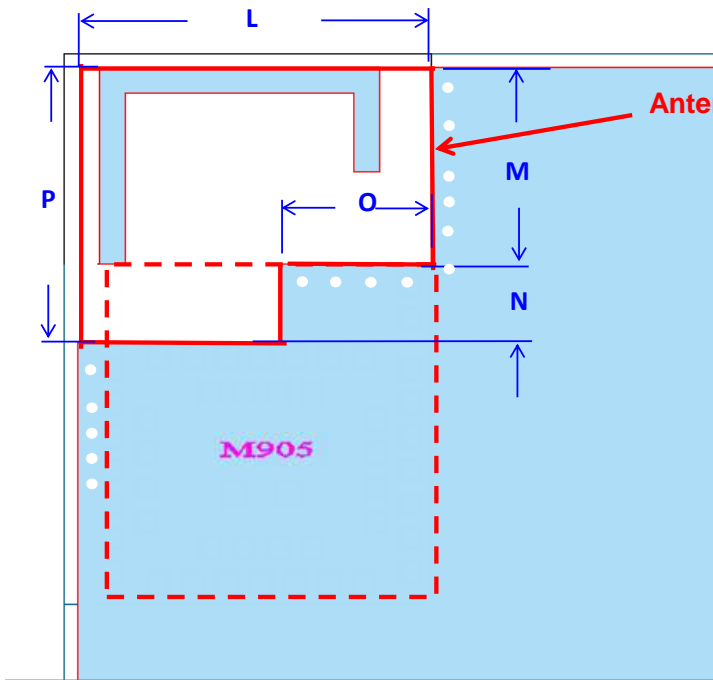
| Parameter | Units : mm |
|-----------|------------|
| M | 4.15 |
| N | 5 |

Option 2: Corner

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

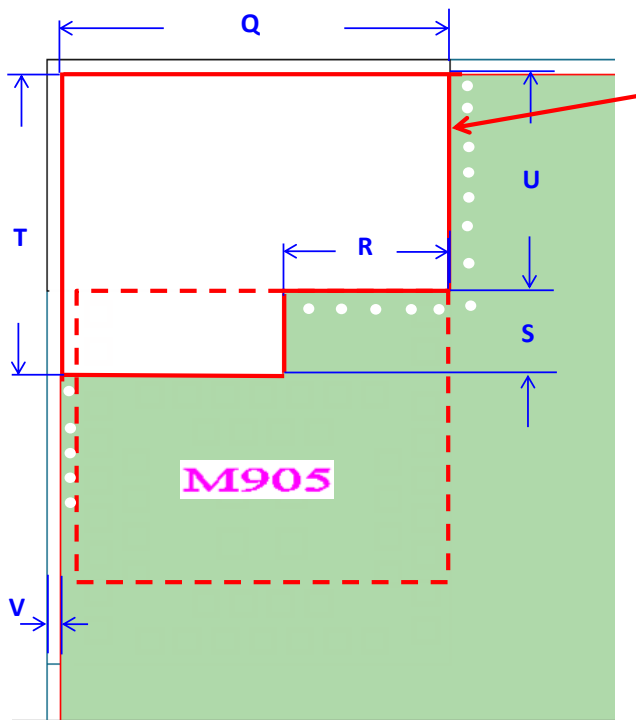


| Parameter | Units : mm |
|-----------|------------|
| A | 0.5 |
| B | 4.34 |
| C | 0.5 |
| D | 1.0 |
| E | 2.0 |
| F | 1.0 |
| G | 1.5 |
| H | 2.9 |
| I | 3.5 |
| J | 0.25 |
| K | 0.25 |



Layer 1

| Parameter | Units : mm |
|-----------|------------|
| L | 6.75 |
| M | 3.5 |
| N | 1.5 |
| O | 2.9 |
| P | 5 |



Layer 2,3,4

| Parameter | Units : mm |
|-----------|------------|
| Q | 6.75 |
| R | 2.9 |
| S | 1.5 |
| T | 5.0 |
| U | 3.5 |
| V | 0.25 |

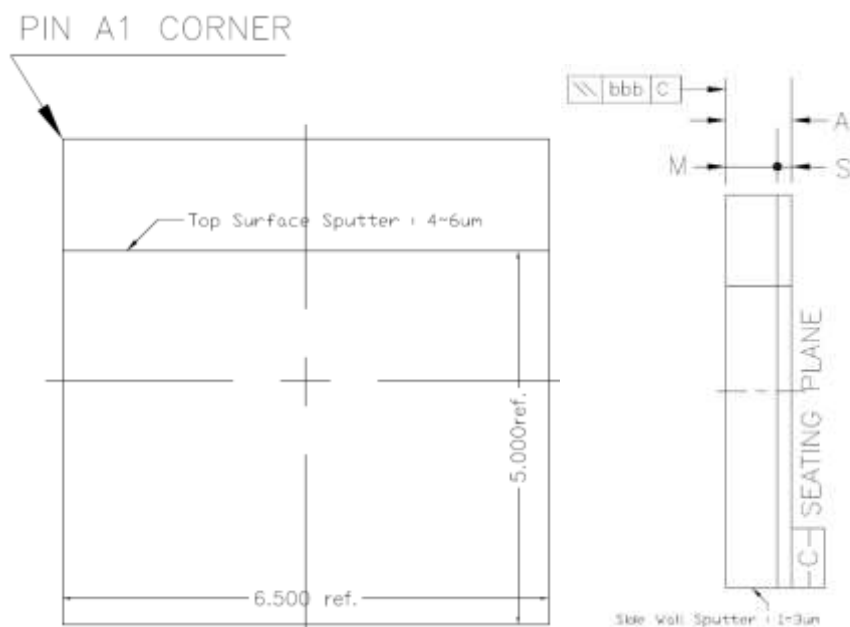
4.6 Power Consumption

| 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 |

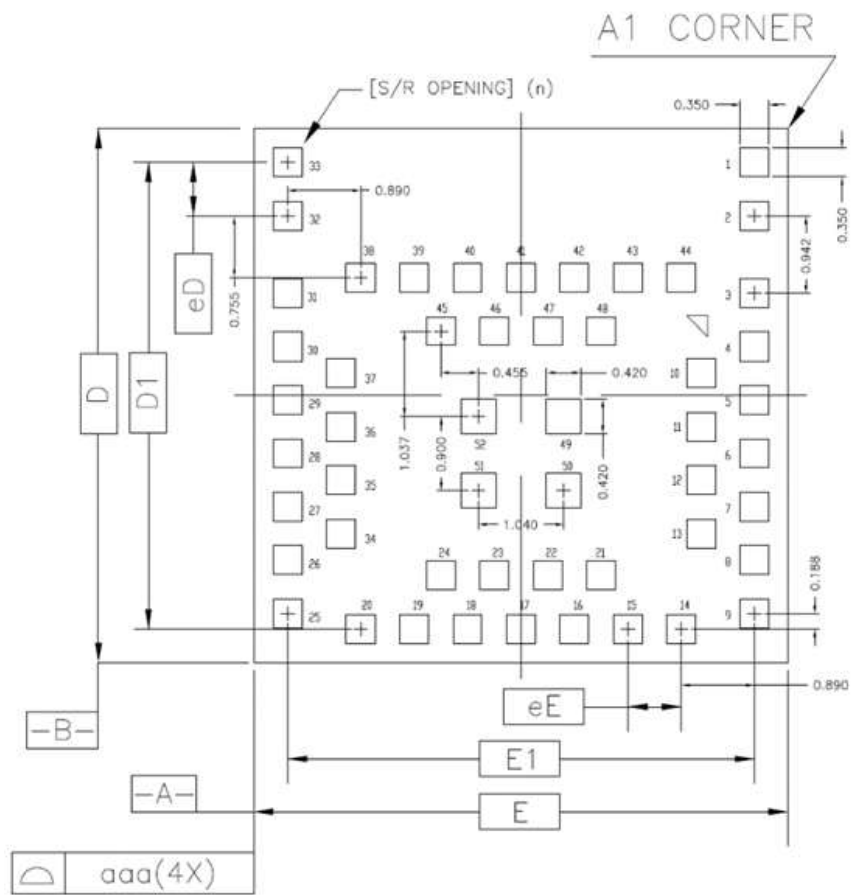
6 Pin Assignments

| 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) |

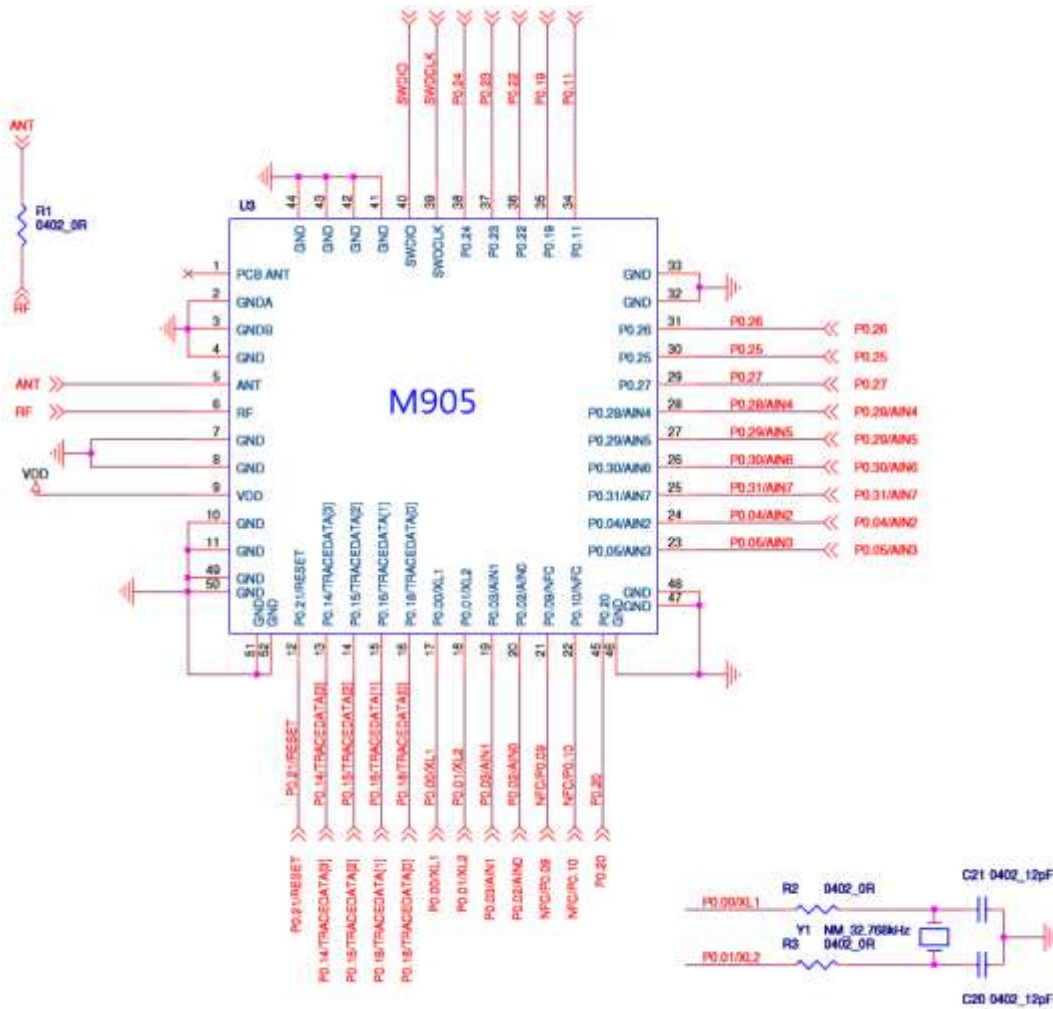
7 Recommended Footprint

Suggest on PCB: SMD (1:1)

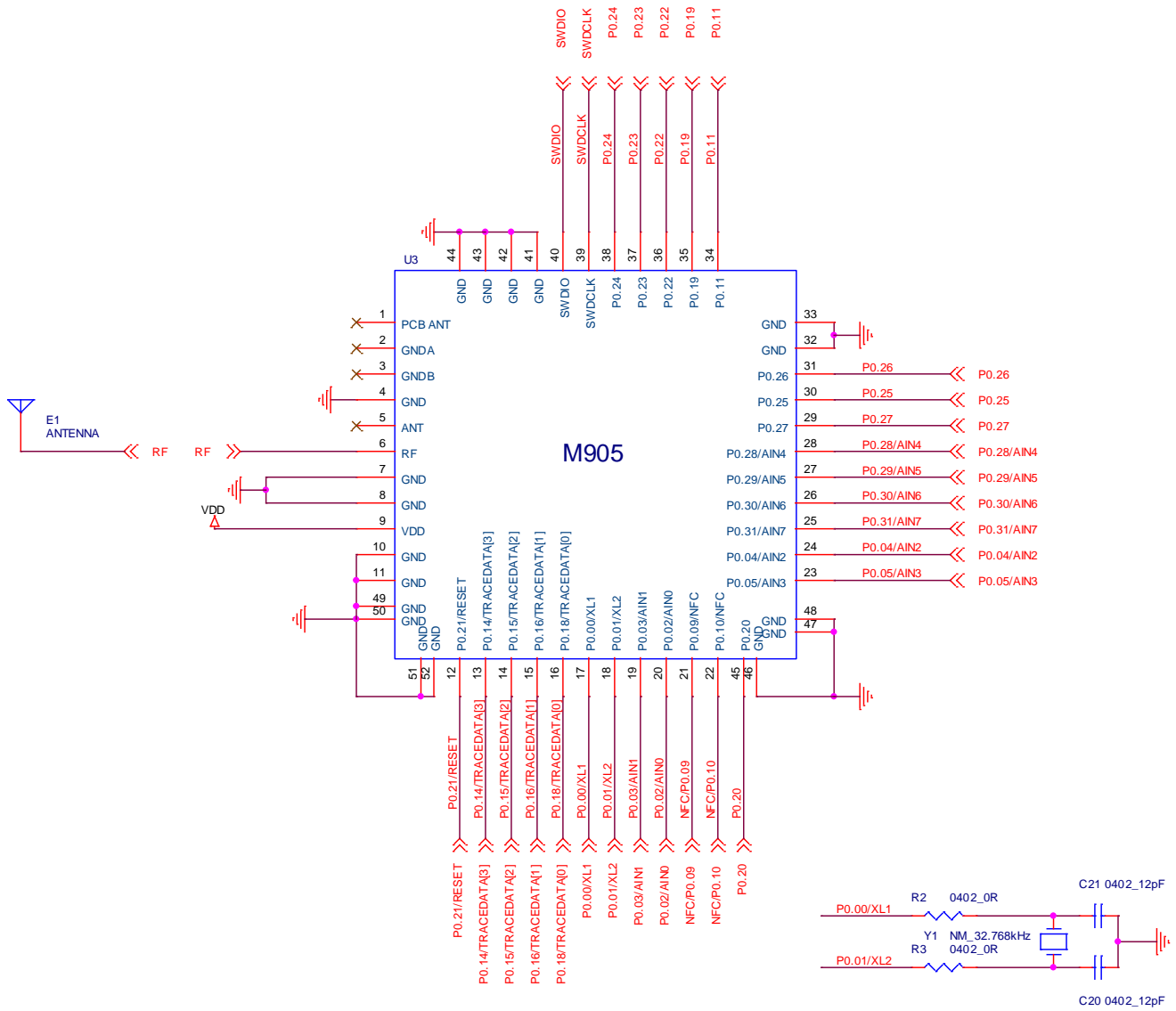


8 Reference Design Circuit

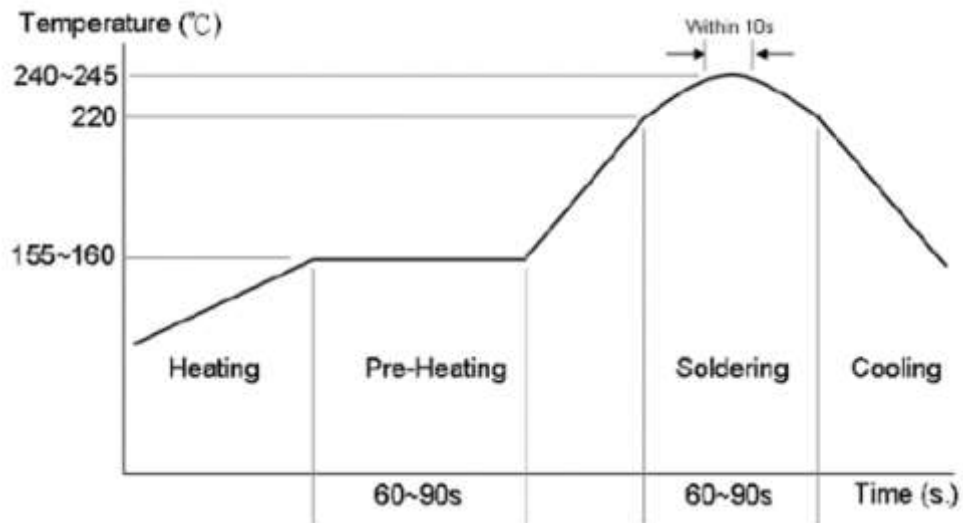
AoP Design



External Antenna Design



9 Recommended Reflow Profile



Profile Condition

- Suitable for lead-free solder
- Between 155~160°C: 60 ~ 90 sec.
- Above 220°C: 60 ~ 90 sec.
- 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 $125\pm 5^{\circ}\text{C}$.

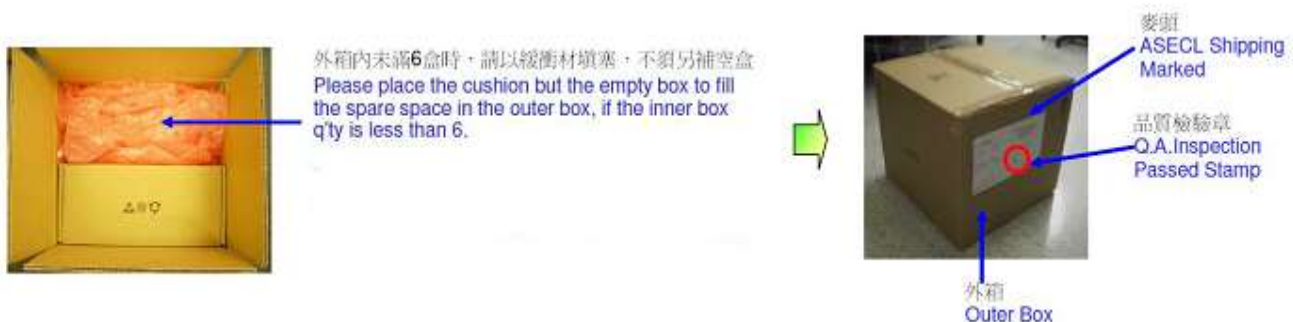
11 Package Information

11.1 Product Marking



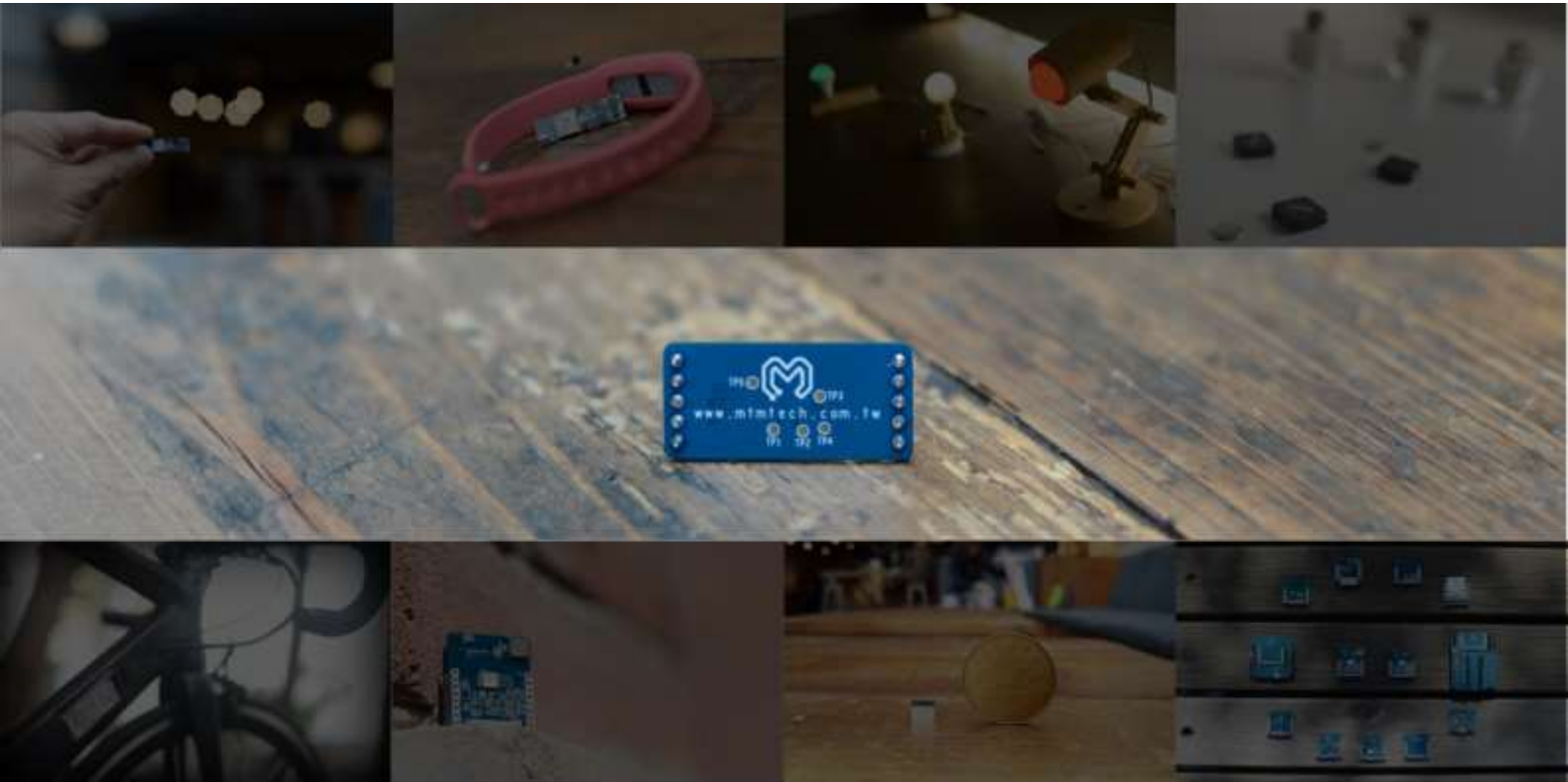
- Line 1: M905 (Model Name)
- Line 2: YYWW (Date Code)
- Line 3: 2AJ9P-M905 (FCC ID)

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 |
| May 28, 2018 | Update "4.5.2 Antenna Design Guide" | 1.5 |



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