



MtM+ Technology

M903L

Bluetooth SiP Module

-BT 4.0 LE

Preliminary DATASHEET
22nd February, 2018

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1 Product Brief

The SiP module M903L is a small size module that provides full function of Bluetooth 4.0 Low Energy in a tiny module via 32 pins LGA footprint. The M903L module provides everything required to create Bluetooth 4.0 Low Energy product with RF, baseband, MCU, qualified Bluetooth v4.0 stack and customer application running on a single IC.

M903L 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 4.0 Low Energy feature, such as, IP camera, car key, sport and fitness watch, mouse, led light bulb, etc.

The module is based on CSR Bluetooth Low Energy single mode chipset provides Bluetooth Low Energy communication.

M903L provides command line interface (CLI) for being easily controlled by a host CPU through UART communication. It also contains a 16-bits MCU to run a variety of applications and for embedded application development.

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® 4.0 Low Energy
- Support Qualcomm® CSRmesh™
- Low Power 16-bits MCU
- Interface for Host: UART, SPI
- Interface for Sensor:
ADC/SPI/I²C/GPIO/PWM

2 Features and Applications

Feature List

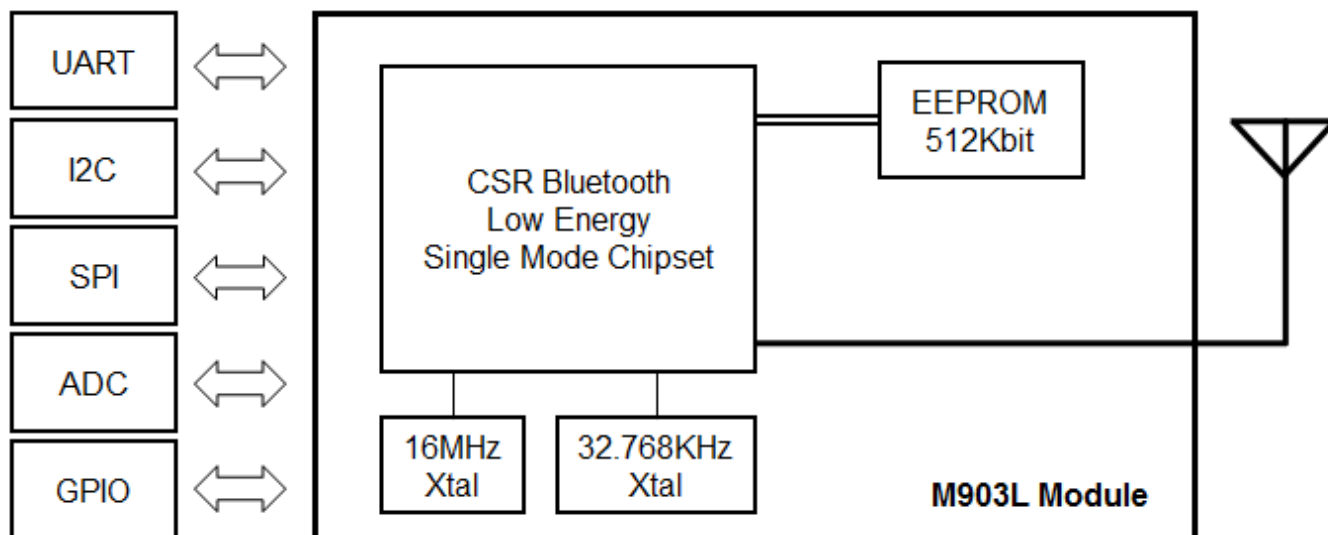
- Bluetooth® v4.0 LE radio technology
- Up to +6.0 dBm TX power with transmit power control.
- High sensitivity (-90.0 dBm.)
- Dimension: 9 x 9 x 1.3 mm
- High performance low power 16-bits microcontroller core
- Fast connection setup.
- Internal 16MHz/32kHz crystal oscillator for sleep timer
- Serial interface for host: UART, SPI
- Application interface for sensor: ADC, SPI, I²C, GPIO, PWM
- Command line Interface (CLI) for host: Node mode setting, Security manager, L2CAP command, Connection Management, power manager command

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

The M903L module is designed based on the CSR Bluetooth 4.0 LE single mode chipset solution. It supports UART command line interface to connect to the host processor. The simplified block diagram of the M903L module is depicted in the figure 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 ~ 3.6	V
3	Operating ambient temperature range		-30 ~ 85	°C
4	Storage temperature range		-40 ~ 85	°C
5	Bluetooth RF output		10	dBm
6	ESD Protection: All pads, according to human-body model, JEDEC STD 22, method A114		2000	V
	Machine Model Contact Discharge per JEDEC EIA/JESD22-A115		200	V
	According to charged-device model, JEDEC STD 22, method C101		500	V

4.2 Recommendable Operation Condition

4.2.1 Temperature & Humidity

The M903L module has to withstand the operational requirements as listed in the table below.

Item	Range	Remark
Operating Temperature	-30 ~ 85°C	
Humidity	Max. 95%	Non-condensing, relative humidity

4.2.2 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

The M903L module is compliant with the following features and standards:

Features	Description
Bluetooth Standards	Bluetooth core v4.0 Low Energy
Antenna Port	Support Single Antenna for Bluetooth
Frequency Band	2.402 – 2.480 GHz

4.4 Radio Specifications – Bluetooth 4.0 Low Energy

Features	Description
Bluetooth Standards	Bluetooth core v4.0 Low Energy
Antenna Port	Support Single Antenna for Bluetooth
Frequency Band	2.402 – 2.480 GHz (2.4 GHz ISM Band)
Number of selectable sub channels	40 Channels
Modulation	GFSK
Support Rates	<1Mbps
Maximum receive level	-10dBm (with PER<8%)

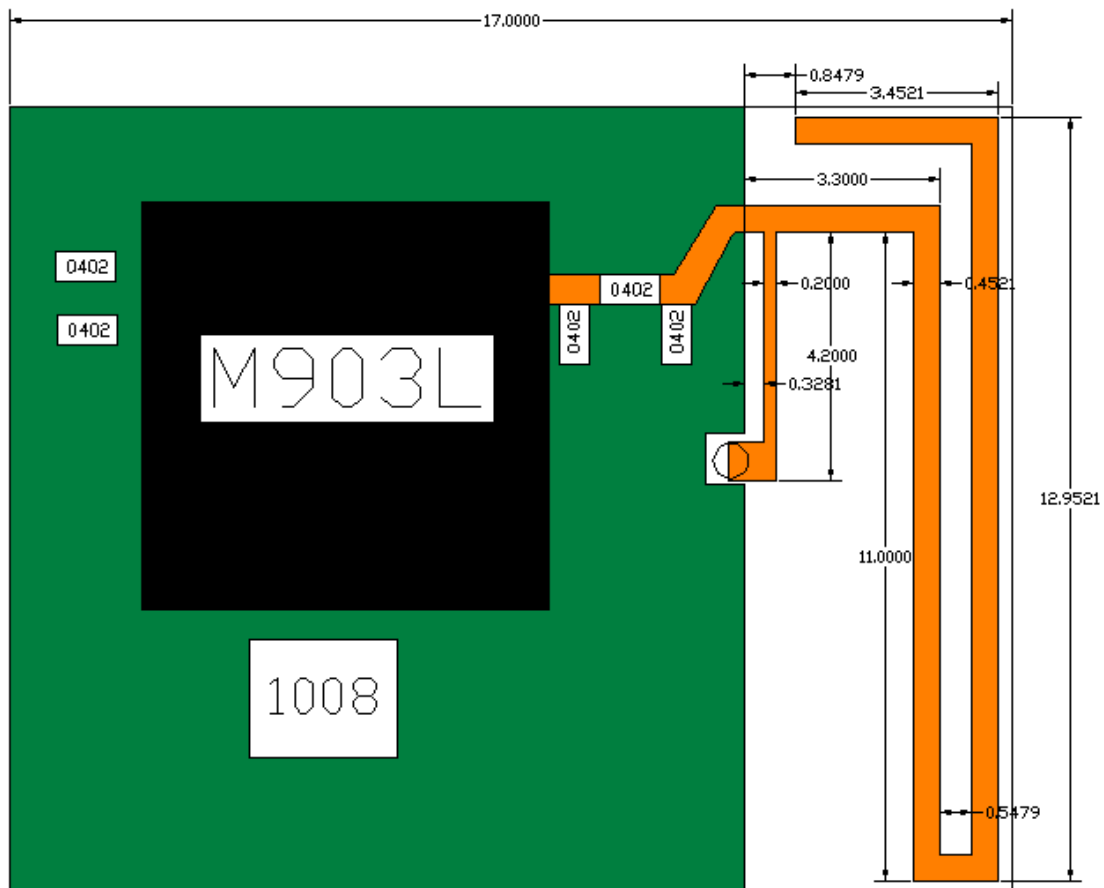
4.5 Power Consumption

Item	Typical	Unit
TX Mode 3.3V	16	mA
RX Mode 3.3V	16	mA
Sleep Mode: Dormant	<0.0006	mA
Sleep Mode: Hibernate	<0.0015	mA
Sleep Mode: Deep Sleep	<0.005	mA

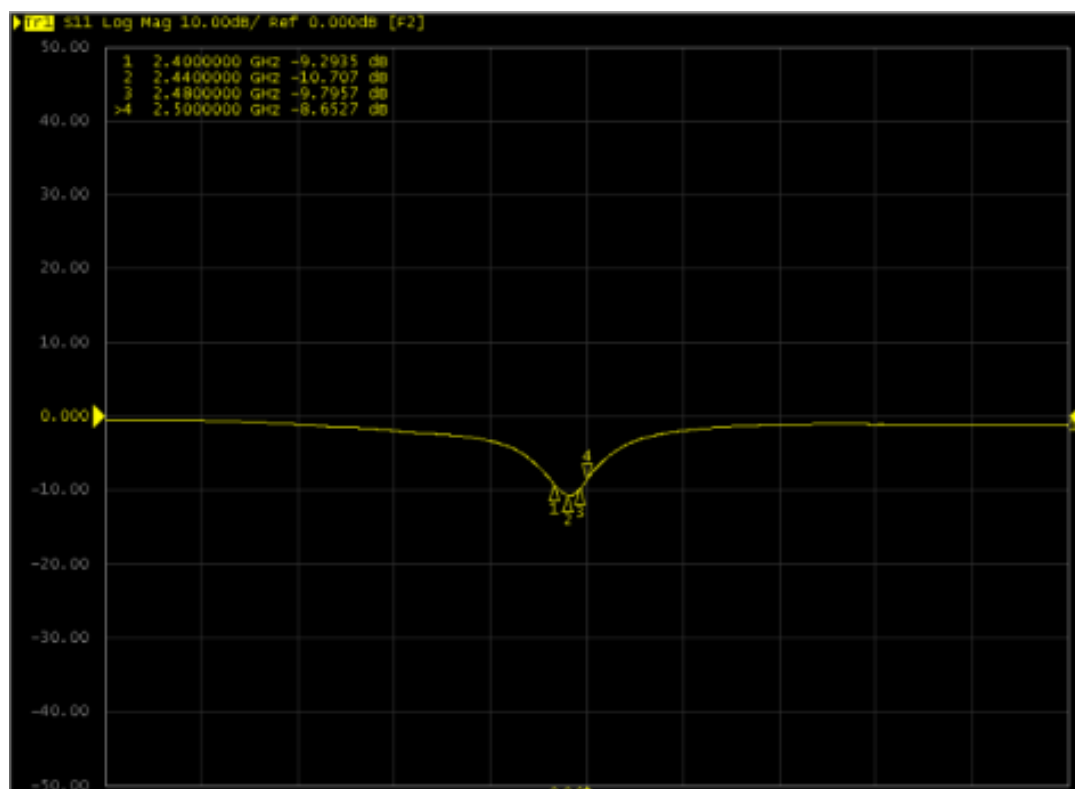
4.6 External Antenna Design Guide

4.6.1 PCB Antenna Design Guide

Peak Gain: -2dBi Typ./ Avg. Gain: -3.5dBi Typ. (XZ-V)

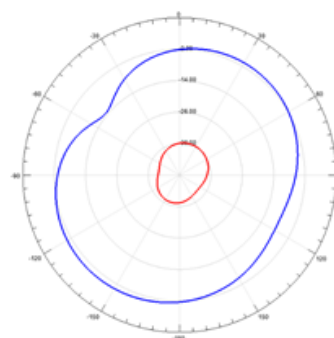
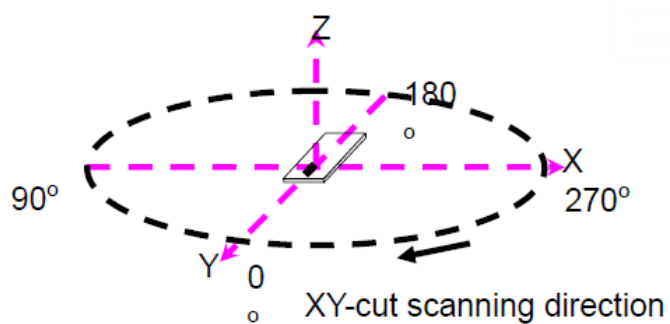


Return Loss

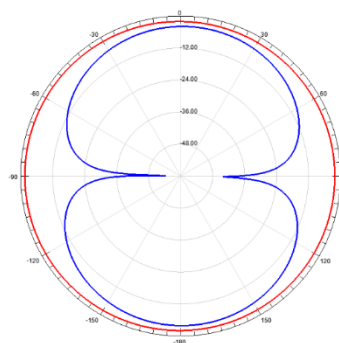
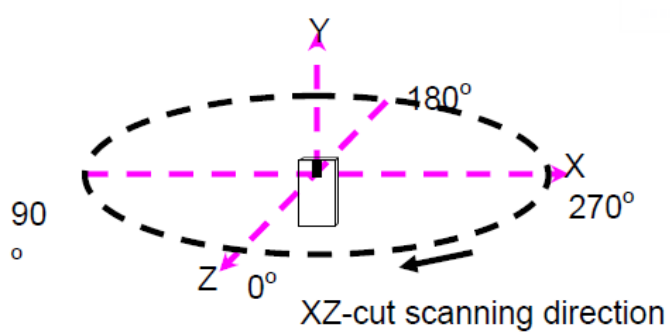


Radiation Patterns

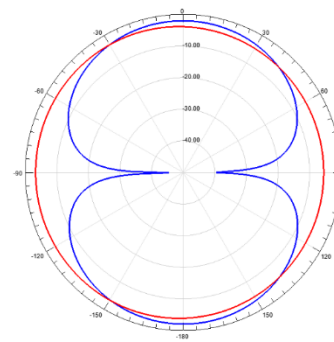
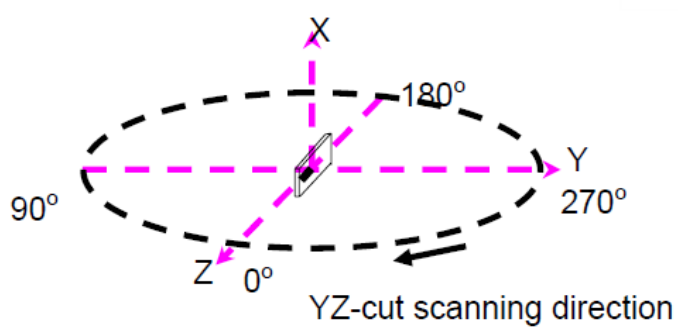
XY-V/XY-H



XZ-V/XZ-H



YZ-V/YZ-H



The PCB antenna gain is -2dB(AV.)

AT3216 Series Multilayer Chip Antenna

Features

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

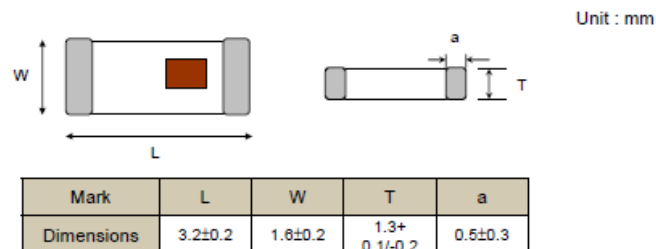
Applications

- ❖ Bluetooth/Wireless LAN/Home RF
- ❖ ISM band 2.4GHz applications

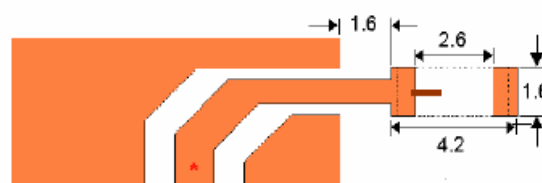


Specifications

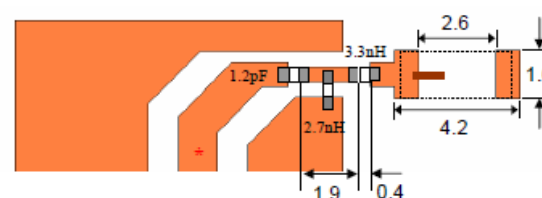
Part Number	Frequency Range (MHz)	Peak Gain (XZ-V)	Average Gain (XZ-V)	VSWR	Impedance
AT3216-B2R7HAA_	2400 ~ 2500	0.5 dBi typ.	-0.5 dBi typ.	2 max.	50 Ω



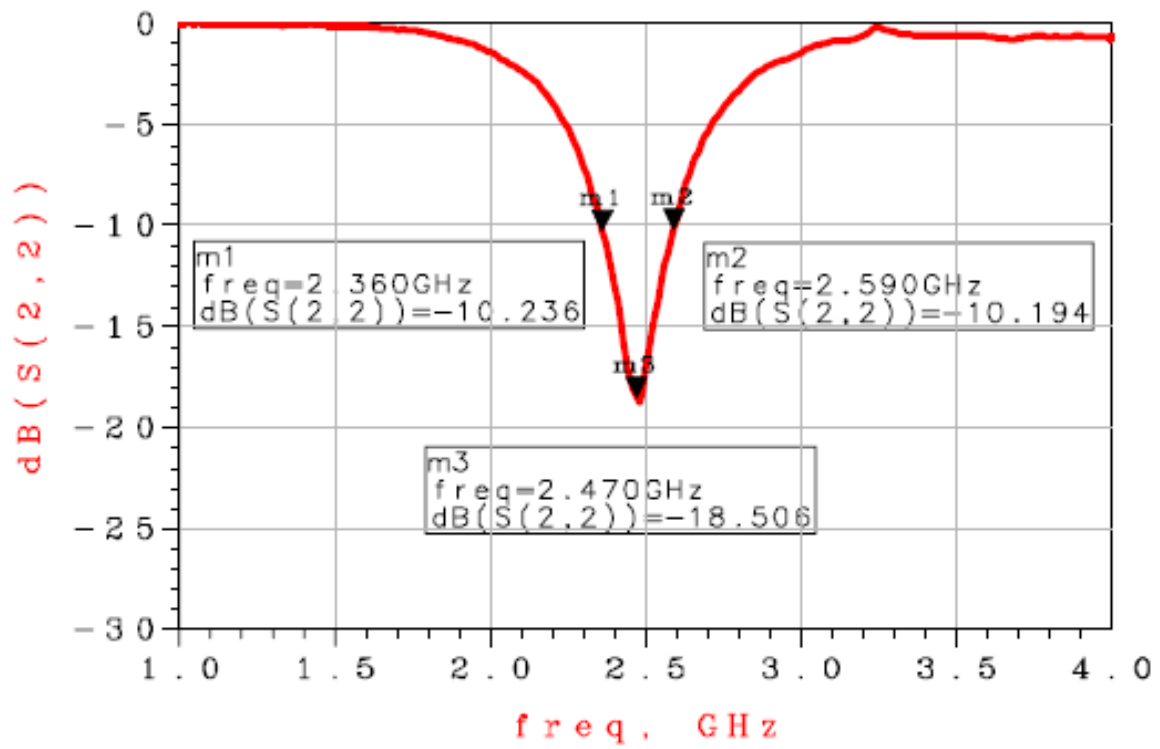
(a) Without Matching Circuits



(b) With Matching Circuits

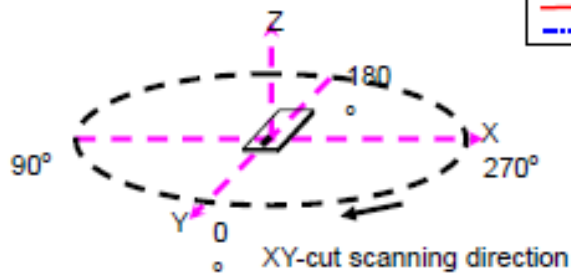


Return Loss with Matching Circuits

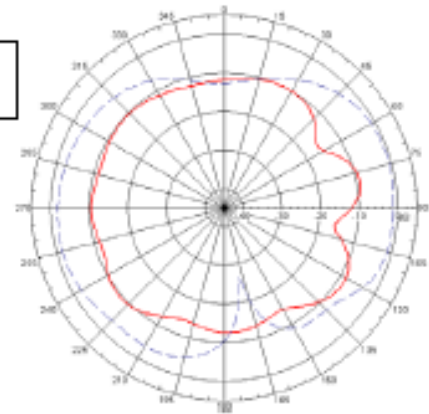


Radiation Patterns

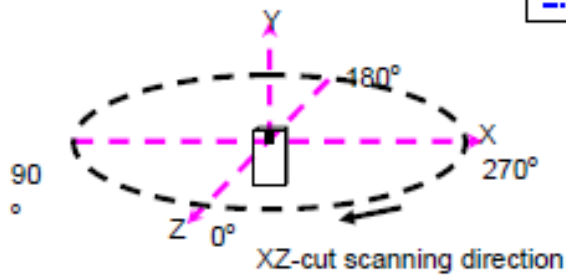
XY-V/XY-H



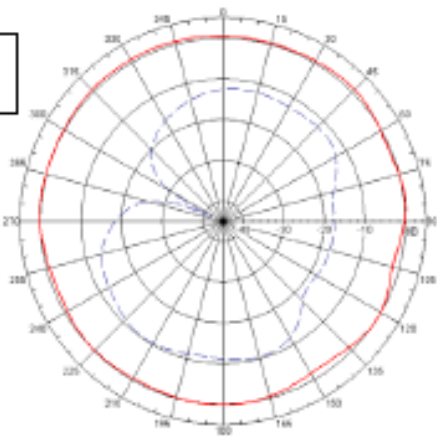
XY cut @2.45GHz
— Vertical
--- Horizontal



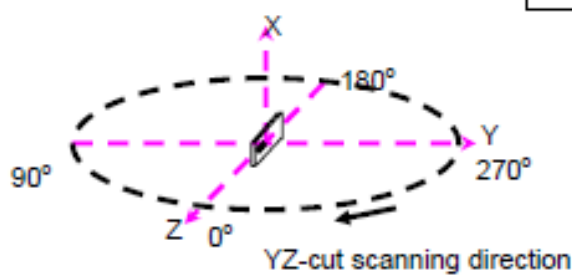
XZ-V/XZ-H



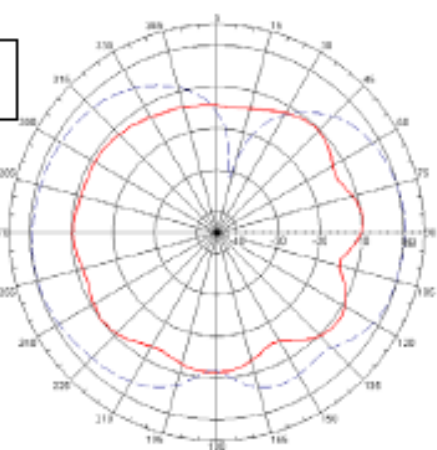
XZ cut @2.45GHz
— Vertical
--- Horizontal



YZ-V/YZ-H

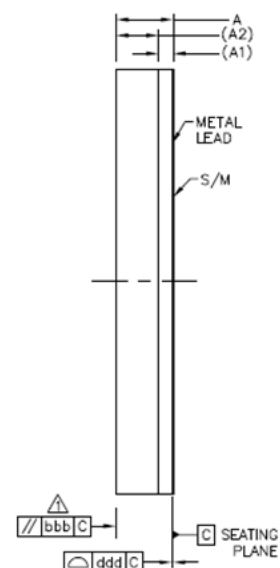
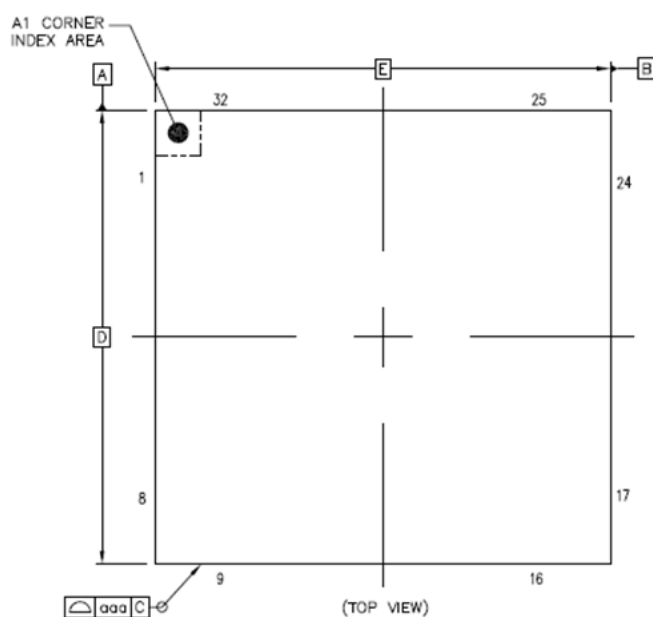
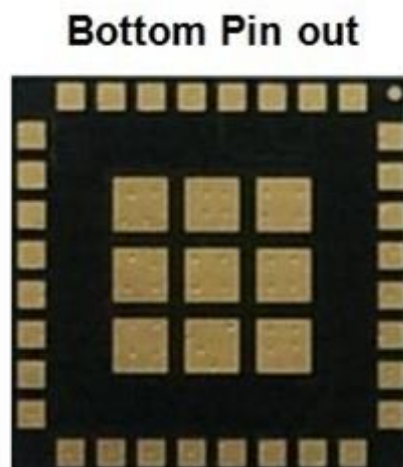
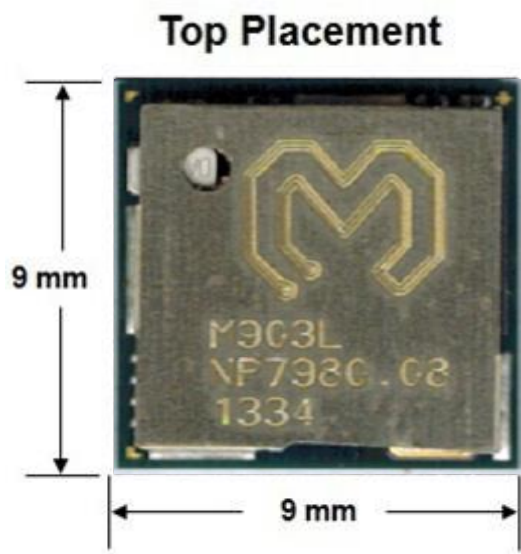


YZ cut @2.45GHz
— Vertical
--- Horizontal



5 Dimensions

The size and thickness of the M903L module 9mm (W) x 9mm (L) x 1.3mm (H):



Dimension Detail

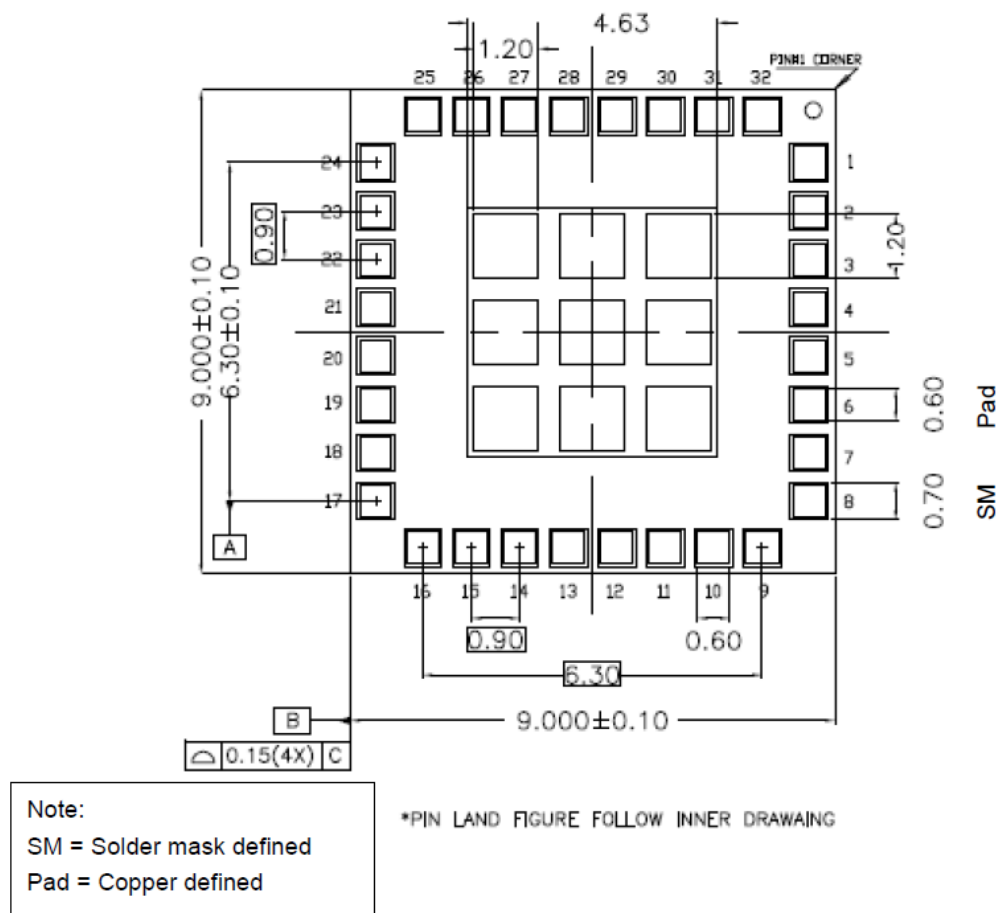
	SYMBOL	COMMON DIMENSIONS		
		MIN.	NOR.	MAX.
TOTAL THICKNESS	A	---	---	1.3
SUBSTRATE THICKNESS	A1	0.31		REF
MOLD THICKNESS	A2	0.9		REF
BODY SIZE	D	9		BSC
	E	9		BSC
LEAD WIDTH	W	0.55	0.6	0.65
LEAD LENGTH	L	0.55	0.6	0.65
LEAD PITCH	e	0.9		BSC
LEAD COUNT	n	32		
EDGE BALL CENTER TO CENTER	D1	6.3		BSC
	E1	6.3		BSC
BODY CENTER TO CONTACT BALL	SD	0.45		BSC
	SE	0.45		BSC
BALL WIDTH	b	---	---	---
BALL DIAMETER		---		
BALL OPENING		---		
BALL PITCH	e1	---		
BALL COUNT	n1	---		
PRE-SOLDER		---	---	---
PACKAGE EDGE TOLERANCE	aaa	0.1		
MOLD FLATNESS	bbb	0.2		
COPLANARITY	ddd	0.08		
BALL OFFSET (PACKAGE)	eee	---		
BALL OFFSET (BALL)	fff	---		

6 Pin Assignments

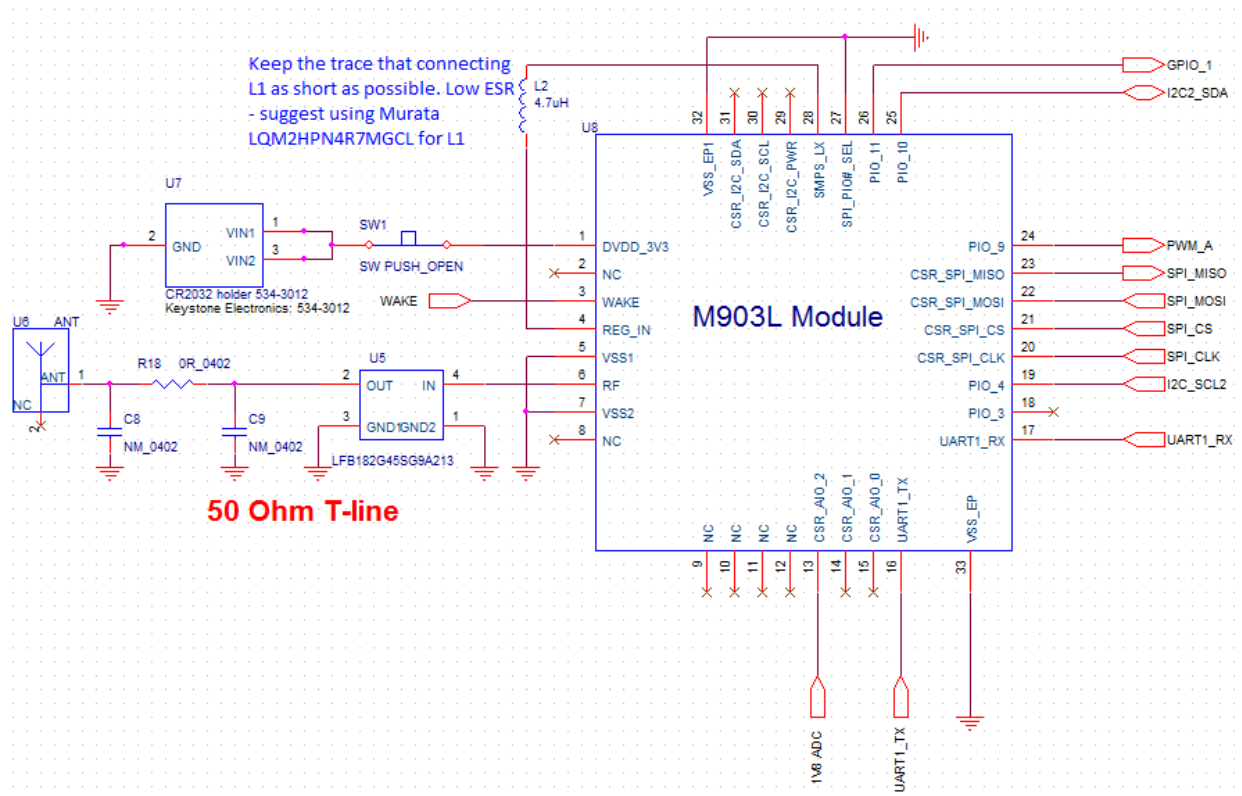
Pin Number	Pin Name	Pin Function	Description
1	DVDD_3V3	Power	Power input and regulator enable (active high)
2	NC	--	Reserved for internal use only
3	WAKE	Analogue	Pull up to wake up module from sleep mode
4	REG_IN	Input	Positive supply for Bluetooth radio and digital linear regulator.
5	GND	Ground	Ground connections.
6	RF	RF	Bluetooth transmitter / receiver.
7	GND	Ground	Ground connections.
8	NC	--	Reserved for internal use only
9	NC	--	Reserved for internal use only
10	NC	--	Reserved for internal use only
11	NC	--	Reserved for internal use only
12	NC	--	Reserved for internal use only
13	CSR_AIO_2	Analogue	Analogue programmable I/O line.
14	CSR_AIO_1	Analogue	Analogue programmable I/O line.
15	CSR_AIO_0	Analogue	Analogue programmable I/O line.
16	UART1_TX	Output	UART TX
17	USART1_RX	Input	UART RX
18	PIO_3	Bidirectional	Do not connect., reserved for internal used only
19	PIO_4	Bidirectional	I ² C2 clock or programmable I/O line.
20	CSR_SPI_CLK	Bidirectional	SPI debug CLK (slave mode) or programmable I/O line.
21	CSR_SPI_CS	Bidirectional	SPI debug CS (slave mode) or programmable I/O line.
22	CSR_SPI_MOSI	Bidirectional	SPI debug MOSI (slave mode) or programmable I/O line.
23	CSR_SPI_MISO	Bidirectional	SPI debug MISO (slave mode) or programmable I/O line.
24	PIO_9	Bidirectional	Programmable I/O line.
25	PIO_10	Bidirectional	I ² C2 data input / output or programmable I/O line.
26	PIO_11	Bidirectional	Programmable I/O line.
27	SPI_PIO#_SEL	Input	Selects Pin 20-23 as SPI debug interface or programmable I/O lines.
28	SMPS_LX	Output	High-voltage switch-mode regulator output.
29	CSR_I2C_PWR	Power	Do not connect., internal EEPROM I ² C1 power
30	CSR_I2C_SCL	Output	Do not connect, internal EEPROM I ² C1 clock
31	CSR_I2C_SDA	Bidirectional	Do not connect, internal EEPROM I ² C1 data input / output
32-41	GND	Ground	Ground connections.

7 Recommended Footprint

Suggest on PCB: SMD

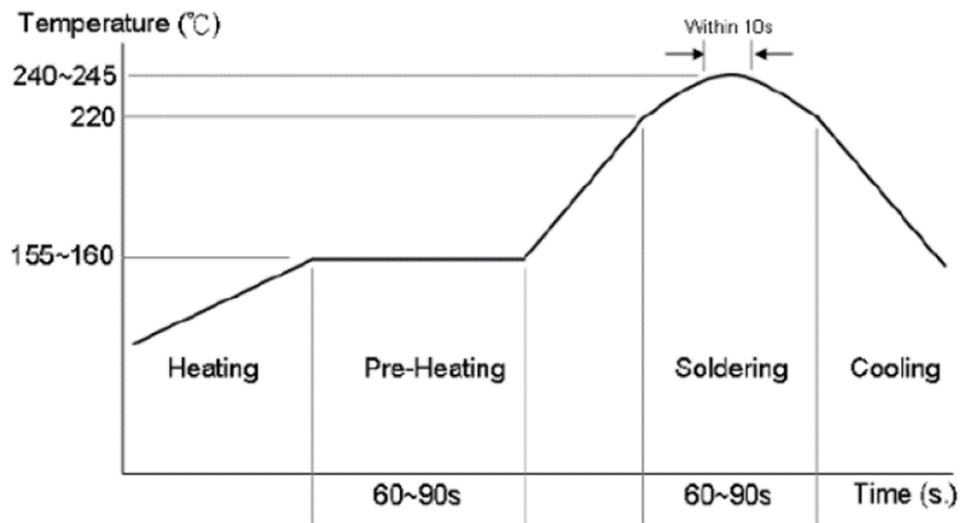


8 Reference Design Circuit



Note: U2 is band pass filter which optional. Ensure the L1 trace width $\geq 220\mu\text{m}$

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

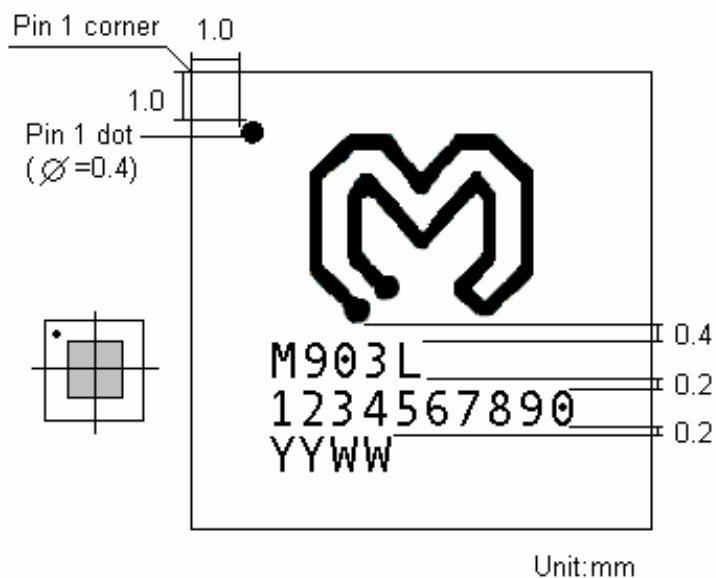
Handling the module must wear the anti-static wrist strap to avoid ESD damage. After each module is aligned and tested, it should be transport and storage with anti-static tray and packing. This protective package must be remained in suitable environment until the module is assembled and soldered onto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

10.2 SMT Preparation

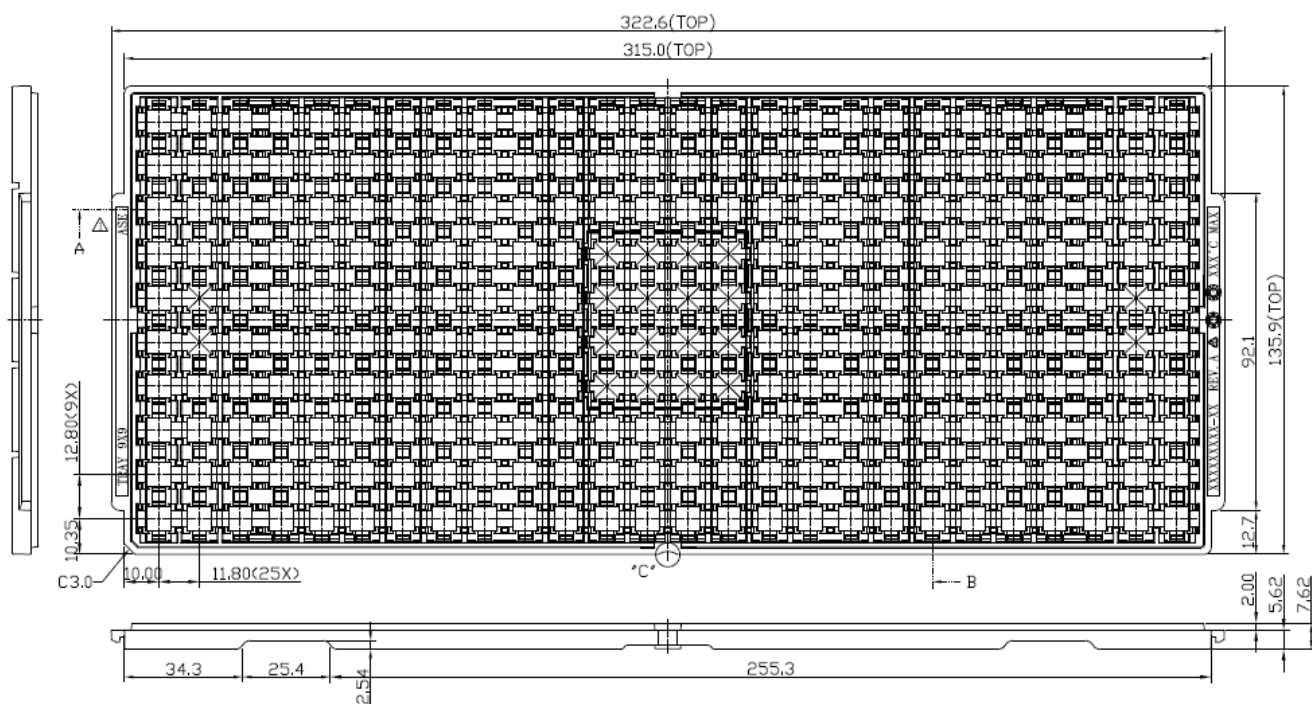
1. Calculated shelf life in sealed bag: 6 months at $<40^{\circ}\text{C}$ and $<90\%$ relative humidity (RH).
2. Peak package body temperature: 250°C .
3. After bag was opened, devices that will be subjected to reflow solder or other high temperature process must.
 - a. Mounted within: 72 hours of factory 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

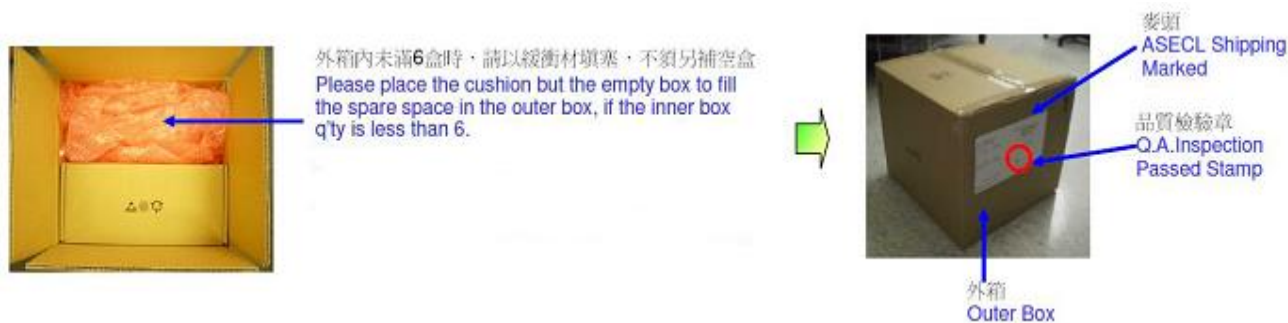


11.2 Tray Drawing



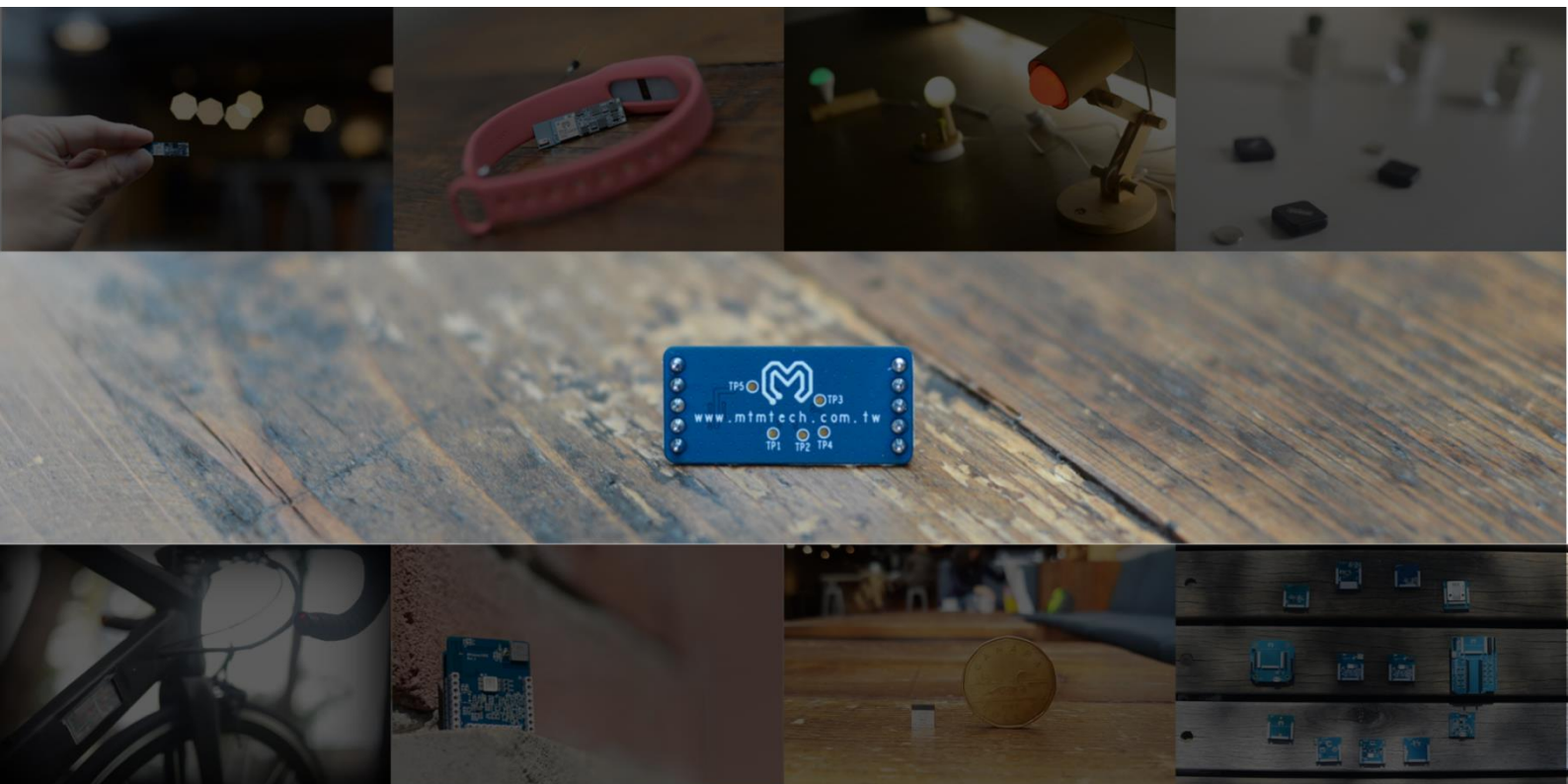
Unit: mm

11.3 Packagin



12 Document History

Date	Modifications	Version
Jan. 23, 2013	Preliminary Version	1.0
Apr. 22, 2013	Update PIN DEFINITION and REFERENCE DESIGN CIRCUIT with wake-up pin feature	1.1
Aug. 21, 2013	Change mold design to metal lid	1.2
Oct. 23, 2013	Add SiP Module Preparation, Package Information, Reference Design Circuit, Operating ambient temperature range	1.3
Oct. 1, 2016	Add the Antenna Design Guide, and modify Power Consumption	1.4
Feb. 22, 2018	Renew format	1.5



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