



# M908

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## LoRa Communication + MCU Module

With Intel Quark

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Preliminary DATASHEET  
14<sup>th</sup> March, 2018

# Table of Contents

1	Product Brief.....	1
1.1	Brief.....	1
1.2	Part Number.....	1
2	Features and Applications .....	2
3	Block Diagram .....	2
4	Technical Specifications.....	3
4.1	Absolute Maximum Ratings .....	3
4.2	Operation Condition .....	3
4.3	Wireless Specifications .....	3
4.4	LoRa RF Performance.....	4
4.4.1	Band 915 MHz (US) .....	4
4.4.2	Band 868 MHz (EU) .....	5
4.4.3	Band 780 MHz (CN) .....	6
4.4.4	Band 923 MHz (AS).....	7
4.4.5	Band 922 MHz (KR).....	8
4.4.6	Band 433 MHz (EU) .....	9
4.4.7	Band 490 MHz (CN) .....	10
4.5	Power Consumption .....	11
5	Dimensions .....	12
6	Pin Assignments.....	13
7	Recommended Footprint.....	14
8	Reference Design Circuit.....	15
9	Recommended Reflow Profile .....	16
10	SiP Module Preparation.....	17
10.1	Handling .....	17
10.2	SMT Preparation .....	17
11	Package Information.....	18
12	Document History.....	19

# 1 Product Brief

## 1.1 Brief

The SiP module includes Intel Quark SE C1000 and Semtech SX1276.

Low-power-consumption system-on-chip that provides edge analytics by combining an x86 MCU with a sensor subsystem and pattern-matching capability through a hardware-accelerated engine.

The Semtech SX1276 carries LoRa® long range modem that provides ultra-long range spread spectrum communication and high interference immunity whilst minimising current consumption.

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

- Intel® Quark™ SE C1000 32 MHz Microcontroller
- Semtech SX1276 LoRa Transceiver
- 384 kB NVM, 8 kB OTP NVM, 80 kB SRAM
- LGA-144 package, 12 x 12 x 1.3 mm
- 24 GPIO
- SPI / UART / PWM / I<sup>2</sup>C interfaces
- -40°C to 85°C operating temperature

## 1.2 Part Number

Part Number	RF Band	Description
908H	868, 915, 780, 922, 923MHz	EU868, US915 ISM Band
908L	433, 490MHz	EU433, AS430 ISM Band

## 2 Features and Applications

### Feature List

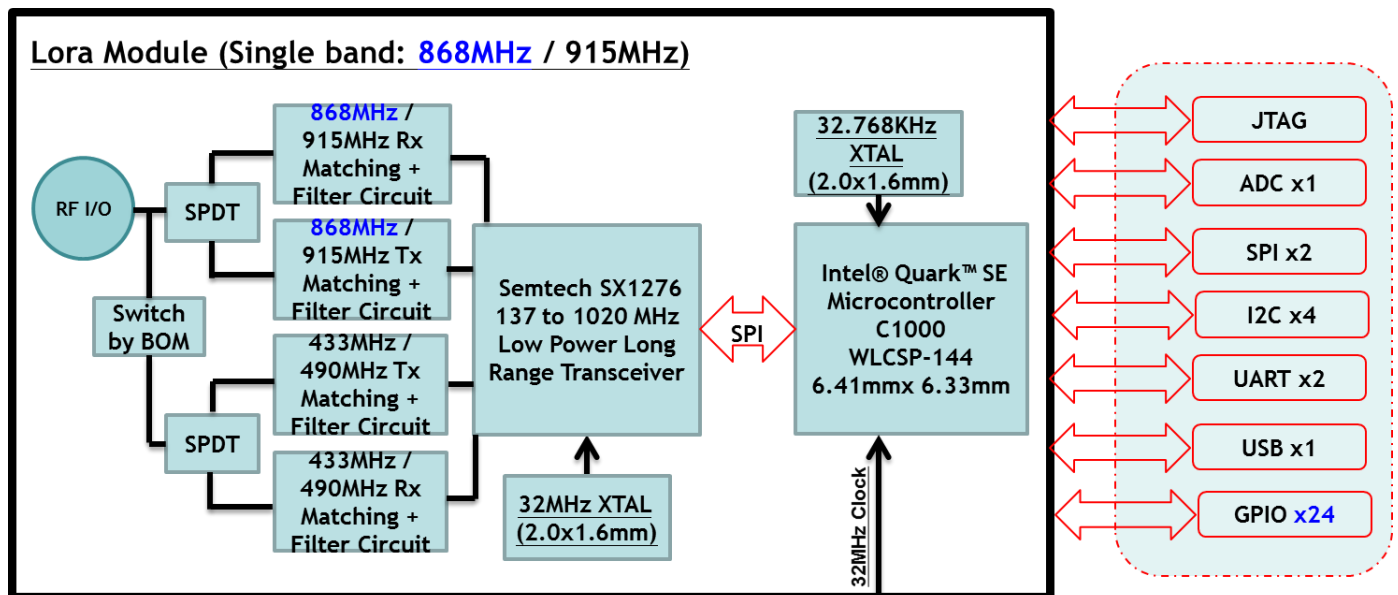
- MCU
  - Intel 32MHz Quark MCU (C1000)
  - 32MHz DSP for sensor subsystem
  - 8 kB 2-way L1 instruction cache
  - Low Latency Data Tightly Coupled Memory (TCM)
  - Interface to on-die SRAM: 1.49 DMIPs/MHz
- LoRa transceiver
  - Full Band 868/915/922/923/780/433/490 MHz
  - Supports end-device class A/B/C
  - 168 dB maximum link budget
  - +20 dBm – 100 mW constant RF output vs. V supply
  - +14 dBm high efficiency PA
  - High sensitivity: Down to -148 dBm
  - Programmable bit rate up to 300 kbps
- Memory
  - 384 kB of on-die NVM + 8 kB OTP on-die NVM
  - 80 kB of on-die SRAM
- Power management
  - SiP Status: Active, Sleep and off
  - Sensor subsystem: Sensing active, sensing wait and sensing standby
  - Platform power DC-DC 1.8V, 3.3V
- Industry standard I/O hardware
  - USB 1.1 FS device
  - 2 I<sup>2</sup>C / 2 SPI / 2 UART, 4 Timers, 4 PWM
- Sensor subsystem interface
  - 2 I<sup>2</sup>C / 2 SPI
  - 4 channel 12-bit ADC
  - 2 timers
- Industry standard I/O hardware characteristics
  - Operation range: -40°C ~ +85°C
  - LGA-144 pins, 12 x 12 x 1.3 mm

### Applications

- Utility metering and lighting control
- Long range irrigation systems
- Wireless alarm and security systems
- Internet of Things (IoT)
  - Industrial monitoring and control
  - Sensor networks
  - Home and building automation

### 3 Block Diagram

There is fully integration module with Semtech SX1276, 32MHz low power crystal. Intel C1000 Quark Processor.



## 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	3.3	V
2	Voltage on any pin		3.3/1.8	V
3	Storage temperature range		-40 ~ 110	°C

### 4.2 Operation Condition

Operating Condition	Min	Typical	Max	Unit
VCC	--	3.3	--	V
Operation ambient temperature range	-40	--	85	°C

### 4.3 Wireless Specifications

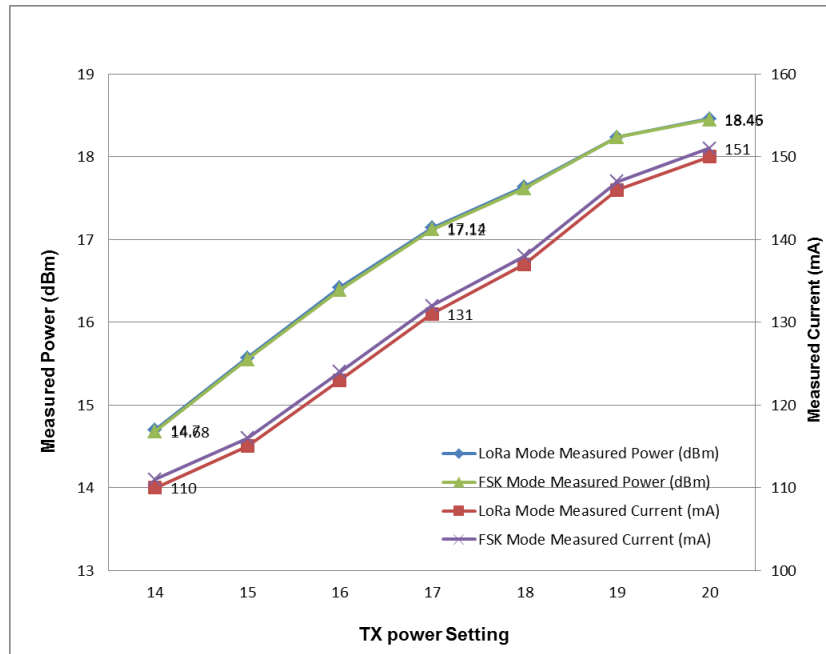
The M908 module is compliant with the following features and standards:

Features	Description
Frequency	868/915/922/923/780/433/490 MHz
Modulation Method	FSK, GFSK and LoRa Technology Modulation
Sensitivity	Down to -148 dBm

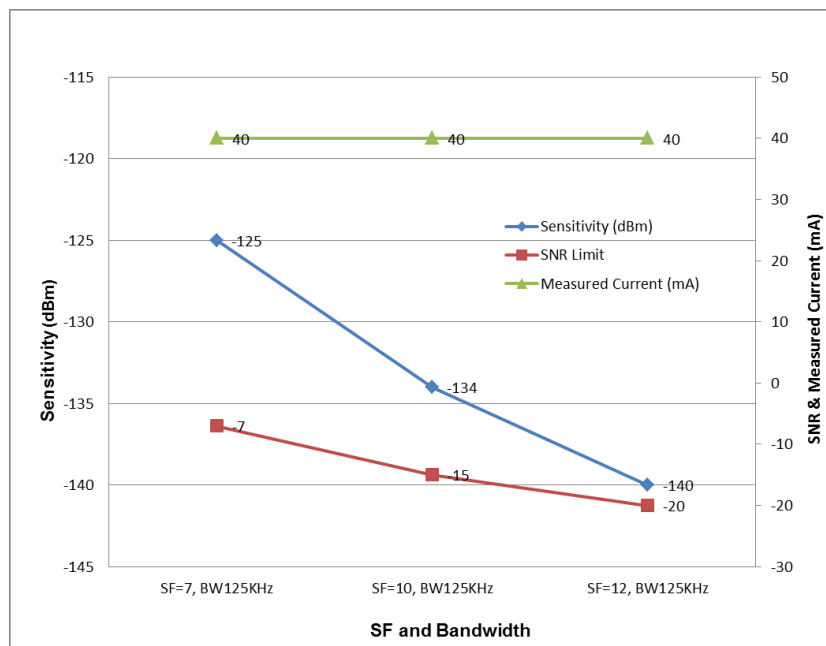
## 4.4 LoRa RF Performance

### 4.4.1 Band 915 MHz (US)

Transmitter output power: (Tx power setting from 14 ~ 20 dBm)

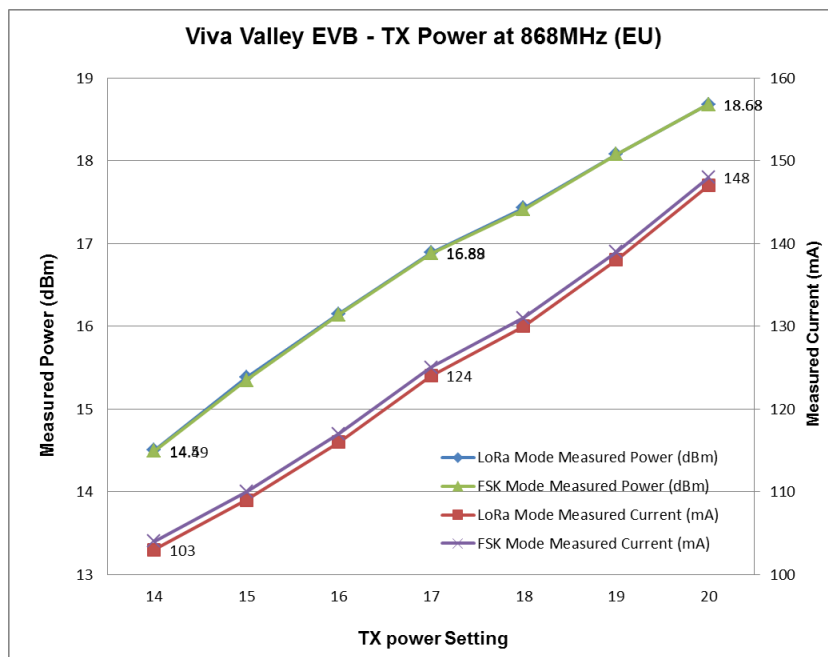


Receiver sensitivity and SNR: (w/ Spreading Factor and Bandwidth)

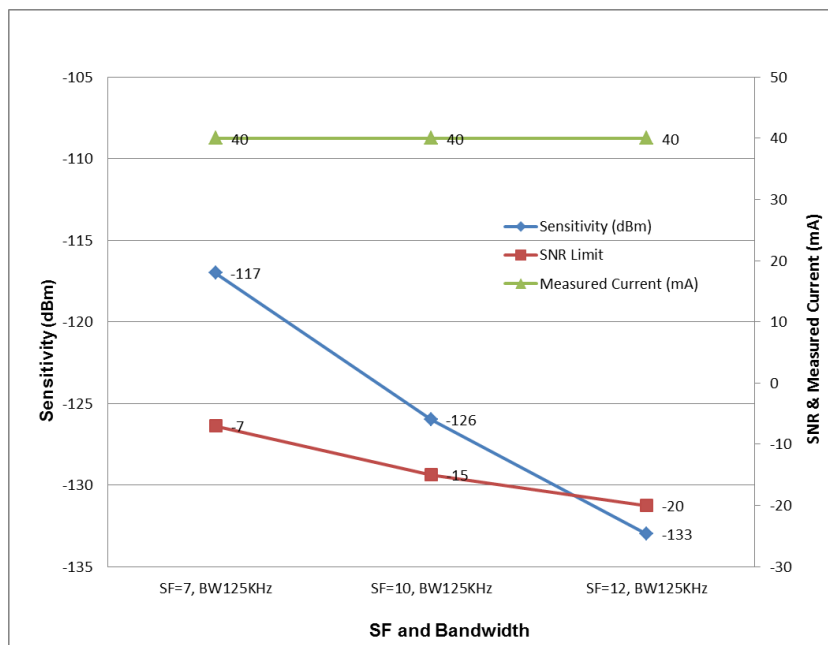


#### 4.4.2 Band 868 MHz (EU)

Transmitter output power: (Tx power setting from 14 ~ 20 dBm)



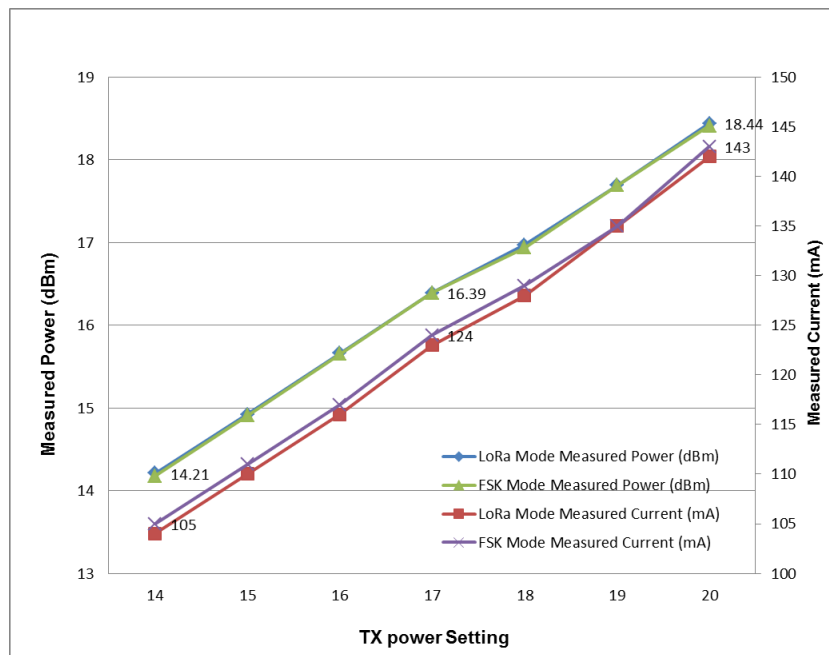
Receiver sensitivity and SNR: (w/ Spreading Factor and Bandwidth)



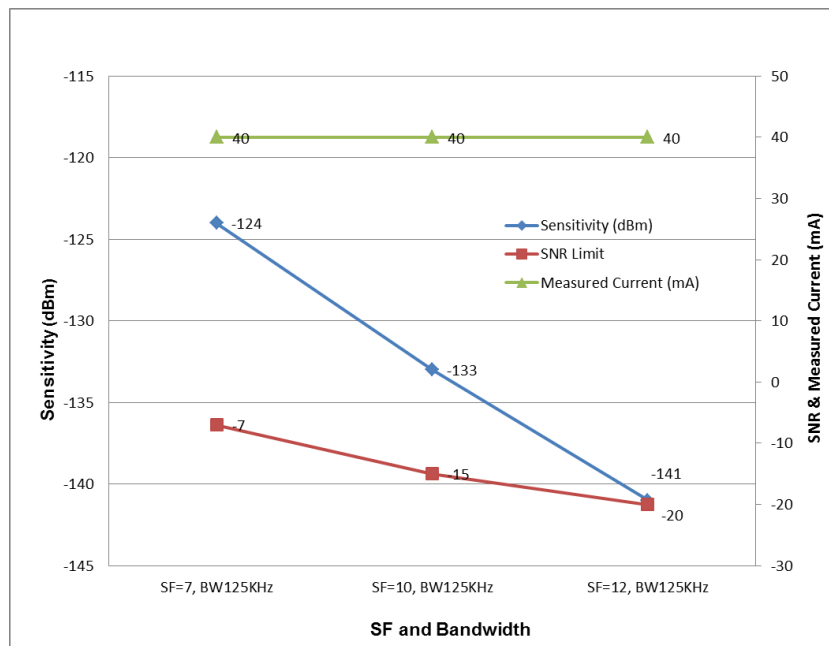


### 4.4.3 Band 780 MHz (CN)

Transmitter output power: (Tx power setting from 14 ~ 20 dBm)

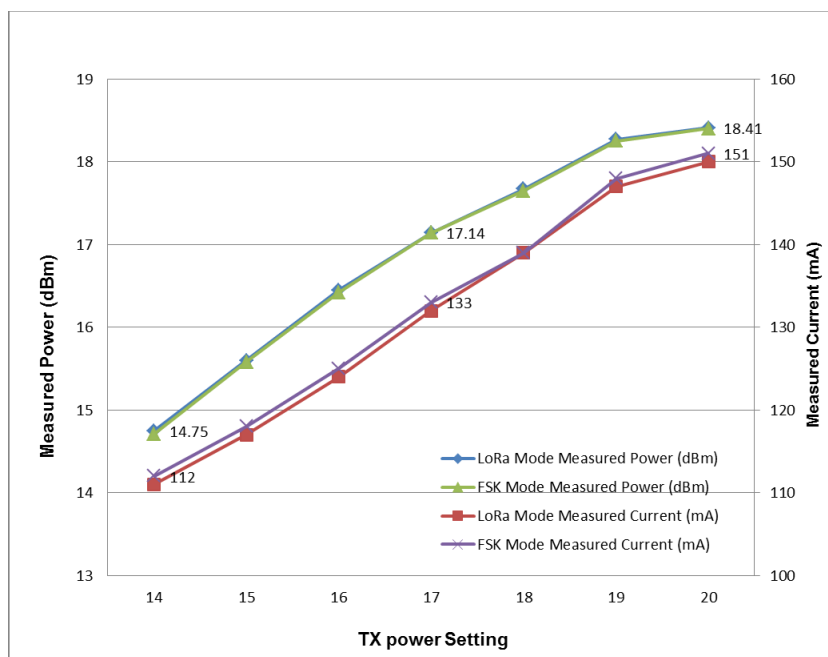


Receiver sensitivity and SNR: (w/ Spreading Factor and Bandwidth)

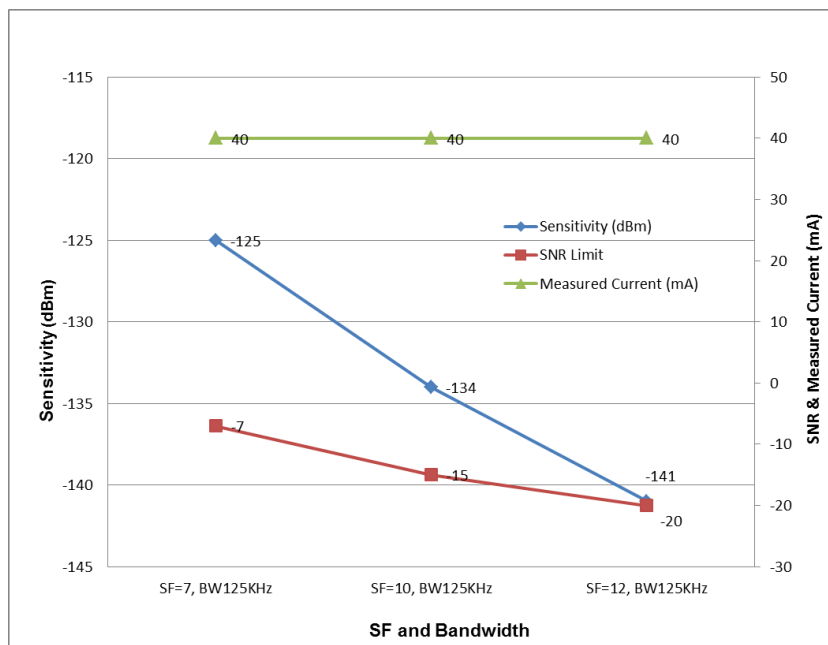


#### 4.4.4 Band 923 MHz (AS)

Transmitter output power: (Tx power setting from 14 ~ 20 dBm)

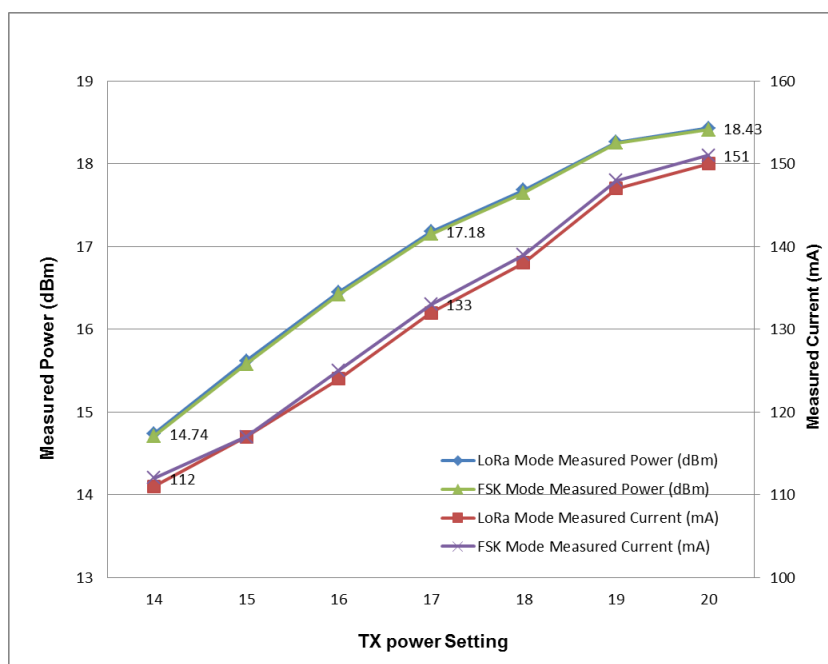


Receiver sensitivity and SNR: (w/ Spreading Factor and Bandwidth)

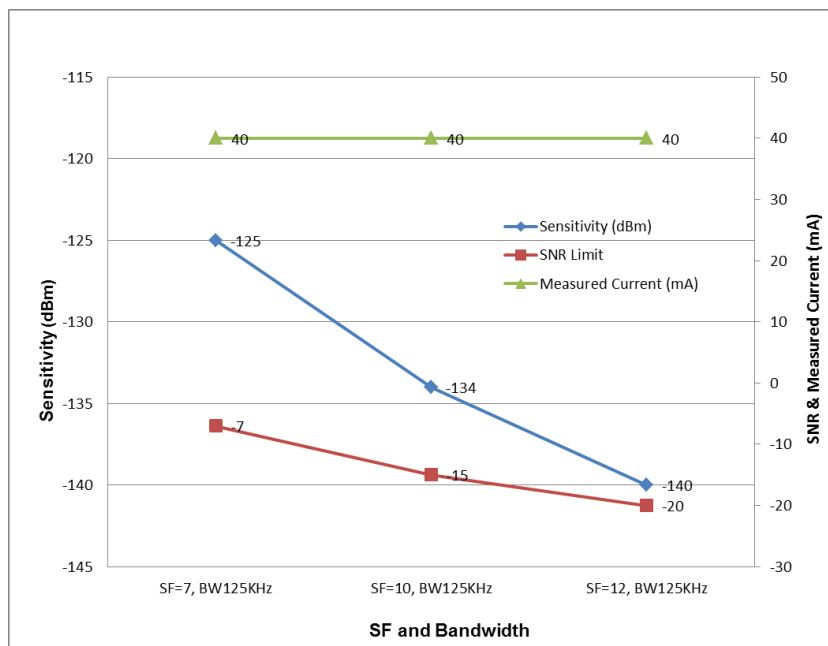


#### 4.4.5 Band 922 MHz (KR)

Transmitter output power: (Tx power setting from 14 ~ 20 dBm)

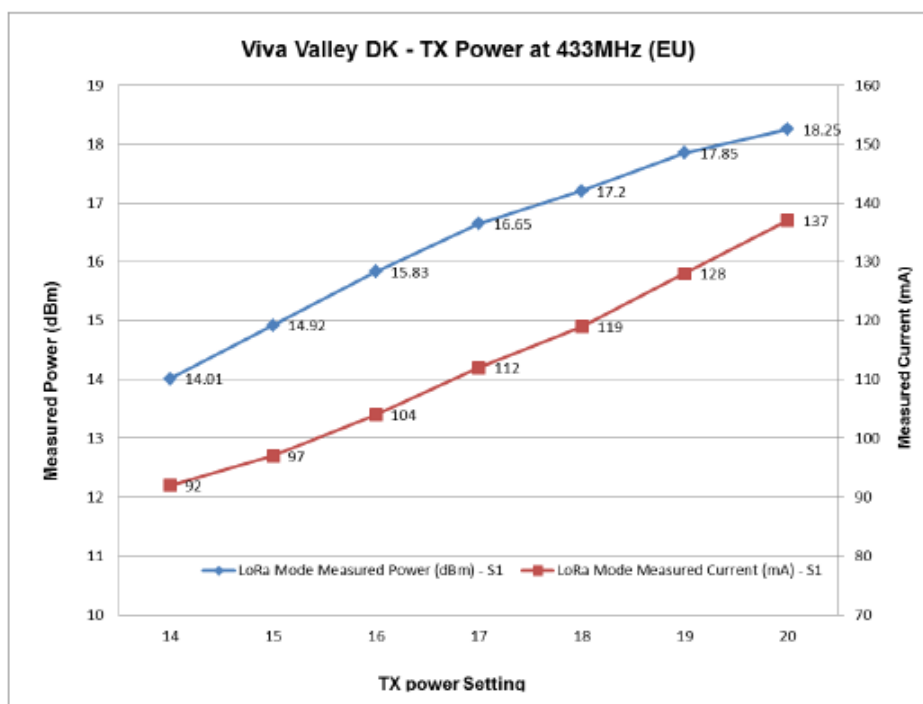


Receiver sensitivity and SNR: (w/ Spreading Factor and Bandwidth)

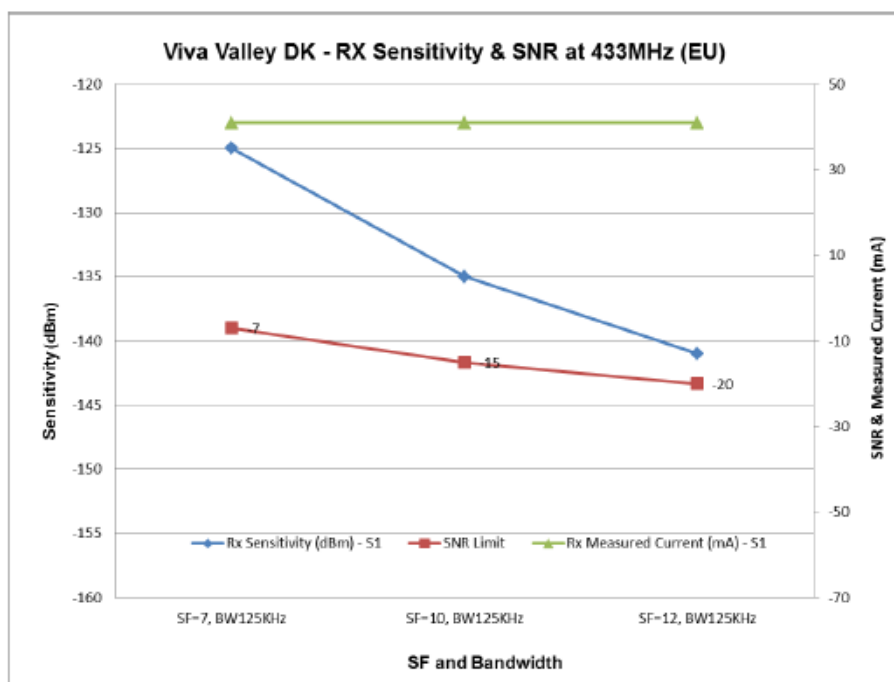


#### 4.4.6 Band 433 MHz (EU)

Transmitter output power: (Tx power setting from 14 ~ 20 dBm)

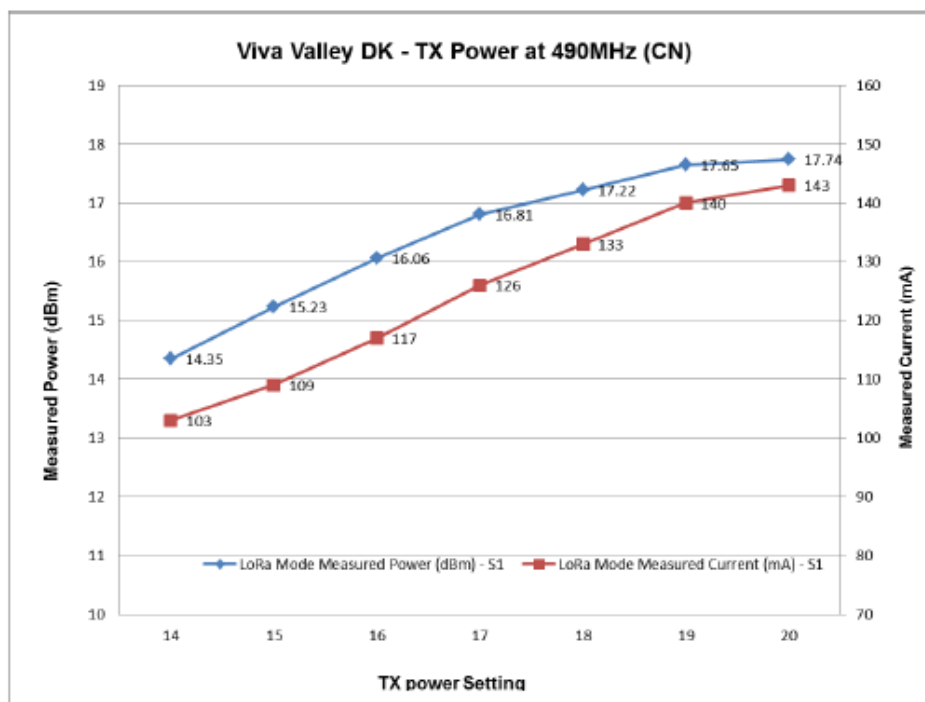


Receiver sensitivity and SNR: (w/ Spreading Factor and Bandwidth)

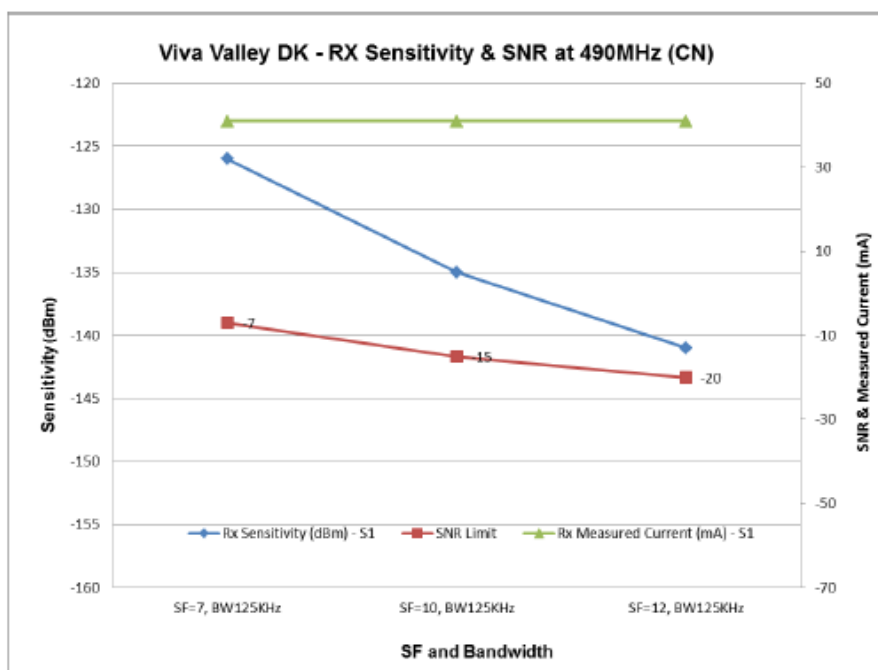


#### 4.4.7 Band 490 MHz (CN)

Transmitter output power: (Tx power setting from 14 ~ 20 dBm)



Receiver sensitivity and SNR: (w/ Spreading Factor and Bandwidth)

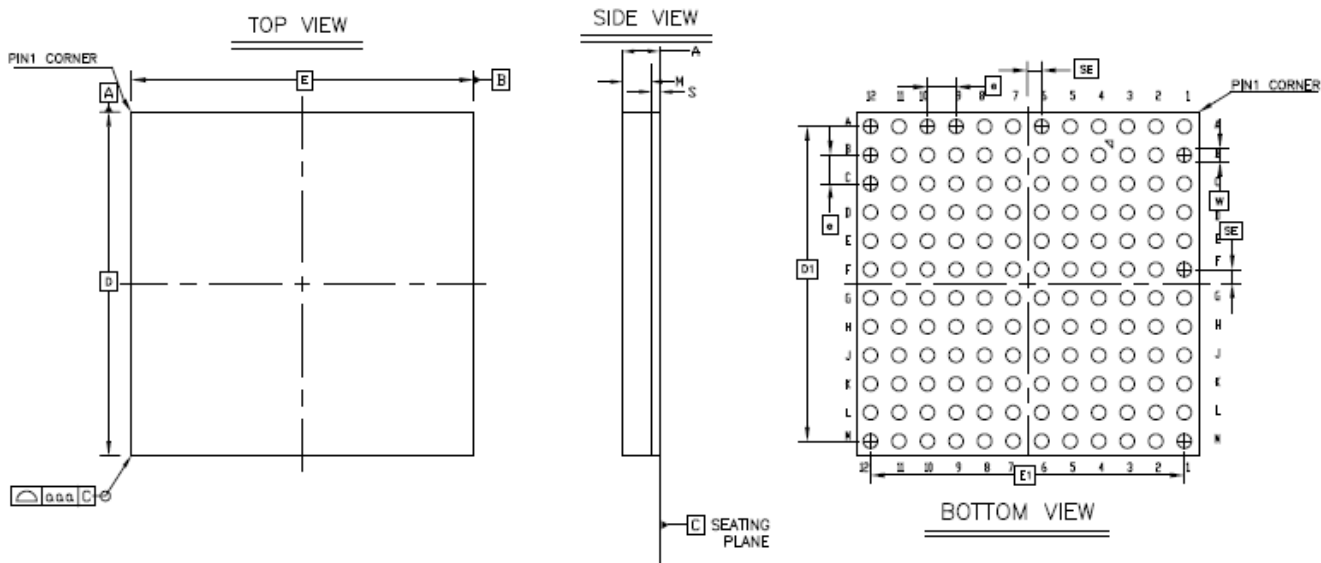


## 4.5 Power Consumption

Item	Typ.	Units
TX with 18.7dBm at 915MHz (Continue Tx with RF Test FW)	149	mA
TX with 18.3dBm at 433MHz (Continue Tx with RF Test FW)	136	mA
Standby Mode with RF Test FW	32 ~ 33	mA
Rx (Continue Rx with RF Test FW)	~40	mA
Deep Sleep	~2	mA

## 5 Dimensions

The size and thickness of the M908 module are 12mm (W) x 12mm (L) x 1.3mm (H):



Dimension Detail

		Symbol	Common Dimensions		
			MIN.	NOM.	MAX.
Package :		PIM	---		
Body Size:	X	E	12.000		
	Y	D	12.000		
Ball Pitch :		e	1.000		
Total Thickness :		A	---	1.332	1.402
Mold Thickness :		M	---	1.000	1.030
Substrate Thickness :		S	---	0.332	0.372
Solder Thickness :		T	---	---	---
Lead Width		W	0.480	0.500	0.520
BODY CENTER TO CONTACT BALL		SD	0.500		
		SE	0.500		
Package Edge Tolerance :		aaa	0.100		
Lead Count :		n	144		
EDGE BALL CENTER TO CENTER:		D1	11.000		
		E1	11.000		

## 6 Pin Assignments

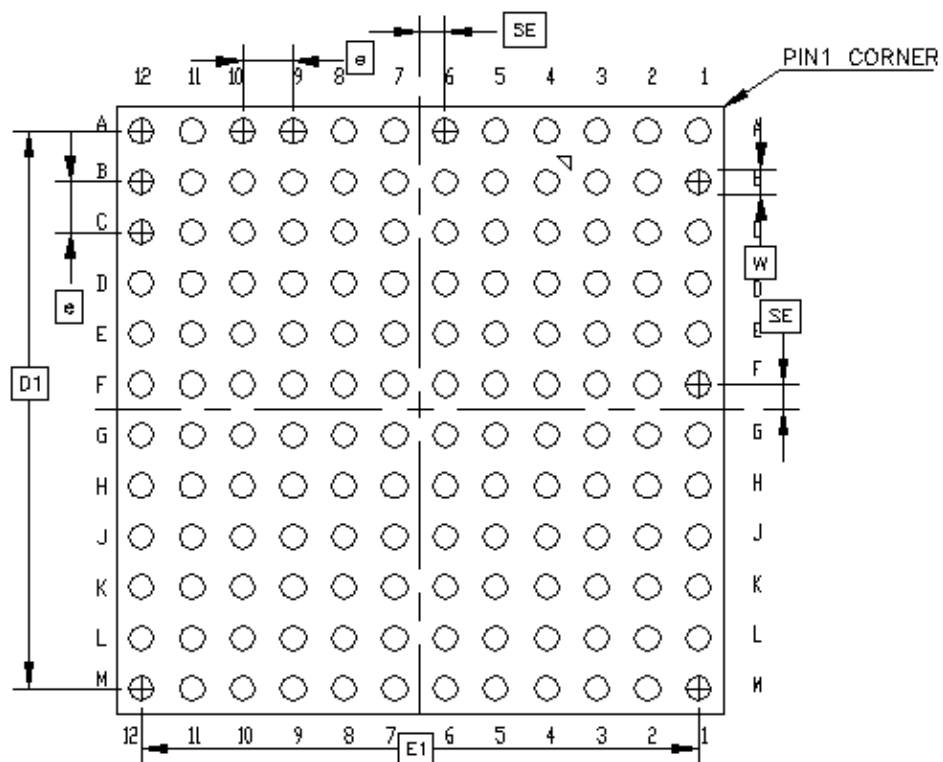
	1	2	3	4	5	6	7	8	9	10	11	12
A	RF_IO	GND	GND	GND	GND	VCC_AON_1P8	TR_RXTX	GPIO[21]	GPIO[24]	GPIO[25]	AREF_PAD	GND
B	GND	GND	GND	GND	GND	GND	SPI1_SS_MISO	GPIO[22]	GPIO[23]	GPIO[26]	GND	VCC_IO_AON
C	I2C0_SDA	I2C0_SCL	I2C1_SCL	I2C1_SDA	SPI0_SS_MISO	SPI0_SS_CS_B[3]	SPI1_SS_MOSI	SPI1_SS_CS_B[2]	GND	GPIO[27]	PWM[3]	PWM[2]
D	I2C1_SS_SCL	I2C1_SS_SDA	GND	GND	SPI0_SS_SCK	SPI0_SS_CS_B[2]	SPI1_SS_SCK	SPI1_SS_CS_B[3]	GND	GND	PWM[0]	PWM[1]
E	I2C0_SS_SCL	I2C0_SS_SDA	GND	GND	SPI0_SS_MOSI	SPI0_SS_CS_B[1]	SPI1_SS_CS_B[1]	SPI1_SS_CS_B[0]	GND	RST_B	GND	VCC_HOSET_1P8_PG
F	ADC[0]	GPIO_SS[5]	GPIO_SS[3]	GND	GND	SPI0_SS_CS_B[0]	TDI	TDO	GND	GND	VCC_AVD_OPM_2P6	VCC_AVD_OPM_2P6
G	USB_NP	USB_DP	GND	GND	GND	GND	TRST_B	TMS	GND	PLT_REG_EN	GND	VCC_PLT_1P8_IND
H	GND	GPIO_SS[4]	GPIO_SS[2]	GND	GND	GPIO[1]	TCK	AON_GPIO[0]	AON_GPIO[4]	AON_GPIO[2]	GND	VCC_PLT_1P8
J	UART0_TXD	UART0_RXD	GND	GND	GND	GPIO[2]	GPIO[3]	AON_GPIO[5]	AON_GPIO[3]	AON_GPIO[1]	GND	VCC_PLT_3P3
K	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	GND	VCC_PLT_3P3_IND
L	OSC32M_OUT	GND	UART1_TXD	UART1_CTS	VCC_CMP	GND	GND	GND	VBAT_SOC	GND	VCCOUT_AON_1P8	VCC_HOSET_1P8_IND
M	OSC32M_IN	GND	UART1_RXD	UART1_RTS	VCC_USB_3P3	VCC_ADC	VDD_RFS	TR_NRESET	VBAT_SOC	GND	VCC_HOSET_1P8	VCC_HOSET_1P8

RF	Clock	UART	PWM	ADC	GND
Power	USB	SPI	JTAG	AON_GPIO	Others

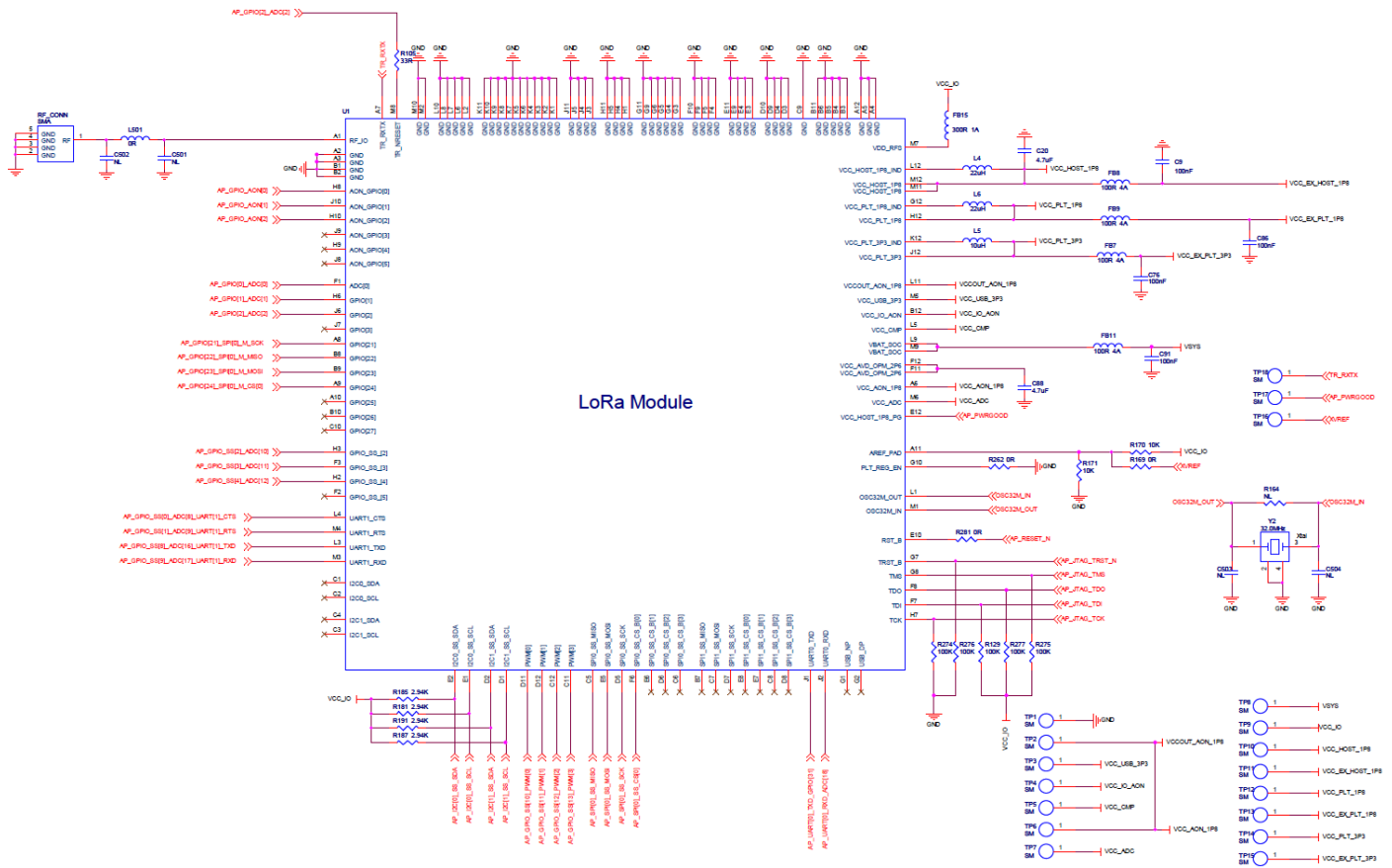


## 7 Recommended Footprint

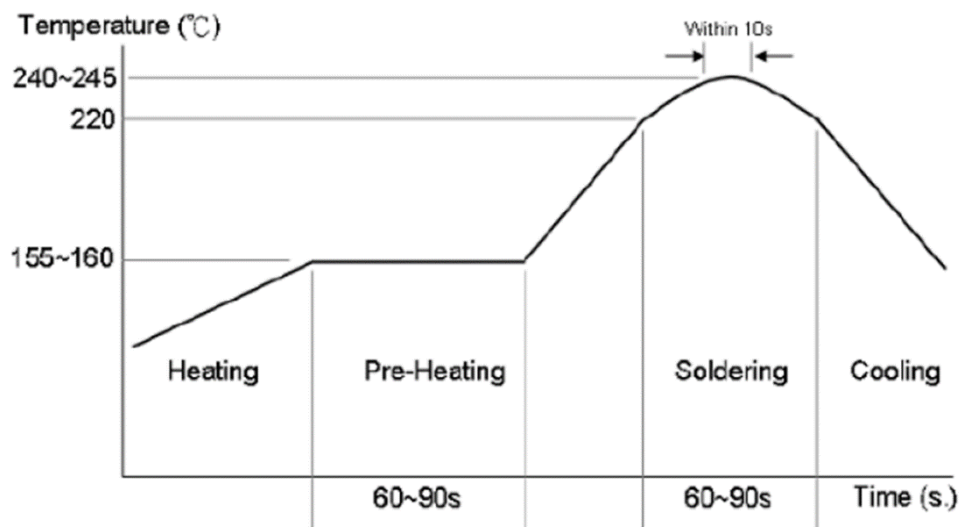
Suggest on PCB: SMD (1:1)



# 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

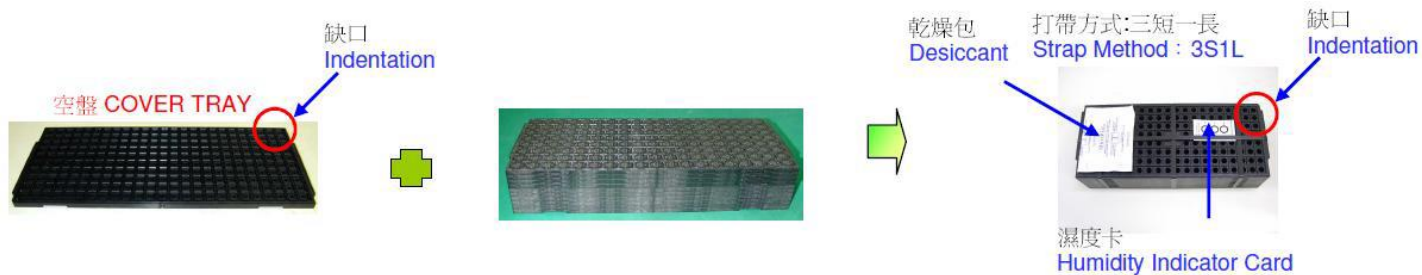
## 10.1 Handling

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

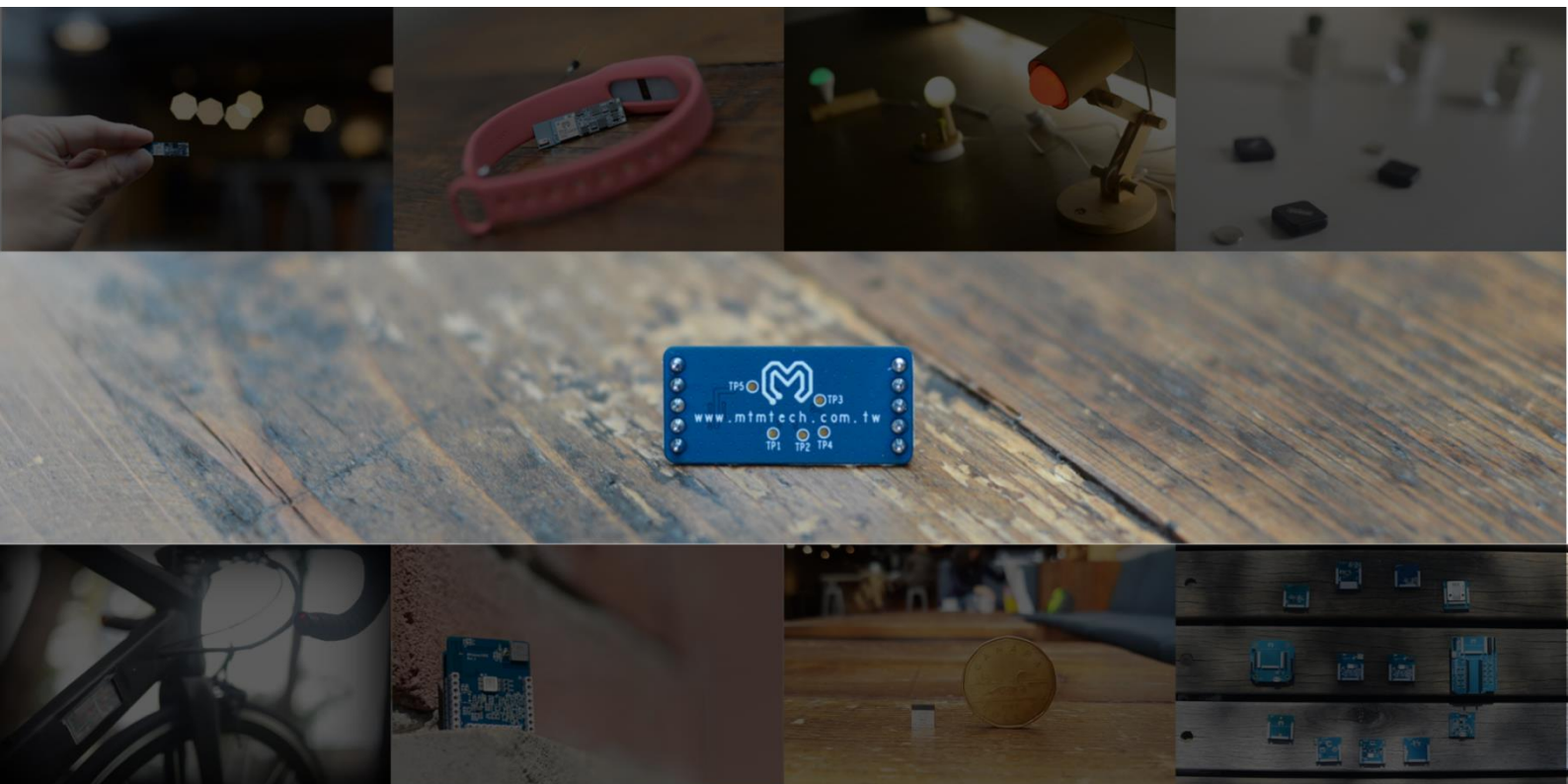
1. Calculated shelf life in sealed bag: 6 months at  $<40^{\circ}\text{C}$  and  $<90\%$  relative humidity (RH).
2. Peak package body temperature:  $250^{\circ}\text{C}$ .
3. After bag was opened, devices that will be subjected to reflow solder or other high temperature process must.
  - a. Mounted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



## 12 Document History

Date	Modifications	Version
Mar. 08, 2017	Preliminary version	1.0
Jan. 03, 2018	Add the power consumption	1.1
Feb. 27, 2018	Add low band of LoRa	1.2
Mar. 14, 2018	Revise the content of “1 Product Brief”	1.3



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