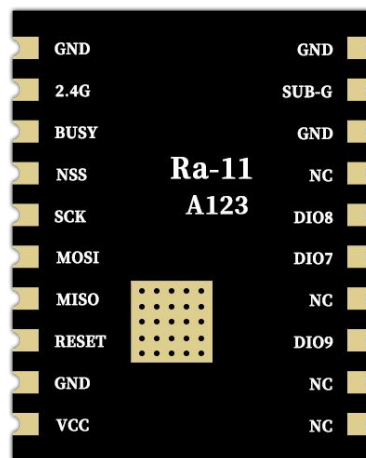


Ra-11 Specification

Version V1.0.1

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1 Product Overview

Ra-11 is an ultra-high-performance RF front-end module designed for IoT, long-range wireless communication, industrial, medical, and other wireless communication applications, featuring the SEMTECH third-generation LoRa transceiver LR1121 RF chip as its core.

Its key advantages include an ultra-compact package and extreme RF performance. By optimizing the collaborative design of power amplifier, low-noise amplifier, filter, and peripheral matching network, it achieves high power, low loss, low spurious emissions, and strong anti-interference capability.

The LR1121 RF chip supports Sub-GHz, 2.4GHz ISM band, and licensed S-band satellite communication bands, enabling both terrestrial communication and satellite communication applications. It features ultra-long-range transmission and ultra-low power consumption.

The Ra-11 module can be widely used in automatic meter reading, home and building automation, security systems, remote irrigation systems, and other fields.

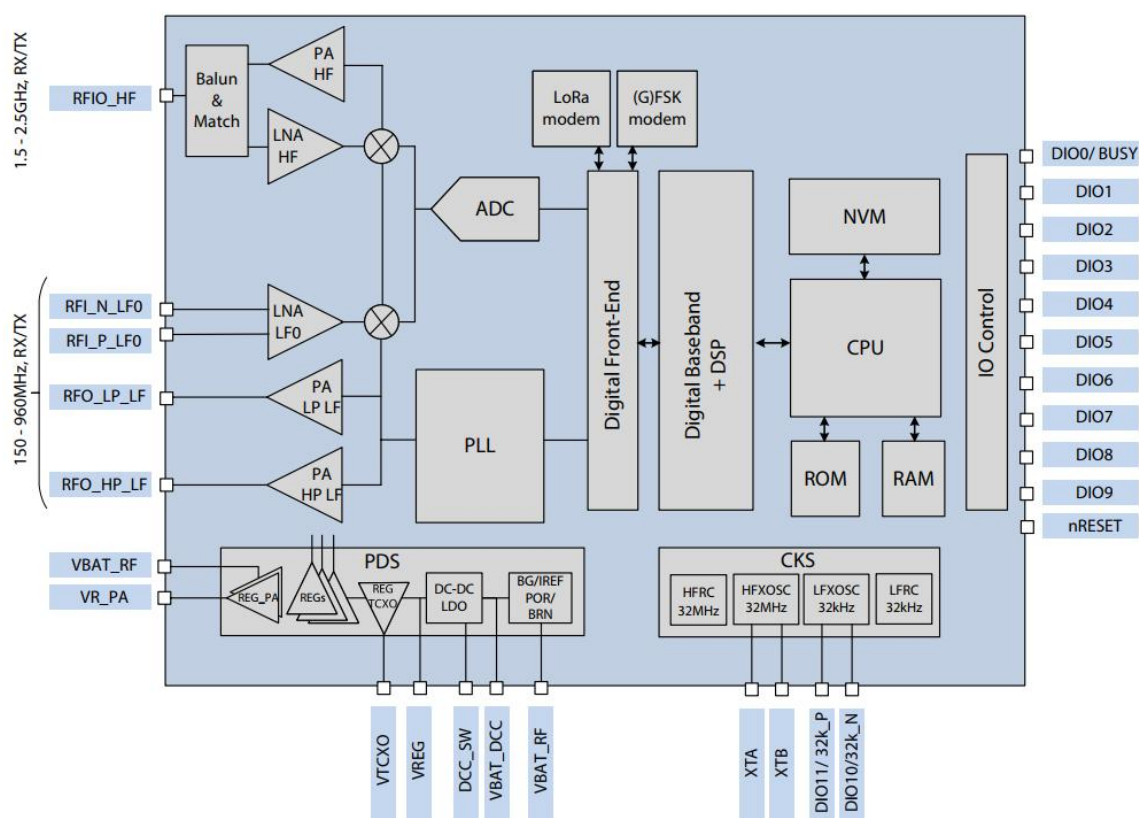


Figure 1 Main Chip Architecture Diagram

1.1 Features

- Supports LoRa / (G)FSK modulation.
- Supports Sub-GHz / 2.4GHz LR-FHSS modulation.
- Modem-E firmware (embedded with LoRaWAN protocol stack) is available for factory pre-programming.
- Low-frequency band: default support for 470–510 MHz in China (433MHz can be customized).
High-frequency band: default support for 2400–2500MHz in China.
- Operating voltage: 3.3V. Theoretical maximum transmit power reaches +22dBm@Sub-GHz and +13dBm@2.4GHz, ensuring stable full-power transmission across the supported frequency bands, with multi-step software-configurable power.
- Integrated PA regulator power selector. This design simplifies the dual power supply configuration for +15/+22dBm@Sub-GHz. Users can select a low-power operating mode with a maximum output power of +15dBm.
- In the Sub-GHz band, it is compatible with SX126X and SX127X series products.
- In the 2.4GHz band, it is compatible with SX128X series products.
- Hardware support for AES-128 encryption/decryption algorithm.
- Built-in power supply ESD protection circuit.
- Antenna interface supports both castellated pads and an IPEX connector.

Note: For features not marked, please refer to the SEMTECH (LR1121) chip datasheet.

1.2 Application Scenarios

- Smart Industry
- Energy Monitoring
- Outdoor IoT
- Consumer Electronics
- Radio and Remote-controlled Drones

2 Key Specifications

Table 1 Key Specifications

Model	Ra-11
Package	SMD-20
Dimensions	20.0 * 16.0 * 3.2 (mm)
Antenna Type	External antenna (IPEX Gen 1 connector) / castellated pad
Frequency Range	470–510MHz and 2400–2500MHz
Operating Temperature	-40–85°C
Storage Conditions	-40–125°C, <90% RH
Power Supply Range	Supply voltage: 1.8V–3.6V; typical value: 3.3V; supply current > 200mA
Communication Interface	SPI

3 Electrical Characteristics

3.1 Recommended Operating Conditions

Table 2 Recommended Operating Conditions

Symbol	Parameter	Min	Typ	Max	Unit
VCC	Supply Voltage	1.8	3.3	3.6	V
I	Supply Current	200	-	-	mA

3.2 I/O DC Electrical Characteristics

Table 3 I/O DC Electrical Characteristics

Symbol	Parameter	Min	Typ	Max	Unit
VIH	High-level Input Voltage	$0.7 * VCC$	-	$VCC + 0.3$	V
VIL	Low-level Input Voltage	-0.3	-	$0.3 * VCC$	V
VOH	High-level Output Voltage	-	$0.9 * VCC$	-	V
VOL	Low-level Output Voltage	0	-	$0.1 * VCC$	V
ZPUD	Pull-up / Pull-down Resistors	-	40	100	k Ω

3.3 Electrostatic Discharge

Ra-11 is an ESD-sensitive device and requires special precautions during handling.



Figure 2 ESD Protection Diagram

3.4 LoRa RF Performance

Table 4 LoRa RF Performance

Description	Typ			Unit
Frequency Range	2400–2500			MHz
2.4GHz Output Power				
TX (Software Setting 13)	Min	Typ	Max	Unit
2400MHz	-	12.8	-	dBm
2450MHz	-	12.8	-	dBm
2500MHz	-	12.3	-	dBm
2.4GHz Receiver Sensitivity				
RX (BW=406kHz, SF7, CR4/5)	Min	Typ	Max	Unit
2400MHz	-	-112	-	dBm
2450MHz	-	-112	-	dBm
2500MHz	-	-112	-	dBm
2.4GHz Harmonic Suppression RBW/VBW (1MHz / 3MHz)				
Condition	Min	Typ	Max	Unit
2450MHz@12dB@2nd Harmonic	-	-39	-	dBm
2450MHz@12dB@3rd Harmonic	-	-39	-	dBm
Description	Typ			Unit
Frequency Range	470–510			MHz
Sub-GHz Output Power				
TX (Software Setting 15)	Min	Typ	Max	Unit
470MHz	-	14.8	-	dBm
490MHz	-	14.8	-	dBm
510MHz	-	14.3	-	dBm

TX (Software Setting 22)	Min	Typ	Max	Unit
470MHz	-	20.8	-	dBm
490MHz	-	20.6	-	dBm
510MHz	-	20.4	-	dBm
Sub-GHz Receiver Sensitivity				
RX@ (BW=125kHz, SF7, CR4/5)	Min	Typ	Max	Unit
470MHz	-	-127	-	dBm
490MHz	-	-127	-	dBm
510MHz	-	-127	-	dBm
Sub-GHz Harmonic Suppression RBW/VBW (1MHz / 3MHz)				
Condition	Min	Typ	Max	Unit
490MHz@22dB@2nd Harmonic	-	-39	-	dBm
490MHz@22dB@3rd Harmonic	-	-39	-	dBm

3.5 Power Consumption

The following power consumption data are measured based on a 3.3V power supply and 25°C ambient temperature.

- The POUT power for all transmit modes is measured at the antenna interface.
- All transmission data are measured at 100% duty cycle in continuous transmit mode.

Table 5 Instantaneous Power Consumption

Mode	Min	Avg	Max	Unit
2.4GHz@TX (12dBm)	-	34	-	mA
Sub-GHz@TX (22dBm)	-	122	-	mA
2.4GHz@RX	-	6	-	mA
Sub-GHz@RX	-	7	-	mA
Sleep Current	-	10	-	μA

4 Mechanical Specifications

4.1 Module Dimensions

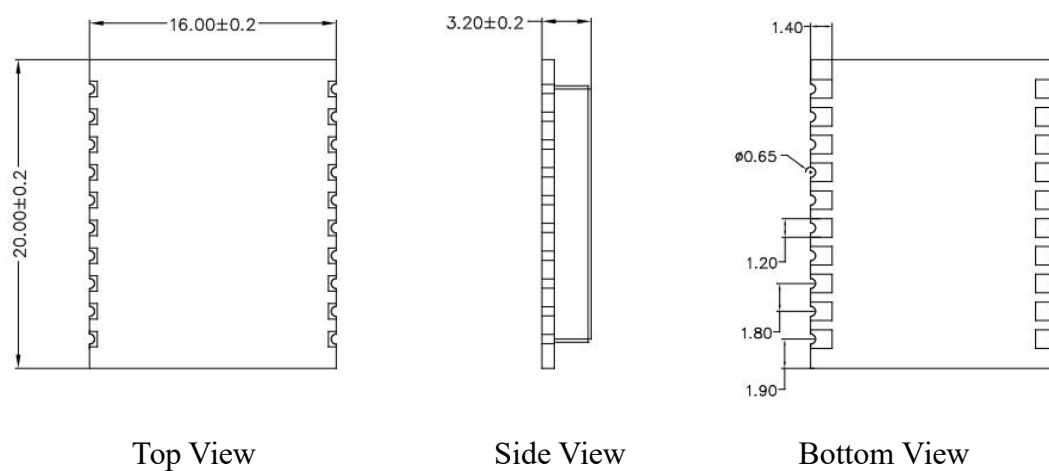


Figure 3 Module Dimensions (Unit: mm)

4.2 External Antenna Connector Dimensions

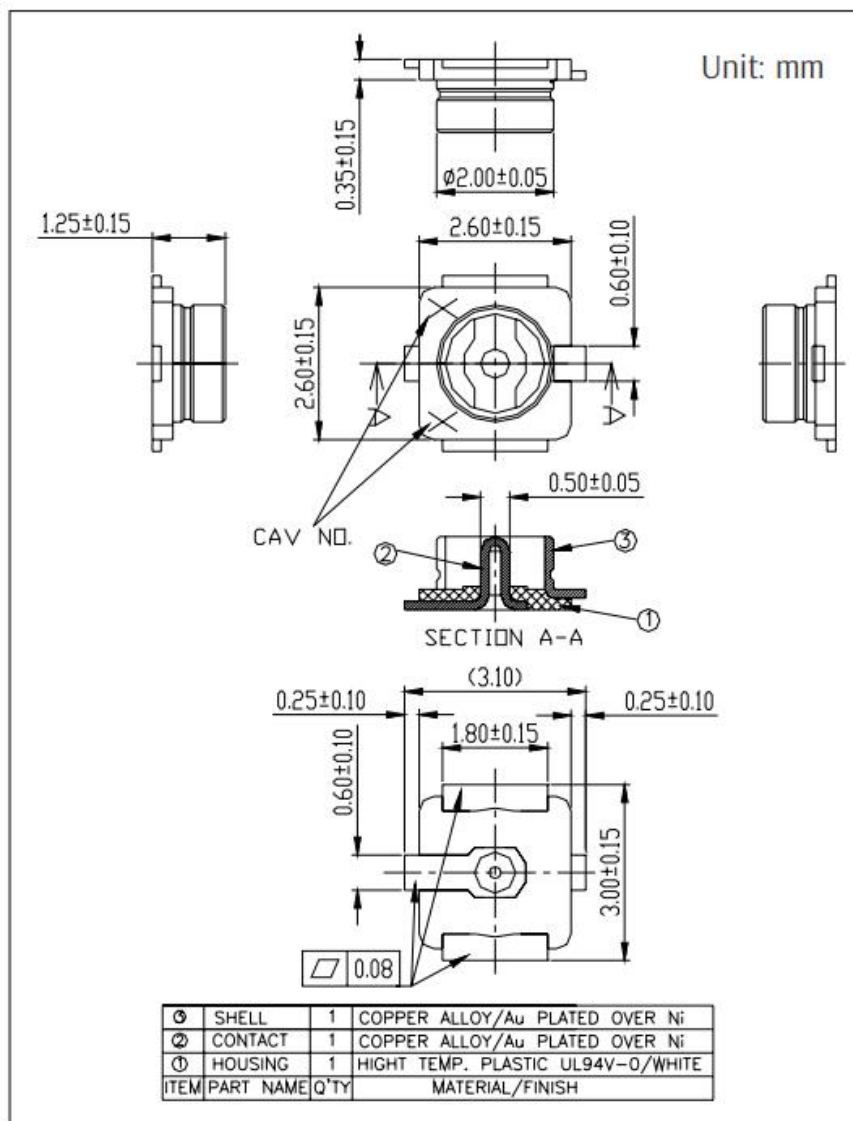


Figure 4 External Antenna Connector Dimensions (Unit: mm)

5 Pin Definition

The Ra-11 module exposes a total of 20 pins, as shown in the pin diagram. The pin function definition table provides the detailed interface specifications.

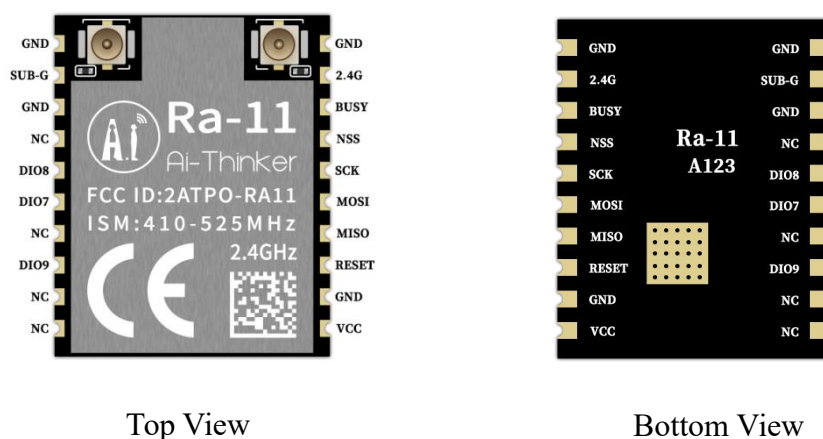


Figure 5 Pin Diagram

Table 6 Pin Function Definition

No.	Name	Function
1	GND	Module ground
2	SUB-G	Sub-GHz and S-band antenna interface, external 50Ω antenna
3	GND	Module ground
4	NC	NC
5	DIO8	Multi-purpose digital interface; refer to the chip datasheet for details
6	DIO7	Multi-purpose digital interface; refer to the chip datasheet for details
7	NC	NC
8	DIO9	Module interrupt interface; refer to the chip datasheet for details
9	NC	NC
10	NC	NC
11	VCC	Connect to power supply positive terminal
12	GND	Module ground

13	RESET	Reset trigger input, active low; refer to the chip datasheet for details
14	MISO	SPI data output
15	MOSI	SPI data input
16	SCK	SPI clock input
17	NSS	SPI chip select input
18	BUSY	Used for status indication; refer to the chip datasheet for details
19	2.4G	2.4GHz antenna interface, external 50Ω antenna
20	GND	Module ground

Notes:

1. The “IO11” and “IO10” pins of the LR1121 chip are internally connected to a 32.768kHz crystal inside the module.
2. The “IO5” and “IO6” pins of the LR1121 chip are internally connected to the RF switch inside the module. They control the Sub-GHz transmit (TX: +22dBm high power and +15dBm low power) and receive (RX) operations, and are consistent with the control states in the official SDK.



7 Design Guide

7.1 Application Reference Circuit

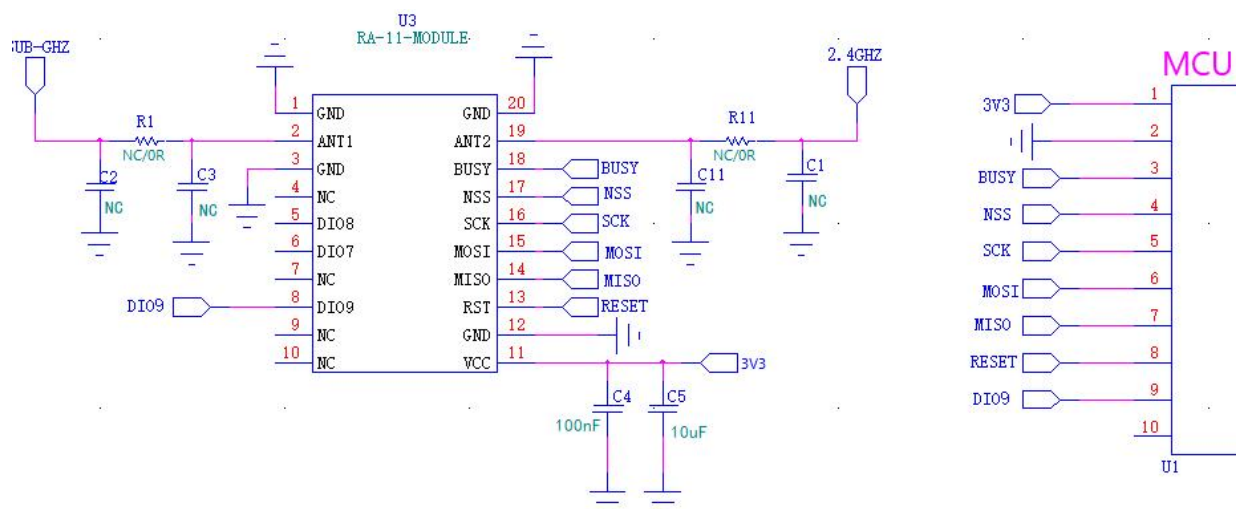


Figure 7 Application Reference Circuit

- VCC supply voltage: 1.8–3.6V. The external power supply output current is recommended to be above 200mA.
- If the antenna is soldered onto the mainboard, it is recommended to reserve a π -type matching circuit at the antenna port.
- DIO9 is the communication interrupt pin and must be connected to an I/O pin of the main MCU.

7.2 Recommended PCB Footprint Dimensions

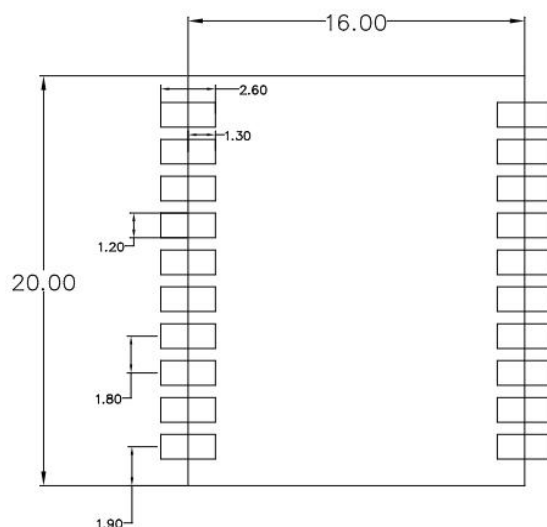


Figure 8 Recommended PCB Footprint Dimensions (Unit: mm)

7.5 GPIO

- Some I/O pins are exposed on the module periphery. To use these I/O pins, it is recommended to connect a 10-100Ω resistor in series with each I/O pin. This helps suppress overshoot, stabilize signal levels, and benefits both EMI and ESD protection.
- The pull-up or pull-down configuration for special I/O pins must refer to the instructions in the specification, as it affects the module boot configuration.
- The module I/O pins level is 3.3V. If the host controller I/O voltage level does not match the module, a level-shifting circuit should be added.
- If an I/O pin is directly connected to a peripheral interface or pin headers, it is recommended to reserve space for an ESD protection device near the connector on the I/O trace.

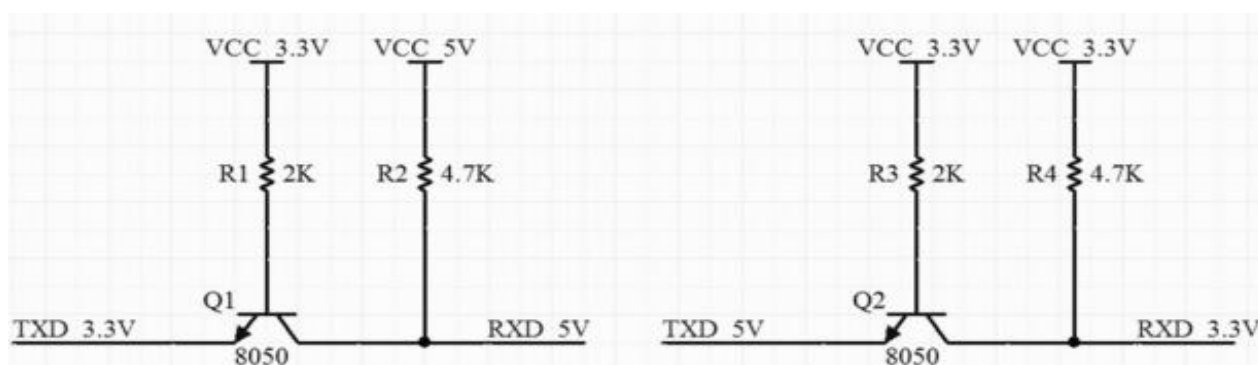


Figure 11 Level-shifting Circuit

8 Storage Conditions

Products sealed in moisture barrier bags should be stored in a non-condensing atmosphere at $< 40^{\circ}\text{C}$ and $< 90\% \text{ RH}$.

The moisture sensitivity level (MSL) of the module is level 3.

The module must be used within 168 hours after vacuum bag removal under conditions of $25 \pm 5^{\circ}\text{C}$ and $60\% \text{ RH}$. Otherwise, the module requires baking before being returned to production.

9 Reflow Soldering Profile

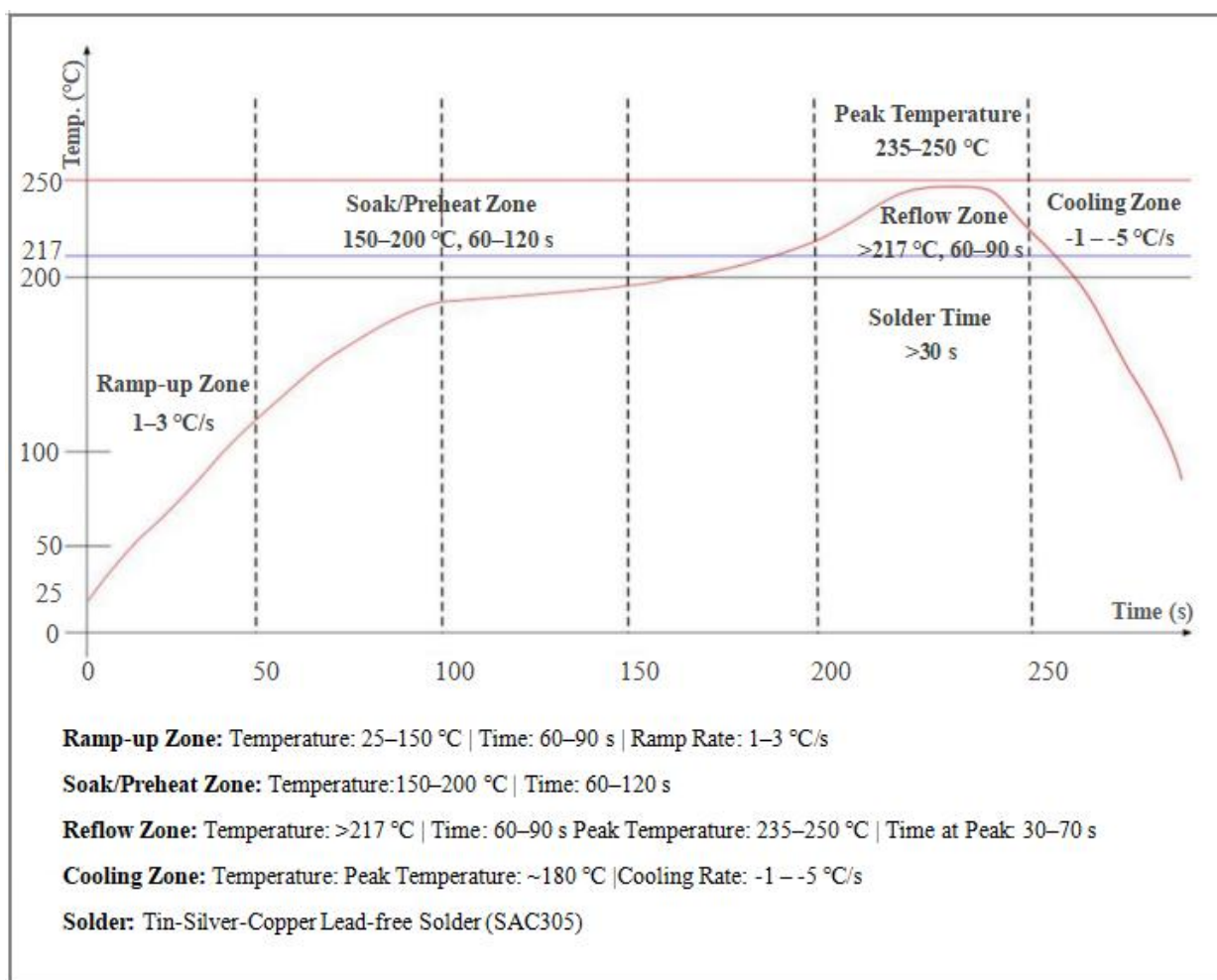


Figure 12 Reflow Soldering Profile

10 Packaging Information

The Ra-11 module is packaged in tape-and-reel, 800 pcs/reel.



Figure 13 Tape and Reel Packaging Diagram

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