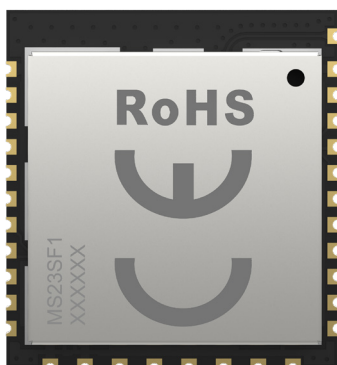


LoRaWAN Module

MS23SF1



Datasheet
V 1.1.0



Version Note

Version	Details	Contributor(s)	Date	Notes
1.0.0	First edit	Vincle, Leo	2024.06.06	
1.1.0	Update HW V1.1 and RF switch logic	Vincle	2026.09.22	

Part Number

Model	Hardware Code
MS23SF1	4YE5AI-X

Note: The meaning of "X"	0 AS923, Support 923MHz frequency 1 AU915, Support 915-928MHz frequency 2 CN470, Support 470-510MHz frequency 3 CN779, Support 779-787MHz frequency 4 EU433, Support 433MHz frequency 5 EU868, Support 863-870MHz frequency 6 IN865, Support 865-867MHz frequency 7 KR920, Support 920-923MHz frequency 8 RU864, Support 864-870MHz frequency 9 US915, Support 902-928MHz frequency
---------------------------------	---



The marking on the product's shielding cover is subject to change based on certification updates. The actual marking on the shielding cover at the time of shipment shall prevail.

Please be aware that changes in the marking do not affect product performance or usage; therefore, no separate notification will be issued regarding such changes.

For customization requests, please contact MineNewSemi's sales team for confirmation.



*Due to the limited module size, regulatory marks and certification IDs are provided in this datasheet and/or on the packaging. The final product incorporating this module shall include a label indicating that it contains a certified module.

Click the icon to view and download the latest product documents electronically.
https://en.minewsemi.com/file/MS23SF1-STM32_Datasheet_K_EN.pdf



MS23SF1-STM32WLE5CC

Low-power, ultra-long-range, small and easy to operate, high-sensitivity, support LoRaWAN

MS23SF1 Module is selected from ST LoRaWAN STM32WLE5CC, Wireless Half duplex transceiver chips, which supports global frequency ISM. It is a typical LoRa®WAN transceiver module, that supports multiple interfaces. The current in receive mode is only 4.2mA. It can achieve transmission power up to +20.5dBm with higher reception sensitivity, and down to -146dBm. compliance with the physical layer requirements of the LoRaWAN® standard specification, and support for LoRa® P2P(points-to-point).Supporting customers in the rapid set-up of their private, long-range LoRa® networks.

FEATURES



Small dimension, built-in 48MHz Arm Cortex-M4



Programmable bit rate, 64KB internal RAM, 256KB Flash



Transmission Range up to 5KM



Multi-IO port support GPIO24



Tx Power maximum up to +20.5dBm, RSSI -146dBm

KEY PARAMETER

MS23SF1

Chip Model	STM32WLE5CC	Antenna	None
Module size	20.72x19.13x3mm	GPIO	24
Flash	256KB	RAM	64KB
Receiving Sensitivity	-146dBm	Transmission Power	+20.5dBm
Current(TX)	120mA	Current(RX)	4.2mA

APPLICATION



Smart
Metering



Building
Automation



Agriculture
Sensor

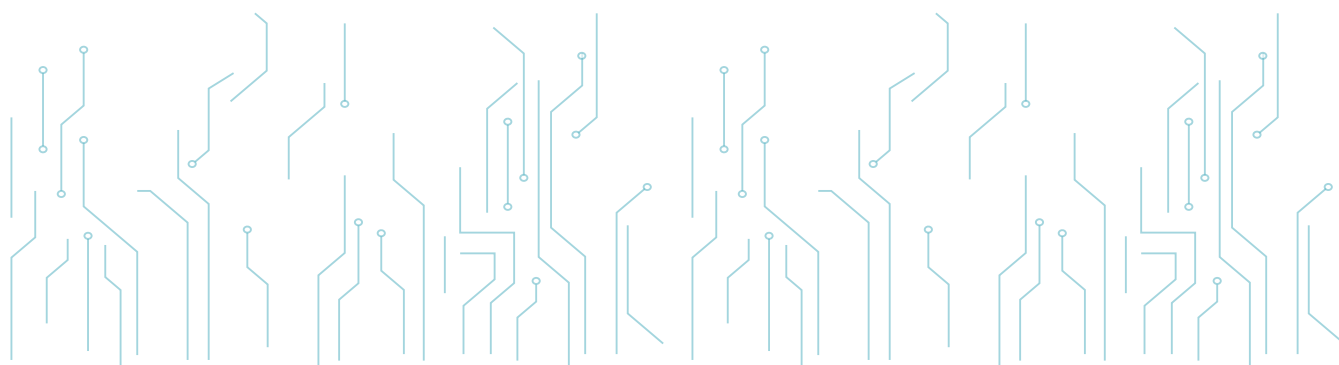


Retail
Sensor

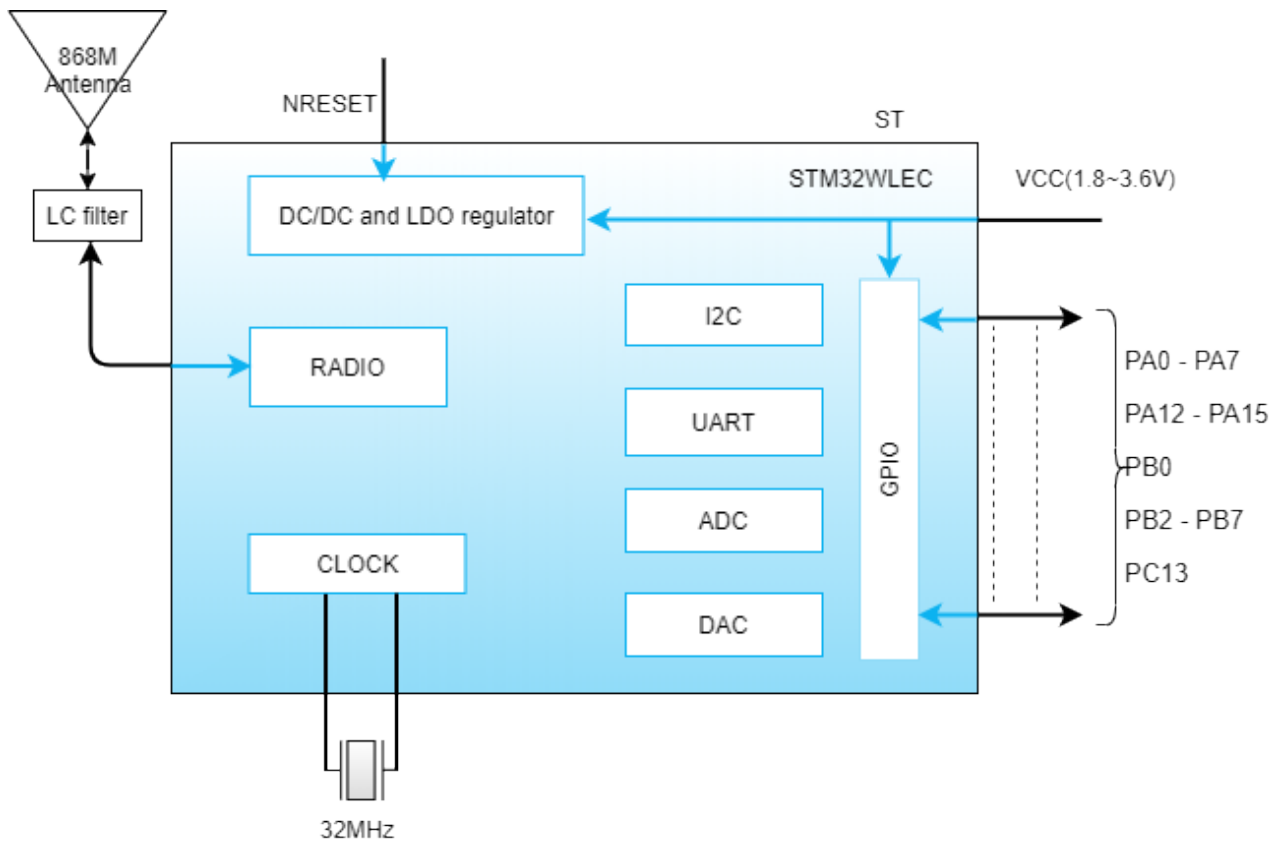


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1 BLOCK DIAGRAM

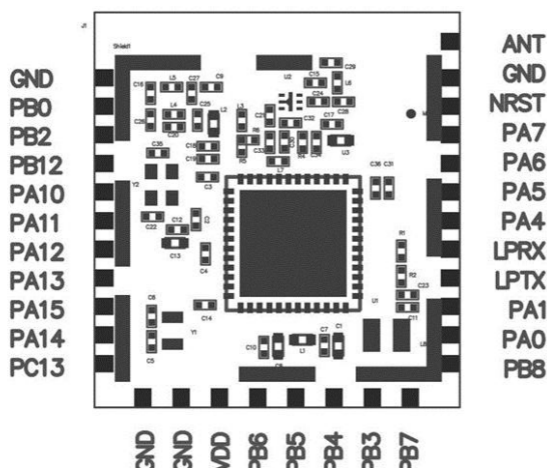


2 ELECTRICAL SPECIFICATION

Parameter	Values	Notes
Operation Voltage	1.8V-3.6V	To ensure RF work, supply voltage suggest not lower than 3.3V
Operation Temperature	-40℃~+85℃	
Transmission Power	+20.5dBm	Optional 14dBm
ISM Frequency	150~960MHz	Optional, Default 868MHz
Current(RX)	4.2mA	Rx mode
Current(TX)	120mA	Max. in Tx mode
Module Dimension	20.72x19.13x3mm	
Quantity of IO Port	24	



3 PIN DESCRIPTION



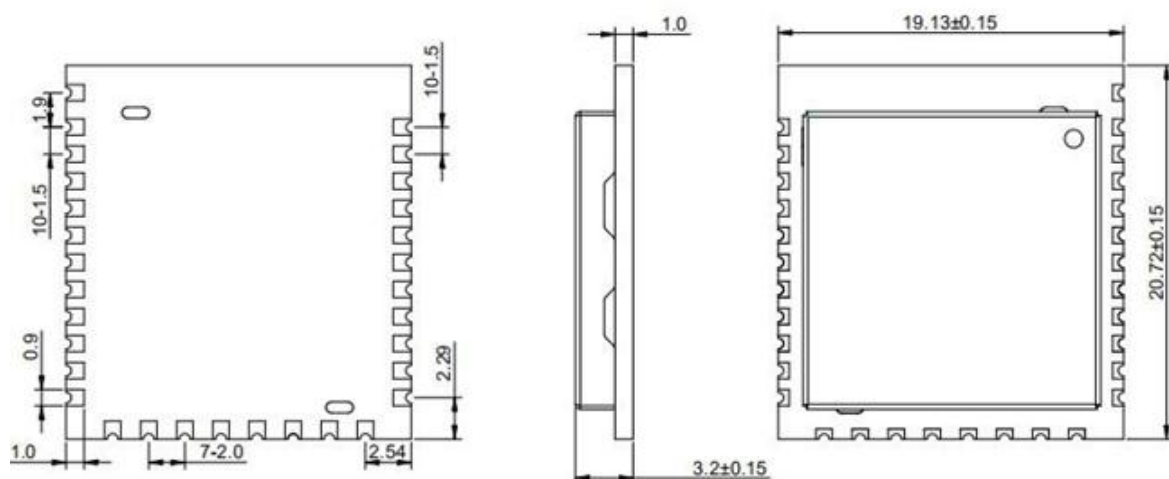
4 PIN DEFINITION

Number	Symbol	Definition	Description	Notes
1	GND	-	Ground	
2	PB0	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
3	PB2	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
4	PB12	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
5	PA10	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
6	PA11	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
7	PA12	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
8	PA13	I/O	Firmware burning interface	SWDIO
9	PA15	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
10	PA14	I/O	Firmware burning interface	SWCLK
11	PC13	I	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
12	GND	-	Grounded	
13	GND	-	Grounded	
14	VDD	I	Power supply	
15	PB6	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
16	PB5	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
17	PB4	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
18	PB3	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)



Number	Symbol	Definition	Description	Notes
19	PB7	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
20	PB8	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
21	PA0	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
22	PA1	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
23	LPTX	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details) UART_TX
24	LPRX	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details) UART_RX
25	PA4	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
26	PA5	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
27	PA6	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
28	PA7	I/O	Multi-functional digital I/O interface	Configurable general purpose IO interface (Check STM32WLE5CCU6 manual for details)
29	NRST	I/O	Reset	Module reset
30	GND	-	Grounded	
31	ANT	I/O	Antenna Connection	RF Antennas Access

5 MECHANICAL DRAWING

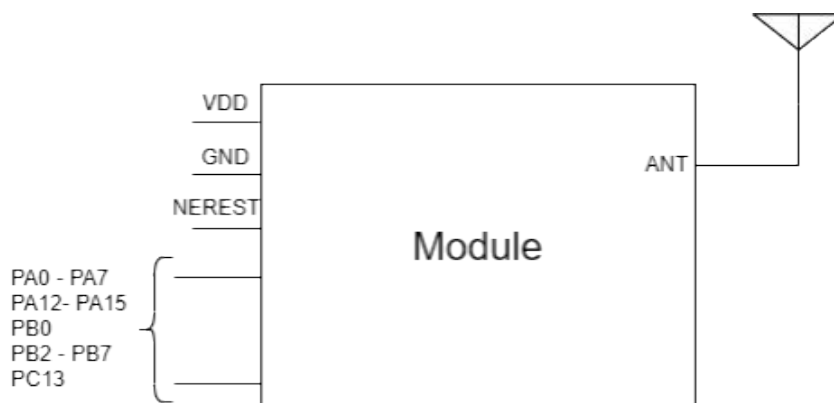


Default unit: mm Default tolerance: ± 0.15



6 MODULE OPERATION INSTRUCTION

6.1 Demonstration of module application



6.1.1 Power supply

The operation voltage is 1.8V-3.6V, to ensure a stable function, supply voltage should be 3.3V as far as possible.

6.1.2 Module consumption description

The power consumption test below is tested at a power supply voltage of 3.3V and normal temperature. 868MHz transmit BW is 125kHz, transmit power is +20.5dBm, Tx mode SF12 frequency band power consumption.

Status	Power	SF Mode	Peak	Avg
TX		SF12	86.41mA	77.19mA

6.1.3 Software development

For LoRaWANTM development, please download and refer to the instructions in ST's STM32CubeWL library file, and use stm32cubemx software to generate the protocol stack project of the relevant development platform;

The PA9 pins are used as the internal control RF switch of the module, which are RF_TXEN and RF_RXEN respectively, and the modes are shown in the figure below.

Generally, it is not recommended to enable RX and TX at the same time. When transmitting, TX is enable and RX is disable ; When receiving, RX is enable and TX is disable.

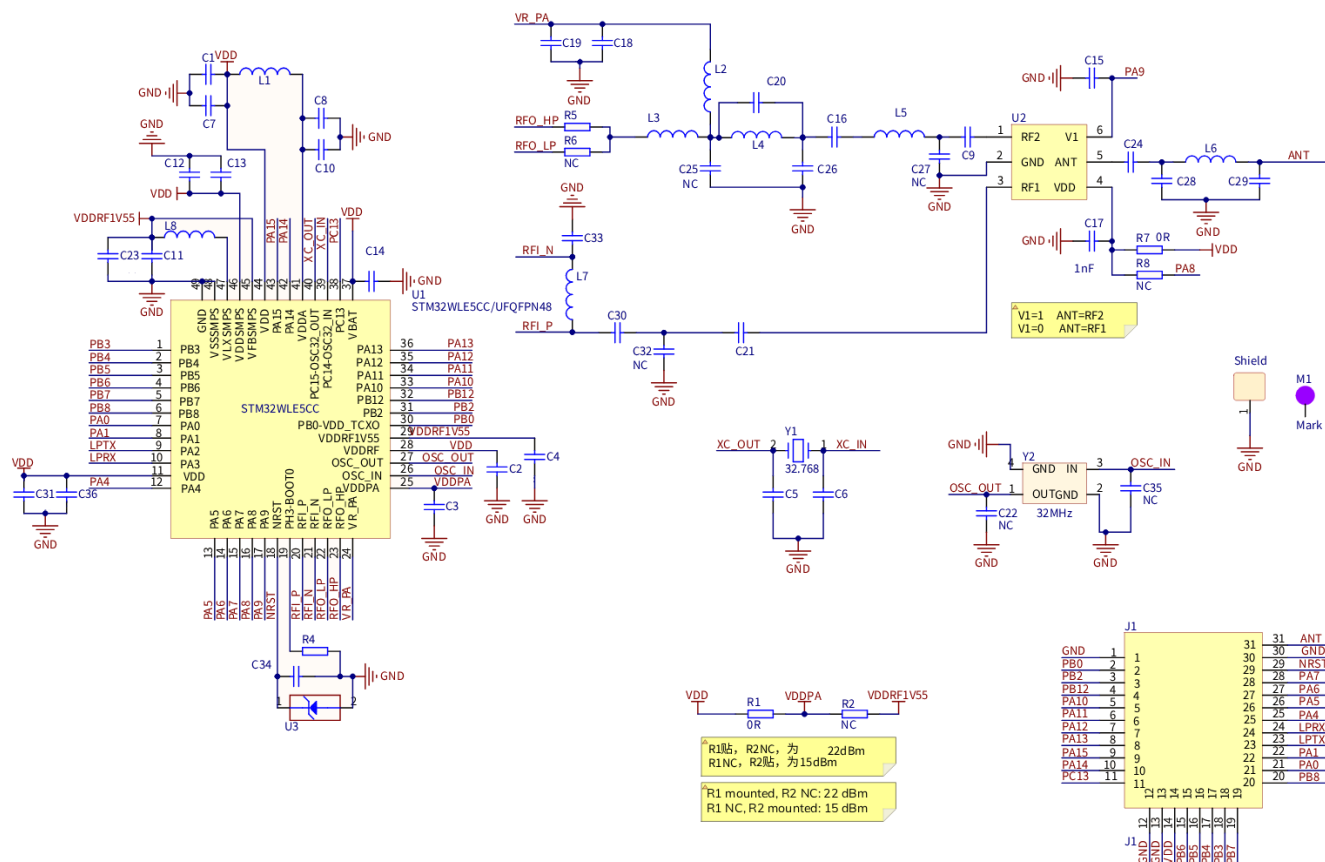
Mode	PA9	PA8
RF_TXEN	1	0
RF_RXEN	0	1



Notice: At present, the supported firmware is "LoRaWAN Transparent Firmware" and "AT Firmware (for demo use)".



7 ELECTRICAL SCHEMATIC



8 PCB DESIGN

8.1 Disclaimer

This document is provided as a recommended design reference for wireless modules and does not constitute any explicit or implied guarantee of performance or compliance. Due to differences in PCB layout, enclosure structure, antenna selection, and application environments of the end product, this document cannot guarantee RF performance in all scenarios. Users must conduct sufficient RF performance and compliance verification after completing the final product design and shall bear full responsibility for design and application outcomes. Our company reserves the right to modify the contents of this document without prior notice.

8.2 Core Rules for Module Placement

Board Edge Priority Rule

The RF output/antenna side of the module must face the edge of the main PCB to ensure that antenna radiation is directed outward from the board without obstruction. Placing the module in a closed central area of the PCB is strictly prohibited.

Keep-Out Area Rule

A 0.5 mm area around the module body must be kept clear. Non-ground components and non-ground signal traces are prohibited within this area. Within 4 mm around the RF side of the module, copper pours, unrelated components, and non-RF signal traces are strictly prohibited.

Interference Isolation Rule

The module must maintain a minimum safe distance from strong interference sources. Adjacent placement on the same layer is prohibited. Isolation using different PCB layers and shielding covers is recommended. General isolation requirements are as follows:

Interference Source Type	Minimum Recommended Isolation Distance
DC-DC switching power supplies, power inductors, power transformers	20mm
USB 3.0 / HDMI 2.0 / DDR / High-speed SDIO interfaces	20mm
MCU high-frequency clock circuits, Ethernet PHY chips	15mm
Displays, cameras, FPC cables with wiring	25mm

Structural Clearance Rule

The minimum distance between the module and metal screws, clips, standoffs, and other structural parts must be ≥ 5 mm. At least 4 mm of SMT soldering and rework clearance must be reserved around the module. The RF side of the module must not be enclosed inside a fully metal cavity.

Multiple Modules on the Same PCB

When placing multiple wireless modules of the same or different types on the same PCB, the minimum spacing between modules must be ≥ 50 mm to avoid mutual interference.

8.3 GENERAL PCB DESIGN REQUIREMENTS

Grounding Design

The main PCB must maintain a complete and continuous ground plane. Splitting the ground plane within the module projection area or RF surrounding area is strictly prohibited. All module ground pins must be soldered. At least one grounding via should be placed near each ground pad and connected to the main ground plane. A complete ground plane with dense grounding vias may be placed under the non-RF area of the module to improve shielding performance.

Power Supply Design

Decoupling capacitor combinations must be placed close to the module power input pins. The trace length between capacitor pads and power pins should be ≤ 0.5 mm, and at least two grounding vias should be placed near the ground terminal. For switching power supply applications, a π -type filter circuit footprint must be reserved near the module power input pins.

RF Trace Design

The entire RF path must maintain a strict 50 Ω characteristic impedance (tolerance $\pm 10\%$). RF traces should be as short as possible and routed preferably in straight lines. Sharp or right-angle corners are prohibited; curved routing with a radius ≥ 3 times the trace width is recommended. Branch traces and stub traces are prohibited. A continuous reference ground plane must exist beneath the RF traces, and no other signal traces should be routed within 3 times the trace width on either side. Ground shielding should be applied throughout the RF routing.

Control Interface Design

Control signal traces such as UART, SPI, and I2C should be routed away from RF areas with short and simple routing paths and continuous ground shielding. Parallel routing adjacent to RF traces is prohibited. ESD protection devices must be placed close to external PCB connectors and must not be placed near module pins.

Footprint Design

Strictly use the standard PCB footprint provided by our company. Unauthorized modification of pad size or spacing is prohibited to ensure soldering reliability.

8.4 DESIGN RESTRICTIONS

Do not place the RF side of the module facing the inside of the PCB or away from the board edge.

Do not place copper pours, components, or fully enclosed metal housings without openings over the antenna area.

Do not route RF traces across split ground planes, without a complete reference ground, or with right-angle corners.

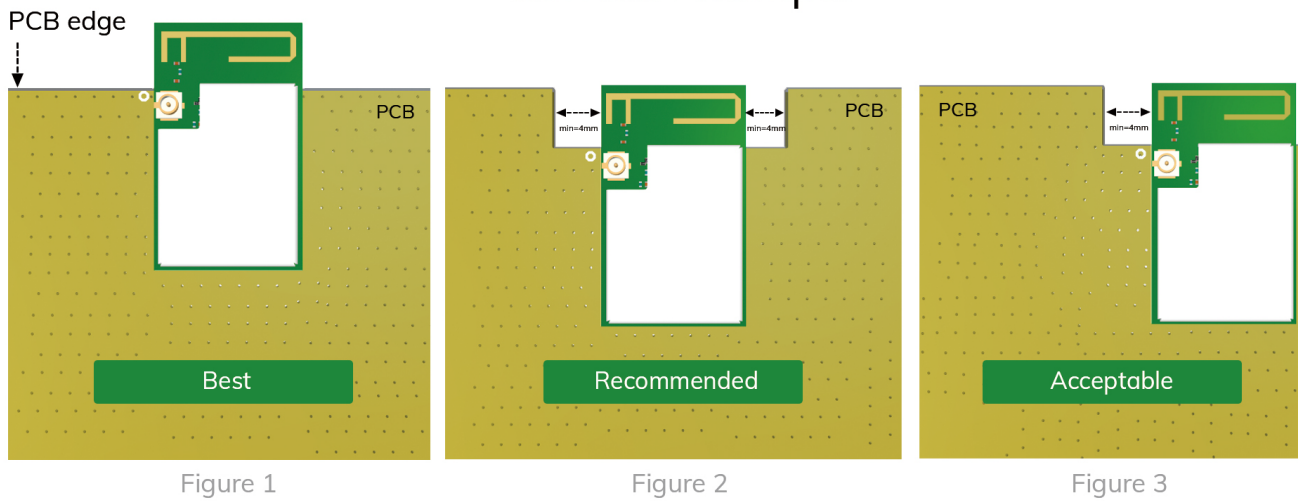
Do not place modules adjacent to strong interference sources or split the ground plane in the module area.

Do not leave module ground pins unconnected or inadequately grounded.

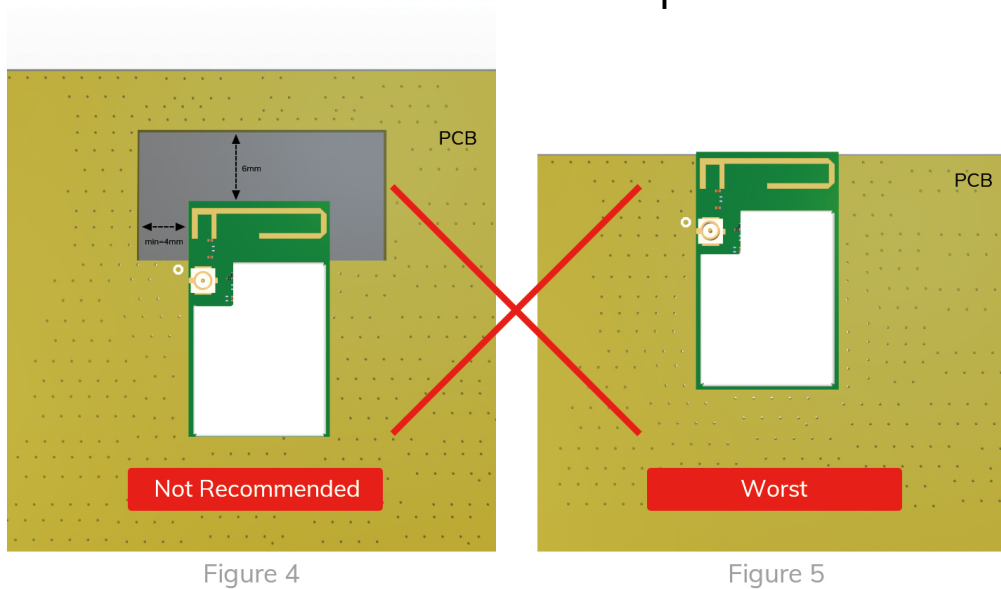
8.5 MODULE PLACEMENT EXAMPLE

For end products, antenna position significantly affects overall system performance. The module should preferably be placed at the edge or corner of the PCB to maximize the clearance area and reduce interference from surrounding components. The PCB area directly beneath the module antenna should be hollowed out to keep the antenna region suspended, while no signal traces, metal objects, or other interference sources should exist within 3–5 mm around the antenna area. The figure below demonstrates an example of proper module placement on the main PCB for optimal RF performance. The first recommended layout method should be used whenever possible, as the module antenna design has been tuned and optimized based on this configuration.

Correct Example



Incorrect Example



Antenna position

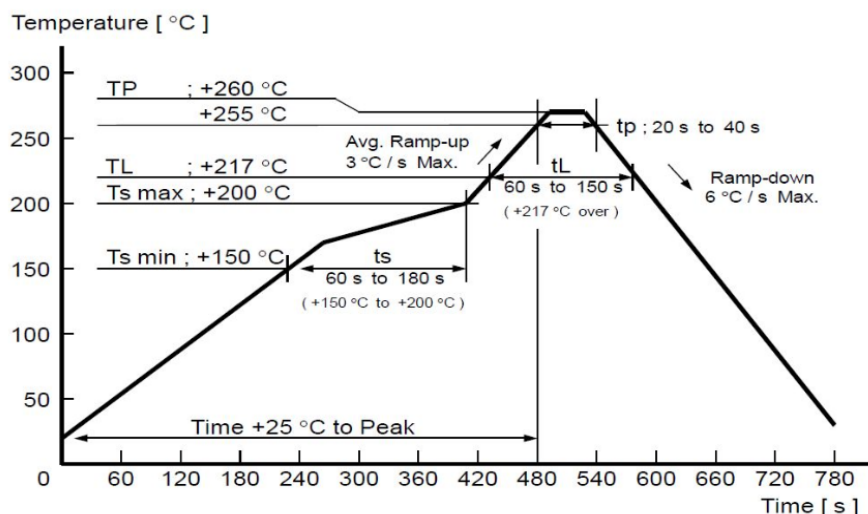


Ground Plane



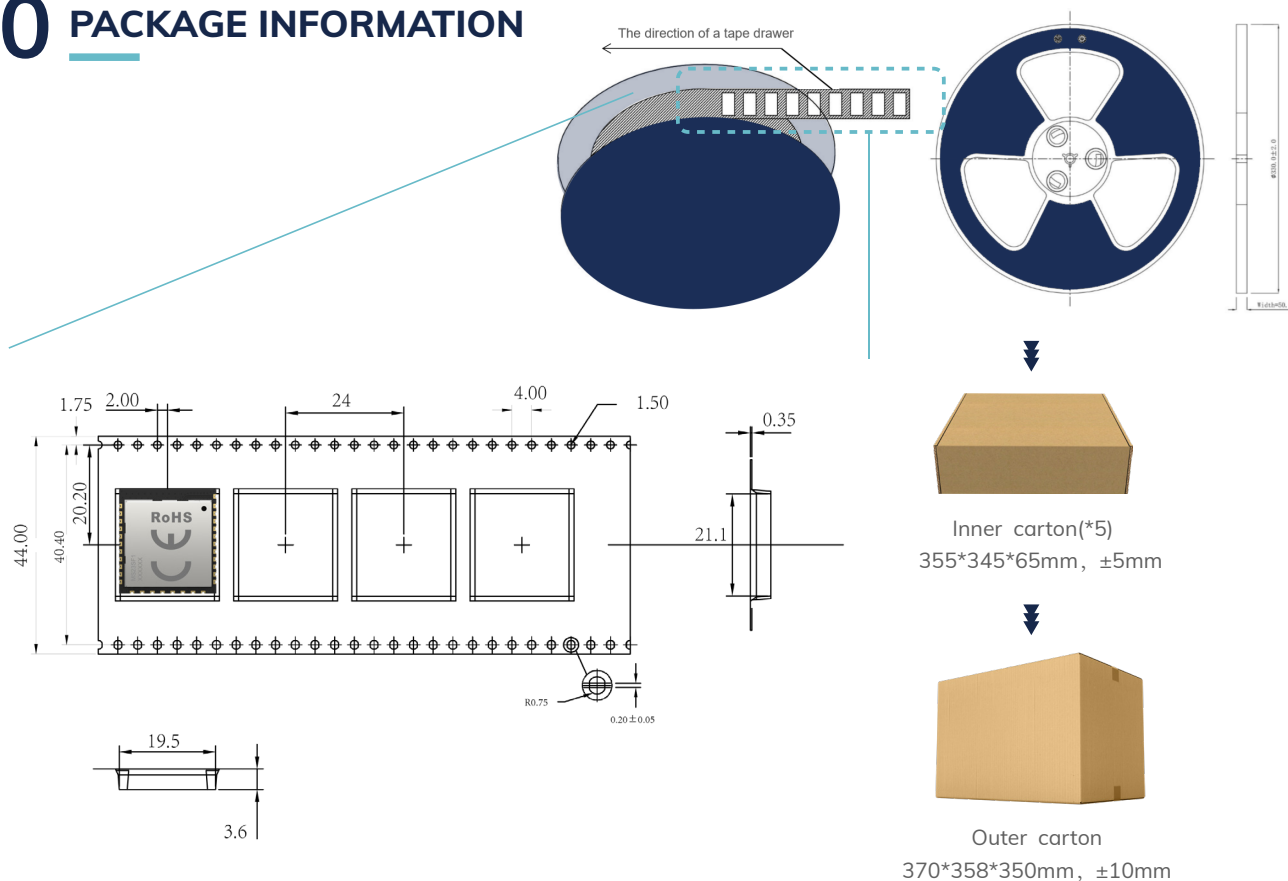
9 REFLOW AND SOLDERING

- 1) Perform SMT according to the reflow oven temperature profile provided below, with a maximum temperature of 260°C;
- 2) Follow IPC/JEDEC standards; Peak temperature: < 260°C; Number of reflows: ≤2 times; For SMT involving double-sided placement, it is recommended that the module side undergoes reflow soldering only once. For any special processes, please contact our company.



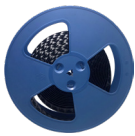
- 3) Suggesting to make 0.2mm thickness of module SMT for partial ladder steel mesh, then make the opening extend 0.8mm
- 4) After opening, if the entire package is not used at once, it should be stored in a vacuum to prevent long-term exposure to air, which can cause moisture absorption and pad oxidation. If there is a gap of 7 to 30 days before reuse, it is recommended to bake the tape at 65-70°C for 24 hours without unrolling it before returning to SMT.
- 5) ESD protection measures should be implemented before using SMT.

10 PACKAGE INFORMATION

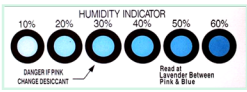


Remarks

General material list for FCL packaging:



Carrier tape packaging tray



Humidity Indicator
(1 pcs/bag)



Desiccant
(placed in a vacuum bag)



Vacuum bag



Inner carton(*5)
355*345*65mm, ±5mm



Outer carton
370*358*350mm, ±10mm

Other:

Moisture-proof label (attached to the vacuum bag)

Certification label (attached to the vacuum bag)

Outer box label

Default unit: mm Default tolerance: ±0.1

Packing detail	Specification	Net weight	Gross weight	Dimension
MS23SF1	750PCS	1395g	1935g	W=44mm, T=0.35mm

Note: Default weight tolerance all are within 10g (except the special notes)

11 STORAGE CONDITIONS

- **Please use this product within 6 months after signing the receipt.**
 - This product should be stored without opening the package at an ambient temperature of 5~35°C and a humidity of 20~70%RH.
 - This product should be left for more than 6 months after receipt and should be confirmed before use.
 - The product must be stored in a non-corrosive gas (Cl₂, NH₃, SO₂, NO_x, etc.).
 - To avoid damaging the packaging material, do not apply any excessive mechanical shocks, including but not limited to sharp objects adhering to the packaging material and product dropping.
- **This product is suitable for MSL2 (based on JEDEC standard J-STD-020).**
 - After opening the package, the product must be stored at ≤30°C/<60%RH. It is recommended to use the product within 3-6 months after opening the package.
 - When the color of the indicator in the package changes, the product should be baked before welding.
- **Baking is not required for one year if exposure is limited to <30°C and 60%RH. Refer to MSL2 for exposure criteria for moisture sensitivity level. If exposed to (≥168h@85°C/60%RH) conditions or stored for more than one year, recommended baking conditions.**
 1. 120 +5/-5°C, 8 hours, 1 timeProducts must be baked individually on heat-resistant trays because the materials (base tape, reel tape, and cover tape) are not heat-resistant, and the packaging material may be deformed at temperatures of 120 °C;
 2. 90°C +8/-0°C , 24hours, 1timesThe base tape can be baked together with the product at this temperature. Please pay attention to the uniformity of heat.

12 HANDLING CONDITIONS

- Be careful in handling or transporting products because excessive stress or mechanical shock may break products.
- Handle with care if products may have cracks or damages on their terminals. If there is any such damage, the characteristics of products may change. Do not touch products with bare hands that may result in poor solder ability and destroy by static electrical charge.

13 QUALITY

Cognizant of our commitment to quality, we operate our own factory equipped with state-of-the-art production facilities and a meticulous quality management system. We hold certifications for ISO9001, ISO14001, ISO27001, OHSA18001, BSCI.

Every product undergoes stringent testing, including transmit power, sensitivity, power consumption, stability, and aging tests. Our fully automated module production line is now in full operation, boasting a production capacity in the millions, capable of meeting high-volume production demands.

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15 RELATED DOCUMENTS

- stm32WLE5c8_Chip_Datasheet
https://en.minewsemi.com/file/stm32WLE5c8_Chip_Datasheet_EN.pdf
- MinewSemi_Product_Naming_Reference_Manual
https://en.minewsemi.com/file/MinewSemi_Product_Naming_Reference_Manual_EN.pdf
- MinewSemi_Connectivity_Module_Catalogue
https://en.minewsemi.com/file/MinewSemi_Connectivity_Module_Catalogue_EN.pdf



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MINEWSEMI
Innovative IoT Module Expert



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