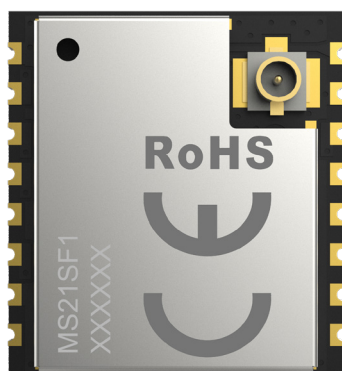


LoRa Module **MS21SF1**



Datasheet
V 1.0.0




Version Note

Version	Details	Contributor(s)	Date	Notes
1.0.0	First edit	Vincke, Leo	2024.06.06	

Part Number

Model	Hardware Code
MS21SF1-LLCC68	3N68AI-X
MS21SF1-SX1262	3N62AI-X

<p>Note: The meaning of "X"</p>	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

	<p>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.</p>
	<p>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.</p>
	<p>For customization requests, please contact MinewSemi's sales team for confirmation.</p>

Click the icon to view and download the latest product documents electronically.
https://en.minewsemi.com/file/MS21SF1-SX1262,LLCC68_Datasheet_K_EN.pdf



MS21SF1-LLCC68/SX1262

Low-power, ultra-long-range, Small and easy to operate, high-sensitivity

MS21SF1 module is based on Semtech's LoRa wireless half-duplex transceiver chip, LLCC68/SX1262, and supports global ISM frequencies. It is a low-power, ultra-long-range, small and easy-to-use SPI-interfaced LoRa® transceiver module, with a current of only 4.7mA in receive mode, and achieves a high +22dBm transmission power through the internal integrated high-efficiency power amplifier. Higher reception sensitivity 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



Non-MCU Control, external MCU is required to connect and control through SPI interface



Transmission Range up to 5KM



Programmable bit rates, with bit rates reaching up to 62.5 kbps for both LoRa and FSK modulation



Support SPI interface, can be connected directly to a variety of MCUs Application

KEY PARAMETER

MS21SF1			
Chip Model	LLCC68/SX1262	Antenna	u.FL
Module size	16.4x15x3mm	GPIO	5
Receiving Sensitivity	-146dBm	Transmission Power	+22dBm
Current(TX)	118mA	Current(RX)	4.7mA

APPLICATION



Smart city



smart medical care



Smart parking



Security warning equipment



Environmental sensor

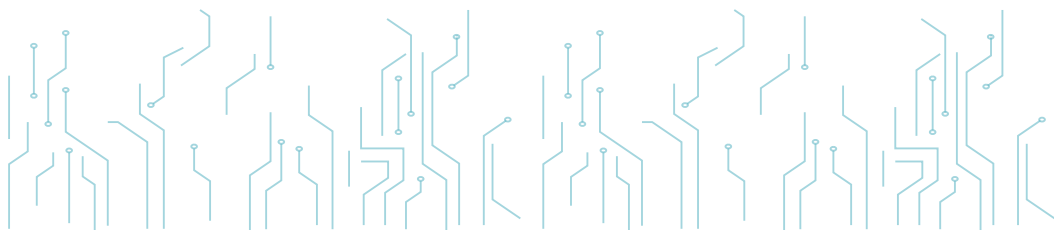


Instrument and meter Smart meter

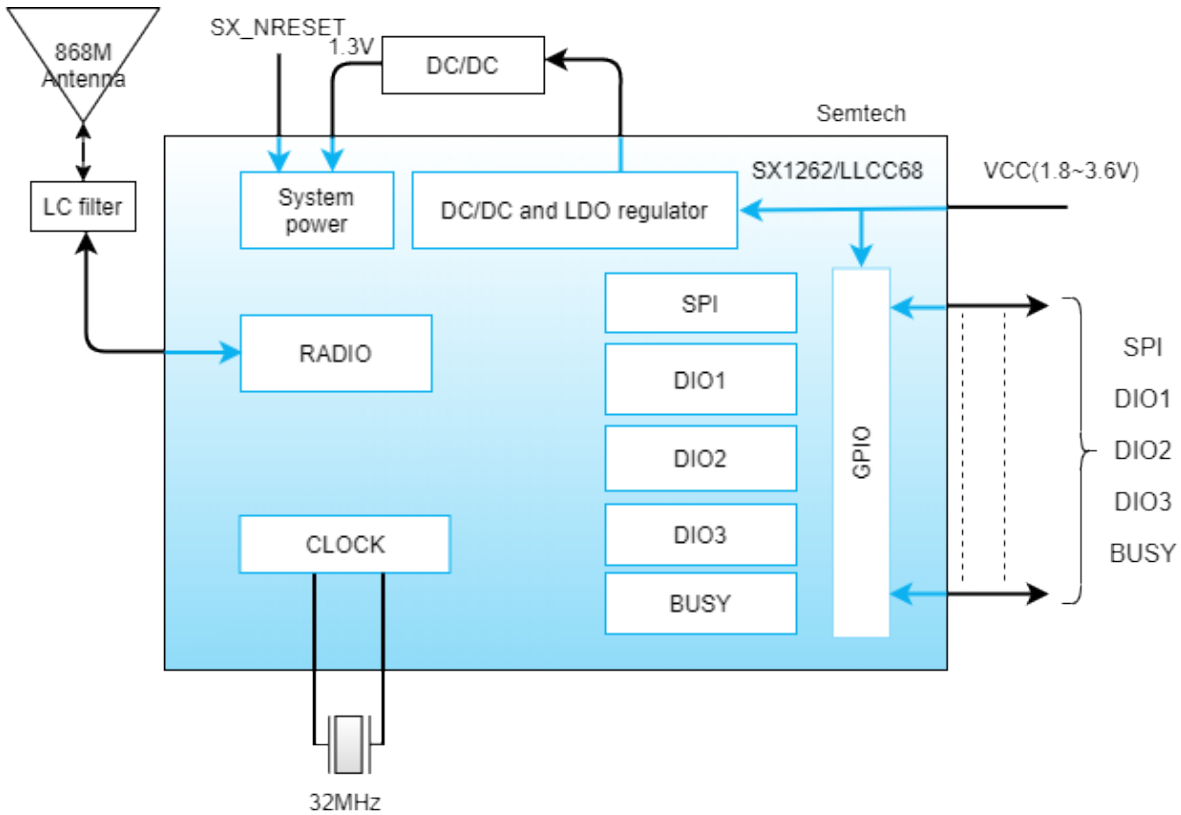


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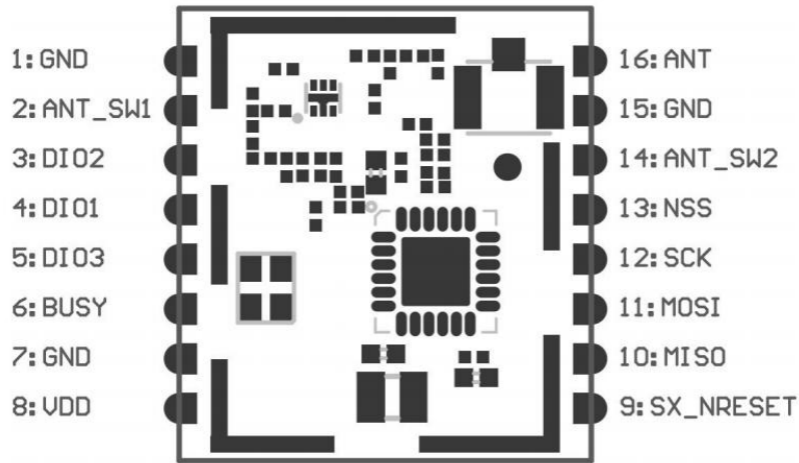
1 BLOCK DIAGRAM



2 ELECTRICAL SPECIFICATION

Parameter	Values	Notes
Operation Voltage	1.8V-3.7V	To ensure RF work, supply voltage suggest not lower than 3.3V
Operation Temperature	-40 C~+85 C	
Transmission Power	+22dBm	Configurable
ISM Frequency	150~960MHz	Optional, default 868MHZ
Current(RX)	4.7mA	RX mode
Current(TX)	118mA	TX mode
Module Dimension	16.4x15x3mm	
Quantity of IO Port	5	

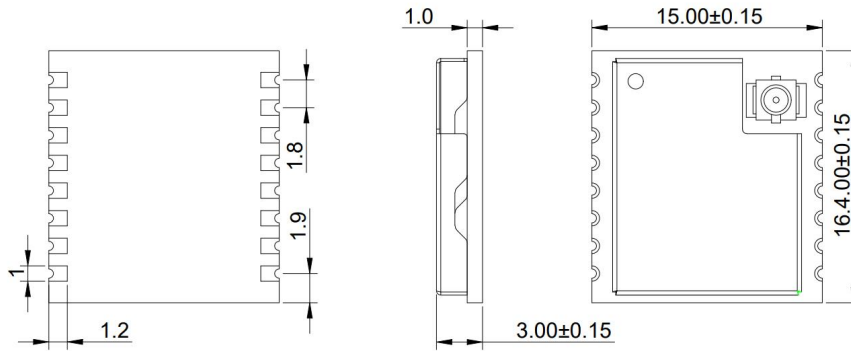
3 PIN DESCRIPTION




4 PIN DEFINITION

Number	Symbol	Type	Function description	Notes
1	GND	-	Grounded	
2	ANT_SW1	SWITCH	Antenna switch control	RF TX signal Control Switch, connect the external MCU IO or DIO2, and the high level is valid
3	DIO2	I/O	Multi-purpose digital I/O / RF Switch control	
4	DIO1	I/O	Multi-purpose digital I/O	
5	DIO3	I/O	Multi-purpose digital I/O - external TCXO supply voltage	
6	BUSY	O	Busy instruct	
7	GND	-	Ground	
8	VDD	I	Input voltage for power amplifier regulator	Power supply to voltage 3.3V
9	SX_NRESET	I/O	Reset signal	Active low
10	MISO	O	SPI Slave output	
11	MOSI	I	SPI Slave input	
12	SCK	I	SPI clock	
13	NSS	I	SPI chip select (CS)	
14	ANT_SW2	SWITCH	Antenna switch control	RF switch receiving control pin, connected to external MCU IO, active at high level
15	GND	-	Grounded	
16	ANT	-	Antenna connect pin	

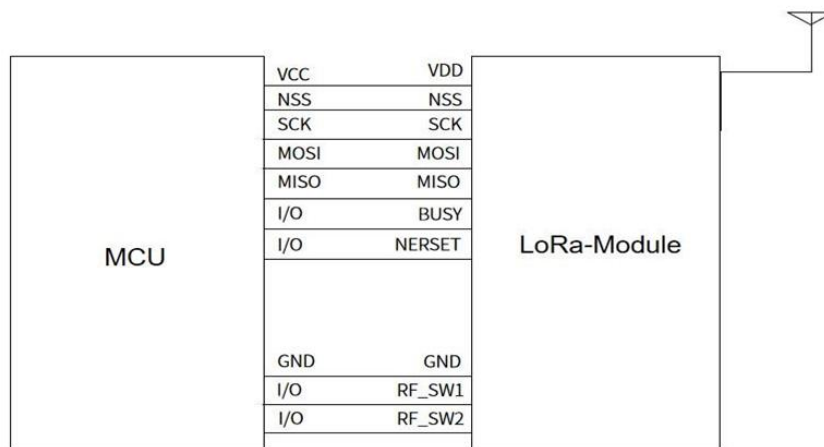
5 MECHANICAL DRAWING



 Default unit: mm Default tolerance: ±0.15

6 MODULE CONNECTION DESCRIPTION

6.1 Connection diagram



6.2 Power supply

The chip-sets operating voltage range is 1.8V-3.6V, to ensure normal use, the power supply voltage shall be 3.3V as far as possible.

6.3 SPI Interface character

The SPI runs on an external SCK clock, allowing it to reach 16MHz.

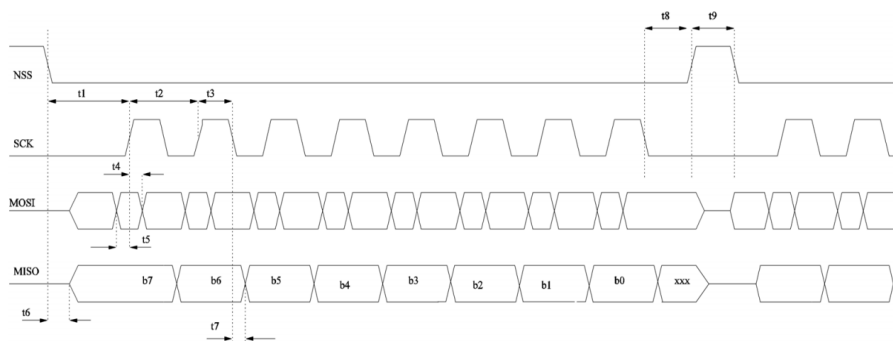
Transmission is initiated when the NSS pin level goes low. When NSS is high, MISO is in a high impedance state.

SPI Timing Requirements (The chip implements only the Slave side function.)



Symbol	Description	Minimum	Typical	Maximum	unit
t1	NSS falling edge to SCK setup time	32	-	-	ns
t2	SCK period	62.5	-	-	ns
t3	SCK high time	31.25	-	-	ns
t4	MOSI to SCK hold time	5	-	-	ns
t5	MOSI to SCK setup time	5	-	-	ns
t6	MOSI to SCK setup time	0	-	15	ns
t7	SCK falling to MISO delay	0	-	15	ns
t8	SCK to NSS rising edge hold time	31.25	-	-	ns
t9	NSS high time	125	-	-	ns
t10	NSS falling edge to SCK setup time when switching from SLEEP to STDBY_RC mode	100	-	-	s
t11	NSS falling to MISO delay when switching from SLEEP to STDBY_RC mode	0	-	150	s

Active Timing



6.3.1 DIO with IRQ control

Commands Controlling the Radio IRQs and DIOs (At least one DIO is required for IRQ, and BUSY cable is also required to be used compulsorily) .

Command	Operate code	Parameters	Description
SetDioIrqParams	0x08	IrqMask[15:0], Dio1Mask[15:0], Dio2Mask[15:0], Dio3Mask[15:0],	Configure the IRQ and the DIOs attached to each IRQ
GetIrqStatus	0x12	-	Get the values of the triggered IRQs
ClearIrqStatus	0x02	-	Clear one or several of the IRQs
SetDIO2AsRfSwitchCtrl	0x9D	Enable	Configure radio to control an RF switch from DIO2
SetDIO3AsTcxoCtrl	0x97	tcxoVoltage, timeout[23:0]	Configure the radio to use a TCXO controlled by DIO3

6.3.2 Module TX,RX Mode controls

In ANT_SW1 and DIO2 connection Point, the two connection points are IO pin and external MCU GPIO for detecting TX and RX level pins, ANT_SW2 is the synchronization control pin:

- 1)When IO pin detects a high level, pin ANT_SW2 sets the level to low, the mode is TX mode .
- 2)When IO pin detects a low level, pin ANT_SW2 sets the level to high, the mode is RX mode

Mode	IO	ANT_SW2
TX	1	0
RX	0	1

Module power consumption description

The following power consumption test is conducted under the normal temperature condition when the power supply voltage is 3.3V. The power consumption in the 915MHz frequency band is measured.

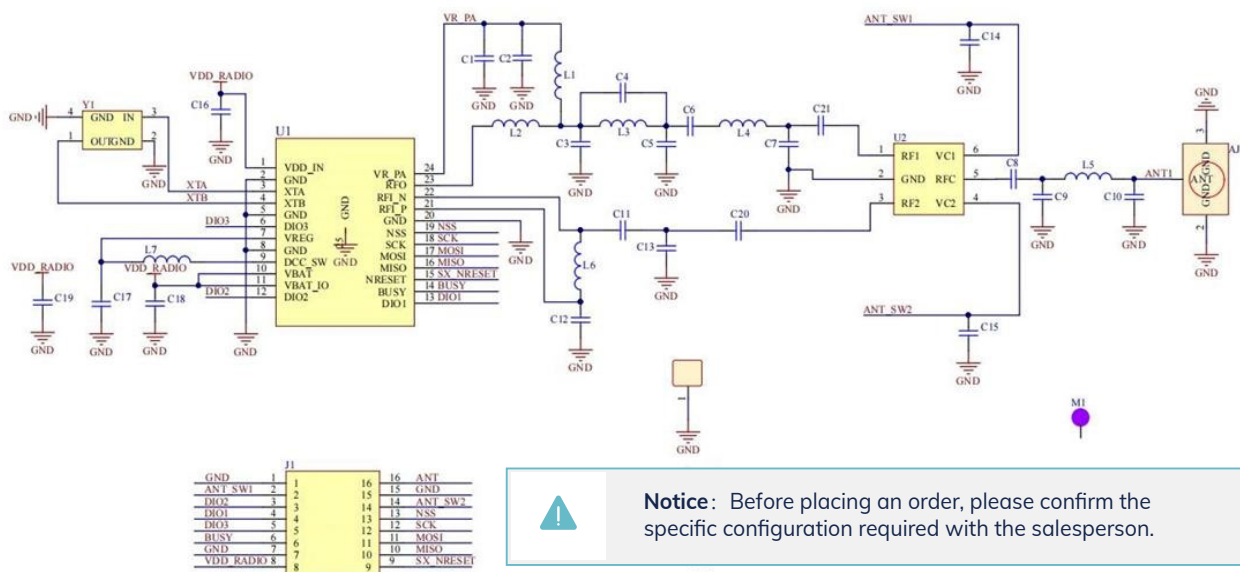
In TX Mode, the power consumption is as follows: (transmission BW is 125kHz, transmission power is +22dBm.

Mode	Power	SF Mode	Peak	Avg
TX		SF7	112.01mA	98.60mA
		SF12	123.32mA	115.62mA

In RX Mode SleepMode, Power consumption as below: (Receiving BW is 125kHz, Transmission power is +22dBm)

Mode	Power	Peak	Avg
Sleep		538.41uA	538.41uA
RX		4.76mA	4.76mA

7 ELECTRICAL SCHEMATIC



8 PCB LAYOUT

There should be no GND plane or metal cross wiring in the module antenna area, and no components should be placed nearby. It is best to make a hollow or clear area, or place it on the edge of the PCB board. The reference example is as follows:

Layout Notes:

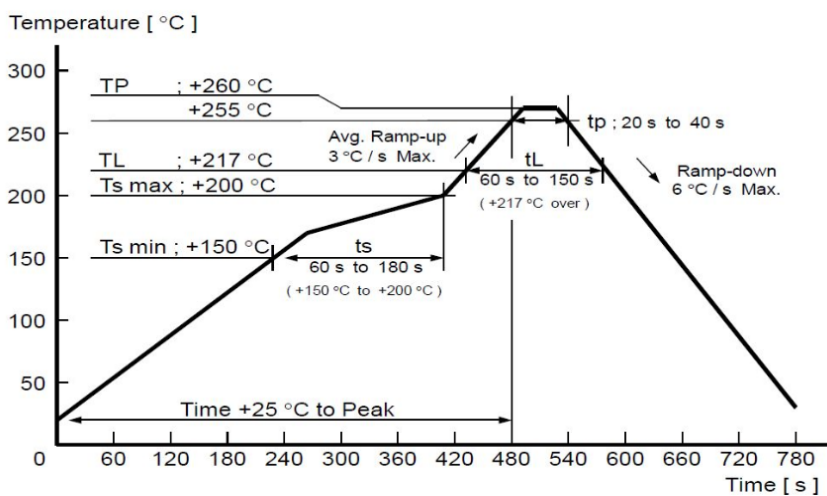
- 1)The module's antenna area should be completely clear of any metal obstructions to avoid affecting antenna performance (as shown in the diagram).
- 2)Outside the module's antenna area, try to maintain a solid copper pour to minimize interference from the mainboard signal lines or other sources.
- 3)A clear area of at least 4mm should surround the module's antenna (including its casing) to reduce interference with the antenna.
- 4)Ensure good grounding for components to minimize parasitic inductance.
- 5)Do not place copper under the module's antenna to prevent interference with signal radiation, which could affect transmission distance.
- 6)The antenna should be kept away from other circuits to maintain radiation efficiency and avoid impacting the normal operation of other circuits.
- 7)Position the module as close to the edge of the circuit board as possible, away from other circuitry.
- 8) It is recommended to use a ferrite bead for isolation when connecting the module to the power supply.



Notice: It is strongly recommended to use the first design method. The module antenna design is debugged according to the first wiring.

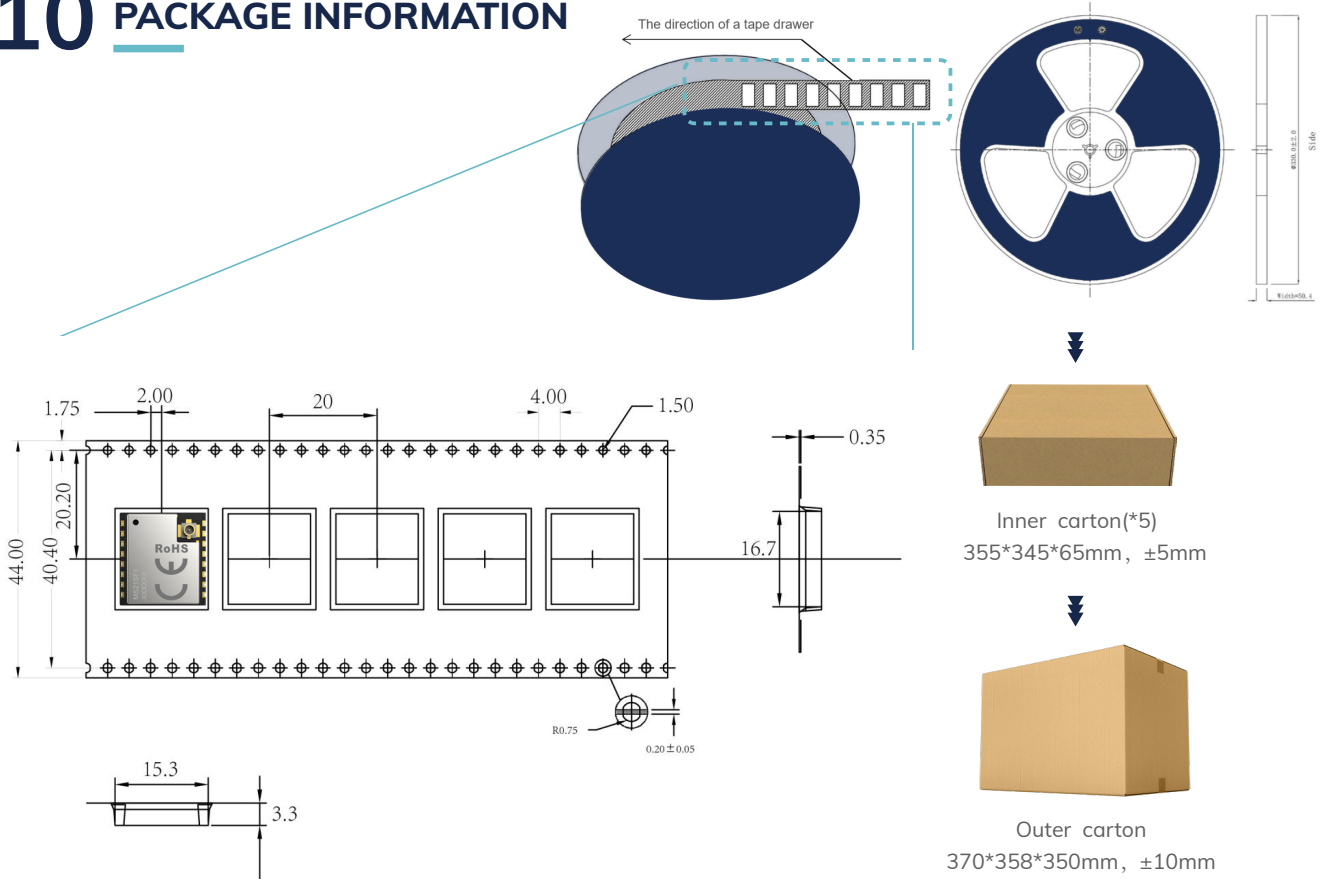
9 REFLOW AND SOLDERING

- 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.




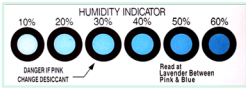


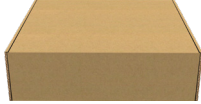

- 3) Suggesting to make 0.2mm thickness of module SMT for partial ladder steel mesh, then make the opening extend 0.8mm
- 4)After opening, if the entire package is not used at once, it should be stored in a vacuum to prevent long-term exposure to air, which can cause moisture absorption and pad oxidation. 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
		Other:	
Inner carton(*5) 355*345*65mm, ±5mm	Outer carton 370*358*350mm, ±10mm	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
MS21SF1	850PCS	935g	1475g	W=44mm, T=0.35mm

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



This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) This device may not cause harmful interference
- (2) This device must accept any interference received, including interference that may cause undesired operation.

11 FCC WARNING

Any Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the device.

Note: This device has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This device generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this device does cause harmful interference to radio or television reception, which can be determined by turning the device off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the device and receiver.
- Connect the device into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

The device has been evaluated to meet general RF exposure requirement. It can be used in portable exposure condition without restriction.

Requirement per KDB996369 D03

2.2 List of applicable FCC rules

List the FCC rules that are applicable to the modular transmitter. These are the rules that specifically establish the bands of operation, the power, spurious emissions, and operating fundamental frequencies. DO NOT list compliance to unintentional-radiator rules (Part 15 Subpart B) since that is not a condition of a module grant that is extended to a host manufacturer. See also Section 2.10 below concerning the need to notify host manufacturers that further testing is required.³Explanation: This module meets the requirements of FCC part 15C(15.247).

2.3 Summarize the specific operational use conditions

Describe use conditions that are applicable to the modular transmitter, including for example any limits on antennas, etc. For example, if point-to-point antennas are used that require reduction in power or compensation for cable loss, then this information must be in the instructions. If the use condition limitations extend to professional users, then instructions must state that this information also extends to the host manufacturer's instruction manual. In addition, certain information may also be needed, such as peak gain per frequency band and minimum gain, specifically for master devices in 5 GHz DFS bands.

Explanation: The EUT has a PCB Antenna, , and the antenna use a permanently attached Antenna which is not replaceable.

2.4 Limited module procedures

If a modular transmitter is approved as a "limited module", then the module manufacturer is responsible for approving the host environment that the limited module is used with. The manufacturer of a limited module must describe, both in the filing and in the installation instructions, the alternative means that the limited module manufacturer uses to verify that the host meets the necessary requirements to satisfy the module limiting conditions.



A limited module manufacturer has the flexibility to define its alternative method to address the conditions that limit the initial approval, such as: shielding, minimum signaling amplitude, buffered modulation/data inputs, or power supply regulation. The alternative method could include that the limited module manufacturer reviews detailed test data or host designs prior to giving the host manufacturer approval.

This limited module procedure is also applicable for RF exposure evaluation when it is necessary to demonstrate compliance in a specific host. The module manufacturer must state how control of the product into which the modular transmitter will be installed will be maintained such that full compliance of the product is always ensured. For additional hosts other than the specific host originally granted with a limited module, a Class II permissive change is required on the module grant to register the additional host as a specific host also approved with the module.

Explanation: The module is not a limited module.

2.5 Trace antenna designs

For a modular transmitter with trace antenna designs, see the guidance in Question 11 of KDB Publication 996369 D02 FAQ – Modules for Micro-Strip Antennas and traces. The integration information shall include for the TCB review the integration instructions for the following aspects: layout of trace design, parts list (BOM), antenna, connectors, and isolation requirements.

- a) Information that includes permitted variances (e.g., trace boundary limits, thickness, length, width, shape(s), dielectric constant, and impedance as applicable for each type of antenna);
- b) Each design shall be considered a different type (e.g., antenna length in multiple(s) of frequency, the wavelength, and antenna shape (traces in phase) can affect antenna gain and must be considered);
- c) The parameters shall be provided in a manner permitting host manufacturers to design the printed circuit (PC) board layout;
- d) Appropriate parts by manufacturer and specifications;
- e) Test procedures for design verification;
- f) Production test procedures for ensuring compliance.

The module grantee shall provide a notice that any deviation(s) from the defined parameters of the antenna trace, as described by the instructions, require that the host product manufacturer must notify the module grantee that they wish to change the antenna trace design. In this case, a Class II permissive change application is required to be filed by the grantee, or the host manufacturer can take responsibility through the change in FCC ID (new application) procedure followed by a Class II permissive change application.

Explanation: Yes, The module with trace antenna designs, and This manual has been shown the layout of trace design,, antenna, connectors, and isolation requirements.

2.6 RF exposure considerations

It is essential for module grantees to clearly and explicitly state the RF exposure conditions that permit a host product manufacturer to use the module. Two types of instructions are required for RF exposure information:

- (1) to the host product manufacturer, to define the application conditions (mobile, portable – xx cm from a person's body); and
- (2) additional text needed for the host product manufacturer to provide to end users in their end-product manuals. If RF exposure statements and use conditions are not provided, then the host product manufacturer is required to take responsibility for the module through a change in FCC ID (new application).

Explanation: This module complies with FCC RF radiation exposure limits set forth for an uncontrolled environment. This device should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body." This module is designed to comply with the FCC statement, FCC ID is: 2BDJ6-MS21SF1



2.7 Antennas

A list of antennas included in the application for certification must be provided in the instructions.

For modular transmitters approved as limited modules, all applicable professional installer instructions must be included as part of the information to the host product manufacturer. The antenna list shall also identify the antenna types (monopole, PIFA, dipole, etc. (note that, for example, an “omnidirectional antenna” is not considered to be a specific “antenna type”).

For situations where the host product manufacturer is responsible for an external connector, for example, with an RF pin and antenna trace design, the integration instructions shall inform the installer that a unique antenna connector must be used on the Part 15 authorized transmitters used in the host product. The module manufacturers shall provide a list of acceptable unique connectors.

Explanation: The EUT has a PCB Antenna, and the antenna uses a permanently attached antenna, which is unique.

2.8 Label and compliance information

Grantees are responsible for the continued compliance of their modules to the FCC rules. This includes advising host product manufacturers that they need to provide a physical or e-label stating “Contains FCC ID” with their finished product. See Guidelines for Labeling and User Information for RF Devices – KDB Publication 784748.

Explanation: The host system using this module, should have label in a visible area indicated the following texts:
"Contains FCC ID: 2BDJ6-MS21SF1

2.9 Information on test modes and additional testing requirements

Additional guidance for testing host products is given in KDB Publication 996369 D04 Module Integration Guide. Test modes should take into consideration different operational conditions for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

The grantee should provide information on how to configure test modes for host product evaluation for different operational conditions for a stand-alone modular transmitter in a host, versus with multiple, simultaneously transmitting modules or other transmitters in a host.

Grantees can increase the utility of their modular transmitters by providing special means, modes, or instructions that simulates or characterizes a connection by enabling a transmitter. This can greatly simplify a host manufacturer's determination that a module as installed in a host complies with FCC requirements.

Explanation: Topband can increase the utility of our modular transmitters by providing instructions that simulates or characterizes a connection by enabling a transmitter.

12 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.

13 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.

14 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, OHSAS18001, 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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16 RELATED DOCUMENTS

- LLCC68_Chip_Datasheet
https://en.minewsemi.com/file/LLCC68_Chip_Datasheet_EN.pdf
- SX1261-2_Chip_Datasheet
https://en.minewsemi.com/file/SX1261-2_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
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