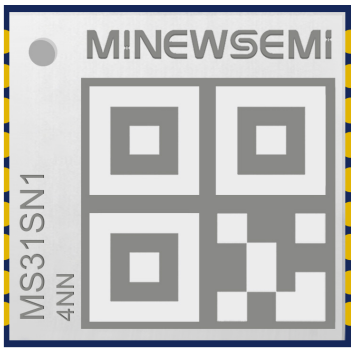
MINEWSEMI

GNSS Module
MS31SN1



Datasheet

V 1.0.0

Version Note

Version	Details	Contributor(s)	Date	Notes
1.0.0	First edit	Michelle, Leo	2024.06.07	

Part Number

Model	Hardware Code
MS31SN1	4NN

Click the icon to view and download the latest product documents electronically.
https://en.minewsemi.com/file/MS31SN1_Datasheet_EN.pdf

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1 PRODUCT INTRODUCTION

1.1 General Description

MS31SN1 series is a GNSS multi-mode, low-power navigation and positioning module. MS31SN1 has a built-in high-sensitivity, low-power GNSS chip and RF devices, which supports a variety of satellite navigation systems, including China's BeiDou satellite navigation system BDS, the United States of America's GPS, Russia's GLONASS, and Japan's QZSS, etc., and realizes the joint positioning of multi-systems.

MS31SN1 adopts standard SMD industrial grade design and ROHS process, featuring high sensitivity, anti-interference, high performance and low power consumption. The product is suitable for vehicle navigation and positioning, locator, tachograph, car recorder, OBD, wearable devices and other scenarios.

1.2 Key Parameters

MS31SN1 Parameters	
Satellite Systems	GPS，BDS，GLONASS，SBAS，QZSS
Sensitivity	Tracking: -162dBm Reacquisition: -160dBm Cold Start: -148dBm
Cold Start1	≤32seconds
Hot Start	Average 1 second
AGPS Assist	Average 10 seconds
Accurate2	Autonomy level：≤2.5m （1σ） Velocimetry accuracy：≤0.1m/s（1σ）
Baud	9600bps (factory default)
Update Frequency	1-5 Hz (software adjustable)
Operating temperature	-40℃ ~ +85℃
Protocols	NMEA0183 version 4.1 is supported by default.
Characterization	Support GPS, BDS, GLONASS, QZSS parallel reception and joint positioning Support BeiDou 3 satellite

Notice：1. 1 CN0 ≥ 40dB, SV ≥ 6 satellites 224 hours, OPEN SKY environment, CN0 is excellent
2.*GLONASS satellites need to be opened through the software configuration, support GPS + BDS + GLONASS + QZSS + SBAS concurrently.

2 TECHNICAL INFORMATION

2.1 Supporting Constellations

MS31SN1 supports multiple satellite constellations due to its multi-constellation RF front-end architecture. It can simultaneously receive signals from GPS, BDS, GLONASS, GALILEO, QZSS, and Satellite-Based Augmentation Systems (SBAS) such as WAAS, EGNOS, GAGAN, and MSAS. The receiving frequencies are: 1575.42 MHz (GPS, GALILEO, QZSS), 1561.098±2.046 MHz (BDS), and 1602.5625 MHz±4 MHz (GLONASS).

2.2 AGPS

The MS31SN1 supports support for the AGPS TCP accelerated positioning scheme. Please refer to "AGPS Integration Guide.pdf" for specific usage methods.

2.3 Satellite-based augmentation system（SBAS）

The MS31SN1 supports the reception of SBAS broadcast signals. These systems supplement GNSS data with other regional or wide-area GPS augmentation data. The system broadcasts distance correction and integrity information via satellite, which can be used by GNSS receivers to improve the accuracy of results. SBAS satellites can be used as additional satellites for ranging (navigation) to further improve availability. The following SBAS types are supported: GAGAN, WAAS, EGNOS and MSAS.

2.4 Quasi-Zenith Satellite（QZSS）

The Quasi-Zenith Satellite System (QZSS) is a navigation satellite overlay system for the Pacific Ocean covering Japan and Australia that transmits other GPS L1C/A signals. The module is capable of receiving and tracking these signals simultaneously with GPS, which improves availability and maintains positioning especially in poor signal conditions such as urban canyons.

2.5 Crystal Oscillator

The MS31SN1 uses TCXO to allow weak signal acquisition, resulting in faster start-up and re-acquisition times.TCXO allows the product to ensure that it is stable and immune to frequency interference over its entire operating range (-40° to + 85°C), making it a reliable positioning module for positioning.

2.6 Real Time Clock（RTC）

The RTC is driven by a 32 kHz oscillator using an RTC crystal. If the mains voltage fails, some parts of the receiver will shut down, but the RTC will still operate to provide a timing reference for the receiver. This mode of operation is called "hardware backup mode" and allows all relevant data to be saved in backup RAM for later hot-booting.

2.7 Power systems

The MS31SN1 module has full working mode and battery backup mode.
Full operation mode: All power supplies are normally supplied and the module is in full operation mode for normal signal reception and interpretation.
Battery Backup Mode: The module only needs a very small current (about 8uA) to maintain the RTC clock and backup RAM, and the Farad capacitor mounted on the module is used for a certain period of time.

3 ELECTRICAL SPECIFICATION

3.1 Absolute Maximum Rating

Notation	Parameters	Minimum Value	Maximum Value	Unit
VCC	Mains voltage	-0.5	3.63	V
VBAT	Backup power supply voltage	-0.5	3.63	V
VI-max	I/O Pin Input Voltage	-0.5	3.63	V
Vhbm	ESD Contact	-	2000	V
T-storage	Storage temperature	-40	+85	℃
T-solder	Reflow temperature	--	250	℃

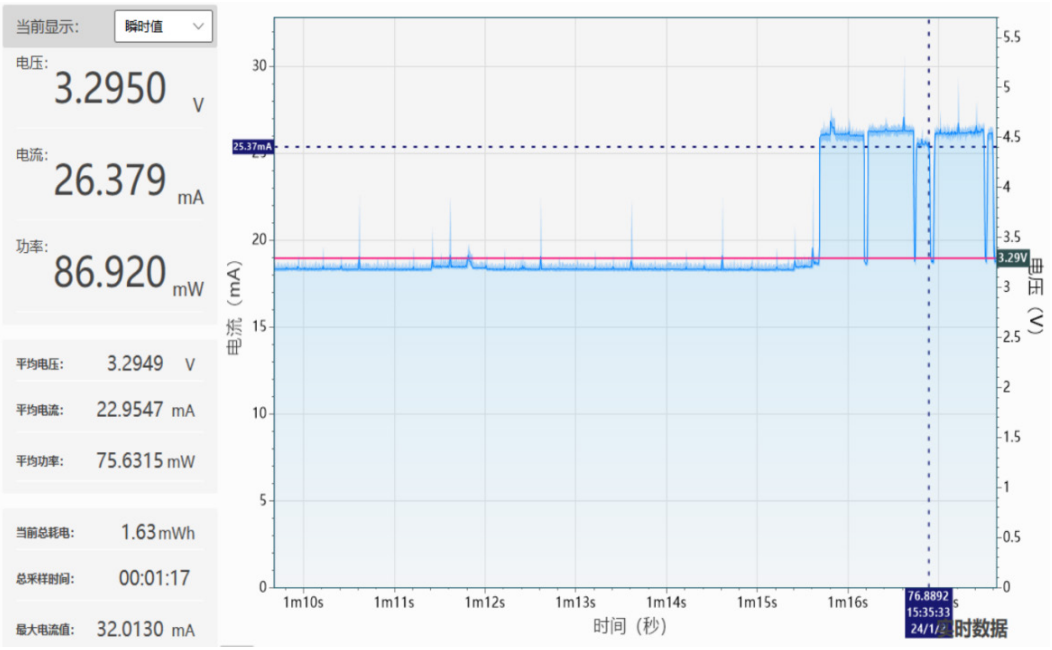
Pressurizing the equipment beyond the "Absolute Maximum Rating" may cause permanent damage.

The above figures are pressure ratings only. Products are not overvoltage or reverse voltage protected. If necessary, voltage spikes exceeding the supply voltage specifications listed in the table above must be limited to the specified range using an appropriate protection diode.

3.2 Electrical Parameters

Parameters	Min	Average	Max	Unit
Power Supply Voltage	2.8	3.3	3.6	V
Supply Current (Acquisition)	-	36	-	mA
Supply Current (Tracking)	-	32	-	mA
Operation Temperature	-40	+25	+85	°C

All specifications are made at an ambient temperature of 25°C. Extreme operating temperatures can seriously affect specification values. Applications operating near temperature limits. The values in the table are for customer reference only and are intended as examples of typical power requirements only. Values are characterized as samples and actual power requirements will vary depending on the firmware version used, external circuitry, number of satellites tracked, signal strength, type of activation as well as time, duration, and test conditions.
The measured values of the capture phase current are as follows:
The measured values of the capture phase current are as follows:



3.3 Antenna Gain Requirements

MS31SN1 has built-in LNA to support passive GNSS antenna, external active antenna gain note control.

Notation	Parameters	Min	Max	Unit
RFgain	Input Gain	0	30	dB

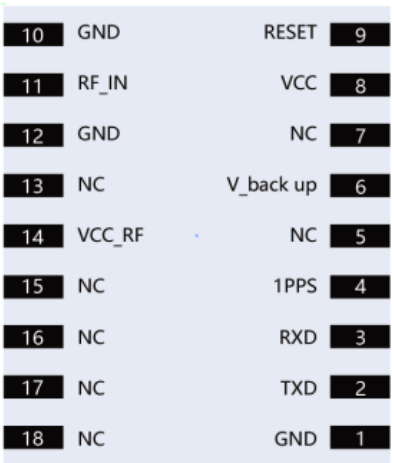
3.4 Antenna Detection

The MS31SN1 supports active antenna detection.

4 PACKAGE DEFINITION

4.1 Module Pin Definitions

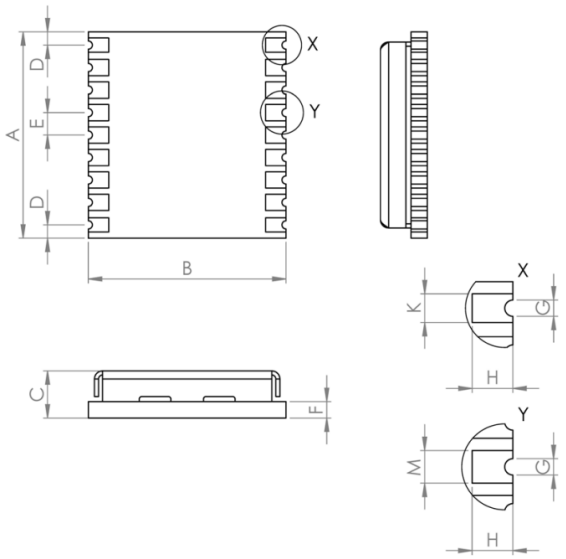
The MS31SN1 is available in a 10.1*9.7mm, LGA-18pin package and is defined as follows:



Functionality	Pin Name	Pin Number	Signal Type	Description
Power supply	VCC	8	Power	Mains Power-Input. Ensure that the power input is clean and stable.
	V_backup	6	Power	Backup power input. It is recommended to connect the backup supply voltage to this pin in order to position the module for hot start and warm start functions. If no backup power supply is available, connect V_backup to the main power supply or suspend the
	GND	1,10,12	GND	Ensure that all GND pins on the module are well grounded.
connection with high-ranking officials	RF_IN	11	I	Antenna input, impedance 50Ω
	VCC_RF	14	O	Antenna bias voltage output for external active antennas.
serial port (computing) /IO	TXD	2	O	UART output, GPS_TX
	RXD	3	I	UART input, GPS_RX
	PPS	4	O	Second pulse signal. Suspend if not used.
	RESET	9	I	Reset signal. Not enabled, please hover.
(sth. or sb) else	NC	5,7,13~18	-	NC, no definition, please hover

5 PACKAGE SPECIFICATION

5.1 sizes



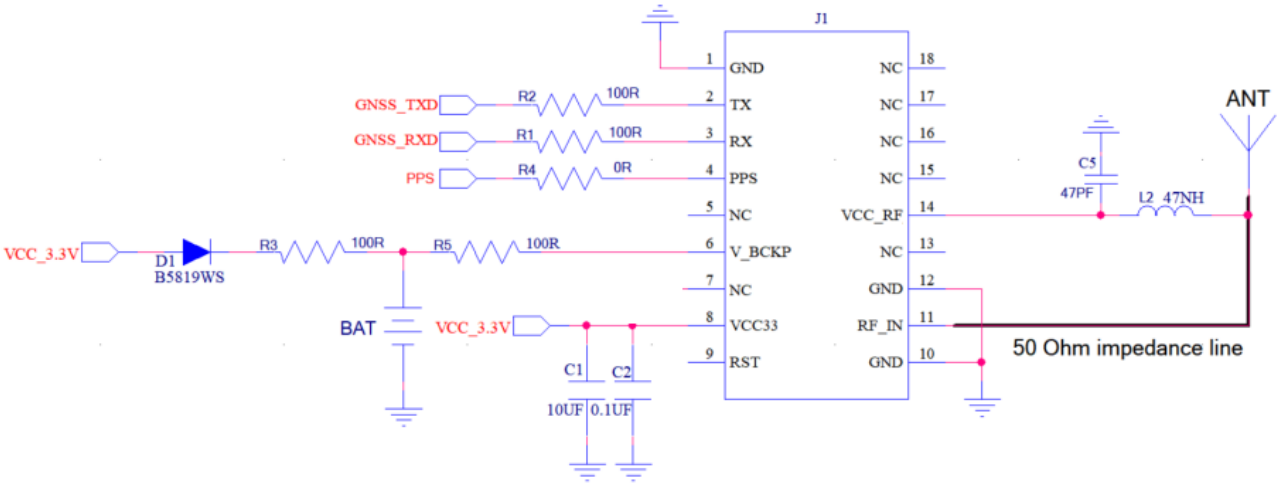
5.2 Mechanical dimensions

Serial Number	Minimum (mm)	Typical Values (mm)	Maximum Value (mm)
A	10.4	10.6	10.8
B	9.5	9.7	9.9
C	1.9	2.0	2.2
D	0.55	0.8	0.95
E	1.0	1.1	1.2
F	0.5	0.6	0.7
G	0.4	0.5	0.6
H	0.7	0.8	0.9
K	0.7	0.8	0.9
M	0.8	0.9	1.0

6 REFERENCE DESIGN

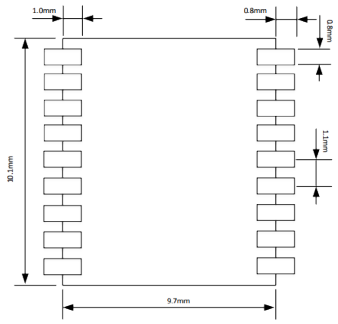
6.1 Schematic design

The reference design of the MS31SN1 is shown below. When connecting an active antenna, please make sure the 47nH inductor is in the SMD state for powering the active antenna; when connecting a passive antenna, the 47nH inductor is not required. The characteristic impedance from the RF_IN pin to the antenna connector is 50 Ω. RESET can be left dangling due to the MS31SN1 power-on self-reset.



6.2 PCB Package Reference

The package reference recommendations for the MS31SN1 are as follows:



6.3 LAYOUT Notes

(1) Decoupling capacitors are placed close to the module power supply pins, and ensure that the power supply alignment width is more than 0.5mm;
(2) No wires are allowed to be routed at the bottom of the module patch;
(3) The RF alignment between the RF port of the module and the antenna interface should be at least 0.2mm~0.3mm, and the coplanar waveguide impedance model should be adopted, and the spacing between the alignment and the ground copper skin should be controlled to be about 1 times of the spacing, and the impedance should be guaranteed to be 50Ω;
(4) The alignment from the module RF port to the antenna connector references Layer 2 ground and ensures that the Layer 2 ground plane is relatively complete;
(5) Modules should not be placed near sources of interference, such as communication module antennas, RF alignments, crystal oscillators, large inductors, and high-frequency digital signal lines.

6.4 Power Supply

The MS31SN1 Positioning Module is equipped with two power supply pins: VCC and V_BACKUP. the main power supply is fed to the module via the VCC pin, and the backup power supply is fed to the module via the V_BACKUP pin. To ensure the positioning performance of the module, the ripple of the module power supply should be controlled as much as possible. It is recommended to use an LDO supply with a maximum output current greater than 100mA. If the module's main power supply is disconnected, the system will provide power to the RTC and the Battery Backup RAM (BBR) through V_BACKUP.
Therefore, even if the main power supply is disconnected, the ephemeris data can still be retained with the backup power supply and can be used for a hot or warm start when the system is powered up again. If no backup power supply is connected and no data is received by the module, then the system will perform a cold start when it is powered up again. Note: If there is no backup power available, connect the V_BACKUP pin to the VCC mains or leave it idle.

6.5 Antenna

The MS31SN1 has a built-in low noise figure LNA and SAW. it is recommended to use an active antenna with a gain of less than 36dB and a noise figure of less than 1.5dB. The module supplies power to the external active antenna via RF_IN. If the active antenna cable is long, an active antenna with at least 15dB of gain is required to compensate for line losses. To maintain ground integrity, it is recommended that no or as few wires as possible be routed under the module.

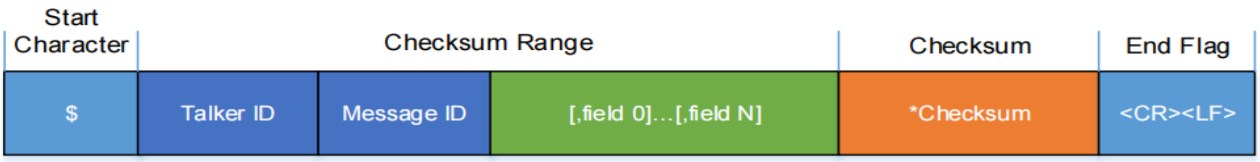
6.6 Serial Port Communication

Provide one way TTL level universal asynchronous transceiver (UART), the data format is: 1 bit start bit, 8 bit data bit, 1 bit stop bit, no parity bit, the default baud rate is 115200bps. after the module is normally powered on, the serial port will automatically send NMEA data. The host computer can set the module working mode and baud rate through the serial port. When this module is used in some specific application scenarios, the main power of the module may be turned off due to the power saving strategy, so as to further reduce the power consumption.
In this case, in order to avoid the high level of the serial port affecting the normal operation of the module, it is strongly recommended to disconnect the serial port connection at the same time when disconnecting the main power supply, or set the serial port to the state of input state + pull-down resistor or high resistance state + pull-down resistor.

7 SOFTWARE PROTOCOL

7.1 NEMA0183 Protocols

The NMEA protocol is an ASCII based protocol where the record starts with a $ and ends with a carriage return/line feed character, and the checksum of the NMEA message, which can be used to detect corrupted data transmission. The frame structure is as follows:



The NEMA message output for the MS31SN1 is shown in the following table:

NMEA Record	Description	Default
GPGGA	Global positioning system fixed data	Y
GNGLL	Geographic position—latitude/longitude	Y
GNGSA	GNSS DOP and active satellites	Y
GPGSV	GNSS satellites in view for GPS	Y
GLGSV	GNSS satellites in view for GLONASS	N
BDGSV	GNSS satellites in view for BD	Y
GNRMC	Recommended minimum specific GNSS data	Y
GNVTG	Course over ground and ground speed	Y
GNZDA	Date and Time	N

7.2 Example Data

Serial port data within 1 second of the example after positioning:

$GNGGA,084921.000,2242.29268,N,11401.68713,E,1,11,0.9,125.0,M,-3.4,M,,*5E
$GNGLL,2242.29268,N,11401.68713,E,084921.000,A,A*4E
$GNGSA,A,3,,,,,,,,,,,,,1.5,0.9,1.1,1*3C
$GNGSA,A,3,07,08,10,19,20,22,24,26,38,40,45,,1.5,0.9,1.1,4*31
$GPGSV,4,1,14,01,,,37,03,,,32,04,,,34,06,,,44,0*67
$GPGSV,4,2,14,09,,,39,11,,,40,14,,,41,17,,,45,0*66
$GPGSV,4,3,14,19,,,44,20,,,39,22,,,44,194,,,43,0*5C
$GPGSV,4,4,14,195,,,44,199,,,37,0*68
$BDGSV,5,1,18,01,,,41,02,,,38,03,,,43,04,,,38,0*7F
$BDGSV,5,2,18,07,79,030,42,08,71,226,40,10,70,339,41,19,49,111,45,0*75
$BDGSV,5,3,18,20,24,055,40,22,27,177,41,24,09,311,34,26,34,266,41,0*75
$BDGSV,5,4,18,35,,,43,38,84,254,44,39,,,34,40,67,061,43,0*71
$BDGSV,5,5,18,45,29,201,40,59,,,44,0*4C
$GNRMC,084921.000,A,2242.29268,N,11401.68713,E,0.01,0.00,210324,,,A,V*04
$GNVTG,0.00,T,,M,0.01,N,0.02,K,A*20
$GNZDA,084921.000,21,03,2024,00,00*4A
$GPTXT,01,01,01,ANTENNA OPEN*25

7.3 Example of an actual star search

7.4 Common Commands

CMD TYPE	CMD Example:
Change Baud-rate to 9600	$PCAS01,1*1D<CR><LF>
Change Baud-rate to 115200	$PCAS01,5*19<CR><LF>
Hot Restart	$PCAS10,0*1C<CR><LF>
Warm Restart	$PCAS10,1*1D<CR><LF>
Cold Restart	$PCAS10,2*1E<CR><LF>
Search GPS satellites only	$PCAS04,1*18<CR><LF>
Search GPS and BDS satellites	$PCAS04,3*1A<CR><LF>

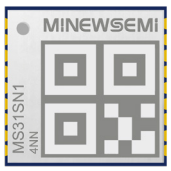
Search GPS and GLONASS satellites	$PCAS04,5*1C<CR><LF>
Search GPS,BDS and GLONASS satellites	$PCAS04,7*1E<CR><LF>
Set Update rate to 1Hz	$PCAS02,1000*2E<CR><LF>
Set Update rate to 2Hz	$PCAS02,500*1A<CR><LF>
Set Update rate to 5Hz	$PCAS02,200*1D<CR><LF>

Remarks:
All software configurations expire after charging and powering up the module's main power supply VCC, and need to be initialized again after powering up the module if required.

8 PACKAGING AND PROTECTION

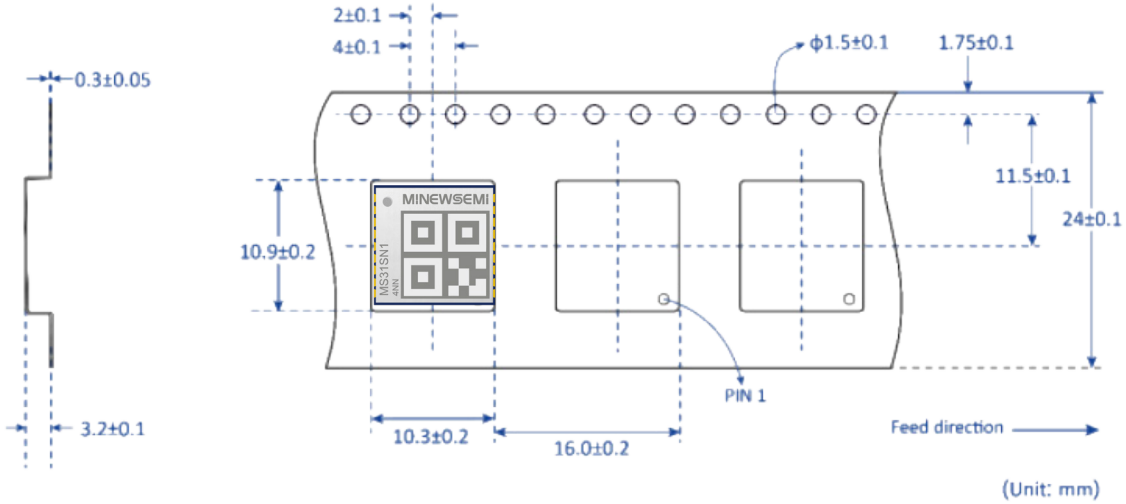
8.1 Wrap

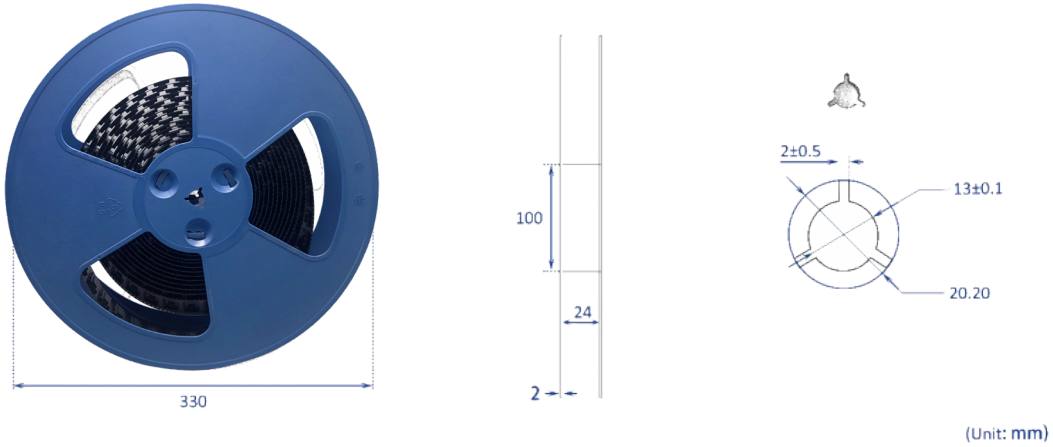
The MS31SN1 is humidity and static sensitive. It is important that you follow the handling requirements and take appropriate precautions to minimize product damage during packaging and shipping of the product. The following table shows the standard packaging structure for product transportation.

Offerings	Reels	Sealed Bags	Shipping Cartons
			
MS31SN1	1000pcs/roll	1 roll/bag	1 bag/box, 3 boxes/ctn

8.2 Tape and Reel

MS31SN1 adopts the method of reel (consisting of tape and reel), and is packed in sealed bag with anti-static effect to meet the needs of customers for efficient production, batch installation and disassembly. The picture below shows the size details of the tape.





8.3 Stockpile

In order to prevent the product from moisture and electrostatic discharge, the sealed bag of the product is equipped with desiccant and humidity indicator card, which allows the user to know the humidity condition of the environment in which the product is located. The product has a moisture sensitivity rating of MSL3.

8.4 ESD Protection

The GNSS positioning module contains highly sensitive electronics and is an electrostatic sensitive device (ESD). Please note the following precautions, as failure to follow these precautions may result in serious damage to the module!

Ground yourself before patching the antenna. Do not touch any charged capacitors and other devices (e.g., antenna patch ~10 pF; coaxial cable ~50 -80 pF/m; soldering iron) when bringing out the RF pin;

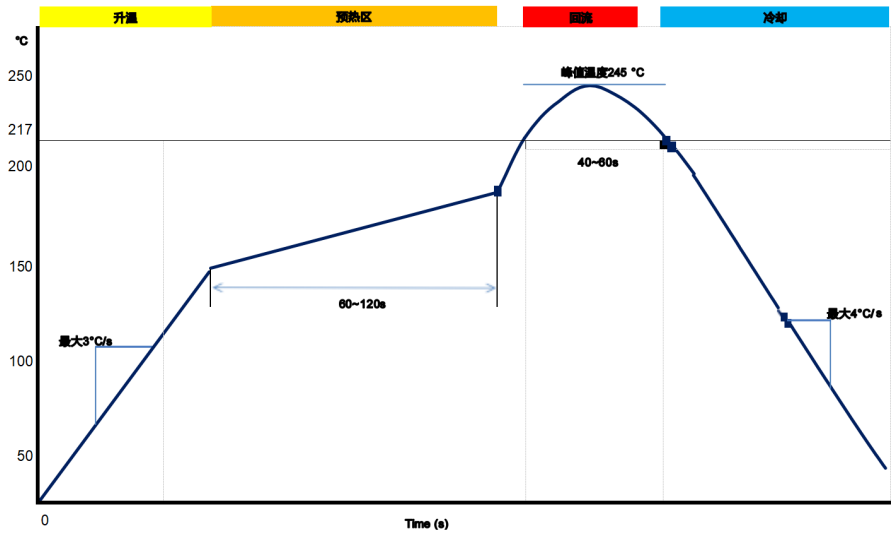
To prevent electrostatic discharge, do not expose the antenna area; if exposed by design, take appropriate ESD precautions and do not touch any exposed antenna area;

Be sure to use an ESD safe soldering iron when s oldering RF connectors and antenna patches.

Add ESD diode to RF input to prevent ESD; add ESD diode to UART interface.

8.5 Production Requirements

The recommended welding temperature profile is shown below:



In order to prevent the module from falling off during soldering, please do not design the module to be soldered on the back of the board, and it is better not to go through two soldering cycles.
The setting of soldering temperature depends on many factors in the product factory, such as the nature of the motherboard, paste type, paste thickness, etc. Please also refer to the relevant IPC standards and paste specifications.
Due to the relatively low temperature of leaded soldering, please prioritize other components on the board if using this soldering method. The openings of the stencil should meet the customer's own product design requirements and inspection specifications, and the thickness of the stencil is recommended to be 0.15mm.

9 ORDERING INFORMATION

9.1 Order Part Number

Ordering Model	Pseudolaric acid	Default Baud Rate	Default Refresh Rate	Default Satellite Reception Frequency	Note
MS31SN1	GNSS Module	9600	1Hz	GPS/BDS/QZSS/SBAS	10.1*9.7mm, LGA18

10 STORAGE CONDITIONS

- **Please use this product within 6 months after signing up for it.**
  - 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 will be stored for more than 6 months after receipt. They must be confirmed before use.
  - Products must be stored in non-corrosive gases (Cl2, NH3, SO2, NOx, etc.).
  - To avoid damage to the packaging materials, no excessive mechanical impact shall be applied, including but not limited to sharp objects adhering to the packaging materials and products falling.

- **This product is suitable for MSL3 (based on JEDEC standard J-STD-020).**
  - After opening the package, the product must be stored under conditions of ≤30°C/<60%RH. It is recommended to use it within 168 hours after opening the package.
  - When the color of the indicator in the package changes, the product should be baked before welding.

- **When exposed to (≥168h@30℃/60%RH) conditions, the recommended baking conditions:**
  1. 120 +5/-5℃, 8 hours, 1 time
  Products must be baked individually on heat-resistant trays because the materials (base tape, roll tape and cover tape) are not heat-resistant and the packaging materials may deform when the temperature is 120°C;
  2. 90℃ +8/-0℃, 24 hours, once
  The base tape can be baked together with the product at this temperature, Please pay attention to even heating.

11 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.

12 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.

13 COPYRIGHT STATEMENT

14 RELATED DOCUMENTS

- MinewSemi_Product_Naming_Reference_Manual_V1.0
  https://en.minewsemi.com/file/MinewSemi_Product_Naming_Reference_Manual_EN.pdf
- MinewSemi_Connectivity_Module_Catalogue_V2.0
  https://en.minewsemi.com/file/MinewSemi_Connectivity_Module_Catalogue_EN.pdf

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