NRM7292B User Manual

Ultra-low power & Long-range Wi-Fi Module

Ver 1
Dec 20, 2021

SRF Co.,Ltd

Notice

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The information in this document has been carefully checked and is believed to be entirely accurate at the release time.
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But, SRF assumes no responsibility, however, for possible errors or missing, or for any result from the use of the information contained documents.
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1 Overview

IEEE 802.11ah is a new Wi-Fi standard operating in the Sub 1GHz license-exempt band, offering longer range and lower power connectivity necessary for internet of things (IoT) applications. NRM7292B contains external RF front end module (FEM) which can increase transmission power up to 23 dBm. On-board serial flash can be used for OTA software development and with internal 32KB cache memory, it can support execution in place (XIP) feature.

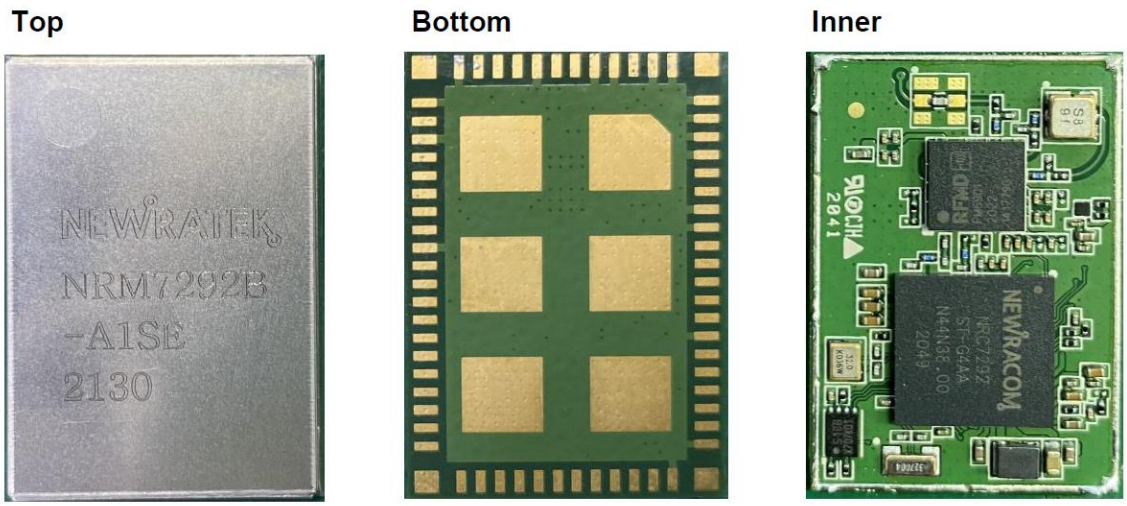


Figure 1.1 NRM7292B pictures

1.1 Applications

Low to high data rate of NRM7292B can be applied in various IoT applications like:

- Wearable
- Home automation
- Healthcare
- Industrial automation
- Safety and security
- Smart grid
- Multimedia streaming

1.2 NRM7292B module features

The main features of NRM7292B are represented as follows:

- Standard
  - IEEE Std 802.11ah™-2016 compliant
  - 1/2/4 MHz channel bandwidth support
  - WPA2 PSK support
  - 150 Kbps ~ 15 Mbps data rate
  - AP and STA role support

- Radio frequency
  - -109 dBm minimum receive sensitivity
  - +23 dBm transmit power
  - 902~928 MHz frequency band
    (By replacing RF SAW filter, other frequency band can be supported within 750~950 MHz)

- CPU
  - ARM Cortex-M3 for application
  - ARM Cortex-M0 for IEEE 802.11ah WLAN
  - Clock frequencies for both processor (32/48 MHz)

- Host interface
  - UART and SPI support for host interface

- Peripherals
  - GPIO, ADC, PWM and timers
  - I2C, SPI and UART

2 Pin Description

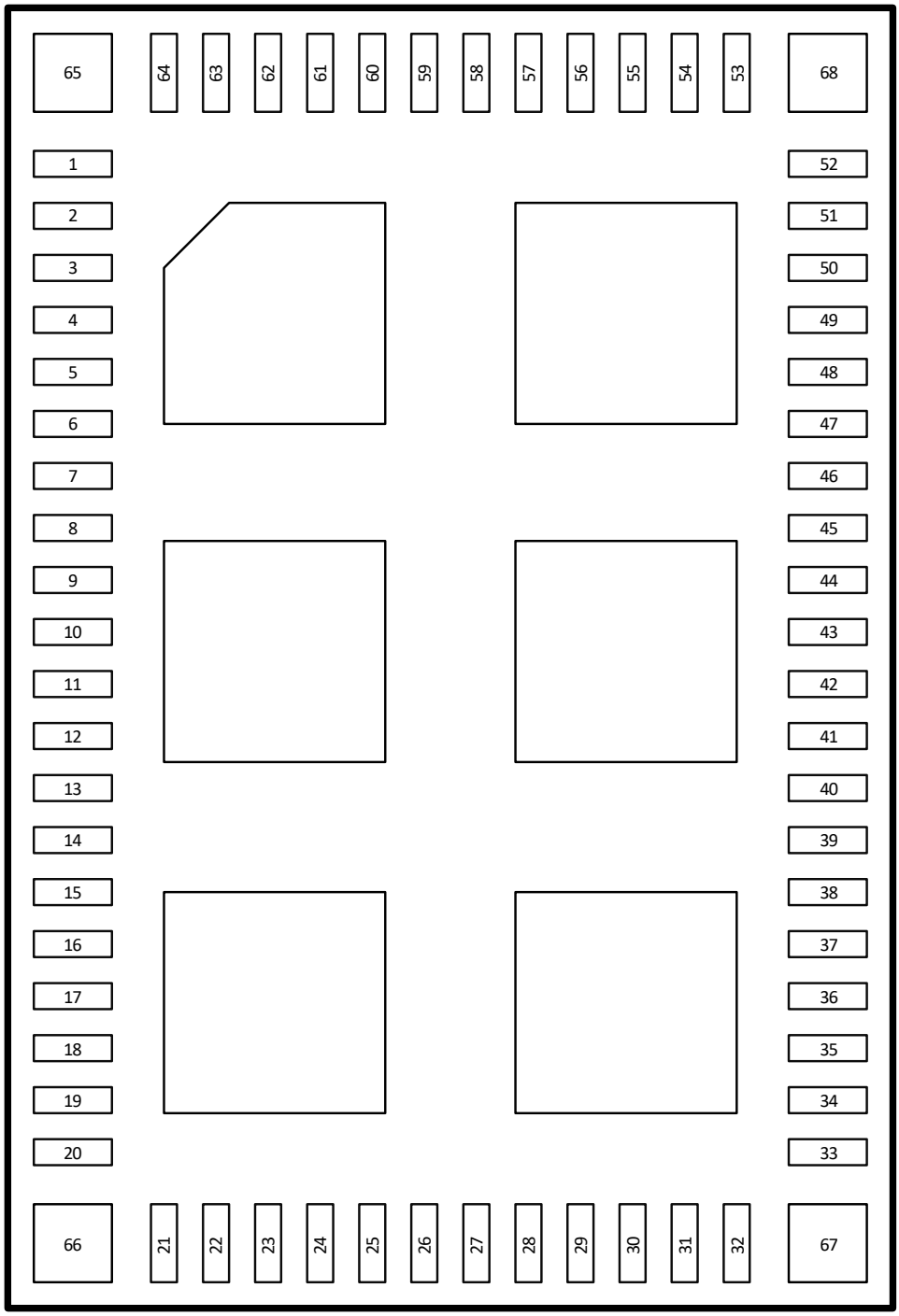


Figure 3.1 NRM7292B module pinout (top view)

Table 3.1 NRM7292B signal description

Pad No	Name	Direction	Volt	Description
1	GROUND	GND		
2	GROUND	GND		
3	GROUND	GND		
4	GROUND	GND		
5	VDD_FEM	P		Front End Module power input
6	VBAT	P		NRC7292 power input
7	GROUND	GND		
8	GROUND	GND		
9	MODE_00	I		SW Define (When ROM BOOT) 11: Internal SRAM BOOT
10	MODE_01	I		
11	MODE_02	I		0: ROM BOOT 1: XIP BOOT
12	MODE_03	I		0: Cortex-M0 Master 1: Cortex-M3 Master
13	MODE_04	I		0: Two CPU 1: One CPU
14	GROUND	GND		
15	HSPI_nCS	I		Host SPI – Chip Select (active low)
16	HSPI_CLK	I		Host SPI – Clock
17	HSPI_MISO	O		Host SPI – Master in Slave out
18	HSPI_MOSI	I		Host SPI – Master out Slave in
19	HSPI_EIRQ	O		Host SPI – Interrupt
20	GROUND	GND		
21	GROUND	GND		
22	NC	-		
23	NC	-		
24	NC	-		
25	GP_00_UART2_TX	I/O		UART Channel2 Tx
26	GP_01_UART2_RX	I/O		UART Channel2 Rx
27	GP_02_UART2_RTS	I/O		UART Channel2 RTS
28	GP_03_UART2_CTS	I/O		UART Channel2 CTS
29	GP_04_UART0_TX	I/O		UART Channel0 Tx
30	GP_05_UART0_RX	I/O		UART Channel0 Rx
31	GP_06_UART3_TX	I/O		UART Channel3 Tx
32	GP_07_UART3_RX	I/O		UART Channel3 Rx
33	GP_08_UART1_RX	I/O		UART Channel1 Rx

34	GP_11_UART1_TX	I/O		UART Channel1 Tx
35	GP_10_GPIO	I/O		Multiple purpose (GPIO,I2C,PWM,SPI, Ext-INT)
36	GP_09_GPIO	I/O		
37	GP_17_I2C_SDA	I/O		I2C_SDA
38	GP_16_I2C_SCL	I/O		I2C_SCL
39	GP_15_SSP0_CLK	O		SPI0_Clock
40	PD_14_SSP0_CS	O		SPI0_Chip Enable(active low)
41	PD_13_SSP0_MOSI	O		SPI0_Master out slave in
42	PD_12_SSP0_MISO	I		SPI0_Master in Slave out
43	RESET	I		Reset (active high)
44	GROUND	GND		
45	JTAG_TRSTN	I		JTAG reset
46	JTAG_TMS	I		JTAG mode selection
47	JTAG_TCK	I		JTAG clock
48	JTAG_TDI	I		JTAG data input
49	JTAG_TDO	O		JTAG data output
50	GROUND	GND		
51	VDDIO	P		NRC7292 I/O supply Input
52	GROUND	GND		
53	GROUND	GND		
54	AUXADCIN3	I		AUXADC input 3
55	AUXADCIN2	I		AUXADC input 2
56	AUXADCIN1	I		AUXADC input 1
57	GROUND	GND		
58	NC	-		
59	NC	-		
60	GROUND	GND		
61	GROUND	GND		
62	RF_ANT	I/O		RF IN/OUT
63	GROUND	GND		
64	GROUND	GND		
65	GROUND	GND		
66	GROUND	GND		
67	GROUND	GND		
68	GROUND	GND		

3 Antenna Connection

3.1 Antenna Connection

An external Antenna is connected through the SMA type connector. It's connected to Pad # 62 (RF_ANT) of NRM7292B through the PCB trace of 50ohm impedance.

- Antenna Requirements
  - Connection Type: External Antenna (SMA female connector)
  - Frequency Range : 902~928MHz
  - Input Impedance: 50ohm
  - Gain: Avg 0dBi (Max ≤1.68dBi)

Please refer to NRM7292 EVK which use 900MHz Dipole Antenna as bellow.

Figure 4.1 Antenna Connection on EVK

4 Operating Condition

4.1 Absolute Maximum Rating

Table 5.1 NRM7292B absolute maximum rating

Symbol		Min	Max	Unit
Storage Temperature		-40	+125	℃
Supply Voltage	VDD_FEM	-0.5	5.25	V
	VBAT	-0.5	3.8	V
	VDDIO	-0.5	3.8	V

✓ NOTE : Stresses above those listed in Absolute Maximum Rating may cause permanent device failure. Functionality at or above these limits is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

4.2 Operating condition

Table 5.2 NRM7292B operating condition

Symbol		Min	Typ	Max	unit
Operating Temperature Range		-40	-	+85	℃
Operating Voltage	VDD_FEM	2.8	4.0	4.2	V
	VBAT	2.8	3.3	3.6	V
	VDDIO	1.8	3.3	VBAT	V

✓ NOTE : To ensure WLAN performance, ripple on the 2.1- to 3.3-V supply must be less than ±300 mV and ripple on the 1.8-V supply must be less than 2% (±40 mV).

4.3 Current consumption

Table 5.3 NRM7292B current consumption

MODE	DUT Status	Band (MHz)	VDDIO (mA)	VBAT (mA)	VDD_FEM (mA)
802.11ah (1/2/4Mhz BW)	Tx @ 17 dBm (VDD_FEM = 3.3V)	915	0.5	33	148
	Tx @ 17 dBm (VDD_FEM = 4.0V)		0.5	33	153
	Tx @ 20 dBm (VDD_FEM = 3.3V)		0.5	33	177
	Tx @ 20 dBm (VDD_FEM = 4.0V)		0.5	33	184
	Continuous Rx @ -80 dBm (VDD_FEM = 3.3V)		0.5	33	7
	Continuous Rx @ -80 dBm (VDD_FEM = 4.0V)		0.5	33	7
	Deep Sleep mode		0.6(uA)	27(uA)	0.4(uA)

- ✓ Note: Unless otherwise specified, TA.=27℃, VBAT= 3.3V, 99% tx burst time, using internal PMU.
- ✓ Power measurements are done at antenna port, which is directly connected to the device.
- ✓ HSPI pins to host are disconnected.

5 11ah WLAN RF Specifications and Performance

5.1 Transmitter Specifications

Table 6.1 Transmitter Spec/Feature (RF)

Parameter	Conditions	Min	Typ	Max	Unit
RF Output Frequency Range (1)		902		928	MHz
EVM Compliant Output Power	15 Mbps (MCS7, 4 MHz BW)		20		dBm
EVM at 0 dBm output power			-35		dB
Transmitter Spurious Signal Emissions	< 700 MHz		<-36		dBm/ MHz
	> 1 GHz		<-45		
RF Output Return Loss	Single ended output port		-10		dB
Output 1dB Gain Compression	0.4 MHz CW signal input		27		dBm
Gain Control Range		30			dB
Gain Control Step			1		dB
Unwanted Sideband	Over RF channel, RF frequency, and baseband frequency at 0 dBm output power		<-40		dBc

✓ Note: Unless otherwise specified, TA.=27℃, VBAT=2.6 to 3.6V, VDD_FEM=4.0V. RF input/outputs specifications are referenced to device pins and do not include 1dB loss from EV kit OCB and SMA connector.

(1) RF output frequency range depends on RF SAW filter on the module. The NRC7292 chipset by itself can support frequency range from 750 to 950 MHz.

5.2 Receiver Specifications

Table 6.2 Receiver Spec/Feature (RF)

Parameter	Conditions	Min	Typ	Max	Unit
RF Input Frequency Range (1)		902		928	MHz
RF Input Return Loss	For LNA high/mid/low gain modes	-10	-12	-15	dB
Total Voltage Gain Range	Analog + Digital Gain	-10		92	dB
RF Gain Step	From high gain mode to medium gain mode		6		dB
RX Gain Step	From RF to Analog		1		dB
DSB Noise Figure	LNA max gain mode		3.5		dB
IIP3	LNA with high gain mode		-17		dBm
	LNA with low gain mode		24		

Baseband Filters for Receiver (Analog + Digital Filter)					
Baseband -3dB Low-pass Corner Frequency (Controllable)	1 MHz channel		0.5		MHz
	2 MHz channel		1.0		MHz
	4 MHz channel		2.0		MHz

✓ Note: Unless otherwise specified, TA.=27℃, VBAT=2.6 to 3.6V, VDD_FEM=4.0V. RF input/outputs specifications are referenced to device pins and do not include 1dB loss from EV kit OCB and SMA connector.

(1) RF input frequency range depends on RF SAW filter on the module. The NRC7292 chipset by itself can support frequency range from 750 to 950 MHz.

5.3 Transmitter Performance

Table 6.3 Maximum EVM

DR/MCS/BW (Mbps/ /MHz)	IEEE Relative constellation error (dB)	EVM (%) (IEEE)	EVM (%) (NRM7292B)	Comments
0.15/MCS10/1	-4	63.1	3.0	BPSK Peak
0.30/MCS0/1	-5	56.2	3.0	BPSK Peak
0.60/MCS1/1	-10	31.6	3.0	18 dBm OFDM, RMS
0.90/MCS2/1	-13	22.4	3.0	18 dBm OFDM, RMS
1.20/MCS3/1	-16	15.8	3.0	18 dBm OFDM, RMS
1.80/MCS4/1	-19	11.2	3.0	18 dBm OFDM, RMS
2.40/MCS5/1	-22	7.9	3.0	18 dBm OFDM, RMS
2.70/MCS6/1	-25	5.6	3.0	18 dBm OFDM, RMS
3.00/MCS7/1	-27	4.5	3.0	18 dBm OFDM, RMS
0.65/MCS0/2	-5	56.2	3.2	BPSK Peak
1.30/MCS1/2	-10	31.6	3.2	18 dBm OFDM, RMS
1.95/MCS2/2	-13	22.4	3.2	18 dBm OFDM, RMS
2.60/MCS3/2	-16	15.8	3.2	18 dBm OFDM, RMS
3.90/MCS4/2	-19	11.2	3.2	18 dBm OFDM, RMS
5.20/MCS5/2	-22	7.9	3.2	18 dBm OFDM, RMS
5.85/MCS6/2	-25	5.6	3.2	18 dBm OFDM, RMS
6.50/MCS7/2	-27	4.5	3.2	18 dBm OFDM, RMS
1.35/MCS0/4	-5	56.2	3.0	BPSK Peak
2.70/MCS1/4	-10	31.6	3.0	18 dBm OFDM, RMS
4.05/MCS2/4	-13	22.4	3.0	18 dBm OFDM, RMS
5.40/MCS3/4	-16	15.8	3.0	18 dBm OFDM, RMS
8.10/MCS4/4	-19	11.2	3.0	18 dBm OFDM, RMS
10.80/MCS5/4	-22	7.9	3.0	18 dBm OFDM, RMS
12.15/MCS6/4	-25	5.6	3.0	18 dBm OFDM, RMS
13.50/MCS7/4	-27	4.5	3.0	18 dBm OFDM, RMS

✓ Conditions: supply voltage VBAT=2.6 ~ 3.6V, VDD_FEM=4.0V, Ta=25℃, signal within spectrum mask.

5.4 Receiver Performance

5.4.1 Receiver Sensitivity

Table 6.4 Sensitivity (minimum input level)

Band	BW	Rate	Modulation/Coding Rate	Conditions	Chip Port Specification [dBm]		
		kbps			Min	Typ	Max
902~ 928MHz	1 MHz	300	BPSK 1/2	@ PER<10%, 256 bytes Full Operating Temperature; Full Battery Voltage Range; Load Z : 50 Ohms;		-106	
		600	QPSK 1/2			-104	
		900	QPSK 3/4			-101	
		1200	16QAM 1/2			-98	
		1800	16QAM 3/4			-95	
		2400	64QAM 2/3			-91	
		2700	64QAM 3/4			-90	
		3000	64QAM 5/6			-88	
		150	BPSK 1/2 rep. 2x			-109	
	2 MHz	650	BPSK 1/2	@ PER<10%, 256 bytes Full Operating Temperature; Full Battery Voltage Range; Load Z : 50 Ohms;		-100	
		1300	QPSK 1/2			-98	
		1950	QPSK 3/4			-97	
		2600	16QAM 1/2			-94	
		3900	16QAM 3/4			-91	
		5200	64QAM 2/3			-86	
		5850	64QAM 3/4			-85	
		6500	64QAM 5/6			-83	
	4 MHz	1350	BPSK 1/2	@ PER<10%, 256 bytes Full Operating Temperature; Full Battery Voltage Range; Load Z : 50 Ohms;		-99	
		2700	QPSK 1/2			-97	
		4050	QPSK 3/4			-94	
		5400	16QAM 1/2			-91	
		8100	16QAM 3/4			-88	
		10800	64QAM 2/3			-83	
		12150	64QAM 3/4			-82	
		13500	64QAM 5/6			-80	

5.4.2 Adjacent Channel Rejection (ACR)

Table 6.5 ACR

Band	BW	Rate	Modulation/Coding Rate	Conditions	ACR [dB]		
		kbps			Min	Typ	Max
902~928MHz	1 MHz	300	BPSK 1/2	@ PER<10%, $P_{desired}=P_{sensitivty}$ + 3dB, $P_{interfere}$]@ N+1 channel		36	
		600	QPSK 1/2			34	
		900	QPSK 3/4			31	
		1200	16QAM 1/2			28	
		1800	16QAM 3/4			26	
		2400	64QAM 2/3			22	
		2700	64QAM 3/4			20	
		3000	64QAM 5/6			19	
		150	BPSK 1/2 rep. 2x			39	
	2 MHz	650	BPSK 1/2	@ PER<10%, $P_{desired}=P_{sensitivty}$ + 3dB, $P_{interfere}$]@ N+1 channel		32	
		1300	QPSK 1/2			31	
		1950	QPSK 3/4			30	
		2600	16QAM 1/2			27	
		3900	16QAM 3/4			24	
		5200	64QAM 2/3			21	
		5850	64QAM 3/4			20	
		6500	64QAM 5/6			19	
	4 MHz	1350	BPSK 1/2	@ PER<10%, $P_{desired}=P_{sensitivty}$ + 3dB, $P_{interfere}$]@ N+1 channel		32	
		2700	QPSK 1/2			29	
		4050	QPSK 3/4			28	
		5400	16QAM 1/2			25	
		8100	16QAM 3/4			22	
		10800	64QAM 2/3			20	
		12150	64QAM 3/4			17	
		13500	64QAM 5/6			15	

6 Packing Specification

6.1 Dimensions of Tape

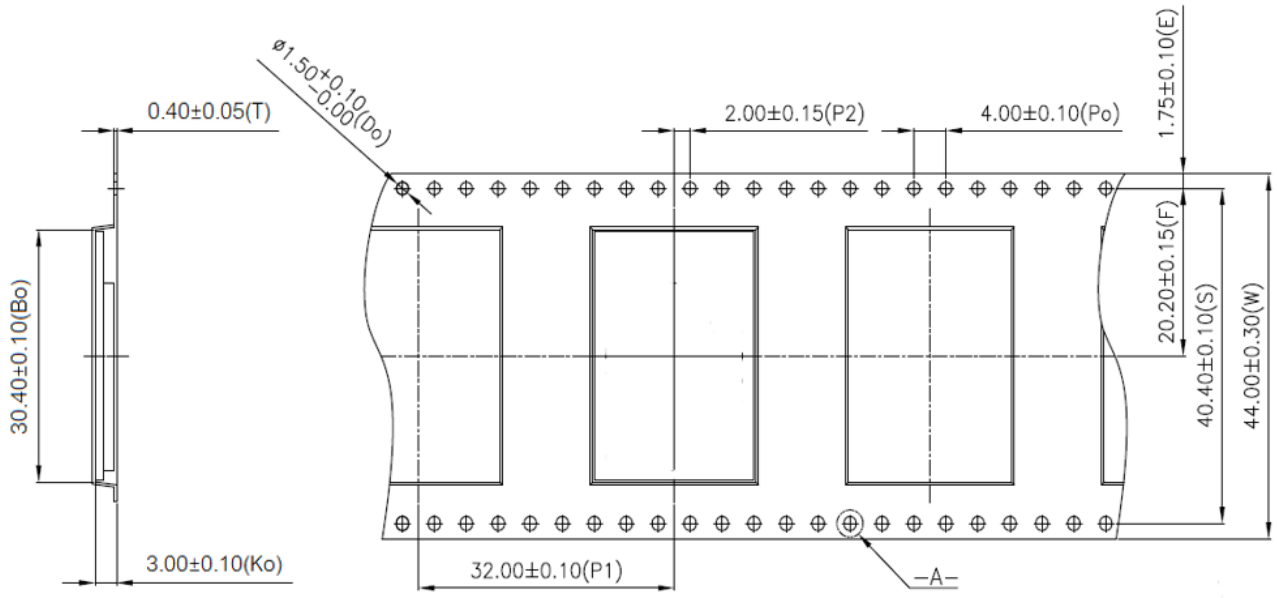


Figure 7.1 Tape information

6.2 Taping Diagrams

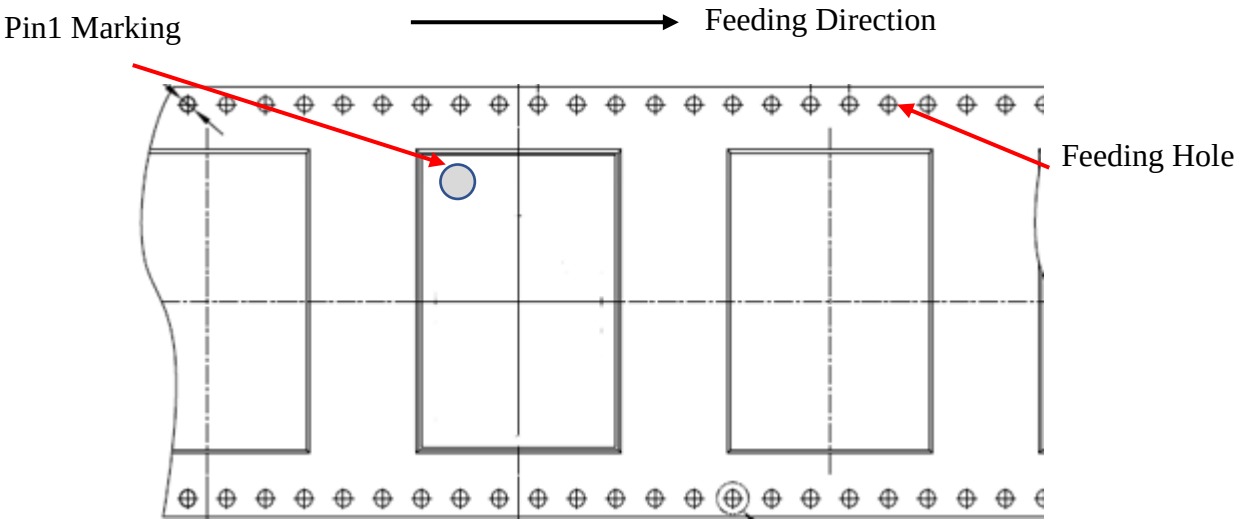
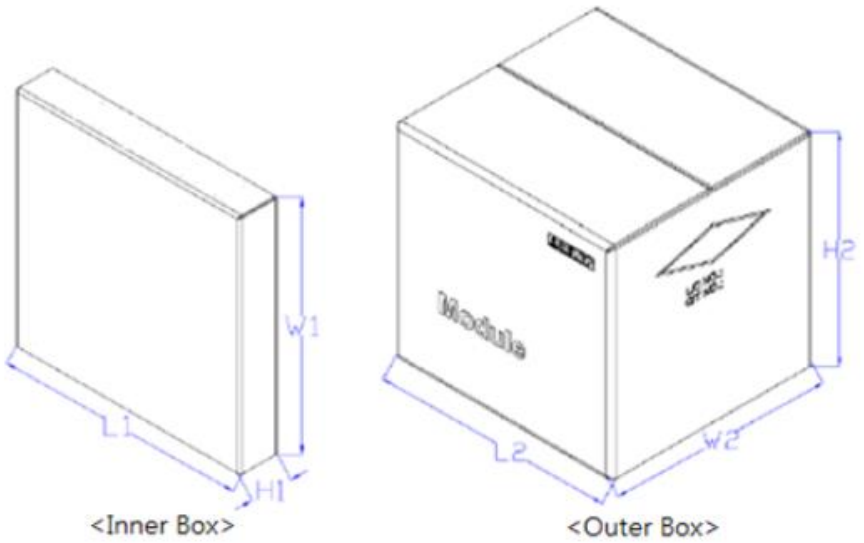


Figure 7.2 Device orientation on tape

6.3 Box Information



Mark	Dimension	Mark	Dimension
L1	340.0 ± 0.4	L2	367.0 ± 0.4
W1	340.0 ± 0.4	W2	330.0 ± 0.4
H1	52.0 ± 0.4	H2	350.0 ± 0.4

Figure 6.3 Box dimension

6.4 Label Information

- Reel / AL Bag / Inner Box

Device	Part Number
Vendor	Module maker
Lot Number	Module Lot
Quantity	
Moisture sensitivity level	
Halogen free mark	
RoHS compliant mark	

Figure 6.4 Label information

6.5 Packing Process

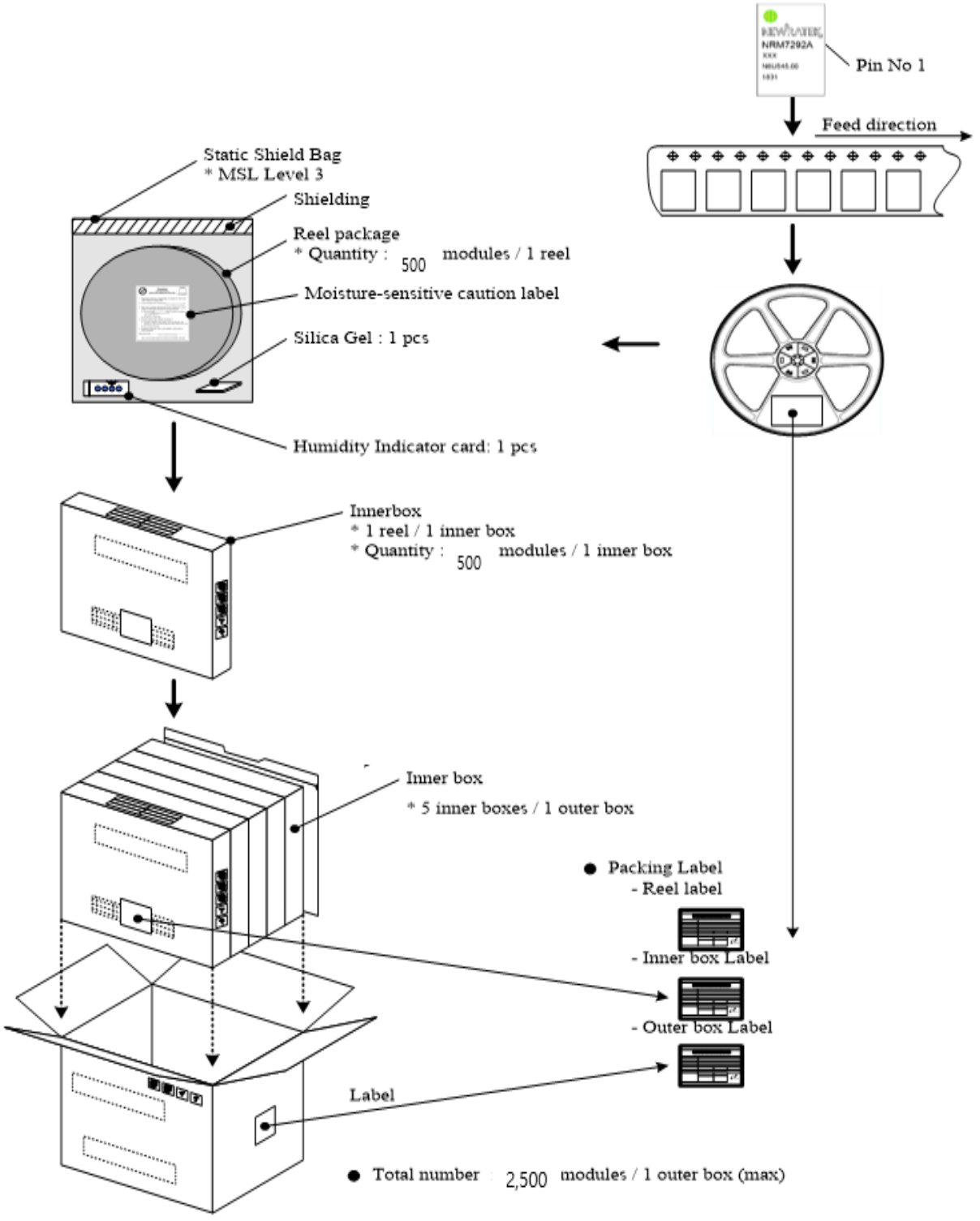


Figure 6.5 Packing process

7 SMT Temperature Sequence (Pb-free)

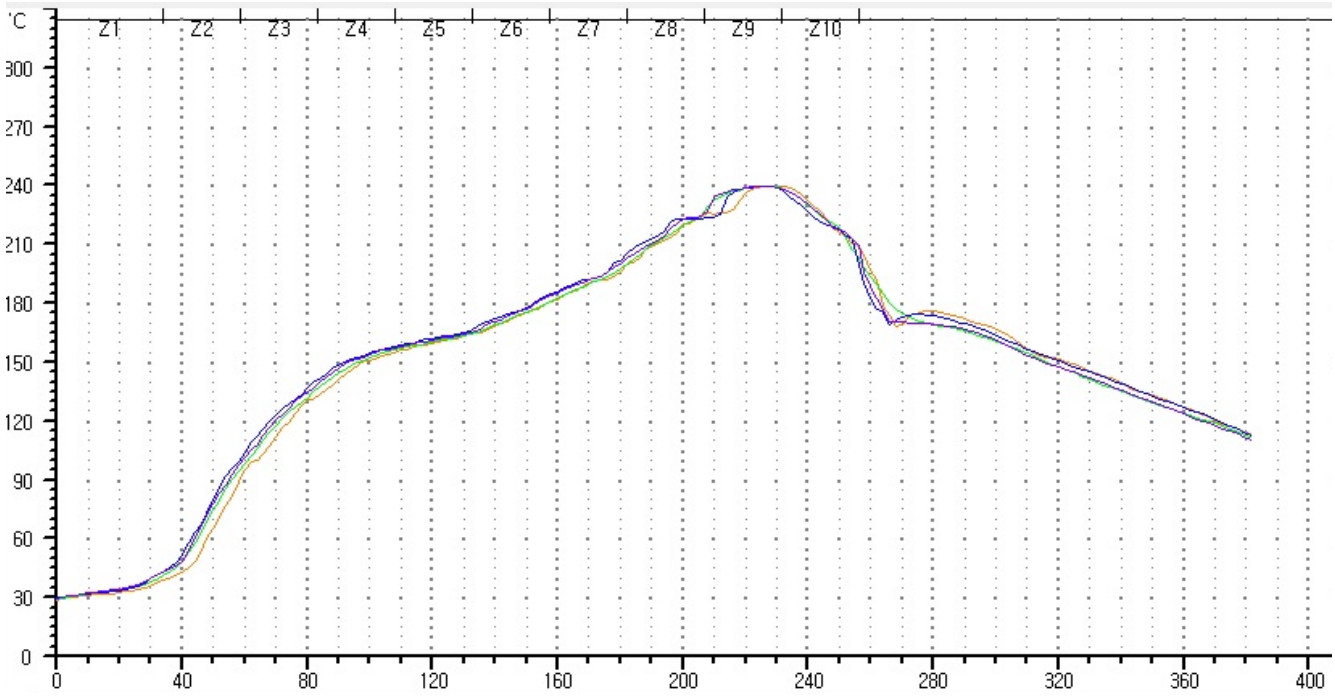


Figure 7.1 Reflow profile

8 Revision History

Revision No	Date	Comments
Ver 1.0	12/20/2021	Initial version for customer release created

FCC Compliance Statement

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, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Interference Statement

This equipment 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 equipment 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 equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to correct the interference by one of the following measures:

• Reorient or relocate the receiving antenna.

• Increase the separation between the equipment and receiver.

• Connect the equipment into an outlet on a circuit different from which the receiver is connected.
• Consult the dealer or an experienced radio/TV technician for help.

FCC Caution

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

Information on test modes and additional testing requirements

a) The modular transmitter has been fully tested by the module grantee on the required number of channels,modulation types and modes, it should not be necessary for the host installer to re-test all the available transmitter modes or settings.It is recommended that the host product manufacturer installing the modular transmitter,perform some investigative measurements to confirm that the resulting composite system does not exceed the spurious emissions limits or band edge limits(e.g.,where a different antenna may be causing additional emissions).

b) The testing should check for emissions that may occur due to the intermixing of emissions with the other transmitter, digital circuitry,or due to physical properties of the host product(enclosure). This investigation is especially important when integrating

multiple modular transmitters where the certification is based on testing each of them in a stand-alone configuration. It is important to note that host product manufactures should not assume that because the modular transmitter is certified that they do not have any responsibility for final product compliance.

Additional testing, Part 15 subpart B disclaimer

The final host/module combination need to be evaluated against the FCC Part 15B criteria for unintentional radiators in order to be properly authorized for operation as a Part 15 digital device.

The host integrator installing this module into their product must ensure that the final composite product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules, including the transmitter operation and should refer to guidance in KDB 996369.

This appliance and its antenna must not be co-located or operation in conjunction with any other antenna or transmitter.

- OEM integrators must ensure that its product is electrically identical to the device, FCC ID: 2A32R-NRM7292B reference designs. Any modifications to module reference designs may invalidate regulatory approvals in relation to the product, or may necessitate notifications to the relevant regulatory authorities.

- OEM integrators are responsible for regression testing to accommodate changes to designs, new antennas, and host and submit for C2PC filings.

- Colocation with other transmitter modules will be addressed through filings for those co-located transmitters when necessary or that colocation of other transmitters will be according to applicable KDB guidelines including those for RF exposure

- Appropriate labels must be affixed to the product that complies with applicable regulations in all respects. The regulatory label on the final system must include the statement:
"Contains FCC ID: 2A32R-NRM7292B".

1. The module is limited to OEM installation **ONLY**.
2. OEM integrators are responsible for ensuring that the end-user has no manual instructions to remove or install module.
3. The module is limited to installation in mobile or fixed applications, according to Part 2.1091(b).
4. Separate approval is required for all other operating configurations, including portable configurations with respect to Part 2.1093 and different antenna configurations.

End Product Labeling

The module is labeled with its own FCC ID. If the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. In that case, the final end product must be labeled in a visible area with the following:

"Contains FCC ID: 2A32R-NRM7292B"