	Ninebot Limited 《 BT-LE01/02-WR02-02 SPECIFICATION》	Document No.	
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1. Product Overview

1.1. Product Information

This manual is applicable to BT-LE01/02-WR02-02 Bluetooth module

Model：BT-LE01/02-WR02-02

1.2. Main Applications

Electric scooter BLE object tracking and positioning

Bluetooth data transparent transmission

BLE master-slave integration, master-slave switching, Etc

1.3. Product Description

BT-LE01/02-WR02-02 is Ninebot Limited A high-performance and low-power Bluetooth module has been launched. Its processor has a clock speed of up to 64MHz, supports Bluetooth 5.3, has built-in 80 KB RAM, and 1MB Flash.

This module adopts a surface-mount half-hole packaging design, with package dimensions of 28 mm × 18 mm × 2.8 mm, which can maximize the satisfaction of end products' demand for small-sized modules and is compatible with diversified structural designs. It supports multiple low-power modes, enabling flexible and extensive applications in intelligent short-distance transportation and meeting different scenario requirements.

1.4. Basic Parameters

The basic parameters are shown in Table 1.

Table 1 Basic parameters

Classification	Parameter
Function	Bluetooth 5.3
Product Model	BT-LE01/02-WR02-02
Working mode	BLE
Kernel	ARM® Cortex™-M4, max 64MHz
Power Supply	3.0V ~ 3.3V DC
GPIO	Quantity：22
Peripherals	2 sets of SPI interfaces 1 set of I2C interfaces 2 sets of UART interfaces 7-channel single ended ADC

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	4 PWM interfaces
Baseband crystal frequency	32MHz
Sensitivity (Indoor office environment)	< -90dBm
Maximum output power (conducted)	7dBm±1dBm
Frequency Band	2.402Ghz to 2.480GHz ISM band
Modulation	GFSK
Hopping & channels	2MHz channel space , 39 Channels
RF Input impedance	50ohms
Antenna	Built in (PCB board mounted) Maximum gain: TBD Maximum efficiency: TBD
Agreement	2.4GHz protocol
Operation Temperature	-30℃~85℃
Storage Temperature	-30℃~85℃
Size	18mm(W) * 28mm(L) * 2.8mm(H) (Tolerance: ±0.2mm)
Authentication	FCC/IC CE SRRC NCC TELEC KC BQB

Note: The power on level of the power supply should ensure that it rises to 1.65V within 35ms

1.5. Specification

Dimension：18mm(W) x 28mm(L) x 2.8mm(H) Tolerance: ±0.2mm

Module size: 18mm X 28mm Tolerance: ±0.2mm

Pad size: 0.89mmX0.86mm Tolerance: ±0.1mm

Pad pitch: 1.27mm Tolerance: ±0.1mm

The physical dimensions are shown in Figure 1.5.

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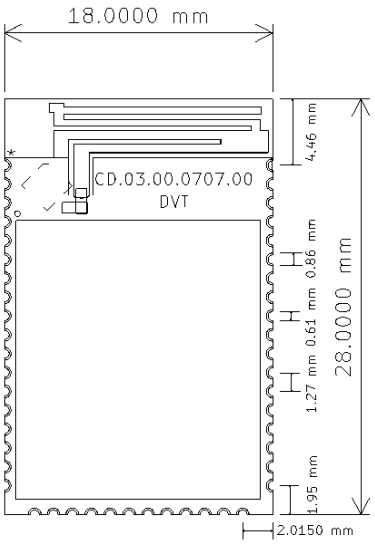

Figure 1.5 Dimensional specifications

2. Physical picture and functional block diagram of Bluetooth module

2.1. Physical picture of Bluetooth module

The physical image of the Bluetooth module is shown in Figure 2.1.

Figure 2.1 Physical picture of Bluetooth module

3. Pin definition and GPIO reuse

3.1. Pin Definition

The pin definitions are shown in Table 2 and Figure 3.1.

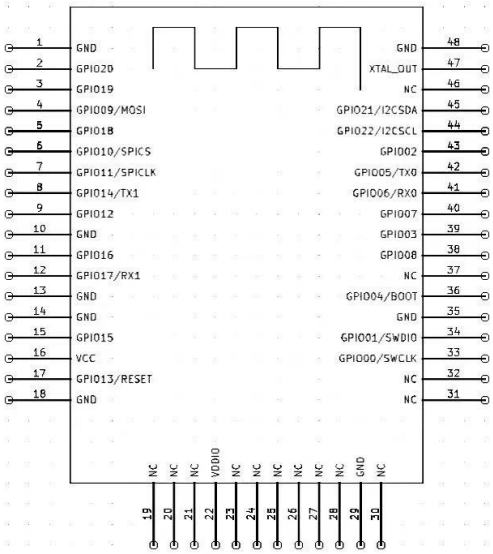

Figure 3.1 Pin Definition

Table 2 Pin Definition

Pin NO.	Pin Name	Type	Pin Descriptions
1	GND	power	GND
2	GPIO_20	I/O	GPIO
3	GPIO_19	I/O	GPIO
4	GPIO_09	I/O	GPIO
5	GPIO_18	I/O	GPIO
6	GPIO_10	I/O	GPIO
7	GPIO_11	I/O	GPIO
8	GPIO_14	I/O	GPIO
9	GPIO_12	I/O	GPIO
10	GND	power	GND

11	GPIO_16	I/O	GPIO
12	GPIO_17	I/O	GPIO
13	NC	/	GND
14	NC	/	GND
15	GPIO_15	I/O	GPIO
16	VCC	Power	Module power supply pin.
17	RESET	I	Module reset pin, reset if high
18	GND	power	GND
19	NC	/	GND
20	NC	/	GND
21	NC	/	GND
22	VDDIO	Power	I/O reference voltage
23	NC	/	GND
24	NC	/	GND
25	NC	/	GND
26	NC	/	GND
27	NC	/	GND
28	NC	/	GND
29	GND	power	GND
30	NC	/	GND
31	NC	/	GND
32	NC	/	GND
33	GPIO_00	I/O	GPIO
34	GPIO_01	I/O	GPIO
35	GND	power	GND
36	GPIO_04	I/O	GPIO
37	NC	/	GND
38	GPIO_08	I/O	GPIO
39	GPIO_03	I/O	GPIO

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40	GPIO_07	I/O	GPIO
41	GPIO_06	I/O	GPIO
42	GPIO_05	I/O	GPIO
43	GPIO_02	I/O	GPIO
44	GPIO_22	I/O	GPIO
45	GPIO_21	I/O	GPIO
46	NC	/	GND
47	XTAL_OUT	DO	XTAL_OUT
48	GND	power	GND

3.2. GPIO Pin-Mux

GPIO Pin Mux is shown in Table 3.

Table 3 GPIO Pin-Mux

GPIO No.	Pin No.	Function 1	Function 2	Function 3	Function 4
GPIO_00	33		SWCLK		
GPIO_01	34		SWDIO		
GPIO_02	43	ADC01			
GPIO_03	39	ADC02			
GPIO_04	36			BOOT	PWM
GPIO_05	42		UART_TX0		PWM
GPIO_06	41		UART_RX0		PWM
GPIO_07	40	ADC03			PWM
GPIO_08	38	ADC04			
GPIO_09	4		SPI_MOSI		
GPIO_10	6		SPI_CS		
GPIO_11	7	ADC05	SPI_CLK		
GPIO_12	9	ADC06			
GPIO_13	17			RESET	

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GPIO_14	8	ADC07	UART_TX1		
GPIO_15	15	ADC08			
GPIO_16	11				PWM
GPIO_17	12		UART_RX1		PWM
GPIO_18	5				PWM
GPIO_19	3				PWM
GPIO_21	45		I2C_SDA		
GPIO_22	44		I2C_SCL		
GPIO_24	/				PWM
GPIO_25	/				PWM

4. Peripheral Interface

4.1. GPIO

There are a total of 22 GPIO, please refer to Table 2 for pin definitions.

4.2. UART

This module has two UARTs: UART0 and UART1. To use UART, the pull-up power supply of UART needs to be set to the same power rail as VCC to prevent VCC from running out of power. If UART has high voltage backflow, it may cause internal logic problems in the chip. Alternatively, an anti backflow diode can be added to the pull-up power supply of UART to avoid this problem.

4.2.1. UART0

UART0 is used for burning and debugging purposes, as shown in Table 4.

Table 4 UART0

Pin No.	GPIO No.	UART
48	GND	GND
42	GPIO_05	UART_TX0
41	GPIO_06	UART_RX0
36	BOOT	BOOT

Note: Main power supply VCC (pin16), main GND (pin18). Except for the first burning of the chip, for each subsequent burning, the Boot pin (pin36) needs to be pulled to the ground before powering on, and then left hanging after burning.

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4.2.2. UART1

UART1 can be interconnected with other UART devices, as shown in Table 5.

Table 5 UART1

Pin No.	GPIO No.	UART
8	GPIO_14	UART_TX1
12	GPIO_17	UART_RX1

4.3. I2C

BLES100-01 supports one set of I2C interfaces, as shown in Table 6.

Supports 7-bit or 10 bit addresses.

Table 6 I2C

Pin No.	GPIO No.	I2C
44	GPIO_22	I2C0_SCL
45	GPIO_21	I2C0_SDA

4.4. GPADC

BLES100-01 has 7 GPADCs: 1 12 bit general purpose Analog to Digital Converter, with a voltage range of 0V~VCC, as shown in Table 8.

Table 8 GPADC

Pin No.	GPADC
43	GPADC1
39	GPADC2
40	GPADC3
38	GPADC4
7	GPADC5
9	GPADC6
15	GPADC8

4.5. RST

Reset signal (GPO-13), low level is valid. It is recommended that the RESET input be greater

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than 0.1ms level, with a typical value of 1.45V.

5. Electrical Parameters

5.1. Power supply

VCC is the power supply for the module, and VDDIO is the reference voltage for module IO, as shown in Table 9.

Table 9 Power supply

Name.	Pin No.	Min	Typ.	Max
VCC	16	1.71V	3.3V	3.6V
VDDIO	22	3V	3.3V	3.3V

5.2. Power Consumption

Table 10 Power Consumption

Working Condition	Power Consumption（mW）
not connected findmy	6.92
connected findmy	6.02

6. RF characteristics

Module OTA test, mode: BR. See Table 10 for details.

Table 11 RF characteristics

Channel	FRQ (MHz)	TRP（dbm）	TIS（dbm）
0	2402	4.18	-92.12
39	2442	3.86	-91.09
78	2480	3.21	-90.44

7. Welding Process Description

The recommended reflow soldering temperature is shown in Figure 7.1.

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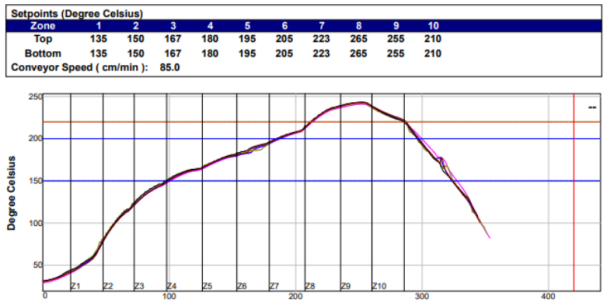

8. Software functions

Bluetooth function:

1. Supports connecting as a BLE peripheral device to BLE central devices;

2. Support connecting peripheral BLE devices as BLE center devices;

3. Support BLE master-slave integration function;

4. Support user-defined Bluetooth GATT services;

5. Support the Apple Findmy protocol.

other:

1. Support serial port upgrade

Connect the OM6626 module serial port using a computer and send serial commands based on the Ninebot Plug Platform, supporting a baud rate of 115200bps.

Protocol Configuration：

Byte	0	1	2	3
Describe	protocol format		Originator-ID	Target ID
Example	0x5A	0xA5	0x00（be pending）	0x0D

2. Support Bluetooth upgrade

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9. Certification related requirements

Country Region	Certification Project	Standard
European Union	RED	EN301 489-1 V2.2.2 EN 301 489-17 V3.2.0 EN300328 EN62479
	Rosh	2011/65/EU、EU 2015/863
	REACH	EC NO 1907/2006 Annex XVII
	POPs	(EU) 2019/1021
CHINA	RoHS	GB/T 26572-2011
	SRRC	【2021】NO.129
Taiwan	NCC	NCC RF Test and EMC
Japan	Telec	Telec
Republic of Korea	KC	KS X3124:2020，KS X3126:2020
North America	FCC/IC	FCC Part 15B/ICES-003 EMC FCC Part 15.247/RSS-247 BT RF KDB447498/RSS-102 MPE
Other	BQB	/

10. Reliability Requirements

10.1. Temperature shock

10.1.1. Test method

The Bluetooth module is not powered on. Conduct a temperature shock test according to the following conditions:

a) Raise the temperature of the test chamber to 80 ℃± 2 ℃ and maintain it for 2 hours;

b) Reduce the temperature of the test chamber to -30 ℃± 2 ℃ and maintain it for 2 hours;

Repeat steps a) and b) for a total of 20 cycles;

The transition time between every two temperatures during the experiment shall not exceed 5 minutes;

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After the experiment, immediately power on the Bluetooth module (3.3V power supply), and use the testing tool to connect Bluetooth 20 times and findmy 20 times at a distance of 20 meters;

After the test is completed, perform performance testing according to the requirements of performance testing;

Note:

During the Bluetooth or Findmy connection testing process, if the module is located outside the temperature box, it needs to be tested in four directions: east, south, west, and north;

2. It is necessary to test with different brands of phones such as Apple and Android, and record the maximum distance that can be connected;

10.1.2. Qualification determination

1. After the test, the product's functional performance is normal and meets the performance parameter requirements in Chapter 2;

2. Bluetooth connection is 100% successful, findmy connection is 100% successful; (100% successful connection within a distance of 20 meters, record the maximum distance that can be connected).

10.2. High Temperature Test

10.2.1. Test method

a) The Bluetooth module is not powered on, raise the temperature of the test chamber to 80 ℃± 2 ℃ and maintain it for 72 hours;

b) At 80 ℃ environment, connect the Bluetooth module power supply with 3.3V voltage and run continuously for 8 hours (insert the action of immediately powering on after power-off for 3 times during high temperature operation, observe whether the power on is successful and whether the power on process is abnormal, with an interval of 1 hour to 2 hours between each time);

c) After the experiment, Bluetooth connection and findmy connection were made 20 times at a distance of 20 meters using testing tools;

d) After the test is completed, perform performance testing according to the requirements of performance testing;

Note:

1.During the Bluetooth or Findmy connection testing process, if the module is located outside the temperature box, it needs to be tested in four directions: east, south, west, and north;

2. It is necessary to test with different brands of phones such as Apple and Android, and record the maximum distance that can be connected

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10.2.2. Qualification determination

After the test, the product's functional performance is normal and meets the performance parameter requirements in Chapter 2;

Bluetooth connection is 100% successful, findmy connection is 100% successful.

10.3. Low Temperature

10.3.1. Test method

a) The Bluetooth module is not powered on, lower the temperature of the test chamber to -30 ℃± 2 ℃ and maintain it for 72 hours;

b) At -30 ℃, power on the Bluetooth module and supply it with 3.3V voltage for 8 hours of continuous operation (insert the action of immediately powering on after power-off for 3 times during low-temperature operation, observe whether the power on is successful and whether the power on process is abnormal, with an interval of 1 hour to 2 hours between each time);

c) After the experiment, Bluetooth connection and findmy connection were made 20 times at a distance of 20 meters using testing tools;

d) After the test is completed, perform performance testing according to the requirements of performance testing;

Note:

1.During the Bluetooth or Findmy connection testing process, if the module is located outside the temperature box, it needs to be tested in four directions: east, south, west, and north;

2. It is necessary to test with different brands of phones such as Apple and Android, and record the maximum distance that can be connected.

10.3.2. Qualification determination

After the test, the product's functional performance is normal and meets the performance parameter requirements in Chapter 2;

Bluetooth connection is 100% successful, findmy connection is 100% successful.

10.4. Vibration Test - Battery Application

10.4.1. Test method

Fix the Bluetooth module on the vibration test bench according to the installation method inside the battery pack, and conduct a sine vibration test according to the parameters in the table below. Perform 12 cycles in each direction, with a vibration time of 3 hours in each direction, and conduct vibration tests in three mutually perpendicular directions.

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frequency		vibration parameters	Logarithmic sweep cycle time
Start	Termination		
7Hz	18Hz	Maximum acceleration 1gn	15min
18Hz	25Hz	Displacement amplitude 0.8mm, acceleration increased to 8gn	
25Hz	200Hz	Maintain an acceleration of 8gn	
Return to 7Hz			

After the experiment, Bluetooth connection and findmy connection were made 20 times at a distance of 20 meters using testing tools;

After the test is completed, perform performance testing according to the requirements of Part 2 Performance Testing.

Note:

1.During the Bluetooth or Findmy connection testing process, it is necessary to test the module's positions in four directions: east, south, west, and north;

2. It is necessary to test with different brands of phones such as Apple and Android, and record the maximum distance that can be connected;

10.4.2. Qualification determination

After the test, the product's functional performance is normal and meets the performance parameter requirements in Chapter 2;

Bluetooth connection is 100% successful, findmy connection is 100% successful.

10.5. Mechanical impact test - battery application

10.5.1. Test method

a) Fix the Bluetooth module on the test bench according to the installation method inside the battery pack;

b) Apply a half sine shock wave with a pulse duration of 6ms and an acceleration of 150gn. Impact 3 times in each direction, with a total of 6 directions including ± X, ± Y, and ± Z axes, for a total of 18 impacts;

c) After the experiment, Bluetooth connection and findmy connection were made 20 times at a distance of 20 meters using testing tools;

d) After the test is completed, perform performance testing according to the requirements of

Part 2 Performance Testing.

Note:

1.During the Bluetooth or Findmy connection testing process, it is necessary to test the module's positions in four directions: east, south, west, and north;

2. It is necessary to test with different brands of phones such as Apple and Android, and record the maximum distance that can be connected.

10.5.2. Qualification determination

After the test, the product's functional performance is normal and meets the performance parameter requirements in Chapter 2;

Bluetooth connection is 100% successful, findmy connection is 100% successful.

10.6. Drop Test - Conducted with Battery Pack

10.6.1. Test method

a) Drop 0.5m 10 times;

b) Falling order: X+, Y+, X -, Y -, Z+, Z-corner, Z-short edge once each;

c) After the experiment, Bluetooth connection and findmy connection were made 20 times at a distance of 20 meters using testing tools;

d) After the test is completed, perform performance testing according to the requirements of Part 2 Performance Testing.

Note: Temporarily 10 times, power on inspection after each drop. If there is a performance failure after 10 drops, record the number of drops allowed. If there is no problem with power on after 10 drops, continue to drop until unable to power on, record the number of drops, up to 15 times.

10.6.2. Qualification determination

After the test, the product's functional performance is normal and meets the performance parameter requirements in Chapter 2;

Bluetooth connection is 100% successful, findmy connection is 100% successful.

10.7. Voltage sag test (probing)

10.7.1. Test method

a) Use a DC power supply to power Bluetooth and connect the working power of the Bluetooth module;

b) Set the output waveform of the programmable DC power supply: supply 5V voltage for 10

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seconds, cut off power for 1 second, restore power for 10 seconds, repeat 50 times;

c) After the experiment, Bluetooth connection and findmy connection were made 20 times at a distance of 20 meters using testing tools;

d) After the test is completed, perform performance testing according to the requirements of Part 2 Performance Testing.

Note:

1.During the Bluetooth or Findmy connection testing process, it is necessary to test the module's positions in four directions: east, south, west, and north;

2. It is necessary to test with different brands of phones such as Apple and Android, and record the maximum distance that can be connected.

10.7.2. Qualification determination

After the test, the product's functional performance is normal and meets the performance parameter requirements in Chapter 2;

Bluetooth connection is 100% successful, findmy connection is 100% successful.

10.8. Work Durability Test

10.8.1. Test method

a) Apply 5V working voltage to Bluetooth;

b) Adjust the temperature of the temperature box to 65 ℃± 2 ℃, and after the temperature stabilizes, Bluetooth will work continuously for 500 hours;

c) Connect Bluetooth 20 times and findmy 20 times at intermediate points of 100h, 200h, 300h, and 400h respectively;

d) After the 500h test is completed, the success rate of connecting the test module in the east, south, west, and north directions at a distance of 20 meters is recorded, and the maximum distance that can be connected is recorded;

Note: During the intermediate inspection process, the module can be removed to the outside of the temperature box for a 20 meter distance connection test

10.8.2. Qualification determination

During and after the experiment, the Bluetooth connection was 100% successful, and the findmy connection was 100% successful.

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10.9. Input Power Short Circuit Test - Conducted with the Whole Machine

10.9.1. Test method

a) Power the Bluetooth module according to the internal power supply method of the battery, and short-circuit the power input terminal;

b) Short circuit for 5 minutes or only until the input voltage drops to 0;

c) After the experiment, remove the short-circuit device and power on the Bluetooth module again;

Note: The battery pack is tested, and single modules are not tested

10.9.2. Qualification determination

a) The Bluetooth module has no burning phenomenon (allowing protection devices such as fuses to operate, without causing open flames in surrounding devices);

b) The BMS board functions normally and cannot affect the battery output performance.

10.10. Output Short Circuit Test - Conducted with the Whole Machine

10.10.1. Test method

a) Power the Bluetooth module according to the internal power supply method of the battery, and short-circuit the internal power supply of the module;

b) Short circuit for 5 minutes or only until the power output voltage inside the board drops to 0;

c) After the experiment, remove the short-circuit device and power on the Bluetooth module again.

Note: The battery pack is tested, and single modules are not tested

10.10.2. Qualification determination

a) The Bluetooth module has no burning phenomenon (allowing protection devices such as fuses to operate, without causing open flames in surrounding devices);

b) The BMS board functions normally and cannot affect the battery output performance.

10.11. Static electricity test

10.11.1. Test method

a) Separate module, powered by a 3.3V power supply;

b) Voltage level: Contact ± 2kv, 10 times each; Air ± 4kv, 10 times each;

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c) Discharge position: shielding cover - contact discharge; Antenna air discharge; Pin (randomly select 10 pins) - contact discharge;

d) After each discharge, it is necessary to discharge through a discharge resistor, and at the same time, connect Bluetooth and Findmy at close range through a mobile phone. If they cannot be connected, the test will be terminated;

e) If the Bluetooth and Findmy function tests are qualified during the static electricity test, after the test is completed, the success rate of connecting the test module in the east, south, west, and north directions at a distance of 20 meters should be recorded, and the maximum distance that can be connected should be recorded;

Note: The actual discharge position can be adjusted based on the physical condition and should be clearly noted; There are other discharge level requirements in the module specification book, which can be adjusted by referring to the specification book.

10.11.2. Qualification determination

During and after the experiment, the Bluetooth connection was 100% successful, and the findmy connection was 100% successful.

10.12. Interference Test

10.12.1. Test method

a) Power the Bluetooth module with a voltage of 3.3V and connect it to the working power supply;

b) In the office building environment, multiple devices coexist: WIFI、 Conduct connection testing in environments with multiple Bluetooth devices enabled;

c) Connect Bluetooth and findmy 20 times at a distance of 20 meters using testing tools;

d) Test the success rate of connecting modules in the east, south, west, and north directions at a distance of 20 meters, and record the maximum distance that can be connected;

10.12.2. Qualification determination

During and after the experiment, the Bluetooth connection was 100% successful, and the findmy connection was 100% successful.

10.13. Packaging and transportation requirements

10.13.1. Package

The products should be packaged with woven tapes, and each product should be located in a different woven tape cavity. Each woven tape should be neatly and orderly placed in the packaging box, and there should be partitions between each woven tape to avoid collision damage. The outer

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box should be packaged in cardboard boxes or other boxes. In special circumstances, it can be determined according to the requirements of the demander (contract).

10.13.2. Transport

When handling packaging boxes containing products, they should be handled with care and not thrown. During transportation, it should not be exposed to sunlight or rain, and it is strictly prohibited to mix and transport with flammable materials and active chemicals.

10.13.3. Storage

The product should be placed indoors in a dry, ventilated, and rain and snow resistant environment. The indoor temperature should be between 18 ℃ and 28 ℃, and the humidity should be between 35% and 75%. It should not be stored together with corrosive substances such as acids, alkalis, or dusty items. The box containing the product should be properly placed and cushioned.

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