INSTALLATION AND OPERATION

USER MANUAL

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UM980

BDS/GPS/GLONASS/Galileo/QZSS

All-constellation Multi-frequency High Precision RTK Positioning Module

Revision History

Version	Revision History	Date
R1.0	First release	2022-08

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Foreword

This document describes the information of the hardware, package, specification and the use of Unicore UM980 modules.

Target Readers

This document applies to technicians who possess the expertise on GNSS receivers.

Contents

1 Introduction

UM980 is a new generation of GNSS high precision RTK positioning module from Unicore. It supports all constellations and all frequencies, and can simultaneously track BDS B1I/B2I/B3I/B1C/B2a/B2b*, GPS L1/L2/L5, GLONASS L1/L2, Galileo E1/E5a/E5b, QZSS L1/L2/L5, and SBAS. The module is mainly used in surveying and mapping, precise agriculture, UAVs, and autonomous robots.

UM980 is based on NebulasIV™, a GNSS SoC which integrates the RF-baseband and high precision algorithm. Besides, the SoC integrates a dual-core CPU, a high speed floating point processor and an RTK co-processor with 22 nm low power design, and it supports 1408 super channels. All these above enable stronger signal processing.

With the built-in JamShield adaptive anti-jamming technology, UM980 can fulfill a strengthening RTK engine solution of multi-mode multi-frequency, which ensures a good performance on RTK initialization speed, measurement accuracy and reliability even in the most challenging environments such as urban canyons and tree shades.

Furthermore, UM980 supports abundant interfaces such as UART, I²C*, SPI*, as well as 1PPS, EVENT, CAN*, which meets the customers' needs in different applications.

Figure 1-1 UM980 Module

* Supports B2b after firmware upgrade

I²C, SPI, CAN: reserved interfaces, not supported currently

1.1 Key Features

- Based on the new generation GNSS SoC -NebulasIV™, with RF-baseband and high precision algorithm integrated
- 17 mm × 22 mm × 2.6 mm, surface-mount device
- Supports all-constellation all-frequency on-chip RTK positioning solution
- Supports BDS B1I/B2I/B3I/B1C/B2a/B2b* + GPS L1/L2/L5 + GLONASS L1/L2 + Galileo E1/E5a/E5b + QZSS L1/L2/L5 + SBAS
- All-constellation all-frequency RTK engine and advanced RTK processing technology
- Instantaneous RTK initialization technology
- Independent track of each frequency, and 60 dB narrowband anti-jamming technology

1.2 Key Specifications

Table 1-1 Technical Specifications

Basic Information	
Channels	1408 channels, based on NebulasIV™
Constellations	BDS/GPS/GLONASS/Galileo/QZSS
Frequencies	BDS: B1I, B2I, B3I, B1C, B2a, B2b[1] GPS: L1 C/A, L1C[1], L2P (Y), L2C, L5 GLONASS: L1, L2 Galileo: E1, E5a, E5b QZSS: L1, L2, L5
Power	
Voltage	+3.0 V ~ +3.6 V DC
Power Consumption	480 mW (Typical)

[1] Supports B2b and L1C after firmware upgrade

Performance				
Positioning Accuracy	Single Point Positioning[2] (RMS)	Horizontal: 1.5 m		
		Vertical: 2.5 m		
	DGPS (RMS)[2,3]	Horizontal: 0.4 m		
		Vertical: 0.8 m		
	RTK (RMS)[2,3]	Horizontal: 0.8 cm + 1 ppm		
		Vertical: 1.5 cm + 1 ppm		
Observation Accuracy (RMS)	BDS	GPS	GLONASS	Galileo
B1I/B1C/L1C[1]/L1 C/A/G1/E1 Pseudorange	10 cm	10 cm	10 cm	10 cm
B1I/B1C/L1C[1]/L1 C/A/G1/E1 Carrier Phase	1 mm	1 mm	1 mm	1 mm
B3I/L2P(Y)/L2C/G2 Pseudorange	10 cm	10 cm	10 cm	10 cm
B3I/L2P(Y)/L2C/G2 Carrier Phase	1 mm	1 mm	1 mm	1 mm
B2I/B2a/B2b[1]/L5/E5a/E5b Pseudorange	10 cm	10 cm	10 cm	10 cm
B2I/B2a/B2b[1]/L5/E5a/E5b Carrier Phase	1 mm	1 mm	1 mm	1 mm
Time Accuracy (RMS)	20 ns			
Velocity Accuracy[4] (RMS)	0.03 m/s			
Time to First Fix[5] (TTFF)	Cold Start < 30 s			

[2] Test results may be biased due to atmospheric conditions, baseline length, GNSS antenna type, multipath, number of visible satellites, and satellite geometry

[3] The measurement uses a 1 km baseline and a receiver with good antenna performance, regardless of possible errors of antenna phase center offset

[4] Open sky, unobstructed scene, 99% @ static

[5] -130dBm @ more than 12 available satellites

	Warm Start < 20 s
	Hot Start < 5 s
Initialization Time[2]	< 5 s (Typical)
Initialization Reliability[2]	> 99.9%
Data Update Rate	50 Hz[6] Positioning
Differential Data	RTCM 3.X
Data Format	NMEA-0183, Unicore
Physical Characteristics	
Package	54 pin LGA
Dimensions	22 mm × 17 mm × 2.6 mm
Weight	1.88 g ± 0.03 g
Environmental Specifications	
Operating Temperature	-40 °C ~ +85 °C
Storage Temperature	-55 °C ~ +95 °C
Humidity	95% No condensation
Vibration	GJB150.16A-2009, MIL-STD-810F
Shock	GJB150.18A-2009, MIL-STD-810F
Functional Ports	
UART × 3	
I²C* × 1	
SPI* × 1	Slave
CAN* × 1	Shared with UART3

* I²C, SPI, CAN: reserved interfaces, not supported currently

[6] Supports 50 Hz after firmware upgrade

1.3 Block Diagram

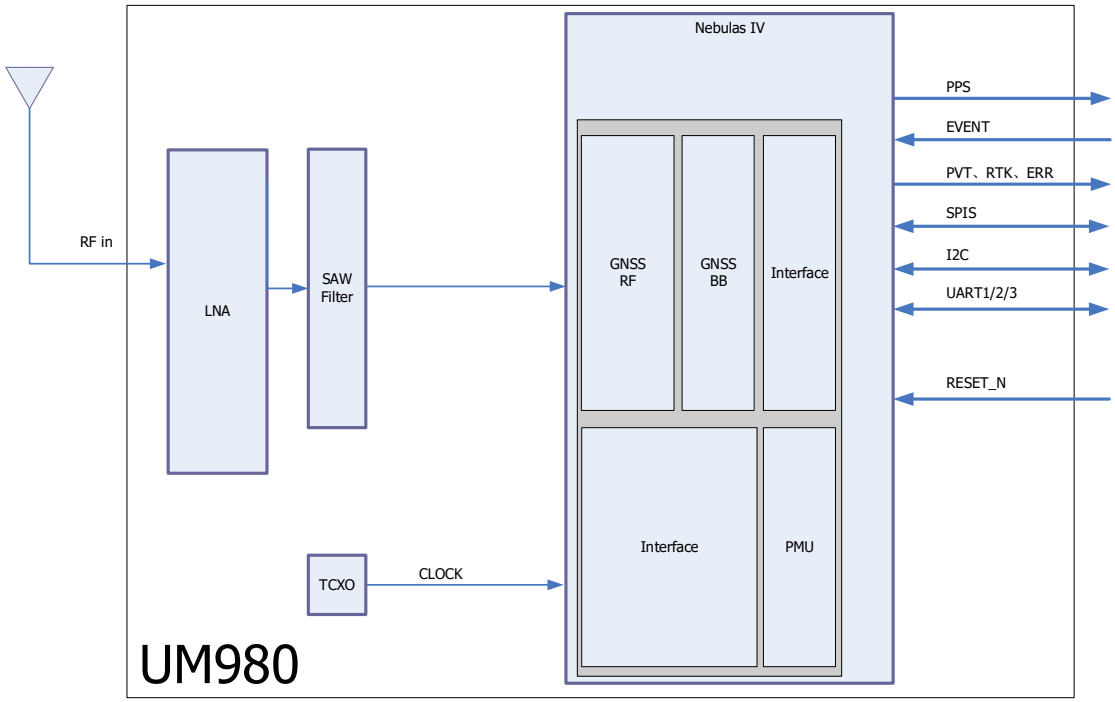


Figure 1-2 UM980 Block Diagram

- **RF Part**

The receiver gets filtered and enhanced GNSS signal from the antenna via a coaxial cable. The RF part converts the RF input signals into the IF signals, and converts IF analog signals into digital signals required for NebulasIV™ chip (UC9810).

- **NebulasIV™ SoC (UC9810)**

NebulasIV (UC9810) is UNICORECOMM's new generation high precision GNSS SoC with 22 nm low power design, supporting all constellations all frequencies and 1408 super channels. It integrates a dual-core CPU, a high speed floating point processor and an RTK co-processor, which can fulfill the high precision baseband processing and RTK positioning independently.

- **1PPS**

UM980 outputs 1 PPS with adjustable pulse width and polarity.

- **Event**

UM980 provides the Event Mark Input with adjustable frequency and polarity.

- **Reset (RESET_N)**

Active LOW, and the active time should be no less than 5 ms.

2 Hardware

2.1 Dimensions

Table 2-1 Dimensions

Symbol	Min. (mm)	Typ. (mm)	Max. (mm)
A	21.80	22.00	22.50
B	16.80	17.00	17.50
C	2.40	2.60	2.80
D	3.75	3.85	3.95
E	0.95	1.05	1.15
F	1.80	1.90	2.00
G	1.00	1.10	1.20
H	0.70	0.80	0.90
K	1.40	1.50	1.60
M	3.55	3.65	3.75
N	3.15	3.25	3.35
P	2.00	2.10	2.20
R	1.00	1.10	1.20
X	0.72	0.82	0.92

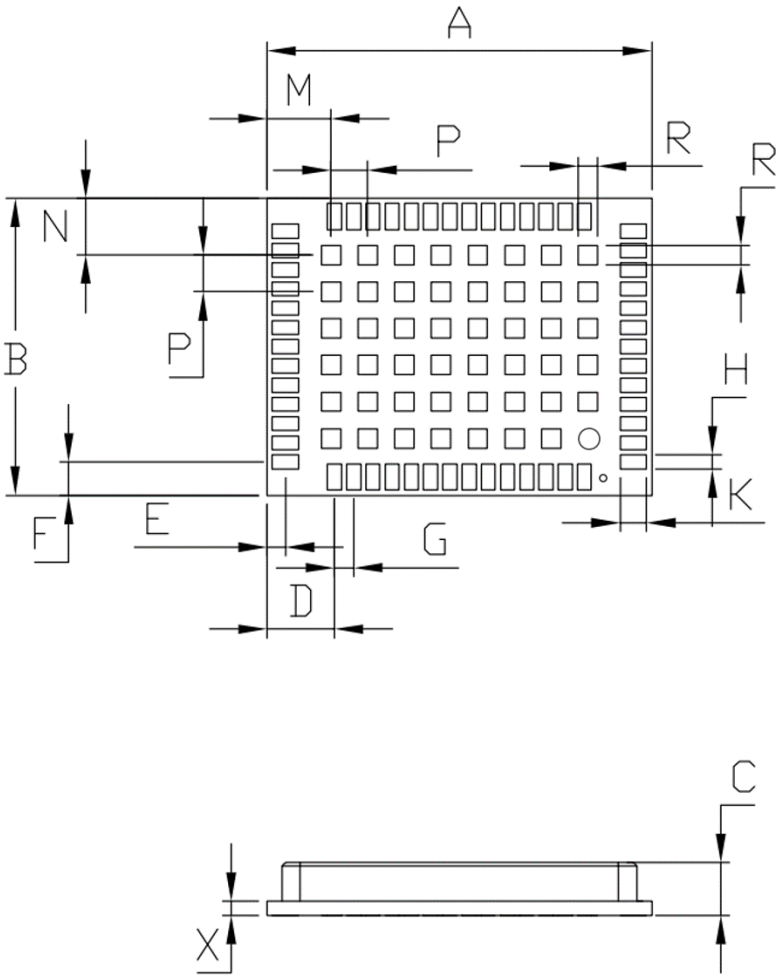


Figure 2-1 UM980 Mechanical Dimensions

2.2 Pin Definition

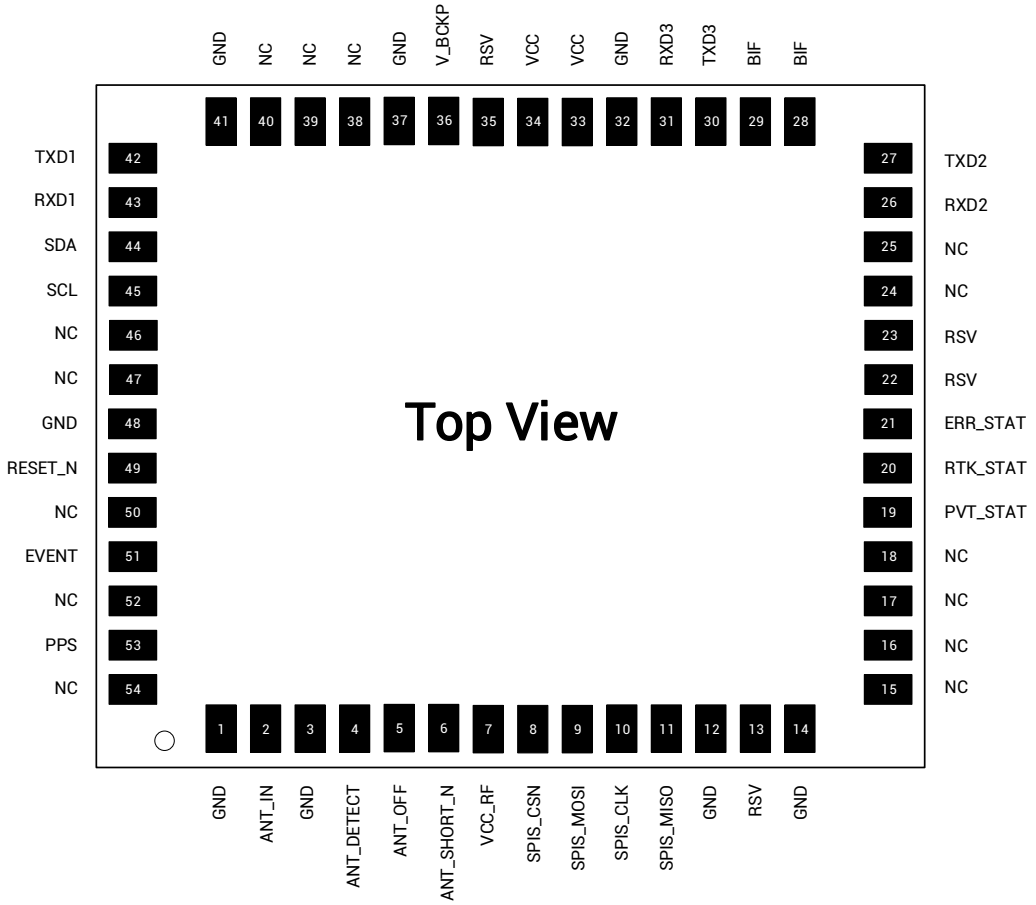


Figure 2-2 UM980 Pin Definition

Table 2-2 Pin Description

No.	Pin	I/O	Description
1	GND	—	Ground
2	ANT_IN	I	GNSS antenna signal input
3	GND	—	Ground
4	ANT_DETECT	I	Antenna signal detection
5	ANT_OFF	O	Disable external LNA
6	ANT_SHORT_N	I	Detection of antenna short circuit; active low

No.	Pin	I/O	Description
7	VCC_RF[7]	O	External LNA power supply
8	SPIS_CSN	I	Chip select input of SPI slave
9	SPIS_MOSI	I	Data input of SPI slave
10	SPIS_CLK	I	Clock input of SPI slave
11	SPIS_MISO	O	Data output of SPI slave
12	GND	—	Ground
13	RSV	—	Reserved
14	GND	—	Ground
15	NC	—	No internal connections
16	NC	—	No internal connections
17	NC	—	No internal connections
18	NC	—	No internal connections
19	PVT_STAT	O	PVT positioning indicator: active high; outputs high when positioning and low when not positioning
20	RTK_STAT	O	RTK positioning indicator: active high; outputs high with RTK fixed solution, and low with other positioning status or no positioning
21	ERR_STAT	O	Abnormal indicator: active high; outputs high when failing self-detection, and low when passing
22	RSV	—	Reserved, recommended to be floating
23	RSV	—	Reserved, recommended to be floating

[7] Not recommended to take VCC_RF as ANT_BIAS to feed the antenna See section 3.1 for more details.

No.	Pin	I/O	Description
24	NC	—	No internal connections
25	NC	—	No internal connections
26	RXD2	I	COM2 receiving data, LVTTL level
27	TXD2	O	COM2 transmitting data, LVTTL level
28	BIF	—	Built-in function; recommended to add a through-hole testing point and a 10 kΩ pull-up resistor; cannot connect ground or power supply, and cannot be peripheral I/O, but can be floating
29	BIF	—	Built-in function; recommended to add a through-hole testing point and a 10 kΩ pull-up resistor; cannot connect ground or power supply, and cannot be peripheral I/O, but can be floating
30	TXD3	O	COM3 transmitting data, LVTTL level, can be used as CAN TXD
31	RXD3	I	COM3 receiving data, LVTTL level, can be used as CAN RXD
32	GND	—	Ground
33	VCC	I	Power supply
34	VCC	I	Power supply
35	RSV	—	Reserved
36	V_BCKP	I	When the main power supply VCC is cut off, V_BCKP supplies power to RTC and relevant register. Level requirements: 2.0 V ~ 3.6 V, and the working current is less than 60 μA at 25 °C. When the hot start function is not used, V_BCKP can be connected to VCC/ground, or floating.

No.	Pin	I/O	Description
37	GND	—	Ground
38	NC	—	No internal connections
39	NC	—	No internal connections
40	NC	—	No internal connections
41	GND	—	Ground
42	TXD1	O	COM1 transmitting data, LVTTL level
43	RXD1	I	COM1 receiving data, LVTTL level
44	SDA	I/O	I^2C data
45	SCL	I/O	I^2C clock
46	NC	—	No internal connections
47	NC	—	No internal connections
48	GND	—	Ground
49	RESET_N	I	System reset; active Low
50	NC	—	No internal connections
51	EVENT	I	Event mark
52	NC	—	No internal connections
53	PPS	O	Pulse per second
54	NC	—	No internal connections

2.3 Electrical Specifications

2.3.1 Absolute Maximum Ratings

Table 2-3 Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit
Power Supply Voltage	VCC	-0.3	3.6	V
Input Voltage	V_{in}	-0.3	3.6	V
GNSS Antenna Signal Input	ANT_IN	-0.3	6	V
Antenna RF Input Power	ANT_IN input power		+10	dBm
External LNA Power Supply	VCC_RF	-0.3	3.6	V
VCC_RF Output Current	ICC_RF		100	mA
Storage Temperature	T_{stg}	-55	95	°C

2.3.2 Operational Conditions

Table 2-4 Operational Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Power Supply Voltage[8]	VCC	3.0	3.3	3.6	V	
Maximum VCC Ripple	V_{rpp}	0		50	mV	
Working Current[9]	I_{opr}		145	180	mA	VCC=3.3 V
VCC_RF Output Voltage	VCC_RF		VCC-0.1		V	
VCC_RF Output Current	ICC_RF			50	mA	
Operating Temperature	T_{opr}	-40		85	°C	
Power Consumption	P		480		mW	

[8] The voltage range of VCC (3.0 V ~ 3.6 V) has already included the ripple voltage.

[9] Since the product has capacitors inside, inrush current occurs during power-on. You should evaluate in the actual environment in order to check the effect of the supply voltage drop caused by inrush current in the system.

2.3.3 IO Threshold

Table 2-5 IO Threshold

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Low Level Input Voltage	V_{in_low}	-0.3		0.7	V	
High Level Input Voltage	V_{in_high}	VCC × 0.65		VCC + 0.3	V	
Low Level Output Voltage	V_{out_low}	0		0.45	V	I_{out} = 2 mA
High Level Output Voltage	V_{out_high}	VCC - 0.45		VCC	V	I_{out} = 2 mA

2.3.4 Antenna Feature

Table 2-6 Antenna Feature

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Optimum Input Gain	G_{ant}	18	30	36	dB	

3 Hardware Design

3.1 Antenna Feed Design

UM980 just supports feeding the antenna from the external of the module rather than from the internal. It is recommended to use devices with high power and that can withstand high voltage. Gas discharge tube, varistor, TVS tube and other high-power protective devices may also be used in the power supply circuit to further protect the module from lightning strike and surge.

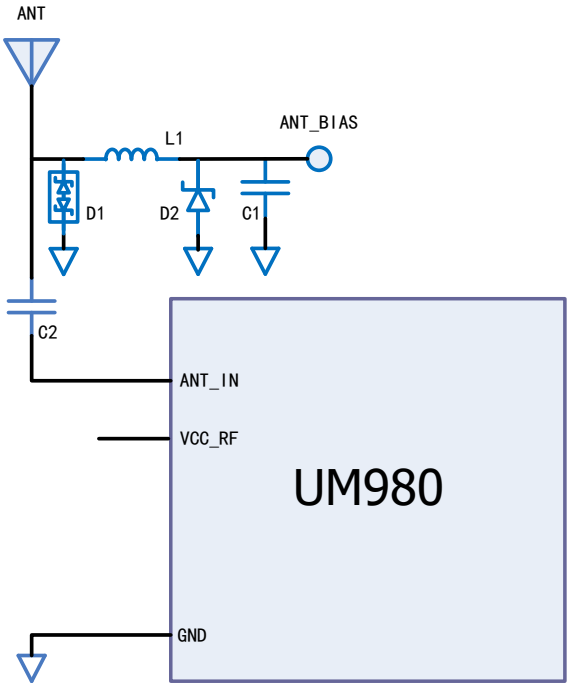


Figure 3-1 UM980 External Antenna Feed Reference Circuit

Remarks:

- L1: feed inductor, 68 nH RF inductor in 0603 package is recommended
- C1: decoupling capacitor, recommended to connect two capacitors of

  100 nF/100 pF in parallel
- C2: DC blocking capacitor, recommended 100 pF capacitor
- It is not recommended to take VCC_RF as ANT_BIAS to feed the antenna (VCC_RF is not optimized for anti-lightning strike, anti-surge and over current protection due to the compact size of the module)
- D1: ESD diode, choose the ESD protection device that supports high frequency signals (above 1000 MHz)
- D2: TVS diode, choose the TVS diode with appropriate clamping specification according to the requirement of feed voltage and antenna voltage

3.2 Grounding and Heat Dissipation

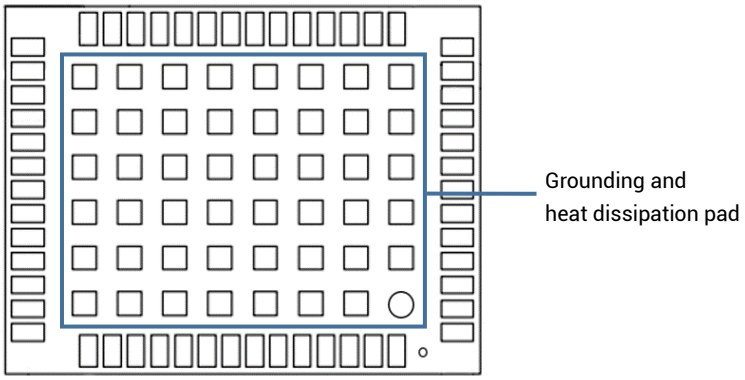


Figure 3-2 Grounding and Heat Dissipation Pad

The 48 pads in the rectangle in Figure 3-2 are for grounding and heat dissipation. In the PCB design, it is recommended to connect them to a large sized ground to strengthen the heat dissipation.

3.3 Power-on and Power-off

VCC

The VCC initial level when power-on should be less than 0.4 V and has good monotonicity. The voltages of undershoot and ringing should be within 5% VCC.

VCC power-on waveform: The time interval from 10% rising to 90% must be within 100 us ~1 ms.

Power-on time interval: The time interval between the VCC < 0.4 V (after power-off) to the next power-on must be larger than 500 ms.

V_BCKP

The V_BCKP initial level when power-on should be less than 0.4 V and has good monotonicity. The voltages of undershoot and ringing should be within 5% V_BCKP.

V_BCKP power-on waveform: The time interval from 10% rising to 90% must be within 100 us ~1 ms.

Power-on time interval: The time interval between the V_BCKP < 0.4 V (after power-off) to the next power-on must be larger than 500 ms.

4 Production Requirement

Recommended soldering temperature curve is as follows:

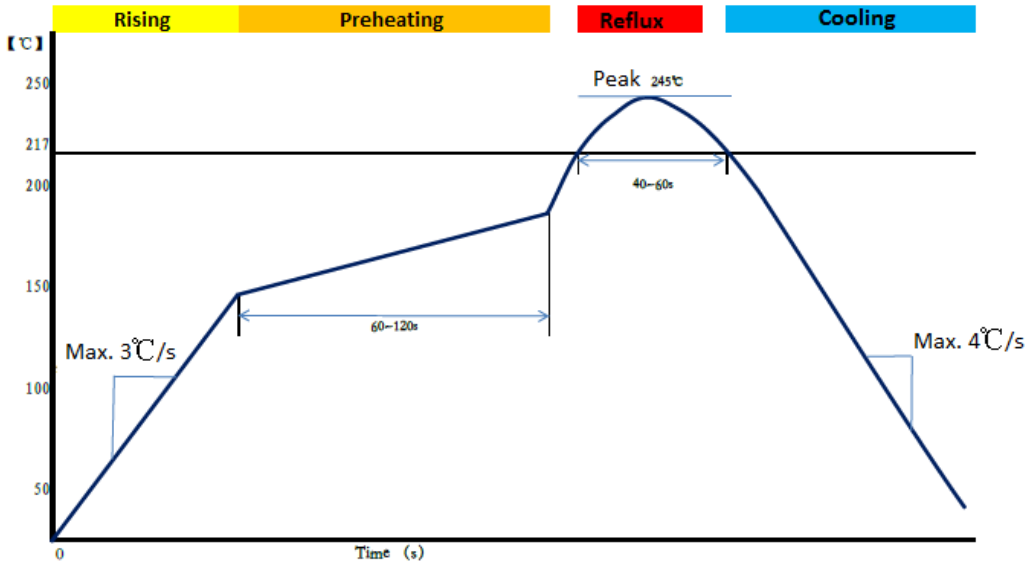


Figure 4-1 Soldering Temperature (Lead-free)

Temperature Rising Stage

- Rising slope: Max. 3 °C/s
- Rising temperature range: 50 °C ~ 150 °C

Preheating Stage

- Preheating time: 60s ~ 120 s
- Preheating temperature range: 150 °C ~ 180 °C

Reflux Stage

- Over melting temperature (217 °C) time: 40s ~ 60 s
- Peak temperature for soldering: no higher than 245 °C

Cooling Stage

- Cooling slope: Max. 4 °C / s

- In order to prevent falling off during soldering of modules, do not solder the module on the back of the board during design, and it is not recommended to go through soldering cycle twice.
- The setting of soldering temperature depends on many factors of the factory, such as board type, solder paste type, solder paste thickness etc. Please also refer to the relevant IPC standards and indicators of solder paste.
- Since the lead soldering temperature is relatively low, if using this method, please give priority to other components on the board.
- The opening of the stencil needs to meet your design requirement and comply to the examine standards. The thickness of the stencil is recommended to be larger than 0.18 mm.

5 Packaging

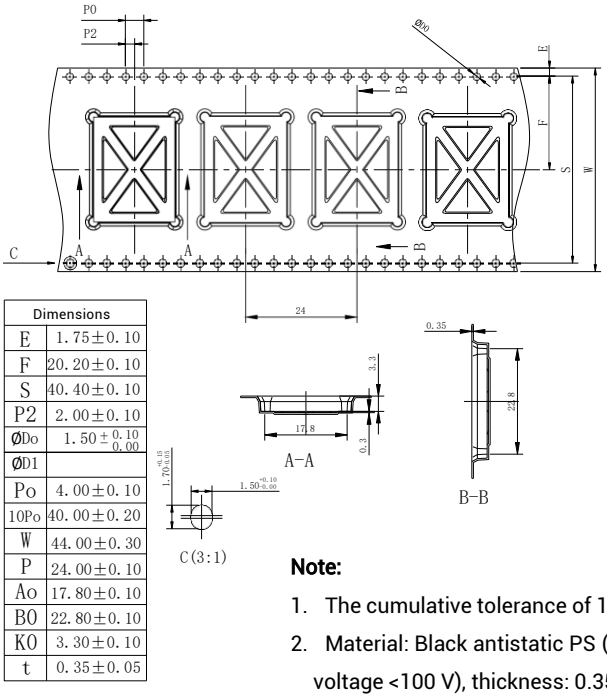
5.1 Label Description

Figure 5-1 Label Description

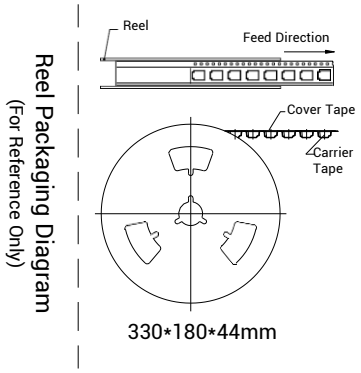
5.2 Product Packaging

The UM980 module uses carrier tape and reel (suitable for mainstream surface mount devices), packaged in vacuum-sealed aluminum foil antistatic bags, with a desiccant inside to prevent moisture. When using reflow soldering process to solder modules, please strictly comply with IPC standard to conduct humidity control on the modules. As packaging materials such as the carrier tape can only withstand the temperature of 55 degrees Celsius, modules shall be removed from the package during baking.

Figure 5-2 UM980 Package



Dimensions	
E	1.75±0.10
F	20.20±0.10
S	40.40±0.10
P2	2.00±0.10
ØDo	1.50 +0.10 0.00
ØD1	
Po	4.00±0.10
10Po	40.00±0.20
W	44.00±0.30
P	24.00±0.10
Ao	17.80±0.10
BO	22.80±0.10
KO	3.30±0.10
t	0.35±0.05



Note:

1. The cumulative tolerance of 10 side holes should not exceed ±0.2 mm.
2. Material: Black antistatic PS (surface impedance 10^5-10^{11}) (surface static voltage <100 V), thickness: 0.35 mm.
3. Total length of the 13-inch reel package: 6.816 m (Length of the first part of empty packets: 0.408 m, length of packets containing modules: 6 m, length of the last part of empty packets: 0.408 m).
4. Total number of packets in the 13-inch reel package: 284 (Number of the first part of empty packets: 17; actual number of modules in the packets: 250; number of the last part of empty packets: 17).
5. All dimension designs are in accordance with EIA-481-C-2003.
6. The maximum bending degree of the carrier tape within the length of 250 mm should not exceed 1 mm (see the figure below).

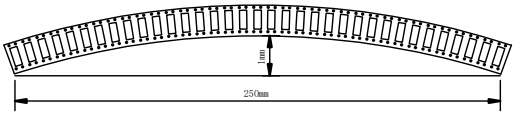


Figure 5-3 UM980 Reel Package Diagram

Table 5-1 Package Description

Item	Description
Module Number	250 pieces/reel
Reel Size	Tray: 13" External diameter: 330 ± 2 mm, Internal diameter: 180 ± 2mm, Width: 44.5 ± 0.5 mm Thickness: 2.0 ± 0.2 mm
Carrier Tape	Space between (center-to-center distance): 24 mm

Before surface mounting, make sure that the color of the 30% circle on the HUMIDITY INDICATOR is blue (see Figure 5-4). If the color of the 20% circle is pink and the color of the 30% circle is lavender (see Figure 5-5), you must bake the module until it turns to blue. The UM980 is rated at MSL level 3. Refer to the relevant IPC/JEDEC J-STD-020 standards for the package and operation requirements. Users may access to the website www.jedec.org to get more information.

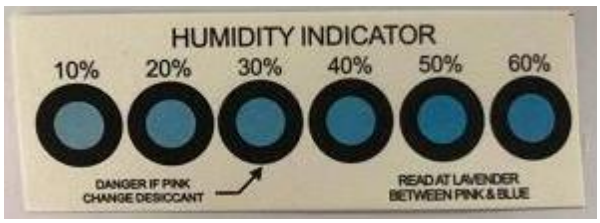


Figure 5-4 Normal Humidity Indication

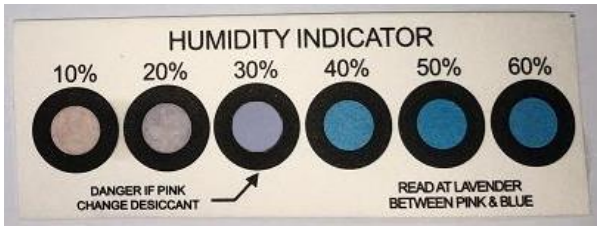


Figure 5-5 Abnormal Humidity Indication

The shelf life of the UM980 module packaged in vacuum-sealed aluminum foil antistatic bags is one year.

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