INSTALLATION AND OPERATION

USER MANUAL

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UM982

GPS/BDS/GLONASS/Galileo/QZSS

All-constellation Multi-frequency High Precision Positioning & Heading Module

Revision History

Version	Revision History	Date
R1.0	First release	2022-05
R1.1	Table 2-1: Update the description of V_BCKP pin; Chapter 3.3: Add requirement for V_BCKP; Add chapter 3.1: Recommended Minimal Design; Table 2-4: Update the IO threshold; Chapter 5.2: Update the description of the humidity indicator; Table 1-1: Update the heading accuracy (0.1°/1m baseline)	2022-09
R1.2	Add Chapter 3.5 Recommended PCB Package Design; Optimize Chapter 3.2 Antenna Feed Design; Optimize Chapter 3.3 Power-on and Power-off	2023-04
R1.3	Add PPP accuracy in section 1.2	2023-09
R1.4	Update section 3.3 Power-on and Power-off; Add the placement direction of UM982 in Figure 5-3	2024-03

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Foreword

This document describes the information of the hardware, package, specification and the use of Unicore UM982 module.

Target Readers

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

Contents

1 Introduction

UM982 is a new generation of GNSS high precision positioning and heading module developed by Unicore Communications. It supports GPS/BDS/GLONASS/Galileo/QZSS, and can simultaneously track GPS L1/L2/L5, BDS B1I/B2I/B3I, GLONASS G1/G2, Galileo E1/E5a/E5b, and QZSS L1/L2/L5. The module is mainly used in UAVs, lawn mowers, precision agriculture, and intelligent driving. With the support of on-chip RTK positioning and dual-antenna heading solution, UM982 can be used as a rover or base station.

UM982 is based on NebulasIV™, a GNSS SoC which integrates 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 capability.

UM982 allows a flexible configuration of multi-system joint positioning or single system standalone positioning. With the built-in advanced anti-jam unit, the module can achieve high accuracy even in the complex electromagnetic environment.

Furthermore, UM982 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 UM982 Module

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

1.1 Key Features

- 16 mm × 21 mm × 2.6 mm, surface-mount device
- Supports all-constellation multi-frequency on-chip RTK positioning and dual-antenna heading solution
- Supports BDS B1I/B2I/B3I + GPS L1/L2/L5 + GLONASS G1/G2 + Galileo E1/E5a/E5b + QZSS L1/L2/L5 + SBAS
- Dual-RTK engine technology
- Adaptive recognition of RTCM input data format
- Dual antenna input
- Supports 3 × UART, 1 × I²C*, 1 × SPI* and 1 × CAN*

1.2 Key Specifications

Table 1-1 Technical Specifications

Basic Information	
Channels	1408 channels, based on NebulasIV™
Constellations	BDS/GPS/GLONASS/Galileo/QZSS
Master Antenna Frequencies	BDS: B1I, B2I, B3I GPS: L1 C/A, L2P (Y)/L2C, L5 GLONASS: G1, G2 Galileo: E1, E5a, E5b QZSS: L1, L2, L5
Slave Antenna Frequencies	BDS: B1I, B2I, B3I GPS: L1 C/A, L2C GLONASS: G1, G2 Galileo: E1, E5b QZSS: L1, L2
Power	
Voltage	+3.0 V ~ +3.6 V DC

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

Power Consumption	600 mW[1]			
Performance[2]				
Positioning Accuracy	Single Point Positioning[3] (RMS)	Horizontal: 1.5 m		
		Vertical: 2.5 m		
	DGPS (RMS)[3,4]	Horizontal: 0.4 m + 1ppm		
		Vertical: 0.8 m + 1ppm		
	RTK (RMS)[3, 4]	Horizontal: 0.8 cm + 1 ppm		
		Vertical: 1.5 cm + 1 ppm		
	PPP (RMS)[5]	Horizontal: 5 cm		
		Vertical: 10 cm		
Observation Accuracy (RMS)	BDS	GPS	GLONASS	Galileo
B1I/L1 C/A/G1/E1 Pseudorange	10 cm	10 cm	10 cm	10 cm
B1I/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/L5/E5a/E5b Pseudorange	10 cm	10 cm	10 cm	10 cm
B2I/L5/E5a/E5b Carrier Phase	1 mm	1 mm	1 mm	1 mm
Heading Accuracy (RMS)	0.1°/1m baseline			
Time Pulse Accuracy (RMS)	20 ns			
Velocity Accuracy[6] (RMS)	0.03 m/s			

[1] Dual antenna 10 Hz PVT + 10 Hz RTK + 10 Hz Heading

[2] Performance specifications of the master antenna

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

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

[5] After 20 minutes of convergence under open sky without jamming

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

Time to First Fix[7] (TTFF)	Cold Start < 30 s
	Hot Start < 4 s
Initialization Time[3]	< 5 s (Typical)
Initialization Reliability[3]	> 99.9%
Data Update Rate	20 Hz Positioning & Heading 20 Hz Raw Data observation
Differential Data	RTCM 3.X
Data Format	NMEA-0183, Unicore
Physical Characteristics	
Package	48 pin LGA
Dimensions	21 mm × 16 mm × 2.6 mm
Weight	1.82 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	
I^2C* × 1	
SPI* × 1	Slave
CAN* × 1	Shared with UART3

[7] -130dBm @ more than 12 available satellites

* I^2C, SPI, CAN: reserved interfaces, not supported currently

1.3 Block Diagram

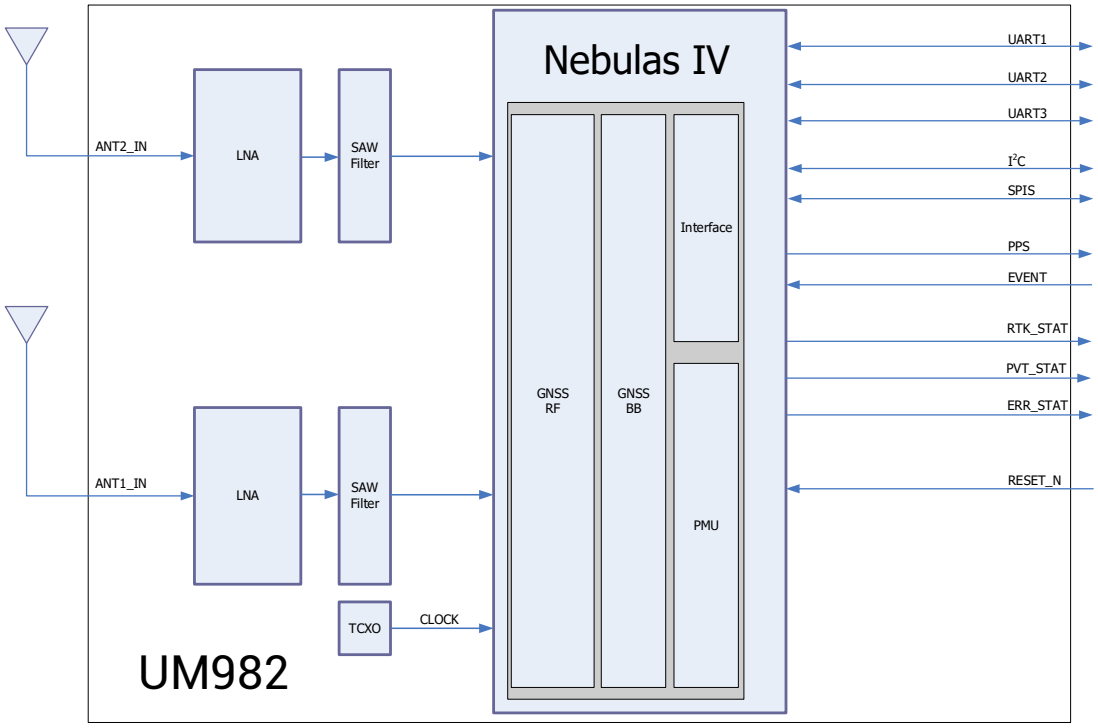


Figure 1-2 UM982 Block Diagram

- **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 Unicore's new generation high precision GNSS SoC with 22 nm low power design, supporting all constellations, multiple 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/heading independently.

- **External Interfaces**

The external interfaces of UM982 include UART, I²C*, SPI*, CAN*, PPS, EVENT, RTK_STAT, PVT_STAT, ERR_STAT, RESET_N, etc.

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

2 Hardware

2.1 Pin Definition

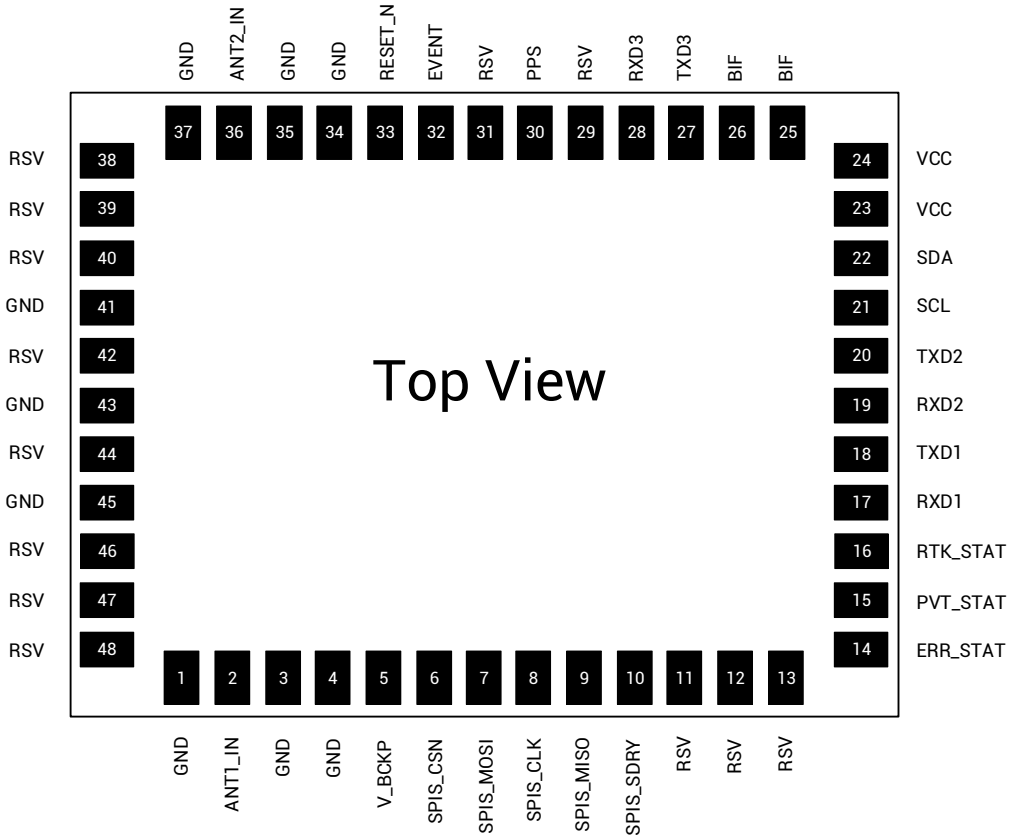


Figure 2-1 UM982 Pin Definition

Table 2-1 Pin Description

No.	Pin	I/O	Description
1	GND	—	Ground
2	ANT1_IN	I	GNSS master antenna signal input
3	GND	—	Ground
4	GND	—	Ground
5	V_BCKP	I	When the main power supply VCC is cut off, V_BCKP supplies power to RTC and relevant register. Level requirement: 2.0 V ~ 3.6 V, and the working current should be less than 60 μA at 25 °C. If you do not use the hot start function, connect V_BCKP to VCC. Do NOT connect it to

No.	Pin	I/O	Description
			ground or leave it floating.
6	SPIS_CSN	I	Chip select pin for SPI slave
7	SPIS_MOSI	I	Master Out / Slave In. This pin is used to receive data in slave mode.
8	SPIS_CLK	I	Clock input pin for SPI slave
9	SPIS_MISO	O	Master In / Slave Out. This pin is used to transmit data in slave mode.
10	SPIS_SDRY	O	Interrupt output of SPI slave
11	RSV	—	Reserved, floating
12	RSV	—	Reserved, floating
13	RSV	—	Reserved, floating
14	ERR_STAT	O	Error status: active high; outputs high when failing self-test, and low when passing self-test
15	PVT_STAT	O	PVT status: active high; outputs high when positioning and low when not positioning
16	RTK_STAT	O	RTK status: active high; outputs high for RTK fixed solution and low for other positioning status or no positioning
17	RXD1	I	COM1 input, LVTTL level
18	TXD1	O	COM1 output, LVTTL level
19	RXD2	I	COM2 input, LVTTL level
20	TXD2	O	COM2 output, LVTTL level
21	SCL	I/O	I^2C clock
22	SDA	I/O	I^2C data
23	VCC	POWER	Power supply (+3.3 V)

No.	Pin	I/O	Description
24	VCC	POWER	Power supply (+3.3 V)
25	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, cannot input/output data, and cannot be floating
26	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, cannot input/output data, and cannot be floating
27	TXD3	O	COM3 output, which can be used as CAN TXD, LVTTL level
28	RXD3	I	COM3 input, which can be used as CAN RXD, LVTTL level
29	RSV	—	Reserved, floating
30	PPS	O	Pulse per second, with adjustable pulse width and polarity
31	RSV	—	Reserved, floating
32	EVENT	I	Event mark input, with adjustable frequency and polarity
33	RESET_N	I	System reset, active low, and the active time should be no less than 5 ms.
34	GND	—	Ground
35	GND	—	Ground
36	ANT2_IN	I	GNSS slave antenna signal input
37	GND	—	Ground
38	RSV	—	Reserved, floating
39	RSV	—	Reserved, floating
40	RSV	—	Reserved, floating
41	GND	—	Ground

No.	Pin	I/O	Description
42	RSV	—	Reserved, floating
43	GND	—	Ground
44	RSV	—	Reserved, floating
45	GND	—	Ground
46	RSV	—	Reserved, floating
47	RSV	—	Reserved, floating
48	RSV	—	Reserved, floating

2.2 Electrical Specifications

2.2.1 Absolute Maximum Ratings

Table 2-2 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
Master/Slave Antenna Signal Input	ANT1_IN/ANT2_IN	-0.3	6	V
Master/Slave Antenna RF Input Power	ANT1_IN/ANT2_IN input power		+10	dBm
Storage Temperature	T_{stg}	-55	95	°C

2.2.2 Operating Conditions

Table 2-3 Operating 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}		180	300	mA	VCC=3.3 V
Operating Temperature	T_{opr}	-40		85	°C	
Power Consumption	P		600		mW	

2.2.3 IO Threshold

Table 2-4 IO Threshold

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Low Level Input Voltage	V_{in_low}	0		0.6	V	
High Level Input Voltage	V_{in_high}	VCC × 0.7		VCC + 0.2	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

2.2.4 Antenna Feature

Table 2-5 Antenna Feature

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

[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 Dimensions

Table 2-6 Dimensions

Parameter	Min. (mm)	Typ. (mm)	Max. (mm)
A	20.80	21.00	21.50
B	15.80	16.00	16.50
C	2.40	2.60	2.80
D	2.78	2.88	2.98
E	0.95	1.05	1.15
F	1.55	1.65	1.75
G	1.17	1.27	1.37
H	0.70	0.80	0.90
K	1.40	1.50	1.60
M	4.10	4.20	4.30
N	3.70	3.80	3.90
P	2.00	2.10	2.20
R	0.90	1.00	1.10
X	0.72	0.82	0.92

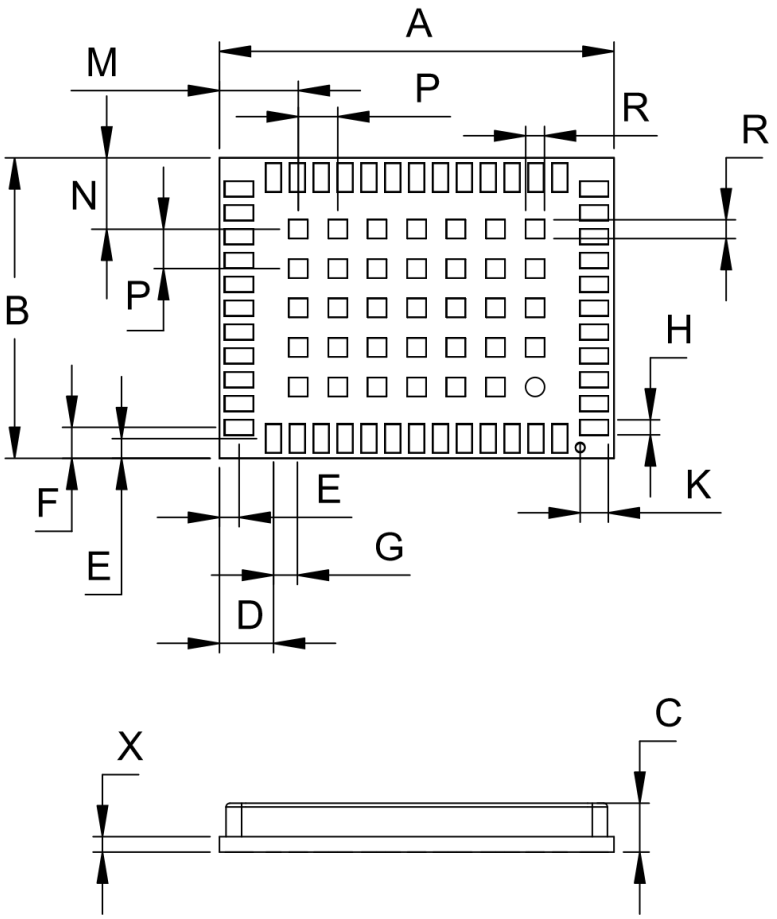


Figure 2-2 UM982 Mechanical Dimensions

3 Hardware Design

3.1 Recommended Minimal Design

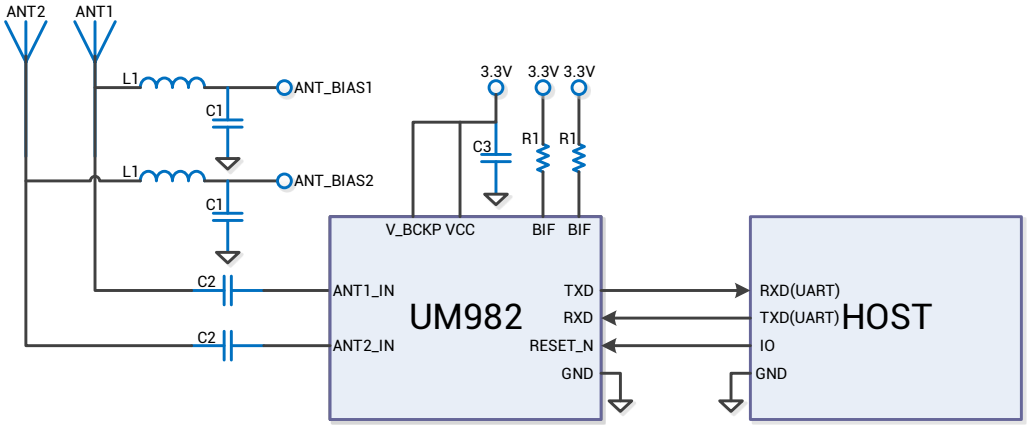


Figure 3-1 Recommended Minimal Design

L1: 68 nH RF inductor in 0603 package is recommended

C1: 100 nF + 100 pF capacitors connected in parallel is recommended

C2: 100 pF capacitor is recommended

C3: N * 10 μF + 1 * 100 nF capacitors connected in parallel is recommended, and the total inductance should be no less than 30 μF

R1: 10 kΩ resistor is recommended

3.2 Antenna Feed Design

When feeding the antenna from the outside, you can 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 improve the protection.

⚠ If the antenna feed supply ANT_BIAS and the module's main supply VCC use the same power rail, the ESD, surge and overvoltage from the antenna will have an effect on VCC, which may cause damage to the module. Therefore, it is recommended to design an independent power rail for the ANT_BIAS to reduce the possibility of module damage.

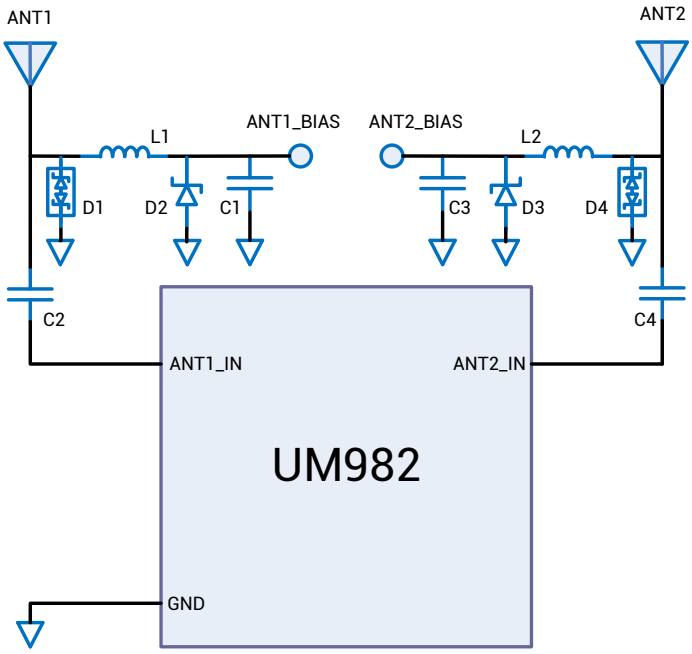


Figure 3-2 UM982 External Antenna Feed Reference Circuit

Notes:

- L1 and L2: feed inductor, 68 nH RF inductor in 0603 package is recommended
- C1and C3: decoupling capacitor, recommended to connect two capacitors of 100 nF / 100 pF in parallel
- C2 and C4: DC blocking capacitor, recommended 100 pF capacitor
- D1and D4: ESD diode, choose the ESD protection device that supports high frequency signals (above 2000 MHz)
- D2 and D3: TVS diode, choose the TVS diode with appropriate clamping specification according to the requirement of feed voltage and antenna withstand voltage

3.3 Power-on and Power-off

VCC

- The VCC initial level when power-on should be less than 0.4 V.
- The VCC ramp when power-on should be monotonic, without plateaus.
- The voltages of undershoot and ringing should be within 5% VCC.
- Power-on time interval: The time interval between the power-off (VCC < 0.4 V) to the next power-on must be larger than 500 ms.

☞ For the module with the PN of 2310415000002, the VCC power-on waveform rising from 10% to 90% should be within 100 μs ~ 1 ms.

V_BCKP

- The V_BCKP initial level when power-on should be less than 0.4 V.
- The V_BCKP ramp when power-on should be monotonic, without plateaus.
- The voltages of undershoot and ringing should be within 5% V_BCKP.
- Power-on time interval: The time interval between the power-off (V_BCKP < 0.4 V) to the next power-on must be larger than 500 ms.

3.4 Grounding and Heat Dissipation

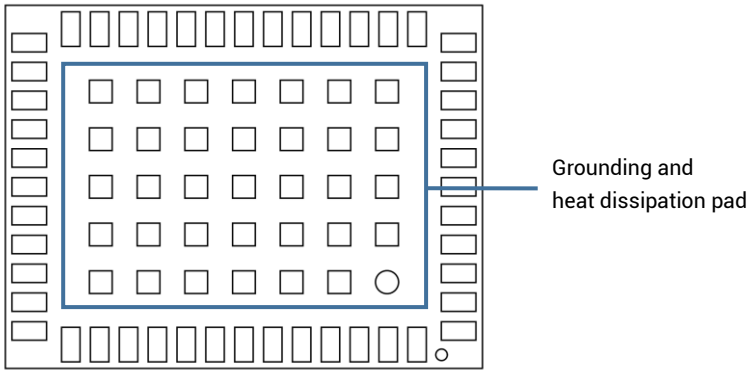


Figure 3-3 Grounding and Heat Dissipation Pad (Bottom View)

The 35 pads in the rectangle in Figure 3-3 are for grounding and heat dissipation. In the PCB design, the pads should be connected to a large sized ground to strengthen the heat dissipation.

3.5 Recommended PCB Package Design

See the following figure for the recommended PCB package design.

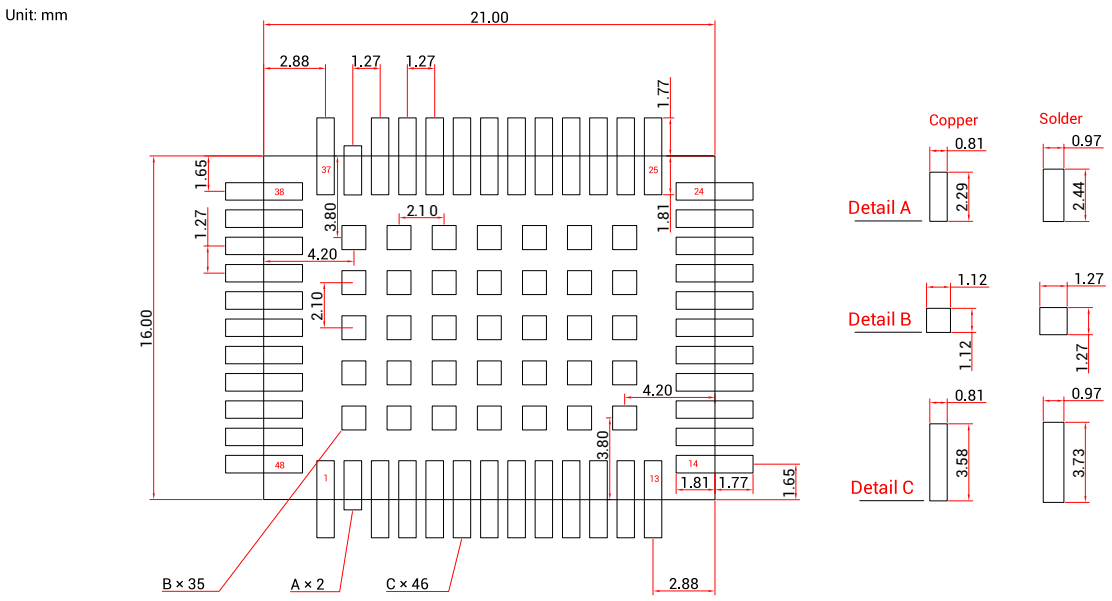


Figure 3-4 Recommended PCB Package Design

Notes:

For the convenience of testing, the soldering pads of the pins are designed long, exceeding the module border much more. For example:

- The pads denoted as detail C are 1.77 mm longer than the module border.
- The pad denoted as detail A is 0.47 mm longer than the module border. It is relatively short as it is an RF pin pad, so we hope the trace on the surface is as short as possible to reduce the impact of external interference on the RF signals.

4 Production Requirement

Recommended soldering temperature curve is as follows:

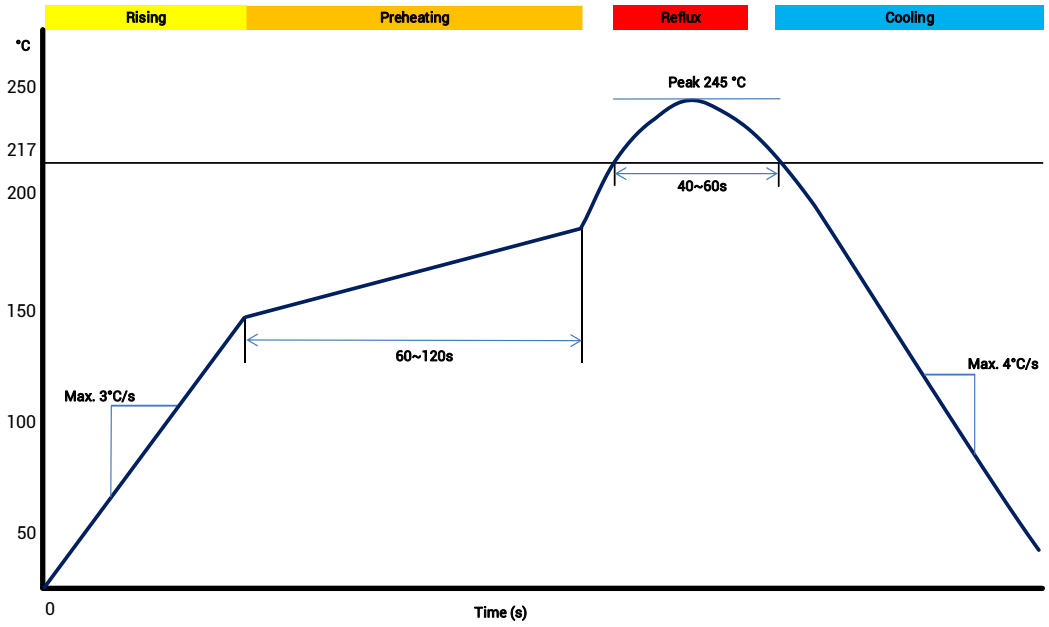


Figure 4-1 Soldering Temperature (Lead-free)

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 the module, do not solder it 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 with the examine standards. The thickness of the stencil is recommended to be larger than 0.15 mm.

5 Packaging

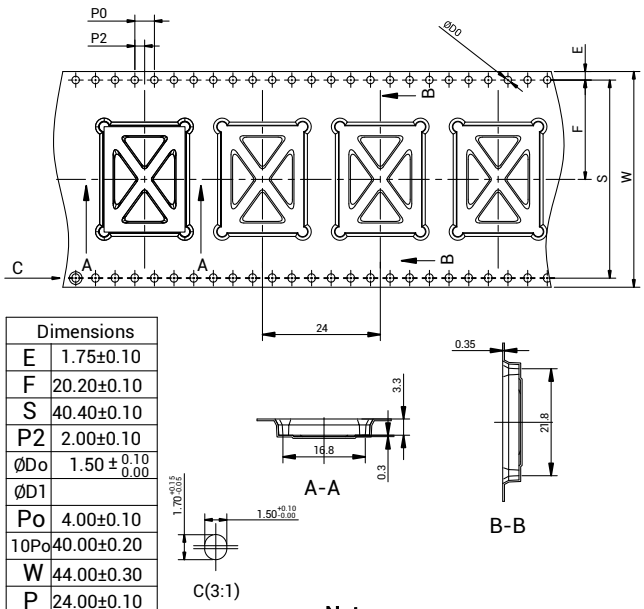
5.1 Label Description

Figure 5-1 Label Description

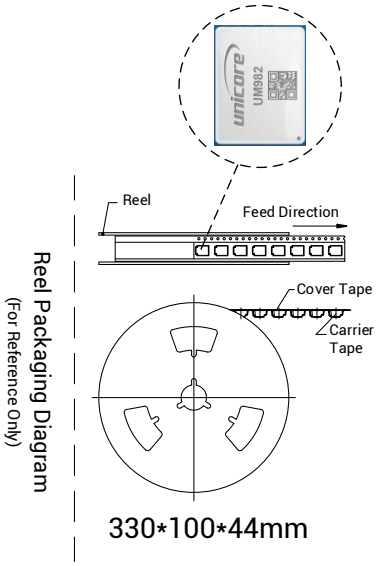
5.2 Product Packaging

The UM982 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 temperature and humidity control. As packaging materials such as the carrier tape can only withstand the temperature of 55 °C, modules shall be removed from the package during baking.

Figure 5-2 UM982 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	16.80±0.10
B0	21.80±0.10
K0	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 of the tape: 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).

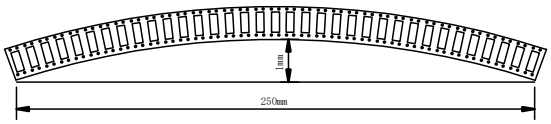


Figure 5-3 UM982 Reel Package Diagram

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.

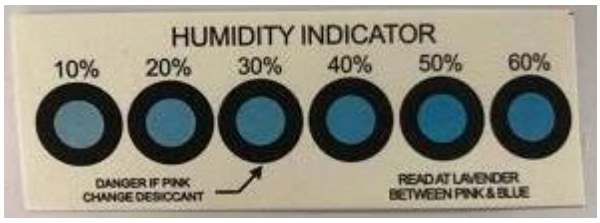


Figure 5-4 Normal Humidity Indication

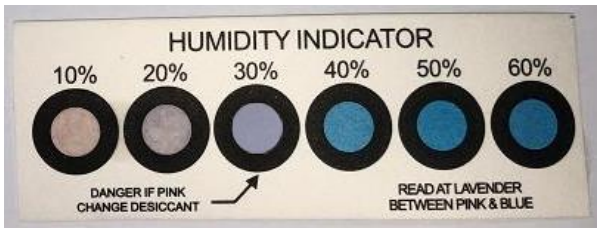


Figure 5-5 Abnormal Humidity Indication

The UM982 is rated at MSL level 3. Please refer to the IPC/JEDEC J-STD-033 standards for the package and operation requirements. You may access to the website www.jedec.org to get more information.

The shelf life of the UM982 module packaged in vacuum-sealed aluminum foil antistatic bags is one year.

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