INSTALLATION AND OPERATION

USER MANUAL

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UM982

GPS/BDS/GLONASS/Galileo/QZSS

All-Constellation Multi-Frequency High Precision Positioning & Heading Module

Foreword

Applicability

This document describes the information of the hardware and specifications of Unicore UM982 module.

Target Readers

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

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Revision History

Version	Revision History	Date
R1.0	First release.	May., 2022
R1.1	Table 2-1: Updated the description of V_BCKP pin. Chapter 3.3: Added a requirement for V_BCKP. Added chapter 3.1: Recommended Minimal Design. Table 2-4: Updated the IO threshold. Chapter 5.2: Updated the description of the humidity indicator. Table 1-1: Updated the heading accuracy (0.1°/1m baseline).	Sept., 2022
R1.2	Added **Chapter 3.5 Recommended PCB Package Design**. Optimized **Chapter 3.2 Antenna Feed Design.** Optimized **Chapter 3.3 Power-on and Power-off**.	Apr., 2023
R1.3	Added PPP accuracy in **1.2 Key Features**.	Sept., 2023
R1.4	Updated **3.3 Power-on and Power-off**. Added the placement direction of UM982 in **Figure 5-3 UM982 Reel Package Diagram**.	Mar., 2024
R1.5	Added parameters of Y, T and Ø in **Figure 2-2 UM982 Mechanical Dimensions**.	Sept., 2024
R1.6	Updated **3.5 Recommended Footprint on the PCB**. Updated the stencil thickness suggestion in **4 Production Requirements**. Added PNs in **5.1 Label Descriptions**.	Mar., 2025
R1.7	Added a note in **3.5 Recommended Footprint on the PCB**. Added a note in **4 Production Requirements**.	Mar., 2025

Version	Revision History	Date
R1.8	Added BDS B1C/B2b, Galileo E6, QZSS L6 in the supported frequency list in **1.2 Key Features** and **Table 1-1 UM982 Technical Specifications**. Added description of the supported PPP services in **1.2 Key Features**. Added a footnote about testing environments to the **Heading Accuracy** data in **1.3 Technical Specifications**.	Apr., 2025

Product Introduction

This chapter introduces the basic information about the UM982 module in the following aspects:

- Product descriptions
- Key features
- Technical specifications
- Block diagram

1.1 Product Descriptions

UM982 is an all-constellation, multi-frequency, high-precision GNSS positioning and heading module. The UM982 module is developed based on Unicore's proprietary chip — NebulasIV™, an RF-baseband and high-precision algorithm integrated GNSS SoC. For more information about NebulasIV™, see 1.4 Block Diagram.

UM982 is designed for UAVs, lawn mowers, precision agriculture, and intelligent driving. The module supports on-chip RTK positioning and dual-antenna heading solution, and can be used as a rover or a base station.

UM982 supports configuring the multi-system joint positioning mode or single-system standalone positioning mode, and tracking multiple signals. With the built-in anti-jamming unit, UM982 ensures high accuracy even in complex electromagnetic environments.

UM982 has various types of interfaces for different purposes, including UART, I2C*, SPI*, PPS, EVENT and CAN*. For details on the interfaces, see 1.3 Technical Specifications.

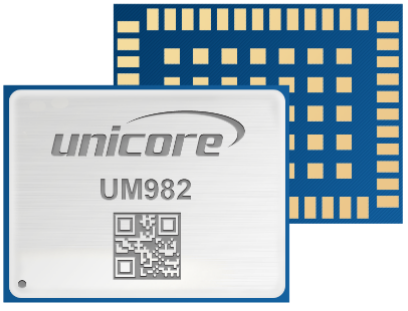

Figure 1-1 UM982 Module

*I2C, SPI and CAN are reserved interfaces and not supported currently.

1.2 Key Features

UM982 all-constellation, multi-frequency, high-precision GNSS positioning and heading module has the following capabilities:

- Dual antenna input,
- All-constellation, multi-frequency on-chip RTK positioning and dual-antenna heading solution,
- Multiple frequencies including BDS B1I/B2I/B3I/B1C/B2b, GPS L1/L2/L5, GLONASS G1/G2,Galileo E1/E5a/E5b/E6, QZSS L1/L2/L5/L6 and SBAS,
- E6-HAS, B2b-PPP and QZSS L6(MADOCA) PPP services,
- Dual-RTK engine technology,
- Adaptive recognition of RTCM input data format,
- Surface Mount Device (SMD) of 16 mm x 21 mm x 2.6 mm,
- Interfaces including UART (x3), I2C* (x1), SPI* (x1) and CAN* (x1).

For more information about UM982 constellations and frequencies, see 1.3 Technical Specifications.

1.3 Technical Specifications

This section introduces the technical specifications of the UM982 module, including the constellations, frequencies, positioning and heading accuracy, etc. For more information, see **Table 1-1**.

Table 1-1 UM982 Technical Specifications

Basic Information	
Channels	1408 channels, based on NebulasIV™
Constellations	BDS, GPS, GLONASS, Galileo, QZSS

Basic Information	
Master Antenna Frequencies	BDS: B1I, B2I, B3I GPS: L1C/A, L2P(Y)/L2C, L5 GLONASS: G1, G2 Galileo: E1, E5a, E5b QZSS: L1, L2, L5 For more information, see the SIGNALGROUP section in *Unicore Reference Commands Manual for N4 High Precision Products_V2*.
Slave Antenna Frequencies	BDS: B1I, B2I, B3I GPS: L1C/A, L2C GLONASS: G1, G2 Galileo: E1, E5b QZSS: L1, L2 For more information, see the SIGNALGROUP section in *Unicore Reference Commands Manual for N4 High Precision Products_V2*.

Power	
Voltage	+3.0 V~3.6 V DC
Power Consumption	600 mW[1]

Performance[2]	
Single Point Positioning (RMS)[3]	Horizontal: 1.5 m Vertical: 2.5 m
DGPS (RMS)[3,4]	Horizontal: 0.4 m+1 ppm Vertical: 0.8 m+1 ppm
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
Heading Accuracy (RMS)[10]	0.1°/1m baseline
PPS (RMS)	20 ns

Performance[2]	
Velocity Accuracy (RMS) [6]	0.03 m/s
TTFF[7]	Cold Start < 30 s Hot Start < 4 s
Initialization Time[3]	< 5 s (typ.)
Initialization Reliability[3]	> 99.9%
Data Update Rate	20 Hz positioning and heading 20 Hz raw measurements
Differential Data	RTCM 3.X
Data Format	NMEA-0183 Unicore

Observation Accuracy (RMS)[2]				
	BDS	GPS	GLONASS	Galileo
B1I, L1C/A, G1, E1 Pseudorange	10 cm	10 cm	10 cm	10 cm
B1I, L1C/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

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	x 3
I2C*	x 1
SPI*	x 1 Slave
CAN*	x 1 Shared with UART3

*. I2C, SPI and CAN are reserved interfaces and not supported currently.

1. Dual antenna 10 Hz PVT + 10 Hz RTK + 10 Hz Heading.

2. Performance specifications of the UM982 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.

7. -130dBm @ more than 12 available satellites.

10. Lab testing under ideal conditions.

1.4 Block Diagram

This section introduces the structure of the UM982 module, which mainly describes the RF part, GNSS SoC and external interfaces.

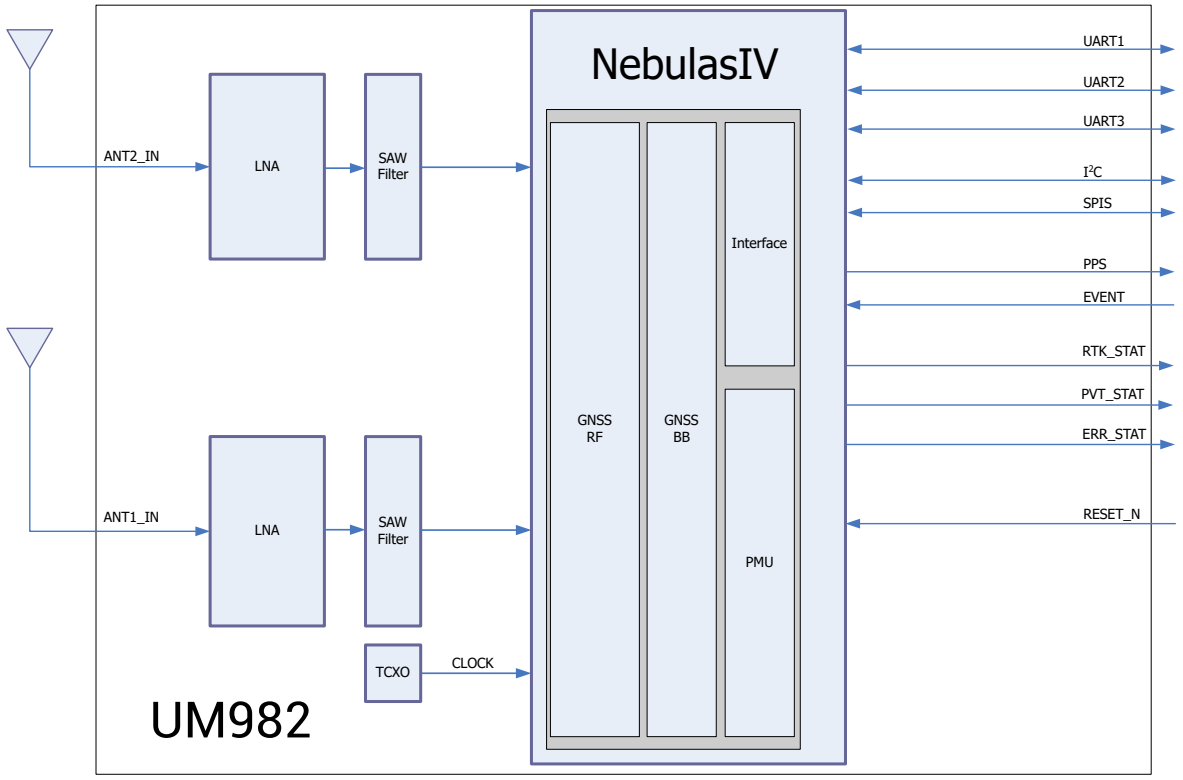

Figure 1-2 UM982 Block Diagram

(1) RF

The receiver gets filtered and enhanced GNSS signals 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.

(2) NebulasIV™

NebulasIV™ is Unicore's proprietary GNSS SoC that has integrated RF, baseband and high-precision algorithm, supporting all constellations and multiple frequencies. The chip has the following characteristics:

- designed with 22 nm low power consumption technique,
- supporting 1408 channels,
- integrating a built-in dual-core CPU, a high-speed floating point processor and an RTK co-processor,

- fulfilling the high-precision baseband processing and RTK positioning/heading independently.

(3) External Interfaces

UM982 has the following external interfaces:

- UART
- I2C*
- SPI*
- CAN*
- PPS
- EVENT
- RTK_STAT
- PVT_STAT
- ERR_STAT
- RESET_N

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*I2C, SPI and CAN are reserved interfaces and not supported currently.

Hardware Introduction

This chapter introduces the hardware information of the UM982 module in the following aspects:

- Pin definitions
- Electrical specifications
- Dimensions

2.1 Pin Definitions

UM982 module has 48 pins. **Figure 2-1** displays the layout of the pins, **Table 2-1** is the pin descriptions.

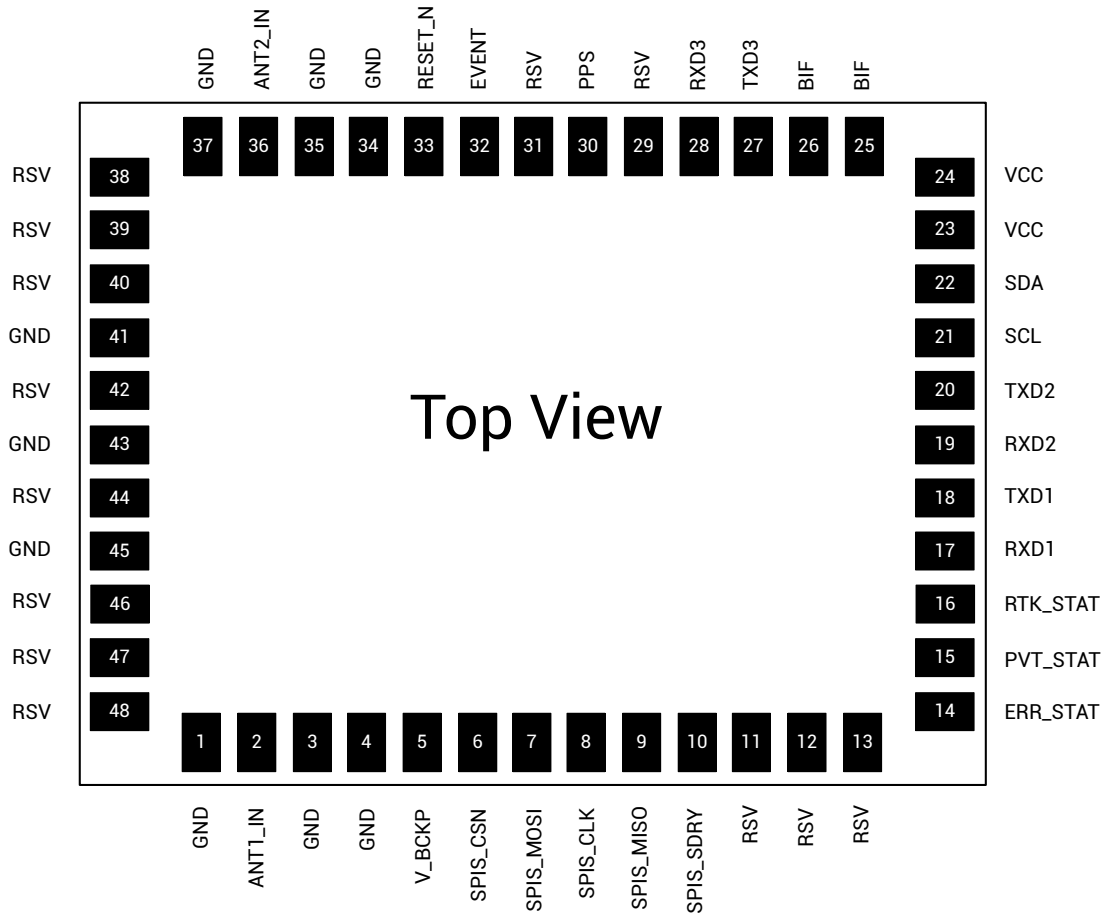


Figure 2-1 UM982 Pins

Table 2-1 UM982 Pin Descriptions

No.	Pins	I/O	Descriptions
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 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. Leave floating.
12	RSV	/	Reserved. Leave floating.
13	RSV	/	Reserved. Leave floating.
14	ERR_STAT	O	Error status: active high; Outputs high when failing self-test, and low when passing self-test.

No.	Pins	I/O	Descriptions
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	I2C clock
22	SDA	I/O	I2C data
23	VCC	POWER	Power supply (+3.3 V)
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

No.	Pins	I/O	Descriptions
29	RSV	/	Reserved. Leave floating.
30	PPS	O	Pulse per second, with adjustable pulse width and polarity
31	RSV	/	Reserved. Leave 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. Leave floating.
39	RSV	/	Reserved. Leave floating.
40	RSV	/	Reserved. Leave floating.
41	GND	/	Ground
42	RSV	/	Reserved. Leave floating.
43	GND	/	Ground
44	RSV	/	Reserved. Leave floating.
45	GND	/	Ground
46	RSV	/	Reserved. Leave floating.
47	RSV	/	Reserved. Leave floating.
48	RSV	/	Reserved. Leave floating.

2.2 Electrical Specifications

This section introduces the electrical specifications in the following aspects:

- Absolute Maximum Ratings
- Operating Conditions
- IO Threshold
- Antenna Feature

2.2.1 Absolute Maximum Ratings

Table 2-2 UM982 Absolute Maximum Ratings

Parameters	Symbols	Min.	Max.	Units
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 UM982 Operating Conditions

Parameters	Symbols	Min.	Typ.	Max.	Units	Conditions
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 UM982 IO Threshold

Parameters	Symbols	Min.	Typ.	Max.	Units	Conditions
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 UM982 Antenna Feature

Parameters	Symbols	Min.	Typ.	Max.	Units	Conditions
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

This section introduces the dimensions, including length, width, thickness, etc. of the UM982 module.

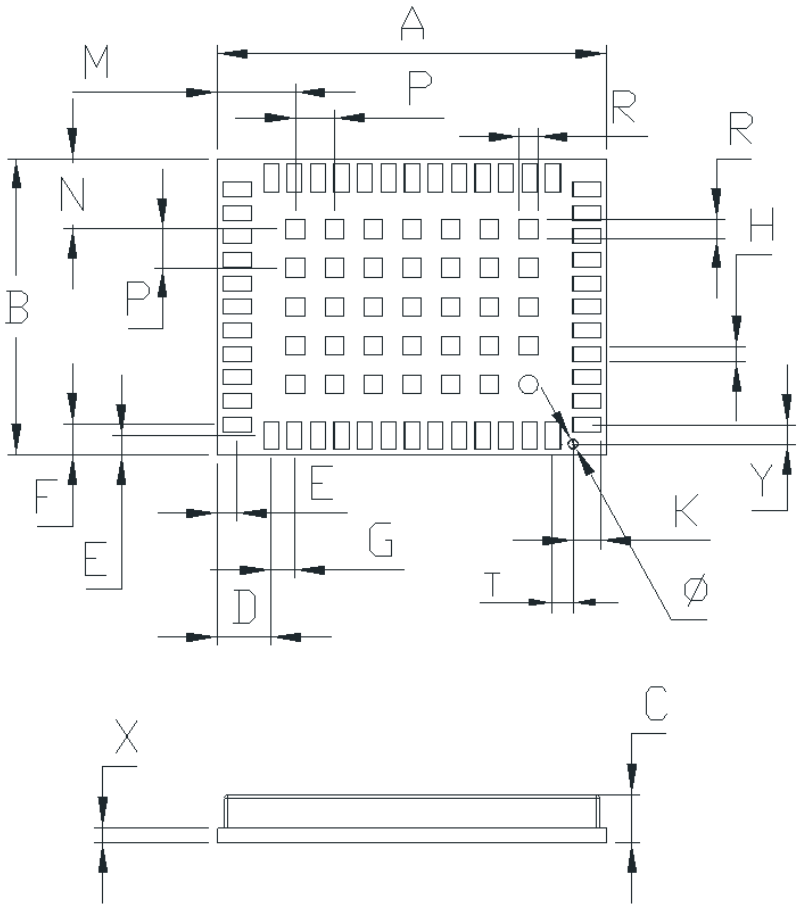


Figure 2-2 UM982 Mechanical Dimensions

Table 2-6 UM982 Dimensions

Parameters	Min. (mm)	Typ. (mm)	Max. (mm)
A	20.80	21.00	21.50
B	15.80	16.00	16.50

Parameters	Min. (mm)	Typ. (mm)	Max. (mm)
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
Y	1.00	1.05	1.10
T	1.03	1.08	1.13
Ø	0.41	0.51	0.61

Hardware Design

This chapter introduces the hardware design information of the UM982 module in the following aspects:

- Recommended minimal design
- Antenna feed design
- Power-on and power-off requirements
- Grounding and heat dissipation
- Recommended PCB design

3.1 Recommended Minimal Design

This section introduces the recommended minimal design for UM982, including the schematic diagram and the values of the inductors, capacitors and resistors.

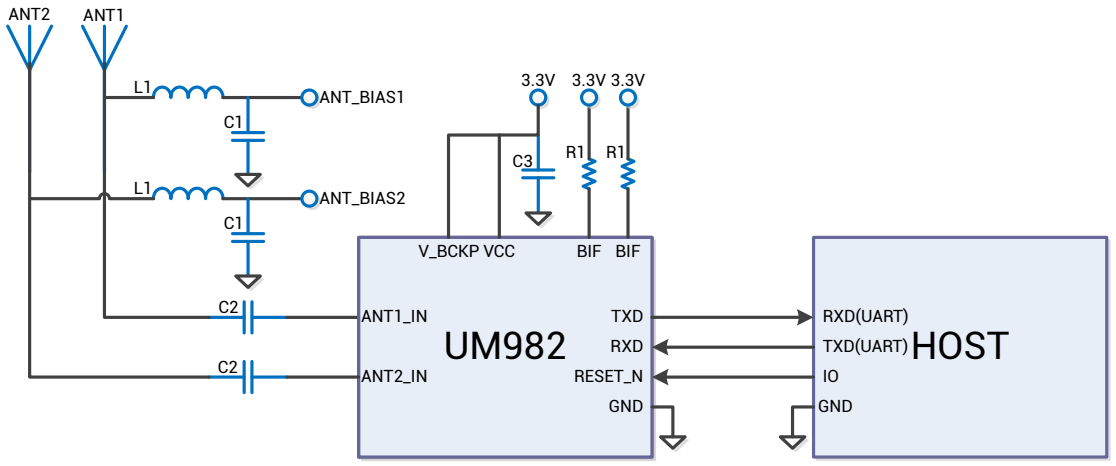


Figure 3-1 UM982 Recommended Minimal Design

Table 3-1 UM982 Recommended Minimal Design

Symbols	Descriptions
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.

Symbols	Descriptions
C3	N * 10 μF + 1 * 100 nF capacitors connected in parallel is recommended, and the total capacitance should be no less than 30 μF.
R1	10 kΩ resistor is recommended.

3.2 Antenna Feed Design

External power supply to the antenna is recommended for the UM982 module.

To improve the protection against lightning strikes and surges, the following measures are recommended:

- Use feeding chips that can withstand high voltage and with high power.
- Use gas discharge tubes, varistors, TVS tubes and other high-power protective devices in the power supply circuit.

> **Caution**
> The antenna power supply (ANT_BIAS) and the module's main power supply (VCC) shall use different power rails to reduce the risk of module damage. If ANT_BIAS and VCC share the same power rail, the ESD, surge and overvoltage coming from the antenna will be conducted to VCC, which may cause damage to the module.

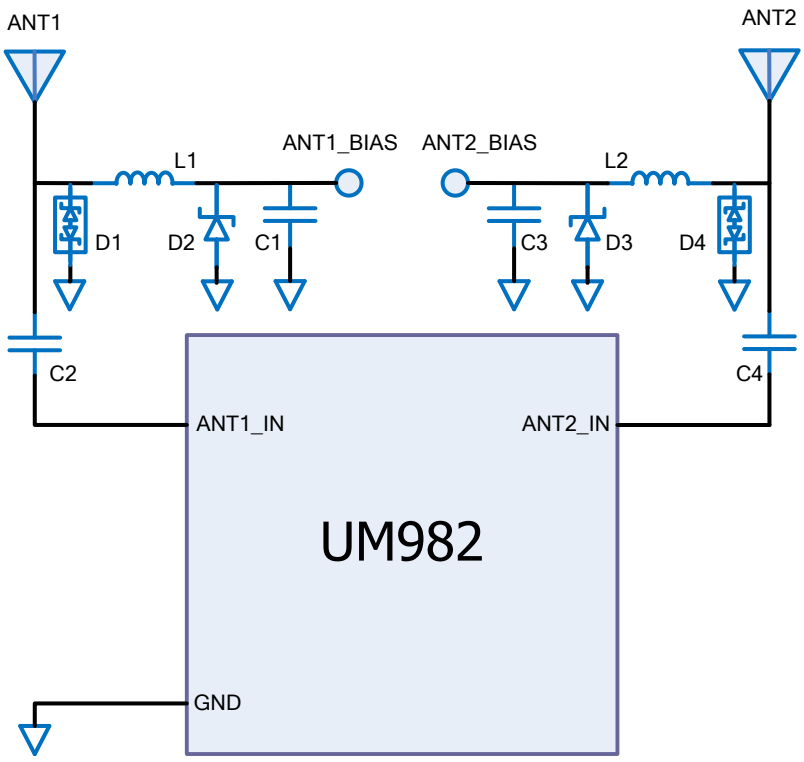


Figure 3-2 UM982 External Antenna Feed Reference Circuit

Table 3-2 UM982 External Antenna Feed Reference Circuit

Symbols	Descriptions
L1 and L2	Feed inductors, recommended 68 nH RF inductors in 0603 package.
C1 and C3	Decoupling capacitors, recommended to connect two capacitors of 100 nF / 100 pF in parallel.
C2 and C4	DC blocking capacitors, recommended 100 pF.
D1 and D4	ESD diodes, choose ESD protection devices that support high-frequency signals (above 2000 MHz).
D2 and D3	TVS diodes, choose those with appropriate clamping specification according to the requirement of the feed voltage and antenna withstand voltage.

3.3 Power-on and Power-off

To properly use UM982, please follow the requirements below:

(1) VCC

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

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

(2) V_BCKP

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

3.4 Grounding and Heat Dissipation

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

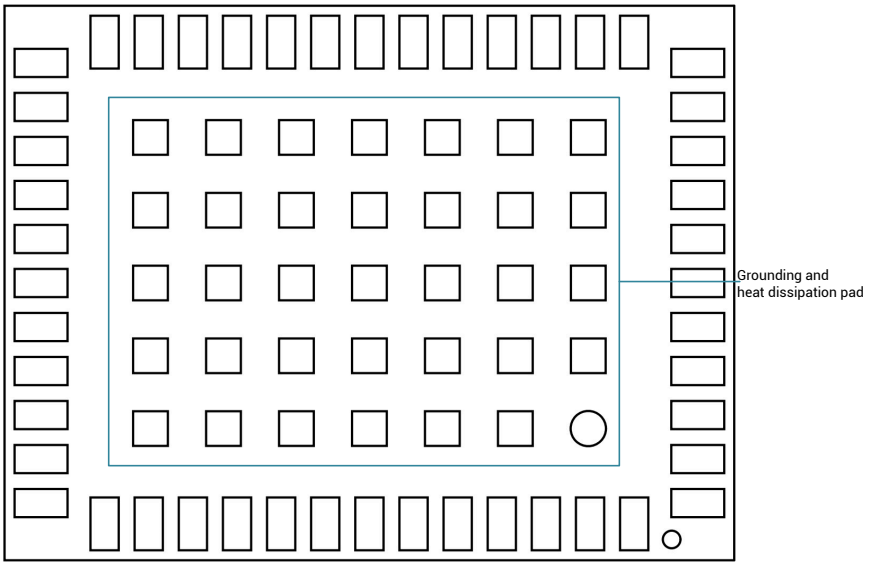


Figure 3-3 UM982 Grounding and Heat Dissipation Pad (Bottom View)

3.5 Recommended Footprint on the PCB

The dimensions of UM982's footprint on the PCB is recommended to be the same as that of the module's pads, as shown in **Figure 3-4 Recommended Footprint**. For more information about the module's dimensions, see Dimensions.

> **Note**
>
> For the convenience of hardware testing and debugging, proper test points can be added for the functional pins of the module.
>
> The dimensions of PCB pads can be optimized according to the specific production process to ensure manufacturability and reliability.

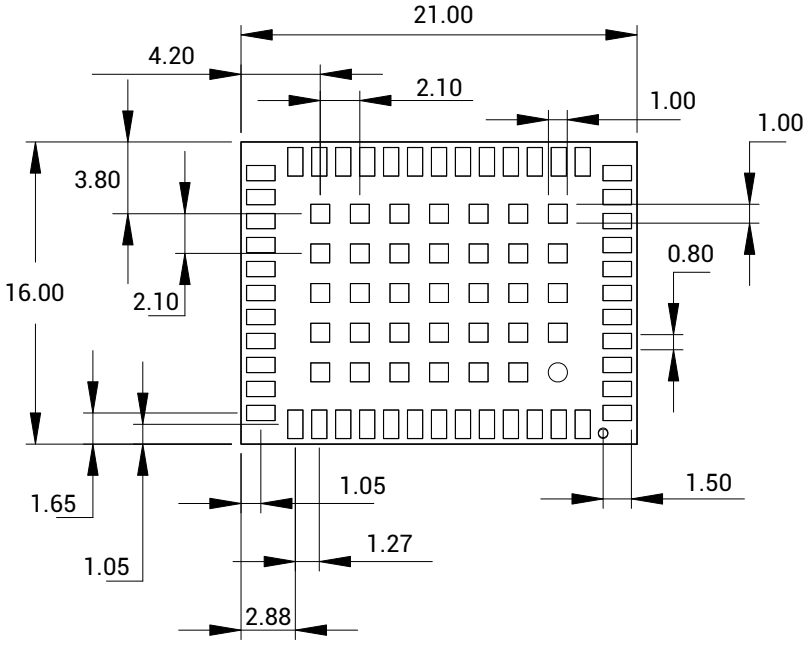


Figure 3-4 Recommended Footprint (Unit: mm)

Production Requirements

This chapter introduces the recommended soldering temperature and stencil design suggestions.

4.1 Soldering

Lead-free soldering is recommended for UM982. **Figure 4-1** is the lead-free soldering temperature curve, and **Table 4-1** is the descriptions of each soldering stage.

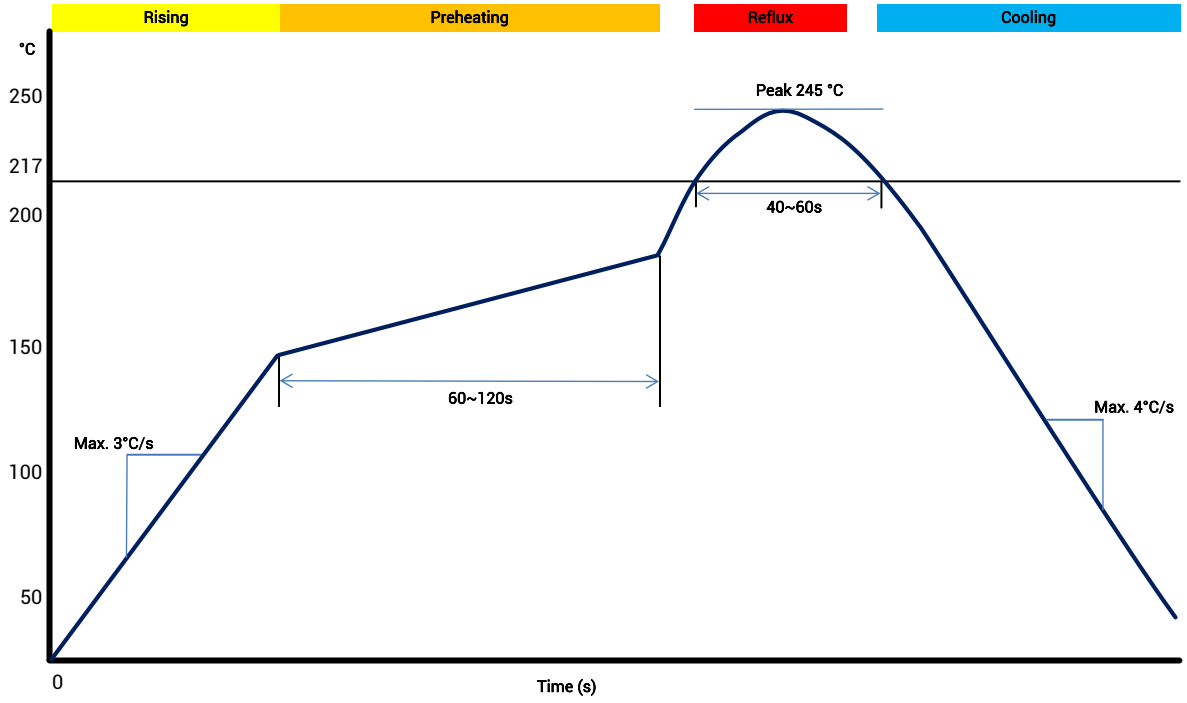


Figure 4-1 UM982 Soldering Temperature (Lead-Free)

Table 4-1 UM982 Soldering Stages

Stages	Descriptions
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

Note

- To prevent the module falling off during soldering, do NOT solder it on the back of the board, and it is NOT recommended to go through the soldering cycle twice.
- The setting of soldering temperature depends on many factors of the factory, such as board type, solder paste type, and solder paste thickness, etc. Please refer to the relevant IPC standards and indicators of the solder paste.
- Since the lead soldering temperature is relatively low, if using this method, please give priority to other components on the board.

4.2 Stencil

The apertures in the stencil need to meet the customer's own design requirements and inspection specifications. The thickness of the stencil is recommended to be 0.15 mm (not less than 0.12 mm).

Note

The design of the stencil can be optimized according to the specific production process to ensure manufacturability and reliability.

Packaging

This chapter introduces the label information and packaging information about UM982.

5.1 Label Descriptions

Figure 5-1 displays the label information of UM982.

Figure 5-1 UM982 Label Descriptions

This manual applies to the UM982 modules with the following PNs:

- PN: 2310415000002,
- PN: 2310415000012.

5.2 Product Packaging

(1) Packaging Type

The UM982 module is a surface mount device (SMD) and packaged with carrier tape and reel in vacuum-sealed aluminum foil antistatic bags. The bags contain desiccants inside to prevent moisture.

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

> **Caution**
> The modules shall be removed from the package before the baking process, because the packaging materials such as the carrier tape can only withstand the temperature of 55 °C.

Figure 5-2 UM982 Package

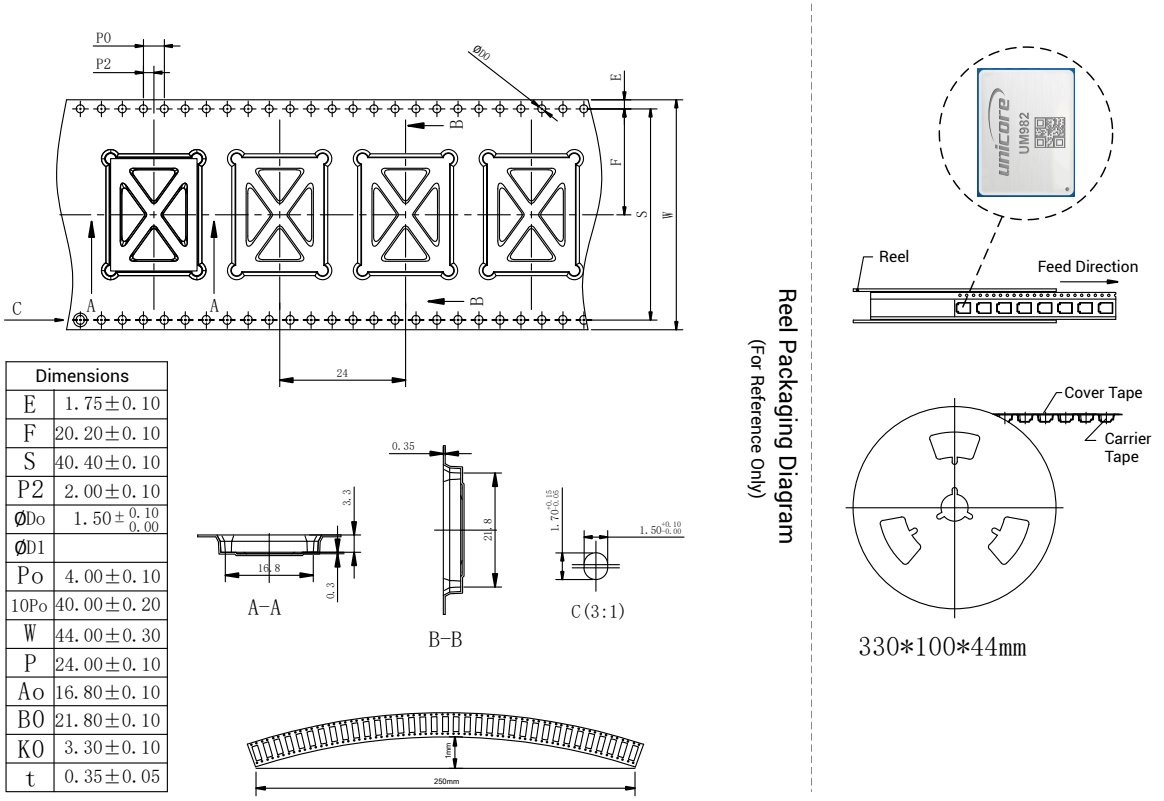
Table 5-1 UM982 Package Descriptions

Items	Descriptions
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

Figure 5-3 is the reel packaging diagram of UM982, and the specifications are shown as follows:

- The cumulative tolerance of 10 side holes should not exceed ±0.2 mm.
- Material of the tape: Black antistatic PS (surface impedance 10^5-10^{11}) (surface static voltage <100 V), thickness: 0.35 mm.
- 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).

- 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).
- All dimension designs are in accordance with EIA-481-C-2003.
- The maximum bending degree of the carrier tape within the length of 250 mm should not exceed 1 mm.



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
BO	21.80±0.10
KO	3.30±0.10
t	0.35±0.05

Figure 5-3 UM982 Reel Package Diagram

(2) Humidity Indicator Card

UM982 package includes a HUMIDITY INDICATOR card, which indicates the humidity inside the package by the colors of different circles. Before surface mounting, check the circle color for the following information:

- When the 30% circle is blue, the humidity condition is normal. See **Figure 5-4**.
- When the 30% circle is lavender and the 20% circle is pink, the humidity condition is abnormal. See **Figure 5-5**. Bake the module before surface mounting.

The UM982 is rated at MSL level 3. Please refer to the IPC/JEDEC J-STD-033 standards for the package and operation requirements. For more information, visit the website JEDEC.

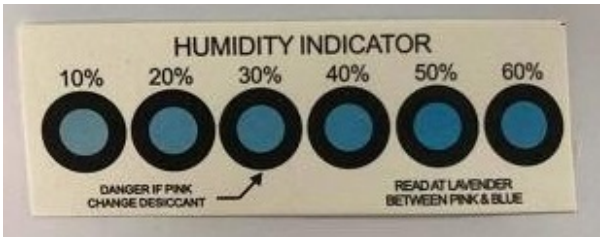


Figure 5-4 Normal Humidity Indication

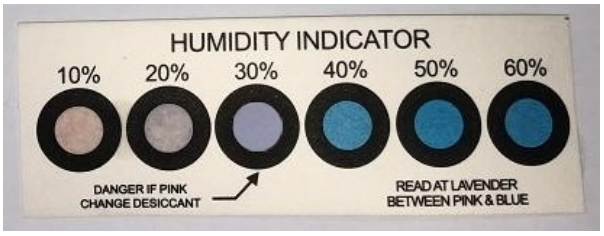


Figure 5-5 Abnormal Humidity Indication

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