INSTALLATION AND OPERATION

USER MANUAL

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UM670A

Automotive-Grade GNSS Navigation and Positioning Module

Revision History

Version	Revision History	Date
R1.0	First release	Jul., 2024

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Foreword

This document describes the information of the hardware, package, specification and the use of Unicore UM670A module.

Target Readers

This document applies to technicians who are familiar with GNSS receivers.

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1 Introduction

UM670A-12 is an automotive-grade multi-system navigation and positioning module designed for intelligent driving field. It supports L1 or L1 + L5 with different firmware.

UM670A-12 is based on the multi-system, dual-frequency and high-performance GNSS SoC - UC6580A, which conforms to the requirements of AEC-Q100, and the manufacturing process is in line with IATF 16949.

Figure 1-1 UM670A High Precision Positioning Module

Model	Order No.	Working Temperature	System					Interface			Data Update
		-40 °C ~ +85 °C	GPS	GLONASS*	BDS	Galileo	QZSS	UART	I2C**	SPI**	
UM670A	12	●	●	●	●	●	●	●			1/5/10* Hz

* Supported by specific firmware.

** Reserved interfaces.

1.1 Key Specifications

Table 1-1 Key Specifications

Power		
Supply Voltage	+2.7 V to +3.6 V DC, Typ.: 3.3 V	
LNA Feed Voltage	2.7 V to 3.3 V, ≤50 mA	
Power Consumption	150 mW	
RF Input		
System	GPS/GLONASS*/BDS/Galileo/QZSS	
VSWR	≤ 2.5	
Input Impedance	50 Ω	
Antenna Gain	15 dB to 30 dB	
Physical Characteristics		
Package	54 pin LGA	
Size	22.0 mm × 17.0 mm × 2.6 mm	
Interface		
UARTx1	TTL; baud rate supports 115200 bps to 921600 bps	
I^2Cx1	Reserved; address: 7 bit; working mode: slave; supports 400 Kbps at most	
SPIx1	Reserved; Alternate function of Pin42 to 45 working mode: slave; supports 4 Mbps at most	
GNSS Performance		
Frequency	L1 single-frequency GPS L1C/A GLONASS* G1 BDS B1 Galileo E1 QZSS L1	L1+L5 dual-frequency GPS L1C/A, L5 GLONASS* G1 BDS B1I, B2a Galileo E1, E5a QZSS L1C/A, L5
TTFF	Cold start:26s Hot start: 2s Reacquisition: 2s	
Positioning Accuracy (RMS)	Horizontal: 1.5 m (open sky) Vertical: 2.5 m (open sky)	
Velocity Accuracy (RMS) [1]	0.05 m/s	

* Supported by the specific firmware.

[1] 68% at 30 m/s for dynamic operation, open sky

Sensitivity		L1 single-frequency	L1+L5 dual-frequency
	Tracking	-162 dbm	-162 dbm
	Cold Start	-147 dbm	-148 dbm
	Hot Start	-157 dbm	-158 dbm
	Requisition	-158 dbm	-160 dbm
GNSS Data Update	1 Hz/5 Hz/10 Hz*		
1PPS Accuracy (RMS)	20 ns		
Data Format	NMEA 0183, Unicore Protocol		
Environment Specifications			
Working Temperature	-40 °C to +85 °C		
Storage Temperature	-40 °C to +85 °C		
Humidity	95% No condensation		
Vibration	GB/T 28046.3; ISO 16750.3		
Shock	GB/T 28046.3; ISO 16750.3		

* Supported by specific firmware.

1.2 Block Diagram

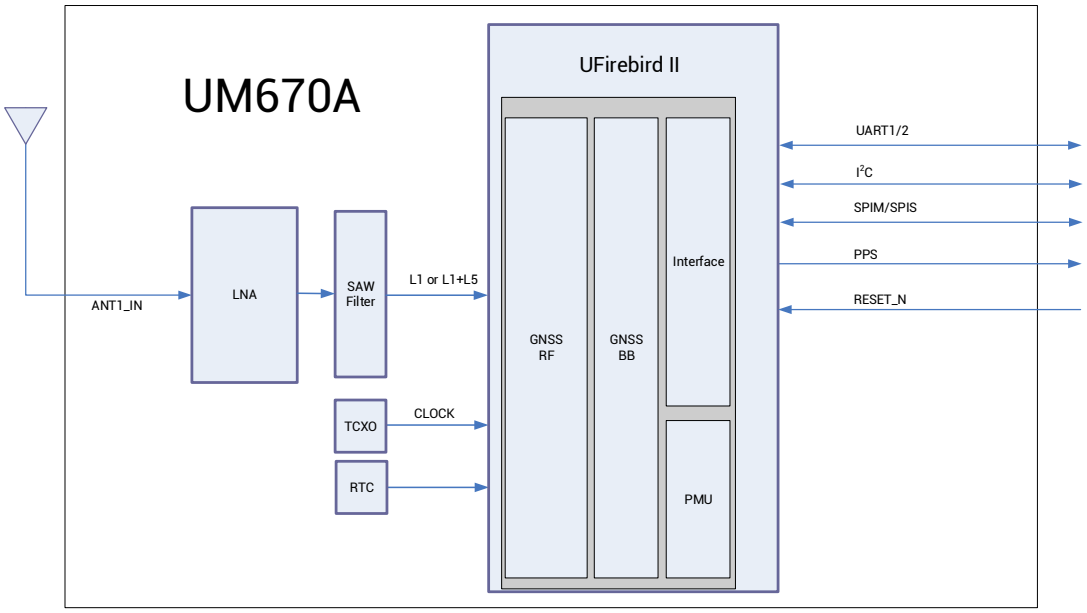


Figure 1-2 UM670A Block Diagram[2]

1. RF Part

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 UFirebirdII chip.

2. UFirebirdII SoC (UC6580A)

UFirebirdII is the new generation RF-baseband and high-precision algorithm integrated SoC developed by Unicore. It adopts 22 nm technology and low power consumption design, supporting multi-path mitigation, anti-jamming and high precision GNSS joint positioning. The chip is especially suitable for the application scenarios which are sensitive to power and size.

3. Interfaces

UM670A has interfaces such as UART, I²C*, SPI*, PPS and RESET_N.

The UART1 and UART2 both support data transmission, and the UART1 also supports firmware upgrade. The I/O signal type is LVTTL and the baud rate can be configured by users.

---

[2] Antenna detection, SPIM and UART2 are supported by the hardware version V1.1 and above. SPIS shares pins with I²C/UART1.

* I²C and SPI are reserved interfaces.

2 Technical Specifications

2.1 Pin Definition

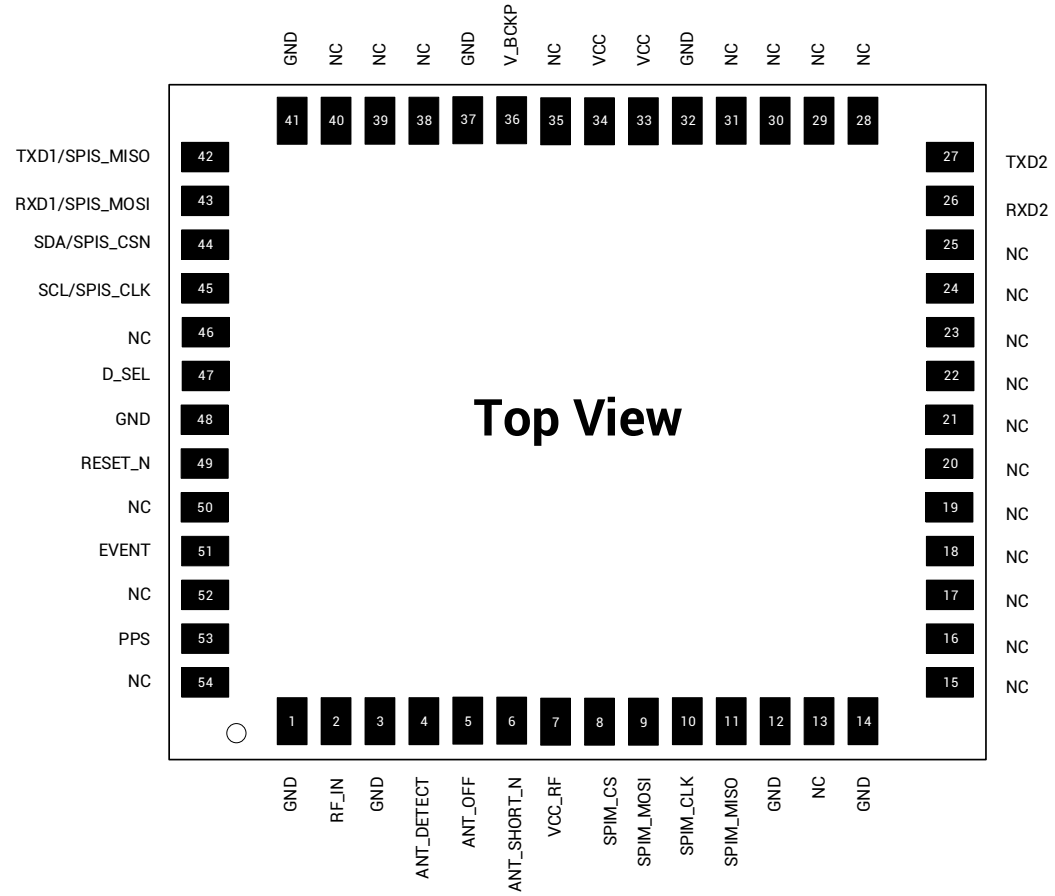


Figure 2-1 UM670A Pin Definition

Table 2-1 Pin Definition

No.	Pin	I/O	Description
1	GND	—	Ground
2	RF_IN	I	GNSS antenna signal input
3	GND	—	Ground
4	ANT_DETECT*	—	Open detection of active antenna
5	ANT_OFF*	—	Disable external antenna feed supply
6	ANT_SHORT_N*	—	Short detection of active antenna
7	VCC_RF[3]	O	Antenna feed output

* Supported by the hardware version V1.1 and above

[3] Not recommended to use VCC_RF to feed the antenna (VCC_RF is not optimized for the anti-lightning strike and anti-surge due to the compact size of the module).

No.	Pin	I/O	Description
8	SPIM_CS*	O	SPI master chip select
9	SPIM_MOSI*	O	SPI master Master Out/Slave In
10	SPIM_CLK*	—	SPI master clock
11	SPIM_MISO*	I	SPI master Master In/Slave Out
12	GND	—	Ground
13	NC	—	No connection inside
14	GND	—	Ground
15	NC	—	No connection inside
16	NC	—	No connection inside
17	NC	—	No connection inside
18	NC	—	No connection inside
19	NC	—	No connection inside
20	NC	—	No connection inside
21	NC	—	No connection inside
22	NC	—	No connection inside
23	NC	—	No connection inside
24	NC	—	No connection inside
25	NC	—	No connection inside
26	RXD2*	I	UART2 input
27	TXD2*	O	UART2 output
28	NC	—	No connection inside
29	NC	—	No connection inside
30	NC	—	No connection inside
31	NC	—	No connection inside
32	GND	—	Ground
33	VCC	I	Power supply (+3.3 V)
34	VCC	I	Power supply (+3.3 V)
35	NC	—	No connection inside

No.	Pin	I/O	Description
36	V_BCKP	I	When the main power supply VCC is cut off, V_BCKP supplies power to RTC and relevant register. Supply voltage: 2.0 V to 3.6 V, and the working current is less than 10 μA at 25 °C. If you do not use the hot start function, connect V_BCKP to VCC or a standalone power source. Do NOT connect it to ground or leave it floating.
37	GND	—	Ground
38	NC	—	No connection inside
39	NC	—	No connection inside
40	NC	—	No connection inside
41	GND	—	Ground
42	TXD1/SPIS_MISO	O	SPI slave Master In/Slave Out (D_SEL=GND); UART1 output (D_SEL=VCC or floating)
43	RXD1/SPIS_MOSI	I	SPI slave Master Out/Slave In (D_SEL=GND); UART1 input (D_SEL=VCC or floating)
44	SDA/SPIS_CSN	I	I^2C data (D_SEL=VCC or floating); SPI slave chip select (D_SEL=GND)
45	SCL/SPIS_CLK	I	I^2C clock (D_SEL=VCC or floating); SPI slave clock (D_SEL=GND)
46	NC	—	No connection inside
47	D_SEL	I	Interface select pin; Use pin 42 to 45 as a SPI slave when D_SEL = GND, as UART1 and I^2C When D_SEL=VCC or floating
48	GND	—	Ground
49	RESET_N	I	System reset; active low; the active time should be no less than 5 ms
50	NC	—	No connection inside
51	EVENT	I	Event Mark, with adjustable frequency and polarity
52	NC	—	No connection inside
53	PPS	O	Pulse per second with adjustable pulse width and polarity
54	NC	—	No connection inside

2.2 Electrical Specifications

2.2.1 Absolute Maximum Ratings

Table 2-2 Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Remark
Power Supply	VCC	-0.2	3.6	V	
Backup Battery	V_BCKP	-0.2	3.6	V	
Digital Pin Voltage		-0.2	3.6	V	
Antenna RF Input Power	RF_IN	-	-3	dBm	
Storage Temperature	T_{STG}	-40	+85	°C	
Reflow Soldering Temperature	T_{SLDR}	-	+245	°C	

2.2.2 Operational Conditions

Table 2-3 Operational Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Condition
Power Supply	VCC	2.7	3.3	3.6	V	
VCC Ripple	Vp-p			50	mV	
Peak Current	Iccp			200	mA	VCC = 3.0 V
Average Tracking Current[4]	I_{ACQ}		45	48	mA	VCC = 3.3 V
Low Level Input Voltage	V_{IL}	-0.3		0.2 × VCC	V	
High Level Input Voltage	V_{IH}	0.7 × VCC		VCC + 0.2	V	
Low Level Output Voltage	V_{OL}	0		0.4	V	I_{out} = -2 mA
High Level Output Voltage	V_{OH}	VCC – 0.4		Vcc	V	I_{out} = 2 mA
Antenna Gain	G_{ANT}	15	20	30	dB	

[4] 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.

This reference value is got from the samples after cold start, and the actual value can vary depending on the factors including firmware version, external circuit, number of the satellites tracked, signal strength, type and time of start, duration, and conditions of test.

2.3 Dimensions

Table 2-4 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

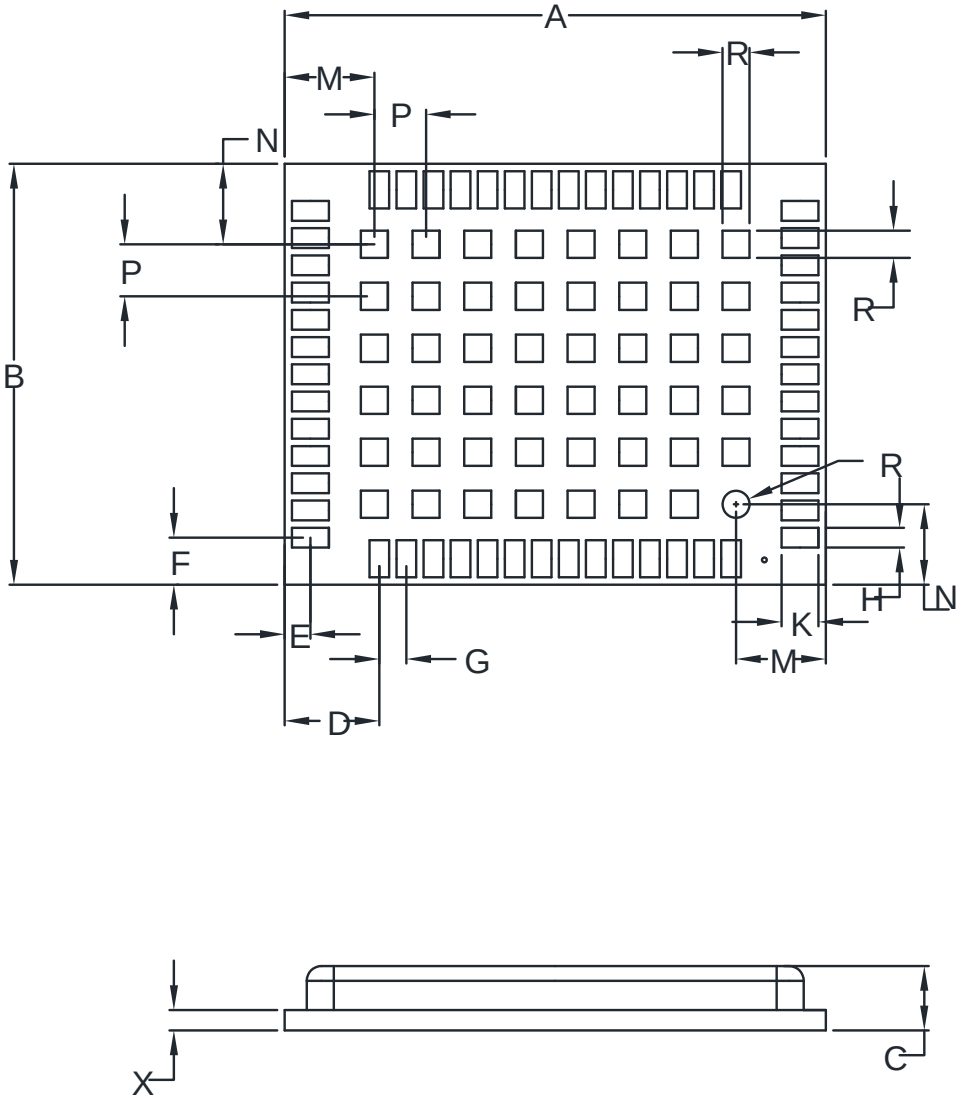


Figure 2-2 UM670A Mechanical Dimensions

3 Hardware Design

3.1 Recommended Minimal Design

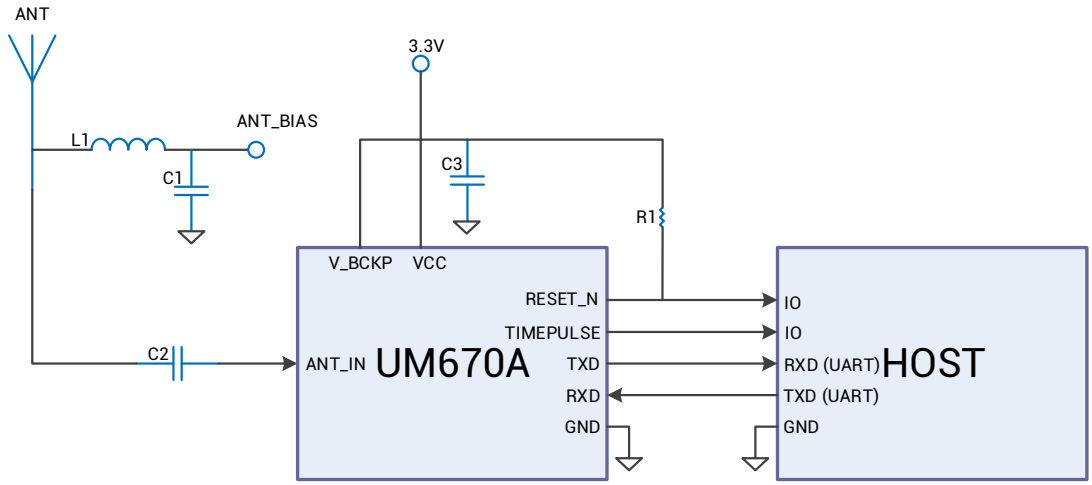


Figure 3-1 UM670A Minimal Design

Remarks:

- 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: Several 10 μF + 100 nF capacitors connected in parallel is recommended
- R1: 10 kΩ resistor is recommended

3.2 Antenna Feed Design

UM670A just supports feeding the antennal from the outside of the module rather than the inside. 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 lighting strike and surge.

⚠ 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.

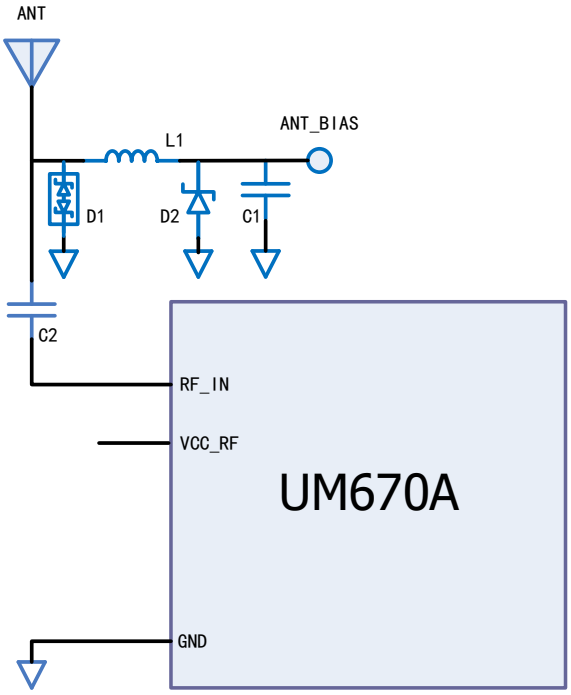


Figure 3-2 UM670A External Antenna Feed Reference Circuit

Remarks:

- L1: feed inductor, 68nH RF inductor in 0603 package is recommended;
- C1: decoupling capacitor, it is recommended to connect two capacitors of 100nF/100pF in parallel;
- C2: DC blocking capacitor, recommended 100pF capacitor;
- Not recommended to take VCC_RF as ANT_BIAS to feed the antenna (VCC_RF is not optimized for the anti-lightning strike and anti-surge due to the compact size of the module)
- D1: ESD diode, choose the ESD protection device that supports high frequency signals (above 2000 MHz)
- D2: TVS diode, choose the TVS diode with appropriate clamping specification according to the requirement of feed voltage and antenna voltage

3.3 Antenna Detection Design[5]

UM670A supports the detection of open circuit and short circuit, and it will cut the antenna feed supply when a short circuit happens. The antenna detection circuit is connected to the pins of ANT_DETECT, ANT_SHORT_N and ANT_OFF, the voltage level of which can be used to judge the antenna status.

☞ Refer to UM670A Hardware Reference Design for the details of the antenna detection circuit.

3.4 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.
- VCC power-on waveform: The time interval from 10% rising to 90% must be within 100 μs to 10 ms.
- 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.

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

[5] Supported by the specific firmware.

3.5 Grounding and Heat Dissipation

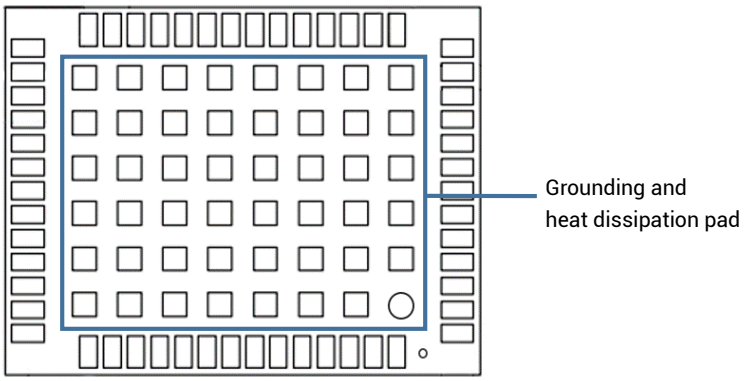


Figure 3-3 Grounding and Heat Dissipation Pad

The 48 pads in the rectangle in Figure 3-3 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.

3.6 Recommended PCB Package Design

See the following figure for the recommended PCB package design of the module UM670A.

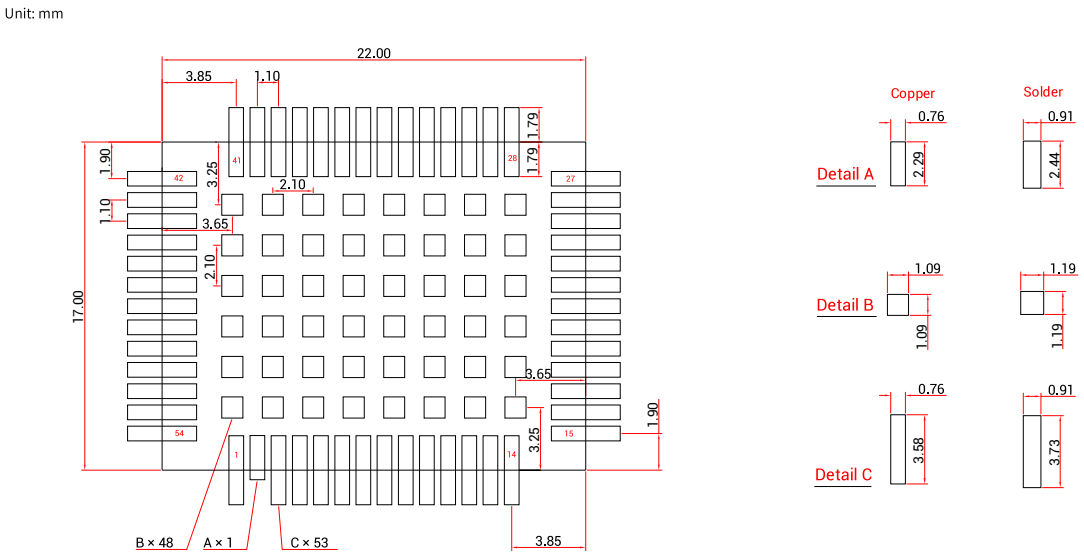


Figure 3-4 Recommended PCB Package Design

Remark:

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 1.79 mm longer than the module border.

The pad denoted as detail A is 0.50 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 interference.

4 Production Requirement

4.1 Clean

Do NOT use alcohol or other organic solvents to clean the module, or it may lead to flux residues entering into the shielding shell, causing mildew and other problems.

4.2 Soldering

Recommended soldering temperature curve is as follows:

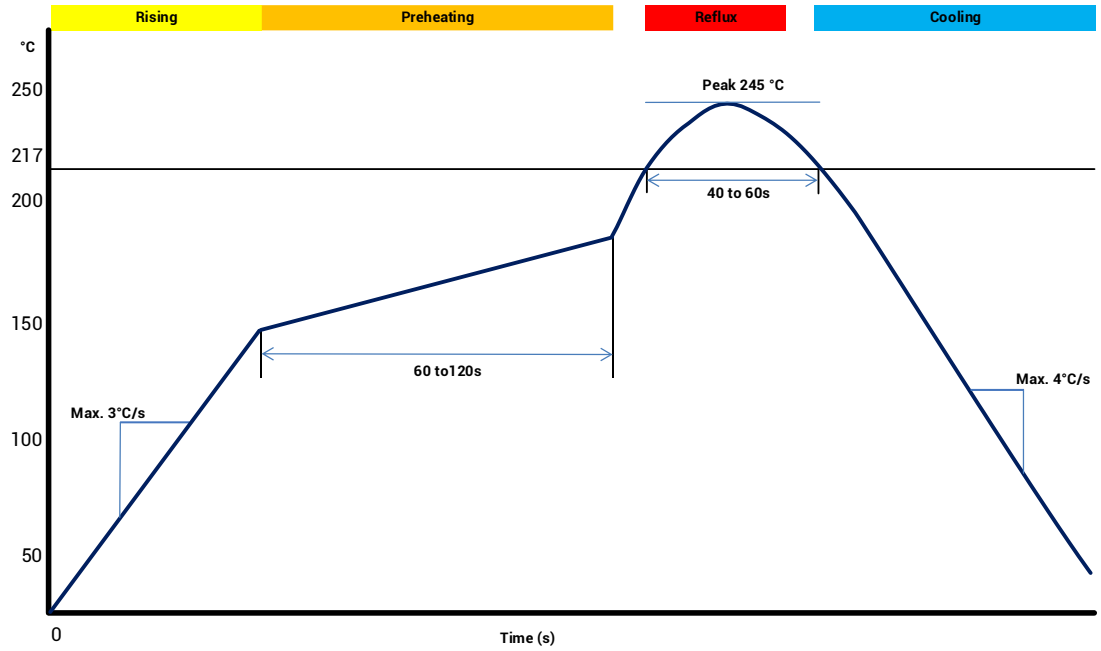


Figure 4-1 Soldering Temperature (Lead-free)

Temperature Rising Stage

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

Preheating Stage

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

Reflux Stage

- Over melting temperature (217 °C) time: 40 s to 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, that is, better not 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.

4.3 Stencil Thickness

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 0.15 mm.

5 Packaging

5.1 Label Description

Figure 5-1 Label Description

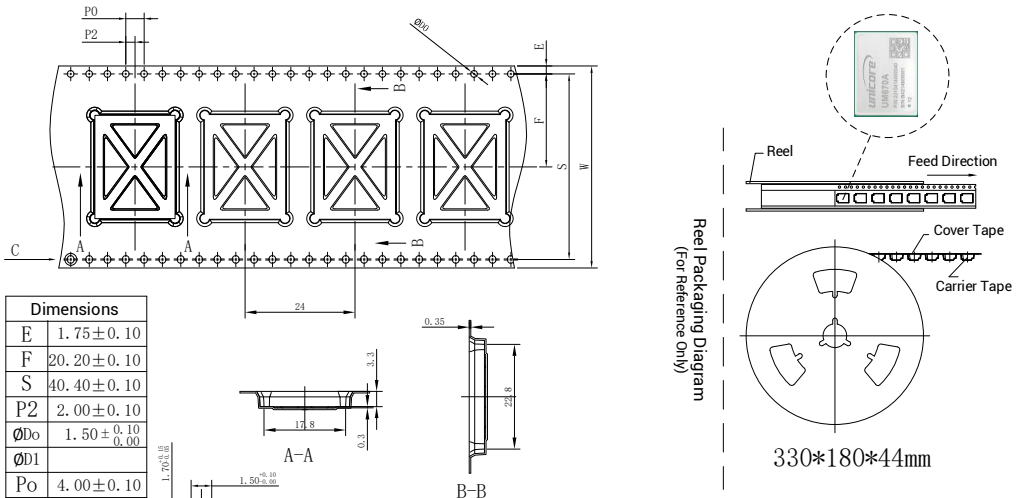
5.2 Ordering Information

Ordering Information	Ordering Code	Description
UM670A	12	Automotive grade; L1 or L1+L5; operating temperature: -40 °C to +85 °C; supporting firmware upgrade; 22 mm x 17 mm; 250 pieces/reel

5.3 Product Packaging

The UM670A 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. 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 UM670A 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 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. 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).

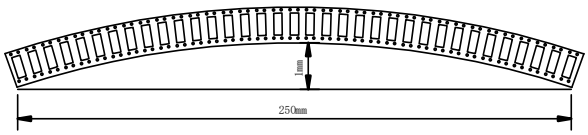


Figure 5-3 UM670A-03 Reel Package Diagram

Table 5-1 Package Description

Item	Description
Module Number	250 pieces/reel
Reel Size	Tray: 13" External diameter: 330 ± 2 mm Internal diameter: 180 ± 2 mm 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 UM670A is rated at MSL level 3. Refer to the relevant IPC/JEDEC J-STD-033 standards for the package and operation requirements. Users may access to the website www.jedec.org to get more information.

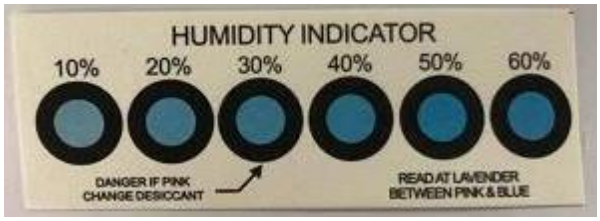


Figure 5-4 Normal Humidity Indication

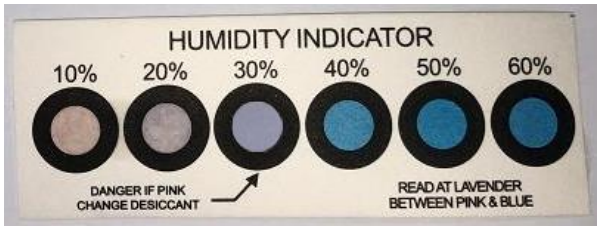


Figure 5-5 Abnormal Humidity Indication

The shelf life of the UM670A module packaged in vacuum-sealed aluminum foil antistatic bags is one year.

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