INSTALLATION AND OPERATION

USER MANUAL

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UM670A-03

Automotive-Grade Multi-Constellation Dual-Frequency GNSS Navigation and Positioning Module

Revision History

Version	Revision History	Date
R1.0	First release	Dec., 2023

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Foreword

This document describes the information of the hardware, package, specification and the use of Unicore UM670A-03 module.

Target Readers

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

Contents

1 Introduction

UM670A-03 is an automotive-grade GNSS navigation and positioning module designed for intelligent driving field. It 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.

UM670A-03 supports GPS/BDS/GLONASS*/Galileo/QZSS/NavIC* and L1 + L5 frequencies, having the functions of raw data output and single point positioning. See Table 1-1 for the detailed specifications.

Figure 1-1 UM670A-03 High Precision Positioning Module

* Supported by the specific firmware.

1.1 Key Specifications

Table 1-1 Key Specifications

Basic Information		
Channel	96 channels, based on UFirebirdII	
Constellation	GPS/BDS/GLONASS*/Galileo/QZSS/NavIC*	
Frequency	GPS: L1C/A + L5; BDS: B1I + B2a; Galileo: E1 + E5a; GLONASS*: G1 QZSS: L1 + L5 NavIC*: L5	
Power		
Voltage	+2.7 V to 3.6 V DC; Typ.: 3.3 V	
Power Consumption	150 mW (Typ.)	
Performance		
Time to First Fix (TTFF)	Cold Start: 26 s Hot Start: 2 s Reacquisition: 2 s	
Positioning Accuracy (RMS)	Horizontal: 1.5 m (open sky) Vertical: 2.5 m (open sky)	
Velocity Accuracy (RMS)[1]	0.05 m/s	
Sensitivity		GNSS
	Tracking	-162 dBm
	Cold Start	-147 dBm
	Hot Start	-157 dBm
	Reacquisition	-158 dBm
Data Update	1 Hz/5 Hz/10 Hz	
1PPS Accuracy (RMS)	20 ns	
Data Format	NMEA 0183, Unicore Protocol, RTCM	

* Supported by specific firmware

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

RF Input	
VSWR	≤ 2.5
Input Impedance	50 Ω
Antenna Gain	15 dB ~ 30 dB
Physical Specifications	
Dimensions	22.0 mm × 17.0 mm × 2.6 mm
Package	54 pin LGA
Environmental Specifications	
Operating Temperature	-40 °C to +105 °C
Storage Temperature	-40 °C to +105 °C
Humidity	95% no condensation
Vibration	GB/T 28046.3, ISO 16750.3
Shock	GB/T 28046.3, ISO 16750.3
Functional Ports	
UART × 1	LVTTL; baud rate supports 115200 to 921600 bps
I^2C^* × 1	Address: 7 bits; works in slave mode; supports 400 kbps at most
SPI* × 1	Pin42 to 45 have alternative functions; works in slave mode; supports 4 Mbps at most
PPS × 1	LVTTL

* I^2C and SPI are reserved interfaces

1.2 Block Diagram

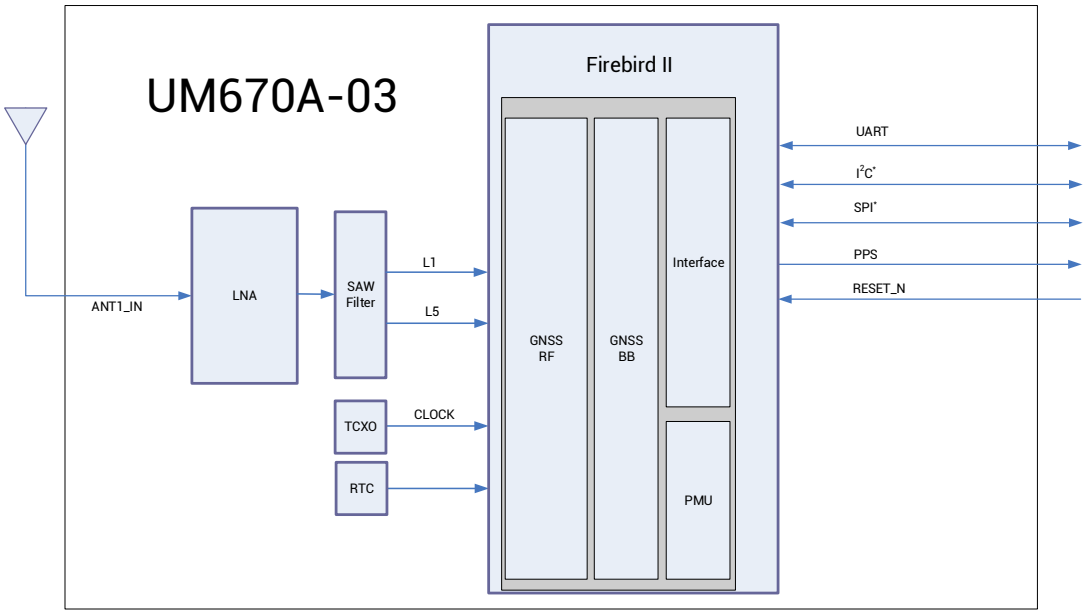

Figure 1-2 UM670A-03 Block Diagram

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-03 has interfaces such as UART, I²C*, SPI*, PPS and RESET_N.

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

* I²C and SPI are reserved interfaces

2 Technical Specifications

2.1 Pin Definition

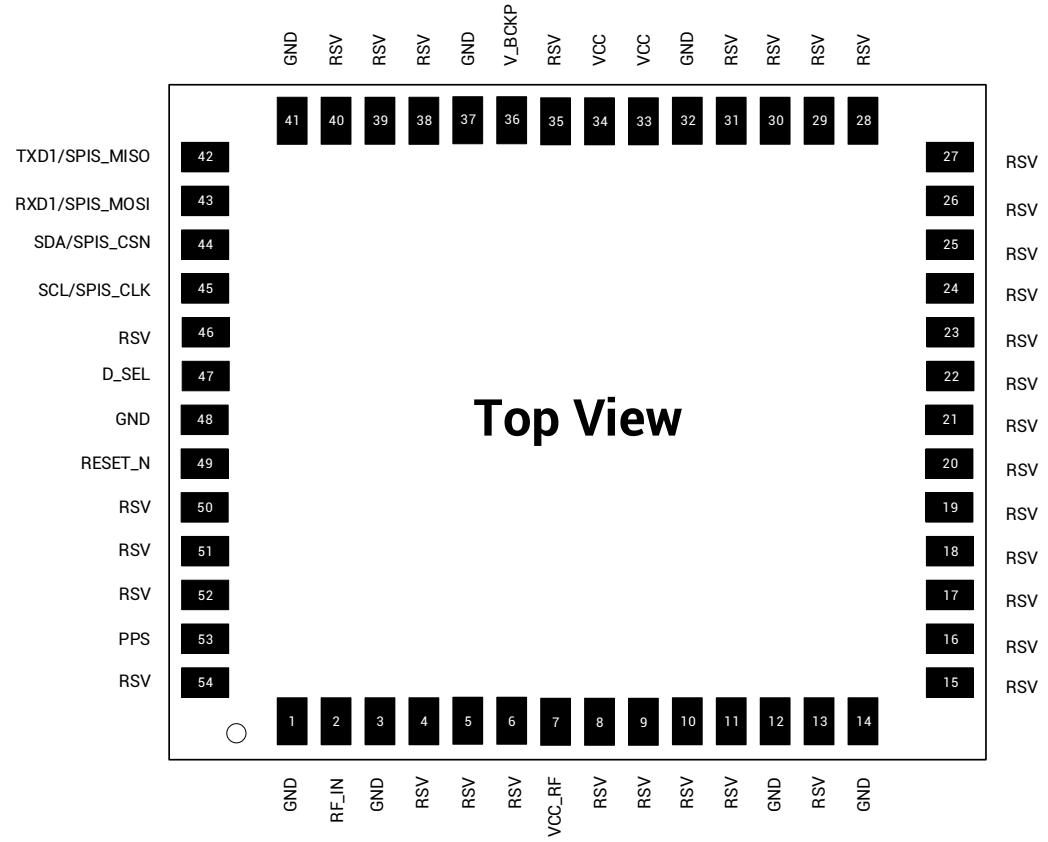

Figure 2-1 UM670A-03 Pin Definition

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	RSV	—	Reserved
5	RSV	—	Reserved
6	RSV	—	Reserved
7	VCC_RF[2]	O	Antenna feed output
8	RSV	—	Reserved
9	RSV	—	Reserved

[2] 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
10	RSV	—	Reserved
11	RSV	—	Reserved
12	GND	—	Ground
13	RSV	—	Reserved
14	GND	—	Ground
15	RSV	—	Reserved
16	RSV	—	Reserved
17	RSV	—	Reserved
18	RSV	—	Reserved
19	RSV	—	Reserved
20	RSV	—	Reserved
21	RSV	—	Reserved
22	RSV	—	Reserved
23	RSV	—	Reserved
24	RSV	—	Reserved
25	RSV	—	Reserved
26	RSV	—	Reserved
27	RSV	—	Reserved
28	RSV	—	Reserved
29	RSV	—	Reserved
30	RSV	—	Reserved
31	RSV	—	Reserved
32	GND	—	Ground
33	VCC	I	Power supply (+3.3 V)
34	VCC	I	Power supply (+3.3 V)
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. Supply voltage: 1.7 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.

No.	Pin	I/O	Description
37	GND	—	Ground
38	RSV	—	Reserved
39	RSV	—	Reserved
40	RSV	—	Reserved
41	GND	—	Ground
42	TXD1/SPIS_MISO	O	Master In/Slave Out (D_SEL=GND); This pin is used as UART1 to transmit data in slave mode (D_SEL=VCC or floating)
43	RXD1/SPIS_MOSI	I	Master Out/Slave In (D_SEL=GND); This pin is used as UART1 to receive data in slave mode (D_SEL=VCC or floating)
44	SDA/SPIS_CSN	—	I^2C data (D_SEL=VCC or floating); SPI slave chip select (D_SEL=GND)
45	SCL/SPIS_CLK	—	I^2C clock (D_SEL=VCC or floating); SPI slave clock (D_SEL=GND)
46	RSV	—	Reserved
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	RSV	—	Reserved
51	RSV	—	Reserved
52	RSV	—	Reserved
53	PPS	O	Pulse per second with adjustable pulse width and polarity
54	RSV	—	Reserved

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	The main supply of the module
Backup Battery	V_BCKP	-0.2	3.6	V	The backup battery to keep RTC work
Digital Pin Voltage		-0.2	3.6	V	
Antenna RF Input Power	RF_IN	-	-3	dBm	The allowed maximum input power
Storage Temperature	T_{STG}	-40	+105	°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 Working Current	Iccp			200	mA	VCC = 3.0 V
Average Tracking Current[3]	I_{ACQ}		46	50	mA	VCC = 3.2 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	

[3] 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

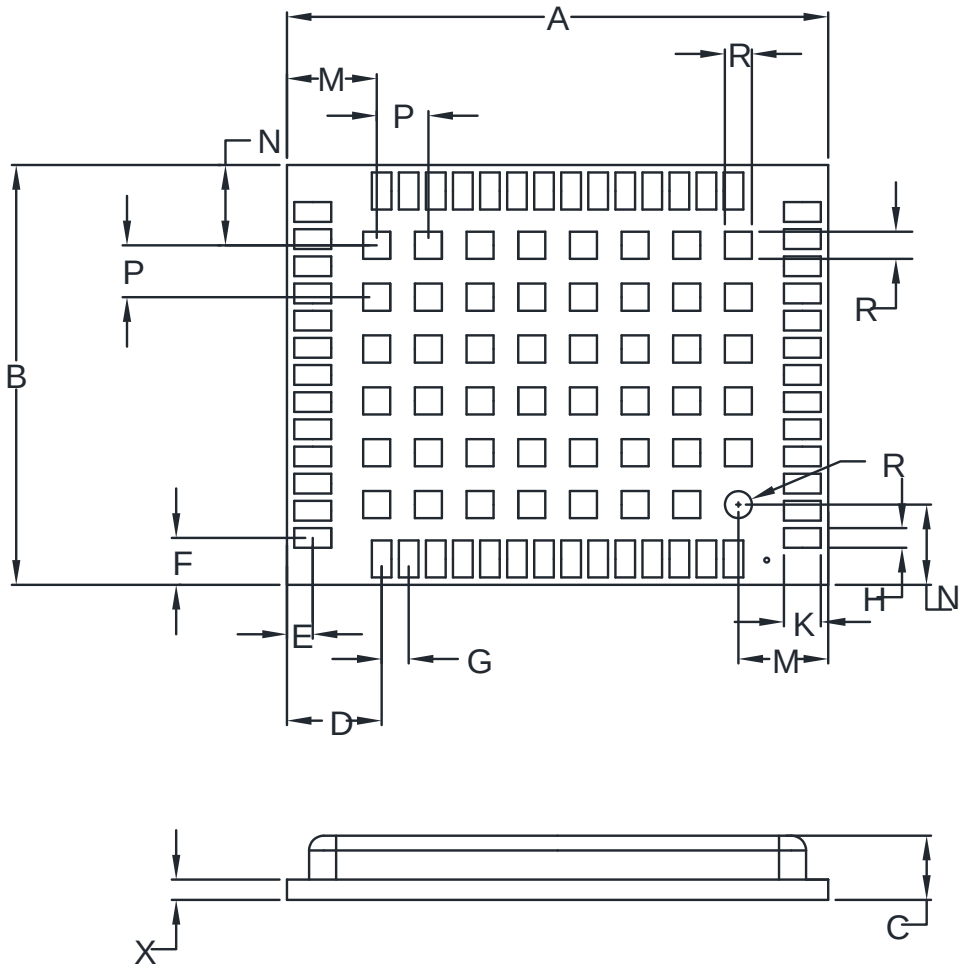

Figure 2-2 UM670A-03 Mechanical Dimensions

3 Hardware Design

3.1 Recommended Minimal Design

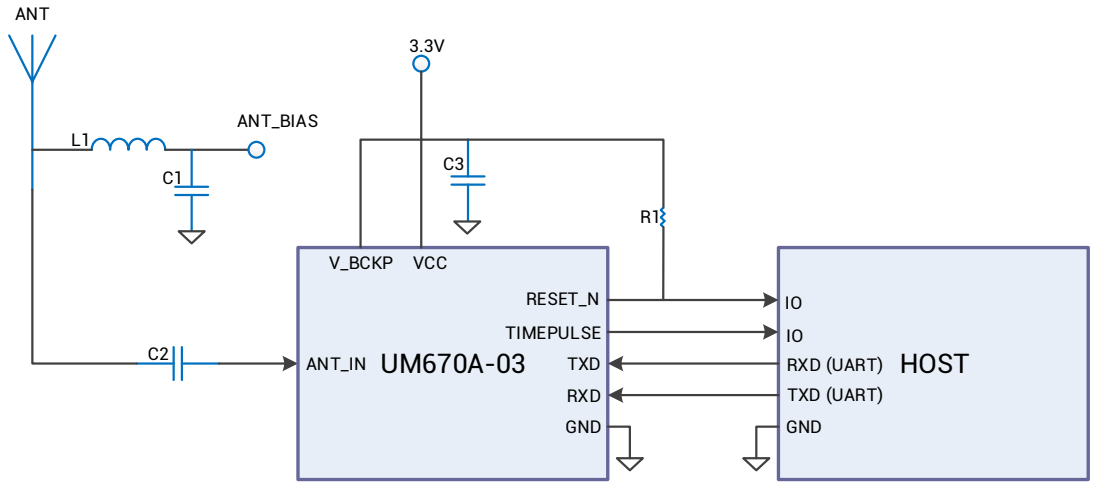

Figure 3-1 UM670A-03 Minimal Design

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-03 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.

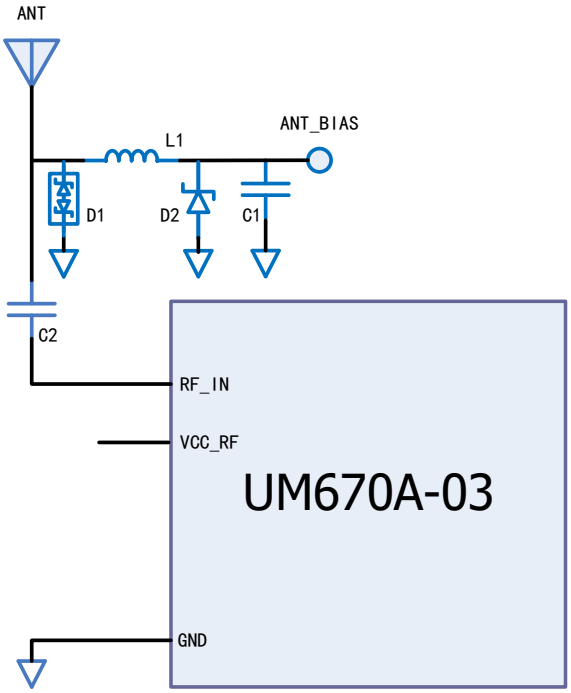

Figure 3-2 UM670A-03 External Antenna Feed Reference Circuit

Remarks:

- L1: feed inductor, 68 nH RF inductor in 0603 package is recommended;
- C1: decoupling capacitor, it is recommended to connect two capacitors of 100 nF/100 pF in parallel;
- C2: DC blocking capacitor, recommended 100 pF 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 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.

3.4 Grounding and Heat Dissipation

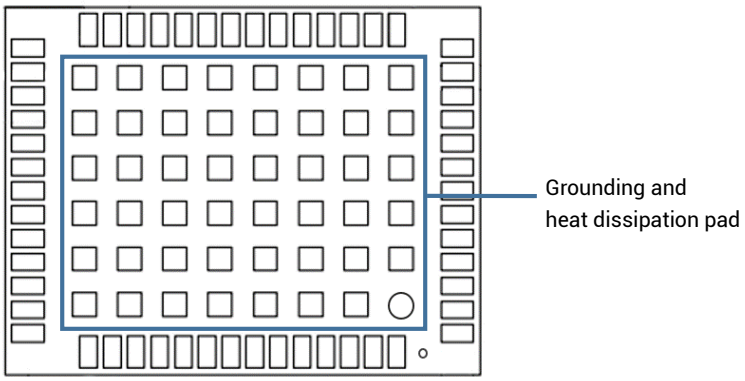

Figure 3-3 Grounding and Heat Dissipation Pad

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.

3.5 Recommended PCB Package Design

See the following figure for the recommended PCB package design of the module UM670A-03.

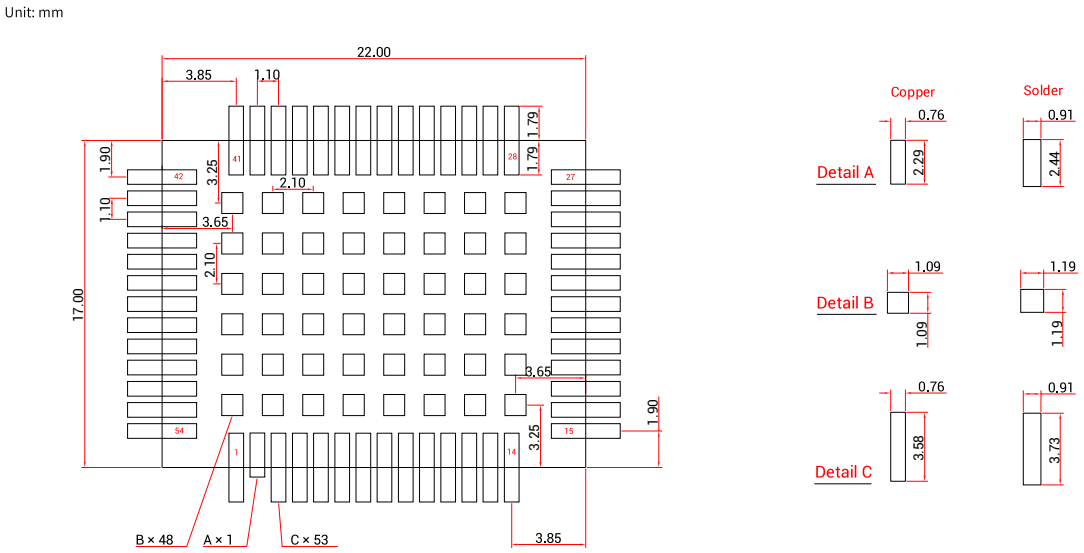

Figure 3-4 Recommended PCB Package Design

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:

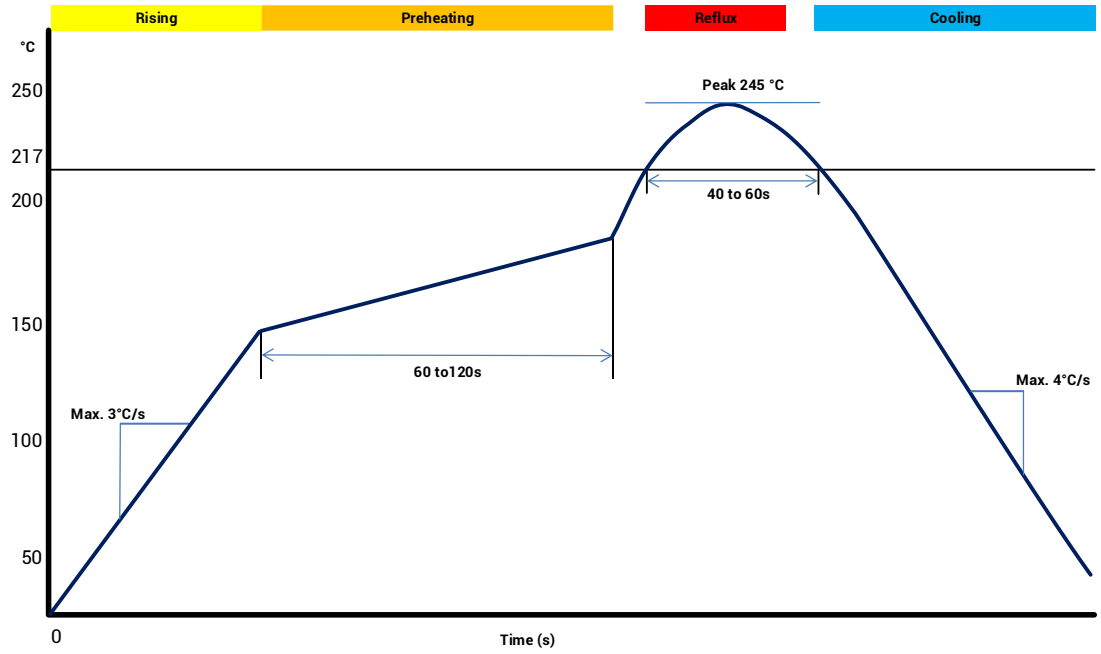

Figure 4-1 Soldering Temperature (Lead-free)

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

Product Model	Sub-model	Description
UM670A	03	Automotive grade; dual-frequency single point positioning module; L1+L5 operating temperature: -40 °C to +105 °C; supporting firmware upgrade; 22 mm x 17 mm; 250 pieces/reel

5.3 Product Packaging

The UM670A-03 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-03 Package

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 5-3). If the color of the 20% circle is pink and the color of the 30% circle is lavender (see Figure 5-4), you must bake the module until it turns to blue. The UM670A-03 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.

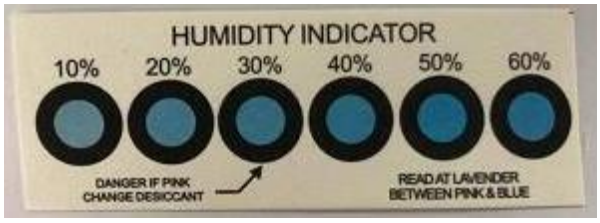

Figure 5-3 Normal Humidity Indication

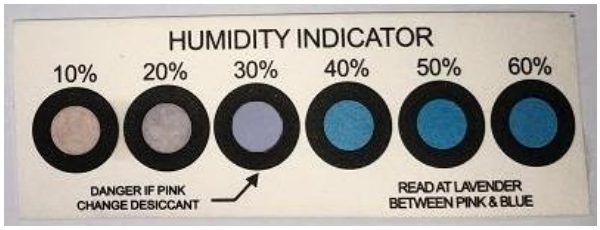

Figure 5-4 Abnormal Humidity Indication

The shelf life of the UM670A-03 module packaged in vacuum-sealed aluminum foil antistatic bags is one year.

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