



INSTALLATION AND OPERATION
USER MANUAL

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UM220-IV L

Single Frequency Multi-GNSS Timing Module

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Revision History

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R1	Initial version	2020-01-06
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Foreword

This document describes the product features and information of the hardware design, installation, specification and the use of Unicore UM220-IV L module.

Audience

This manual is created for the technical personnel, who possess the expertise of GNSS receivers.

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1 Product Introduction

1.1 Overview

UM220-IV L is a GNSS multisystem, high-precision timing module, based on the low power, multisystem, high-performance SoC-UFirebird independently developed by Unicore. It supports GPS, BDS, GLONASS and Galileo, etc. Moreover, it is capable to receive and process data of two or three systems concurrently, or work on a single system.

UM220-IV L module supports SBAS, QZSS and DGNSS input function, and provides the advanced AGNSS function. It can improve the positioning speed through the assistant data service of Unicore in the scenario of networking.

With the combined function of filter, linear amplifier and antenna protection, and optimized RF architecture and interference rejection capability, UM220-IV L module provides the reliable performance in complex electromagnetic environments.

UM220-IV L module supports various timing modes including fixed-location timing, optimized-location timing and positioning timing, which ensure the good timing accuracy even in complex signal environmental conditions.

UM220-IV L module features compact dimensions, SMT PADS, full-automatic integration of standard pick-and-place and reflow soldering, and is especially suitable for low-cost, low-power applications.



1.2 Features

Table 1- 1 Product Feature

Variant	Grade		Size	GNSS				Supply	Interfaces				Features						
	Professional	Automotive		GPS/QZSS	BDS	GLONASS	Galileo		UART1	UART2	Antenna Detection	1PPS	Antenna Feed	Built-in flash	Update Rate	AGNSS	DGNSS		
UM220-IV L	•		17x22 mm	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•

1.3 Block Diagram

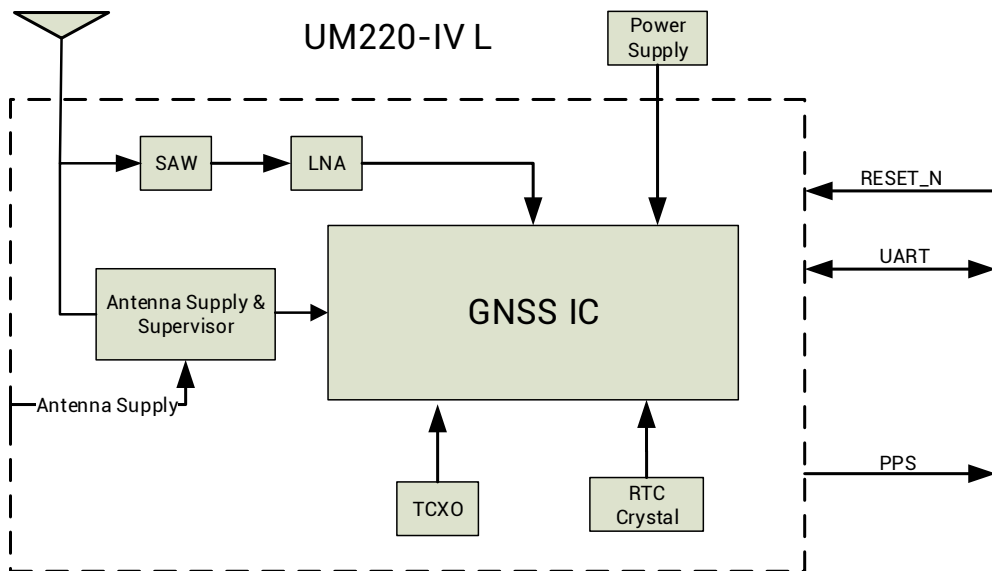


Figure 1- 1 UM220-IV L Block Diagram

1.4 Performance

Table 1- 2 Specifications

Power					
Voltage	3.0~3.6VDC				
Power Consumption ¹	62mW @3.3V				
RF Input					
VSWR	≤2.5				
Input Impedance	50Ω				
Antenna Gain	5 ~ 35dB				
Physical Characters					
Dimensions	17.0mm*22.4mm*2.4mm				
Weight	1.7g				
Environment					
Operating Temperature	-40°C ~ +85°C				
Storage Temperature	-40°C ~ +85°C				
RoHS2.0	Compliant				
Input/ Output Data Interface					
UART	UART*2, LVTTTL. Baud Rate: 4800~115200 bps				
GNSS Performance					
Constellations	BDS B1: 1561.098MHZ GPS L1: 1575.42MHZ GLONASS L1OF: 1602MHZ Galileo E1-B/C: 1575.42MHZ				
TTF ² (Time to First Fix)	Cold Start: 28s Hot Start: 1s Reacquisition: 1s AGNSS ³ : 4s				
Positioning Accuracy (CEP) ⁴	2.0m (Horizontal) 3.5m (Vertical)				
Velocity Accuracy (RMS) ⁵	0.1m/s (Horizontal)				
Sensitivity ⁶		GPS	BDS	GLONASS	Galileo
	Cold Start	-147dBm	-144dBm	-142dBm	-135dBm
	Tracking	-160dBm	-160dBm	-158dBm	-154dBm

1 Continuous positioning, typical value

2 All satellites C/N0 at 41

3 Assisted data injection in time

4 All satellites C/N0 at 41

5 All satellites C/N0 at 41

6 Tested with a good external LNA



	Hot Start	-155dBm	-151dBm	-150dBm	-143dBm
	Reacquisition	-155dBm	-151dBm	-150dBm	-140dBm
1PPS (RMS) ⁷	20ns				
Data Update Rate	1Hz				
Format	NMEA 0183, Unicore Protocol, RTCM3.2				

1.5 Precision Timing and Raw Data Output

UM220-IV L module supports three timing modes: fixed-location timing, optimized-location timing and positioning timing. Switch or query the above timing modes through **CFGTM**. It can also track all four GNSS systems including GPS, BDS, GLONASS and Galileo, and switch back and forth between these four systems using **CFGGNSS**.

UM220-IV L module is set to optimized-location timing mode by default, and outputs information of real-time position and site-specific position, which can be queried by **TIMPPPOS**. Refer to *UM220-IV L_Protocol Specification* for more details.

- Fixed-location Timing

Fixed-location timing mode is applied to static scenes. In this mode, users are required to input the exact position of receiver antenna center through **CFGTM** manually, which are used by UM220-IV L module to calculate the distance between the antenna and the satellite, and calculate time to perform timing service.


- Optimized-location Timing

Optimized-location timing mode is another application used in static scenes. In this mode, the receiver collects a set number of positioning points (within observation time) and calculates the exact position of the antenna. After that, the exact position is locked down, and the timing mode is switched to the fixed-location timing mode.

The observation time and accuracy are configured through **CFGTM**, but only when both above-mentioned conditions are met to use fixed-location timing mode. Query the observation status through **TPFINFO**.

The position estimation process is only required once after the UM220-IV L is installed. When the position optimization is completed, the timing mode set in the receiver automatically switches to the fixed-location timing mode.

⁷ Open sky

 If the position of UM220-IV L antenna changes, the command CFGTM must be sent again to switch the timing mode back to the optimized position mode to recalibrate the antenna position. Refer to *UM220-IV L Protocol Specification* for more details.

- Positioning Timing

Positioning timing is the only timing mode that supports dynamic timing. In this mode, UM220-IV L calculates the antenna position and time in real time. The timing quality depends on the satellite environment, and it is difficult to guarantee the timing accuracy.

1.6 Pulses per Second (1PPS)

UM220-IV L module provides a pulse width output and 1PPS signal of which the pulse polarity is adjustable, and can be configured and queried through **CFGTP.TIMTP** is used to describe the related 1PPS information including the corresponding time and time accuracy indicators.

1.7 UART

Two UART interfaces are integrated in the UM220-IV L module. UART1 is the master serial port, supports data transmission and firmware upgrade, the I/O signal type is LVTTTL. The default baud rate varies according to the version of firmware and the baud rate can be configured by users⁸. Please ensure that UART1 is connected to a PC or external processor to support firmware upgrade.

Serial 2 only supports data transmission and is unavailable for firmware upgrade, only for backup.

1.8 Protocol

Table 1- 3 Supported Interface Protocols

Protocol	Type
NMEA0183	I/O, ASCII, NMEA3.0, NMEA4.1 (Default output)
Unicore Protocol	I/O, ASCII, Unicore Protocol
RTCM ⁹	Input, RTCM3.2

⁸⁻⁹ Refer to UM220-IV L Protocol Specification for more details



1.9 Clock

The industrial TCXO is built into the UM220-IV L module to ensure the stability of the clock system and the ability to capture signals quickly in weak signal environments.

UM220-IV L also integrates the 32k crystal to maintain the RTC clock. When the main power supply is removed, the normal operation of the RTC can be maintained by providing V_BCKP.

1.10 Antenna

The filter and linear amplifier are built in the UM220-IV L module. They support active antennas and passive antennas, and the former provides better performance.

2 Installation

2.1 Prerequisites

Most components on the UM220-IV L module are static sensitive devices (SSD) and require ESD protection for IC circuits and other devices. Perform the following protection measures before opening antistatic plastic boxes.

- Perform the steps in section 2.2 Installation in the correct order;
- Electrostatic discharge (ESD) may cause a damage to the device. All operations referred to in this section should be performed on an ESD workbench using wrist straps and conductive foam pads. If there is no anti-static workbench, wear wrist straps and connect their other ends to the metal frame to avoid electrostatic damages;
- Hold the edge of the module, do NOT touch the components directly;
- Carefully check the module for any apparent loose or damaged components. If there are any questions, please contact Unicore or the local distributors.

Figure 2- 1 Typical Installation of UM220-IV L shows the typical installation of the UM220-IV L EVK.

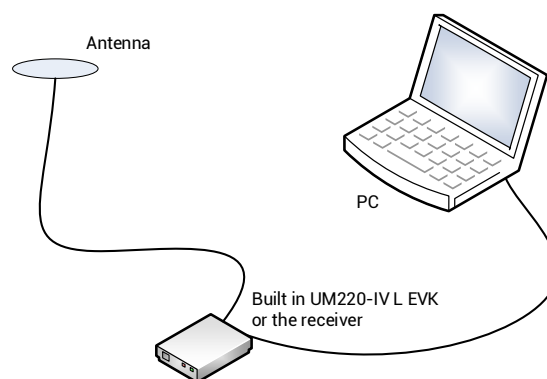


Figure 2- 1 Typical Installation of UM220-IV L

Have the following accessories ready before starting the installation:

- UM220-IV L EVK (including a power supply)
- UM220-IV L User Manual
- uSTAR_L executable file
- Qualified GNSS antennas



- Antenna cable
- Straight-through cable
- Desktop or laptop computer with serial port and installed with uSTAR_L

 Please keep the packing box and anti-static box for storage and handling.

2.2 Installation

Follow the below steps to install UM220-IV L and EVK.

- Step 1. Ensure adequate anti-static measures, such as wrist straps, workbench grounding, etc.
- Step 2. Open UM220-IV L EVK suite, and take out the evaluation board.
- Step 3. Select the GNSS antenna with the appropriate gain (the system frequency supported by the antenna should be consistent with the module) , fix it in the non-occluded area, and use the appropriate cable to connect the antenna and the UM220-IV L EB (evaluation board);
- Step 4. Connect the PC to the EVK serial port using a straight-through cable.
- Step 5. Power on the evaluation board and initialize UM220-IV L.
- Step 6. Open the uSTAR_L software.
- Step 7. Configure the receiver through uSTAR to display constellations view, messages, and receiver status, etc.

3 Technical Specifications

3.1 Electrical Specifications

Table 3- 1 Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units	Condition
Power Supply Voltage	VCC	-0.5	3.6	V	
VCC Maximum Ripple	Vrpp	0	50	mV	
Backup Power Supply Voltage	V_BCKP	-0.5	3.6	V	
Antenna Bias Voltage	V_ANT		6	V	
VCC_RF Voltage	VCC_RF		3.6	V	
Input Pin Voltage	Vin	-0.5	3.6	V	
Storage Temperature	Tstg	-40	85	°C	
Maximum ESD Stress	VESD (HBM)		500	V	

3.2 Operating Conditions

Table 3- 2 Operating Conditions

Parameter	Symbol	Min	Typical Value	Max	Units	Condition
Power Supply Voltage	VCC	3.0	3.3	3.6	V	
Peak Current	Iccp			100	mA	VCC=3.0V
Backup Power Supply Voltage	V_BCKP	1.65		3.6	V	
Antenna Bias Voltage	V_ANT	2.8		5.5	V	
VCC_RF Voltage	VCC_RF		VCC-0.1		V	
Low Level Input Voltage	Vin_low			0.2*VCC	V	
High Level Input Voltage	Vin_high	0.7*VCC			V	
Low Level Output Voltage	Vout_low			0.4	V	Iout=8mA
High Level Output Voltage	Vout_high	VCC-0.4			V	Iout=8mA
Antenna Gain	Gant	5		35	dB	
Noise Figure	Nftot		4		dB	
Operating Temperature	Topr	-40		85	°C	

3.3 Mechanical Specifications

Table 3- 3 Dimensions

Parameter	Min (mm)	Typical Value (mm)	Max (mm)
A	22.1	22.4	23.0
B	16.9	17.0	17.1
C	2.1	2.4	2.7
D	2.45	2.55	2.85
E	1.0	1.1	1.2
F	3.7	3.8	3.9
G	2.75	2.85	3.15
H		0.82	
K	0.7	0.8	0.9
M	0.9	1.0	1.1
N	0.4	0.5	0.6

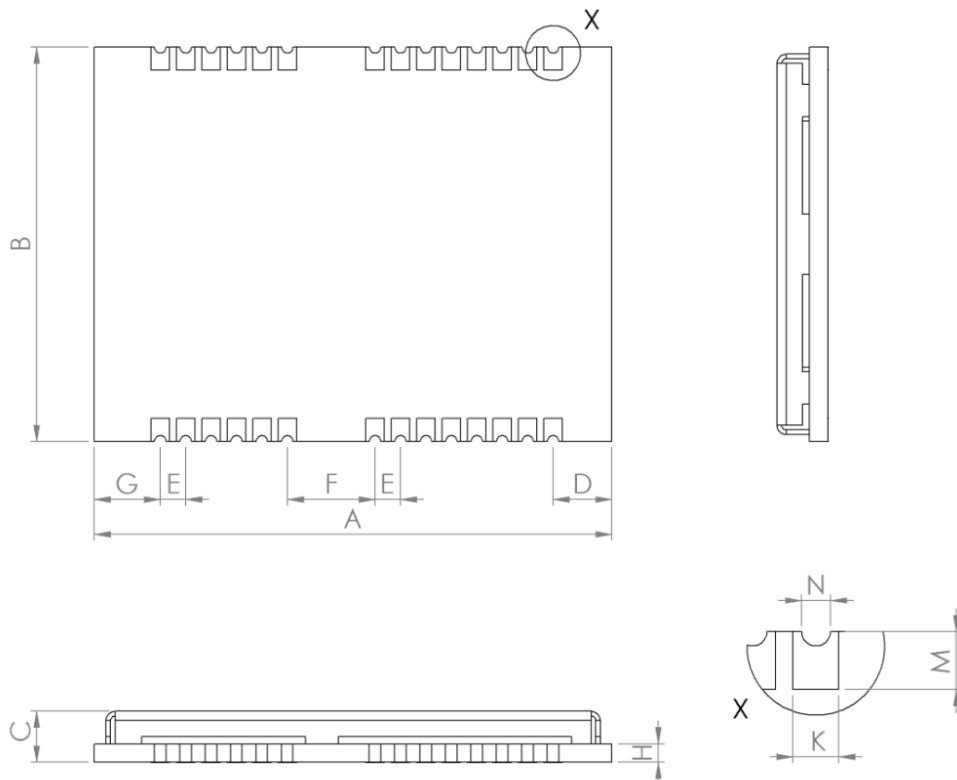


Figure 3- 1 Mechanical Layout

3.4 Pin Definition

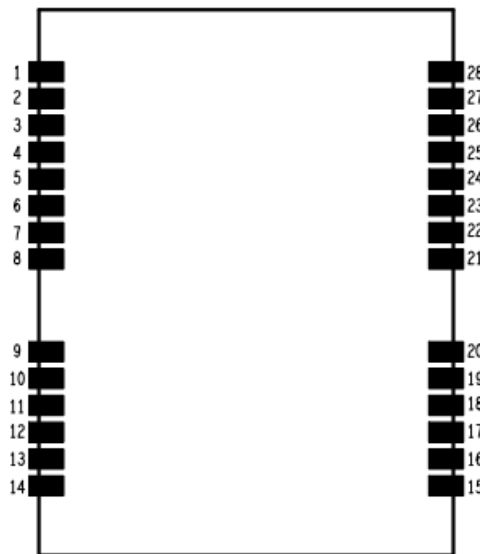


Figure 3- 2 UM220-IV L Pin Assignment

Table 3- 4 Pin Definition

No	Name	I/O	Electrical Level	Description
1	TXD2	O	LVTTL	COM2 is for data transmission. Firmware upgrade is not supported. Leave this pin floating if idle.
2	RXD2	I	LVTTL	COM2 is for data transmission. Firmware upgrade is not supported. Leave this pin floating if idle.
3	TXD1	O	LVTTL	COM1 is for data transmission. Firmware upgrade is supported.
4	RXD1	I	LVTTL	COM1 is for data transmission. Firmware upgrade is supported.
5	NC			Leave floating
6	VCC	I	3.0V~3.6V	Power supply
7	GND			Ground
8	VCC_OUT	O	3.0V~3.6V	Power supply output, leave this pin floating if idle
9	NC			Leave floating
10	nRESET	I	LVTTL	External Reset Pin, low active

No	Name	I/O	Electrical Level	Description
11	V_BCKP	I	1.65V~3.6V	When the main power supply VCC of the module is cut off, V_BCKP supplies power to RTC and SRAM; Current value is about 50μA. V_BCKP is necessary for hot start. If you do not use the hot start function, connect V_BCKP to VCC. Do NOT leave it floating or connect it to ground.
12	NC			Leave floating
13	GND	—		Ground
14	GND	—		Ground
15	GND	—		Ground
16	RF_IN	I		GNSS signal input
17	GND	—		Ground
18	VCC_RF	O	3.0V~3.6V	RF power supply output, leave this pin floating if idle
19	V_ANT	I		Antenna bias voltage, ground this pin if idle
20	ANT_DET_N	I	LVTTL	Open circuit detection of the active antenna
21	NC			Leave floating
22	NC			Leave floating
23	NC			Leave floating
24	NC			Leave floating
25	NC			Leave floating
26	NC			Leave floating
27	NC			Leave floating
28	TIME PULSE	O	LVTTL	1PPS, leave this pin floating if idle

3.5 PCB Packaging

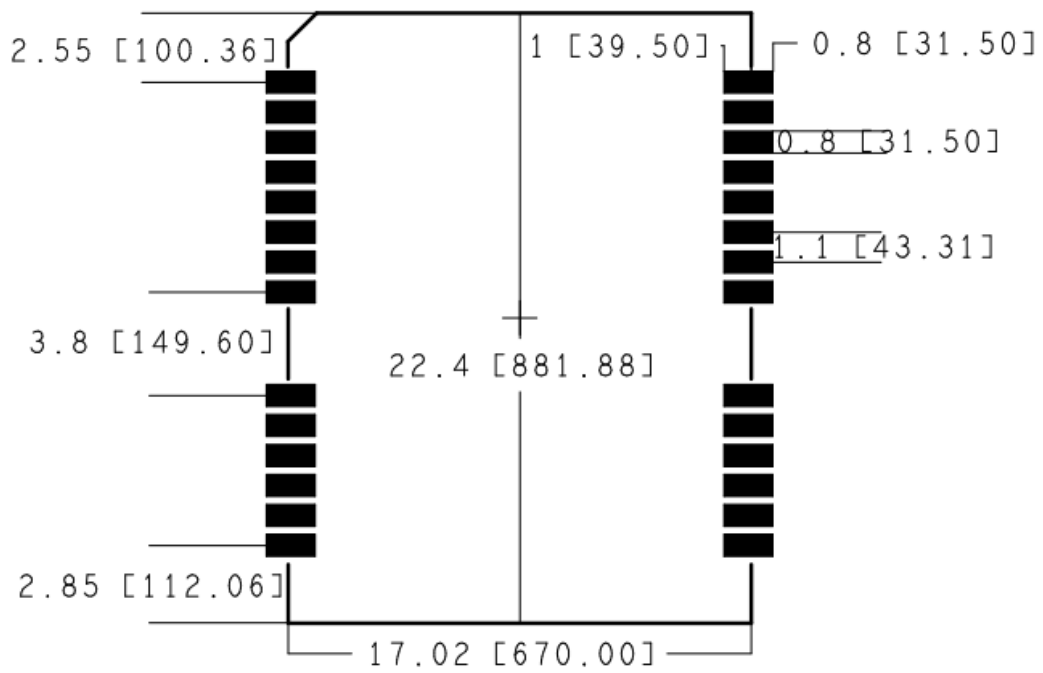


Figure 3- 3 UM220-IV L Recommended PCB Packaging (unit: mm, in brackets: mil)

☞ When designing PCB solder mask, make sure that the area under UM220-IV L module is completely coated with solder mask.

4 Hardware Design

4.1 Power Supply

4.1.1 Main Supply (VCC)

The voltage range of VCC is 3.0 V ~ 3.6 V.

Notes:

- 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 μ s ~ 10 ms.
- Power-on time interval: The time interval between the power-off (VCC < 0.4 V) to the next power-on is recommended to be larger than 500 ms.

4.1.2 Backup Supply (V_BCKP)

If the hot start function is needed, users should supply backup power to the module. The voltage range of V_BCKP is 1.65 V ~ 3.6 V.

Notes:

- 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 μ s ~ 10 ms.
- Power-on time interval: The time interval between the power-off (V_BCKP < 0.4 V) to the next power-on is recommended to be larger than 500 ms.
- The V_BCKP pin cannot be floating or connected to ground. When V_BCKP is not used, it should be connected to VCC or connected to backup power.

4.2 Antenna Design

4.2.1 Passive Antenna

The RF input port of the module can be connected directly to the RF_IN without providing a DC voltage. There are a few things to note when using a passive antenna:

- Select a proper installation position of the antenna to reduce the interference of electromagnetic noise, so as to enable the optimum performance of the antenna;
- A 50 impedance match of RF link is needed;

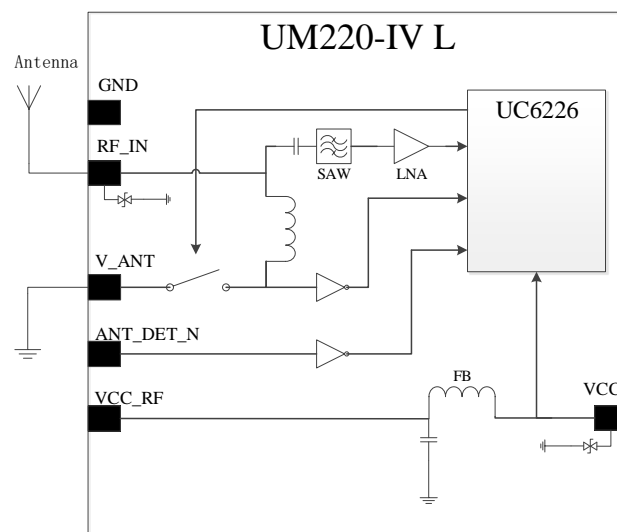


Figure 4- 1 UM220-IV L Passive Antenna Solution

To improve the performance of RF analog front-end, a low noise amplifier (LNA) can be added behind the passive antenna. UM220-IV L module provides a 3.3V power supply (VCC_RF) for LNA.

Note: If the user has a high requirement for ESD (higher than the maximum specification in User Manual), the user should consider other method to power the LNA rather than using the VCC_RF pin. In this case, it is recommended to choose a power supply chip with high ESD protection level. 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 ESD damage or other Electrical Over-Stress (EOS).

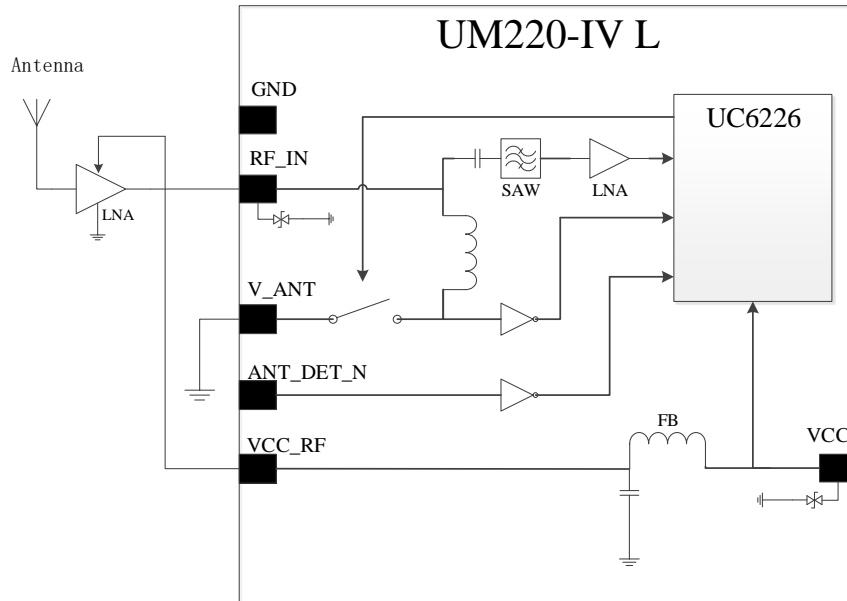


Figure 4- 2 UM220-IV L Passive Antenna High-performance Solution

4.2.2 Active Antenna

The active antenna increases the system power consumption when improving the system performance. The 3.3V Power Supply (VCC_RF) provided by the UM220-IV I module can be used to power the antenna directly if the function of detecting the state of the antenna inside the module is not used and the working voltage of the antenna is 3.3V.

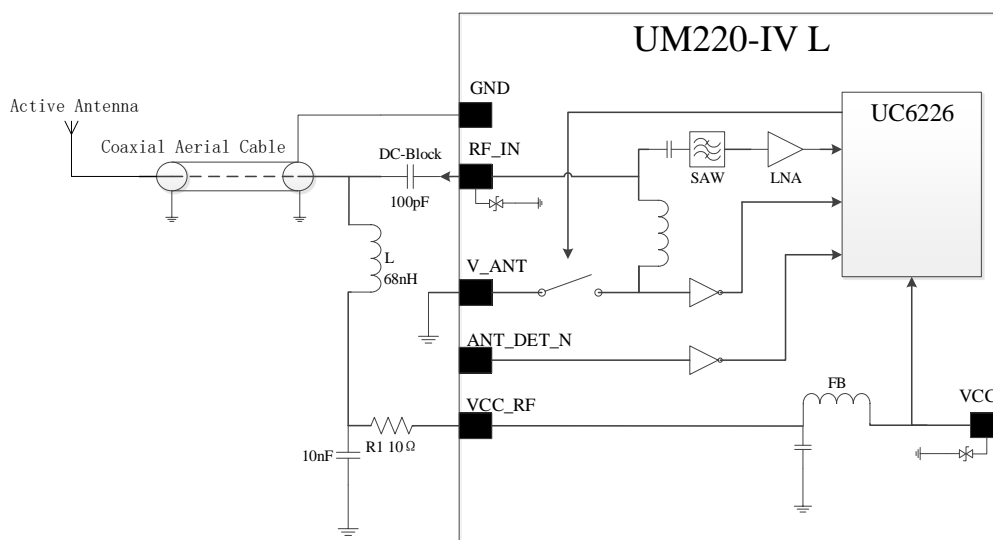


Figure 4- 3 UM220-IV L Active Antenna Solution Powered by VCC_RF

☞ If the user has a high requirement for ESD (higher than the maximum specification in User Manual), the user should consider other method to feed the antenna rather than using the VCC_RF pin. In this case, it is recommended to choose a power supply chip with high ESD protection level. 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 ESD damage or other Electrical Over-Stress (EOS).

When the working voltage of the active antenna is not 3.3V, the antenna can be powered by the external power supply.

☞ If the antenna power supply 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's recommended to design an independent power rail for the antenna to reduce the possibility of damage to the module.

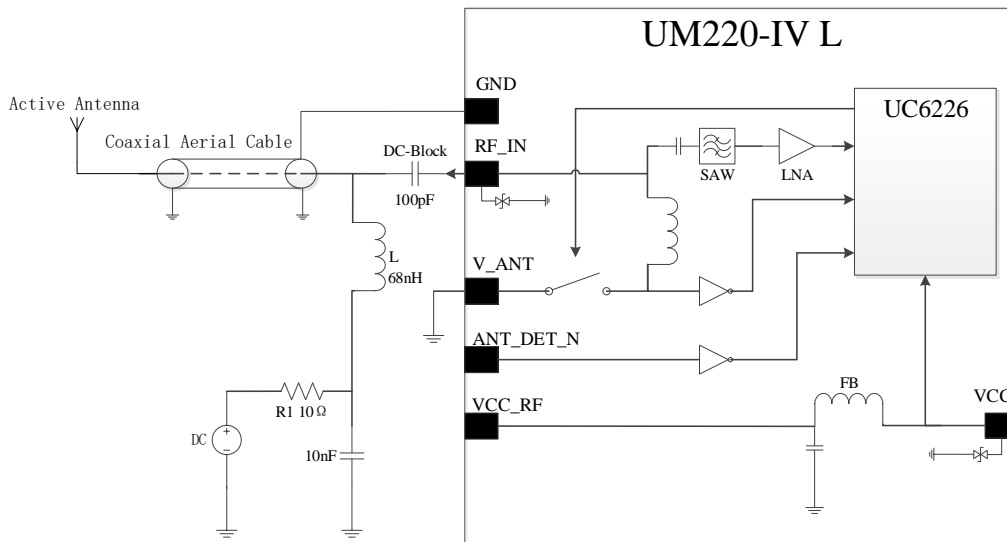


Figure 4- 4 UM220-IV L Active Antenna Solution Powered by External Power Supply

4.2.3 Active Antenna State Detection

UM220-IV L module can detect the active antenna state including open-circuit, short-circuit and normal state. The host computer enables or disables the antenna state detection function by transmitting commands via serial ports, and receives the detected antenna state via serial ports. The module cuts off the power supply automatically when detecting the short-circuit state of antenna.

1) Antenna Short-circuit Detection

If the antenna short-circuit detection function is required, connect the antenna power supply to the module's V_ANT Pin after cascading an appropriate value of resistance, and feed the antenna through the internal switch. If the V_ANT pin is directly connected without a serial resistor, the module will be damaged when the antenna is short-circuited. The internal switch is turned off by default, which can be switched with the CFGANT command.

When the module detects an antenna short-circuit, the antenna feed is cut off immediately through the internal switch, periodically feeds the antenna and detects the state. Use **ANTSTAT** for the query.

If the working voltage of the antenna is 3.3V, the 3.3V power supply (VCC_RF) provided by the module can be connected in series with a 10Ω resistor to the V_ANT pin, and turn on the internal switch through CFGANT to power the antenna. If an antenna short circuit is detected at this time, the module will automatically turn off the switch. When there is a need to save the power consumption, turn off the switch through **CFGANT**.

 Refer to *UM220-IV L_ Protocol Specification* for more details

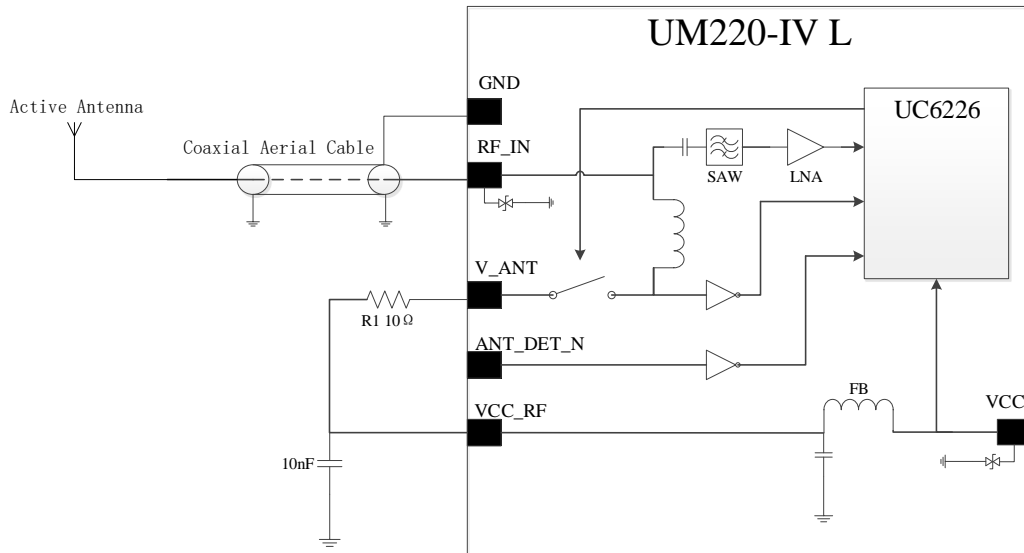


Figure 4- 5 UM220-IV L Antenna Short-circuit Detection Powered by VCC_RF

When the working voltage of the antenna is 5V, the antenna can be powered by connecting an external power supply with a 10Ω serial resistor to the V_ANT pin. Since this power supply is directly connected to the RF_IN pin of the module, this power supply cannot introduce noise. It's recommended to use the power supply from analog network.

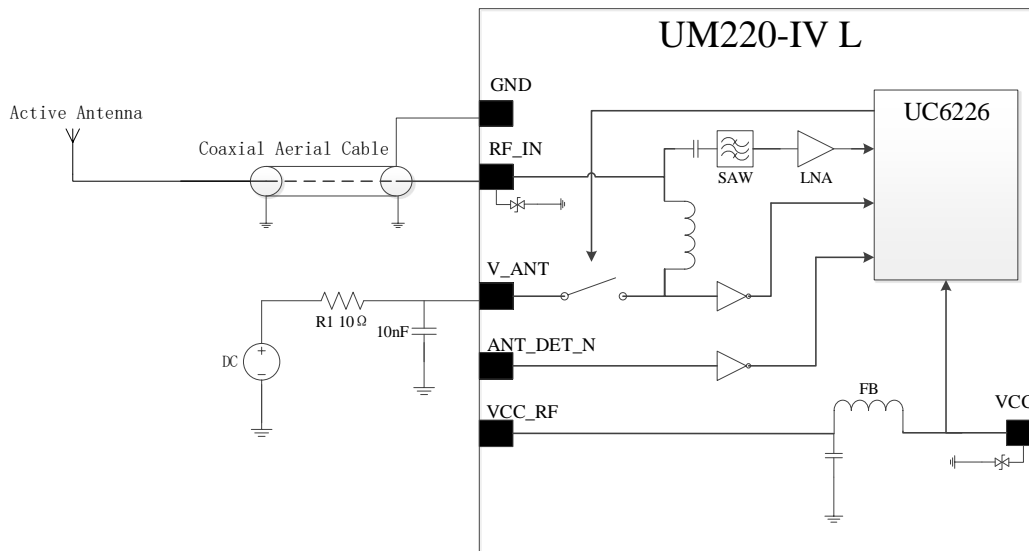


Figure 4- 6 UM220-IV L Antenna Short-circuit Detection Powered by External Power Supply

2) Antenna Short-circuit and Open-circuit Detection

If the short-circuit and open-circuit detection functions of the module are required concurrently, use the ANT_DET_N pin to cooperate with an external circuit. The threshold current for open circuit detection can be calculated by formula (4-1). When the antenna working current is less than the calculated value, the module determines that the antenna is open-circuit. The resistance of the series resistor R1 can be adjusted according to the antenna working current.

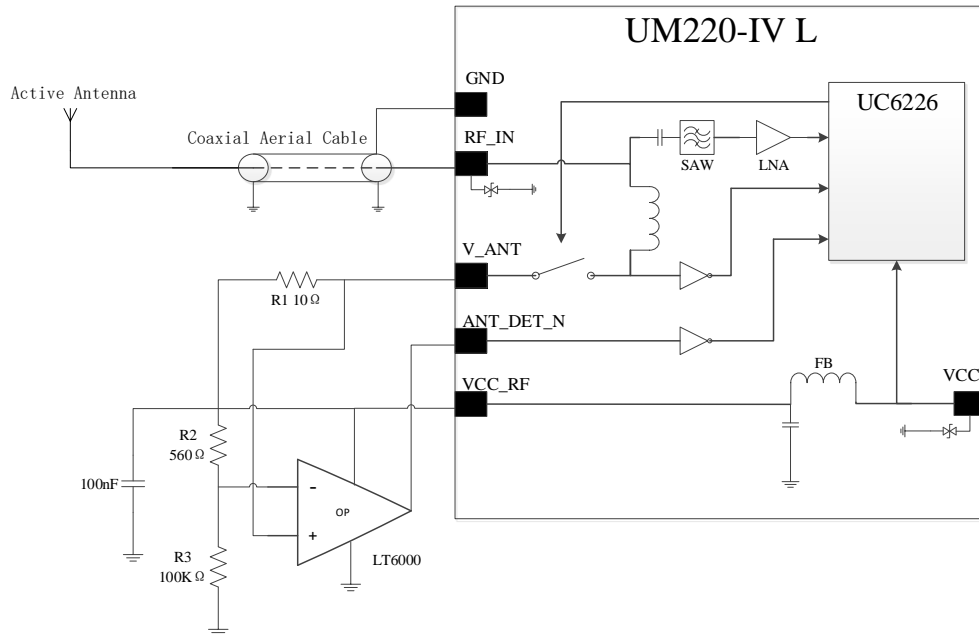


Figure 4- 7 UM220-IV L Antenna Short-circuit and Open-circuit Detection Powered by VCC_RF

$$I = \frac{\left(\frac{R_2}{R_2+R_3}\right)}{R_1} V_{CC_RF} \quad (4-1)$$

If an external power supply is used to power the antenna, the maximum power supply voltage cannot exceed 5.5V to protect the ANT_DET_N pin.

Use ANTSTAT to query the antenna state.

4.3 UART

The two serial ports of UM220-IV L are LVTTTL levels, which need to be converted through RS232 level if connected to PC.

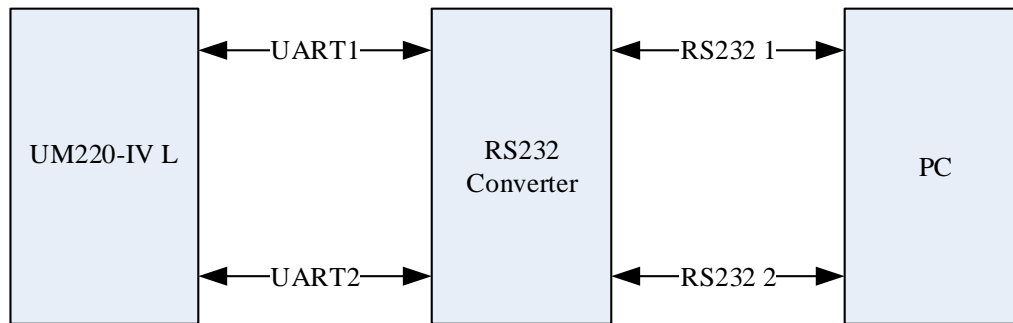



Figure 4- 8 Connect to PC through UART

It is recommended that users reserve a test point for serial port 2 as the debug port.

 If there is data input on the module input ports (RXD, GPIO) when the module is not powered on, it will form power leakage on the module VCC. When the leakage voltage is higher than 1.6V, it may cause a start failure when the module is powered on. To prevent the leakage power, ensure that the IO port connected to the module is in high impedance or low level when the module is not powered on.

4.4 RESET Time Sequence

There is a reset chip inside the module. When VCC is lower than 2.63V (typical value of ambient temperature) or nRESET is at low level, the module is in reset state. After VCC rises to 2.63V or nRESET changes from low to high, the reset state of the chip will continue to remain for 200ms.

It is recommended to keep the reset signal of the nRESET pin for 10ms after VCC is valid at power-up. During normal operation, the minimum valid time of the reset signal for the nRESET pin is 500ns.

4.5 TIME PULSE Output

The period of the TIME PULSE output signal is 1s, the peak-to-peak value is VCC, and the default duty cycle is 10%.

4.6 Layout Recommendation

- Power supply: Stable and low ripple power is necessary for good performance. Make sure the peak-to-peak voltage ripple does not exceed 50mV.
 - Use LDO to ensure the purity of power supply;
 - Place LDO to the module as close as possible in layout;
 - Widen the power circuit wiring or use split copper surface to transmit current;
 - Avoid the high-power or high inductance devices such as magnetic coil.
- Antenna interface: note with the antenna impedance matching, and the circuit is short and smooth, try to avoid acute angles.
- Connect the RF signal to the antenna and make sure the 50 Ω impedance match on the circuit.
- Antenna location: to obtain a good signal-to-noise ratio, ensure that the antenna is well isolated from electromagnetic radiation sources, especially electromagnetic radiation in the frequency range of 1559 to 1605 MHz.
- Try to avoid circuits below the UM220-IV L module.
- UM220-IV L module is a temperature sensitive device, rapid temperature changes will result in reduced performance. Keep it as far away from the high-power high-temperature air and heating devices as possible.

5 Packaging

5.1 Product Labeling

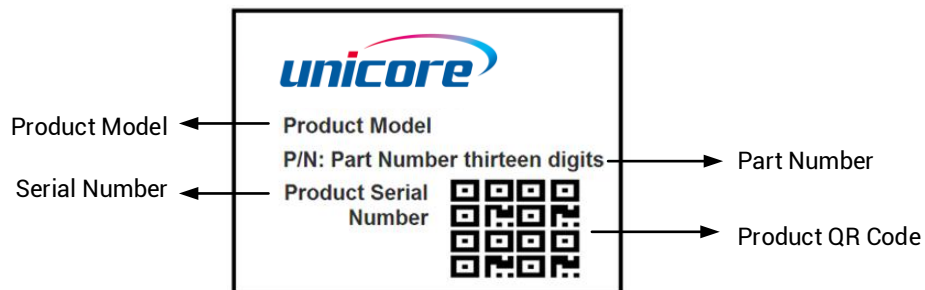


Figure 5- 1 Product Label

5.2 Packaging Description

UM220-IV L modules use carrier tape and reel (suitable for mainstream surface mount equipment), packaged in vacuum-sealed aluminum foil antistatic bags, with a desiccant inside to prevent moisture. When using reflow welding process to weld modules, please strictly comply with IPC standard to conduct humidity control on modules. As packaging materials such as carrier belt can only withstand the temperature of 65 degrees Celsius, modules shall be removed from the packaging during baking.



Figure 5- 2 UM220-IV L Package Diagram



Table 5- 1 Package Instructions

Item	Description
Module	500 pics/reel
Reel size	Tray: 13" external diameter: 330mm, internal diameter: 100mm, width: 24mm thickness: 2.0mm
Carrier tape	Space between: 20mm

UM220-IV L module is rated at MSL level 3, refer to the relevant IPC/JEDEC standards for baking requirements. Please access to the website www.jedec.org to download for details.

The shelf life of UM220-IV L module is one year.

6 Soldering and Disassembly

6.1 Disassembly

When it is necessary to remove the module, it is recommended to melt the soldering tin of the pins on both sides of the module with an electric soldering iron and remove the module with tweezers. Do NOT use other means to remove the module (for example, the module is blown off by a hot air gun), which may lead to module damage.

6.2 Clean

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

6.3 Reflow Soldering

In order to avoid component falling off, the module should be placed on the upper part of the motherboard when soldering. The reflow temperature curve is recommended as shown in figure 6-1 below (M705-GRN360 is recommended for solder paste).

Note: The module can only be soldered once.

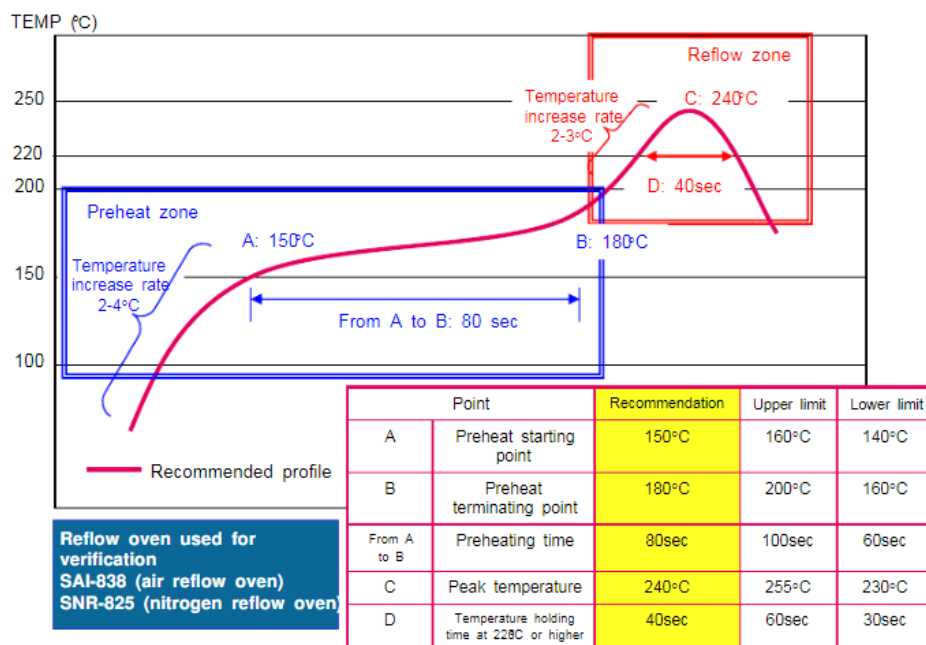


Figure 6- 1 Reflow Soldering Curve

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