Waveshare RM502Q-AE

Waveshare RM502Q-AE 5G HAT Instruction Manual

Model: RM502Q-AE

1. INTRODUCTION

The Waveshare RM502Q-AE 5G HAT is an expansion board designed for Raspberry Pi and other host boards, enabling 5G/4G/3G cellular communication. It features an M.2 B KEY slot for compatible 5G modules, multiple antenna interfaces, and various control pins for flexible integration. This manual provides essential information for setting up, operating, and maintaining your 5G HAT.

Standard M.2 B KEY Slot

Compatible With RM500U-CN, RM500Q-GL, RM500Q-AE, RM502Q-AE Series Modules

5G SUB-6	RM500U-CN	RM500Q-GL	RM500Q-AE	RM502Q-AE
Region / Provider	China	Global (except US)	Global (except China)	Global (except China)
Operating temperature	-30 °C ~ +75 °C		-30 °C ~ +70 °C	
Extension temperature	-40 °C ~ +85 °C			
Dimensions	30.0 × 52.0 × 2.3 (mm)			
Weight	8.9 (g)		8.7 (g)	
Power supply	3.3~4.4 V, typical 3.7 V		3.135~4.4 V, typical 3.7 V	
Power consumption	90 µA @ shutdown 3.7 mA @ hibernate TBD @ USB 2.0, idle TBD @ USB 3.0, idle	70 µA @ shutdown 4.0 mA @ hibernate 32 mA @ USB 2.0, idle 54 mA @ USB 3.0, idle	80 µA @ shutdown 4.2 mA @ hibernate 39 mA @ USB 2.0, idle 54.5 mA @ USB 3.0, idle	

An assembled view of the Waveshare RM502Q-AE 5G HAT connected to a Raspberry Pi (not included), showcasing the module with four antennas attached. This image illustrates the compact form factor and connectivity options.

2. PACKAGE CONTENTS

Please verify that all items listed below are included in your package. **Note: The 5G module (e.g., RM502Q-AE) is typically sold separately and is not included in the standard HAT package.**

*This image displays all components typically included in the package: 1. M.2 TO 4G/5G HAT, 2. 5G Module (for reference only, not included), 3. Antennas (4 pcs), 4. IPEX adapter cables (4 pcs), 5. GNSS antenna, 6. 2*20PIN pin header, 7. 5V 3A Type-C power adapter, 8. Dual plug USB3.0 cable, 9. USB3.0 adapter, 10. USB2.0 adapter, 11. SMA protective caps (4 pcs), and 12. Screws pack.*

- 1x M.2 TO 4G/5G HAT
- 4x Antennas
- 4x IPEX adapter cables
- 1x GNSS antenna
- 1x 2*20PIN pin header
- 1x 5V 3A Type-C power adapter
- 1x Dual plug USB3.0 cable
- 1x USB3.0 adapter
- 1x USB2.0 adapter
- 4x SMA protective caps
- 1x Screws pack

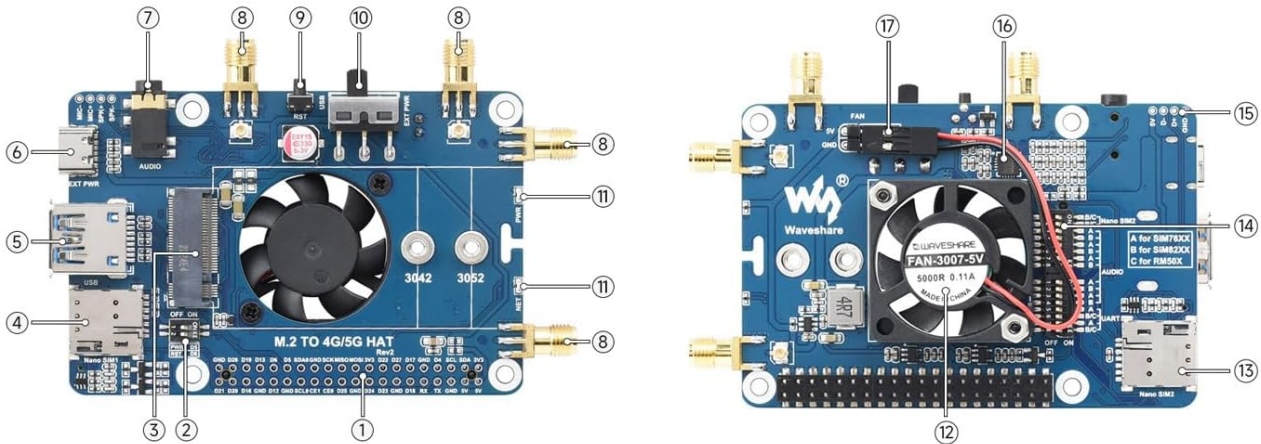## 3. PRODUCT OVERVIEW AND FEATURES

The RM502Q-AE 5G HAT is designed for robust and high-speed cellular connectivity. Key features include:

- **Extensive Protocol Support:** Integrates various network protocols with multi-driver and software support, compatible with Windows, Linux, and Android operating systems.
- **High-Speed USB Connectivity:** Features a USB 3.1 port (USB 2.0 compatible) for connecting to PCs, Raspberry Pi, or Jetson Nano host boards, enabling high-speed 5G communication.
- **Standard M.2 B KEY Slot:** Compatible with different 5G modules such as RM500U-CN, RM500Q-GL, RM500Q-AE, and RM502Q-AE series.
- **Flexible Control Pins:** Onboard UART, PWR, and RST control pins with a built-in voltage level translator, enabled via

DIP switch, for use with hosts like Raspberry Pi or Arduino.

- **Dedicated Power Supply:** An onboard USB-C connector, enabled via switch, allows for a standalone power supply to the module, ensuring stable and flexible power delivery for higher loads.
- **User-Friendly Controls:** Includes an onboard power supply on/off switch, reset button, and LED indicator for easy module management and status monitoring.
- **Dual SIM Card Support:** Two SIM card slots offer dual card single standby functionality, switchable via AT command.
- **Efficient Power Management:** High-efficiency power supply circuit provides up to 3A output current.

What's On Board

1. **Raspberry Pi GPIO header**
   for connecting with Raspberry Pi
2. **DIP switches**
   Enables the power control and reset pins
3. **M.2 slot**
   Compatible with most SIMCom and QUECTEL 4G/5G modules in M.2 form factor
4. **SIM card slot 1**
   one of the 2x SIM card slots, dual card single standby
5. **USB3.1 port**
   USB 2.0 compatible, for connecting with different hosts
6. **USB Type-C port**
   5V 3A input, stable and flexible power supply

7. **Audio jack**
   SIM7600X/SIM8XXX series supports audio function, but RM5XX/EM06XX series temporarily does not support this function
8. **Antenna connector**
   Supports quad antennas
9. **Reset button**
10. **Power supply switch**
    Switch the power supply mode:
    When set to USB, the module is powered via the "5. USB3.1 port"
    When set to EXT PWR, the module is powered by the external power supply via the "6. USB Type-C port"
11. **Indicator**
    Easy to monitor the operating status of module

12. **Cooling fan**
    Better heat dissipation for both Raspberry Pi and the 5G module
13. **SIM card slot 2**
    Switchable via AT command
14. **Module settings switch**
    Switch A to ON for SIM7600X/A7906X/SIM7906X/SIM7912X series 4G M.2 modules;
    Switch B to ON for SIM8202X/SIM8200EA/SIM8262X series 5G M.2 modules;
    Switch C to ON for RM50X/RM520N-GL/EM06X series 5G/LTE-A M.2 modules

15. **USB 2.0 interface pads**
16. **NAU8810X Audio Chip**
    For SIM7600X/SIM8XXX series modules, RM5XX and EM06XX series modules temporarily does not support this function
17. **Fan Header**
    5V cooling fan power supply

A comprehensive diagram labeling all key components on the Waveshare RM502Q-AE 5G HAT board, including the Raspberry Pi GPIO header, DIP switches, M.2 slot, SIM card slots, USB3.1 port, USB Type-C port, audio jack, antenna connectors, reset button, power supply switch, LED indicator, cooling fan, USB2.0 interface pads, NAUB810X Audio Chip, and fan header.

4. SPECIFICATIONS

Below are the general specifications for the Waveshare RM502Q-AE 5G HAT and compatible modules. Specific performance may vary based on the installed 5G module and network conditions.

General Specifications

Feature	Description
Model	RM502Q-AE 5G HAT
Connectivity	5G/4G/3G (via M.2 module), USB 3.1 (compatible with USB 2.0)
M.2 Slot	Standard M.2 B KEY, compatible with RM500U-CN / RM500Q-GL / RM500Q-AE / RM502Q-AE series
Host Compatibility	Raspberry Pi, PC, Jetson Nano, Arduino
Operating System Support	Windows, Linux, Android
SIM Card Slots	2 (dual card single standby, switchable via AT command)
Power Supply	USB-C (5V 3A recommended), USB 3.1 port
GNSS Support	GPS, BeiDou, Glonass, Galileo (module dependent)

FREQUENCY BAND					
5G	5G NR NSA	n41, n78, n79	n41, n77, n78, n79	n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n38, n40, n41, n48*, n66, n71, n77, n78, n79	
	5G NR SA	n1, n28, n41, n77, n78, n79	n1, n2, n3, n5, n7, n8, n12, n20, n25, n28, n38, n40, n41, n48*, n66, n71, n77, n78, n79		
LTE	LTE-FDD	B1, B2, B3, B5, B7, B8, B20, B28	B1, B2, B3, B4, B5, B7, B8, B12(B17), B13, B14, B18, B19, B20, B25, B26, B28, B29, B30, B32, B66, B71		
	LTE-TDD	B34, B38, B39, B40, B41	B34, B38, B39, B40, B41, B42, B43, B48		
	LAA	-	B46		
UMTS	WCDMA	B1, B2, B5, B8	B1, B2, B3, B4, B5, B6, B8, B19		
GNSS		-	GPS / GLONASS / BeiDou (Compass) / Galileo		
DATA RATE					
5G SA Sub-6		downlink 2 Gbps; uplink 1 Gbps	downlink 2.1 Gbps; uplink 900 Mbps	downlink 2.1 Gbps; uplink 450 Mbps	downlink 4.2 Gbps; uplink 450 Mbps
5G NSA Sub-6		downlink 2.2 Gbps; uplink 575 Mbps	downlink 2.5 Gbps; uplink 600/650 Mbps	downlink 2.5 Gbps; uplink 650 Mbps	downlink 5 Gbps; uplink 650 Mbps
LTE		downlink 600 Mbps; uplink 150 Mbps	downlink 1.0 Gbps; uplink 200 Mbps	downlink 1.0 Gbps; uplink 200 Mbps	downlink 2 Gbps; uplink 200 Mbps
UMTS		downlink 42.2 Mbps; uplink 11 Mbps	downlink 42 Mbps; uplink 5.76 Mbps		
* means developing/planning/processing					

This table provides a comparison of various compatible M.2 B KEY 5G modules (RM500U-CN, RM500Q-GL, RM500Q-AE, RM502Q-AE, RM520N-GL series), including their region/provider, operating temperature, extension temperature, dimensions, weight, power supply, power consumption, frequency bands (5G NR NSA/SA, LTE-FDD/TDD, UMTS, GNSS), and data rates. Refer to this table for detailed module specifications.
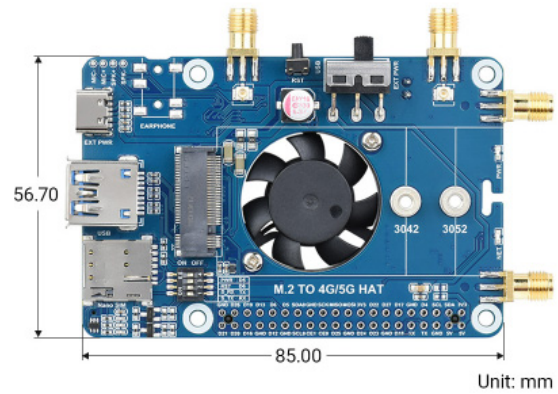
This image includes a detailed technical drawing showing the outline dimensions of the HAT in millimeters (85.00 mm x 56.70 mm).
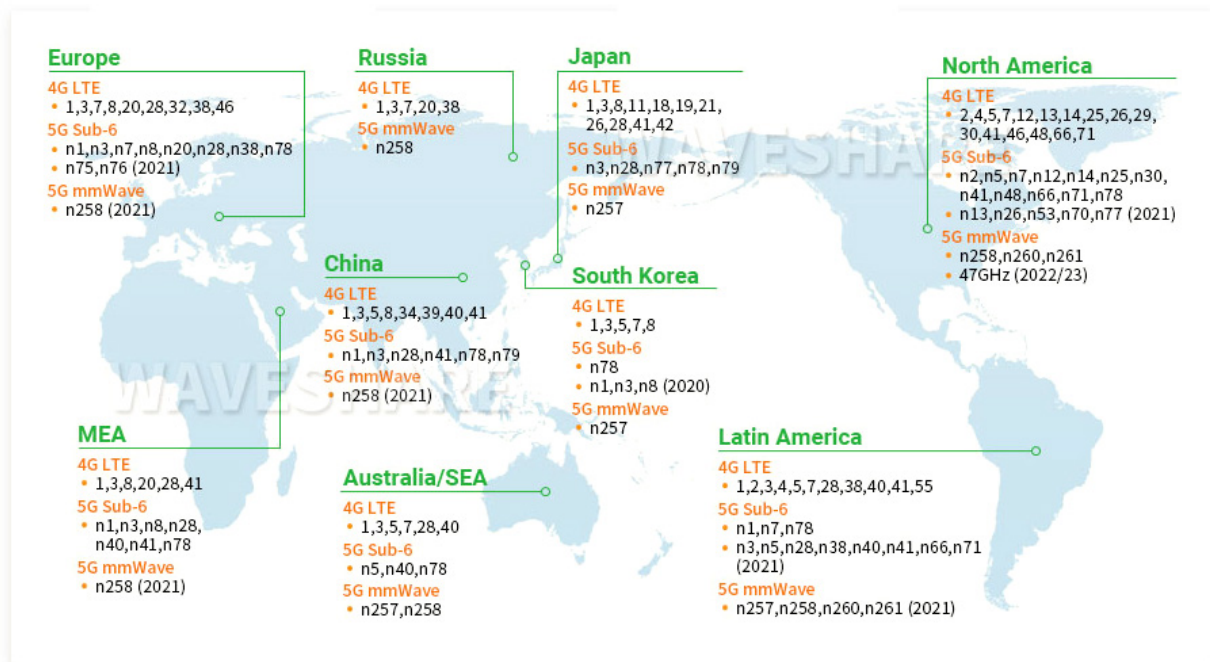
5. SETUP GUIDE

5.1 Hardware Installation

1. **Install 5G Module:** Carefully insert your compatible M.2 5G module into the M.2 B KEY slot on the HAT. Secure it with the provided screw.

2. **Attach Antennas:** Connect the four cellular antennas to the SMA connectors on the HAT. Connect the GNSS antenna to its dedicated connector. Ensure all connections are finger-tight.

3. **Insert SIM Card:** Open the SIM card slot cover and insert your activated Nano-SIM card(s). The HAT supports two SIM cards for dual standby.

4. **Connect to Host Board:**

   - **For Raspberry Pi:** Align the 40-pin GPIO header of the HAT with the Raspberry Pi's GPIO pins and gently press down to connect. Ensure proper alignment to avoid damage.
   - **For PC/Jetson Nano:** Use the provided USB 3.0 cable to connect the HAT's USB 3.1 port to your host device.
   - **For CM4-IO Base:** Use the purpose-made USB adapter for connection.

5. **Power Connection:**

   - If using with Raspberry Pi, the HAT can draw power from the Pi's GPIO.
   - For standalone operation or if additional power is required, connect the 5V 3A Type-C power adapter to the HAT's USB-C port. Ensure the power switch on the HAT is set to the appropriate source (USB or external Type-C).

Supports 5G/4G/3G Networking

Support 5G NSA (4G And 5G Co-Networking) And SA (5G Separate Networking) Support 4G/3G Internet

Europe
4G LTE
• 1,3,7,8,20,28,32,38,46
5G Sub-6
• n1,n3,n7,n8,n20,n28,n38,n78
• n75,n76 (2021)
5G mmWave
• n258 (2021)

Russia
4G LTE
• 1,3,7,20,38
5G mmWave
• n258

Japan
4G LTE
• 1,3,8,11,18,19,21, 26,28,41,42
5G Sub-6
• n3,n28,n77,n78,n79
5G mmWave
• n257

North America
4G LTE
• 2,4,5,7,12,13,14,25,26,29, 30,41,46,48,66,71
5G Sub-6
• n2,n5,n7,n12,n14,n25,n30, n41,n48,n66,n71,n78
• n13,n26,n53,n70,n77 (2021)
5G mmWave
• n258,n260,n261
• 47GHz (2022/23)

China
4G LTE
• 1,3,5,8,34,39,40,41
5G Sub-6
• n1,n3,n28,n41,n78,n79
5G mmWave
• n258 (2021)

South Korea
4G LTE
• 1,3,5,7,8
5G Sub-6
• n78
• n1,n3,n8 (2020)
5G mmWave
• n257

MEA
4G LTE
• 1,3,8,20,28,41
5G Sub-6
• n1,n3,n8,n28, n40,n41,n78
5G mmWave
• n258 (2021)

Australia/SEA
4G LTE
• 1,3,5,7,28,40
5G Sub-6
• n5,n40,n78
5G mmWave
• n257,n258

Latin America
4G LTE
• 1,2,3,4,5,7,28,38,40,41,55
5G Sub-6
• n1,n7,n78
• n3,n5,n28,n38,n40,n41,n66,n71 (2021)
5G mmWave
• n257,n258,n260,n261 (2021)

* the frequency band diagram above is for reference only, please confirm the supported bands according to your local service provider.

This image shows various connection examples: the HAT connected to a laptop via USB, a Raspberry Pi 4B, a Raspberry Pi 3B+, and a CM4-IO Base.

5.2 Software Configuration

The RM502Q-AE 5G HAT supports various operating systems including Windows, Linux, and Android. Drivers and software support are typically provided by the 5G module manufacturer (e.g., Quectel). Refer to the module's documentation for specific driver installation and configuration steps.

- **Driver Installation:** Install the necessary drivers for your 5G module on your chosen operating system. These are usually available from the module manufacturer's website.
- **Network Configuration:** Configure your operating system's network settings to recognize and utilize the 5G modem. This may involve setting up APN (Access Point Name) settings.
- **AT Commands:** The module can be controlled and configured using AT commands via a serial interface (UART or USB virtual COM port). Refer to the 5G module's AT command manual for detailed instructions.

6. OPERATING INSTRUCTIONS

Once the hardware is installed and software configured, you can begin operating the 5G HAT.

1. **Power On:** Ensure the power supply is connected and the power switch on the HAT is in the 'ON' position. The LED indicator will show the operating status.
2. **Network Connection:** The 5G module will attempt to connect to the cellular network. Monitor the LED indicator for network status (e.g., blinking for searching, solid for connected).
3. **Data Communication:** Once connected, your host device (Raspberry Pi, PC, etc.) should be able to access the internet via the 5G connection.
4. **SIM Card Switching:** If using two SIM cards, you can switch between them using specific AT commands. Consult your 5G module's documentation for the relevant commands.
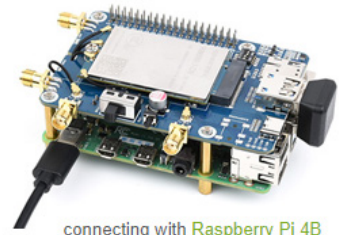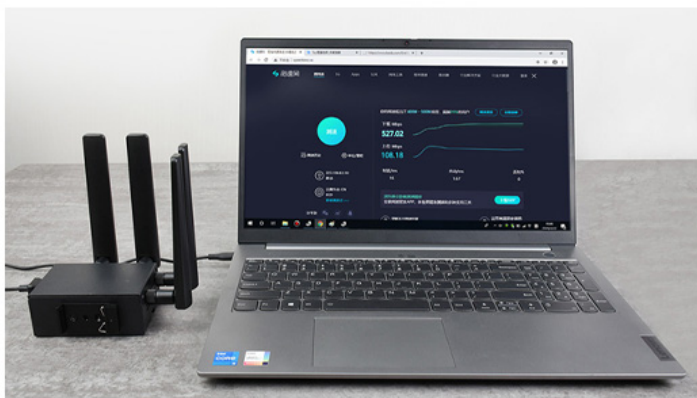
7. MAINTENANCE

Proper maintenance ensures the longevity and reliable operation of your 5G HAT.

- **Keep Clean:** Regularly clean the HAT and its components with a soft, dry cloth. Avoid using liquids or abrasive cleaners.
- **Environmental Conditions:** Operate the HAT within its specified temperature and humidity ranges. Avoid extreme temperatures, direct sunlight, and high moisture environments.
- **Antenna Care:** Ensure antennas are securely connected and not bent or damaged. Proper antenna placement is crucial for optimal signal reception.
- **Firmware Updates:** Periodically check the 5G module manufacturer's website for firmware updates. Keeping the module firmware up-to-date can improve performance and stability.
- **Cooling Fan:** The HAT includes a high-speed cooling fan. Ensure it is free from obstructions to maintain effective heat dissipation for both the Raspberry Pi and the 5G module.
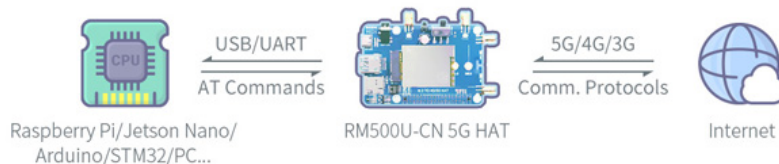

This image shows a close-up of the high-speed cooling fan on the HAT, designed for better heat dissipation.

8. TROUBLESHOOTING

If you encounter issues with your RM502Q-AE 5G HAT, refer to the following common troubleshooting steps:

- **No Power/LED Off:**

  - Check power connections. Ensure the USB-C power adapter is correctly plugged in or the HAT is properly seated on the Raspberry Pi.
  - Verify the power switch on the HAT is in the 'ON' position and set to the correct power source.

- **Module Not Detected:**

  - Ensure the M.2 5G module is correctly inserted and secured in its slot.
  - Verify the USB cable connection to the host device. Try a different USB port or cable.
  - Check if the necessary drivers for the 5G module are installed on your operating system.

- **No Network Connection:**

- Confirm that the SIM card is correctly inserted and activated with a data plan.

  - Check antenna connections. Ensure all cellular antennas are securely attached.

  - Verify APN settings in your operating system's network configuration.

  - Ensure you are in an area with 5G/4G/3G network coverage.

  - Use AT commands to query the module's network registration status.

- **Slow Data Speeds:**

  - Check antenna placement and orientation for optimal signal strength.

  - Ensure the 5G module firmware is up-to-date.

  - Verify network congestion in your area.

- **Overheating:**

  - Ensure the cooling fan is operating correctly and not obstructed.

  - Provide adequate ventilation around the HAT and host device.

9. WARRANTY AND SUPPORT

For warranty information, please refer to the terms and conditions provided by Waveshare at the time of purchase or visit the official Waveshare website. Technical support and additional resources, including detailed documentation and software downloads, can be found on the Waveshare product page for the RM502Q-AE 5G HAT.

Online Resources:

- Waveshare Official Website

- Refer to the specific 5G module manufacturer's website (e.g., Quectel) for module-specific documentation and drivers.