LG290P (03)&LGx80P (03) RTK Application Note

GNSS Module Series

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About the Document

Document Information	
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Revision History

Version	Date	Description
-	2024-06-10	Creation of the document
1.0	2024-07-17	First official release
1.1	2025-07-17	1. Added applicable modules LG580P (03) and LG680P (03). 2. Updated the RTK high-precision positioning operation guide (*Chapter 2*). 3. Updated the RTK FAQs (*Chapter 3*).

Contents

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1 Introduction

Quectel LG290P (03), LG580P (03) and LG680P (03) are a high-precision RTK positioning module that supports multiple GNSS constellations. RTK (Real-Time Kinematic) is a real-time differential GNSS technology based on carrier phase measurements, which achieves high-precision positioning centimeter-level accuracy. For more details on RTK, see document [1] RTK application note.

1.1. RTK Application Scenarios

The main application scenarios of RTK include lawn mowers, drones and lane-level navigation.

Figure 1: UAV

Figure 2: Automatic Mower

Figure 3: Lane-level Navigation

1.2. RTK Related Messages

When RTK is used, RTCM messages are sent to the module through the UART interface. The LG290P (03), LG580P (03) and LG680P (03) modules support RTCM 10403.3 input messages as shown in the following table.

Table 1: Supported RTCM Input Messages

Message Type	Message Name
1005	Stationary RTK Reference Station ARP
1006	Stationary RTK Reference Station ARP with Antenna Height
1073	GPS MSM3
1074	GPS MSM4
1075	GPS MSM5
1076	GPS MSM6
1077	GPS MSM7
1083	GLONASS MSM3
1084	GLONASS MSM4
1085	GLONASS MSM5
1086	GLONASS MSM6
1087	GLONASS MSM7
1093	Galileo MSM3
1094	Galileo MSM4
1095	Galileo MSM5
1096	Galileo MSM6
1097	Galileo MSM7
1113	QZSS MSM3
1114	QZSS MSM4

Message Type	Message Name
1115	QZSS MSM5
1116	QZSS MSM6
1117	QZSS MSM7
1123	BDS MSM3
1124	BDS MSM4
1125	BDS MSM5
1126	BDS MSM6
1127	BDS MSM7
1133	NavIC/IRNSS MSM3
1134	NavIC/IRNSS MSM4
1135	NavIC/IRNSS MSM5
1136	NavIC/IRNSS MSM6
1137	NavIC/IRNSS MSM7

2 RTK High-precision Positioning Operation Guide

This chapter will describe how to set up the RTK rover system with the evaluation kit using the LG290P (03) module as an example. There are two ways to establish the connection between the rover kit and the NTRIP correction service.

- Connection via computer: this method is suitable for quick RTK function verification in the environment where the internet is accessible from the computer. By using the NTRIP client function inside the QGNSS tool, you can easily connect to the NTRIP service and evaluate the RTK function.

- Connection via integrated 4G: this approach works well for RTK function verification in situations when connecting to a computer via QGNSS is difficult or impossible, such as in applications involving lawnmowers and drones. After installing the 4G TE-A board and antenna, you must use a computer to specify the necessary corrective service parameters. After that, the evaluation kit can operate in RTK mode without a computer connection.

2.1. Preparation

2.1.1. Acquisition of RTK Correction Data

RTK requires access to an RTK correction stream, and RTK correction data is provided through the NTRIP service in RTCM format. There are two ways to get RTK corrections:

- An RTK correction service, it's purchased from an RTK correction service provider. (e.g. *RTK correction service by Quectel*).
- A physical RTK base station built by the users, the base station transmits the data via cellular to an NTRIP Caster service.

If customers choose to build an RTK base station themselves, for the steps of building the base station and establishing the transmission link, see *document [1] RTK application note* and *document [2] application note*.

2.2. Connection via Computer

By directly connecting the QGNSS tool to the LG290P (03) module, the RTK high-precision positioning function can be realized. The connection diagram is as follows:

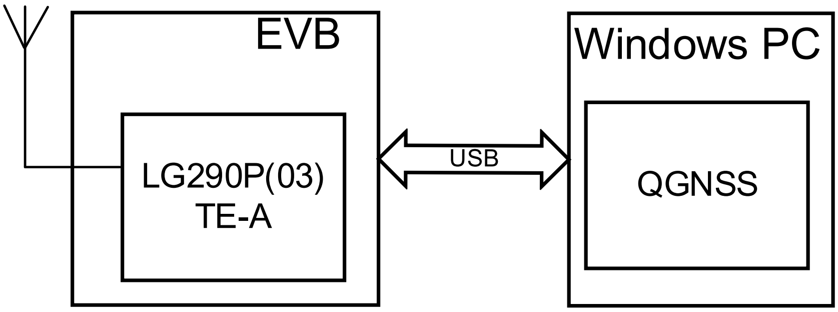

Figure 4: Connection Diagram Using QGNSS Tool

In the block diagram above, the Windows PC provides network connectivity, enabling QGNSS to connect to the NTRIP Caster server, thereby obtaining differential correction data and injecting it into the LG290P (03) module to achieve high-precision positioning.

2.2.1. Hardware Connection

If you choose to connect via computer, you will need:

- GNSS-MODULE-EVB (V1.3 or higher)
- LG290P (03) TE-A
- GNSS Antenna
- USB Type-C cable
- Windows computer (with Internet access)
- EVB USB-to-Serial port driver
- QGNSS Tool (V2.0 or higher)

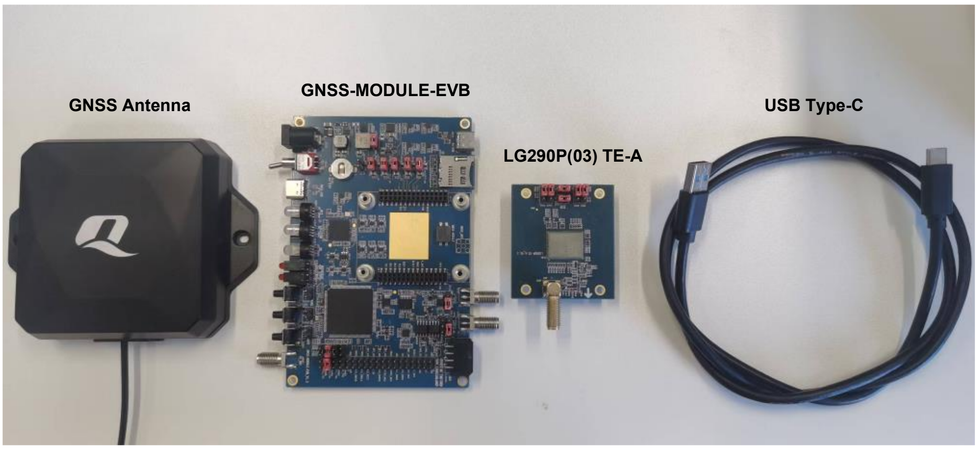

Figure 5: Required Materials (1)

Steps:

1. After assembling the above components.
2. Use USB Type-C data cable to connect the GNSS-USB (J0506) interface of EVB to the PC.
3. For Windows 10 and Windows 11 systems, the serial port driver of EVB will be automatically recognized and installed. If the computer does not automatically install the driver, you need to manually install the USB-to-Serial port driver of the FT4232HAQ chip (*click to download*).
4. After the driver is installed, 4 consecutive COM ports will appear in the system's device manager. The port numbers are randomly assigned by the system and are consecutive. The port with the smallest number (COM5) is directly connected to the UART0 of the LG290P (03) module. Using the QGNSS tool to open this port (COM5) can directly read the NMEA sentences of the LG290P (03) module or inject differential correction data into the LG290P (03) module.

Figure 6: EVB and Windows Computer Connection

To ensure stable and effective communication between LG290P (03) and QGNSS tool, please make sure J0404 on EVB is disconnected and J0402, J0405 and J0406 are short-circuited.

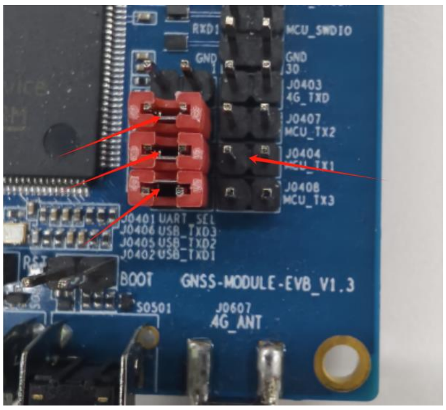

Figure 7: J0402, J0405 and J0406 Shorted & J0404 Open

2.2.2. Connection to QGNSS

Start the QGNSS tool (QGNSS V2.0 or higher are recommended) on a Windows computer. After EVB successfully connects to the computer, 4 consecutive port numbers will appear. Select the smallest port number (COM5) among the four consecutive port numbers. See *Figure 6: EVB and Windows Computer Connection*.

2.2.3. RTK Demo with QGNSS

The steps to use QGNSS tool for RTK service are as follows:

Step 1 Open QGNSS tool, click  to access "**Device Information**" window as shown in *Figure 8: Device Information.*

Step 2 Choose the module.

Step 3 Choose the smallest port (COM5) among the 4 consecutive port numbers.

Step 4 Choose baudrate. The default baudrate: 460800 bps.

Step 5 Click "**OK**".

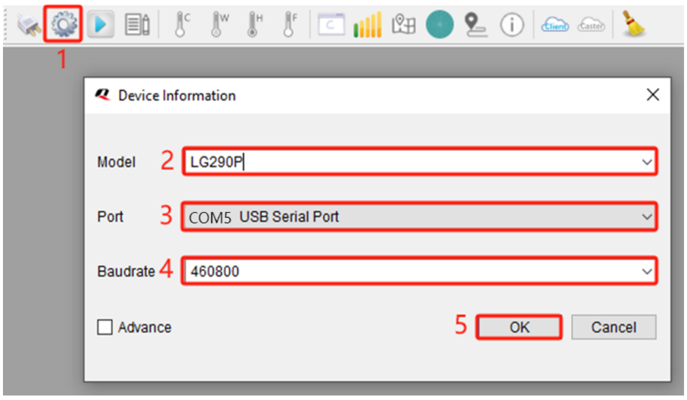

Figure 8: Device Information

Step 6 Click  to enter "**NTRIP Client**" window.

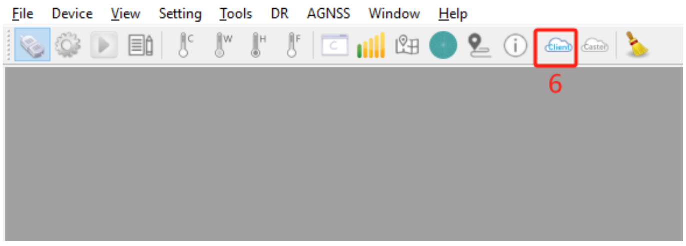

Figure 9: NTRIP Client

Step 7 Fill in the information of "**Caster settings**" and "**NTRIP mount point**" as shown in *Figure 10: NTRIP Caster Configuration*. Test accounts can be obtained by sending an email to (support@quectel.com).

Step 8 Click "**Connect To Host**" to connect host as shown in *Figure 10: NTRIP Caster Configuration*.

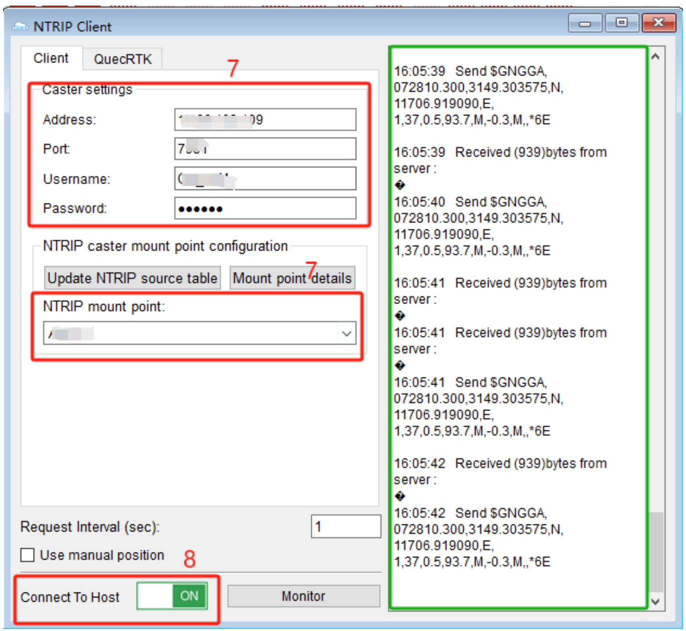

Figure 10: NTRIP Caster Configuration

Step 9 If configured correctly, you can see the message sent to the RTK server and the differential data received in the right box as shown in *Figure 11: Successful Connection to the Server.*

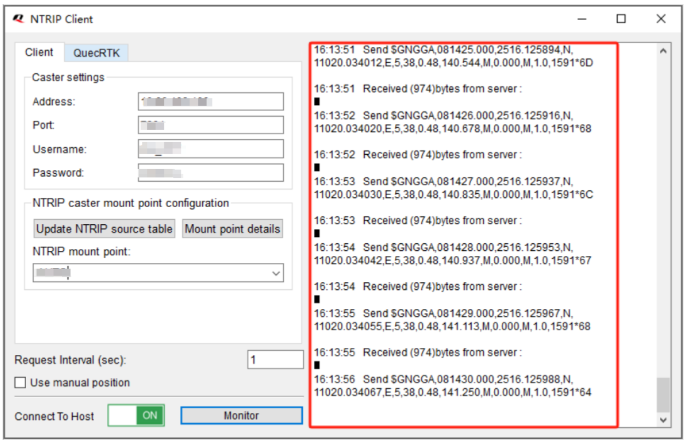

Figure 11: Successful Connection to the Server

Step 10 You can judge whether the module has entered RTK mode by outputting **GGA** message as shown in *Figure 12: View <Quality> Parameter*. GGA quality indicator in below can range from 0 to 5 for LG290P (03). If the quality indicator is 1, it means standalone GNSS mode and the module does not enter differential mode. When the module successfully receives the RTCM correction data, the quality indicator should switch to 4 or 5. Quality indicator of 4 means the RTK achieved ambiguity fixed results with cm accuracy.

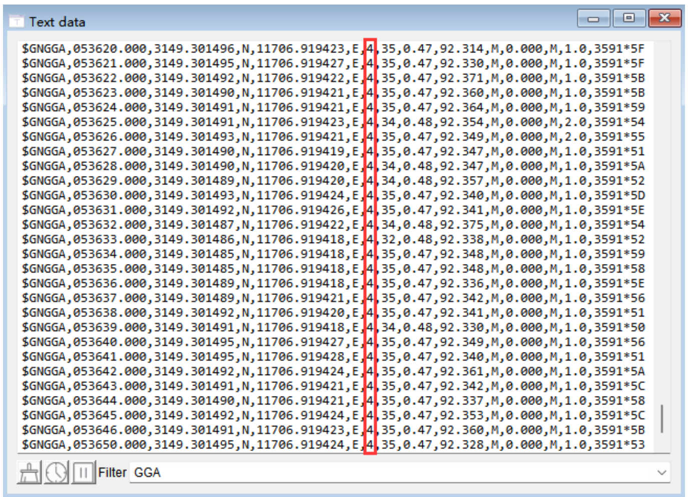

Figure 12: View <Quality> Parameter

In the actual operation process, if the NMEA message from LG290P (03) module cannot be received after opening the serial port, please check whether the connection of the jump cap on the EVB bottom plate and TE-A is correct. The reference hop connection of the jump cap is as follows:

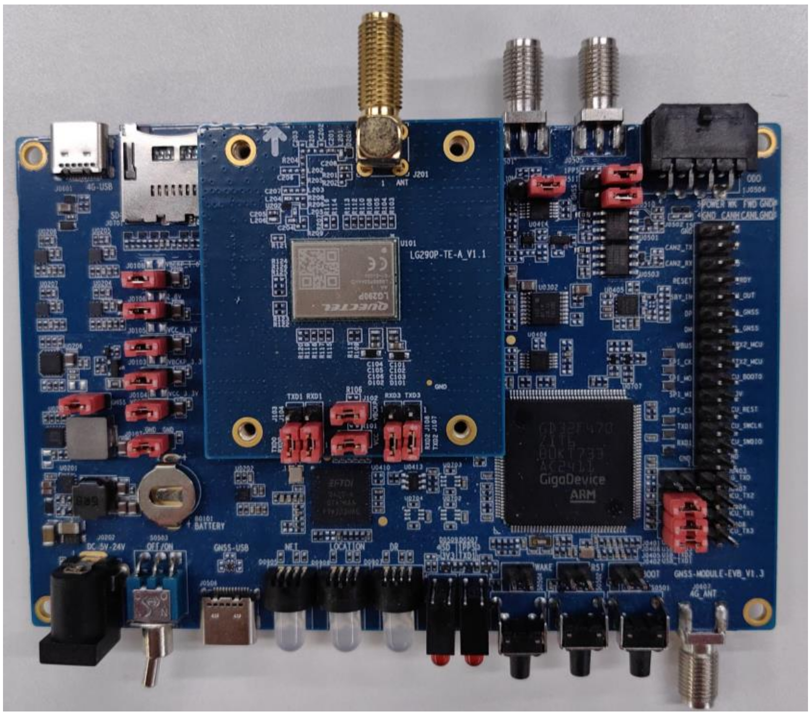

Figure 13: Jump Cap Connection

2.3. Connection via Integrated 4G

This chapter will introduce an alternative way to setup the RTK system with 4G TE-A board sent with the LG290P (03) evaluation kit. With this setup, you will only need a computer to configure the NTRIP parameters inside the evaluation kit before field test. Once done, you will be able to carry out the RTK testing with single evaluation kit. This will enable simplified setup without needing of a computer. The test data is stored inside the Micro SD card.

Refer to *Figure 6: EVB and Windows Computer Connection*. To configure the NTRIP parameters, you will need to connect to the EVB serial port with the largest port (COM8).

The port is connected to the MCU on the EVB. You can configure the NTRIP using integrated command line via this serial port interface. The configured parameters will be saved automatically and will not be erased after power cycle. This chapter describes how to use the EVB board for RTK operation. The connection diagram is shown below:

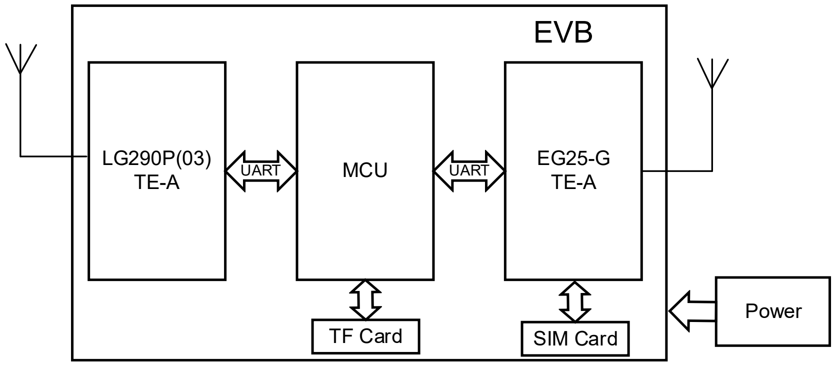

Figure 14: Connection Diagram Using EVB

2.3.1. Hardware Connection

If you choose to connect via integrated 4G, you will need:

- GNSS-MODULE-EVB
- LG290P (03) TE-A
- GNSS Antenna
- USB Type-C cable
- EG25-G TE-A
- SIM card, 4G cellular antenna and 4G RF cable.
- Micro SD card (used to save LG290P (03) 's NMEA log)
- Windows computer (only used to configure EVB parameters, not needed for the test run)
- EVB USB-to-Serial port driver
- QGNSS Tool (Configure the NTRIP parameters of the MCU)
- Power Bank

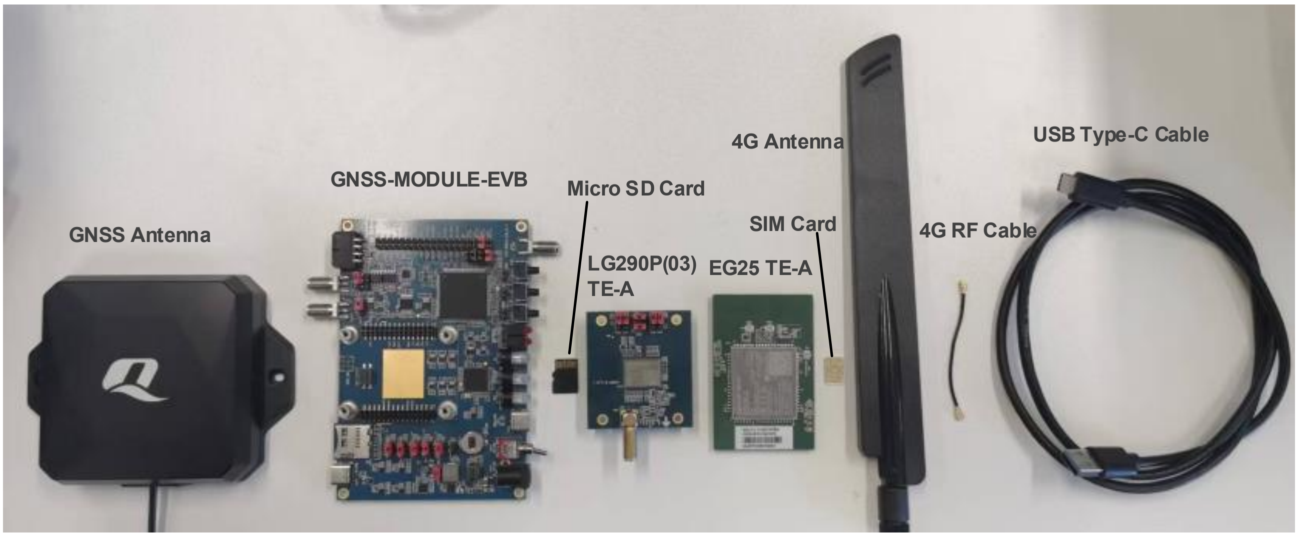

Figure 15: Required Materials (2)

Assemble the above materials onto the GNSS-MODULE-EVB. The front and back of the EVB after successful assembly are shown in the figure below. The EVB can be powered by either USB Type-C or an external power supply. For actual field testing, it is recommended to use an external power supply because it has a more reliable connection.

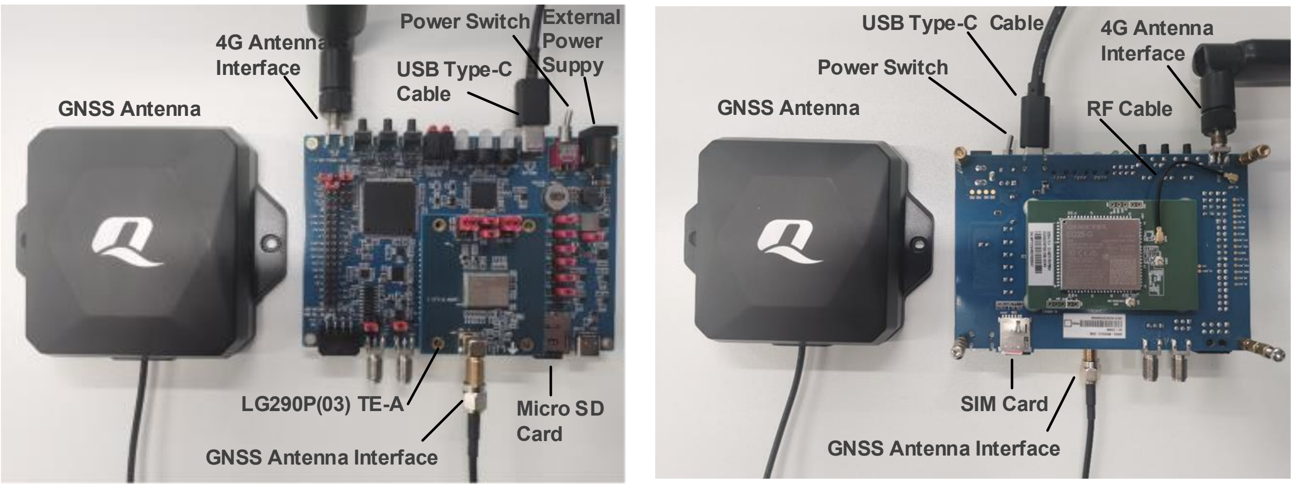

Figure 16: Front and Back of EVB

Refer to *Figure 6: EVB and Windows Computer Connection*. The port with the largest number (COM8) is connected to the serial port of the MCU on the EVB. The default baudrate is 921600 bps. Use the QGNSS tool to open this port (COM8) and enter commands to configure the parameters of the EVB. For details of supported commands, see *document [3] EVB user guide*.

In this mode, the LG290P (03) main serial port is connected to one of the MCU serial ports on the EVB. To ensure stable and effective communication, please make sure that J0404 and J0402 on the EVB are in a short-circuited state.

Figure 17: J0402 and J0404 Short-circuited

2.3.2. Connect to EVB Serial Console

Refer to *Figure 6: EVB and Windows Computer Connection*, use the serial port assistant tool to open the largest port number (COM8) among the four consecutive ports. The baudrate is 921600 bps, the data bit is 8 bits, the stop bit is 1 bit, no parity check, and no flow control.

Turn on the EVB power supply, and the following log data will be output on the serial port assistant software interface, indicating that the connection is successful.

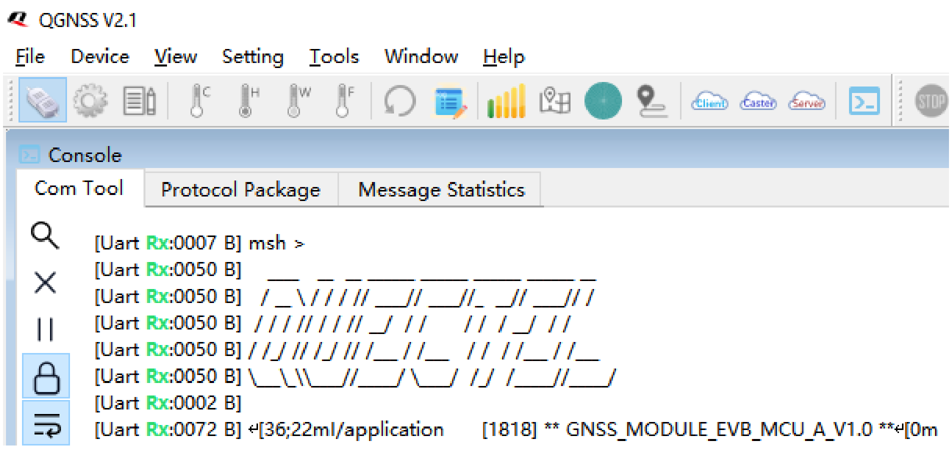

Figure 18: EVB Boot Output Log

Successfully connecting to EVB, you can enter content on the serial console.

2.3.3. Related NTRIP Commands

2.3.3.1. ntrip---query/configure the NTRIP working mode

Option	Parameter	Description
-	-	configure the working mode (base station mode or rover mode).
--mode	base rover none	base: base station rover: rover station none: turn off NTRIP, saved upon power-off.
--stop	-	Stop NTRIP, not saved on power-off.
--start	-	Start NTRIP, not saved on power-off.
--debug	on/off	Enable or disable the function of displaying RTK data injected into the UART1 (COM1) of the GNSS module on the console.
--help	-	Display help information.

Example:

Configure NTRIP as rover mode.

```
ntrip --mode rover
```

2.3.3.2. ntripclient---query/configure NTRIP client parameters.

Option	Parameter	Description
-	-	Query or configure NTRIP client parameters
--type	SelfBuild	Server type, self-built station service.
--host	<host>	The IP address or domain name of the server.
--port	<port>	The port of the server.
--user	<username>	Username.
--pwd	<password>	Password.
--mnt	<mount point>	Mount point.
--help	-	Display help information.

Example:

Configure the type and parameters of the NTRIP client.

```
ntripclient --type SelfBuild
ntripclient --host 192.168.1.100
ntripclient --port 1001
ntripclient --user quectel
ntripclient --pwd 123456
ntripclient --mnt AUTO
```

or

```
ntripclient --type SelfBuild
ntripclient --host 192.168.1.100 --port 1001 --user quectel --pwd 123456 --mnt AUTO
```

2.3.4. Configure the EVB as RTK Rover

Standard NTRIP client mode is also commonly referred to as "self-built station mode". In this mode, the NTRIP client exchanges data with NTRIP Caster through the standard NTRIP protocol. For details about the NTRIP protocol, see *document [1] RTK application note*.

Step 1: Enable EVB to save correction data log function:

```
gnss --vrslog on
```

Step 2: Configure EVB to work in standard NTRIP client mode:

```
ntripclient --type SelfBuild
```

Step 3: Configure NTRIP Caster server related parameters:

```
ntripclient --host 192.168.1. xxx --port 1xxx --user admin --pwd 123456 --mnt AUTO
```

Step 4: Start RTK rover mode:

```
ntrip --mode rover
```

After successfully starting the RTK rover mode, the EVB will automatically trigger the networking function of the cellular module and connect to the NTRIP Caster server. When you see the log print " ICY 200 OK ", it means that the EVB has successfully connected to the NTRIP Caster server.

```
[Uart Rx:0060 B] type    SelfBuild                    ok
[Uart Rx:0002 B]
[Uart Tx:0030 B] ntripclient --type SelfBuild
[Uart Rx:0035 B] msh >ntripclient --type SelfBuild
[Uart Rx:0060 B] type    SelfBuild                    ok
[Uart Rx:0002 B]
[Uart Tx:0092 B] ntripclient --host          --port      --user          --pwd        --mnt
[Uart Rx:0097 B] msh >ntripclient --host          --port      --user          --pwd        --mnt
[Uart Rx:0060 B] host                                  ok
[Uart Rx:0060 B] port                                  ok
[Uart Rx:0060 B] user                                  ok
[Uart Rx:0060 B] pwd                                   ok
[Uart Rx:0060 B] mnt                                   ok
[Uart Rx:0002 B]
[Uart Tx:0020 B] ntrip --mode rover
[Uart Rx:0025 B] msh >ntrip --mode rover
[Uart Rx:0060 B] mode    rover                        ok
[Uart Rx:0094 B] ↵[36;22mI/CELL_HANDLE      [2024/11/30 05:26:09] last_work_mode = 0,current_workmode = 2↵[0m
[Uart Rx:0093 B] ↵[36;22mI/CELL_HANDLE      [2024/11/30 05:26:09] no ntrip server service is in progress↵[0m
[Uart Rx:0066 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:09] CorsType[2]↵[0m
[Uart Rx:0087 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:09] ---------STARTING NTRIP---------↵[0m
[Uart Rx:0084 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:09] CorsType[2],Ql_Ntrip_Step[-1]↵[0m
[Uart Rx:0089 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:09] ----- NtripCLI WaitBits[0x1] -----↵[0m
[Uart Rx:0105 B] ↵[36;22mI/CELLULAR_SOCKETS [2024/11/30 05:26:09] Ql_Sock_App[0] is assined successfully by appid[3]↵[0m
[Uart Rx:0109 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:09] CorsType [2],ready to connect to                ↵[0m
[Uart Rx:0002 B]
[Uart Rx:0120 B] msh >↵[36;22mI/CELLULAR_SOCKETS [2024/11/30 05:26:09] Ql_Sock_App[0] is assined successfully by sockid[0],appid[3]↵[0m
[Uart Rx:0059 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:09] ReqBuff:
[Uart Rx:0022 B] GET /      HTTP/1.0
[Uart Rx:0033 B] User-Agent: QNTRIP Quectel-GNSS
[Uart Rx:0013 B] Accept: */*
[Uart Rx:0019 B] Connection: close
[Uart Rx:0047 B] Authorization: Basic UUxfR1VJTElOOjEyMzQ1Ng==
[Uart Rx:0002 B]
[Uart Rx:0006 B] ↵[0m
[Uart Rx:0109 B] msh >↵[31;22mE/NtripClient      [2024/11/30 05:26:11 NtripRTK] (813 NtripRTK_Task)No response,reconnect↵[0m
[Uart Rx:0114 B] ↵[31;22mE/NtripClient      [2024/11/30 05:26:11 NtripRTK] (937 NtripRTK_Task)something went wrong,xStatus[0]↵[0m
[Uart Rx:0094 B] msh >↵[36;22mI/NtripClient      [2024/11/30 05:26:16] ----- NtripCLI WaitBits[0x2] -----↵[0m
[Uart Rx:0106 B] ↵[36;22mI/CELLULAR_SOCKETS [2024/11/30 05:26:16] Ql_Sock_App[0] was unbound successfully by AppId[3]↵[0m
[Uart Rx:0075 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:16] close the connection↵[0m
[Uart Rx:0110 B] msh >↵[36;22mI/CELLULAR_SOCKETS [2024/11/30 05:26:26] Ql_Sock_App[0] is assined successfully by appid[3]↵[0m
[Uart Rx:0109 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:26] CorsType [2],ready to connect to                ↵[0m
[Uart Rx:0120 B] msh >↵[36;22mI/CELLULAR_SOCKETS [2024/11/30 05:26:26] Ql_Sock_App[0] is assined successfully by sockid[0],appid[3]↵[0m
[Uart Rx:0059 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:26] ReqBuff:
[Uart Rx:0022 B] GET /      HTTP/1.0
[Uart Rx:0033 B] User-Agent: QNTRIP Quectel-GNSS
[Uart Rx:0013 B] Accept: */*
[Uart Rx:0019 B] Connection: close
[Uart Rx:0047 B] Authorization: Basic UUxfR1VJTElOOjEyMzQ1Ng==
[Uart Rx:0002 B]
[Uart Rx:0006 B] ↵[0m
[Uart Rx:0064 B] msh >↵[36;22mI/NtripClient      [2024/11/30 05:26:26] RspBuff:
[Uart Rx:0012 B] ICY 200 OK
[Uart Rx:0007 B] O↵[0m
[Uart Rx:0078 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:26] NtripClient login succeeded
[Uart Rx:0006 B] ↵[0m
[Uart Rx:0086 B] ↵[36;22mI/NtripClient      [2024/11/30 05:26:26] Receiving rtcm & sending GGA...↵[0m
```

Figure 19: Configured in NTRIP Client Mode and Successfully Connected to NTRIP Caster

When the EVB is working as an RTK Rover, the NET and the LOCATION indicator lights will display different colours. Please refer to *Table 2: LED Indicator*.

Figure 20: NET and LOCATION Indication

Table 2: LED Indicator

Interfaces	Description
NET Indication D0905	● Network searching and registration failed, indicated in red. ● Network registration successful and standby state, indicated in green. ● Data transmission (network is being using), indicated in blue.
LOCATION Indication D0906	● GNSS single point solution, indicated in red. ● RTK floating point solution, indicated in green. ● RTK fixed solution, indicated in blue.

When the NET indicator light turns blue, it indicates that the RTK Rover has successfully connected to the Caster server, the "LOCATION" indicator light will gradually change from red (GNSS single-point solution) to green (RTK floating solution) and then to blue (RTK fixed solution), and stay on.

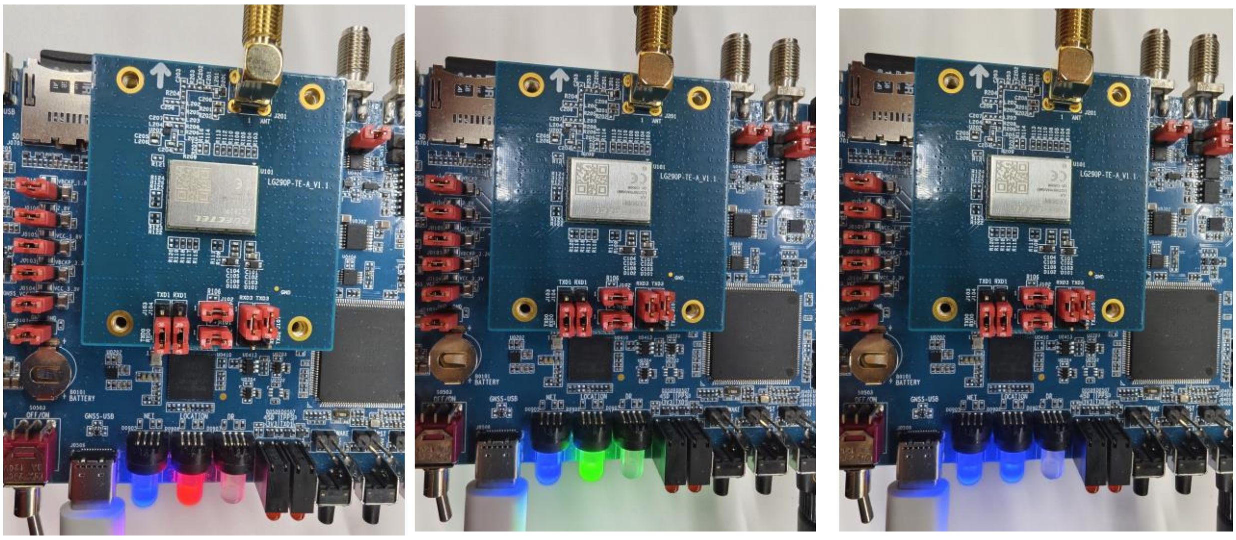

Figure 21: Changes in the D0906 Indicator Light During RTK Solution

Enter the ls command in the console to view the log list saved in the Micro SD card. Under normal circumstances, the saved log list is as follows:

```
[19:29:47.384 Uart Tx:0004 B] ls
[19:29:47.423 Uart Rx:0009 B] msh >ls
[19:29:47.424 Uart Rx:0098 B] 1:/com1_20241205_111704.log          2024-12-05 11:29:44    1.42 MB     1484856 Byte
[19:29:47.425 Uart Rx:0098 B] 1:/com2_20241205_111704.log          2024-12-05 11:29:46    1.42 MB     1484856 Byte
[19:29:47.425 Uart Rx:0098 B] 1:/RunLog/evb_20241205_111705.log      2024-12-05 11:29:20    3.02 KB      3094 Byte
[19:29:47.426 Uart Rx:0098 B] 1:/VRS/com1_rtk_20241205_111715_vrs.bin     2024-12-05 11:29:44   233.50 KB    239106 Byte
[19:29:47.426 Uart Rx:0002 B]
[19:29:47.427 Uart Rx:0019 B] SD Size: 14.99 GB
[19:29:47.427 Uart Rx:0019 B] SD Free: 14.98 GB
[19:29:47.428 Uart Rx:0002 B]
```

Figure 22: Log List Saved in Micro SD Card

3 RTK FAQs

This chapter describes problems encountered with RTK use and their countermeasures, taking the LG290P (03) module as an example (Situations for other applicable modules are the same as the LG290P (03) module).

1. What is the default coordinate system for LG290P (03) module?

- WGS84 coordinate system.

2. Why does the <Quality> parameter in GGA show “5” (RTK float) instead of “4” (RTK fixed) after using RTK?

- If the quality indicator displays “5”, it indicates that the module has received RTK messages, but it is unable to achieve the high-precision positioning. It may be due to severe interference from the surrounding environment, such as magnetic field, trees, resulting in an insufficient number of received satellites signals. You can check the frequency information of the correction data by QGNSS NTRIP Client. In this case, it is necessary to move the module to an open area for testing.

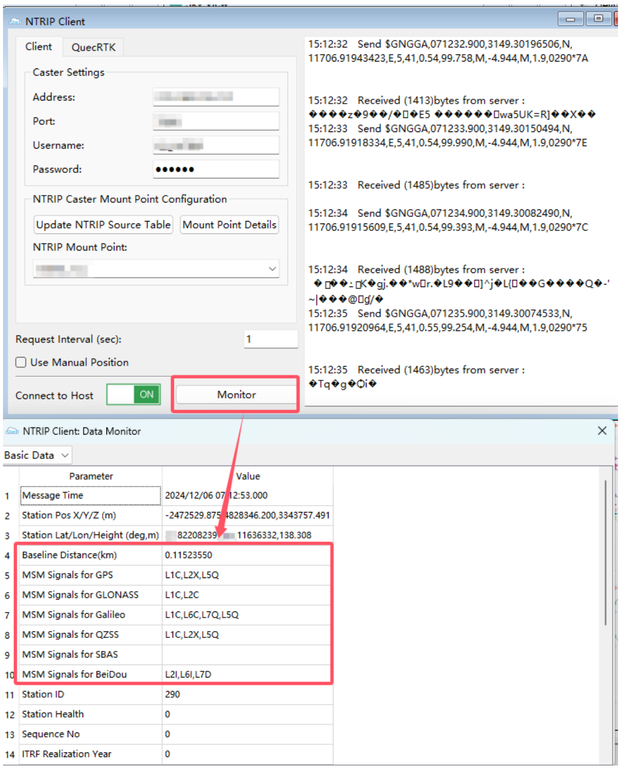

Figure 23: Check Correction Data Frequency Information

3. Possible reasons for not being able to access RTK?

- Account abnormality: Customer can check QGNSS NTRIP Client output, check if there is some feedback from the NTRIP Caster. E.g. “Incorrect username or password”. If username and password are normal, please communicate with the location operator for confirmation.
- No network connection: If the NET indicator light stays red, check the SIM card and the cellular module's 4G antenna to make sure the cellular module can connect to the network properly.
- GNSS satellite signal: Please check C/N_0 from QGNSS signal view or check GSV messages in NMEA. The C/N_0 is expected to be greater than 35. If C/N_0 is less than or equal to 35, it means that the GNSS signal gain is small and the positioning performance is limited.

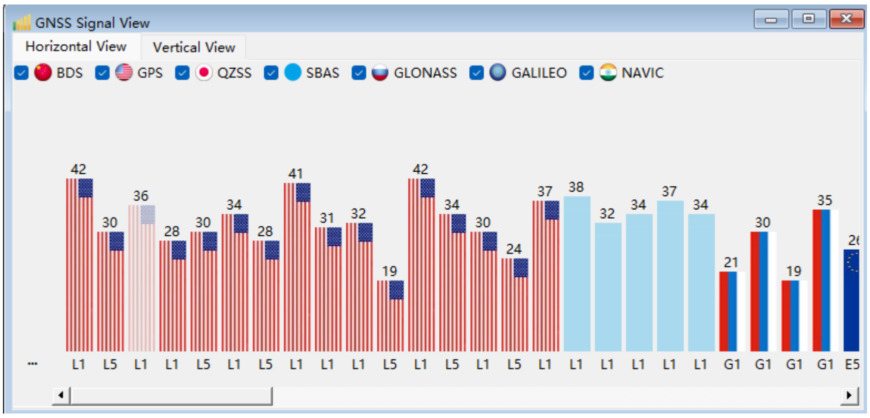

Figure 24: Check C/N_0 from GNSS Signal View

- The LG290P (03) module did not receive correction data: Check whether there is data inject into the serial receive pins of the LG290P (03) module, or the differential age of the correction data received is too large (≥ 120 s). Users can check the differential age value from the QGNSS Data View. The value is expected to be less than 120 seconds.

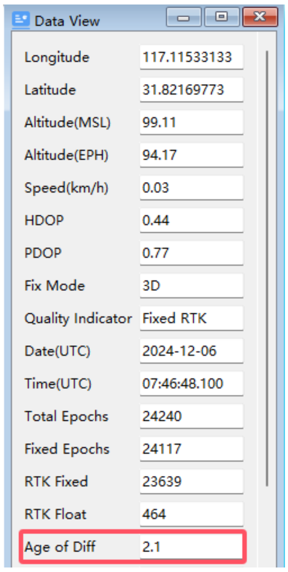

Figure 25: Check Differential Age Value from the QGNSS Data View

4. **What should do if Users still cannot enter the RTK high-precision positioning mode after the above troubleshooting?**
   Users can get more help by sending an email to (support@quectel.com). In order to locate and solve the current problem more efficiently, please provide the following information when sending the email:
   - On-site photos of the test environment (a top view of the GNSS antenna used by the module and the surrounding environment, as well as an upward view of the GNSS antenna directed toward the sky).
   - NMEA log of LG290P (03) module (recommended to save a 15-minute log).
   - The acquired raw correction data (recommended to save a 15-minute file).

4 Appendix References

Table 3: Related Documents

Document Name
[1] Quectel_GNSS_RTK_Application_Note
[2] Quectel_LG290P(03)_Base_Station_Mode_Application_Note
[3] Quectel_GNSS_MODULE_EVB_User_Guide

Table 4: Terms and Abbreviations

Abbreviation	Description
ARP	Antenna Reference Point
C/N_0	Carrier Noise
EVB	Evaluation Board
GGA	Global Positioning System Fix Data
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
LED	Light-emitting Diode
MCU	Microprogrammed Control Unit
NTRIP	Networked Transport of RTCM via Internet Protocol
PC	Personal Computer
RTCM	Radio Technical Commission for Maritime services
RTK	Real-Time Kinematic
SD	Secure Digital

Abbreviation	Description
SIM	Subscriber Identity Module
TF	Trans-flash
UART	Universal Asynchronous Receiver/Transmitter
WGS84	World Geodetic System 1984