

# LC29H (EA) Moving Base Application Note

**GNSS Module Series**

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Ensure that the product may be used in the country and the required environment, as well as that it conforms to the local safety and environmental regulations.



Keep away from explosive and flammable materials. The use of electronic products in extreme power supply conditions and locations with potentially explosive atmospheres may cause fire and explosion accidents.



The product must be powered by a stable voltage source, and the wiring shall conform to security precautions and fire prevention regulations.



Proper ESD handling procedures must be followed throughout the mounting, handling and operation of any devices and equipment that incorporate the module to avoid ESD damages.

# About the Document

## Document Information

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# 1 Introduction

This document presents the software and hardware designs of the two LC29H (EA) modules in the Moving Base application. Quectel LC29H (EA) supports multi-band RTK technology, which can output high precision position, heading and attitude information. RTK technology includes **the rover** and **the base**. The base sends a differential correction data stream to the rover via a communication link continuously. In standard RTK mode, the base remains static in a known position, while the rover can move. However, in Moving Base mode, both the base and the rover can move, making it suitable for use in drones, mowers and vehicles. To enable the Moving Base function, both two LC29H (EA) modules must be installed on the same carrier platform.

The terms “base”, “rover”, “baseline” and “heading” are used to describe the functionality of the Moving Base.

- **Base:** Receiver that transmits the different correction data stream.
- **Rover:** Receiver that receives the different correction data stream.
- **Baseline:** Vector connecting the base antenna to the rover antenna. The LC29H (EA) Moving Base function supports baseline lengths varying from 0.2 m to 5 m.
- **Heading:** Angle from true north to baseline measured in a clockwise direction.

# 2 Hardware Design

For two LC29H (EA) modules, one can be select as a base and the other as a rover. The base and rover can be distinguished from the connection diagram. The base communicates with the MCU via its UART1, and the rover communicates with the UART2 on base via its UART1. [Figure 1: Schematic Diagram of Connection Between Base and Rover](#) illustrates the specific connection configuration.

In the Moving Base application, function configurations of pins 5, 6 and 15–19 are different from those in the general application, as shown in below.

**Table 1: Pin Function Differences for LC29H (EA) in Different Applications**

Pin No.	Pin Function	
	General Application (Single Module)	Moving Base Application (Two Modules)
5	D_SEL1: Selects UART1/I2C/SPI	RESERVED
6	D_SEL2: Selects UART1/I2C/SPI	RESERVED
15	TXD2: UART2 transmits data	RESERVED
16	RXD2: UART2 receives data	RESERVED
17	WI: Warning indicator	RESET_CTL: Controls the RESET_N of the rover
18	I2C_SDA/SPI_CS: I2C serial data/SPI chip-select	TXD2: UART2 transmits data
19	I2C_SCL/SPI_CLK: I2C serial clock/SPI clock	RXD2: UART2 receives data



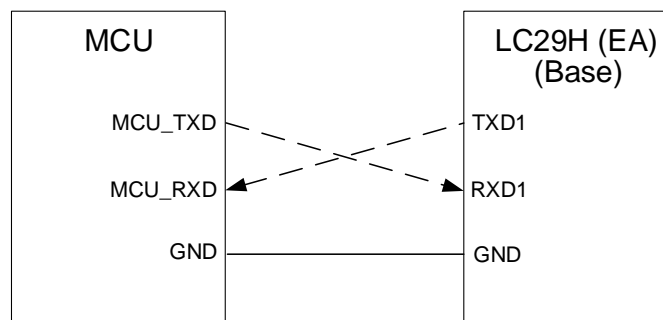
**NOTE**

1. The modules operate at an I/O voltage of 2.8 V. If the I/O voltage of the MCU differs from this value, a level-shifting circuit must be used.
2. It is recommended to use an OC drive circuit for the RESET\_N pin of base. For more information, see [Chapter 2.1.3 RESET\\_N](#).

## 2.1. Application Interfaces

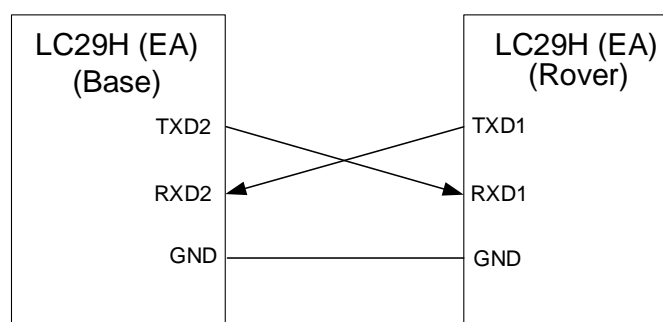
### 2.1.1. UART Interfaces

The UART1 on the base is connected to MCU, as shown below:



**Figure 2: Reference Design of UART1 Interface on Base**

The UART1 on the rover is connected to the UART2 on the base, as shown below:



**Figure 3: Reference Design of UART1 Interface on Rover**

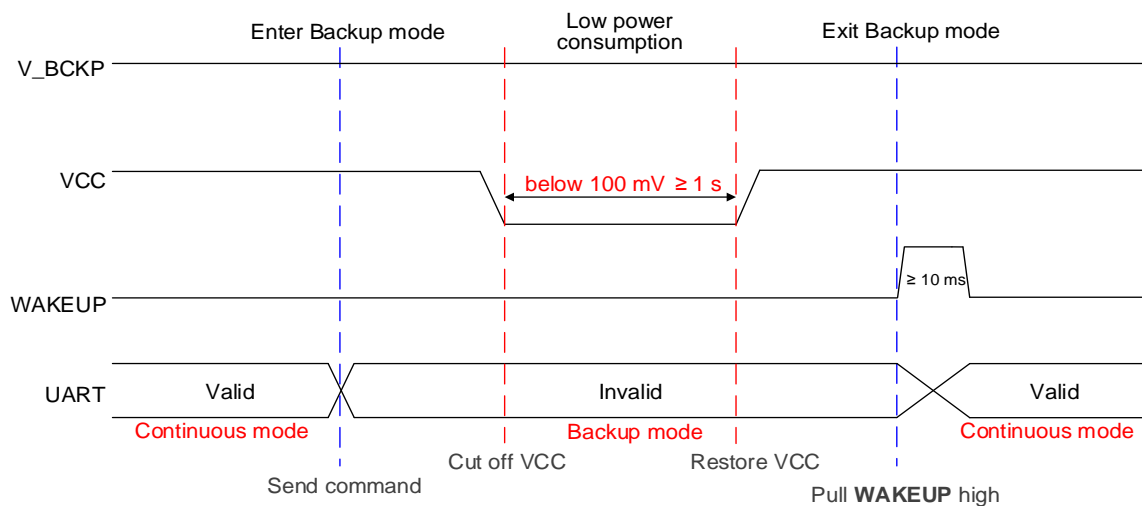
### 2.1.2. WAKEUP

For power-sensitive applications, the module supports a Backup mode to reduce power consumption. Pull the WAKEUP pin high for at least 10 ms to wake up the module from the Backup mode. Keep this pin

open or pulled low before entering the Backup mode. The WAKEUP pin is pulled down internally and it belongs to backup domain. If unused, leave the pin N/C.

The base can synchronously transmit the commands received from the MCU to the rover via UART interfaces. Thus, the MCU sends commands to the base via UART interfaces to enable the base and the rover enter the Backup mode at the same time.

- Enter the Backup mode:
  1. Send **\$PAIR650** to shut down internal main power supply in sequence. For more information about the relevant software command, see [document \[1\] protocol specification](#).
  2. Cut off the power supply to the VCC pin and keep the V\_BCKP pin powered.
  
- Exit the Backup mode:
  1. Restore VCC.
  2. Pull the WAKEUP pin high for at least 10 ms.



**Figure 4: Enter/Exit Backup Mode Sequence**

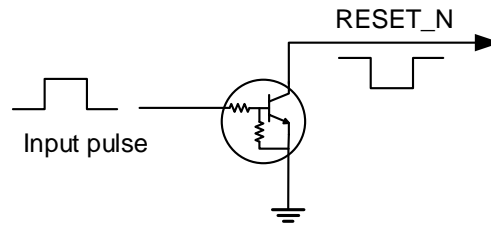
**NOTE**

The WAKEUP pin is pulled down internally with a 47 kΩ resistor, and the GPIO of MCU connected to the WAKEUP pin needs to support push-pull output.

**2.1.3. RESET\_N**

RESET\_N is an input pin. The module can be reset by driving the RESET\_N pin low for at least 100 ms and then releasing it.

For the base, the RESET\_N pin is connected to the GPIO control pin of the MCU. An OC driver circuit as shown below is recommended to control the RESET\_N pin.



**Figure 5: Reference OC Circuit for Base Reset**

For the rover, the RESET\_N pin is connected in series with the RESET\_CTL pin of the base through a 0 Ω resistor for upgrading.

#### **2.1.4. RESET\_CTL**

For the base, the RESET\_CTL is used to control the RESET\_N of the rover for upgrading. The RESET\_N pin of the base is pulled down via the GPIO of the MCU to complete the base’s upgrading, and then the RESET\_CTL is pulled down automatically so that the RESET\_N pin of the rover is also pulled down, allowing the rover’s upgrading to be completed. The default state is 2.8 V high level, active low.

For the rover, leave the pin floating.

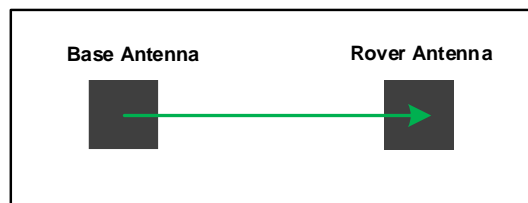
# 3 System Construction

This chapter provides system-level recommendations for using the base and rover to develop high-performance Moving Base solutions.

## 3.1. Precautions for GNSS Antenna Mounting

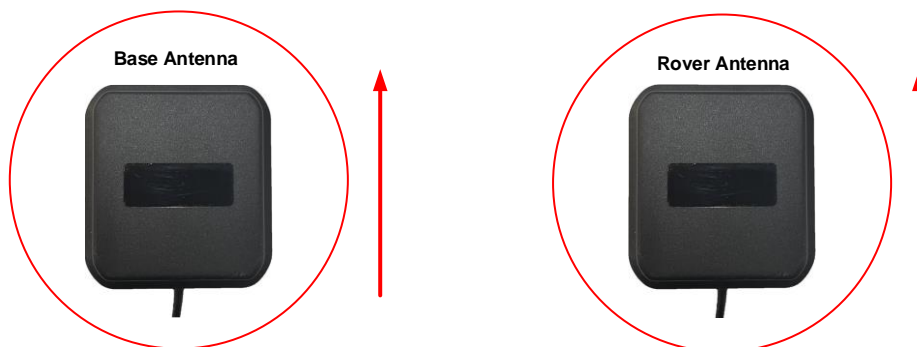
### 3.1.1. Antenna Mounting Method

In practical applications, it is important to fix GNSS antennas during mounting, as shown in the following figure. The vector from the base antenna to the rover antenna is called the baseline. Its minimum length is 0.2 m.



**Figure 6: Antenna Mounting Top View**

If the orientation test is carried out on the same device, ensure to use two identical GNSS antennas and place them on the same reference ground plane (with the same ground plane size, shape, angle of the horizontal plane). However, the use of a helix antenna does not require reference ground plane.



**Figure 7: Antenna Mounting (Same Reference Ground Plane)**

### 3.1.2. Recommended Mounting for GNSS Antennas

The recommended mounting for GNSS antennas depends on the application. For a drone, place the GNSS antennas on top of the drone to avoid interference from crowded structures and motors, as shown in the figure below:



**Figure 8: Antenna Mounting – Drone**

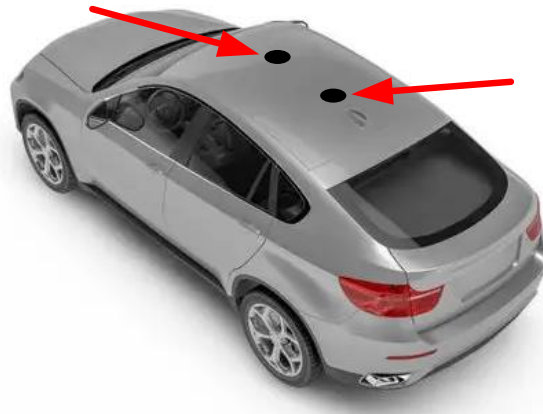
For mowers, apply the GNSS antennas in an open, unstructured environment.



**Figure 9: Antenna Mounting – Mower**



For a vehicle, apply GNSS antennas in the same plane and unstructured environment.



**Figure 10: Antenna Mounting – Vehicle**

**NOTE**

For recommended antenna selection and design, see [document \[2\] GNSS antenna selection guidance](#) or contact Quectel Technical Support ([support@quectel.com](mailto:support@quectel.com)).

# 4 Reference Frame

## 4.1. Local Cartesian Coordinate System (ENU)

Local Cartesian coordinate system is a right-handed rectangular coordinate system where the coordinate origin is located at the station center. In the Moving Base application, the phase center of the base antenna is considered the station center, and the heading and pitch angle outputs of rover are referenced to this coordinate system.

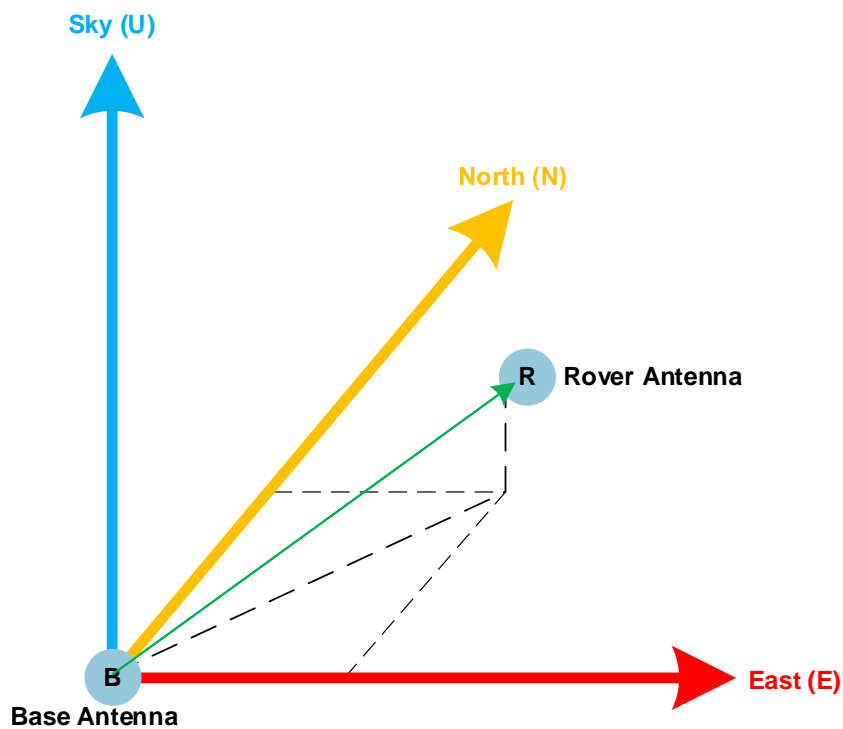


Figure 11: Local Cartesian Coordinate System

# 5 Angle Definition

This chapter provides the definitions of the heading and pitch angles in the LC29H (EA) Moving Base applications.

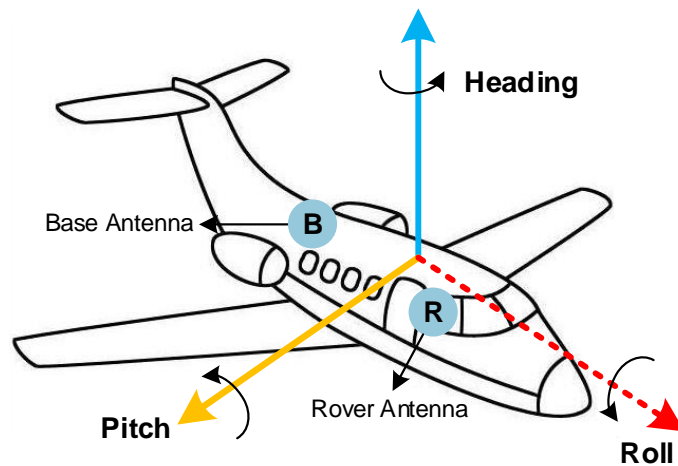


Figure 12: Heading and Pitch Angles

**NOTE**

Roll angle is not supported by the LC29H (EA) Moving Base applications.

## 5.1. Heading

The heading angle in the dual antenna setup is referenced to the local Cartesian coordinate system (ENU). It is defined as the angle between the projection of the baseline vector (i.e., the vector connecting the base antenna and rover antenna) on the horizontal plane and the true north (i.e., N-axis) with the effective range of [0,360). For details about the heading angle output, see [Chapter 7.2 PQTMTAR Message](#).

The heading angle (with north and east directions as reference planes) is illustrated below:

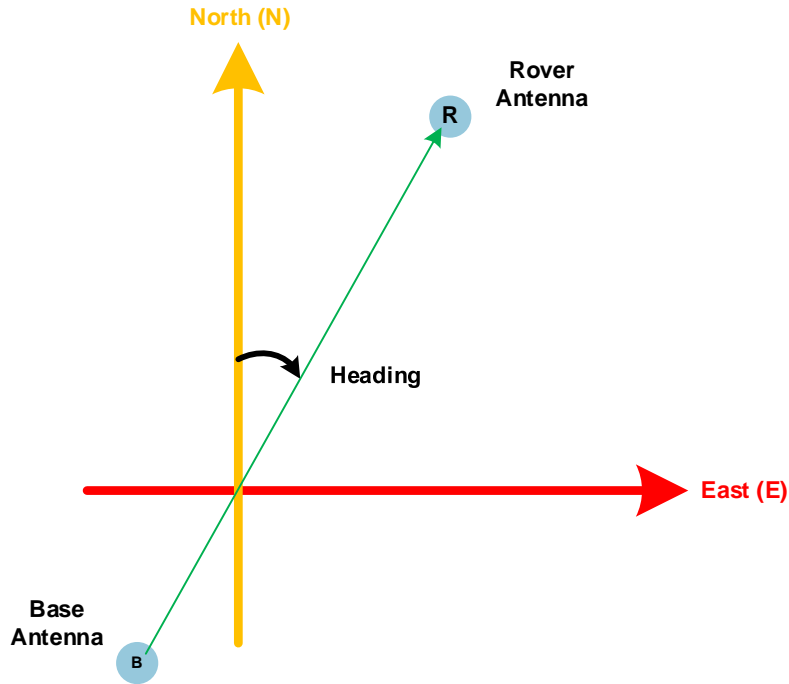


Figure 13: Heading Angle

**NOTE**

This heading angle is derived using dual antenna orientation, and it is different from the heading angle output in **RMC** message.

## 5.2. Pitch

The pitch angle references local Cartesian coordinate system (ENU). It is the angle between the baseline vector (base antenna to rover antenna) and the horizontal plane, with a range of  $[-90,+90]$ . Positive values correspond to upward pitch, while negative values correspond to downward pitch. For details about the pitch angle output, see [Chapter 7.2 PQTMTAR Message](#).

The pitch angle is illustrated below:

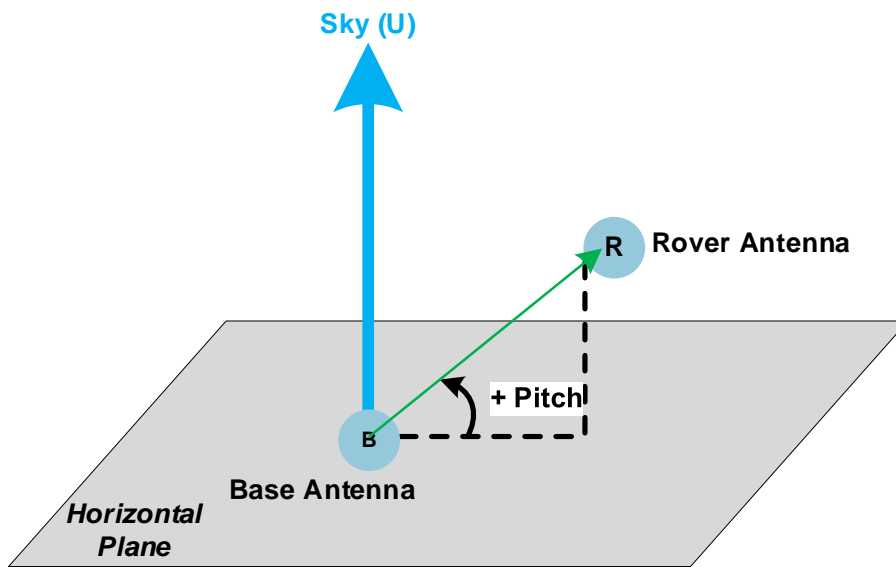


Figure 14: Pitch Angle

# 6 Configuration

As long as the two LC29H (EA) modules are properly connected as shown in [Figure 1: Schematic Diagram of Connection Between Base and Rover](#), the system automatically identifies them as rover or base and no special configuration is required for the Moving Base application.

The heading and attitude information are provided by **\$PQMTAR** message on the rover. Use **\$PQTMCFGMSGRATE** command (see [Chapter 7.1 PQTMCFGMSGRATE Message](#) for details) to enable the output of **\$PQMTAR** message (see [Chapter 7.2 PQMTAR Message](#) for details).

## Example:

```
//Enable $PQMTAR message:
$PQTMCFGMSGRATE,W,PQMTAR,1,1*09
$PQTMCFGMSGRATE,OK*29
```

# 7 Moving Base Related Messages

## 7.1. PQTMCFGMSGRATE Message

Configures the message output rate on the current port.

**Type:**

Set/Get

**Synopsis:**

```
//Set:
$PQTMCFGMSGRATE,W,<MsgName>,<Rate>,<MsgVer>*<Checksum><CR><LF>
//Get:
$PQTMCFGMSGRATE,R,<MsgName>,<MsgVer>*<Checksum><CR><LF>
```

**Parameter:**

Field	Format	Unit	Description
<MsgName>	String	-	Configuration message name.
<Rate>	Numeric	-	Message output rate. 0 = Output disabled. 1 = Output once every position fix.
<MsgVer>	Numeric	-	Message version.

**Result:**

- If successful, the module returns:

```
//Response to Set command:
$PQTMCFGMSGRATE,OK*<Checksum><CR><LF>
//Response to Get command:
$PQTMCFGMSGRATE,OK,<MsgName>,<Rate>,<MsgVer>*<Checksum><CR><LF>
```

- If failed, the module returns:

```
$PQTMCFGMSGRATE,ERROR,<ErrCode>*<Checksum><CR><LF>
```

For details about **<ErrCode>**, see [Table 2: Error Codes](#).

**Table 2: Error Codes**

Field	Format	Unit	Description
<ErrCode>	Numeric	-	Error code. 1 = Invaild parameters. 2 = Execution failed.

**Example:**

```
//Enable $PQMTMTAR message:
$PQTMCFGMSGRATE,W,PQMTMTAR,1,1*09
$PQTMCFGMSGRATE,OK*29
```

**NOTE**

The set command will take effect after sending **\$PQTMSAVEPAR\*5A** (see [document \[1\] protocol specification](#) for details) and resetting the module.

## 7.2. PQMTMTAR Message

Outputs the UTC and attitude of the module (rover). This message can be enabled or disabled by **\$PQTMCFGMSGRATE** command.

**Type:**

Output

**Synopsis:**

```
$PQMTMTAR,<MsgVer>,<Time>,<Quality>,<Res1>,<Length>,<Pitch>,<Res2>,<Heading>,<Acc_Pitch>,<Res3>,<Acc_Heading>,<UsedSV>*<Checksum><CR><LF>
```



**Parameter:**

Field	Format	Unit	Description
<MsgVer>	Numeric	-	Message version. 1 = Version 1 (Always 1 for this message version.)
<Time>	hhmmss.sss	-	UTC time. hh: Hours (00–23) mm: Minutes (00–59) ss: Seconds (00–59) sss: Decimal fraction of seconds
<Quality>	Numeric	-	GNSS quality indicator: 0 = Fix not available or invalid 1 = GPS SPS mode 2 = Differential GPS, SPS mode 4 = Real Time Kinematic (RTK) mode. System used in RTK mode with fixed integers. 5 = Float RTK mode. Satellite system used in RTK mode, floating integers.
<Res1>	-	-	Reserved. Always null.
<Length>	Numeric	Meter	Baseline length.
<Pitch>	Numeric	Degree	Pitch angle. Range: -90.000000 to 90.000000. Note that this field is null in case of an invalid value.
<Res2>	Numeric	Degree	Reserved. Always null.
<Heading>	Numeric	Degree	Heading angle. Range: 0.000000 to 359.999999. Note that this field is null in case of an invalid value.
<Acc_Pitch>	Numeric	Degree	Vehicle pitch accuracy. Note that this field is null in case of an invalid value.
<Res3>	Numeric	Degree	Reserved. Always null.
<Acc_Heading>	Numeric	Degree	Vehicle heading accuracy. Note that this field is null in case of an invalid value.
<UsedSV>	Numeric	-	Number of satellites used in heading solution.

**Example:**

```
$PQTMTR,1,165034.000,4,,0.860,1.124780,,50.968541,0.254125,,0.012547,21*59
```

# 8 Appendix A References

**Table 3: Related Documents**

Document Name
[1] <a href="#">Quectel LC29H Series&amp;LC79H(AL) GNSS Proocol Specification</a>
[2] <a href="#">Quectel_GNSS_Antenna_Selection_Guidance</a>

**Table 4: Terms and Abbreviations**

Abbreviation	Description
ENU	East North Up
GNSS	Global Navigation Satellite System
I/O	Input/Output
MCU	Microcontroller Unit/Microprogrammed Control Unit
RF	Radio Frequency
RMC	Recommended Minimum Specific GNSS Data
RTK	Real-Time Kinematic
RXD	Receive Data (Pin)
TXD	Transmit Data (Pin)
UART	Universal Asynchronous Receiver/Transmitter
UTC	Coordinated Universal Time
VRS	Virtual Reference Station

# 9 Appendix B Special Characters

Table 5: Special Characters

Special Character	Definition
<CR>	Carriage return character.
<LF>	Line feed character.
<...>	Parameter name. Angle brackets do not appear in the message.
[...]	Optional field of a message. Square brackets do not appear in the message.
{...}	Repeated field of a message. Curly brackets do not appear in the message.
<u>Underline</u>	Default setting of a parameter.