# LC29H (BA,CA,DA,EA)
# DR&RTK Application Note

**GNSS Module Series**

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# About the Document

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## Revision History

| Version | Date | Description |
|---|---|---|
| - | 2022-02-25 | Creation of the document |
| 1.0 | 2022-09-19 | First official release |
| 1.1 | 2023-04-27 | 1. Added applicable module LC29H (EA).<br>2. Added an overview on DR (*Chapter 1.1*).<br>3. Changed the driving speed of more than 3 m/s to 2 m/s in step 4 of DR calibration, updated the testing scenarios in open sky area, urban main road, and added a note about scenarios where the module exits DR mode (*Chapter 2.1.3*).<br>4. Added PQTMCFGDRRTD, PQTMCFGIMUTC, PQTMDRPVA, PQTMCFGDRHOT and PQTMCFGDR commands (*Chapters 3.1.12*, *3.1.13*, *3.1.14*, *3.1.15* and *3.1.16*). |

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# 1 Introduction

This document describes the dead reckoning (DR) and real-time kinematic (RTK) features, including DR and RTK configurations and DR related messages for Quectel LC29H (BA), LC29H (CA), LC29H (DA) and LC29H (EA) modules. The features supported by each module are as follows:

- LC29H (BA) supports DR and RTK.
- LC29H (CA) only supports DR.
- LC29H (DA) only supports RTK (update rate: 1 Hz).
- LC29H (EA) only supports RTK (update rate: 1–10 Hz, 10 Hz by default).

## 1.1. Overview on DR

LC29H (BA) and LC29H (CA) support two DR modes: ADR (Automotive Dead Reckoning) and UDR (Untethered Dead Reckoning). In ADR mode, the module relies on speed data from the vehicle and the onboard 6-axis sensor for enhanced accuracy in environments with nonexistent GNSS coverage. The UDR mode does not require speed data. The firmware automatically switches to UDR mode if no speed data is injected upon module power-up.

The module obtains vehicle speed data through wheel-ticks or direct vehicle speed data output (m/s). There are two wheel-tick injection methods: 1) injection through the WHEELTICK pin (See *document [1] hardware design*), with a maximum distance increment of 0.05 m per pulse; 2) cumulative wheel-tick injection through the UART interface (See *Chapter 3.1.3.2 If <MsgType> = 2* for the command), with a minimum injection frequency of 10 Hz, and a maximum distance increment of 0.05 m per pulse. The direct vehicle speed output can only be injected through the UART interface, with the minimum injection frequency of 20 Hz, and the maximum error of 0.1 m/s between the injected speed and actual speed. Ensuring a stable vehicle speed injection is crucial, as any interruption during driving will affect performance.

# 2 Configuration

## 2.1. DR Configuration

### 2.1.1. Orientation

The LC29H (BA) and LC29H (CA) modules are designed to work on two-wheel or four-wheel vehicles. Both modules integrate an IMU as well as the GNSS receiver. Therefore, you must ensure that the device incorporating the module is firmly fixed to vehicle body. No relative movement is allowed between vehicle and device and maximum isolation from shock or vibration must be applied. Manually holding the device is not acceptable. The best way to guarantee good installation is to firmly screw the device down to the vehicle frame. Mounting location should permit easy access to power supply and GNSS antenna, and should not be exposed to excessive heat.

Definitions of reference frame axes:

- X-axis points towards the right of the vehicle.
- Y-axis points towards the front of the vehicle.
- Z-axis points towards the roof of the vehicle.

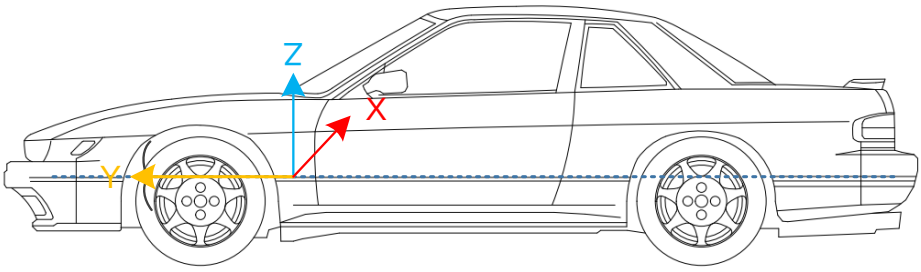


**Figure 1: Reference Frame**

Module orientation is shown below:

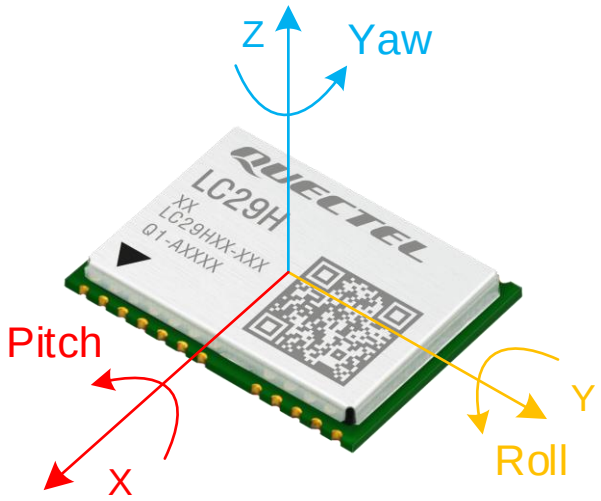


**Figure 2: Module Orientation**

**NOTE**

Firmly affix the device incorporating the module to vehicle body. Select a structurally sound location that is not prone to flexing (bending motion of vehicle chassis).

### 2.1.2. Mounting

There are no mounting direction and angle limitations for mounting the Quectel LC29H (BA) or LC29H (CA) module on the vehicle. The reference model is as follows:

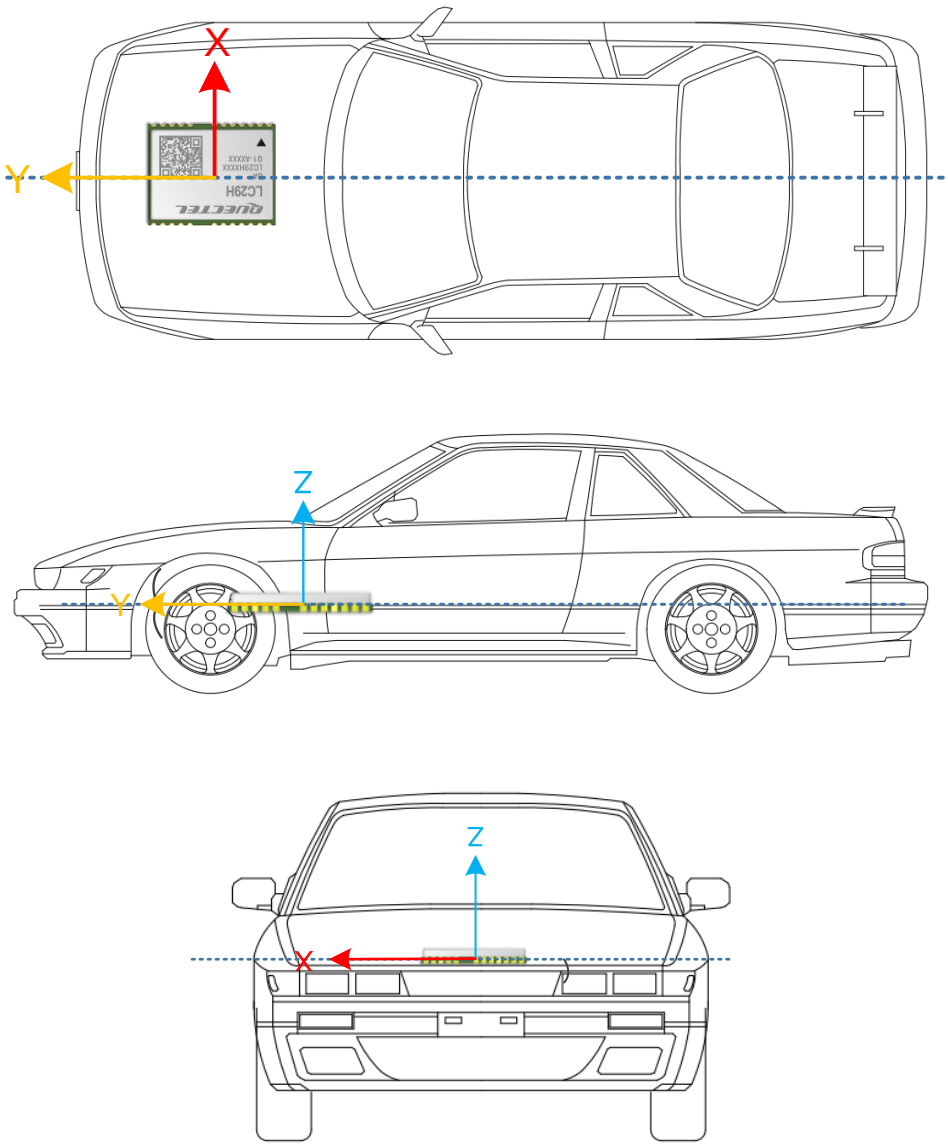


**Figure 3: Module Mounting Example**

### 2.1.3. DR Calibration

The module needs to be calibrated before the DR functionality will be useful.

The DR calibration steps are as listed below:

**Step 1:** Fix the device incorporating the module on the vehicle frame firmly. Any displacement, rotation or tilt of the device relative to vehicle plane, however small, may cause performance issues and/or void the calibration.

**Step 2:** Calibration should be performed under good GNSS signal and clear sky conditions.

**Step 3:** Power up the module, then start the vehicle on a plain surface.

**Step 4:** Drive at a speed of more than 2 m/s, and perform 3–4 turning movements. The module will start self-calibration, which will be completed in approximately 3 minutes.

**Step 5:** The calibration process ends when **<CalState>** of **$PQTMDRCAL** message value is 2 (DR is fully calibrated). See *Chapter 3.1.1 PQTMDRCAL* for details about the message.

After the calibration, there is no limit to driving trajectory and driving dynamics. You can perform verification tests in the following scenarios:

1) Open sky area, urban main road ($C/N_0$ value is greater than 30 dB-Hz, and the number of satellites is greater than 12).
2) Tunnels (assessment of DR performance in absence of satellite visibility).
3) Viaduct (assessment of DR performance in weak signal conditions).
4) Underground vehicle parking (DR performance in satellite signal absence).
5) Areas surrounded with dense buildings (multi-path signals with limited sky view).
6) City boulevards (weak satellite signals).
7) Urban canyon (high multi-path signals with limited sky view).

**NOTE**

1. If the wheel speed sensor of the vehicle is connected to the module, make sure that its precision is at least 0.05 m/tick.
2. The module will exit GNSS + DR or DR only mode in the following scenarios:
   - No speed data injection for 5 seconds in ADR mode;
   - Handling scenario;
   - High-speed elevator scenario;
   - IMU data interruption;
   - Inadequate inertial navigation calibration before entering a tunnel or underground garage;
   - Exceeding the set running time or distance of the receiver in environments with nonexistent GNSS coverage (See *Chapter 3.1.12 PQTMCFGDRRTD*).

## 2.2. RTK Configuration

### 2.2.1. RTCM Input

Quectel LC29H (BA), LC29H (DA) and LC29H (EA) modules support the RTCM 10403.3 input messages listed in the table below.

**Table 1: Supported RTCM Input Messages**

| Message Type | Description |
|---|---|
| 1005 | Stationary RTK Reference Station ARP |
| 1006 | Stationary RTK Reference Station ARP with Antenna Height |
| 1074 | GPS MSM4 |
| 1077 | GPS MSM7 |
| 1084 | GLONASS MSM4 |
| 1087 | GLONASS MSM7 |
| 1094 | Galileo MSM4 |
| 1097 | Galileo MSM7 |
| 1114 | QZSS MSM4 |
| 1117 | QZSS MSM7 |
| 1124 | BDS MSM4 |
| 1127 | BDS MSM7 |

# 3 DR Related Messages

## 3.1. PQTM Messages

This chapter outlines the Quectel DR related PQTM (proprietary NMEA) messages supported by the Quectel LC29H (BA) and LC29H(CA) modules.

**Table 2: Error Codes**

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

### 3.1.1. PQTMDRCAL

Indicates the DR calibration state.

**Type:**

Output

**Synopsis:**

```
$PQTMDRCAL,<MsgVer>,<CalState>,<NavType>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <MsgVer> | Numeric | - | Message version.<br>1 = Version 1 (Always 1 for this version.) |
| <CalState> | Numeric | - | DR calibration state.<br>0 = Not calibrated<br>1 = DR is lightly calibrated<br>2 = DR is fully calibrated |
| <NavType> | Numeric | - | Navigation type. |

| Field | Format | Unit | Description |
|---|---|---|---|
| | | | 0 = No position<br>1 = GNSS only<br>2 = DR only<br>3 = Combination (GNSS + DR) |

**Example:**

```
$PQTMDRCAL,1,0,1*5C
```

### 3.1.2. PQTMIMUTYPE

Outputs the IMU type once after each boot-up.

**Type:**

Output

**Synopsis:**

```
$PQTMIMUTYPE,<MsgVer>,<Type>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <MsgVer> | Numeric | - | Message version.<br>1 = Version 1 (Always 1 for this version.) |
| <Type> | Numeric | - | IMU type.<br>0 = IMU error<br>1 = LSM6DSR<br>2 = ICM-40608<br>3 = BMI160<br>4 = ICM-42670-P |

**Example:**

```
$PQTMIMUTYPE,1,2*52
```

### 3.1.3. PQTMVEHMSG

Inputs/outputs vehicle information.

**Type:**

Input/output

**Synopsis:**

```
$PQTMVEHMSG,<MsgType>,<Timestamp>,<Par1>[,<Par2>,…,<ParN>]*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <MsgType> | Numeric | - | Type of message input/output via UART interface.<br>1 = Vehicle speed (in m/s)<br>2 = Cumulative wheel tick<br>3 = Speeds of four wheels (in m/s)<br>4 = Cumulative wheel ticks of four wheels |
| <Timestamp> | Numeric | Millisecond | Timestamp since power-on. 32-bit unsigned integer. Always 0 when this message is input. |
| <Par1> to <ParN> | Numeric | - | Vehicle information. This field varies with the message type. See *Chapter 3.1.3.1 If <MsgType> = 1* to *3.1.3.4 If <MsgType> = 4* for details. |

**NOTE**

**<MsgType>** can only be 2 for LC29H (BA) and LC29H (CA) with software versions dedicated for two-wheel vehicles. Contact Quectel Technical Support (support@quectel.com) for details about the software versions.

#### 3.1.3.1. If <MsgType> = 1

**Synopsis:**

```
$PQTMVEHMSG,1,<Timestamp>,<VehSpeed>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Timestamp> | Numeric | Millisecond | Timestamp since power-on. 32-bit unsigned integer. Always 0 when this message is input. |
| <VehSpeed> | Numeric | m/s | Speed. Range: -100 to 100. |

**Result:**

Returns the input vehicle speed with timestamp:

```
$PQTMVEHMSG,1,<Timestamp>,<VehSpeed>*<Checksum><CR><LF>
```

**Example:**

```
//Input:
$PQTMVEHMSG,1,0,3.6*1C
//Output:
$PQTMVEHMSG,1,3748292,3.6*1D
```

#### 3.1.3.2. If <MsgType> = 2

**Synopsis:**

```
$PQTMVEHMSG,2,<Timestamp>,<WheelTickCNT>,<FWD_Ind>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Timestamp> | Numeric | Millisecond | Timestamp since power-on. 32-bit unsigned integer. Always 0 when this message is input. |
| <WheelTickCNT> | Numeric | Tick | Cumulative wheel ticks. |
| <FWD_Ind> | Numeric | - | Forward/backward indicator.<br>0 = Invalid state<br>1 = Forward<br>2 = Backward |

**Result:**

Returns the input cumulative wheel ticks with timestamp:

```
$PQTMVEHMSG,2,<Timestamp>,<WheelTickCNT>,<FWD_Ind>*<Checksum><CR><LF>
```

**Example:**

```
//Input:
$PQTMVEHMSG,2,0,100,1*18
//Output:
$PQTMVEHMSG,2,153954,100,1*27
```

**NOTE**

1. When inputting cumulative wheel ticks through UART interface, make sure the input rate is at least 10 Hz.
2. For LC29H (BA) and LC29H (CA) with software versions dedicated for two-wheel vehicles:
   1) Keep **<FWD_Ind>** always 1;
   2) **$PQTMVEHMSG** will not be returned, but the input **<WheelTickCNT>** can be found in **$PQTMIMU**.

   Contact Quectel Technical Support (support@quectel.com) for details about the software versions.

#### 3.1.3.3. If <MsgType> = 3

**Synopsis:**

```
$PQTMVEHMSG,3,<Timestamp>,<LF_Spd>,<RF_Spd>,<LR_Spd>,<RR_Spd>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <TimeStamp> | Numeric | Millisecond | Timestamp since power-on. 32-bit unsigned integer. Always 0 when this message is input. |
| <LF_Spd> | Numeric | m/s | Left front wheel speed. Range: -100 to 100. |
| <RF_Spd> | Numeric | m/s | Right front wheel speed. Range: -100 to 100. |
| <LR_Spd> | Numeric | m/s | Left rear wheel speed. Range: -100 to 100. |
| <RR_Spd> | Numeric | m/s | Right rear wheel speed. Range: -100 to 100. |

**Result:**

Returns the input speeds of four wheels with timestamp:

```
$PQTMVEHMSG,3,<Timestamp>,<LF_Spd>,<RF_Spd>,<LR_Spd>,<RR_Spd>*<Checksum><CR><LF>
```

**Example:**

```
//Input:
$PQTMVEHMSG,3,0,3.6,3.6,3.6,3.6*19
//Output:
$PQTMVEHMSG,3,3748292,3.6,3.6,3.6,3.6*18
```

#### 3.1.3.4. If <MsgType> = 4

**Synopsis:**

```
$PQTMVEHMSG,4,<Timestamp>,<LF_TickCNT>,<RF_TickCNT>,<LR_TickCNT>,<RR_TickCNT><FWD_Ind>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Timestamp> | Numeric | Millisecond | Timestamp since power-on. 32-bit unsigned integer. Always 0 when this message is input. |
| <LF_TickCNT> | Numeric | Tick | Left front wheel tick count. |
| <RF_TickCNT> | Numeric | Tick | Right front wheel tick count. |
| <LR_TickCNT> | Numeric | Tick | Left rear wheel tick count. |
| <RR_TickCNT> | Numeric | Tick | Right rear wheel tick count. |
| <FWD_Ind> | Numeric | - | Forward/backward indicator.<br>0 = Invalid state<br>1 = Forward<br>2 = Backward |

**Result:**

Returns the input cumulative wheel ticks of four wheels with timestamp:

```
$PQTMVEHMSG,4,<Timestamp>,<LF_TickCNT>,<RF_TickCNT>,<LR_TickCNT>,<RR_TickCNT><FWD_Ind>*<Checksum><CR><LF>
```

**Example:**

```
//Input:
$PQTMVEHMSG,4,0,100,100,100,100,1*03
//Output:
$PQTMVEHMSG,4,153954,100,100,100,100,1*3C
```

### 3.1.4. PQTMSAVEPAR

Saves the configurations set via **$PQTM** commands or **$PAIR6010** into NVM. Reset the module after executing this command.

**Type:**

Command

**Synopsis:**

```
$PQTMSAVEPAR*<Checksum><CR><LF>
```

**Parameter:**

None

**Result:**

- If successful, the module returns:

```
$PQTMSAVEPAR,OK*72
```

- If failed, the module returns:

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

For details about <**ErrCode**>, see *Table 2: Error Codes*.

**Example:**

```
$PQTMSAVEPAR*5A
$PQTMSAVEPAR,OK*72
```

### 3.1.5. PQTMRESTOREPAR

Restores all DR related configurations to default values.

**Type:**

Command

**Synopsis:**

```
$PQTMRESTOREPAR*<Checksum><CR><LF>
```

**Parameter:**

None

**Result:**

- If successful, the module returns:

```
$PQTMRESTOREPAR,OK*3B
```

- If failed, the module returns:

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

For details about <**ErrCode**>, see *Table 2: Error Codes*.

**Example:**

```
$PQTMRESTOREPAR*13
$PQTMRESTOREPAR,OK*3B
```

### 3.1.6. PQTMINS

Outputs navigation results.

**Type:**

Output

**Synopsis:**

```
$PQTMINS,<Timestamp>,<SolType>,<Lat>,<Lon>,<Height>,<VEL_N>,<VEL_E>,<VEL_D>,<Roll>,<Pitch>,<Heading>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Timestamp> | Numeric | Millisecond | Timestamp since power-on. 32-bit unsigned integer. |
| <SolType> | Numeric | - | Solution type.<br>0 = DR not ready. Roll and pitch ready.<br>1 = DR not ready. GNSS, roll, pitch, and relative heading ready.<br>2 = GNSS + DR mode. DR calibrated.<br>3 = DR only mode. |
| <Lat> | Numeric | Degree | Latitude. |
| <Lon> | Numeric | Degree | Longitude. |
| <Height> | Numeric | Meter | Height. |
| <VEL_N> | Numeric | m/s | Northward velocity. |
| <VEL_E> | Numeric | m/s | Eastward velocity. |
| <VEL_D> | Numeric | m/s | Downward velocity. |
| <Roll> | Numeric | Degree | Roll angle. |
| <Pitch> | Numeric | Degree | Pitch angle. |
| <Heading> | Numeric | Degree | Heading angle. |

**Example:**

```
$PQTMINS,240951,1,31.82222216,117.11578436,62.555605,-0.004233,0.005535,-0.004011,0.00,0.00,127.41*40
```

**NOTE**

1. All angles are scaled from -180.0 to 179.9 with a wrap-around to 0.0 at +180.0. -180/ +180 = South, 0.0 = North, +90.0 = East, and -90.0 = West.
2. This message is only supported by LC29H (BA) and LC29H (CA) with software versions dedicated for two-wheel vehicles. Contact Quectel Technical Support (support@quectel.com) for details about the software versions.

### 3.1.7. PQTMIMU

Outputs the IMU raw data: acceleration, angular rate, and hardware wheel ticks. These values should match vehicle frame, and see *Figure 1: Reference Frame* for details.

**Type:**

Output

**Synopsis:**

```
$PQTMIMU,<Timestamp>,<ACC_X>,<ACC_Y>,<ACC_Z>,<AngRate_X>,<AngRate_Y>,<AngRate_Z>,<WheelTickCNT>,<LastTick_Timestamp>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Timestamp> | Numeric | Millisecond | Timestamp since power-on. 32-bit unsigned integer. |
| <ACC_X> | Numeric | m/s^2 | Acceleration in X-axis direction. |
| <ACC_Y> | Numeric | m/s^2 | Acceleration in Y-axis direction. |
| <ACC_Z> | Numeric | m/s^2 | Acceleration in Z-axis direction. |
| <AngRate_X> | Numeric | deg/s | Angular rate in X-axis direction. |
| <AngRate_Y> | Numeric | deg/s | Angular rate in Y-axis direction. |
| <AngRate_Z> | Numeric | deg/s | Angular rate in Z-axis direction. |
| <WheelTickCNT> | Numeric | Tick | Cumulative wheel ticks. |
| <LastTick_Timestamp> | Numeric | Millisecond | Last tick timestamp. |

**Example:**

```
$PQTMIMU,45454,-1.356730,-0.210568,9.757930,0.564879,0.549612,-0.412209,0,0*77
```

**NOTE**

This message is only supported by LC29H (BA) and LC29H (CA) with software versions dedicated for two-wheel vehicles. Contact Quectel Technical Support (support@quectel.com) for details about the software versions.

### 3.1.8. PQTMGPS

Outputs the position status in GNSS only mode.

**Type:**

Output

**Synopsis:**

```
$PQTMGPS,<Timestamp>,<TOW>,<Lat>,<Lon>,<Altitude>,<Speed>,<Yaw>,<Accuracy>,<HDOP>,<PDOP>,<NumSatUsed>,<FixMode>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Timestamp> | Numeric | Millisecond | Timestamp since power-on. 32-bit unsigned integer. |
| <TOW> | Numeric | Second | Time of week. |
| <Lat> | Numeric | Degree | Latitude. |
| <Lon> | Numeric | Degree | Longitude. |
| <Altitude> | Numeric | Meter | Altitude. |
| <Speed> | Numeric | m/s | Ground speed (two-dimensional). |
| <Yaw> | Numeric | Degree | Heading of vehicle (two-dimensional). |
| <Accuracy> | Numeric | Meter | Horizontal accuracy estimate. |
| <HDOP> | Numeric | - | Horizontal dilution of precision. |
| <PDOP> | Numeric | - | Position dilution of precision. |
| <NumSatUsed> | Numeric | - | Number of satellites used in navigation. |
| <FixMode> | Numeric | - | Fix mode.<br>0 = No fix<br>2 = 2D fix<br>3 = 3D fix |

**Example:**

```
$PQTMGPS,86139,94183,31.82218794,117.11579022,65.755080,0.027,94.68,2.533952,0.555471,0.886183,29,3*6B
```

**NOTE**

This message is only supported by LC29H (BA) and LC29H (CA) with software versions dedicated for two-wheel vehicles. Contact Quectel Technical Support (support@quectel.com) for details about the software versions.

### 3.1.9. PQTMCFGEINSMSG

Sets/gets **$PQTMINS**, **$PQTMIMU** and **$PQTMGPS** message configurations.

**Type:**

Set/get

**Synopsis:**

```
//Set message configurations:
$PQTMCFGEINSMSG,<Type>,<INS_Enabled>,<IMU_Enabled>,<GPS_Enabled>,<Rate>*<Checksum>
<CR><LF>
//Get message configurations:
$PQTMCFGEINSMSG,<Type>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Type> | Numeric | - | Set/get message configurations.<br>0 = Get<br>1 = Set |
| <INS_Enabled> | Numeric | - | Enable/disable the output of **$PQTMINS** message.<br>0 = Disable<br>1 = Enable |
| <IMU_Enabled> | Numeric | - | Enable/disable the output of **$PQTMIMU** message.<br>0 = Disable<br>1 = Enable |
| <GPS_Enabled> | Numeric | - | Enable/disable the output of **$PQTMGPS** message.<br>0 = Disable<br>1 = Enable |
| <Rate> | Numeric | Hz | Set the output rate of **$PQTMINS**, **$PQTMIMU** or **$PQTMGPS** message.<br>It can be set to 1, 2, 4, 5, 10, 20, 50, or 100. For **$PQTMGPS**, the output rate is fixed at 1 Hz. For **$PQTMINS**, when <Rate> is set to be greater than 10, the message will be output at 10 Hz. |

**Result:**

- If successful, the module returns:

```
//Set:
$PQTMCFGEINSMSGOK*16
//Get:
$PQTMCFGEINSMSG,<Type>,<INS_Enabled>,<IMU_Enabled>,<GPS_Enabled>,<Rate>*<Checksum>
<CR><LF>
```

- If failed, the module returns:

```
$PQTMCFGEINSMSGERROR*4A
```

**Example:**

```
//Set message configurations:
$PQTMCFGEINSMSG,1,1,1,1,10*3F
$PQTMCFGEINSMSGOK*16
//Get message configurations:
$PQTMCFGEINSMSG,0*0E
$PQTMEINSMSG,0,1,1,1,10*3E
```

**NOTE**

1. Send **$PQTMSAVEPAR*5A** and reset the module for **$PQTMCFGEINSMSG** to take effect.
2. This command is only supported by LC29H (BA) and LC29H (CA) with software versions dedicated for two-wheel vehicles. Contact Quectel Technical Support (support@quectel.com) for details about the software versions.

### 3.1.10. PQTMVEHMOT

Outputs vehicle motion information after DR calibration.

**Type:**

Output

**Synopsis:**

```
$PQTMVEHMOT,<MsgVer>,<PeakAcceleration>,<PeakAngularRate>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <MsgVer> | Numeric | - | Message version.<br>1 = Version 1 (Always 1 for this version.) |
| <PeakAcceleration> | Numeric | $m/s^2$ | Peak acceleration of vehicle. |
| <PeakAngularRate> | Numeric | deg/s | Peak angular rate of vehicle. |

**Example:**

```
$PQTMVEHMOT,1,0.288124,0.159930*0A
```

**NOTE**

This message is only supported by LC29H (BA) and LC29H (CA) with software versions dedicated for four-wheel vehicles. Contact Quectel Technical Support (support@quectel.com) for details about the software versions.

### 3.1.11. PQTMSENMSG

Outputs sensor information.

**Type:**

Output

**Synopsis:**

```
$PQTMSENMSG,<MsgVer>,<TimeStamp>,<Par1>[,<Par2>,…,<ParN>]*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <MsgVer> | Numeric | - | Message version.<br>4 = IMU sensor data matching vehicle reference frame. See *Figure 1: Reference Frame* for details. |
| <TimeStamp> | Numeric | Millisecond | Timestamp since power-on. 32-bit unsigned integer. |
| <Par1> to <ParN> | Numeric | - | Sensor information. See *Chapter 3.1.11.1 If <MsgVer> = 4* for details. |

#### 3.1.11.1. If <MsgVer> = 4

**Synopsis:**

```
$PQTMSENMSG,4,<TimeStamp>,<IMU_Temp>,<IMU_GYRO_X>,<IMU_GYRO_Y>,<IMU_GYRO_Z>,<IMU_ACC_X>,<IMU_ACC_Y>,<IMU_ACC_Z>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <TimeStamp> | Numeric | Millisecond | Timestamp since power-on. 32-bit unsigned integer. |
| <IMU_Temp> | Numeric | Celsius | IMU temperature. |
| <IMU_GYRO_X> | Numeric | dps | IMU X-axis gyro value. |
| <IMU_GYRO_Y> | Numeric | dps | IMU Y-axis gyro value. |
| <IMU_GYRO_Z> | Numeric | dps | IMU Z-axis gyro value. |
| <IMU_ACC_X> | Numeric | g | IMU X-axis accelerometer value. |

| Field | Format | Unit | Description |
|---|---|---|---|
| <IMU_ACC_Y> | Numeric | g | IMU Y-axis accelerometer value. |
| <IMU_ACC_Z> | Numeric | g | IMU Z-axis accelerometer value. |

**Example:**

```
$PQTMSENMSG,4,1977253,29.830917,1.727613,0.015743,0.804347,-0.250096,-
0.467039,10.444151*24
```

**NOTE**

This message is only supported by LC29H (BA) and LC29H (CA) with software versions dedicated for four-wheel vehicles. Contact Quectel Technical Support (support@quectel.com) for details about the software versions.

### 3.1.12. PQTMCFGDRRTD

Sets/gets the DR running time and distance in DR only mode. If the running time or distance of the receiver exceeds the set values, the receiver will exit GNSS + DR or DR only mode.

**Type:**

Set/Get

**Synopsis:**

```
//Set:
$PQTMCFGDRRTD,W,<Time>,<Dist>*<Checksum><CR><LF>
//Get:
$PQTMCFGDRRTD,R*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Time> | Numeric | Second | Configuration of DR running time.<br>0 = No limitation |
| <Dist> | Numeric | Meter | Configuration of DR running distance.<br>0 = No limitation |

**Result:**

- If successful, the module returns:

```
//Set:
$PQTMCFGDRRTD,OK*<Checksum><CR><LF>
//Get:
$PQTMCFGDRRTD,OK,<Time>,<Dist>*<Checksum><CR><LF>
```

- If failed, the module returns:

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

For details about <**ErrCode**>, see *Table 2: Error Codes*.

**Example:**

```
//Set:
$PQTMCFGDRRTD,W,600,10000*72
$PQTMCFGDRRTD,OK*26
//Get:
$PQTMCFGDRRTD,R*70
$PQTMCFGDRRTD,OK,600,10000*21
```

### 3.1.13. PQTMCFGIMUTC

Sets/gets the IMU temperature compensation feature.

**Type:**

Set/Get

**Synopsis:**

```
//Set:
$PQTMCFGIMUTC,W,<State>*<Checksum><CR><LF>
//Get:
$PQTMCFGIMUTC,R*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <State> | Numeric | - | State of IMU temperature compensation feature.<br>0 = Disabled<br>1 = Enabled |

**Result:**

- If successful, the module returns:

```
//Set:
$PQTMCFGIMUTC,OK*<Checksum><CR><LF>
//Get:
$PQTMCFGIMUTC,OK,<State>*<Checksum><CR><LF>
```

- If failed, the module returns:

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

For details about <**ErrCode**>, see *Table 2: Error Codes*.

**Example:**

```
//Enable temperature compensation feature.
$PQTMCFGIMUTC,W,1*7A
$PQTMCFGIMUTC,OK*34

//Query temperature compensation state.
$PQTMCFGIMUTC,R*62
$PQTMCFGIMUTC,OK,1*29
```

### 3.1.14. PQTMDRPVA

Outputs the DR position, velocity and attitude.

**Type:**

Output

**Synopsis:**

```
$PQTMDRPVA,<MsgVer>,<Timestamp>,<Time>,<SolType>,<Lat>,<Lon>,<Alt>,<Sep>,<VelN>,<VelE>,<VelD>,<Spd>,<Roll>,<Pitch><Heading>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <MsgVer> | Numeric | - | Message version.<br>1 = Version 1 (Always 1 for this version.) |
| <Timestamp> | Numeric | Millisecond | Milliseconds since module turn-on. 32-bit unsigned integer. |

| Field | Format | Unit | Description |
|---|---|---|---|
| <Time> | hhmmss.sss | - | UTC time.<br>hh: Hours (00–23)<br>mm: Minutes (00–59)<br>ss: Seconds (00–59)<br>sss: Decimal fraction of seconds |
| <SolType> | Numeric | - | Solution type.<br>0 = No fix<br>1 = GNSS only<br>2 = Combination (GNSS + DR)<br>3 = DR only |
| <Lat> | Numeric | Degree | Latitude.<br>Note that this field is empty in case of an invalid value. |
| <Lon> | Numeric | Degree | Longitude.<br>Note that this field is empty in case of an invalid value. |
| <Alt> | Numeric | Meter | Altitude above mean-sea-level.<br>Note that this field is empty in case of an invalid value. |
| <Sep> | Numeric | Meter | Geoidal separation (the difference between the WGS84 earth ellipsoid surface and the mean-sea-level surface).<br>Note that this field is empty in case of an invalid value. |
| <VelN> | Numeric | m/s | North velocity.<br>Note that this field is empty in case of an invalid value. |
| <VelE> | Numeric | m/s | East velocity.<br>Note that this field is empty in case of an invalid value. |
| <VelD> | Numeric | m/s | Down velocity.<br>Note that this field is empty in case of an invalid value. |
| <Spd> | Numeric | m/s | Ground speed.<br>Note that this field is empty in case of an invalid value. |
| <Roll> | Numeric | Degree | Roll angle.<br>Note that this field is empty in case of an invalid value.<br>Range: -180.000000 to 180.000000 |
| <Pitch> | Numeric | Degree | Pitch angle.<br>Note that this field is empty in case of an invalid value.<br>Range: -90.000000 to 90.000000 |
| <Heading> | Numeric | Degree | Heading.<br>Note that this field is empty in case of an invalid value.<br>Range: 0.000000–360.000000 |

**Example:**

```
//No fix.
$PQTMDRPVA,1,1000,163355.000,0,,,,,,,,,*7C

//GNSS + DR fix.
$PQTMDRPVA,1,75000,083737.000,2,31.12738291,117.26372910,34.212,5.267,3.212,2.928,0.238,4.346,0.392663,1.300793,0.030088*5E
```

### 3.1.15. PQTMCFGDRHOT

Sets/gets the DR hot start feature.

**Type:**

Set/Get

**Synopsis:**

```
//Set:
$PQTMCFGDRHOT,W,<Mode>*<Checksum><CR><LF>
//Get:
$PQTMCFGDRHOT,R*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Mode> | Numeric | - | Enable/disable the DR hot start mode.<br>0 = Disable DR hot start. DR needs to be recalibrated after each power-up.<br>1 = Enable DR hot start. DR does not need to be recalibrated after each power-up, and the module outputs position information immediately after power-up in the case of no signal.<br>2 = Enable DR hot start. DR does not need to be recalibrated after each power-up, but the module does not output position information after power-up in the case of no signal. |

**Result:**

- If successful, the module returns:

```
//Set:
$PQTMCFGDRHOT,OK*<Checksum><CR><LF>
//Get:
$PQTMCFGDRHOT,OK,<Mode>*<Checksum><CR><LF>
```

- If failed, the module returns:

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

For details about <**ErrCode**>, see *Table 2: Error Codes*.

**Example:**

```
//Set:
$PQTMCFGDRHOT,W,1*79
$PQTMCFGDRHOT,OK*37
//Get:
$PQTMCFGDRHOT,R*61
$PQTMCFGDRHOT,OK,1*2A
```

**NOTE**

This message is only supported by LC29H (BA) and LC29H (CA) with software versions dedicated for four-wheel vehicles. Contact Quectel Technical Support (support@quectel.com) for details about the software versions.

### 3.1.16. PQTMCFGDR

Sets/gets the DR state.

**Type:**

Set/Get

**Synopsis:**

```
//Set:
$PQTMCFGDR,W,<State>*<Checksum><CR><LF>
//Get:
$PQTMCFGDR,R*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <State> | Numeric | - | Enable/disable the DR feature.<br>0 = Disable DR feature<br>1 = Enable DR feature |

**Result:**

- If successful, the module returns:

```
//Set:
$PQTMCFGDR,OK*<Checksum><CR><LF>
//Get:
$PQTMCFGDR,OK,<State>*<Checksum><CR><LF>
```

- If failed, the module returns:

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

For details about <**ErrCode**>, see *Table 2: Error Codes*.

**Example:**

```
//Set:
$PQTMCFGDR,W,1*2A
$PQTMCFGDR,OK*64
//Get:
$PQTMCFGDR,R*32
$PQTMCFGDR,OK,1*79
```

## 3.2. PAIR Messages

This chapter explains DR related PAIR messages (proprietary NMEA messages defined by the chipset supplier). "**P**" means proprietary message, "**AIR**" means the command defined by the chipset supplier.

### 3.2.1. Packet Type: 6010 PAIR_CUSTOM_SET_MSG_OUTPUT

Enables/disables the output of **$PQTMVEHMSG**, **$PQTMSENMSG**, **$PQTMDRCAL**, **$PQTMIMUTYPE** and **$PQTMVEHMOT** messages.

**Type:**

Set

**Synopsis:**

```
$PAIR6010,<Type>,<Output_State>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Type> | Numeric | - | Message type.<br>-1 = Reset output state of all following sentence types to the default value<br>0 = $PQTMVEHMSG (Default: disabled)<br>1 = $PQTMSENMSG (Default: disabled)<br>2 = $PQTMDRCAL (Default: disabled)<br>3 = $PQTMIMUTYPE (Default: enabled)<br>4 = $PQTMVEHMOT (Default: disabled) |
| <Output_State> | Numeric | - | Message output state.<br>0 = Disabled<br>1 = Enabled |

**Result:**

Returns **$PAIR001** message. See *document [2] protocol specification* for details.

**Example:**

```
$PAIR6010,0,1*0C
$PAIR001,6010,0*0C
```

**NOTE**

1. Send **$PQTMSAVEPAR*5A** and reset the module for **$PAIR6010** to take effect.
2. The output rate of **$PQTMVEHMSG** and **$PQTMSENMSG** is always 10 Hz. The output rate of **$PQTMDRCAL** and **$PQTMVEHMOT** depends on position fix rate. **$PQTMIMUTYPE** is only output once after each boot-up.

### 3.2.2. Packet Type: 6011 PAIR_CUSTOM_GET_MSG_OUTPUT

Gets whether the output of **$PQTMVEHMSG**, **$PQTMSENMSG**, **$PQTMDRCAL**, **$PQTMIMUTYPE** and **$PQTMVEHMOT** messages is enabled.

**Type:**

Get

**Synopsis:**

```
$PAIR6011,<Type>*<Checksum><CR><LF>
```

**Parameter:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Type> | Numeric | - | Message type.<br>0 = $PQTMVEHMSG<br>1 = $PQTMSENMSG<br>2 = $PQTMDRCAL<br>3 = $PQTMIMUTYPE<br>4 = $PQTMVEHMOT |

**Result:**

Returns **$PAIR001** message and query result. See *document [2] protocol specification* for details.

**Query result message format:**

```
$PAIR6011,<Type>,<Output_State>*<Checksum><CR><LF>
```

**Parameters included in the result:**

| Field | Format | Unit | Description |
|---|---|---|---|
| <Type> | Numeric | - | Message type.<br>0 = $PQTMVEHMSG<br>1 = $PQTMSENMSG<br>2 = $PQTMDRCAL<br>3 = $PQTMIMUTYPE<br>4 = $PQTMVEHMOT |
| <Output_State> | Numeric | - | Message output state.<br>0 = Disabled<br>1 = Enabled |

**Example:**

```
$PAIR6011,1*11
$PAIR001,6011,0*0D
$PAIR6011,1,0*0D
```

**NOTE**

This command is only supported by LC29H (BA) and LC29H (CA) with software versions dedicated for four-wheel vehicles. Contact Quectel Technical Support (support@quectel.com) for details about the software versions.

# 4 Appendix A References

**Table 3: Related Documents**

| Document Name |
|---|
| [1] Quectel_LC29H_Series_Hardware_Design |
| [2] Quectel_LC29H_Series&LC79H(AL)_GNSS_Protocol_Specification |

**Table 4: Terms and Abbreviations**

| Abbreviation | Description |
|---|---|
| ARP | Antenna Reference Point |
| BDS | BeiDou Navigation Satellite System |
| DR | Dead Reckoning |
| Galileo | Galileo Satellite Navigation System (EU) |
| GLONASS | Global Navigation Satellite System (Russian) |
| $C/N_0$ | Carrier-to-Noise-Density Ratio |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| IMU | Inertial Measurement Unit |
| MSM | Multiple Signal Message |
| NMEA | NMEA (National Marine Electronics Association) 0183 Interface Standard |
| PQTM | Proprietary Protocol of Quectel |
| QZSS | Quasi-Zenith Satellite System |
| RTCM | Radio Technical Commission for Maritime Services |
| RTK | Real-Time Kinematic |

# 5 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. |
| Underline | Default setting of a parameter. |