LC29D DR&RTK(0) Application Note

GNSS Module Series

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1 Introduction

The dead reckoning (DR) and real-time kinematic (RTK) features, mounting, calibration, and messages related to DR and RTK of Quectel LC29D module are described in this document.

This document is applicable to the following variants of Quectel LC29D module:

- LC29D (A)
- LC29D (B)
- LC29D (C)

2 Configuration

2.1. Orientation

The reference frame axes definitions are shown below. The X-axis represents the vehicle forward direction, the positive direction of Y-axis is pointing to the right side of the vehicle, and the positive direction of Z-axis is downwards.

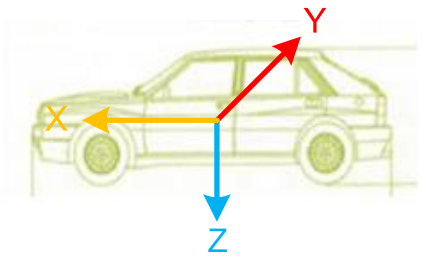

Figure 1: Reference Frame

The orientation of the module is shown below:

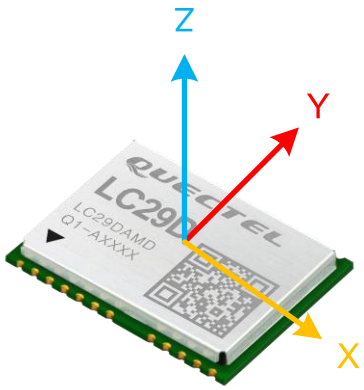

Figure 2: Module Orientation

Some Quectel LC29D module installation examples are show below:

Figure 3: Quectel LC29D Module Installation Example 1

If Quectel LC29D module is installed as in the figure above, the positive direction of X-axis is inverted, the direction of Y-axis is the same as in the reference frame, and the direction of Z-axis is also inverted compared to the reference frame; therefore, configuration should be **-XY-Z**, and the command is **$PQTMCFGORIENTATION,1,-XY-Z*66**.

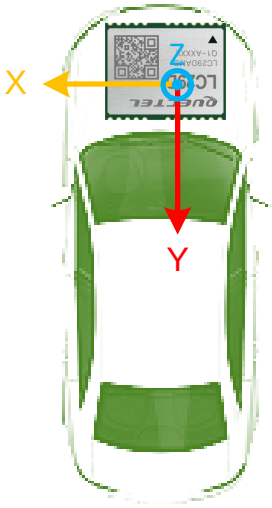

Figure 4: Quectel LC29D Module Installation Example 2

If Quectel LC29D module is installed as in the above figure, the X-axis is oriented in the direction of Y-axis of the reference frame, the Y-axis is oriented in the direction of the X-axis of the reference frame, and the direction of Z-axis is inverted to the direction of the Z-axis of reference frame; therefore, the configuration should be **-Y-X-Z**, and the command is **$PQTMCFGORIENTATION,1,-Y-X-Z*4B**.

NOTE

Save the orientation configurations to flash with **$PQTMSAVEPAR*5A** command and restart the module.

2.2. Mounting

When mounting the Quectel LC29D module on the carrier, you need to keep the yaw, pitch and roll angles within 5 degrees of the reference frame.

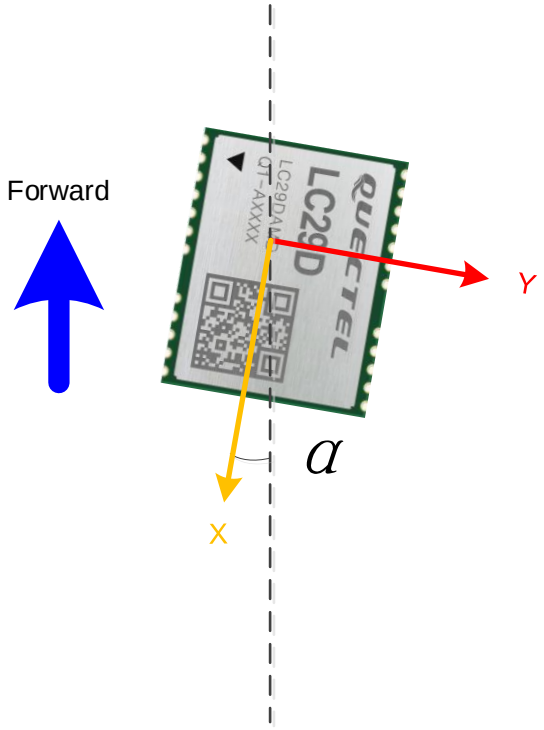

Figure 5: Yaw Angle

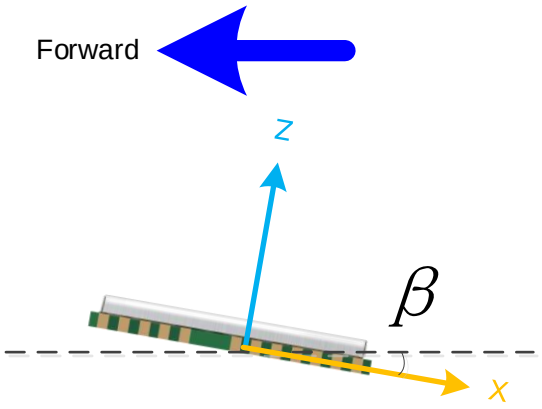

Figure 6: Pitch and Roll Angles

When mounting the Quectel LC29D module, make sure that -5° ≤ α ≤ 5°, -5° ≤ β ≤ 5°.

2.3. DR Calibration

DR calibration steps:

Step 1: Fix the module on the vehicle frame. Any displacement, turn or tilt of the device, however small, will cause performance issues and/or void 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 and keep it still for at least 30 s.

Step 4: Start driving the vehicle under good GNSS signal conditions. The module will start self-calibration, which would be completed in a few minutes.

Step 5: The calibration process ends when the **<SolType>** of **$PQTMINS** message indicates a combined solution (GNSS + DR). See ***Chapter 3.1.1*** for details about the message.

2.4. RTCM Input

Quectel LC29D module supports the RTCM version 3.3 input messages listed in 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
1084	GLONASS MSM4
1094	Galileo MSM4
1124	BeiDou MSM4

3 Messages

3.1. PQTM Messages

This chapter introduces the PQTM messages (proprietary NMEA messages defined by Quectel) supported by Quectel LC29D module.

3.1.1. PQTMINS

This message 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	ms	Milliseconds since turn on. 32-bit unsigned integer.
<SolType>	Numeric	-	Solution type. 0 = DR not ready. Roll and Pitch ready. 1 = GNSS, Roll, Pitch and Relative Heading ready. DR not ready. 2 = GNSS + DR mode. DR calibrated. 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,42529,1,31.822038000,117.115182800,67.681000,,,,-0.392663,1.300793,0.030088*4D
```

NOTE

All angles are scaled from -180.0 to 179.9 with a wrap-around to 0.0 at +180.0.
-180.0 = South, 180.0/0.0 = North, +90.0 = East, and -90.0 = West.

3.1.2. PQTMIMU

This message outputs the IMU Raw Data: Acceleration, Angular Rate and Hardware Wheel Ticks.

Type:

Output.

Synopsis:

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

Parameter:

Field	Format	Unit	Description
<Timestamp>	Numeric	ms	Milliseconds since turn on. 32-bit unsigned integer.
<ACC_X>	Numeric	g	Acceleration in X-axis direction.
<ACC_Y>	Numeric	g	Acceleration in Y-axis direction.
<ACC_Z>	Numeric	g	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.
<TickCount>	Numeric	-	Cumulative ticks.
<LastTick_Timestamp>	Numeric	ms	Last tick timestamp.

Example:

```
$PQTMIMU,42634,-0.006832,-0.022814,1.014552,0.315000,-0.402500,-0.332500,0,0*55
```

3.1.3. PQTMGPS

This message outputs the GNSS position status.

Type:

Output.

Synopsis:

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

Parameter:

Field	Format	Unit	Description
<Timestamp>	Numeric	ms	Milliseconds since turn on. 32-bit unsigned integer.
<TOW>	Numeric	Second	Time of week.
<Lat>	Numeric	Degree	Latitude.
<Lon>	Numeric	Degree	Longitude.
<Height>	Numeric	Meter	The earth ellipsoid surface.
<Altitude>	Numeric	Meter	Altitude above mean-sea-level (geoid).
<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 (3D) dilution of precision.

<FixType>	Numeric	-	Fix type. 0 = No fix. 2 = 2D fix. 3 = 3D fix.
<NumSat>	Numeric	-	Number of navigation satellites.

Example:

```
$PQTMGPS,671335,463792.000,31.822084600,117.115221100,59.4260,63.0420,0.0270,-171.7101,5.9890,1.3300,2.1100,3,18,*75
```

3.1.4. PQTMCFGEINSMSG

This message sets/gets **PQTMINS**, **PQTMIMU** and **PQTMGPS** message settings.

Type:

Set/Get.

Synopsis:

```
$PQTMCFGEINSMSG,<Set/Get>,<INS>,<IMU>,<GPS>,<Rate>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<Set/Get>	Numeric	-	0 = Get the current settings 1 = Set the message settings
<INS>	Numeric	-	Enable/disable **PQTMINS** message. 0 = Disable 1 = Enable
<IMU>	Numeric	-	Enable/disable **PQTMIMU** message. 0 = Disable 1 = Enable
<GPS>	Numeric	-	Enable/disable **PQTMGPS** message. 0 = Disable 1 = Enable
<Rate>	Numeric	Hz	Set the output rate of **PQTMINS** and **PQTMIMU** messages. It can be 10, 20, 50, 100. When set to 100, the maximum output rate is baud rate dependent.

Result:

If successful, the module returns:

```
$PQTMCFGEINSMSGOK*16
```

If failed, the module returns:

```
$PQTMCFGEINSMSGERROR*4A
```

Example:

```
//Set message settings
$PQTMCFGEINSMSG,1,1,1,1,10*3F
$PQTMCFGEINSMSGOK*16
//Get message settings
$PQTMCFGEINSMSG,0*0E
$PQTMEINSMSG,0,1,1,1,10*7C
```

NOTE

For the above command to take effect, save it with **$PQTMSAVEPAR*5A** command and restart the module.

3.1.5. PQTMVEHMSG

This message inputs/outputs vehicle information.

Type:

Input/Output.

Synopsis:

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

Parameter:

Field	Format	Unit	Description
<MsgType>	Numeric	-	Message type. 2 = Input/Output cumulative wheel tick via UART port
<Par1>,…,<ParN>	-	-	This field varies with the message type. See ***Chapter 3.1.5.1*** for details

3.1.5.1. When <MsgType> = 2

Synopsis:

```
$PQTMVEHMSG,<MsgType>,<Timestamp>,<WheelTickCount>,<Reserved>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<MsgType>	Numeric	-	Message type. 2 = Input/Output cumulative wheel tick via UART port.
<Timestamp>	Numeric	ms	Milliseconds since turn on. 32-bit unsigned integer. While inputting vehicle message, keep this field as 0.
<WheelTickCount>	Numeric		Cumulative wheel ticks.
<Reserved>	Numeric	-	Reserved. Keep this field as 1.

Result:

Returns the cumulative wheel tick with timestamp.

Example:

```
//Input cumulative wheel ticks.
$PQTMVEHMSG,2,0,100,1*18
//Response
$PQTMVEHMSG,2,153954,100,1*27
```

NOTE

While inputting cumulative wheel ticks through UART port, make sure the input rate is at least 10 Hz.

3.1.6. PQTMCFGWHEELTICK

This message sets/gets the wheel tick pin and the meters per tick.

Type:

Set/Get.

Synopsis:

```
$PQTMCFGWHEELTICK,<Set/Get>,<Edge>,<Pull>,<MPT>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<Set/Get>	Numeric	-	0 = Get the current settings 1 = Set the wheel tick pin and the meters per tick
<Edge>	Numeric	-	Signal edge of wheel tick pin. 0 = Rising-edge (default) 1 = Falling-edge
<Pull>	Numeric	-	Pull state of wheel tick pin. 0 = No pull (default) 1 = Pull up 2 = Pull down
<MPT>	Numeric	Meter	Meters per tick. Default 0.25.

Result:

If successful, the module returns:

```
$PQTMCFGWHEELTICKOK*18
```

If failed, the module returns:

```
$PQTMCFGWHEELTICKERROR*44
```

Example:

```
//Set the wheel tick pin and the meters per tick
$PQTMCFGWHEELTICK,1,0,0,0.25*34
$PQTMCFGWHEELTICKOK*18
//Get the current settings
$PQTMCFGWHEELTICK,0*00
$PQTMWHEELTICK,0,0,0,0.250000*77
```

NOTE

For the above command to take effect, save it with **$PQTMSAVEPAR*5A** command and restart the module. Even though **<MPT>** is set by this command, the DR engine will also calculate the real meters per tick value.

3.1.7. PQTMQMPT

This message queries the current meters per tick value.

Type:

Query.

Synopsis:

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

Parameter:

None.

Result:

If successful, the module returns:

```
$PQTMMPT,<CurrentMPT>*<Checksum><CR><LF>
```

Field	Format	Unit	Description
<CurrentMPT>	Numeric	Meter	The current meters per tick value.

If failed, the module returns:

```
$PQTMQMPTERROR*58
```

Example:

```
$PQTMQMPT*00
$PQTMMPT,0.250000*64
```

NOTE

Even though the meters per tick value is set by **<MPT>** in **$PQTMCFGWHEELTICK**, the DR engine calculates/calibrates the meters per tick all the time. This command gets the real-time meters per tick value.

3.1.8. PQTMCFGORIENTATION

This message sets/gets the orientation.

Type:

Set/Get.

Synopsis:

```
$PQTMCFGORIENTATION,<Set/Get>,<ORI>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<Set/Get>	Numeric	-	0 = Get the current setting 1 = Set the orientation
<ORI>	String	-	Orientation string, it can be X, Y, Z or -X, -Y, -Z. Default “-Y-X-Z”. See ***Chapter 2.1*** for details.

Result:

If successful, the module returns:

```
$PQTMCFGORIENTATIONOK*08
```

If failed, the module returns:

```
$PQTMCFGORIENTATIONERROR*54
```

Example:

```
//Set the orientation
$PQTMCFGORIENTATION,1,-Y-X-Z*4B
$PQTMCFGORIENTATIONOK*08
//Get the current orientation setting
$PQTMCFGORIENTATION,0*10
$PQTMORIENTATION,0,-Y-X-Z*08
```

NOTE

For the above command to take effect, save it with **$PQTMSAVEPAR*5A** command and restart the module.

4 Appendix A References

Table 2: Related Documents

Document Name
[1] Quectel_LC29D_Protocol_Specification
[2] Quectel_LC29D_Hardware_Design

Table 3: Terms and Abbreviations

Abbreviation	Description
ARP	Antenna Reference Point
DR	Dead Reckoning
GLONASS	Global Navigation Satellite System (Russian)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HDOP	Horizontal Dilution of Precision
IMU	Inertial Measurement Unit
MSM4	Type 4 Multiple Signal Message
NMEA	NMEA (National Marine Electronics Association) 0183 Interface Standard
PDOP	Position Dilution of Precision
RTK	Real-Time Kinematic
UART	Universal Asynchronous Receiver/Transmitter