

L76 Series&L96

GNSS Raw Measurements

Application Note

GNSS Module Series

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About the Document

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1 Introduction

This document outlines the constellation raw measurement data and ephemeris/almanac information. The messages mentioned in this document complies to NMEA format. For more information, see [document \[1\] protocol specification](#).

This document is applicable to the following Quectel modules:

- L76
- L76-L
- L76-LB
- L96

NOTE

Quectel assumes no responsibility if commands other than the ones listed herein are used.

2 Raw Data-Related Message

2.1. PQRAW

Enables/disables standard NMEA message or raw data output.

Type:

Set/Get

Synopsis:

```
//Set:
$PQRAW,W,<EnNMEA>,<EnRAW>*<Checksum><CR><LF>

//Get:
$PQRAW,R*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<EnNMEA>	Numeric	-	Enable/disable standard NMEA message output. 0 = Disable. 1 = Enable.
<EnRAW>	Numeric	-	Enable/disable standard raw data output. 0 = Disable. 1 = Enable.

Result:

- If successful, the module returns:

```
//Set:
$PQRAW,W,OK*<Checksum><CR><LF>

//Get:
PQRAW,R,<EnNMEA>,<EnRAW>*<Checksum><CR><LF>
```

- If failed, the module returns:

```
$PQRAW,W,ERROR*<Checksum><CR><LF>
```

Example:

```
//Successful setting:
```

```
$PQRAW,W,0,1*3F
```

```
$PQRAW,W,OK*16
```

```
//Unsuccessful setting:
```

```
$PQRAW,W,0,2*3C
```

```
$PQRAW,W,ERROR*4A
```

```
//Get:
```

```
$PQRAW,R*3B
```

```
$PQRAW,R,0,1*3A
```

3 Raw Measurement Messages

The GNSS raw data messages listed in this chapter provide the GPS/GLONASS/Galileo/BDS raw data to external Kalman filters.

Table 1: List of GNSS Raw Measurement Messages

Message	Type	Description
\$PMTKCHL	Output	Provides raw measurement information for each channel of GPS, GLONASS, Galileo and BDS constellations.
\$PMTKGRP	Output	Provides the group message include GPS/receiver time information.
\$PMTKVNED	Output	Provides the GPS/receiver velocity information.

3.1. PMTKCHL

Provides raw measurement information for each channel of GPS, GLONASS, Galileo and BDS constellations.

Type:

Output

Synopsis:

```
$PMTKCHL,<SysID>,<SatID>,<Pseudorange>,<TimeSyncCarrierPhase>,<Doppler>,<CycleSlipCount>,<SNR>,<SatPos(X)>,<SatPos(Y)>,<SatPos(Z)>,<FreqCh>,<IODE/tb>,<IonosphereCorrection>,<IonosphereSource>,<SyncStatus>,<CodePhase>,<OutputPseudorange>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SysID>	Numeric	-	System ID: 0 = GPS 1 = GLONASS 2 = BDS

Field	Format	Unit	Description
			3 = Galileo
<SatID>	Numeric	-	Satellite ID.
<Pseudorange>	Numeric	Meter	Raw pseudorange measurements.
<TimeSyncCarrierPhase>	Numeric	Cycle	Raw carrier phase measurements synchronized to GPS time. If the carrier phase is unlocked, the value will be 0.000.
<Doppler>	Numeric	Hz	Doppler measurements.
<CycleSlipCount>	Numeric	-	Incremented at every cycle slip on this satellite. Range: 0–999.
<SNR>	Numeric	dB-Hz	SNR (C/N ₀). Range: 00–99. Null while not tracking.
<SatPos(X)>	Numeric	Meter	ECEF coordinate system (X axis)
<SatPos(Y)>	Numeric	Meter	ECEF coordinate system (Y axis)
<SatPos(Z)>	Numeric	Meter	ECEF coordinate system (Z axis)
<FreqCh>	Numeric	-	GLONASS satellite frequency channel number. This item is only valid for GLONASS. The frequency channel number (K) equals this item minus eight.
<IODE/tb>	Hexadecimal	-	IODE is for GPS/BDS. tb is for GLONASS, null when system ID is Galileo. <ul style="list-style-type: none"> ● IODE for GPS: Range: 0x00–0xFF. No IODE: Null ● IODE for BDS: Range: 0x00–0x1F. No IODE: Null
<IonosphereCorrection>	Numeric	Meter	Ionosphere correction value.
<IonosphereSource>	Numeric	-	Ionosphere source. 0 = None 1 = Broadcast 2 = SBAS
<SyncStatus>	Numeric	-	GPS + BDS data synchronization status. 0 = None 1 = Bit synchronization. 2 = Subframe synchronization.

Field	Format	Unit	Description
			3 = Exact synchronization (Measurement is usable).
<CodePhase>	Numeric	-	Satellite code phase.
<OutputPseudorange>	Numeric	-	Pseudorange source. 0 = From ephemeris 1 = From almanac

Example:

```
$PMTKCHL,0,016,23394543.67,4992.633,-176.5,0,39,-25781982.00,1761937.12,6862459.50,00,4B,0.00,0,3,263.317932,0*20
```

NOTE

Carrier phase raw measurements of Geostationary Earth Orbit (GEO) in BDS system are not supported. In such a case, <TimeSyncCarrierPhase> and <CycleSlipCount> will be 0.000 and 999.

3.2. PMTKGRP

Provides the group message include GPS/receiver time information.

Type:

Output

Synopsis:

```
$PMTKGRP,<ClockTime>,<TOW>,<WN>,<ClockStatus>,<UTCOffset>,<ClockBias>,<ClockOffsetA>,<ClockOffsetB>,<TOWAcc>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<ClockTime>	Numeric	Millisecond	Local receiver time tick. Range: 0–4294967295 (2 ³² -1).
<TOW>	Numeric	Second	GPS time of week. Range: 0.000–00604800.000.
<WN>	Numeric	Week	GPS Week number. Range: 0–9999.

Field	Format	Unit	Description
<ClockStatus>	Numeric	-	Clock status. 0 = No clock 1 = RTC 2 = Synchronized to GPS 3 = From GPS fix
<UTCOffset>	Numeric	Second	The difference between GPS and UTC.
<ClockBias>	Numeric	Meter	Clock bias.
<ClockOffsetA>	Numeric	Meter	Clock offset between GPS clock and GLONASS clock.
<ClockOffsetB>	Numeric	Meter	Clock offset between GPS clock and BDS clock.
<TOWAcc>	Numeric	-	Time of week (TOW) accuracy. 0 = TOW accuracy exceeds 1 ms. 1 = TOW accuracy is within 1 ms.

Example:

```
$PMTKGRP,34995,00408979.000,1776,3,16,-76792,0,56,1*6D
```

3.3. PMTKVNED

Provides the GPS/receiver velocity information.

Type:

Output

Synopsis:

```
$PMTKVNED,<ClockTime>,<NorthVelocity>,<EastVelocity>,<UpVelocity>,<HorizontalSpeed>,<Speed>*  
<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<ClockTime>	Numeric	Millisecond	Local receiver time tick. Range: 0–4294967295 (2 ³² -1).
<NorthVelocity>	Numeric	m/s	North velocity.
<EastVelocity>	Numeric	m/s	East velocity.

Field	Format	Unit	Description
<UpVelocity>	Numeric	m/s	Up velocity.
<HorizontalSpeed>	Numeric	m/s	Horizontal ground speed.
<Speed>	Numeric	m/s	Object speed, including horizontal and vertical speeds.

Example:

```
$PMTKVNED,109057,10.00,20.00,0.00,0.00,0.00*0C
```

4 Ephemeris and Almanac Messages

Table 2: List of GNSS Ephemeris and Almanac Messages

Message	Type	Description
\$PMTK473	Command	Requests the ephemeris data of a single GPS satellite.
\$PMTK710	Output	Response to \$PMTK473 , returning the requested ephemeris data for the specified GPS satellite.
\$PMTK474	Command	Requests the almanac data of a single GPS satellite.
\$PMTK711	Output	Response to \$PMTK474 , returning the requested almanac data for the specified GPS satellite.
\$PMTK477	Command/Output	Requests the ephemeris data of a single GLONASS satellite/ Responds to GLONASS ephemeris data request.
\$PMTK478	Command/Output	Requests the almanac data of a single GLONASS satellite/ Responds to GLONASS almanac data request.
\$PMTK493	Command/Output	Requests the ephemeris data of a single BDS satellite/ Responds to BDS ephemeris data request.
\$PMTK494	Command/Output	Requests the almanac data of a single BDS satellite/ Responds to BDS almanac data request.
\$PMTK668	Command/Output	Requests the GPS ephemeris data parameters/ Responds to GPS ephemeris data parameter request.
\$PMTK669	Command/Output	Requests the BDS ephemeris data parameters/ Responds to BDS ephemeris data parameter request.

4.1. PMTK473: GPS Ephemeris Request

Requests the ephemeris data of a single GPS satellite. For response message, see [Chapter 4.2 PMTK710: Response to GPS Ephemeris Request](#).

Type:

Command

Synopsis:

```
$PMTK473,<SatID>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Numeric	-	GPS satellite ID for ephemeris data.

NOTE

If the module does not have the ephemeris data of the specified GPS satellite, it will return **\$PMTK001,473,2*31** to indicate the **\$PMTK473** message execution failure.

Example:

```
$PMTK473,1*2F
$PMTK710,01,0D5000,74F54E,9E2E5F,DADC08,6D7E0C,411DE2,00FFA3,D14BBE,41F667,2BCE30,
B3BA58,F76904,F35233,0F25A1,0D0F30,1DE27D,FFD19B,E6C751,001C27,EABAAA,1F6F1F,0B6DEA
,FFA906,41015D*1C
```

4.2. PMTK710: Response to GPS Ephemeris Request

Responds to **\$PMTK473**, returning the requested ephemeris data for the specified GPS satellite. It returns the most recently processed GPS ephemeris sub-frame data block, consisting of 8 words from the GPS navigation message sub-frames 1, 2 and 3 (24 words in total) following the HOW (Handover Word). The data excludes the 6 most significant parity bits. For detailed information, see the GPS Interface Control Document (ICD).

Type:

Output

Synopsis:

```
$PMTK710,<SatID>,<Data0>,...,<Data23>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Hexadecimal	-	GPS satellite ID.
<Data0>...<Data23>	Hexadecimal	-	GPS ephemeris data words.

Example:

```
$PMTK473,1*2F
$PMTK710,01,0D5000,74F54E,9E2E5F,DADC08,6D7E0C,411DE2,00FFA3,D14BBE,41F667,2BCE30,
B3BA58,F76904,F35233,0F25A1,0D0F30,1DE27D,FFD19B,E6C751,001C27,EABAAA,1F6F1F,0B6DEA
,FFA906,41015D*1C
```

4.3. PMTK474: GPS Almanac Request

Requests the almanac data of a single GPS satellite. For response message, see [Chapter 4.4 PMTK711: Response to GPS Almanac Request](#).

Type:

Command

Synopsis:

```
$PMTK474,<SatID>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Numeric	-	GPS satellite ID for almanac data.

NOTE

If the module does not have the almanac data of the specific GPS satellite, it will return **\$PMTK001,474,2*36** to indicate the **\$PMTK474** message execution failure.

Example:

```
$PMTK474,1*28
$PMTK711,01,0835,414F51,4E1846,FD4E00,A10CA9,9BD650,1F1676,C3F101,D1FFA1*45
```

4.4. PMTK711: Response to GPS Almanac Request

Responds to **\$PMTK474**, returning the requested almanac data for the specified GPS satellite. It returns the most recently processed GPS almanac sub-frame data block, consisting of the almanac reference GPS week, and the 8 words following the HOW (Handover Word) from the GPS navigation message, either pages 1 to 24 of sub-frame 4 or pages 2 to 10 of sub-frame 5. The data excludes the 6 most significant parity bits. For detailed information, see the GPS ICD.

Type:

Output

Synopsis:

```
$PMTK711,<SatID>,<WN>,<Data0>,...,<Data7>* <Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Hexadecimal	-	GPS satellite ID.
<WN>	Hexadecimal	Week	GPS week number.
<Data0>...<Data7>	Hexadecimal	-	GPS ephemeris data words.

Example:

```
$PMTK474,14*1C
$PMTK711,0E,0898,4E0CAF,7B06F8,FD4D00,A10CCC,4E8750,7B0333,C2F828,F3FFFD*4F
```

4.5. PMTK477: GLONASS Ephemeris

4.5.1. Poll Request

Requests the ephemeris data of a single GLONASS satellite.

Type:

Command

Synopsis:

```
$PMTK477,<SatID>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Numeric	-	GLONASS satellite ID for ephemeris data. Range: 1–24. Note: <SatID> is different from GSV/GSA message. If the satellite ID in GSV/GSA messages is used, it should be minus 64.

NOTE

If the module does not have the ephemeris data of the specified GLONASS satellite, it will return **\$PMTK001,477,2*35** to indicate the **\$PMTK477** message execution failure.

Example:

```
$PMTK477,20*18
$PMTK477,14,951F898C,3104034D,00000005,11AA4E13,20AAA097,00000015,8260CD08,061FD474,
00000040,02658FD1,59ACA000,00000004,23800068,E0000003,00000063,4F531686,A*74
```

4.5.2. Response

Responds to GLONASS ephemeris data request. It returns the most recently processed GLONASS ephemeris sub-frame data block.

Type:

Output

Synopsis:

`$PMTK477,<SatID>,<Data0>,...,<Data14>,<GPS_Time>,<ChannelNum>*<Checksum><CR><LF>`

Parameter:

Field	Format	Description
<SatID>	Hexadecimal	GLONASS satellite ID.
<Data0>...<Data14>	Hexadecimal	GLONASS ephemeris data words.
<GPS_Time>	Hexadecimal	GPS time when this ephemeris message is saved. Starting from January 6, 1980. Unit: Second.
<ChannelNum>	Hexadecimal	GLONASS channel number plus 8.

The structure of GLONASS ephemeris raw data is illustrated below. For more details, see GLONASS ICD.

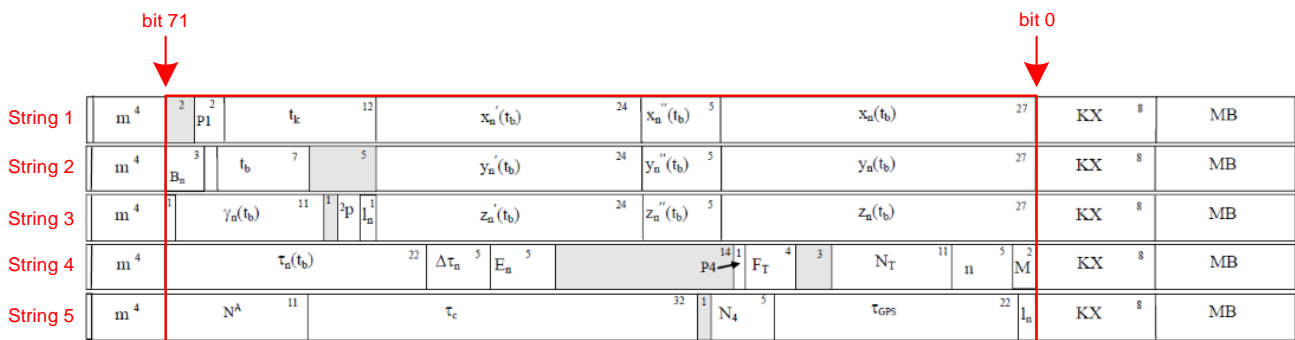


Figure 1: GLONASS Ephemeris Raw Data

Structure Introduction:

Each <DataN> field contains 32-bit data, every 3 <DataN> fields make up a string.

<Data0> to <Data2> make up string 1, <Data0> contains bit 0–31 of string 1, <Data1> contains bit 32–63 of string 1, <Data2> contains bit 64–71 of string 1. (The last 8-bit of <Data2> is valid.)

<Data3> to <Data5> make up string 2, <Data3> contains bit 0–31 of string 2, <Data4> contains bit 32–63 of string 2, <Data5> contains bit 64–71 of string 2. (The last 8-bit of <Data5> is valid.)

...

<Data12> to <Data14> make up string 5, <Data12> contains bit 0–31 of string 5, <Data13> contains bit 32–63 of string 5, <Data14> contains bit 64–71 of string 5. (The last 8-bit of <Data14> is valid.)

Example:

```
$PMTK477,06,06A6C7DD,C411177E,00000006,093985C3,E0897A34,00000016,81153FC2,06347F63,
00000080,02603419,72E06000,0000008B,8380005C,E0000000,0000000C,4BBF053E,4*79
```

The bit 71–0 of string 1 is **06 C411177E 06A6C7DD**.

The bit 71–0 of string 2 is **16 E0897A34 093985C3**.

The bit 71–0 of string 3 is **80 06347F63 81153FC2**.

The bit 71–0 of string 4 is **8B 72E06000 02603419**.

The bit 71–0 of string 5 is **0C E0000000 8380005C**.

4.6. PMTK478: GLONASS Almanac

4.6.1. Poll Request

Requests the almanac data of a single GLONASS satellite.

Type:

Command

Synopsis:

```
$PMTK478,<SatID>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Numeric	-	GLONASS satellite ID for almanac data. Range: 1–24. Note: <SatID> is different from GSV/GSA message. If the satellite ID in GSV/GSA messages is used, it should be minus 64.

NOTE

If the module does not have the almanac data of the specified GLONASS satellite, it will return **\$PMTK001,478,2*3A** to indicate the **\$PMTK478** message execution failure.

Example:

```
$PMTK478,22*15
$PMTK478,16,21F70953,0B3492D8,000000B6,97FB82BA,7300F746,00000007*6A
```

4.6.2. Response

Responds to GLONASS almanac data request. It returns the most recently processed GLONASS almanac sub-frame data block.

Type:

Output

Synopsis:

```
$PMTK478,<SatID>,<Data0>,...,<Data5>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Hexadecimal	-	GLONASS satellite ID.
<Data0>...<Data5>	Hexadecimal	-	GLONASS almanac data words.

The structure of GLONASS almanac raw data is illustrated below. For more details, see GLONASS ICD.

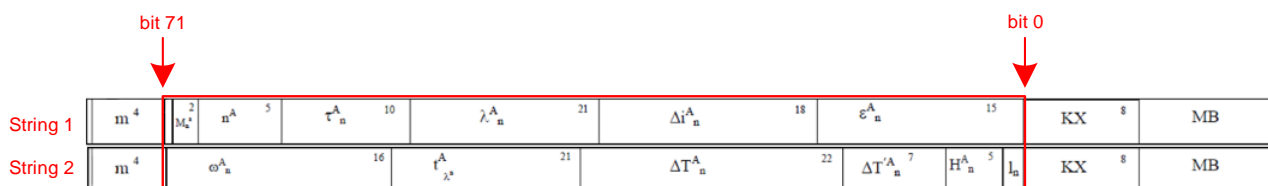


Figure 2: GLONASS Almanac Raw Data

Structure Introduction:

Each <DataN> field contains 32-bit data, every 3 <DataN> fields make up a string.

<Data0> to <Data2> make up string 1, <Data0> contains bit 0–31 of string 1, <Data1> contains bit 32–63 of string 1, <Data2> contains bit 64–71 of string 1. (The last 8-bit of <Data2> is valid.)

<Data3> to <Data5> make up string 2, <Data3> contains bit 0–31 of string 2, <Data4> contains bit 32–63 of string 2, <Data5> contains bit 64–71 of string 2. (The last 8-bit of <Data5> is valid.)

Example:

```
$PMTK478,16,21F70953,0B3492D8,000000B6,97FB82BA,7300F746,00000007*6A
```

The bit 71–0 of string 1 is **B6 0B3492D8 21F70953**.

The bit 71–0 of string 2 is **07 7300F746 97FB82BA**.

4.7. PMTK493: BDS Ephemeris

4.7.1. Poll Request

Requests the ephemeris data of a single BDS satellite.

Type:

Command

Synopsis:

```
$PMTK493,<SatID>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Numeric	-	BDS satellite ID for ephemeris data.

NOTE

If the module does not have the ephemeris data of the specified BDS satellite, it will return **\$PMTK001,493,2*3F** to indicate the **\$PMTK493** message execution failure.

Example:

\$PMTK493,2*22

```
$PMTK493,02,3BD20500,907702C4,15,4EDB2107,817FBA46,55,00000000,17BDDDB00,D5,00804BE4,6B428B56,55,D0F906E4,001C28FF,55,2B2B57CA,FFC34BAE,55,477900F3,117A8078,55,90876103,5FFF8542,95,9A11F056,F55447FC,55,AA0A3DB0,AAAAAAAA,AA*65
```

\$PMTK493,6*26

```
$PMTK493,06,B44740E2,48174008,FB5018F6,D2370702,609F3011,2C001141,05A60188,B48740E2,FDAF4A20,3B4A311E,7AC50469,7E2915CA,43EBCFCF,0011A72B,B4C740E2,3431EC39,FCD78D4A,E0D1FFD3,BB7F0201,D192C3E7,4616B84B*47
```


4.7.2. Response

Responds to BDS ephemeris data request. It returns the most recently processed BDS ephemeris sub-frame data block. For MEO/IGSO satellites, the data consists of 7 words from the BDS navigation message sub-frames 1, 2 and 3 (21 words in total). For GEO satellites, the data is extracted from pages 1–10 of sub-frame 1 following the Pnum1 (see [Figure 3: Bit Allocation for 150 MSBs of Page 1 of Subframe 1 in Format D2](#) for details). All parity-bits from the navigation message have been removed.

Type:

Output

Synopsis:

```
//MEO/IGSO satellites
$PMTK493,<SatID>,<Data0>,...,<Data20>*<Checksum><CR><LF>
//GEO satellites
$PMTK493,<SatID>,<Page1A>,<Page1B>,<Page1C>,...,<Page10A>,<Page10B>,<Page10C>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Hexadecimal	-	BDS satellite ID.
<Data0>...<Data20>	Hexadecimal	-	BDS ephemeris data words.
<PageNA>	Hexadecimal	-	The first 32 bits of page N data.
<PageNB>	Hexadecimal	-	The second 32 bits of page N data.
<PageNC>	Hexadecimal	-	The third 8 bits of page N data.

For details on the structure of BDS ephemeris raw data for MEO/IGSO satellites and GEO Satellites, see BDS ICD. Below is a brief illustration on the data structure for GEO satellites:

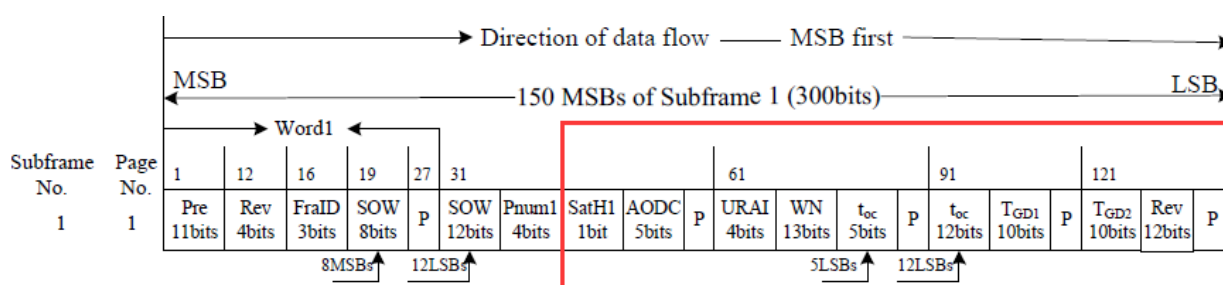


Figure 3: Bit Allocation for 150 MSBs of Page 1 of Subframe 1 in Format D2

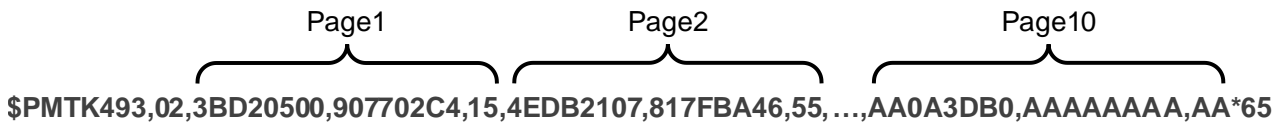


Figure 4: GEO Satellite Ephemeris Corresponding to Each Page

4.8. PMTK494: BDS Almanac

4.8.1. Poll Request

Requests the almanac data of a single BDS satellite.

Type:

Command

Synopsis:

```
$PMTK494,<SatID>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Description
<SatID>	Numeric	BDS satellite ID for almanac data.

NOTE

If the module does not have the almanac data of the specified BDS satellite, it will return `$PMTK001,494,2*38` to indicate the `$PMTK494` message execution failure.

Example:

```
$PMTK494,2*25
$PMTK494,02,02E8,B10741E2,AD2B0B80,EB9BFC6B,1A409522,9823A008,B3E1FE00,E1A822ED*65

$PMTK494,6*21
$PMTK494,06,02E8,B24741E2,A52BABAC,FF8F0000,62E2F88C,9FCB1138,8D9722FD,CDA2B5FC*
61
```

4.8.2. Response

Responds to BDS almanac data request. It returns the most recently processed BDS almanac sub-frame data block, namely, the almanac reference BDS week, followed by the 7 words from the BDS navigation message broadcasted on pages 1 to 24 of sub-frame 4 and pages 1 to 6 of sub-frame 5 for MEO/IGSO satellites and broadcasted on pages 35 to 36 of sub-frame 5 for GEO satellites. All parity bits have been removed.

Type:

Output

Synopsis:

```
$PMTK494,<SatID>,<WN>,<Data0>,...,<Data6>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Description
<SatID>	Hexadecimal	BDS satellite ID.
<WN>	Hexadecimal	BDS week number.
<Data0>...<Data6>	Hexadecimal	BDS almanac data words.

NOTE

For details on the structure of BDS almanac raw data for MEO/IGSO satellites and GEO Satellites, see BDS ICD.

4.9. PMTK668: GPS Ephemeris Parameters

4.9.1. Poll Request

Requests the GPS ephemeris data parameters.

Type:

Command

Synopsis:

```
$PMTK668,<SatID>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Description
<SatID>	Numeric	GPS satellite ID.

NOTE

If the module does not have the parameters of the specified GPS satellite, it will return **\$PMTK668,<SatID>,0*<Checksum><CR><LF>**.

Example:

```
$PMTK668,1*27
$PMTK668,1,1077,0,87,65,7650,0,-93,-765201,65,-2457,11214,817085016,-2199,83055155,3877,2701
987632,7650,-47,-1679374511,28,669694634,8047,520842730,-22266,12,0*08
```

4.9.2. Response

Responds to GPS ephemeris data parameter request. It returns the GPS ephemeris data parameters.

Type:

Output

Synopsis:

```
$PMTK668,<SatID>,<WN>,<URAI>,<IDOT>,<IODE>,<toc>,<af2>,<af1>,<af0>,<IODC>,<Crs>,<Δn>,<M0>,<Cuc>,<Eccentricity>,<Cus>,<√A>,<toe>,<Cic>,<Ω0>,<Cis>,<i0>,<Crc>,<ω>,<Ωdot>,<Tgd>,<SVHealth>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Numeric	-	GPS satellite ID.
<WN>	Numeric	Week	GPS week number.
<URAI>	Numeric	-	User range accuracy index.
<IDOT>	Numeric	2 ⁻⁴³ π/sec	Rate of Inclination Angle.
<IODE>	Numeric	-	Issue of data, ephemeris.
<t _{oc} >	Numeric	2 ⁴ sec	Time of clock.

Field	Format	Unit	Description
<af2>	Numeric	2^{-55} sec/sec ²	Drift Rate Correction Coefficient.
<af1>	Numeric	2^{-43} sec/sec	Space Vehicle (SV) Clock Drift Correction Coefficient.
<af0>	Numeric	2^{-31} sec	SV Clock Bias Correction Coefficient.
<IODC>	Numeric	-	Issue of Data, Clock.
<C _{rs} >	Numeric	2^{-5} meter	Amplitude of the Sine Harmonic Correction Term to the Orbit Radius.
<Δn>	Numeric	2^{-43} π/sec	Mean Motion Difference from Computed Value.
<M ₀ >	Numeric	2^{-31} π	Mean Anomaly at Reference Time.
<C _{uc} >	Numeric	2^{-29} rad	Amplitude of Cosine Harmonic Correction Term to the Argument of Latitude.
<Eccentricity>	Numeric	2^{-33}	Eccentricity.
<C _{us} >	Numeric	2^{-29} rad	Amplitude of Sine Harmonic Correction Term to the Argument of Latitude.
<√A>	Numeric	2^{-19} meter ^{1/2}	Square Root of the Semi-Major Axis.
<t _{oe} >	Numeric	2^4 sec	Time of Ephemeris.
<C _{ic} >	Numeric	2^{-29} rad	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination.
<Ω ₀ >	Numeric	2^{-31} π	Longitude of Ascending Node of Orbit Plane at Weekly Epoch.
<C _{is} >	Numeric	2^{-29} rad	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination.
<i ₀ >	Numeric	2^{-31} π	Inclination angle at reference time.
<C _{rc} >	Numeric	2^{-5} meter	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius.
<ω>	Numeric	2^{-31} π	Argument of Perigee.
<Ω _{dot} >	Numeric	2^{-43} π/sec	Rate of right ascension.
<T _{gd} >	Numeric	2^{-31} sec	Group Delay Differential.
<SVHealth>	Numeric	-	SV health status.

4.10. PMTK669 BDS: Ephemeris Parameters

4.10.1. Poll Request

Requests the BDS ephemeris data parameters.

Type:

Command

Synopsis:

```
$PMTK669,<SatID>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Description
<SatID>	Numeric	BDS satellite ID.

NOTE

If the module does not have the parameters of the specified BDS satellite, it will return `$PMTK669,<SatID>,0*<Checksum><CR><LF>`.

Example:

```
$PMTK669,1*26
$PMTK669,1,1077,0,-816,2,16200,0,40730,-5227056,0,-15255,21444,-564748513,-17301,4677831,-5582,
3404452729,16200,369,172423346,155,60460899,5163,-13124251,-18181,-5,0*01
```

4.10.2. Response

Responds to BDS ephemeris data parameter request. It returns the BDS ephemeris data parameters.

Type:

Output

Synopsis:

```
$PMTK669,<SatID>,<WN>,<URAI>,<IDOT>,<IDOE>,<toc>,<a2>,<a1>,<a0>,<IODC>,<Crs>,<Δn>,<M0>,<Cuc>,<Eccentricity>,<Cus>,<√A>,<toe>,<Cic>,<Ω0>,<Cis>,<i0>,<Crc>,<ω>,<Ωdot>,<Tgd>,<SVHealth>*<Checksum><CR><LF>
```

Parameter:

Field	Format	Unit	Description
<SatID>	Numeric	-	BDS satellite ID.
<WN>	Numeric	Week	GPS week number. Note: <WN> is the GPS week number in both \$PMTK668 and \$PMTK669 output messages.
<URAI>	Numeric	-	User range accuracy index
<IDOT>	Numeric	2^{-43} π/sec	Rate of inclination angle.
<IODE>	Numeric	-	Issue of data, ephemeris.
<t _{oc} >	Numeric	2^3 sec	Time of clock.
<a2>	Numeric	2^{-66} sec/sec ²	Drift Rate Correction Coefficient.
<a1>	Numeric	2^{-50} sec/sec	Space Vehicle (SV) Clock Drift Correction Coefficient.
<a0>	Numeric	2^{-33} sec	SV Clock Bias Correction Coefficient.
<IDOC>	Numeric	-	Issue of Data, Clock.
<C _{rs} >	Numeric	2^{-6} meter	Amplitude of the Sine Harmonic Correction Term to the Orbit Radius.
<Δn>	Numeric	2^{-43} π/sec	Mean Motion Difference from Computed Value.
<M ₀ >	Numeric	2^{-31} π	Mean Anomaly at Reference Time.
<C _{uc} >	Numeric	2^{-31} rad	Amplitude of Cosine Harmonic Correction Term to the Argument of Latitude.
<Eccentricity>	Numeric	2^{-33}	Eccentricity.
<C _{us} >	Numeric	2^{-31} rad	Amplitude of Sine Harmonic Correction Term to the Argument of Latitude.
<√A>	Numeric	2^{-19} meter ^{1/2}	Square Root of the Semi-Major Axis.
<t _{oe} >	Numeric	2^3 sec	Time of Ephemeris.
<C _{ic} >	Numeric	2^{-31} rad	Amplitude of the Cosine Harmonic Correction Term to the Angle of Inclination.
<Ω ₀ >	Numeric	2^{-31} π	Longitude of ascending node of orbital of plane computed according to reference time.
<C _{is} >	Numeric	2^{-31} rad	Amplitude of the Sine Harmonic Correction Term to the Angle of Inclination.

Field	Format	Unit	Description
<i ₀ >	Numeric	2 ⁻³¹ π	Inclination angle at reference time.
<C _{rc} >	Numeric	2 ⁻⁶ meter	Amplitude of the Cosine Harmonic Correction Term to the Orbit Radius.
<ω>	Numeric	2 ⁻³¹ π	Argument of Perigee.
<Ω _{dot} >	Numeric	2 ⁻⁴³ π/sec	Rate of right ascension.
<T _{gd} >	Numeric	0.1ns	Group Delay Differential.
<SVHealth>	Numeric	-	SV health status.

5 Appendix A References

Table 3: Related Documents

Document Name
[1] Quectel_Lx0&Lx6&LC86L&LG77L_GNSS_Protocol_Specification

Table 4: Terms and Abbreviations

Abbreviation	Description
ECEF	Earth-Centered, Earth-Fixed
GEO	Geostationary Earth Orbit
GLONASS	Global Satellite Navigation System (Russian)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HOW	Hand-Over Word
ICD	Interface Control Document
IGSO	Inclined Geosynchronous Orbit
IODE	Issue of Data (Ephemeris)
MEO	Medium Earth Orbit
NMEA	National Marine Electronics Association
PRN	Pseudo Random Noise
RTC	Real Time Clock
SBAS	Satellite-Based Augmentation System
SNR	Signal-to-Noise Ratio

Abbreviation	Description
SV	Space Vehicle
TOW	Time of Week
UTC	Coordinated Universal Time

6 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> </u>	Default setting of a parameter.