



# MTK Raw GPS/GLONASS/Beidou Data Packet User Manual

Version: 10.7  
Release date: 2017-02-20

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## Document Revision History

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Revision	Date	Author	Description
10.0	2013-12-26	WenChun Shih	Initial draft
10.1	2013-12-31	WenChun Shih	Add range of IODE for Beidou
10.2	2014-01-24	WenChun Shih	Add PMTK command to get ephemeris and almanac raw data of GPS system and Beidou system
10.3	2014-03-14	WenChun Shih	Add PMTK command to get the parameter of ephemeris
10.4	2015-10-27	WenChun Shih	Add PMTK command to get ephemeris and almanac raw data of GLONASS system
10.5	2015-10-28	Louis Hsieh	Review and change document format
10.6	2017-01-04	WenChun Shih	Add carrier phase measurement status to indicate the quality of the carrier phase
10.7	2017-2-20	WenChun Shih	Add carrier phase measurement status "2" to indicate the quality of the carrier phase is half wave cycle locked

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## 1 Constellation Raw Data

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### 1.1 Raw GPS/GLONASS/Beidou data sentences

The raw GPS/GLONASS/Beidou data sentences provide GPS/GLONASS/Beidou data for external Kalman filter. The raw GPS/GLONASS/Beidou data measurements are included the channel message (\$PMTKCHL). And the group message (\$PMTKGRP) includes the GPS/GLONASS/Beidou and receiver time information. And the velocity message (\$PMTKVNED) includes receiver velocity information. The PMTK473/474/477/478/493/494 commands include the ephemeris and almanac raw data of GPS/GLONASS/Beidou system. These sentences are described subsequently.

**Table 1 Raw Data Sentences**

Sentence
\$PMTKCHL
\$PMTKGRP
\$PMTKVNED
\$PMTK473/474
\$PMTK477/478
\$PMTK493/494
\$PMTK668/669

### 1.2 PMTKCHL –Channel message

The channel message includes raw GPS/GLONASS/Beidou measurement information.

Example:

```
$PMTKCHL,0,016,23394543.67,4992.633,4992.679,-176.5,0,39,-
25781982.00,1761937.12,6862459.50,00,4B,0.00,0,3,1*25
```

**Table 2 Channel Message**

Field	Example	Comments
Sentence ID	\$PMTKCHL	Channel Message.
System ID	0	0:GPS 1:GLONASS 2:Beidou
Satellite ID	016	Satellite ID.

		minimum 3 characters(decimal) fixed length
Pseudorange	23394543.67	Raw pseudorange measurements. Float.(meter)
Time Sync Carrier phase	4992.633	Raw carrier phase measurement sync to GPS time Float(cycle) Note. If phase unlock, the value will show 0.0.
Doppler	-176.5	Doppler measurement. Float.(Hz)
Cycle slip count	0	Incremented every time there is a cycle slip on this satellite. 0 – 999
SNR	39	SNR (C/No), 00-99 dB-Hz, null while not tracking Integer
Satellite positions (X)	-25781982.00	ECEF coordinate system
Satellite positions (Y)	1761937.12	ECEF coordinate system
Satellite positions (Z)	6862459.50	ECEF coordinate system
Frequency channel	00	GLONASS Satellite Frequency channel number This item is only valid for GLONASS, the frequency channel number K equal this item minus eight.
IODE or tb	4B	IODE is for GPS/Beidou tb is for GLONASS 1. IODE for GPS: Range 00 – FF, fixed length No IODE = empty field Hexadecimal 2. IODE for Beidou: Range 00 – 1F, fixed length No IODE = empty field Hexadecimal
Ionosphere Correction	0.00	Ionosphere Correction value Float(meter)
Ionosphere source	0	0 :NONE

		1 :broadcast, 2 :SBAS
Sync Status	3	G+B data sync status. 0:None 1:Bit sync. 2:Subframe sync. 3:Exact sync.(Measurement is usable.)
CPM Status	1	Carrier phase measurement status 0: Carrier phase measurement is unlocked. 1: Carrier phase measurement is carrier locked. 2: Carrier phase measurement is half wave cycle locked.
Checksum	*25	
Terminator	<CR> <LF>	

### 1.3 PMTKGRP –Group message

The group message includes the GPS/ receiver time information. It is sent last and signals the end of the channel reports.

Example:

```
$PMTKGRP,34995,00408979.000,1776,3,16,-76792,0,56*70
```

**Table 3 Group Message**

Field	Example	Comments
Sentence ID	\$PMTKGRP	Group Message
Clock time	34995	Local receiver time tick Range:0-4294967295( $2^{32}-1$ ). Integer(ms)
Time of week	00408979.000	GPS TOW Range:0-604800000 Integer(s).
Week number	1776	GPS Week number Range:0-9999 Integer
Clock Status	3	0 :no clock 1 :RTC,

		2 : synced to GPS, 3 : from GPS fix.
UTC offset	16	The difference between GPS and UTC. Integer(sec)
Clock Bias	-76792	Integer(meter)
Clock OffsetA	0	The clock offset between GPS clock and GLONASS clock Integer(meter)
Clock OffsetB	56	The clock offset between GPS clock and Beidou clock Integer(meter)
Checksum	*70	
Terminator	<CR> <LF>	

#### 1.4 PMTKVNED–Velocity message

The velocity message includes the GPS/receiver velocity information.

Example:

```
$PMTKVNED,109057,10.00,20.00,0.00,0.00,0.00*2A
```

**Table 4 Velocity Message**

Field	Example	Comments
Sentence ID	\$PMTKVNED	Velocity Message
Clock time	109057	Local receiver time tick Range:0-4294967295( $2^{32}-1$ ). Integer(ms)
North Velocity	10.00	North Velocity Integer(m/s)
East Velocity	20.00	East Velocity Integer(m/s)
Up Velocity	0.00	Up Velocity Integer(m/s)
Horizontal speed	0.00	Horizontal ground speed Integer(m/s)
Speed	0.00	Object Speed, include horizontal and vertical speed Integer(m/s)



Checksum	*2A	
Terminator	<CR> <LF>	



## 2 Constellation Ephemeris Information

---

### 2.1 PMTK473–Ephemeris information of GPS system

**[Packet Meaning]**

Get a single GPS Ephemeris. Return the most recently processed GPS Ephemeris sub-frame data-block. The data is the 8 words from the GPS navigation message sub-frames 1, 2 and 3 ( 24 words in total) following the Hand-Over Word ( HOW). The 8 most significant parity-bits have been removed.

**[Data Field]**

***PMTK473,PRN***

PRN: Which GPS satellite ephemeris to return.

**[Example]**

\$PMTK473,1\*2F<CR> <LF>

**[Return]**

\$PMTK710,01,BC1000,7C3FBA,3390FD,29EAC2,AB5912,326432,000015,0D6AAD,32FA9E,33C9F4,6D4133,FB5B01,5E6E5F,1195A1,0D74AF,64327F,002216,BE4A72,FFFE27,25E729,1B6110,4D2578,FFA70F,32F9D6\*12

### 2.2 PMTK474–Almanac information of GPS system

**[Packet Meaning]**

Get a single GPS Almanac. Return the most recently processed GPS Almanac sub-frame data-block. The data is the Almanac reference GPS week, followed by the 8 words following the Hand-Over Word ( HOW) from the GPS navigation message, either pages 1 to 24 of sub-frame 4 or pages 2 to 10 of sub-frame 5. The 8 most significant parity-bits have been removed.

**[Data Field]**

***PMTK474,PRN***

PRN: Which GPS satellite almanac to return.

**[Example]**

\$PMTK474,1\*28<CR> <LF>

**[Return]**

\$PMTK711,01,06F0,4115E6,900BFA,FD4B00,A10D00,16AF18,10444C,1EBE0D,0D0031\*34

### 2.3 PMTK477–Ephemeris information of GLONASS system

**[Packet Meaning]**

Get a single GLONASS Ephemeris. Return the most recently processed GLONASS Ephemeris sub-frame data-block.

**[Data Field]**

**PMTK477, Satellite number**

Satellite number: Which GLONASS satellite ephemeris to return.

**[Example]**

\$PMTK477,1\*2B<CR><LF>

**[Return]**

PMTK477, Satellite number, item1, item2, item3, item4, item5, item6, item7, item8, item9, Item10, item11, item12, item13, item14, item15

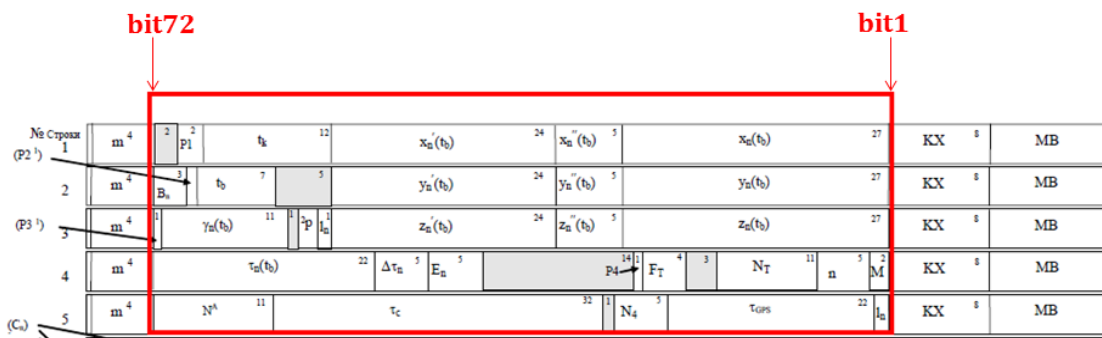
Detail information refers to figure 1.

Example:

\$PMTK477,09,059612C1,14AA7150,00000003,093CFC24,20054C50,00000013,8A60855F,069EE7EA,00000080,00652125,66786000,00000000,C2C00332,50000032,00000048\*4F

**Table 5 PMTK477 Command Field**

Field	Example	Comments
Sentence ID	\$PMTK477	GLONASS ephemeris message.
Satellite number	1	GLONASS satellite number 0x1 – 0x18 Hexadecimal
Item1	059612C1	Raw GLONASS ephemeris data 32 bits Hexadecimal
.....		
Item15	00000048	Raw GLONASS ephemeris data 32 bits Hexadecimal
CheckSum	*0C	
Terminator	<CR><LF>	



**Figure 1 GLONASS Ephemeris Raw Data**

Every item contain 32 bits, every three items make up a string.

Item1~3 make up string 1.

.....

Item13~15 make up string 5.

The first item of a string contain bit1~32.

The second item of a string contain bit33~64.

The third item of a string contains bit65~72, the last eight bits of item is valid.

For example,

\$PMTK477,09,059612C1,14AA7150,00000003,093CFC24,20054C50,00000013,8A60855F,069EE7EA,00000080,00652125,66786000,00000000,C2C00332,50000032,00000048\*4F

The bit72~bit1 of string 1 is **03 14AA7150 059612C1**

Note: If MTK GPS Chip don't have ephemeris of one GLONASS Satellites, it will return string "PMTK001,477,2", means set PMTK477 fail.

## 2.4 PMTK478–Almanac information of GLONASS system

### [Packet Meaning]

Get a single GLONASS Almanac. Return the most recently processed GLONASS Almanac sub-frame data-block.

### [Data Field]

#### **PMTK478, Satellite number**

Satellite number: Which GLONASS satellite almanac to return.

### [Example]

\$PMTK478,1\*24<CR><LF>

### [Return]

\$PMTK478, Satellite number, item1, item2, item3, item4, item5, item6

Detail information refers to figure 2.

Example:

\$PMTK478, 09, 182608D3, 00496440, 000000A9, 97FF24BC, D6220E6E, 00000012\*63

**Table 6 PMTK478 Command Field**

Field	Example	Comments
Sentence ID	\$PMTK478	GLONASS almanac message.
Satellite number	1	GLONASS satellite number 0x1 – 0x18 Hexadecimal
Item1	182608D3	Raw GLONASS almanac data 32 bits Hexadecimal
.....		
Item6	00000012	Raw GLONASS almanac data 32 bits Hexadecimal
Checksum	*0C	
Terminator	<CR><LF>	

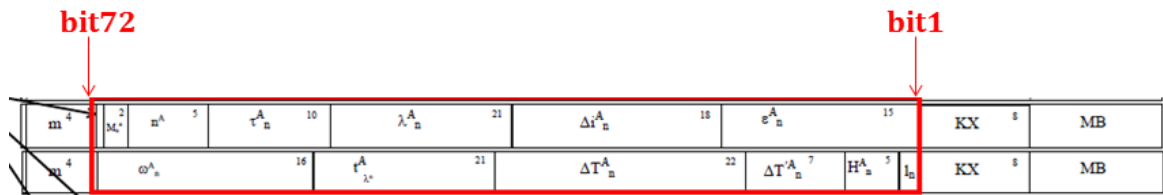


Figure 2 GLONASS Almanac Raw Data

Every item contain 32 bits, every three items make up a string.

Item1~3 make up string 1.

Item4~6 make up string 2.

The first item of a string contain bit1~32.

The second item of a string contain bit33~64.

The third item of a string contains bit65~72, the last eight bits of item is valid.

For example,

\$PMTK478, 09, 182608D3, 00496440, 00000A9, 97FF24BC, D6220E6E, 0000012\*63

The bit72~bit1 of string 1 is A9 00496440 182608D3

Note: If MTK GPS Chip don't have almanac of one GLONASS Satellites, it will return string "PMTK001, 478, 2", means set PMTK478 fail.

## 2.5 PMTK493–Ephemeris information of Beidou system

### [Packet Meaning]

Get a single Beidou Ephemeris. Return the most recently processed Beidou Ephemeris sub-frame data-block. The data of MEO/IGSO is 7 words from the Beidou navigation message sub-frame 1, 2 and 3 (21 words in total). The data of GEO is from pages 1~10 of sub-frame 1 following Pnum1. All the parity-bits in navigation message have been removed.

GEO

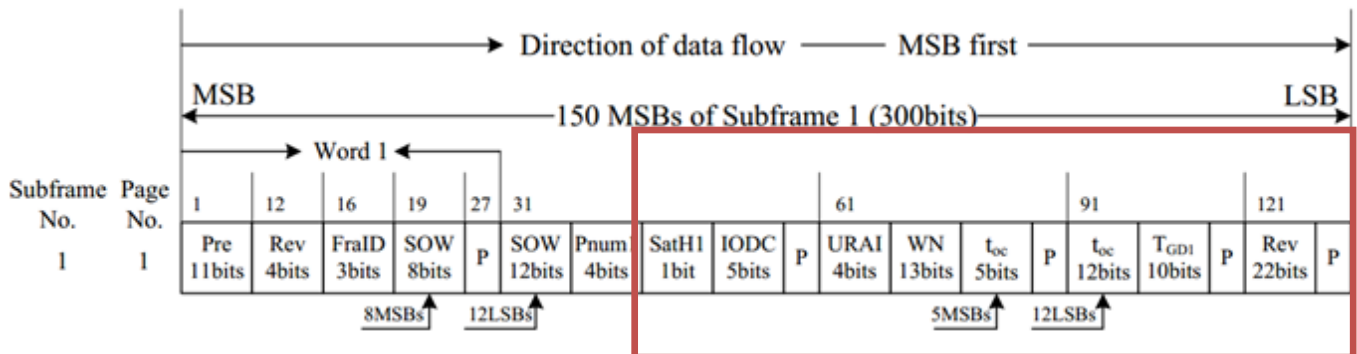
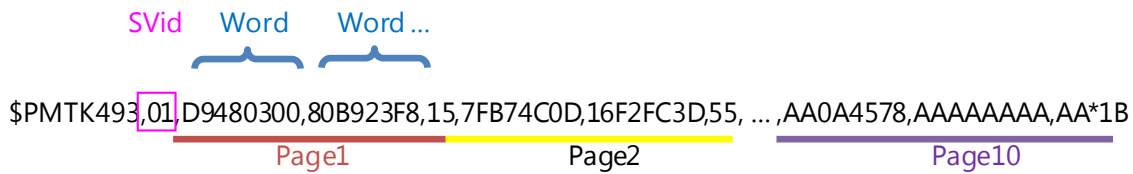


Figure 3 Bits Allocation of 150 MSBs of page 1 in subframe 1 of format D2

SVid   Word   Word ...  


**[Data Field]**

***PMTK493,PRN***

PRN: Which Beidou satellite ephemeris to return.

**[Example]**

```
$PMTK493,1*2F<CR> <LF>
$PMTK493,8*2F<CR> <LF>
```

**[Return]**

```
$PMTK493,01,D9480300,80B923F8,15,7FB74C0D,16F2FC3D,55,00000000,70FEE900,15,0080C815,0
FFD217D,55,3F2C06E5,00FC26E1,55,2B1338A6,FF4B01AA,55,1BCBFFD7,0896003F,55,6FE89D7B,3000DE
AE,15,2AEF709D,60829AF4,55,AA0A4578,AAAAAAAA,AA*1B
$PMTK493,08,6D5B40E2,230D00E0,0093E067,DF2D5343,853C7FCF,2B160780,8150E987,6D9B40E
2,ECEF3CF8,78BA199D,DD670112,40680F5E,B7B78F38,79609D2B,6DDB40E2,40C1CF9A,012880BD,1ED
0FFF5,7F0A7300,24BA0FD2,EA4BB1FF*4A
```

## 2.6 PMTK494–Almanac information of Beidou system

**[Packet Meaning]**

Get a single Beidou Almanac. Return the most recently processed Beidou Almanac sub-frame data-block. The data is the Almanac reference Beidou week, followed by the 7 words which are from the Beidou navigation message broadcasted in pages 1 to 24 of sub-frame 4 and pages 1 to 6 of sub-frame 5 for MEO/IGSO and broadcasted in pages 35 to 36 of sub-frame 5 for GEO. All the parity-bits have been removed.

**[Data Field]**

***PMTK494,PRN***

PRN: Which Beidou satellite almanac to return.

**[Example]**

```
$PMTK494,1*28<CR> <LF>
```

**[Return]**

```
$PMTK494,01,01A4,F61841E2,AA2B0748,EA9C0260,15308DD8,18F99038,D25B7201,CDB823CF*67
```

## 2.7 PMTK668/669–Ephemeris parameter of GPS/Beidou system

### [Packet Meaning]

Get the parameter of ephemeris of GPS/Beidou.

### [Data Field]

**PMTK668, PRN**

**PMTK669, PRN**

PRN : Which GPS/Beidou ephemeris parameter to return.

### [Example]

```
$PMTK668,1*28<CR><LF>
```

### [Return]

```
$PMTK668,8,759,0,-
```

```
828,10,25649,0,37,694960,10,845,11392,617108091,828,60842889,6088,2701997165,25649,12,1942684
461,41,665917451,5304,-1940320170,-21933,-23,0*1A
```

**Table 7 PMTK668 Command Field**

Field	Example	Comments
Sentence ID	\$PMTK668/669	GPS/Beidou Ephemeris Parameter
Satellite ID	8	PRN
Week Number	759	GPS Week Number Range : 0~1023 Note. Both of these column in PMTK668 and PMTK669 present as the gps week.
URAI	0	SV Accuracy
IDOT	-828	Integer ( Units : $2^{-43} \pi/\text{sec}$ )
IDOE	10	Integer
toc	25649	Integer Units in GPS : $2^4 \text{ sec}$ Units in Beidou : $2^3 \text{ sec}$
af2 ( means $a_2$ in Beidou ICD)	0	Integer Units in GPS : $2^{-55} \text{ sec}/\text{sec}^2$ Units in Beidou : $2^{-66} \text{ sec}/\text{sec}^2$
af1 ( means $a_1$ in Beidou ICD)	37	Integer Units in GPS : $2^{-43} \text{ sec}/\text{sec}$ Units in Beidou : $2^{-50} \text{ sec}/\text{sec}$
af0 ( means $a_0$ in Beidou ICD)	694960	Integer Units in GPS : $2^{-31} \text{ sec}$

		Units in Beidou : $2^{-33}$ sec
IODC	10	Integer
$C_{rs}$	845	Integer Units in GPS : $2^{-5}$ meter Units in Beidou : $2^{-6}$ meter
$\Delta n$	11392	Integer ( Units : $2^{-43}$ $\pi$ /sec )
$M_0$	617108091	Integer ( Units : $2^{-31}$ $\pi$ )
$C_{uc}$	828	Integer Units in GPS : $2^{-29}$ rad Units in Beidou : $2^{-31}$ rad
Eccentricity(e)	60842889	Integer ( Units : $2^{-33}$ )
$C_{us}$	6088	Integer Units in GPS : $2^{-29}$ rad Units in Beidou : $2^{-31}$ rad
$\sqrt{A}$	2701997165	Integer ( Units : $2^{-19}$ meter <sup>1/2</sup> )
$t_{oe}$	25649	Integer Units in GPS : $2^4$ sec Units in Beidou : $2^5$ sec
$C_{ic}$	12	Integer Units in GPS : $2^{-29}$ rad Units in Beidou : $2^{-31}$ rad
$\Omega_0$	1942684461	Integer ( Units : $2^{-31}$ $\pi$ )
$C_{is}$	41	Integer Units in GPS : $2^{-29}$ rad Units in Beidou : $2^{-31}$ rad
$i_0$	665917451	Integer ( Units : $2^{-31}$ $\pi$ )
$C_{rc}$	5304	Integer Units in GPS : $2^{-5}$ meter Units in Beidou : $2^{-6}$ meter
$\omega$	-1940320170	Integer ( Units : $2^{-31}$ $\pi$ )
$\Omega$	-21933	Integer ( Units : $2^{-43}$ $\pi$ /sec )
$T_{gd}$	-23	Integer Units in GPS : $2^{-31}$ sec Units in Beidou : 0.1 nanoseconds
SV HEALTH	0	Integer
Checksum	*1A	
Terminator	<CR> <LF>	