FURUNO

FURUNO Multi-GNSS Disciplined Oscillator

Models GF-8801, GF-8802, GF-8803, GF-8804, GF-8805

Protocol Specifications

(Document No. SE18-600-004-00)

FURUNO ELECTRIC CO., LTD.

www.furuno.com

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- GLONASS: Russia
- Galileo, SBAS (EGNOS): Europe
- QZSS, SBAS (MSAS): Japan
- SBAS (GAGAN): India

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This document describes the eSIP protocol specifications for the following products.
・GF-8801
・GF-8802
・GF-8803
・GF-8804
・GF-8805

Although this product is paying attention to compatibility with the past products, due to the correspondence to various additions of specifications, some actions may differ unavoidably. Regarding the specifications, the contents described in this document are set as true, and for items not described in this document, the actual operations of this product are set as true. For this product, if you need items compatible with past products, please consult us before mass-producing this product.

We pay through attention about the software of this product. But, if perchance you found a bug or a trouble, please feel free to contact us directly. We will check it, and if it is a bug, we may send you a new version with a bug fix. If perchance we found a bug or a trouble, we may send you a new version after we contact you.

When we send you the new version software, we may ask you to update software. Therefore, we strongly recommended being able to access to serial port of this product from outside of your product to make software update easy. In addition, we also strongly recommend connecting between serial port of this product and network to remote access and update software.

In this product, FURUNO can ensure safe performance only the commands and the sentences which are written in this document or are written in the document for this product. Please do not use the commands of the others products, otherwise this product may have troubles and FURUNO may not support about the troubles.

FURUNO may inform some internal commands for verification etc. In this case, please use the commands only for operation test and please do not use them for technical operation.

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Revision History

Version	Changed contents	Date
0	Initial release.	2019.03.28

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1 Outline

This document describes the serial communications interface protocol for the FURUNO Multi-GNSS Disciplined Oscillator (GNSSDO) which is GF-8801, GF-8802, GF-8803, GF-8804 and GF-8805 [*1].

The software version covered by this document is 4850-577-000 (ENP708A) or later.

[*1]
This document shows these GNSSDO as GF-880X.

2 Terms

This chapter describes details of terms used in this document.
Since it contains a lot of important information on the behavior of this product, we strongly recommend you to read it carefully.

Table 2.1 Terms Related to Communication

Terms	Description
Protocol	It is a communication procedure for sending and receiving data using the communication port.
Command	In this document, the data sent to the product is called a command.
Sentence	In this document, the data received from the product is called a sentence.
Serial data	It is a generic name of the data itself to transmit and receive using the communication port. Although it may be described as output of serial data in this document, in that case it is synonymous with sentence.
eSIP	It is one of protocol format. It is the standard format output by our GNSS receiver. This document mainly describes details about the eSIP.
National Marine Electronics Association (NMEA)	In this document, ASCII and communication protocol of NMEA 0183 standard are called NMEA. The product outputs serial data conforming to NMEA0183 Ver. 4.10 established in June 2012.
ACK	It means acknowledgement. When a command is input to the product, if the command is accepted as being appropriate, the product returns ACK as a response sentence.
NACK	It means negative acknowledgement. When a command is input to the product, if the command is ignored as being inappropriate, the product returns NACK as a response sentence. If NACK is returned, please check whether the format of the transmitted command is appropriate and checksum is appropriate.

Table 2.2 Terms Related to Messages Broadcast by Satellites

<table>
<tr><th>Terms</th><th>Description</th></tr>
<tr><td>Ephemeris</td><td>It is one of information that the satellite is broadcasting. Mainly satellite time and detailed orbit information of its satellite are broadcasted. It is information necessary for positioning, and it is repeatedly broadcast in short cycles. In case of GPS satellites, the ephemeris is broadcasted every 30 seconds.

It is called HOT START especially in this product to start up with ephemeris information remaining in the receiver.

Although the expiration date of the ephemeris it possesses depends on the type of satellite, but it is 1 to 4 hours since the last ephemeris was received.</td></tr>
<tr><td>Almanac</td><td>It is one of information that the satellite is broadcasting. Mainly various correction information, UTC parameters and rough orbit information of all satellites are broadcasted. In case of GPS satellites, the almanac is broadcasted at a cycle of 900 seconds. Therefore, it may take up to 900 seconds from GPS synchronization to UTC synchronization after initial positioning.

It is called WARM START especially in this product to start with almanac information remaining in the receiver. If neither ephemeris nor almanac information remains in the receiver, it will start by COLD START.

There is no expiration date for the almanac it possesses.</td></tr>
<tr><td>Interface Control Document (ICD)</td><td>It is a document defining the content and structure broadcasted by each satellite as a specification by the relevant division of the country that operates the satellites. This product is designed based on those ICD. The ICD referred to by this product is as follows.
<table>
<tr><th>Satellite</th><th>ICD</th></tr>
<tr><td>GPS</td><td>IS-GPS-200
Revision H,IRN003
28 July 2016</td></tr>
<tr><td>GLONASS</td><td>Navigation radio signal In bands L1, L2
Version 5.1
2008</td></tr>
<tr><td>Galileo</td><td>EUROPEAN GNSS(GALILEO) OPEN SERVICE
SIGNAL-IN-SPACE
Issue 1 revision 3
December 2016</td></tr>
<tr><td>QZSS L1C/A</td><td>IS-QZSS-PNT-002
29 January 2018</td></tr>
<tr><td>QZSS L1S</td><td>IS-QZSS-L1S-002
13 April 2018</td></tr>
</table>
ICD does not claim permanent specification definition, but ICD of the satellite may be updated in the future depending on the type of satellite, and a part of the broadcast content may be changed. Please note that this product does not guarantee including the changed part of those updated ICD.</td></tr>
</table>

Table 2.3 Terms Related to Satellite and Satellite Signal

<table>
<tr><th>Terms</th><th>Description</th></tr>
<tr><td>GNSS (GNSS satellite)</td><td>GNSS stands for Global Navigation Satellite System. It may be described as a generic name of satellites such as GPS, GLONASS, Galileo, QZSS and SBAS.</td></tr>
<tr><td>SBAS (Differential correction)</td><td>SBAS is a satellite transmitting correction information useful for positioning calculations. This correction information is called differential information, and correcting the positioning calculation process using this information is called differential correction. This product supports differential correction and this is done by default.

It is possible to add SBAS itself as one satellite to the positioning calculation like GPS. However, experiments show that the positioning performance deteriorates when SBAS is added to the positioning calculation. Therefore, in this product, SBAS is set not to add to positioning calculation by default.

In our experiment, the order of contributing to performance improvement by using SBAS is as follows: Use differential positioning only > Use differential positioning + SBAS positioning > Do not use SBAS. In addition, since SBAS alone cannot align parameters necessary for initial positioning, SBAS standalone positioning setting is prohibited in this product.</td></tr>
<tr><td>SLAS correction information</td><td>It is correction information broadcasted from the QZSS L1S signal. It can be used when QZSS L1S signal is received.</td></tr>
<tr><td>Satellite number</td><td>It is the number assigned to the satellite. In this product, the satellite number is assigned as follows. These satellite numbers are mainly used for GSA and GSV. (Please refer to the hardware specifications for satellite numbers that can be actually received.)

<table>
<tr><th>Satellite</th><th>MIN</th><th>MAX</th><th>Notes</th></tr>
<tr><td>GPS</td><td>01</td><td>32</td><td>Same as PRN No</td></tr>
<tr><td>SBAS</td><td>33</td><td>51</td><td>Subtract 87 from PRN No</td></tr>
<tr><td>GLONASS</td><td>65</td><td>96</td><td>Same as PRN No</td></tr>
<tr><td>QZSS L1C/A</td><td>93</td><td>99</td><td>Subtract 100 from PRN No</td></tr>
<tr><td>QZSS L1S</td><td>83</td><td>89</td><td>Subtract 100 from PRN No</td></tr>
<tr><td>Galileo</td><td>01</td><td>36</td><td>Same as PRN No</td></tr>
</table>

When the satellite number is duplicated, the type of satellite can be distinguished by the GNSS system ID of GSA sentence or the talker ID of GSV sentence.</td></tr>
<tr><td>Jamming signal</td><td>It is a signal other than the satellite signal that is mixed in the frequency band of the satellite signal. Noises of other equipment may accidentally be mixed in, or intentional broadcasting by malicious persons may be mixed. If the jamming signal is received, it will be impossible to receive the frequency of the satellite signal, resulting in a poor positioning or undetectable state.</td></tr>
<tr><td>Anti-Jamming</td><td>Even if a jamming signal is mixed in, the receiver masks the signal as much as possible so that it can receive satellite signals normally. In this product, the Anti-Jamming function is operating by default, and it is possible to mask up to eight jamming signals.</td></tr>
<tr><td>Spoofing signal</td><td>It is a signal generated by a malicious person mimicking the broadcast contents of GNSS satellite using what is similar to simulator. Reception of this signal may affect the position and time. This product has a function to detect and eliminate spoofing signal. For details, please refer to TPS3 sentence.</td></tr>
</table>

Table 2.4 Terms Related to Time

Terms	Description
Leap second	It means one second that is inserted so that there is no gap in the difference between the rotation of the earth and the atomic clock that is the time reference. Normally, the leap second insertion is determined, announced, and broadcasted one to two months in advance. Insertion timing is January 1st or July 1st. The leap second has been inserted since 1972. However, considering that GPS and QZSS satellites are being operated starting from January 6, 1980, this product displays the leap second integrated value since January 6, 1980. This is consistent with the integrated value of leap second that the GPS, QZSS and Galileo satellite actually broadcast as a message. In this document, the integrated value of leap second may be referred to simply as leap second.
GPS time	It is time system broadcasted by GPS satellite. It is broadcasted as a continuous time that does not consider the leap second since the start of January 6, 1980. GPS satellites broadcast the week number (0 to 1023) and the week second (0 to 640799). The receiver converts to the current time by using them. In recent years the time difference between UTC time and GPS time is on the order of a few nanoseconds. However, there is no guarantee that this time difference will be kept for the future.
Week number rollover	The week number broadcasted by the GPS and QZSS satellite returns to 0 the next week of 1023. Therefore, if only these satellites are being received, it is known that there is a limit in the period during which the current time can be properly converted by a general GNSS receiver. In this document, the timing at which week number 1023 goes to 0 is called week number rollover. This product addresses to this week number rollover, and even if the broadcasted week number returns to 0 from 1023, the correct time can be displayed continuously. However, the time range that can be converted properly is still up to 1024 weeks. The range in which this product can display an appropriate time without backup is up to **23:59:59 on October 10, 2037**. If the receiver starts and restarts without backup after then, the time before 1024 weeks may be displayed. In this case, you can display the correct time by setting the correct time with the command or by positioning with the GLONASS satellite or Galileo satellite. If the power is on continuously, the time update can be continued appropriately even if it exceeds the above date.
GLONASS time	It is time system broadcasted by GLONASS satellite. It is a time that always considered leap second, starting from January 1, 1996. Time parameters that can be uniquely converted until 2100 or later are broadcasted. By receiving the GLONASS satellite, it is possible to display the correct time without being conscious of week number rollover that was concerned with receiving only GPS and QZSS satellites. Also, because it includes leap seconds in the time system, by receiving the GLONASS satellite and other satellites at the same time, it is possible to immediately acquire the correct leap second without waiting for the reception of the UTC parameter.

Table 2.5 Terms Related to Time

Terms	Description
Galileo time	It is time system broadcasted by Galileo satellite. It starts from August 22, 1999. However, practically it is broadcasted as a continuous time that does not consider the leap second since January 6, 1980, so that each parameter matches the GPS and QZSS satellite. Time parameters that can be uniquely converted until February 19, 2078 are broadcasted. By receiving the Galileo satellite, it is possible to display the correct time until 2078 without being conscious of the week number rollover that was concerned with receiving only GPS and QZSS satellites.
UTC time	UTC stands for Coordinated Universal Time. It is always considered leap second and matches the time we usually use by considering the time difference of each country. UTC is set for each country by the atomic clock owned by each country, and it is slightly different on the nanosecond scale although it cannot see any difference in any country over integer seconds. For example, in case of the United States, the United States Naval Observatory prescribes the UTC time as UTC (USNO). Similarly, in case of Russia it is called UTC (SU). This product can select which UTC to synchronize by command. The default is synchronized to UTC (USNO).
UTC parameter	It is a parameter broadcasted by each satellite to convert the time system of each satellite to UTC time. Mainly it includes integrated value of leap second, leap second insertion timing and correction information of nanosecond scale. However, since the GLONASS satellite contains leap seconds in the time system, the accumulated value of the leap second is not broadcasted. The UTC parameters are generally included in navigation messages called almanac, and there is a gap in the broadcasting interval.
Default leap second	This value is set to temporarily bring the sentence output time closer to the UTC time when the leap second information has not been acquired from the GPS satellite. This value can also be stored in FLASH ROM. By setting this properly in advance, it is possible to get the time information equivalent to the UTC time earlier from the sentence before acquiring the UTC parameter. Note that this setting only adjusts the display time before acquiring the correct leap second, and even if this value is incorrect it does not affect positioning calculation. Also, if leap second information can be obtained from the satellite at least once, it will be used with priority thereafter.
Local Zone Time (LZT)	It means time offset value from UTC time. By setting the LZT with the TIMEZONE command, you can obtain the time information with LZT added from the ZDA sentence.
Estimated accuracy	It shows how far the receiver's time may deviate from the synchronization target. The standard deviation (1 sigma) of the pseudorange of all satellites displayed in the GSA sentence is displayed in nanoseconds. In an open sky environment, this value will be lower. In poor environments such as indoors, this value will increase due to the influence of multipath satellites. Therefore, it can be used to judge whether the reception environment is good or bad. For explanation of pseudorange and multipath, please refer to the following.

Table 2.6 Terms Related to PPS and Frequency

Terms	Description
Pulse Per Second (PPS)	Outputting one pulse per second is called 1PPS.
VCLK frequency	It is the frequency output by the voltage controlled oscillator installed in this product. While receiving GNSS, a stable clock is provided by adjusting the frequency based on the time acquired from the GNSS satellite. In some environments that GNSS cannot receive, some products guarantee clock stability in free running state. Please refer to the item of holdover for details.
GCLK frequency	It is a mechanism to generate arbitrary frequency by using the system clock of this product and built-in adder. By receiving the GNSS satellite, it is possible to output arbitrary frequency accurately. Since the frequency is generated using the adder, it is necessary to check in advance whether jitter and spurious included in the GCLK frequency are within the allowable range of the application to be used.
VCLK PPS	It is PPS that the clock edge of the VCLK frequency and the timing of the pulse edge of PPS are synchronized. This product outputs this PPS. Note that the pulse edge of VCLK PPS is not synchronized with the GCLK frequency.
Holdover	It is a function to maintain the performance of 1PPS and frequency during satellite reception as much as possible while GNSS satellites cannot be received. Holdover performance varies depending on the product. For detailed specifications, please refer to the hardware specifications of the products.
Learning period (time)	For holdover, it is necessary to continuously receive GNSS satellites for a predetermined period. This product estimates the frequency aging deterioration characteristics and frequency temperature characteristics of the oscillator during this period, and then automatically learns the optimum control at the time of the GNSS satellite interruption. In this document, the above period is called the learning period or learning time. In addition, it may be said that learning has been completed when the learning period is satisfied.
Cable delay	When connecting the antenna and this product with a cable, a delay occurs in PPS according to the cable length. In this document, this delay is called cable delay. This delay can be corrected with the PPS command.
RTC synchronization	RTC stands for Real Time Clock. It is sometimes described as RTC synchronization especially in this document to indicate that the PPS and frequency are in free-run state before receiving the satellite and confirming the time, or when GNSS interruption continues for more than a certain period of time.
GPS synchronization	It is a state outputting the time, PPS and frequency in synchronization with the GPS time. This product transits to this state when GPS synchronization is set or UTC parameter is not acquired.
UTC synchronization	It is a state outputting the time, PPS and frequency in synchronization with the UTC time. Which UTC to synchronize can be selected by a command.
EPPS synchronization	It is a state that the oscillator is synchronized with the signal input from the EPPS pin without using GNSS. It is paired with GNSS synchronization.
GNSS synchronization	It is a state to receive GNSS and synchronize the oscillator to the GNSS time. It is paired with EPPS synchronization. The default is GNSS synchronization. In case of GNSS synchronization, the synchronization target is further divided into GPS sync and UTC sync.

Table 2.7 Terms Related to PPS and Frequency

Terms	Description
Frequency mode (Frequency control mode)	It mainly shows the stable state of the VCLK frequency. There are six kinds of frequency modes: WARMUP, PULLIN, COARSE LOCK, FINE LOCK, HOLDOVER, and OUT OF HOLDOVER.
WARMUP	It is a state waiting for stabilization of the internal clock after turning on the power supply.
PULLIN	It is a state that GNSS is received and in the middle of synchronizing the VCLK frequency and PPS with the synchronization target based on the time obtained from GNSS.
COARSE LOCK	It is a state that GNSS is received and the VCLK frequency and PPS are synchronized with the synchronization target based on the time obtained from GNSS. However, the synchronization accuracy is coarse than FINE LOCK.
FINE LOCK	It is a state that GNSS is received and the VCLK frequency and PPS are synchronized with the synchronization target precisely based on the time obtained from GNSS. While in this state, this product learns for holdover.
HOLDOVER	When GNSS cannot be received, if the learning for holdover is completed beforehand, the frequency mode transits to this mode. The frequency of the oscillator is automatically controlled in consideration of the frequency aging deterioration characteristics and the frequency temperature characteristics. A better frequency and PPS than the free-run state are provided. For product specifications in this state, please refer to the corresponding hardware specifications.
OUT OF HOLDOVER	It is a state that holdover has ended or GNSS cannot be received when the learning for holdover is not satisfied. In this mode, the output frequency and 1PPS of this product are out of specification.

Table 2.8 Terms Related to Storage Area

Terms	Description
Battery Backup Random Access Memory (BBRAM)	It is a storage area that can be used as a backup area only when backup current is applied to this product. Ephemeris data, almanac data, command setting values and so on are sequentially stored. The storage area is read at startup or at restart. You can erase the stored information by interrupting the application of backup current or sending a prescribed reset command to this product.
FLASH ROM (FLASH)	It is a storage area using Flash ROM. By sending FLASHBACKUP command to this product, some settings can be saved at that timing. The storage area is read at startup or at restart. Once backed up to FLASH, it can be erased only when software update or FLASHBACKUP command is sent again. When settings related to the same item are stored in both BBRAM and FLASH, BBRAM setting takes precedence. At this time, if the data on the BBRAM side becomes invalid due to stoppage of backup power supply, FLASH data will be applied at the next start or restart.

Table 2.9 Terms Related to Positioning Processing

Terms	Description
Time Receiver Autonomous Integrity Monitoring (T-RAIM)	It is a mechanism to identify and eliminate satellites that may have a bad influence on the positioning calculation by combining and principle of majority when the number of satellites in use is larger than the minimum number of satellites required for positioning. With this function, the results of the positioning calculation are further improved. The maximum number of satellites eliminated by this function is 3.
Position mode	Generally, the GNSS receiver calculates parameters such as latitude, longitude, height, speed, direction and time by receiving four or more satellites. On the other hand, if it is known in advance to use the receiver at a fixed position, by preparing the latitude, longitude and height in advance, the time can be calculated with only one or more satellite reception, precise 1PPS and frequency can be maintained. There are four kinds of position mode: NAV mode, TO mode, SS mode and CSS mode.
Fixed position	The position of the fixed point to be set when using the TO mode may be described like this in this document.
Estimated position (Position estimation)	In the process of calculating the fixed position, the position that the position accuracy is not sufficiently converged yet may be described as the estimated position in this document. In addition, the process of calculating the estimated position may be described to as position estimation.
NAV mode (Navigation)	Latitude, longitude, height, speed, direction and time are calculated every second. Since position, speed and direction are updated every second, it is suitable for mobile use. In order to perform positioning in this mode, it is required to receive four or more satellites except SBAS.
TO mode (Time Only)	By using the fixed position, only time is calculated every second. Compared to NAV mode, it is excellent in time stability and it is suitable for use at fixed points. In order to perform positioning in this mode, it is required to receive one or more satellites except SBAS.
SS mode (Self Survey)	Latitude, longitude, height and time are calculated every second. This mode is suitable when you want to use the TO mode but you do not know the position of the fixed point. This mode calculates the position of the fixed point with high accuracy based on the position information obtained during a fixed period (default 24 hours), and after calculating it transits to the TO mode automatically. In order to calculate the fixed position in this mode, it is required to receive four or more satellites except SBAS. However, even if it is less than four satellites, if there is more than one satellite, processing equivalent to the TO mode is performed using the information of the fixed position calculated so far, the time is appropriately updated, precise 1PPS and frequency can be maintained.
CSS mode (Continuous Self Survey)	Although processing similar to the SS mode is performed, while the SS mode discards the calculation process of the fixed position when the power is off, the CSS mode backs up the calculation process to the BBRAM. Therefore, the calculation of the fixed position is continued using the calculation process before turning off the power even at the next startup.

Table 2.10 Terms Related to Positioning Processing

Terms	Description
Positioning calculation	It means that the GNSS receiver calculates various kinds of information such as satellite and receiver position, speed, time and receiver azimuth based on information from the satellites.
Pseudorange	It is one of the information used by the GNSS receiver at positioning calculation. It is the result of calculating the distance between the satellite and the receiver.
Doppler frequency	It is one of the information used by the GNSS receiver at positioning calculation. It is the result of calculating the frequency of the signal received from the satellite.
Line Of Sight (LOS)	It means that a signal from a satellite is coming directly to the antenna connected to this product. It is synonymous with the state where there is no shielding between the satellite and the antenna, and the satellite in such state is called LOS satellite especially in this document. If many LOS satellites can be received, not only stable signal level can be expected but also position accuracy and time accuracy can be obtained satisfactorily.
Non Line Of Sight (NLOS)	In contrast to LOS satellites, it means that there is some sort of obstruction between a satellite and the antenna. Although satellites whose signals are completely discontinued and determined as satellite discontinuities are also strictly included in NLOS satellites, in this document they are simply described as satellite interruption and shall not be described as NLOS satellites. In this document, we define the satellite as the NLOS satellite, which cannot receive the direct signal from the satellite but only weak signals that arrive bypassing by reflecting to the surrounding building. Signals that are reflected to surrounding buildings and are received bypassing are particularly called multipath. It is known that using this multipath signal tends to degrade the positioning accuracy because errors are generated in the calculation of pseudorange and Doppler frequency. Determining appropriately what satellite is the NLOS satellite and appropriately masking them and performing positioning with only the LOS satellite leads to an improvement in positioning accuracy.

3 Communication Specifications

Signal Lines used:	TXD, RXD
Flow Control:	None
System:	Full Duplex Asynchronous
Speed:	38400 bps [*1]
Start Bit:	1 bit
Data Length:	8 bits
Stop Bit:	1 bit
Parity Bit:	None
Data Output Interval:	1 second
Character Codes used:	NMEA-0183 Ver.4.10 data based ASCII code [*2]

Protocol:
Input data
NMEA Proprietary sentence
Output data
NMEA Standard sentence
NMEA Proprietary sentence

Notes:
[*1] Baud rate
It can be changed by a command. Please see UART1 command page for details. For the relationship between UART baud rate and error, please refer to the hardware specifications.

[*2] NMEA format
“NMEA 0183 STANDARD FOR INTERFACING MARINE ELECTRONIC DEVICES Version 4.10” (NATIONAL MARINE ELECTRONICS ASSOCIATION, June, 2012)

4 Serial Data Output Timing

4.1 Output Timing of 1PPS and Serial Data

The output timing of sentence (serial data) is synchronized with 1PPS output from PPS port when the frequency mode is COARSE LOCK, FINE LOCK and HOLDOVER. The sentence output begins in the range from 25 ms to 75 ms after the rising of 1PPS.

The time of the sentence indicates the time of the next 1PPS output timing. However, information and status related to positioning other than time information are generated based on the positioning results one second before.

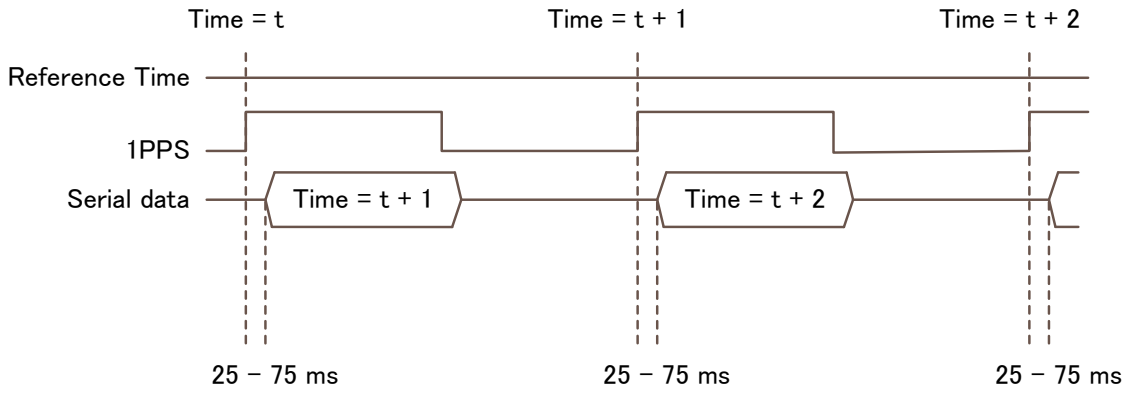


Figure 4.1 Relation between 1PPS, Serial Data and Output Time

4.2 Notes on Sentence Output

This product limits the amount of sentences that can be outputted per second in order to maintain the output relation between 1PPS and sentence. Sentence output per second is set to 90% of the number of bytes that can be output at the current baud rate. Specifically, it is defined by the following calculation formula.

Maximum amount that can be output per second [Byte] = Current baud rate [bps] / 10 [Bit] *0.9

Therefore, when the baud rate is 38400 bps, it is possible to output up to 3456 bytes, but if you set it beyond that, the sentence after the line considered to exceed it will be discarded without being output. When outputting a large number of sentences, it is recommended to change to a higher baud rate by UART1 command.

5 NMEA Sentence Format

5.1 Standard Sentence

Format:

$	<address field>	,	<data field>	···	*<checksum field>	<CR>	<LF>

5 bytes

Field	Description
$	Start-of Sentence marker
<address field>	5-byte fixed length. First 2 bytes represent a talker ID, and the remaining 3 bytes represent the sentence data type. The relevant talker IDs are GP for GPS, GN for GNSS, GL for GLONASS and GA for Galileo. In this document, the talker ID is expressed as "XX" indicating a wild card.
<data field>	Variable or fixed-length fields preceded by delimiter “,” (comma). Comma(s) are required even when valid field data is not available i.e. null fields. Ex. “,,,,,” In a numeric field with fixed field length, fill unused leading digits with zeroes.
*<checksum field>	8 bits data between “$” and “*” (excluding “$” and “*”) are XORed, and the resultant value is converted to 2 bytes of hexadecimal letters. Note that two hexadecimal letters must be preceded by “*”, and delimiter “,” is not required before *<checksum>. All output sentences have checksum. For input sentences, the resultant value is checked and if it is not correct, the sentence is treated invalid.
<CR><LF>	End-of-Sentence marker

5.2 Proprietary Sentence

Format:

$	P	<maker ID>	<sentence type>	,	<data field>	···	*<checksum field>	<CR>	<LF>
		3 bytes	3 bytes						

Field	Description
$	Start-of Sentence marker
P	Proprietary sentence identifier
<maker ID>	3-byte fixed length. GF-880X's maker ID is "ERD" meaning *eRide*.
<sentence type>	Indicates the type of sentence.
<data field>	Variable or fixed-length fields preceded by delimiter "," (comma). (Layout is maker-definable.) The fields inside [ ] are optional fields.
*<checksum field>	8 bits data between "$" and "*" (excluding "$" and "*") are XORed, and the resultant value is converted to 2 bytes of hexadecimal letters. Note that two hexadecimal letters must be preceded by "*", and delimiter "," is not required before *<checksum>. All output sentences have checksum. For input sentences, the resultant value is checked and if it is not correct, the sentence is treated invalid.
<CR><LF>	End-of-Sentence marker

5.3 Talker ID

The talker ID displayed in the standard NMEA format changes as shown in Table 5.1, depending on the type of satellite being received and the talker ID field of the GNSS command.

In this chapter, in the following chapters, the talker ID part is expressed as "XX" indicating a wild card.

Table 5.1 Talker ID Displayed in Standard NMEA Format

<table>
<tr><th rowspan="2">Standard NMEA</th><th colspan="3">Talker ID setting</th></tr>
<tr><th>AUTO</th><th>GN</th><th>LEGACYGP</th></tr>
<tr><td>RMC</td><td rowspan="7">GN/GP/GL/GA [*1]</td><td rowspan="7">GN</td><td rowspan="8">GP [*2]</td></tr>
<tr><td>GNS</td></tr>
<tr><td>GGA</td></tr>
<tr><td>GLL</td></tr>
<tr><td>VTG</td></tr>
<tr><td>ZDA</td></tr>
<tr><td>GSA</td><td>GN/GP/GL/GA [*1]</td></tr>
<tr><td>GSV</td><td>GP/GL/GA [*3]</td><td>GP/GL/GA [*4]</td></tr>
</table>

[*1]
GN/GP/GL/GA switches according to the type of satellite used in positioning as follows.
GN: Multi satellite system is available [*5], or no position fix.
GP: Only GPS/QZSS/SBAS is used in position fix.
GL: Only GLONASS is used in position fix.
GA: Only Galileo is used in position fix.

[*2]
Even if it is set to use GLONASS or Galileo, and even if it is actually received, GSA and GSV will be displayed only in GP, and GSA / GSV information of GLONASS and Galileo will not be displayed. However, these satellites are not actually displayed, they are actually counted by the number of positioning satellites of GNS and GGA, and used in positioning calculations, various status calculations and displays.

[*3]
GP/GL/GA switches according to the type of satellite used in positioning as follows.
- GP is displayed while no positioning fix, receiving GPS/QZSS/SBAS, or receiving multi satellite system [*5].
- GL is displayed while no positioning fix, receiving GLONASS, or receiving multi satellite system [*5].
- GA is displayed while no positioning fix, receiving Galileo, or receiving multi satellite system [*5].

[*4]
The GPGSV, GLGSV, and GAGSV sentences are always output to maintain the display form of the sentence even if it is no position fix or it cannot receive the satellite corresponding to the talker ID.

[*5]
The multi satellite system means a state that two or more groups are received from the combination of groups "GPS/QZSS/SBAS", "GLONASS", and "Galileo". Therefore, for example, even if GPS and QZSS are received, only GPGSV will be displayed as it is only receiving "GPS/QZSS/SBAS" group. Meanwhile, for example, when GPS and GLONASS are received, GAGSV is also displayed even if Galileo is not received because it satisfies the condition that it is receiving multiple kinds of satellites.

5.4 Output Priority of Sentence and Default Output Sentence

Sentences are output in the order shown in Table 5.2. Table 5.2 also shows the sentences that are output by default. They are output every second. Sentence output switching is possible with the CROUT command and the NMEAOUT command.

Table 5.2 Output Priority of Sentence and Default Output Sentence

Output priority	Sentence	Default output	Setting command
High	RMC	●	NMEAOUT
	GNS	●	
	GGA	-	
	GLL	-	
	VTG	-	
	GSA	●	
	ZDA	●	
	GSV	●	
	QSM	-	
Low	CRG	-	CROUT
	CRJ	-	
	CRP	-	
	CRQ	-	
	CRW(TPS1)	●	
	CRX(TPS2)	●	
	CRY(TPS3)	●	
	CRZ(TPS4)	●	
	QUERY	-	Each command

6 Output Sentences

This chapter describes details of sentences output from GF-880X. There are unsupported fields in the output sentences. This document shows these fields as “NULL”. These fields are null fields.

6.1 RMC – Recommended Minimum Navigation Information

Format:

$XXRMC	,	hhmmss.sss	,	a	,	ddmm.mmmm	,	a	,	dddmm.mmmm	,	a	,	x.xx	,
		1		2		3		4		5		6		7	

x.xx	,	ddmmyy	,		,		,	a	,	V	*hh	<CR>	<LF>
8		9		10		11		12		13			

Field	Data	Range	Default	Description
1	Time	000000.000 to 235960.000	-	It is output at RTC, GPS, UTC time according to positioning status, synchronization setting status, parameter acquisition status and so on. 60 seconds is displayed only when the leap is inserted.
2	Status	A, V	V	A: Data valid V: Data invalid
3	Latitude	0000.0000 to 9000.0000	ALL 0	dd: [degree], mm.mmmm: [minute]
4	Latitude direction	N, S	N	"N" (North) or "S" (South)
5	Longitude	00000.0000 to 18000.0000	ALL 0	ddd: [degree], mm.mmmm: [minute]
6	Longitude direction	E, W	E	"E" (East) or "W" (West)
7	Speed	-	0.00	[knot]
8	True course	0.00 to 359.99	0.00	[degree] Variable length
9	Date	010100 to 311299	-	dd: [day], mm: [month], yy: [year] (last two digits)
10	Magnetic declination	NULL	NULL	Always NULL
11	Magnetic direction	NULL	NULL	Always NULL
12	Positioning mode	A, D, N	N	A: GNSS fix D: Differential GNSS fix N: No position fix
13	Navigation status	V	V	Always “V”

Example:

$GNRMC,012344.000,A,3442.8266,N,13520.1233,E,0.00,0.00,191132,,,D,V*0B

Time: 01:23:44.000 Data valid 34 deg 42.8266 min N 135 deg 20.1233 min E Speed: 0.0 knots
True Course: 0.0 degrees Date: 19th November, 2032 Differential GNSS fix

6.2 GNS – GNSS Fix Data

Format:

$XXGNS	,	hhmmss.sss	,	ddmm.mmmm	,	a	,	dddmm.mmmm	,	a	,	ccc	,	xx	,
		1		2		3		4		5		6		7	

x.x	,	x.x	,	x.x	,		,		,	V	*hh	<CR>	<LF>
8		9		10		11		12		13			

Field	Data	Range	Default	Description
1	Time	000000.000 to 235960.000	-	It is output at RTC, GPS, UTC time according to positioning status, synchronization setting status, parameter acquisition status and so on. 60 seconds is displayed only when the leap is inserted.
2	Latitude	0000.0000 to 9000.0000	ALL 0	Latitude dd: [degree], mm.mmmm: [minute]
3	Latitude direction	N, S	N	"N" (North) or "S" (South)
4	Longitude	00000.0000 to 18000.0000	ALL 0	Longitude ddd: [degree], mm.mmmm: [minute]
5	Longitude direction	E, W	E	"E" (East) or "W" (West)
6	Positioning status	NNN to DDD (A,D,N)	NNN	Positioning status for each satellite system (GPS, GLONASS, Galileo) A: GNSS fix D: Differential GNSS fix N: No position fix
7	Number of satellites in use	00 to 32	00	Number of satellites in use
8	HDOP	0.0 to 50.0 or NULL	NULL	Horizontal dilution of precision (HDOP) Variable length A null field is output while positioning is interrupted.
9	Sea-level altitude	-	-18.0	[meter] Variable length
10	Geoidal height	-	18.0	[meter] Variable length
11	DGPS time	NULL	NULL	Always NULL
12	DGPS number	NULL	NULL	Always NULL
13	Navigation status	V	V	Always “V”

Example:

$GNGNS,004457.000,3442.8266,N,13520.1235,E,DDN,22,0.5,40.6,36.7,,,V*60

Time: 00:44:57.000 34 deg 42.8266 min N 135 deg 20.1235 min E

Status: [GPS: Differential GNSS fix, GLONASS: Differential GNSS fix, Galileo: No position fix]

Number of satellites: 22 satellites HDOP: 0.5 Altitude: 40.6 meters high

Geoidal height: 36.7 meters high Navigation status indicator: Not valid

6.3 GGA – Global Positioning System Fix Data

Format:

$XXGGA	,	hhmmss.sss	,	ddmm.mmmm	,	a	,	dddmm.mmmm	,	a	,	x	,	xx	,
		1		2		3		4		5		6		7	

x.x	,	x.x	,	M	,	x.x	,	M	,		,		*hh	<CR>	<LF>
8		9		10		11		12		13		14			

Field	Data	Range	Default	Description
1	Time	000000.000 to 235960.000	-	It is output at RTC, GPS, UTC time according to positioning status, synchronization setting status, parameter acquisition status and so on. 60 seconds is displayed only when the leap is inserted.
2	Latitude	0000.0000 to 9000.0000	ALL 0	Latitude dd: [degree], mm.mmmm: [minute]
3	Latitude direction	N, S	N	"N" (North) or "S" (South)
4	Longitude	00000.0000 to 18000.0000	ALL 0	Longitude ddd: [degree], mm.mmmm: [minute]
5	Longitude direction	E, W	E	"E" (East) or "W" (West)
6	Positioning status	0 to 2	0	1: GNSS fix 2: Differential GNSS fix 0: No position fix
7	Number of satellites in use	00 to 12	00	Number of satellites in use [*1]
8	HDOP	0.0 to 50.0, or NULL	NULL	Horizontal dilution of precision (HDOP) Variable length A null field is output while positioning is interrupted.
9	Sea-level altitude	-	-18.0	[meter] Variable length
10	Unit	M	M	Units of altitude, meters
11	Geoidal height	-	18.0	[meter] Variable length
12	M	M	M	Units of Geoidal height, meters
13	DGPS time	NULL	NULL	Always NULL
14	DGPS number	NULL	NULL	Always NULL

Example:
$GPGGA,025411.516,3442.8146,N,13520.1090,E,1,11,0.8,24.0,M,36.7,M,,*66
Time: 02:54:11.516 34 deg 42.8146 min N 135 deg 20.1090 min E Status: GNSS fix
Number of satellites: 11 satellites HDOP: 0.8 Altitude: 24.0 meters high
Geoidal height: 36.7 meters high

[*1]
GPS, SBAS, QZSS only. GLONASS and Galileo are not counted. The upper limit is 12.

6.4 GLL – Geographic Position - Latitude/Longitude

Format:

$XXGLL	,	ddmm.mmmm	,	a	,	dddmm.mmmm	,	a	,	hhmmss.sss	,	a	,	a	*hh	<CR>	<LF>
		1		2		3		4		5		6		7			

Field	Data	Range	Default	Description
1	Latitude	0000.0000 to 9000.0000	ALL 0	Latitude dd: [degree], mm.mmmm: [minute]
2	Latitude direction	N, S	N	"N" (North) or "S" (South)
3	Longitude	00000.0000 to 18000.0000	ALL 0	Longitude ddd: [degree], mm.mmmm: [minute]
4	Longitude direction	E, W	E	"E" (East) or "W" (West)
5	Time	000000.000 to 235960.000	-	It is output at RTC, GPS, UTC time according to positioning status, synchronization setting status, parameter acquisition status and so on. 60 seconds is displayed only when the leap is inserted.
6	Status	A, V	V	A: Data valid V: Data invalid
7	Positioning mode	A, D, N	N	A: GNSS fix D: Differential GNSS fix N: No position fix

Example:
$GPGLL,3442.8146,N,13520.1090,E,025411.516,A,A*5F
34 deg 42.8146 min N 135 deg 20.1090 min E Time: 02:54:11.516 Status: Data valid
Mode: GNSS fix

6.5 VTG – Course Over Ground and Ground Speed

Format:

$XXVTG	,	x.x	,	T	,		,	M	,	x.xx	,	N	,	x.xx	,	K	,	a	*hh	<CR>	<LF>
		1		2		3		4		5		6		7		8		9			

Field	Data	Range	Default	Description
1	True course	0.00 to 359.99	0.00	[degree] Variable length
2	Unit	T	T	Unit of true course, "T" (True)
3	Magnetic direction	NULL	NULL	Always NULL
4	Unit	M	M	"M" (Magnetic direction)
5	Speed	-	0.00	Speed [knot]
6	Unit	N	N	"N" (knots)
7	Speed	-	0.00	Speed [km/h]
8	Unit	K	K	"K" (Kilo meters/ Hour)
9	Positioning mode	A, D, N	N	A: GNSS fix D: Differential GNSS fix N: No position fix

Example:
$GNVTG,0.00,T,,M,0.00,N,0.00,K,D*26
True Course: 0.00 degree Speed: 0.00 knot, 0.00 km/h Mode: Differential GNSS fix

6.6 GSA – GNSS DOP and Active Satellites

Format:

$XXGSA	,	A	,	a	,	xx	,	···	,	xx	,	x.x	,	x.x	,	x.x	,	x	*hh	<CR>	<LF>
		1		2		3		4-13		14		15		16		17		18			

Field	Data	Range	Default	Description
1	Operational mode	A	A	2D/3D auto-switching mode
2	Positioning mode	1 ~ 3	1	1: No fix 2: 2D fix 3: 3D fix
3-14	Satellite numbers used in positioning	01 to 99	NULL	If it is less than 12 satellites, it is filled with NULL. [*1]
15	PDOP	0.0 to 50.0, or NULL	NULL	Variable length A null field is output unless 3D-positioning is performed.
16	HDOP	0.0 to 50.0, or NULL	NULL	Variable length A null field is output while positioning is interrupted.
17	VDOP	0.0 to 50.0, or NULL	NULL	Variable length A null field is output unless 3D-positioning is performed.
18	GNSS System ID	1 to 3	-	It shows which satellite information this GSA sentence is displaying. 1: GPS (involve SBAS and QZSS) 2: GLONASS 3: Galileo

Example:
$GNGSA,A,3,09,15,26,05,24,21,08,02,29,28,18,10,0.8,0.5,0.5,1*33
$GNGSA,A,3,79,69,68,84,85,80,70,83,,,,,0.8,0.5,0.5,2*30
Position fix mode: 3D fix PDOP: 0.8 HDOP: 0.5 VDOP: 0.5
Satellite used [GPS]: 09, 15, 26, 05, 24, 21, 08, 02, 29, 28, 18, 10
Satellite used [GLONASS]: 79, 69, 68, 84, 85, 80, 70, 83

[*1] Satellite numbers used in positioning
Please use the GNSS system ID in the GSA sentence to identify which satellite the satellite number to be used belongs to. For example, if 01 is displayed in the satellite number of the GSA sentence and the GNSS system ID is 1, it means that it is No.1 satellite of GPS. If the GNSS system ID is 3, it means that it is No.1 satellite of Galileo.

For the convenience of outputting the satellite number to be used in correspondence with the GNSS system ID, the GSA may display up to three lines; one line for GPS/QZSS/SBAS, one line for GLONASS, and one line for Galileo. When multiple lines are displayed, it is displayed in the order of GPS/QZSS/SBAS > GLONASS > Galileo. A GSA with GNSS system ID of 1 takes precedence over GPS > QZSS > SBAS.

Since this GSA sentence is compliant with NMEA ver. 4.10 established in June 2012, up to 12 satellite numbers can be displayed on one line of GSA. Therefore, even if more than 13 satellites are used, only 12 satellites will be displayed. However, if you wish to cancel this restriction and display more satellite numbers to be used, you can display it by entering the following EXTENDGSA command.

$PERDAPI,EXTENDGSA,num*hh<CR><LF>
num: Number of satellites to be display (Range: 12 to 16, Default: 12)

For example, if the number of satellites to be displayed is set to 16 by using this command, the field of satellite number will be extended from “3 to 14” to “3 to 18”. The fields of PDOP, HDOP, VDOP are shifted behind.

For the satellite number, please also refer to corresponding items in Chapter 2.

6.7 ZDA – Time & Date

Format:

$XXZDA	,	hhmmss.sss	,	xx	,	xx	,	xxxx	,	xxx	,	xx	*hh	<CR>	<LF>
		1		2		3		4		5		6			

Field	Data	Range	Default	Description
1	Time	000000.000 to 235960.000	-	It is output at RTC, GPS, UTC time according to positioning status, synchronization setting status, parameter acquisition status and so on. 60 seconds is displayed only when the leap is inserted. When LZT is set, time will be displayed after adding it.
2	Day	01 to 31	-	When LZT is set, it will be displayed after adding LZT.
3	Month	01 to 12	-	When LZT is set, it will be displayed after adding LZT.
4	Year	1999 to 2099	-	When LZT is set, it will be displayed after adding LZT.
5	Local zone time [hour]	-23 to +23	+00	The LZT value set by the TIMEZONE command is displayed. The unit is hour.
6	Local zone time [minute]	00 to 59	00	The LZT value set by the TIMEZONE command is displayed. The unit is minute.

Example:
$GPZDA,014811.000,13,09,2021,+09,00*73
Time: 01:48:11 13th September, 2021
Local zone time: +9 hours

6.8 GSV – GNSS Satellites in View

Format:

$XXGSV	,	x	,	x	,	xx	,	xx	,	xx	,	xxx	,	xx	,	xx	,	xx	,	xxx	,	xx	,
		1		2		3		4		5		6		7		8		9		10		11	

xx	,	xx	,	xxx	,	xx	,	xx	,	xx	,	xxx	,	xx	,	h	*hh	<CR>	<LF>
12		13		14		15		16		17		18		19		20			

Field	Data	Range	Default	Description
1	Total number of messages	1 to 5	1	Total number of messages per talker ID
2	Message number	1 to 5	1	Message number per talker ID
3	Number of satellites in line-of-sight	00 to 16	0	Number of satellites in line-of-sight per talker ID
4	Satellite number	01 to 99	NULL	1st satellite number
5	Elevation	00 to 90	NULL	1st satellite elevation angle [degree]
6	Azimuth	000 to 359	NULL	1st satellite azimuth angle [degree]
7	C/N0	00 to 69	NULL	1st satellite C/N0 [dB-Hz]
8	Satellite number	01 to 99	NULL	2nd satellite details Output in the same format as the first one.
9	Elevation	00 to 90	NULL	
10	Azimuth	000 to 359	NULL	
11	C/N0	00 to 69	NULL	
12	Satellite number	01 to 99	NULL	3rd satellite details Output in the same format as the first one.
13	Elevation	00 to 90	NULL	
14	Azimuth	000 to 359	NULL	
15	C/N0	00 to 69	NULL	
16	Satellite number	01 to 99	NULL	4th satellite details Output in the same format as the first one.
17	Elevation	00 to 90	NULL	
18	Azimuth	000 to 359	NULL	
19	C/N0	00 to 69	NULL	
20	Signal ID	1 or 7	-	1: GPGSV or GLGSV 7: GAGSV

Example:

$GPGSV,4,1,14,15,67,319,52,09,63,068,53,26,45,039,50,05,44,104,49,1*6E
$GPGSV,4,2,14,24,42,196,47,21,34,302,46,18,12,305,43,28,11,067,41,1*68
$GPGSV,4,3,14,08,07,035,38,29,04,237,39,02,02,161,40,50,47,163,44,1*67
$GPGSV,4,4,14,42,48,171,44,93,65,191,48,,,,,,,,1*60
$GLGSV,3,1,09,79,66,099,50,69,55,019,53,80,33,176,46,68,28,088,45,1*76
$GLGSV,3,2,09,70,25,315,46,78,24,031,42,85,18,293,44,84,16,246,41,1*7A
$GLGSV,3,3,09,86,02,338,,,,,,,,,,,,1*45

Not fixed

[Note]

The GSV sentence outputs up to four satellite information per line. More than four satellite information is output to the second and subsequent messages. Conversely, if less than a multiple of 4 or there are items that are not fixed in the satellite information, the item is NULL.

The satellite information of GPS/QZSS/SBAS is GPGSV, the satellite information of GLONASS is GLGSV, and the satellite information of Galileo is output with GAGSV. The output order is GPGSV > GLGSV > GAGSV. However, there are GSVs that are hidden depending on GNSS command setting and reception status. For details, see about talker ID in Section 5.3.

In the GSV of the same talker ID, after satellite position calculation, in principle, satellites are displayed in order of elevation angle. However, in the case of GPGSV, priority is given to GPS, QZSS and SBAS. In other words,

the display order is as follows: GPS high elevation angle > GPS low elevation angle > QZSS high elevation angle > QZSS low elevation angle > SBAS high elevation angle > SBAS low elevation angle. However, depending on the relation of search, and before satellite position calculation, that is not the limit.

When both QZSS L1C/A and QZSS L1S are used, the output order is QZSS L1S > QZSS L1C/A.

In case of setting to receive SBAS, the satellite number of SBAS may change gradually until SBAS first fix. This shows the process of searching SBAS and will be resolved after receiving SBAS. Also, until the SBAS position is calculated, 0 may be output temporarily in the elevation angle and azimuth fields of the SBAS, but this will also be resolved after receiving the SBAS.

For the satellite number, please also refer to corresponding items in Chapter 2.

6.9 QSM – Satellite Report for Disaster and Crisis Management (DC Report) Message

QSM sentence is not a protocol of NMEA 4.1 support, but it is the output format recommended by NEC operating and managing QZSS satellite to output DC report message. The output of DC report is also supported by CRG sentence.

Format:

$QZQSM	,	Satellite ID	,	DC Report MSG	*hh	<CR>	<LF>
		1		2			

Field	Data	Range	Default	Description
1	Satellite ID	55, 56, 57, 58, 61	-	Satellite number that received the DC report [*1]
2	DC Report MSG	63 Bytes (HEX)	-	DC report [*2]

[*1]
The satellite number is the lower 6 BIT in decimal notation of the 8 BIT which expresses the PRN number of L1S in binary number. In other words, 55 means 183, 56 means 184, 57 means 185, 58 means 186, 61 means 189.

[*2]
In this field, "00" is added to the last 2 BIT of the 250 BIT DC report message and it is displayed with 252 BIT (63 Bytes). Each BIT is represented by HEX and takes a range from 0 to F.

[Restrictions]
In order to properly output the DC report in this field, it is necessary to be set to receive the QZSS L1S signal with the GNSS command. This sentence will not be output unless it is set to receive QZSS L1S signal.

This sentence outputs the information obtained by receiving the QZSS L1S signal as it is. The content of the DC report message needs to be interpreted by the host based on the user interface specification of the Cabinet Office. Please be aware that depending on the timing of message decoding, two different messages may be output from the same satellite in one second.

Example:
$QZQSM,55,53AC12345……9ABCDEFC*1F
DC report “53AC12345……9ABCDEFC” is received.

6.10 CRW (TPS1) – Time and Leap Second

Format:

$PERDCRW	,	TPS1	,	Date & Time	,	Time status	,	Update date	,	Present LS	,
		1		2		3		4		5	

Future LS	,	PPS status	,	Drift	,	Temperature	*hh	<CR>	<LF>
6		7		8		9			

Field	Data	Range	Default	Description
1	TPS1	-	-	Command name
2	Date & Time	- (14 bytes)	-	Present date and time year, month, day, hour, minute, second It is output at RTC, GPS, UTC time according to positioning status, synchronization setting status, parameter acquisition status and so on. 60 seconds is displayed only when the leap is inserted.
3	Time status	0 to 2 (1 byte)	0	Present time status of output sentence [*1] 0: Before time fix 1: Leap second unknown or leap second ignored 2: Leap second fix
4	Update date	- (14 bytes)	-	Leap second update schedule year, month, day, hour, minute, second It is filled with 0 when UTC parameter has not been received or when there is no schedule for leap second insertion even if it is received. It is calculated based on satellite broadcast contents. Therefore, the update date may remain displayed for a while after the leap second insertion until the satellite broadcast content changes.
5	Present LS	-99 to +99 (3 bytes)	+18	Present leap second [*2]
6	Future LS	-99 to +99 (3 bytes)	+00	Future leap second [*3]
7	PPS status	0 to 5 (1 byte)	0	Present PPS is synced with the follow. [*4] 0: RTC 1: GPS 2: UTC (USNO) 3: UTC (SU) 4: UTC (EU) 5: UTC (NICT)
8	Drift	(10byte)	-	Clock drift [ppb] [*5]
9	Temperature	(5byte)	-	The ambient temperature is displayed as 100 times the value of [°C].

Example:
$PERDCRW,TPS1,20120303062722,2,20120701000000,+15,+16,2,+00002.910,+4312*29
Present time: 2012/03/03 06:27:22
Present time status: UTC (leap second fix)
Leap second update date: 2012/7/1 00:00:00
Present leap second: +15
Future leap second: +16
PPS status: UTC (USNO)
Clock drift: An offset of + 2.910 [ppb] is being detected for the built-in 26 MHz TCXO.
Ambient temperature: +43.12 [°C]

[*1] Time status
Time status indicates the synchronization status of the time displayed in each sentence (including sentences other than TPS1). It is useful for determining whether the sentence's output time is after the time information is obtained from the satellite or contains an appropriate leap second.

I. 0: Before time fix
The display time is incorrect since the time is not obtained from the satellites.

II. 1: Leap second unknown or leap second ignored
(1) "Ignore leap second" is selected with the TIMEALIGN command.
Time is displayed as GPS time. Leap second is not used.

(2) “Use leap second” is selected with the TIMEALIGN command.
Leap second has not been received from the satellites, and the time is displayed with the default leap second.

III. 2: Leap second fix
Time is displayed as UTC time including the leap second.

[*2] Present leap second
This field shows the default leap second until information on leap second is obtained from the satellites. Also, after the leap second information is obtained from the satellite, the information from the satellite is displayed as it is. Therefore, when a leap second is inserted, even after insertion, the update date and the present LS fields are not updated immediately, but are updated at the timing when the satellite actually updates the broadcast contents (Usually within a few days after leap second insertion).

[*3] Future leap second
Like the AC field, this field also displays the information from the satellite as it is. Also, 0 is filled before UTC parameter is received. Even if there is no schedule of leap second insertion, 0 may be displayed.

[*4] PPS status
PPS status indicates the synchronization status of PPS. It is useful for determining whether PPS is output at the specified synchronization timing. It is different from the time status in that it shows the nanosecond scale synchronization state below the integer seconds.

I. 0: RTC
The output PPS is not yet synchronized to anything. Even when the PPS status is GPS synchronization or UTC synchronization, if satellite interruption occurs and it is determined that PPS is largely out of synchronization target, RTC synchronization is displayed until re-positioning and time fix.
Even when the frequency mode is WARM UP, PULLIN or OUT OF HOLDOVER, it will be RTC synchronization.

II. 1: GPS
(1) “GPS synchronization” is selected with the TIMEALIGN command.
PPS is synchronized with GPS time.

(2) “UTC synchronization” is selected with the TIMEALIGN command.
The specified UTC parameter has not been received yet, it is provisionally synchronized with the GPS time.

III. 2~5: UTC
It is synchronized with the UTC time set by the TIMEALIGN command. (The corresponding UTC parameter has been received.)

[*5] Clock drift
The Drift field indicates the frequency deviation with respect to TCXO with a nominal frequency of 26 MHz built in this product by ppb value. This is obtained from the positioning calculation, and is generally called clock drift. There are two causes of clock drift fluctuation: TCXO origin (TCXO aging and temperature variation characteristics) and GNSS origin (positioning calculation error using GNSS signal).

Since this product synchronizes 1PPS to the synchronization target based on this clock drift, this value and 1PPS output value correlate. By observing this value, it is possible to estimate fluctuation of 1PPS.

For example, when there is no temperature fluctuation around this product, the clock drift caused by TCXO does not increase so much, so in an environment like open sky, clock drift will maintain a relatively stable value. Meanwhile, in the case of an adverse condition where the buildings are lined up, short-term clock drift tends to be disturbed due to the GNSS caused by multipath signals and others.

6.11 CRX (TPS2) – PPS Information

Format:

$PERDCRX	,	TPS2	,	PPS output	,	PPS mode	,	PPS period	,	Pulse width	,	Cable delay	,
		1		2		3		4		5		6	

Polarity	,	PPS type	,	Estimated accuracy	,	Reserve1	,	Reserve2	,	Reserve3	,	Reserve4	*hh	<CR>	<LF>
7		8		9		10		11		12		13			

Field	Data	Range	Default	Description
1	TPS2	-	-	Command name
2	PPS output	0, 1 (1 byte)	1	0: 1PPS OFF 1: 1PPS ON
3	PPS mode	0 to 3 (1 byte)	1	Current PPS mode [*1] 0: Always stop 1: Always output 2: Output only when position and time fix 3: Output only when TRAIM is OK
4	PPS period	0 (1 byte)	0	PPS output interval 0: 1PPS
5	Pulse width	001 to 500 (3 bytes)	500	PPS pulse width [msec]
6	Cable delay	-100000 to +100000 (7 bytes)	+000000	PPS cable delay [nsec]
7	Polarity	0, 1 (1 byte)	0	PPS polarity 0: Rising edge 1: Falling edge
8	PPS type	1 (1 byte)	1	PPS type 1: VCLK PPS
9	Estimated accuracy	0000 to 9999 (4 bytes)	9999	Displays the estimation accuracy of the GNSS time being calculated. For details of estimation accuracy, see the terms in Chapter 2.
10	Reserve1	-1.760 to +1.760 (6 bytes)	+0.000	Reserve field
11	Reserve2	0000 (4 bytes)	0000	Reserve field
12	Reserve3	(8 bytes)	-	Reserve field
13	Reserve4	(7 bytes)	-	Reserve field

Example:
$PERDCRX,TPS2,1,1,0,200,+000000,0,1,0005,-0.876,0000,00000000,+000000*0F
PPS output: 1PPS ON
PPS mode: Always output
PPS period: 1PPS
Pulse width: 200 msec
Cable delay: 0 nsec
Polarity: Rising edge
PPS type: VCLK PPS
Estimated accuracy: 5 nsec

[*1] PPS mode
When the PPS mode is 2, positioning is performed with more than 1 satellite in TO mode and 4 satellites or more in NAV mode. In SS mode and CSS mode, more than 4 satellites are necessary to calculate the estimated position, but even if it becomes 3 satellites or less, if it can receive more than 1 satellite, using the estimated position so far, processing equivalent to TO mode is performed with the few satellites, and PPS that is synchronized with the synchronization target is continuously output.

When the PPS mode is set to 3, PPS is output only when satisfying all the conditions of PPS mode 2 and using the satellite that passed the TRAIM judgment. Reliability of PPS improves more than PPS mode 2.

However, please note that holdover to 1PPS cannot be performed when the PPS mode is set to 2 or 3.

6.12 CRY (TPS3) – Position Mode & TRAIM

Format:

$PERDCRY	,	TPS3	,	Pos mode	,	Pos diff	,	Sigma threshold	,	Time	,	Time threshold	,
		1		2		3		4		5		6	

TRAIM solution	,	TRAIM status	,	Removed SVs	,	Receiver status	,	Reserve	*hh	<CR>	<LF>
7		8		9		10		11			

Field	Data	Range	Default	Description
1	TPS3	-	-	Command name
2	Pos mode	0 to 3 (1 byte)	1	Positioning mode 0: NAV mode 1: SS mode 2: CSS mode 3: TO mode
3	Pos diff	0000 to 9999 (4 bytes)	1000	Difference between the fixed position (or the estimated position) and the calculated position calculated by the positioning calculation in this second. [meter] [*1]
4	Sigma threshold	000 to 255 (3 bytes)	000	Sigma threshold which changes automatically to TO mode. [meter] When the threshold value is 0, it is not used.
5	Time	000000 to 999999 (6 bytes)	000000	Current update times of estimated position This value increments by 1 during 3D positioning.
6	Time threshold	000000 to 604800 (6 bytes)	000000	Survey time threshold which changes automatically to TO mode. When the threshold value is 0, it is not used.
7	TRAIM solution	0 to 2 (1 byte)	2	TRAIM solution 0: OK 1: ALARM 2: Insufficient satellites being tracked
8	TRAIM status	0 to 2 (1 byte)	2	TRAIM status 0: There are enough number of satellites in use 1: There are a number of satellites for alarm determination 2: Not enough satellites
9	Removed SVs	00 to 03 (2 bytes)	00	Number of satellites removed by TRAIM
10	Receiver status	(10 bytes)	0x00000000	Receiver status [*2]
11	Reserve	(10 bytes)	0x00000000	Reserve field

Example:
$PERDCRY,TPS3,2,0003,001,002205,086400,0,0,00,0x00000001,0x00000000*0D
Positioning mode: CSS mode
Position difference: 3 [m] Sigma threshold: 1 [m]
Update times: 2205 times Time threshold: 86400 times
TRAIM solution: OK
TRAIM status: There are enough number of satellites in use
Removed satellites: 0
Receiver status: 0x00000001 (Antenna short)

[*1] Reliability of fixed position
When the position mode is SS, CSS, TO mode, the Pos Diff field displays the difference between the fixed position (or the estimated position created by integrating the position information for a certain period) and the position obtained by positioning calculation at that time in meters per second. This value can be used as an indicator of reliability of position information.

For example, if this value continuously maintains a small value, it means that the fixed position is set correctly. Conversely, if this value continues to maintain a large value, there is a possibility that the fixed position being set is offset from the true value.

If you know that the fixed position is set correctly, this value is an indicator of the reliability of the position information calculated every second. For example, if this value is stable and maintains a small value, the positioning calculation per second can be performed satisfactorily, and it can be inferred that the time calculated by positioning calculation and 1PPS is also good. Conversely, if this value becomes larger or smaller, it can be inferred that the reception environment is bad and the positioning calculation is disturbed under the influence of multipath. At this time, 1PPS stability is expected to deteriorate.

Furthermore, this value can also be used for detection of anomaly of the antenna and spoofing signal. When this value suddenly jumped from a small value to a large value in spite of knowing that the fixed position was set correctly, it is expected to be caused by a sudden deterioration of the reception environment or a reception of a spoofing signal by a malicious person. In this case, since the time and 1PPS calculated from positioning calculation may be greatly jumped, risk avoidance is recommended in consideration of them.

[*2] Receiver status
The operation status of this product is displayed in BIT unit. The meaning of each BIT is as follows. If two or more BIT conditions are satisfied at the same time, they are displayed as a logical sum of these BITs.

BIT (LSB=0)	Item	Description
00 to 03	Antenna current detection	0: Normal 1: Antenna short 2: Antenna open 3: No antenna voltage
04 to 07	Spoofing signal detection	Notify when a spoofing signal is detected. [*3] 0: Spoofing signal is not detected. 1: Spoofing signal is being detected.
08 to 11	Operation status of NLOSMASK mode	Notify the processing status of multipath countermeasure set with the NLOSMASK command. 0: NLOSMASK mode OFF 1: Step 1 in NLOSMASK mode 2: Step 2 in NLOSMASK mode 3: Step 3 in NLOSMASK mode
12 to 15	Energization time	Total energization time since turning on the power supply of this product 0: Less than 1 hour 1: 1 hour elapsed 2: 1 day elapsed 3: 7 days elapsed 4: 30 days elapsed
16 to 19	Reserved	
20 to 23	Reserved	
24 to 27	Reserved	
28 - 31	Antenna installation environment	Determination result of the installation environment of the antenna connected to this product 0: No position fix or non-positioning environment 1: Open sky environment 2: Semi-shielding environment 3: High shielding environment

[*3]
When an apparent abnormality (excluding the unhealth satellite) is seen in the contents of the navigation message received from one of the GNSS satellites after the initial positioning using the appropriate GNSS satellite, while the message is being received, 1 is set for the bit of this field. Error messages found by this detection are discarded. Also, the satellite that broadcasts it will not be used for positioning.

[*4]
This field is used only for indicator, so this does not guarantee the timing performance.

6.13 CRZ (TPS4) – VCLK Frequency and Control

Format:

$PERDCRZ	,	TPS4	,	Freq mode	,	Phase skip flag	,	Alarm	,	Status	,	PPS timing error	,
		1		2		3		4		5		6	

Freq error	,	Reserve1	,	Learning time	,	Available time	,	Reserve2	*hh	<CR>	<LF>
7		8		9		10		11			

Field	Data	Range	Default	Description
1	TPS4	-	-	Command name
2	Freq mode	0 to 5 (1 byte)	0	Frequency mode [*1] 0: Warm up 1: Pull-in 2: Coarse lock 3: Fine lock 4: Holdover 5: Out of holdover
3	Phase skip flag	0, 1 (1 byte)	1	Phase skip flag [*2] 0: Automatic judge 1: Execute
4	Alarm	00 to FF (2 bytes)	00	Alarm [*3]
5	Status	00 to FF (2 bytes)	01	Status [*4]
6	PPS timing error	-999999999 to +999999999 (10 bytes)	-	Time difference between the timing of the synchronization target and the PPS generated by the oscillator [nsec] When the frequency mode is WARM UP, PULL IN, COARSE LOCK, FINE LOCK, the smaller this value, the more the 1PPS generated by the oscillator is synchronized with the synchronization target.
7	Freq error	-99999 to +99999 (6 bytes)	-	VCLK frequency deviation [ppb] When the frequency mode is WARM UP, PULL IN, COARSE LOCK, FINE LOCK, the smaller this value, the closer the frequency output by the oscillator is to the nominal frequency.
8	Reserve1	(4 bytes)	-	Reserve field
9	Learning time	0000000 to 9999999 (7 bytes)	0	Learning time for Holdover [sec] When this value exceeds the desired learning time, learning is satisfied. [*5]
10	Available time	000000 to 999999 (6 bytes)	0	Holdover available time [sec] This value is set when learning is satisfied and decreases during holdover. [*5]
11	Reserve2	(7 bytes)	-	Reserve field

[*1] Frequency mode
Figure 6.1 shows the state diagram of frequency mode.

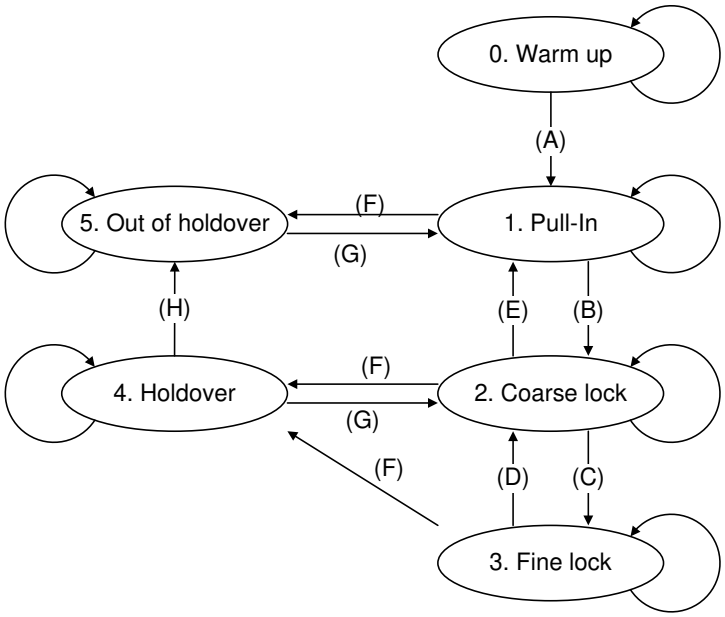


Figure 6.1 Frequency Mode State Diagram

Table 6.1 Transition Condition

Transition	Use GNSS synchronization	Use EPPS synchronization
(A)	GNSS fix. Warm up of the oscillator is completed.	EPPS input is confirmed. Warm up of the oscillator is completed.
(B)	The oscillator is controlled to some extent, and the timing is synchronized to some extent to the synchronization target. (*1)	The oscillator is controlled to some extent, and the timing is synchronized to some extent to the synchronization target. (*1)
(C)	The oscillator is sufficiently controlled, and the timing is synchronized with the synchronization target.	The oscillator is sufficiently controlled, and the timing is synchronized with the synchronization target.
(D)	Timing accuracy deteriorated (e.g. jamming signal). Or, phase skip flg is 1.	Timing accuracy deteriorated (e.g. jamming signal). Or, phase skip flg is 1.
(E)	Timing stability is not stable, exceeding the threshold for restarting control. (e.g. returning from Holdover) Or, phase skip flg is 1.	Timing stability is not stable, exceeding the threshold for restarting control. (e.g. returning from Holdover) Or, phase skip flg is 1.
(F)	GNSS fix interrupts. (*2)	EPPS input is no longer confirmed. (*2)
(G)	GNSS fix again (More than 2 seconds GNSS fix is necessary for judgment)	EPPS input is restarted. (More than 2 seconds is necessary for judgment)
(H)	Holdover available time has become "0".	Holdover available time has become "0".

(*1) This transition condition can be changed by MODESET command.
(*2) For Coarse lock or Fine lock, there is a mask period of up to 10 seconds. The mask period is intended to prevent frequent occurrence of temporary interference waves and GNSS reception interruption, and is set in anticipation of a period that does not fall outside the specification range. There is no specification regulation for holdover in case of EPPS input.

[*2] Phase skip flag
In order to shorten the control time in Pull in mode, this product can perform control called phase skip. Phase skip is to adjust the output PPS by changing the relationship of the pulse edge between VCLK frequency and VCLK PPS.

Normally, while maintaining the relationship of the pulse edge between the VCLK frequency and VCLK PPS, the PPS is pulled into the synchronization target while gradually moving the VCLK frequency. Therefore, depending on the time difference from the synchronization target, it takes much time to control. On the other hand, using phase skip has the advantage that PPS can be controlled at high speed. However, there is a disadvantage that the pulse edge relationship temporarily collapses.

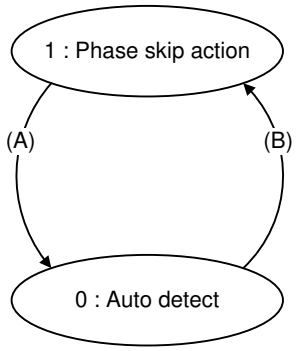
Depending on the customer's equipment, it seems to be divided whether to shorten the synchronous control time or maintain the relation of the pulse edge. This product can set whether or not phase skip is performed by command. In this document, the flag which determines the phase skip is called phase skip flag.

The settings related to phase skip can be set with the PHASESKIP command and the MODESET command. For details, refer to the section of each command.

When the phase skip flag of the TPS4 sentence is 0, the phase skip is automatically determined based on the threshold set by the MODESET command. This is done only in Pull in mode. As a result, if the threshold value is exceeded, the phase skip flag temporarily changes to 1 and the phase skip is performed. After the phase skip, the phase skip flag returns to 0.

When the phase skip flag of the TPS4 sentence is 1, the phase skip is always performed when the Pull in mode is reached. This setting is displayed mainly when setting to perform the phase skip forcibly with PHASESKIP command. After the phase skip, the phase skip flag returns to 0.

The state transition diagram of the phase skip flag is as follows.



Transition	Transition condition
(A)	Phase skip has been completed. (The status transfer only when the frequency mode is "Pull-in".)
(B)	PHASESKIP command is input. The threshold set by the MODSET command has been exceeded. (The status transfer only when the frequency mode is "Pull-In".)

[*3] Alarm
The alarm status of this product is displayed in BIT unit. The meaning of each BIT is as follows. If two or more BIT conditions are satisfied at the same time, they are displayed as a logical sum of these BITs.

BIT (LSB=1)	Item	Description
01 to 02	Antenna current detection	0: Normal 1: Antenna current open 2: Antenna current short 3: Not displayed
03	Oscillator error	0: Normal 1: Oscillator output error
04	Oscillator control error	0: Normal 1: Oscillator cannot be controlled (e.g. lifetime)
05 to 08	Reserved	

[*4] Status
The status of this product is displayed in BIT unit. The meaning of each BIT is as follows. If two or more BIT conditions are satisfied at the same time, they are displayed as a logical sum of these BITs.

BIT (LSB=1)	Item	Description
1	Power supply to antenna pin	0: OFF 1: ON
2	EPPS signal	0: Not use EPPS and synchronizes with GNSS time 1: Synchronizes to the signal input to the EPPS pin
3	Reference signal detection	Signal status of EPPS pin 0: Pulse is not detected 1: Pulse is being detected
4	Reserved	
5	Reserved	
6	Reserved	
7	For debugging	This BIT is set in the debug mode.
8	Temperature correction data	This BIT is set when there is no temperature correction data.

[*5] Learning time and Available time
The counters in TPS4 sentence are set under the following conditions.

frequency mode	learning time	available time
0: Warm up	“0”	“0”
3: Fine lock	“++” (Upper limit: learning time set0 + 3600)	if leaning time ≧learning time set0: available time set0 else if ≧learning time set1: available time set1 else if ≧learning time set2: available time set2 else if < learning time set2: “--“
1: Pull-in	“0”	“0”
2: Coarse lock		“--“
4: Holdover		
5: Out of holdover		“0”

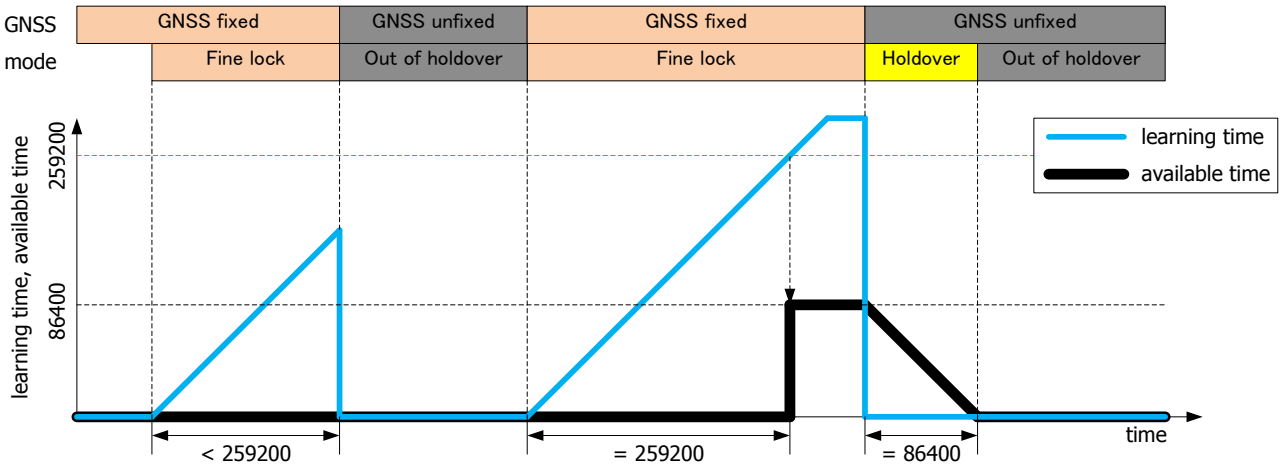
The default values of learning time set0 to 2 and the available time set0 to 2 are below. These values can be set by HOSET command. Although you can change the conditions to shift to Holdover mode and the holdover period by setting the HOSET command, the holdover capability guaranteed by this product is only for the conditions described in the hardware specifications.

Parameter	Default
learning time set0	259200
available time set0	86400
learning time set1	3600
available time set1	3600
learning time set2	0
available time set2	0

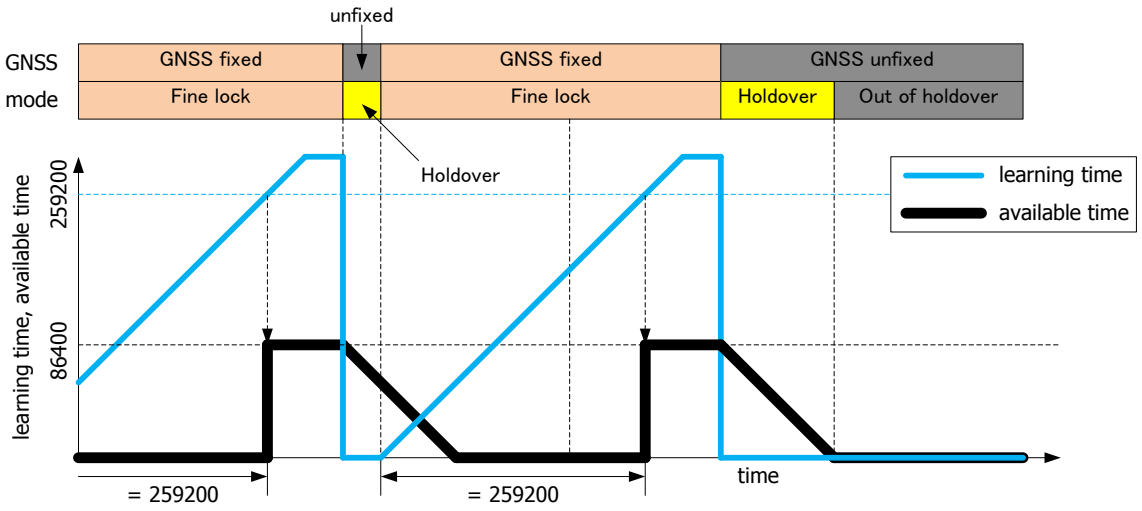
At the timing when EPPS synchronization and GNSS synchronization are switched, the learning time is reset to 0.

Examples of transition when all parameters are initial values are described on the next page.

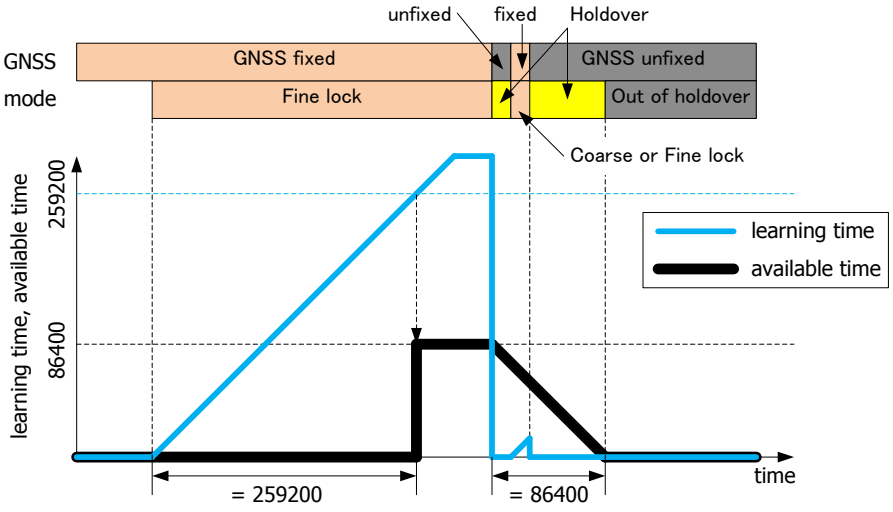
[Example 1] More than 3 days of learning is necessary for Holdover of 1 day.



[Example 2] Once it is in Holdover mode, more than 3 days of learning is necessary for Holdover of 1 day again.



[Example] Even when GNSS is fixed again during Holdover, the Holdover available state will continue for one day after the first transition to Holdover. However, this does not apply if it is in Pull-in when re-positioning.



6.14 CRG – QZSS L1S Disaster and Crisis Management Report Message

The DC report message broadcasted with QZSS L1S signal is output. [*1]

In order to receive messages in this sentence, it is necessary not only to output this sentence but also to be set to receive the QZSS L1S signal with the GNSS command.

Format:

$PERDCRG	,	DCR	,	sequence	,	prn	,	type	,	dcreport	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Data	Range	Description
1	DCR	-	QZSS L1S DC Report
2	sequence	1 to 4	Sequence number of sentence
3	prn	Null, 83 to 91	PRN number of satellite broadcasted the message
4	type	Null, 43, 44, 63	Message type [*2]
5	dcreport	XX・・・・・・・・X | | MSB LSB	Message is output when decoding is successful. It outputs 212 BITS (53 Bytes) which is the DATA FIELD part as a hexadecimal number sequence (0 to F). [*2]

Example:
$PERDCRG,DCR,1,85,43,7C4E43C00161158000000000000000000000000000000004A*29
$PERDCRG,DCR,2,84,43,7C4E43C00161158000000000000000000000000000000004A*2B
$PERDCRG,DCR,3,,,*1F
$PERDCRG,DCR,4,,,*18

[*1]
This sentence outputs the information obtained by receiving the QZSS L1S signal as it is. The content of the DC report message needs to be interpreted by the host based on the user interface specification of the Cabinet Office. Please be aware that depending on the timing of message decoding, two different messages may be output from the same satellite in one second. Also, even if receiving a DC report message, when the CRC of the message does not match, Fields 3 to 5 of this sentence will be Null.

[*2]
When the prn is Null, this field is also Null.

6.15 CRJ – Detection Status of Jamming Signal

This sentence outputs the status of Anti-Jamming function.

Format:

$PERDCRJ	,	FREQ	,	type	,	LineMax	,	Line	,	Jamming 1 Freq	,	Jamming 1 Signal Peak	,
		1		2		3		4		5		6	

Jamming 2 Freq	,	Jamming 2 Signal Peak	*hh	<CR>	<LF>
7		8			

Field	Data	Range	Default	Description
1	FREQ	-	-	Command name
2	Type	GP or GL	-	Frequency band of this sentence GP: GPS GL: GLONASS
3	LineMax	1 to 4	NULL	Total number of output lines for each band information
4	Line	1 to 4	NULL	Current output line for each band information
5	Jamming 1 Freq	NULL or 10 bytes	NULL	First frequency of the jamming signal masked by the Anti-Jamming function is indicated by 4 digits of integer part and 5 digit of decimal part.
6	Jamming 1 Signal Peak	1 ~ 255	NULL	Signal strength of the first frequency of the jamming signal masked by the Anti-Jamming function The larger the value, the stronger the jamming signal.
7	Jamming 2 Freq	NULL or 10 bytes	NULL	Second frequency of the jamming signal masked by the Anti-Jamming function is indicated by 4 digits of integer part and 5 digit of decimal part.
8	Jamming 2 Signal Peak	1 ~ 255	NULL	Signal strength of the second frequency of the jamming signal masked by the Anti-Jamming function The larger the value, the stronger the jamming signal.

Example:
$PERDCRJ,FREQ,GP,,,,,*4F
$PERDCRJ,FREQ,GL,1,1,1601.999787,171,,*4D
Jamming signal in GPS band is not detected.
In GLONASS band, frequency of 1601.999787 MHz is detected at signal strength 171 and masked by the Anti-Jamming function.

[Precautions for use]
- Anti-Jamming function works up to 8 channels only for GPS and GLONASS.
- Up to 5 sentences may be output depending on the number of jamming signals being detected.
- When detecting more than nine jamming signals, this function masks in order from the stronger signal.

6.16 CRP – High Resolution Current Position

This sentence displays position information with higher resolution than GNS or GGA sentence.

Format:

$PERDCRP	,	LatDegree	,	LonDegree	,	Altitude	*hh	<CR>	<LF>
		1		2		3			

Field	Data	Range	Description
1	LatDegree	-90.0000000 to 90.0000000	Current position (Latitude) [degree] [*1] A positive number means the north latitude and a negative number means the south latitude.
2	LonDegree	-180.0000000 to 180.0000000	Current position (Longitude) [degree] [*1] A positive number means the east longitude and a negative number means the west longitude.
3	Altitude	-1000.00 to 18000.00	Current altitude [meter] [*1]

Example:
$PERDCRP,+34.1234567,-51.6543210,35.12*47
34.1234567 deg N 51.6543210 deg W
Altitude: 35.12 m

[*1]
The fixed position is displayed in TO mode.

6.17 CRQ – SAR / RLM Information Broadcasted by Galileo Satellites

This sentence outputs the Search and Rescue (SAR) and the Return Link Message (RLM) received from Galileo satellites.

Format:

$PERDCRQ	,	SentNum	,	SentIndex	,	Prn_1	,	Sar_1	[,	Prn_2	,	Sar_2	,
		1		2		3		4		5		6	

Prn_3	,	Sar_3	,	Prn_4	,	Sar_4]	*hh	<CR>	<LF>
7		8		9		10			

Field	Data	Range	Description
1	SentNum	1 to 2	Total number of CRQ sentence in this second
2	SentIndex	1 to 2	Number for identifying the number of lines in this sentence
3	Prn_1	01 to 36 or NULL	Galileo satellite number that decoded the message (This field is NULL when it is impossible to decode the SAR/RLM)
4	Sar_1	000000 to 3FFFFF or NULL	SAR/RLM message [*1] (This field is NULL when it is impossible to decode the SAR/RLM)
5	Prn_2	01 to 36 or NULL	Galileo satellite number that decoded the message (This field is NULL when it is impossible to decode the SAR/RLM)
6	Sar_2	000000 to 3FFFFF or NULL	SAR/RLM message [*1] (This field is NULL when it is impossible to decode the SAR/RLM)
7	Prn_3	01 to 36 or NULL	Galileo satellite number that decoded the message (This field is NULL when it is impossible to decode the SAR/RLM)
8	Sar_3	000000 to 3FFFFF or NULL	SAR/RLM message [*1] (This field is NULL when it is impossible to decode the SAR/RLM)
9	Prn_4	01 to 36 or NULL	Galileo satellite number that decoded the message (This field is NULL when it is impossible to decode the SAR/RLM)
10	Sar_4	000000 to 3FFFFF or NULL	SAR/RLM message [*1] (This field is NULL when it is impossible to decode the SAR/RLM)

Example:
$PERDCRQ,2,1,01,2AAAAA,02,2AAAAA,10,100000,11,200000*41
$PERDCRQ,2,2,13,2AAAAA,35,2AAAAA,,,,*47
SAR/RLM are received from Galileo satellite 01, 02, 10, 11, 13, 35.

$PERDCRQ,1,1,,*43
The receiver cannot decode the data or is not set to receive Galileo.

[*1]
It is data contained in I/Nav odd page that is decoded from Galileo E1-B signal. MSB is far leftmost bit.

6.18 ACK – Output the Command Reception Check

This sentence is output when this product receives the checksum of the command.

Format:

$PERDACK	,	Command	,	Sequence	,	Sub-command	*hh	<CR>	<LF>
		1		2		3			

Field	Data	Range	Default	Description
1	Command	-	-	First field of received command
2	Sequence	-1 to 255	0	The number of times successful for the reception. It is added 1 whenever it succeeds in command reception, and 0 to 255 is repeated. When command reception is failed, -1 is returned. The positive number means ACK, and the negative number means NACK.
3	Sub-command	-	-	Second field of received command

Example:
$PERDACK,PERDAPI,-1,PPS*72
PERDAPI,PPS command input is failed.

6.19 MSG – Event Driven Message

This sentence is output when certain events occur. This is a sentence for FURUNO engineer use only.

Format:

$PERDMSG	,	key	[,	string]	*hh	<CR>	<LF>
		1		2			

Field	Data	Range	Default	Description
1	key	-	-	Alphanumeric event indicator
2	string	-	-	Description of event

Example:
$PERDMSG,1A*06

6.20 VERSION – Software Version

Format:

$PERDSYS	,	VERSION	,	Device	,	Version	,	Reserve	,	DO type	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Data	Range	Default	Description
1	VERSION	-	-	Command name
2	Device	-	-	Device name
3	Version	-	-	Version number
4	Reserve	-	-	Reserve field
5	DO type	GF-8801 GF-8802 GF-8803 GF-8804 GF-8805	-	GNSSDO product type

Example:
$PERDSYS,VERSION,OPUS7_SFLASH_MP_64P,ENP708A1830501T,QUERY,GF8801*14

6.21 FIXSESSION – Fix Session

This is a sentence for FURUNO engineer use only. It is automatically output at startup, restart, and initial positioning.

Format:

$PERDSYS	,	FIXSESSION	,	Reserve1	,	Reserve2	,	Reserve3	*hh	<CR>	<LF>
		1		2		3		4			

Field	Data	Range	Default	Description
1	FIXSESSION	-	-	Command name
2	Reserve1	-	-	Reserve field
3	Reserve2	-	-	Reserve field
4	Reserve3	-	-	Reserve field

Example:
$PERDSYS,FIXSESSION,OFF,37249,37.249*32
$PERDSYS,FIXSESSION,INIT*49
$PERDSYS,FIXSESSION,ON*52

6.22 ANTSEL – Antenna Selecting

This sentence is output when the following events occur:
- Initialization at power on
- Reception of $PERDSYS,ANTSEL,QUERY command
- $PERDSYS,ANTSEL command input

Format:

$PERDSYS	,	ANTSEL	,	Input	,	mode	*hh	<CR>	<LF>
		1		2		3			

Field	Data	Range	Default	Description
1	ANTSEL	-	-	Command name
2	Input	FORCE1L FORCE2	FORCE2	GNSS antenna input setting FORCE1L,1LOW: Use #6(RF PIN) FORCE2,2: Use #RF(RF_COAX)
3	mode	1LOW 2	2	

Example:
$PERDSYS,ANTSEL,FORCE1L,1LOW*32
$PERDSYS,ANTSEL,FORCE2,2*2A

7 Input Commands

These are input commands for the protocol of the receiver.

7.1 API [GNSS] – Satellite System Configuration

COLD restart (time also cleared) is run when satellite system configuration is changed from or to GLONASS only fix configuration. In the others configurations HOT restart is run.

To turn off the use of GPS satellites, please also set the TIMEALIGN command properly.

Format:

$PERDAPI	,	GNSS	,	TalkerID	,	Gps	,	Glonass	,	Galileo	,	Qzss	,	Sbas/L1s	*hh	<CR>	<LF>
		1		2		3		4		5		6		7			

Field	Data	Range	Default	Description
1	GNSS	-	-	Command name
2	TalkerID	AUTO LEGACYGP GN	GN	Talker ID See Section 5.3 for details.
3	Gps	0, 2	2	GPS setting 0: Do not receive 2: Receive
4	Glonass	0, 2	2	GLONASS setting 0: Do not receive 2: Receive
5	Galileo	0, 2	0	Galileo setting 0: Do not receive 2: Receive
6	Qzss	0, 2	2	QZSS (L1C/A) setting 0: Do not receive 2: Receive
7	Sbas/L1s [*1]	0 to 4	1	SBAS / QZSS L1S 0: Do not receive either 1: Differential fix with SBAS 2: In addition to the above 1, SBAS is used in positioning calculation 3: Receive QZSS L1S (No SLAS correction) 4: Receive QZSS L1S (SLAS correction)

Example:
$PERDAPI,GNSS,AUTO,2,2,0,2,2*41
Use: GPS, GLONASS, QZSS(L1C/A), SBAS Mask: Galileo
Not receive: QZSS(L1S)

[*1]
SBAS and QZSS L1S cannot be received at the same time. Only one of them can be used.

The current setting value can be checked by the following command.
$PERDAPI,GNSS,QUERY*18

7.2 API [PPS] – PPS Setting

Various setting status of PPS can be confirmed by TPS2 sentence.

Format:

$PERDAPI	,	PPS	,	Type	,	Mode	,	Period	,	Pulse width	,	Cable delay	,
		1		2		3		4		5		6	

Polarity	*hh	<CR>	<LF>
7			

Field	Data	Range	Default	Description
1	PPS	-	-	Command name
2	Type	VCLK	VCLK	VCLK stable
3	Mode	0 to 3	1	PPS output mode [*1] 0: Always stop 1: Always output 2: Output when the time is fixed after GNSS position fix 3: In addition to the above 2, output when there is no TRAIM error
4	Period	0	0	PPS output interval 0: 1PPS (A pulse is output per second)
5	Pulse width	1 to 500	500	PPS pulse width [msec]
6	Cable delay	-100000 to 100000	0	PPS cable delay [nsec] PPS is delayed by setting a positive value.
7	Polarity	0, 1	0	PPS polarity 0: Rising edge 1: Falling edge

Example:
$PERDAPI,PPS,VCLK,1,0,200,0,0*05
PPS output mode: Always output PPS pulse width: 200 msec PPS cable delay: 0 nsec
PPS polarity: Rising edge of PPS is synchronous with GPS, UTC (USNO) or UTC (SU)

[*1]
When using holdover, please use PPS mode 1.

7.3 API [GCLK] – GCLK Frequency Setting

Format:

$PERDAPI	,	GCLK	,	Mode	,	Freq	[,	Duty	,	Offset]	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Data	Range	Default	Description
1	GCLK	-	-	Command name
2	Mode	0, 1	0	GCLK output mode 0: Do not output 1: Output
3	Freq	10 to 40000000	10000000 (10MHz)	GCLK frequency [Hz]
4	Duty	50	50	Duty cycle 50 stable It is omissible after the 4th field.
5	Offset	0	0	0 stable

Example:
$PERDAPI,GCLK,1,10000000,50,00*41
GCLK output mode: Output GCLK output frequency: 10MHz

The current setting value can be checked by the following command.
$PERDAPI,GCLK,QUERY*12

[Notes on GCLK]
GCLK frequency is a frequency output from GCLK pin of this product. Stability of GCLK PPS and GCLK frequency depends on the frequency value set with this command. For details, please refer to the hardware specifications. Also, there is jitter at the GCLK frequency. It is necessary to evaluate in advance whether it is appropriate for the application to be used. The clock edge of the GCLK frequency does not match VCLK PPS. (Non-coherent)

7.4 API [SURVEY] – Position Mode Setting

HOT restart is occurred when the position mode is shifted to the NAV mode.

Format:

$PERDAPI	,	SURVEY	,	Position mode	[,	Sigma threshold	,	Time threshold	[,
		1		2		3		4	

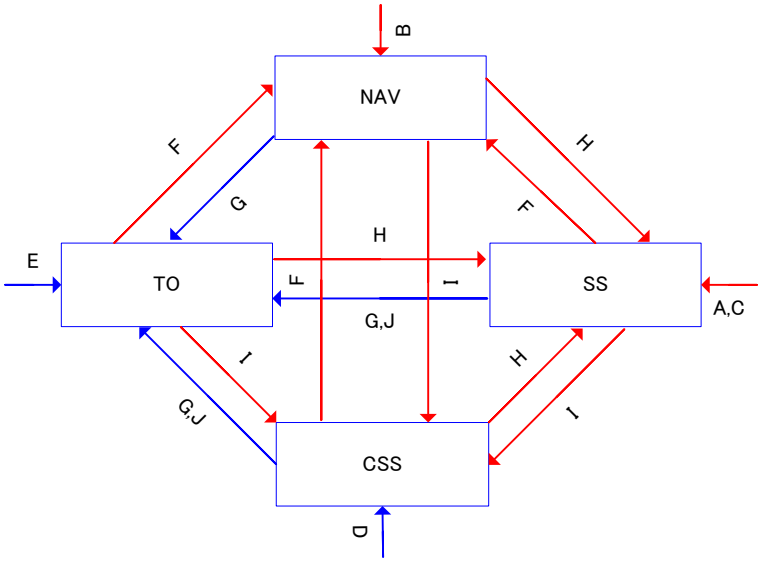
Latitude	,	Longitude	,	Altitude]]	*hh	<CR>	<LF>
5		6		7			

Field	Data	Range	Default	Description
1	SURVEY	-	-	Command name
2	Position mode	0 to 3	1	Position mode [*1] 0: NAV mode 1: SS mode 2: CSS mode 3: TO mode
3	Sigma threshold	0 to 255	0	Sigma threshold which changes automatically to TO mode. [m] When the threshold value is 0, it is not used. [*2]
4	Time threshold	0 to 10080	0	Time threshold which changes automatically to TO mode. [minute] When the threshold value is 0, it is not used. [*2]
5	Latitude	-90.0000000 to 90.0000000	0	Latitude for hold position in TO mode. [degree] [*3] A positive number means the north latitude and a negative number means the south latitude. This field can be set only when position mode is 3. It accepts up to the seventh decimal place.
6	Longitude	-180.0000000 to 180.0000000	0	Longitude for hold position in TO mode. [degree] [*3] A positive number means the east longitude and a negative number means the west longitude. This field can be set only when position mode is 3. It accepts up to the seventh decimal place.
7	Altitude	-1000.00 to 18000.00	0	Altitude above sea level for hold position in TO mode. [m] [*3] This field can be set only when position mode is 3. It accepts up to two decimal place.

Example:
$PERDAPI,SURVEY,1,10,1440*74
Mode: SS mode
When the variance value of the estimated position is 10 or less and the number of calculation times of the estimated position reaches 86400 times, it automatically transits to TO mode.

$PERDAPI,SURVEY,3,0,0,37.7870,-122.4510,31*48
Mode: TO mode Sigma threshold: 0 Time threshold: 0
Fixed position: 37.7870 degrees north 122.4510 degrees west Altitude: 31 m

[*1]
Whether the calculation result of the estimated position is discarded when changing the position mode is as follows.



	Transition condition	Survey position and number of times of survey process
A	After first power on, or after factory restart (default)	Discard
B	After power on in case that last mode is NAV mode.	Discard
C	After power on in case that last mode is SS mode.	Discard
D	After power on in case that last mode is CSS mode.	Keep
E	After power on in case that last mode is TO mode.	Keep
F	Set to NAV mode	Discard
G	Set to TO mode (After initial positioning, or when fixed position input)	Keep
H	Set to SS mode	Discard
I	Set to CSS mode	Discard
J	The condition of survey is satisfied. **Note:** This product starts in TO mode when the position mode changes to TO mode by satisfying the transition condition before power off.	Keep

[*2]
When both Sigma threshold and Time threshold are satisfied, the position mode transits to TO mode. If you want to use only one of the thresholds, set the threshold value of the one not used to 0. If both are set to 0, the mode will not change to TO mode.

[*3]
In some cases, the actual input position and the position indicated by the sentence may rarely differ slightly on the scale of the least significant digit. However, it is due to the conversion error of the coordinate system at sentence display, there is no problem in performance. Due to the convenience of trigonometric calculations, when the position near the North Pole and South Pole points is set, there may be some error included in the reflected position.

[Note]
Since the Time threshold and the Sigma threshold are set to 0 in this product in the default state, the mode does not transition to TO mode automatically. However, even in this state, by performing positioning for several hours in an open sky environment or for a few days in a semi-shielding environment, the calculation of the fixed position automatically converges and the state equivalent to the TO mode at a good fixed position . (Although it remains in SS mode, the position will eventually hardly move.)

Even during the SS mode and the CSS mode, when there is more than one satellite, time (1PPS) is calculated appropriately using the fixed position calculated up to that time (processing equivalent to TO mode). Therefore, we recommend that you use the default settings unless your equipment needs to see the TO mode flag. The best performance can be obtained regardless of the reception environment.

7.5 API [RESTART] – Restart Command

The details of RESTART command are described below. This command does not delete the backup data in FLASH.

Format:

$PERDAPI	,	RESTART	[,	Restart type]	*hh	<CR>	<LF>
		1		2			

Field	Data	Range	Default	Description
1	RESTART	-	-	Command name
2	Restart type	HOT WARM COLD FACTORY	-	Restart mode The backup data retained after restart varies depending on the restart mode. See Chapter 8 for details. When this field is omitted, the restart mode is HOT.

Example:
$PERDAPI,RESTART,COLD*08
Mode: COLD restart

7.6 API [FLASHBACKUP] – Back up to FLASH ROM

Format:

$PERDAPI	,	FLASHBACKUP	,	Type	*hh	<CR>	<LF>
		1		2			

Field	Data	Range	Default	Description
1	FLASHBACKUP	-	-	Command name
2	Type	0x0000 to 0xFFFF	0x0000	Select the item to be stored in FLASH. Each bit corresponds to each command setting value. Please set by OR. When this command is entered more than once, only the command of the bit specified by this command is stored at the end. 0x00: Clear the data stored in FLASH 0x01: Back up GCLK command 0x02: Back up DEFLS command 0x04: Back up TIMEALIGN command 0x08: Reserved 0x10: Back up FIXMASK command 0x20: Back up GNSS command 0x40: Back up PPS command 0x80: Reserved 0x100: Back up NLOSMASK command 0x200: Back up SURVEY command [*1] 0x400: Back up HOSET command Reserved after 0x800

Example:
$PERDAPI,FLASHBACKUP,0x03*4E
Back up GCLK and DEFLS command setting.

[*1]
The SURVEY command cannot be backed up to FLASH in CSS mode and TO mode. Please use it in NAV mode or for threshold setting in SS mode.

[Precautions for use]
- The contents stored by this command are deleted by software update.
- The contents stored by this command are not deleted by RESTART command (including FACTORY).
- When this command is input, positioning is temporarily interrupted and HOT restart is performed thereafter.
- Do not turn off the power for at least 4 seconds after this command input.

The current setting value can be checked by the following command.
$PERDAPI,FLASHBACKUP,QUERY*4F

The response of QUERY is displayed in a command list format over multiple lines. An output example of backing up GCLK, DEFLS and TIMEALIGN is as follows.

$PERDCFG,FORMAT,ESIP*4D
$PERDAPI,GCLK,0,10000000,50,0*70
$PERDAPI,DEFLS,18*0A
$PERDAPI,TIMEALIGN,4*37
$PERDACK,PERDAPI,5,FLASHBACKUP*56

7.7 API [DEFLS] – Default Leap Second Setting

Please send this command before initial positioning. COLD restart (time also cleared) is run when this command is input.

Format:

$PERDAPI	,	DEFLS	,	Sec	*hh	<CR>	<LF>
		1		2			

Field	Data	Range	Default	Description
1	DEFLS	-	-	Command name
2	Sec	-99 to 99	18	Default leap second

Example:
$PERDAPI,DEFLS,19*0B
Default leap second: 19 second

The current setting value can be checked by the following command.
$PERDAPI,DEFLS,QUERY*49

7.8 API [TIMEZONE] – Local Zone Time Setting

The current setting value can be checked in ZDA sentence. (Except sec field)

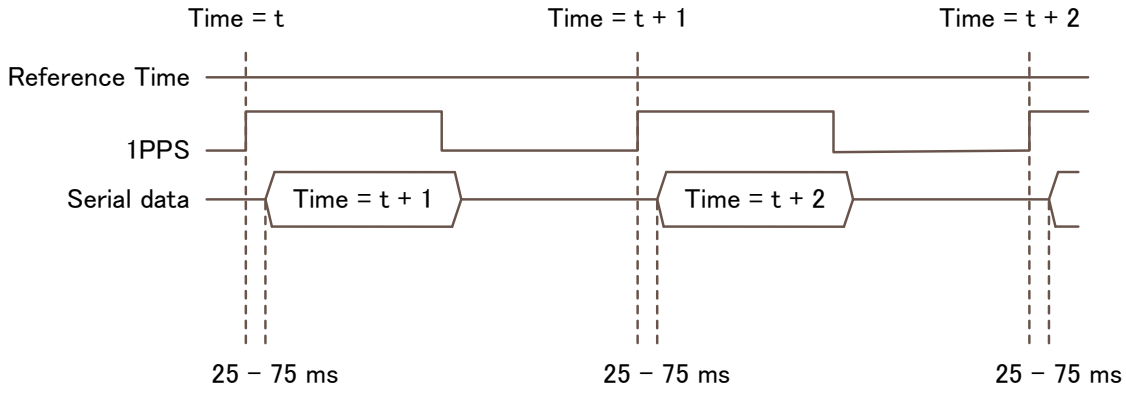
Format:

$PERDAPI	,	TIMEZONE	,	Sign	,	Hour	,	Minute	[,	Sec]	*hh	<CR>	<LF>
		1		2		3		4					

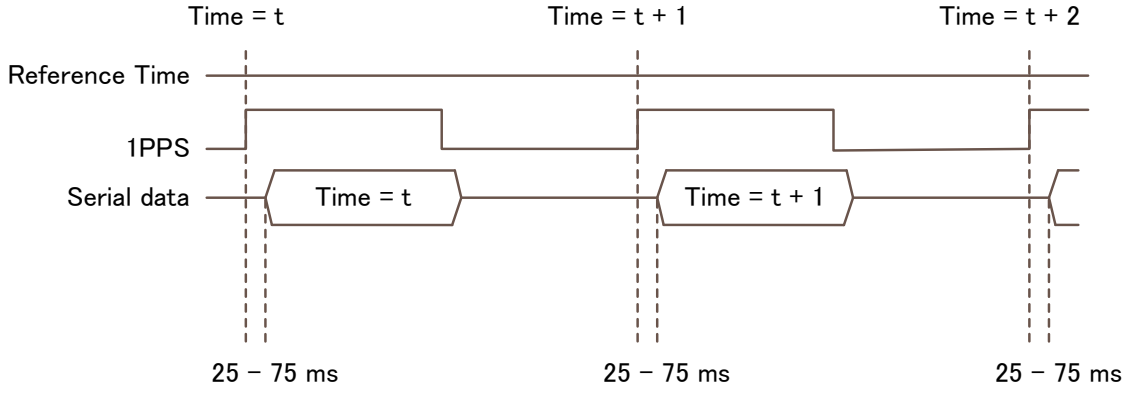
Field	Data	Range	Default	Description
1	TIMEZONE	-	-	Command name
2	Sign	0 to 1	0	LZT sign 0: Positive 1: Negative This setting is applied only to the ZDA sentence.
3	Hour	0 to 23	0	LZT (Hour) This setting is applied only to the ZDA sentence.
4	Minute	0 to 59	0	LZT (Minute) This setting is applied only to the ZDA sentence.
5	Sec	E, M	E	By using this field, user can change the relationship between 1PPS and time stamp of sentence. This setting is applied to all sentences which time is output. Please use this field by default as it is unnecessary. E: Time is output with the relationship of [* 1] below. Time stamp shows the time of **next** 1PPS output. This output mode is eSIP specification. M: Time is output with the relationship of [* 2] below. Time stamp shows the time of **last** 1PPS output. This output mode is M12 specification.

Example:
$PERDAPI,TIMEZONE,0,9,0*69
LZT: +9 hours

[*1]


Time = t
Time = t + 1
Time = t + 2
Reference Time
1PPS
Serial data
Time = t + 1
Time = t + 2
25 – 75 ms
25 – 75 ms
25 – 75 ms

[*2]


Time = t
Time = t + 1
Time = t + 2
Reference Time
1PPS
Serial data
Time = t
Time = t + 1
25 – 75 ms
25 – 75 ms
25 – 75 ms

7.9 API [TIMEALIGN] – Time and PPS Alignment Setting

Please send this command only before initial positioning of COLD start.

Format:

$PERDAPI	,	TIMEALIGN	,	Mode	*hh	<CR>	<LF>
		1		2			

Field	Data	Range	Default	Description
1	TIMEALIGN	-	-	Command name
2	Mode	1 to 6	2	Select the output time and PPS synchronization target [*1]

Example:
$PERDAPI,TIMEALIGN,2*31
Apply the leap second to the output time, PPS synchronizes with UTC time.
The output time means the time field of GNS, ZDA and TPS1 sentences.

[*1]
The details of each time alignment mode are as follows:

Mode	Output time	PPS synchronization target	Description
1	Leap second is ignored	GPS time	Ignore leap second and UTC parameter, output GPS time, and synchronize PPS with GPS time.
2	Leap second is applied	UTC (USNO) time	Output time that leap second is applied. 1PPS is synchronized with UTC (USNO) time. [*] Reception of GPS satellite is required.
3		UTC (SU) time	Output time that leap second is applied. 1PPS is synchronized with UTC (SU) time. [*] Reception of GLONASS satellite is required.
4		UTC (EU) time	Output time that leap second is applied. 1PPS is synchronized with UTC (EU) time. [*] Reception of Galileo satellite is required.
5		UTC (NICT) time	Output time that leap second is applied. 1PPS is synchronized with UTC (NICT) time. [*] Reception of QZSS satellite is required.
6		GPS time	Output time that leap second is applied. Ignore UTC parameter, and synchronize PPS with GPS time.

The current setting value can be checked by the following command.
$PERDAPI,TIMEALIGN,QUERY*49

[Restrictions]
This command selects which satellite to acquire UTC parameters (leap seconds, leap second insertion timing, UTC correction coefficient, etc.). If not set properly, leap seconds update or leap second insertion may not be performed. Therefore, please set this command appropriately according to the setting with the GNSS command. In the default state, UTC parameters are acquired from the GPS satellites. When turning off the use of GPS satellites with the GNSS command, please select another satellite for UTC parameter acquisition again from the satellites set for use with the GNSS command.

GLONASS broadcasts the time including the leap second and does not broadcast the cumulative value of the leap second. When Mode=1 is selected during GLONASS standalone positioning, in order to match the correct output time, it is necessary to set the correct default leap second with the DEFLS command beforehand.

7.10 API [TIME] – Time Setting

This command can be used before initial positioning only when all of the following conditions are satisfied.
- After October 11, 2037 that is the timing of internal rollover
- Not use GLONSS or Galileo
- Start up with no time backup

By setting the appropriate current date with this command, it is possible to output the correct date even after internal rollover. For details of internal rollover, please also refer to the technical document (SE18-100-034).

Format:

$PERDAPI	,	TIME	,	Time of date	,	Day	,	Month	,	Year	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Data	Range	Default	Description
1	TIME	-	-	Command name
2	Time of date	00 to 23 00 to 59 00 to 59	-	Set the current hour, minute, second with 2 digits each. It does not need to be accurate.
3	Day	1 to 31	-	Current day
4	Month	1 to 12	8	Current month
5	Year	2018 to 2099	1999	Current year

Example:
$PERDAPI,TIME,021322,24,11,2020*64
Time: 02:13:22 on 24th November, 2020

[Restrictions]
- This command is required to input correct date within +/- 512 weeks.
- Do not use this command after position fix since the time obtained from satellites is used.
- For the output time, please also refer to corresponding items in Chapter 2.

7.11 API [FIXMASK] – Positioning and Satellite Mask Setting

Format:

$PERDAPI	,	FIXMASK	,	Mode	,	Elevmask	,	Reserve	,	SNRmask	,	IDSM	[,
		1		2		3		4		5		6	

Prohibit SVs (GPS)	,	Prohibit SVs (GLONASS)	,	Prohibit SVs (Galileo)	,	Prohibit SVs (QZSS)	,	Prohibit SVs (SBAS)	] *hh	<CR>	<LF>
7		8		9		10		11			

Field	Data	Range	Default	Description
1	FIXMASK	-	-	Command name
2	Mode	USER	-	Fixed value
3	Elevmask	0 to 90	0	Elevation mask [degree] Only satellites at elevation above this value are used in positioning.
4	Reserve	0	0	Reserve field
5	SNRmask	0 to 99	0	Signal level mask [dB-Hz] Only satellites with signal levels above this value are used in positioning.
6	IDSM	0	0	0 stable
7	Prohibit SVs (GPS)	32BIT (HEX)	0	GPS satellite number mask [*1] Lowest order bit means SV=01.
8	Prohibit SVs (GLONASS)	24BIT (HEX)	0	GLONASS satellite number mask [*1] Lowest order bit means SV=65.
9	Prohibit SVs (Galileo)	36BIT (HEX)	0	Galileo satellite number mask [*1] Lowest order bit means SV=01.
10	Prohibit SVs (QZSS)	5BIT (HEX)	0	QZSS L1C/A Satellite number mask [*1] In order from the lowest BIT, 93, 94, 95, 96, 99
11	Prohibit SVs (SBAS)	19BIT (HEX)	0	SBAS Satellite number mask [*1] Lowest order bit means SV=33. Set to 0 when using QZSS L1S signal.

Example:
$PERDAPI,FIXMASK,USER,10,0,37,0,0x00000092,0x000001,0x000000000,0x00,0x20000*60
Elevation mask: 10 degrees Signal level mask: 37 dB-Hz
GPS mask: GPS (BIT2 = SVID 2), GPS (BIT5 = SVID 5) and GPS (BIT8 = SVID 8)
GLONASS mask: GLONASS (BIT1 = SVID 65)
SBAS mask: SBAS (BIT18 = SVID 50)

[*1]
Each BIT corresponds to one satellite. When entering, please add 0x to the beginning. Do not set the command with a length exceeding the range.

The current setting value can be checked by the following command.
$PERDAPI,FIXMASK,QUERY*52

7.12 API [OCP] – Detailed Elevation and Azimuth Mask Setting

The elevation mask can be set for each azimuth angle of 1 degree instead of the conventional unique elevation angle mask. It is useful when fixedly installing in an environment where there are many shields such as urban areas.

When this command is used with the elevation mask of FIXMASK command, the higher mask value is applied. For example, if the elevation mask is set to 5 degrees with the FIXMASK command and the elevation mask of 30 degrees is set for the azimuth angle of 100 degrees with this command, the elevation mask 30 degrees is applied only at the azimuth angle of 100 degrees, and at the other azimuth angles the elevation mask 5 degrees is applied.

Format:

$PERDAPI	,	OCP	,	az_1	,	el_1	[,	az_2	,	el_2	[,	…	[,	az_9	,	el_9]	…	]	*hh	<CR>	<LF>
		1		2		3		4		5				18		19					

Field	Data	Range	Default	Description
1	OCP	-	-	Command name
2	az_1	000 to 359	0	Specify azimuth angle
3	el_1	00 to 99	0	Set elevation angle for the azimuth angle specified above
…	…	…	…	…
18	az_9	000 to 359	0	Specify azimuth angle
19	el_9	00 to 99	0	Set elevation angle for the azimuth angle specified above

Example:
$PERDAPI,OCP,015,45*1E
Set elevation mask 45 degrees for azimuth angle 15 degrees.
For all other azimuths, keep the state just before the command input.

$PERDAPI,OCP,015,5,244,21*1B
Set elevation mask 5 degrees for azimuth angle 15 degrees and elevation mask 244 degrees for azimuth angle 21 degrees.
For all other azimuths, keep the state just before the command input.

[Note]
It is omissible after the 4th field. You can add 0 to the beginning or omit it. For example, if you input 015 or 15, it accepts the same as 15.

The following command can specify an azimuth range and set an elevation mask for that range. It is convenient when you set the elevation mask manually.

Format:

$PERDAPI	,	OCP	,	RANGE	,	start_angle	,	end_angle	,	elevation	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Data	Range	Default	Description
1	OCP	-	-	Command name
2	RANGE	RANGE	-	Indicates that azimuth is specified as a range
3	start_angle	0 to 359	0	Start position of the azimuth angle range From this azimuth angle, specify the range in the clockwise direction.
4	end_angle	0 to 359	0	End position of the azimuth angle range Determines the azimuth range with this azimuth as the end point.
5	elevation	0 to 90	0	Set this elevation mask for the range specified above

Example:
$PERDAPI,OCP,RANGE,15,45,60*77
Set the elevation mask 60 degrees in the range from 15 to 45 degrees in the clockwise direction.
For all other azimuths, keep the state just before the command input.

$PERDAPI,OCP,RANGE,330,15,45*41
Set the elevation mask 45 degrees in the range from 315 to 15 degrees in the clockwise direction. (That is, ranges from 315 to 359 degrees and from 0 to 15 degrees are specified.)
For all other azimuths, keep the state just before the command input.

[Note]
The current set value can be checked by one of the following commands. Since this sentence has a lot of output, please choose according to the baud rate and the output of other sentences.

$PERDAPI,OCP,QUERY*4D
The setting value is output for all azimuth angles from 0 to 360 degrees. Since it is displayed in a total of 18 lines, the sentence output amount increases, and in some cases it may not be able to output all of them.

$PERDAPI,OCP,QUERY1*7C
The setting value is output for the first half azimuth angle from 0 to 180 degrees. It displays with a total of 9 lines.

$PERDAPI,OCP,QUERY2*7F
The setting value is output for the second half azimuth angle from 180 to 360 degrees. It displays with a total of 9 lines.

The output format for QUERY is as follows.

Format:

$PERDAPI	,	OCP	,	num	,	el_0	,	el_1	,	···	,	el_19	*hh	<CR>	<LF>
		1		2		3		4				23			

Field	Data	Range	Default	Description
1	OCP	-	-	Command name
2	num	01 to 18	-	Current number of lines of OCP sentence. In case of 01, the elevation mask value for the azimuth angle 0 to 19 degrees is output, and in case of 02, the elevation mask value for the azimuth angle 20 to 39 degrees is output on that line.
3	el_0	00 to 99	0	Elevation mask for azimuth angle “num * 20 + 0” degrees
4	el_1	00 to 99	0	Elevation mask for azimuth angle “num * 20 + 1” degrees
…	…	…	…	…
23	el_19	00 to 99	0	Elevation mask for azimuth angle “num * 20 + 19” degrees

Example:

$PERDAPI,OCP,01,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15*06
$PERDAPI,OCP,02,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15*05
$PERDAPI,OCP,03,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15*04
$PERDAPI,OCP,04,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15*03
$PERDAPI,OCP,05,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15*02
$PERDAPI,OCP,06,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15*01
$PERDAPI,OCP,07,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15*00
$PERDAPI,OCP,08,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15*0F
$PERDAPI,OCP,09,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15*0E
$PERDAPI,OCP,10,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15,15*06
$PERDAPI,OCP,11,15,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00*03
$PERDAPI,OCP,12,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00*04
$PERDAPI,OCP,13,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00*05
$PERDAPI,OCP,14,00,00,00,00,00,00,00,00,00,00,45,45,45,45,45,45,45,45,45,45,45*02
$PERDAPI,OCP,15,45,45,45,45,45,45,45,45,45,45,45,45,45,45,45,45,45,45,45,45,45,45*03
$PERDAPI,OCP,16,45,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00*01
$PERDAPI,OCP,17,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00*01
$PERDAPI,OCP,18,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00,00*0E

Elevation mask 15 degrees in the range from 0 to 200 degrees and Elevation mask 45 degrees in the range from 270 to 300 degrees are set.

7.13 API [NLOSMASK] – NLOS Satellite Elimination Algorithm Setting

We recommend using the default setting when there is no particular need.

Format:

$PERDAPI	,	NLOSMASK	,	mode	,	Threshold1	,	Threshold2	,	Threshold3	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Data	Range	Default	Description
1	NLOSMASK	-	-	Command name
2	mode	0, 1	1	Algorithm to eliminate NLOS satellites [*1] 0 : OFF / 1 : ON
3	Threshold 1	0 to 3600	0	Time to intentionally hold the positioning calculation after starting or restarting [second] [*2]
4	Threshold 2	0 to 99	30	Signal level mask which is limitedly set only until the probable position is calculated [dB-Hz] [*3] After calculating the probable current position, this mask setting will be invalid.
5	Threshold 3	0 to 9999	50	Threshold for determining which satellite is the NLOS satellite [nsec] [*4] The smaller the numerical value, the more severe the condition of LOS satellite.

Example:
$PERDAPI,NLOSMASK,1,1000,40,50*4C
Use algorithm to eliminate NLOS satellites. Positioning is held for 1000 seconds after starting or restarting, and then positioning calculation will start. Signal level mask 40 [dB-Hz] is applied until the probable position is calculated, satellites below that are not used in positioning. After calculating the probable current position, the signal level mask 40 is canceled, and only satellites within the threshold value of 50 ns are used in time calculation.

The current setting value can be checked by the following command.
$PERDAPI,NLOSMASK,QUERY*1B

[*1]
Fine adjustment of this algorithm is possible by adjusting the threshold after the third field.

[*2]
Normally, general GNSS receivers tend to start positioning calculation as soon as possible when satellite signals can be received. This is because they are tuned for solutions that require the need to quickly fix the position for car navigation etc.

On the other hand, in the timing solution focused on long-term time stability, it is important to continually determine the position and time rather than the initial positioning quickness.

The setting tuned for car navigation is effective for getting rough location information quickly. However, depending on the positioning environment, there are concerns that positioning is performed with four satellites including only NLOS satellites and the initial position is determined. This is because even if LOS satellites can be found by searching enough time, positioning calculation is performed using the previously received satellites. In this case, position accuracy is bad and time accuracy may be affected.

This field addresses such concerns. By setting a value in this field, deliberately delay the start of positioning calculation and set a period to focus only on satellite search. GNSS satellites generally broadcast almanac which is rough orbital information of the satellite in about 900 seconds cycle. By holding this time or more, it is possible to drastically reduce the loss of the satellite existing above the sky.

The counter to be compared with this threshold value is unconditionally incremented every second regardless of the connection state of the antenna or reception environment after startup or restart. The counter is reset only at restart.

This setting is not applied in the NAV mode.

[*3]
This field sets a signal level mask. The same setting can be done with the FIXMASK command. However, unlike the setting of the FIXMASK command which is executed at all times, this setting is applied only for a limited period until the probable position can be calculated.

In general, the signal level mask is considered useful for eliminating NLOS satellites. The setting of an appropriate signal level mask is said to be useful for improving positioning accuracy. However, the persistent signal level mask has a problem that it is difficult to use because there is a possibility that the satellite interruption may be immediately caused when the reception environment deteriorates.

This field focuses on determining the fixed position which has a particularly large effect on the calculation of time. The signal level is masked until the fixed position is roughly determined. After finding a certain position, the mask is released. As a result, positioning can be continued while ensuring time accuracy even in a badly conditioned environment with many shielding objects.

When using the signal level mask of the FIXMASK command together, the higher mask value is applied.

This setting is not applied in the NAV mode.

[*4]
This product is equipped with an algorithm that regards it as an NLOS satellite when the time until the satellite signal arrives at the receiver is later than the expected time. This field can fine-tune the threshold to determine it.

Even satellites that do not satisfy the threshold set in this field are counted as positioning satellites and also displayed on the GSA sentence. Internally, the process of reducing the contribution to the positioning of the target satellite is applied.

This setting may be applied even in the NAV mode.

7.14 API [MODESET] – Frequency Mode Transition Condition Setting

We recommend using the default setting when there is no particular need.

Format:

$PERDAPI	,	MODESET	,	Lock port	,	Coarse lock threshold	,	Phase skip threshold	*hh	<CR>	<LF>
		1		2		3		4			

Field	Data	Range	Default	Description
1	MODESET	-	-	Command name
2	Lock port	0 to 5	1	Frequency mode for changing LOCK terminal to logic high (Lock) 0: Frequency mode is 2, 3 or 4 1: Frequency mode is 2 or 3 2: Frequency mode is 3 3: Frequency mode is 3 or 4 4: Always Logic L 5: Always Logic H
3	Coarse lock threshold	0 to 999999	GF-8801: 50000 GF-8802: 50000 GF-8803: 10000 GF-8804: 5000 GF-8805: 1500	PPS timing accuracy for changing the frequency mode from "Pull-in" to "Coarse lock" [nsec] GF-8801: <+/- 50 usec GF-8802: <+/- 50 usec GF-8803: <+/- 10 usec GF-8804: <+/- 5 usec GF-8805: <+/- 1.5 usec
4	Phase skip threshold	0 to 999999	0	Threshold of PPS timing error for running phase skip when phase skip flag setting is automatic execution. [nsec] [*1]

Example:
$PERDAPI,MODESET,1,4000,1000*2E
LOCK terminal will be Logic H when the frequency mode is Fine lock or Coarse lock.
Threshold for transition from Pull-in to Coarse lock: 4000 nsec
Phase skip threshold in Pull-in: 1000 nsec (In Pull-in mode, phase skip is executed when the time difference exceeds 1000 ns)

[*1]
0: Phase skip is always executed when the frequency mode is "Pull-In".
999999: Phase skip is not executed. (Even if 999999 is set, when setting 1 with the PHASESKIP command, phase skip will be executed.)

The current setting value can be checked by the following command.
$PERDAPI,MODESET,QUERY*50

7.15 API [PHASESKIP] – Phase Skip Setting

The state of the current phase skip flag can be checked with TPS4 sentence. You do not need to use this command when there is no particular need.

Format:

$PERDAPI	,	PHASESKIP	,	phase skip flag	*hh	<CR>	<LF>
		1		2			

Field	Data	Range	Default	Description
1	PHASESKIP	-	-	Command name
2	phase skip flag	1	1	1: Set the phase skip flag [*1]

[*1]
By default, phase skip is executed when the frequency mode is Pull-in. After executing the phase skip, the phase skip flag returns to 0. When the phase skip flag is set to 1 with this command, if the frequency mode is Fine lock or Coarse lock, forcibly return to Pull-in and execute the phase skip. Please use only when executing the phase skip at arbitrary timing.

7.16 API [HOSET] – Holdover Setting

This command customizes the conditions to transition to HOLDOVER and the HOLDOVER period.

Format:

$PERDAPI	,	HOSET	,	Ho set flag	[,	Learning time set0	,	Available time set0	,
		1		2		3		4	

Learning time set1	,	Available time set1	,	Learning time set2	,	Available time set2]	*hh	<CR>	<LF>
5		6		7		8			

Field	Data	Range	Default	Description
1	HOSET	-	-	Command name
2	Ho set flag	0,1	0	Set flag [*1] 0: Default 1: Manual setting
3	Learning time set0	0 to 9999999	259200	Learning time (set0) [sec] (259200 [sec] = 72 [hour])
4	Available time set0	0 to 999999	86400	Holdover available time (set0) [sec] (86400 [sec] = 24 [hour])
5	Learning time set1	0 to Learning time set0	600	Learning time (set1) [sec]
6	Available time set1	0 to Available time set0	3600	Holdover available time (set1) [sec]
7	Learning time set2	0 to Learning time set1	0	Learning time (set2) [sec]
8	Available time set2	0 to Available time set1	0	Holdover available time (set2) [sec]

Example:
$PERDAPI,HOSET,1,259200,86400,172800,57600,86400,28800*29
When the learning time of 3 days or more is satisfied, the holdover for 86400 seconds is available.
When the learning time of more than 2 days and less than 3 days is satisfied, the holdover for 57600 seconds is available.
When the learning time of more than 1 day and less than 2 days is satisfied, the holdover for 28800 seconds is available.

[*1]
When 0 is set, all settings after the third field are reset to their initial values. When 0 is set in this field, do not set after the third field.

The current setting value can be checked by the following command.
$PERDAPI,HOSET,QUERY*54

7.17 API [EXTSYNC] – External Synchronized Function Setting

Format:

$PERDAPI	,	EXTSYNC	,	mode	,	delay set	*hh	<CR>	<LF>
		1		2		3			

Field	Data	Range	Default	Description
1	EXTSYNC	-	-	Command name
2	mode	0 to 4	0	External synchronized mode [*1] 0: OFF 1: ON mode (1) 2: ON mode (2) 3: Automatic change mode (1) 4: Automatic change mode (2)
3	delay set	-999999 to +999999	0	EPPS timing delay time between the EPPS and the output PPS [nsec] [*2]

Example:
$PERDAPI,EXTSYNC,1,100*39
External synchronized mode: ON mode (1)
Output PPS is offset to EPPS by 100 nsec.

[*1]
When changing the mode, it is necessary to set to OFF mode (0) once. Details of the synchronous mode are as follows.

mode	Description
0	Use GNSS synchronization mode. EPPS is not used.
1	Synchronize with EPPS. The delay set value is used for the timing delay time.
2	Synchronize with EPPS. The timing delay time is automatically calculated in Fine lock.
3	Synchronize with GNSS during GNSS fix, and synchronize with EPPS only when GNSS interrupted. The delay set value is used for the timing delay time.
4	Synchronize with GNSS during GNSS fix, and synchronize with EPPS only when GNSS interrupted. The timing delay time is automatically calculated in Fine lock.

[*2]
This value is available only when the mode is "1" or "3". Set to "0" at the other mode.

The current setting value can be checked by the following command.
$PERDAPI,EXTSYNC,QUERY*5F

The following field is added to the response sentence of QUERY.

4	delay calculate	-999999 to +999999	0	EPPS timing delay time calculated from the PPS generated by GNSS fix [nsec]

7.18 API [ANTSET] – Antenna Power Feed Setting

Format:

$PERDAPI	,	ANTSET	,	Antenna status	*hh	<CR>	<LF>
		1		2			

Field	Data	Range	Default	Description
1	ANTSET	-	-	Command name
2	Antenna status	0, 1	1	Antenna power status to antenna terminal 0: Antenna power OFF 1: Antenna power ON

Example:
$PERDAPI,ANTSET,1*73
Supply power to the antenna.

The current setting value can be checked by the following command.
$PERDAPI,ANTSET,QUERY*08

7.19 API [ALMSET] – Alarm Output Setting

Format:

$PERDAPI	,	ALMSET	,	Force alarm	,	Alarm mask	*hh	<CR>	<LF>
		1		2		3			

Field	Data	Range	Default	Description
1	ALMSET	-	-	Command name
2	Force alarm	0x00 to 0xFF	0x00	Forcibly set alarm of this BIT. [*1]
3	Alarm mask	0x00 to 0xFF	0xFF	Forcibly mask alarms other than this BIT. [*1]

[*1]
Mask processing takes precedence.

Example:
$PERDAPI,ALMSET,0x00,0xFC*70
Not output the antenna current error (0x01: OPEN, 0x02: SHORT) in the alarm field of CRZ(TPS4). !0xFC masks 0x03 bit. (alarm mask)

The current setting value can be checked by the following command.
$PERDAPI,ALMSET,QUERY*13

7.20 API [CROUT] – CR Sentence Output Setting

Format:

$PERDAPI	,	CROUT	,	Type	,	Rate	*hh	<CR>	<LF>
		1		2		3			

Field	Data	Range	Default	Description
1	CROUT	-	-	Command name
2	Type	G, J, P, Q, W, X, Y, Z	W,X,Y,Z	Output CR sentence Multiple sentences can be set at the same time. Alphabets of outside range are reserved.
3	Rate	W,X,Y,Z: 0 to 255 Others: 0 or 1	1	Output interval or stop setting P,W,X,Y,Z: 1 to 255: Output interval [second] 0: Output stop Others: 1: Output every event occurrence 0: Output stop Reserved except for the above range

Example:
$PERDAPI,CROUT,W,1*4E
CRW (TPS1) sentence is output every second.

$PERDAPI,CROUT,XZ,3*19
CRX (TPS2) sentence and CRZ (TPS4) sentence are output every 3 seconds.

$PERDAPI,CROUT,W,0*4F
CRW (TPS1) sentence is stopped.

7.21 CFG [NMEAOUT] – Standard NMEA Output Setting

Format:

$PERDCFG	,	NMEAOUT	,	Type	,	Interval	*hh	<CR>	<LF>
		1		2		3			

Field	Data	Range	Default	Description
1	NMEAOUT	-	-	Command name
2	Type	[*1]	-	Standard NMEA sentence [*1] GGA, GLL, GNS, GSA, GSV, RMC, VTG, ZDA, ALL. (ALL means all sentences from GGA to ZDA.)
3	Interval	0 to 60	-	Output interval [second] When set to 0, output is stopped after outputting sentence only once.

Example:
$PERDCFG,NMEAOUT,GGA,2*57
GGA sentence is output every 2 sec.

$PERDCFG,NMEAOUT,GSV,0*56
After outputting GSV sentence only once, stop outputting.

7.22 CFG [UART1] – Serial Communication Port Setting

Format:

$PERDCFG	,	UART1	,	Baudrate	*hh	<CR>	<LF>
		1		2			

Field	Data	Range	Default	Description
1	UART1	-	-	Command name
2	Baudrate	4800, 9600, 19200, 38400, 57600, 115200, 230400, 460800	38400	Baud rate [bps] Depending on the hardware, it may not support 230400 bps or higher.

Example:
$PERDCFG,UART1,115200*65
Baud rate: 115200 bps

7.23 SYS [VERSION] – Software Version Request

This command requests output of software version information.

Format:

$PERDSYS	,	VERSION	*hh	<CR>	<LF>
		1			

Field	Data	Range	Default	Description
1	VERSION	-	-	Command name

Example:
$PERDSYS,VERSION*2C

7.24 SYS [ANTSEL] – Antenna Input Setting

Format:

$PERDSYS	,	ANTSEL	,	Input	*hh	<CR>	<LF>
		1		2			

Field	Data	Range	Default	Description
1	ANTSEL	-	-	Command name
2	Input	FORCE1L FORSE2	FORCE2	GNSS antenna input setting FORCE1L: Use #6(RF PIN) FORCE2: Use #RF(RF_COAX)

Example:
$PERDSYS,ANTSEL,FORCE1L*7B
Use #6(RF PIN)

The current setting value can be checked by the following command.
$PERDSYS,ANTSEL,QUERY*11

[Notes on ANTSEL command]
This setting is only available for GF-8801, GF-8802 and GF-8803.
Do not use the command for GF-8804 and GF-8805.

8 Backup of the Receiver Parameters (for BBRAM)

The GF-880X stores the satellite information, the positioning result and the command setting to a backup area, and can use them at the next power on. The GF-880X has a BBRAM as a backup area. The BBRAM is a storage area which can back up while the backup power supply (VBK) is available. The backup to the BBRAM executes automatically every second. When inputting a command, the setting is backed up at the timing. The stored data are erased by RESTART command and an interruption of the backup power supply.

The parameters which this receiver has backed up are shown below.

Table 8.1 Backup of Receiver Parameters (Time, Position, Satellite Data)

CONTENTS	PARAMETER	HOT	WARM	COLD	FACTORY	POWER OFF/ON
Present time	Date & Time	YES	YES	YES	NO	YES [*2]
	Millennium	YES	YES	YES	NO	YES
Current position	Latitude	YES	YES	YES	NO	YES
	Longitude	YES	YES	YES	NO	YES
	Altitude	YES	YES	YES	NO	YES
Hold position [*1]	Latitude	YES	YES	YES	NO	YES [*3]
	Longitude	YES	YES	YES	NO	YES [*3]
	Altitude	YES	YES	YES	NO	YES [*3]
Ephemeris	Ephemeris data	YES	NO	NO	NO	YES [*4]
Almanac	Almanac data	YES	YES	NO	NO	YES

[*1] The survey position has been calculated, or the position mode is set to TO (Time only) mode by "$PERDAPI,SURVEY,3".
[*2] The updating time during the backup may have a big difference depending on the length of power-off time due to the internal LC circuit. In this case, the time will be adjusted by GNSS position fix.
[*3] CSS (continues survey) mode or TO (time only) mode only.
[*4] HOT start with the ephemeris data is available only when the power supply interruption is less than five seconds.

Table 8.2 Backup of Communication Setting

COMMAND NAME	PARAMETER	HOT	WARM	COLD	FACTORY	POWER OFF/ON
UART1	Baud rate of UART1	YES	YES	YES	YES	NO
NMEAOUT	NMEA output interval	YES	YES	YES	YES	NO

Table 8.3 Backup of Command Setting

COMMAND NAME	PARAMETER	HOT	WARM	COLD	FACTORY	POWER OFF/ON
GNSS	GNSS setting	YES	YES	YES	NO	YES
PPS	PPS setting	YES	YES	YES	NO	YES
GCLK	GCLK setting	YES	YES	YES	NO	YES
SURVEY	position mode	YES	YES	YES	NO	YES
	Sigma threshold	YES	YES	YES	NO	YES
	Time threshold	YES	YES	YES	NO	YES
	Calculation process of survey position	YES [*1]	YES [*1]	YES [*1]	NO	YES [*1]
DEFLS	Default leap second	YES	YES	YES	NO	YES
TIMEZONE	LZT setting	YES	YES	YES	NO	YES
TIMEALIGN	Time alignment	YES	YES	YES	NO	YES
FIXMASK	FIXMASK setting	YES	YES	YES	NO	YES
OCP	OCP setting	NO	NO	NO	NO	NO
NLOSMASK	NLOS satellite elimination setting	YES	YES	YES	NO	YES
MODESET	Frequency mode setting	YES	YES	YES	NO	YES
HOSET	Holdover setting	YES	YES	YES	NO	YES
EXTSYNC	EPPS setting	YES	YES	YES	NO	YES
ANTSET	Antenna power feed setting	YES	YES	YES	NO	YES
ALMSET	Alarm setting	YES	YES	YES	NO	YES
CROUT	CR sentence output setting	YES	YES	YES	NO	YES
ANTSEL	Antenna input setting	YES	YES	YES	YES	NO

[*1] CSS (continues survey) mode or TO (time only) mode only.

9 Insertion of Leap Second

This product outputs the time information as shown below when a leap second is adjusted.

[Leap second (+1) insertion]
When inserting a leap second (+1), 23:59:60 is inserted at the update timing.
The table below shows an example.

GPS time	UTC date	UTC time
1009411213	December 31, 2011	23:59:58
1009411214	December 31, 2011	23:59:59
1009411215	December 31, 2011	23:59:60
1009411216	January 1, 2012	00:00:00
1009411217	January 1, 2012	00:00:01
1009411218	January 1, 2012	00:00:02

[Leap second (-1) insertion]
When inserting a leap second (-1), 23:59:59 is removed at the update timing.
The table below shows an example.

GPS time	UTC date	UTC time
1056672013	June 30, 2013	23:59:57
1056672014	June 30, 2013	23:59:58
1056672015	July 1, 2013	00:00:00
1056672016	July 1, 2013	00:00:01
1056672017	July 1, 2013	00:00:02

10 Instructions and Directions for Use

When using GLONASS with this product, please use a multi-GNSS antenna. When setting to use GLONASS with GPS antenna, GLONASS signals may be received in rare case. However, this product does not guarantee the operation in this state.

In case of selecting GLONASS and the other satellites (GPS/Galileo/QZSS) together, this product uses GLONASS in position fix after the time is fixed with either GPS/Galileo/QZSS. Therefore, when it cannot receive the required number of GPS/Galileo/QZSS for position fix, it may not do position fix with GLONASS satellites. However, in case of GLONASS standalone positioning, GLONASS positioning is immediately performed.

Galileo and GLONASS satellites output parameters for converting the time system of each satellite to GPS time. According to ICD, it is defined as follows.

GGTO: Difference between Galileo time and GPS time
tauGPS: Difference between GLONASS time and GPS time

GGTO is broadcasted from the Galileo satellite in a cycle of 60 seconds, and tauGPS is broadcasted from the GLONASS satellite in a cycle of 30 seconds.

When setting to use multiple satellites including Galileo (e.g. GPS+Galileo) with GNSS command, Galileo will not be used for positioning until GGTO acquisition. However, when using Galileo alone, positioning will start without waiting for GGTO acquisition. In this case, 1PPS is output at Galileo time until GGTO acquisition even if 1PPS is set to GPS synchronization.

As of 2018, QZSS has fewer satellites being operated compared to GPS and GLONASS. Therefore, depending on the time zone it may not be received because it is located at a low elevation angle. We recommend that you use QZSS in conjunction with other satellites in order to ensure consistent time output and positioning continuously.

QZSS satellites do not broadcast parameters for converting to GPS time like GGTO of Galileo satellite or tauGPS of GLONASS satellite. Therefore, 1PPS is output in synchronization with the QZSS time even if 1PPS is set to GPS synchronization.

This product implements a mechanism to check the consistency of the message content of the signal received from the antenna. Therefore if the product is connected to the simulator after positioning with the actual satellite in the continuous energized state without turning the power OFF/ON or restarting, or vice versa, positioning may not be performed. The case that the simulator scenario is changed in the middle is the same. In this case, positioning can be performed by executing power OFF/ON or by sending a RESTART command.

Details of the specifications other than the protocol of this product are also described in the hardware specifications.

11 FAQ

Q. The receiver cannot receive satellite signals. What kind of causes can you think of?

A. Please check whether this product and the antenna are properly connected. Especially when the signal level is low as a whole, there is a possibility that proper gain may not be maintained even if this product and the antenna are physically connected by cables.

Q. Even though the antenna setting is appropriate, positioning is not possible. What kind of causes can you think of?

A. Among the commands being backed up, there may be a factor impeding positioning. Or, positioning may not be possible since almanac data being backed up is abnormal. In this case, execute FACTORY COLD with the RESTART command and erase all backups with the FLASHBACKUP command.

Q. Is there a command to output the almanac acquisition time?

A. eSIP protocol does not have such command.

Q. Is there an expiration date for the almanac?

A. With this product, the almanac has no expiration date.

Q. **In case of any abnormality in this product, how is it notified?**

A. When this product finds an unexpected exception processing, it will automatically restart after outputting the following message. “*” in the message indicates the register value, and “xx” indicates the type of exception.
<CRASH PC=* SR=* EXCEPTION=xx R0=* R1=* R2=* R3=* R4=* R5=* R6=* R7=* R8=* R9=* R10=* R11=* R12=* SP=* LR=*>