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FURUNO

FURUNO Multi-GNSS Disciplined Oscillator

Models GF-8701, GF-8702, GF-8703, GF-8704, GF-8705

Protocol Specifications

(Document No. SE17-600-006-00)

FURUNO ELECTRIC CO., LTD.

www.furuno.com

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Revision History

Version	Changed contents	Date
0	Changed from G15-000-11-001-00.	2017.02.27
	Chapter 3—Added Notes (*2)	
	5.2 GLL—Corrected the range of Status (field 6).	
	5.4 GSA—Corrected the example.	
	5.5 GSV—Corrected the range of field 3. Corrected the unit of SNR.	
	6.1.1 ALMSET—Added.	
	6.1.4 DEFLS—Updated the default value of field 2.	
	6.1.5 EXTSYNC—Added Notes.	
	6.1.6 FIXMASK—Corrected the range of field 8, the example and the Notes.	
	6.1.7 GCLK—Changed the field 4 and 5. Added Notes.	
	6.1.8 GNSS—Added Notes.	
	6.1.9 HOSET—Added.	
	6.1.10 MODESET—Added “4” and “5” to Lock port set (field 2).	
	6.1.12 PPS—Updated Notes.	
	6.1.14 SURVEY—Changed the position mode name (field 2). Updated Notes.	
	6.3.1 ANTSEL—Added.	
	7.3.1 CRW (TPS1)—Updated the default value of field 5. Removed Notes.	
	7.3.2 CRX (TPS2)—Corrected the example.	
	7.3.3 CRY (TPS3)—Changed the position mode name (field 2).	
	7.3.4 CRZ (TPS4)—Added “0x02” and “0x04” to status (field 5). Update field 9. Corrected the range of field 10. Added note (*2). Added Notes.	
	7.4.1 ANTSEL—Updated field 2 and field 3.	
	Removed BBRAM sentence.	
	Chapter 8—Added descriptions. Added commands to Table 8.2. Added Notes.	
	Added Chapter 9, 10 and 11.	

Table of Contents

1 Outline

This document describes the serial communications interface protocol for the FURUNO Multi-GNSS Disciplined Oscillator (GNSSDO) which is GF-8701, GF-8702, GF-8703, GF-8704 and GF-8705(*1).

Notes:
(*1) This document shows these GNSSDO as GF-870x.

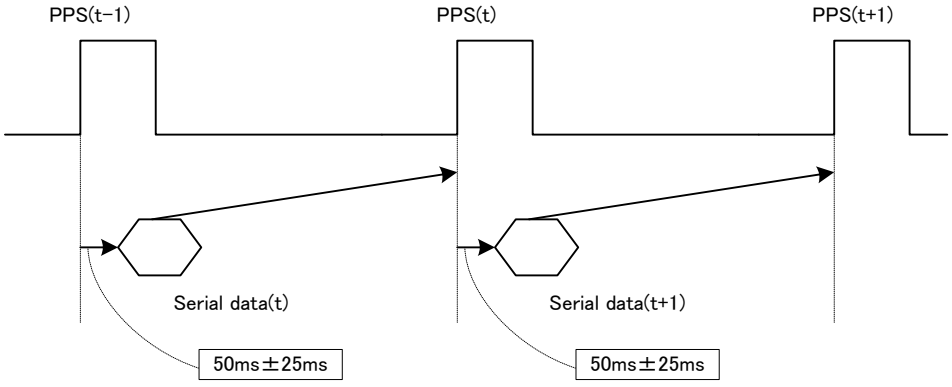
2 Communication Specifications

Signal Lines used:	TXD, RXD
Flow Control:	None
System:	Full Duplex Asynchronous
Speed:	38400 bps
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 (*1)
Protocol:	Input data NMEA Proprietary sentence Output data NMEA Standard sentence NMEA Proprietary sentence

Notes:
(*1) "NMEA 0183 STANDARD FOR INTERFACING MARINE ELECTRONIC DEVICES Version 4.10" (NATIONAL MARINE ELECTRONICS ASSOCIATION, June, 2012)

3 Serial Data Output Timing

The output timing of serial data is synchronized with PPS output timing (*1)(*2). Serial data output begins in the 25ms to 75ms range after PPS is output. The serial data time indicates the next PPS output timing.



Notes:
(*1) When the frequency mode is in Warm Up state, the serial data is not synchronized with PPS. After the mode changes to Pull-In, the data is synchronized with PPS. (See Section 7.3.4 about the frequency mode.)
▲0 (*2) The serial data should be output within the one second time period to keep the output synchronized between the serial data and the PPS. If NMEA messages exceed one second period, the messages will need to be reduced or alternately a higher baud rate must be used. For example outputting RMC, GNS, VTG, GSA, ZDA and GSV sentences at 4800 bps will exceed the one second time period before the ZDA sentence is output. In this case, remove the GSV sentence output or set to a higher baud rate.

4 NMEA Sentence Format

4.1 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 formatter. All output sentences must begin with a “$” followed by a TalkerID. The relevant Talker IDs are GP for GPS, GN for GNSS and GL for GLONASS. For the sentences received from external equipment, the GNSSDO accepts any talker ID. Talker ID “--” found on the succeeding pages denotes a wildcard meaning “any valid talker ID”.
<data field>	Variable or fixed-length fields preceded by delimiter “,” (comma). Comma(s) are required even when valid field data is not available i.e. null fields. Ex. “,,,,,” In a numeric field with fixed field length, fill unused leading digits with zeroes.
*<checksum field>	8 bits data between “$” 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

4.2 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. GNSSDO'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.)
*<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 Standard NMEA Output Sentences

The receiver supports eight standard NMEA output sentences (GGA, GLL, GNS, GSA, GSV, RMC, VTG and ZDA) per NMEA standard 0183 Version 4.10 (June, 2012). By default, the RMC, GNS, GSA, ZDA, GSV and TPS sentences (TPS1, TPS2, TPS3 and TPS4) will be output every second. The sentences can be independently enabled and disabled using the NMEAOUT and/or CROUT command described later in this document, as well as use differing transmission rates.

The NMEA sentence descriptions in this sentence are for reference only. The sentence formats are defined exclusively by the copyrighted document from NMEA.

There are unsupported fields in the output sentences. This document shows these fields as "n/a". These fields are null fields.

5.1 GGA – Global Positioning System Fix Data

Format:

$--GGA	,	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	,	xxx	,	xxx	*hh	<CR>	<LF>
8		9		10		11		12		13		14			

Field	Data type	Range	Description
1	hhmmss.sss	000000.000 to 235959.999	Coordinated Universal Time (UTC) hh: [hour], mm: [minute], ss.sss: [second]
2	ddmm.mmmm	0000.0000 to 9000.0000	Latitude dd: [degree], mm.mmmm: [minute]
3	a	N,S	"N" (North) or "S" (South)
4	dddmm.mmmm	00000.0000 to 18000.0000	Longitude ddd: [degree], mm.mmmm: [minute]
5	a	E,W	"E" (East) or "W" (West)
6	x	0 to 2	GNSS Quality Indication 0: Fix not available or invalid 1: Valid fix 2: DGPS positioning
7	xx	00 to 12	Number of satellites in use (*1)
8	x.x	Null, 0.0 to 50.0	Horizontal dilution of precision (HDOP) A null field is output while positioning is interrupted.
9	x.x	-	Altitude above/below mean sea-level (Geoid)
10	M	M	Units of altitude, meters
11	x.x	-	Geoidal height
12	M	M	Units of Geoidal height, meters
13	xxx	n/a	Age of differential GPS data
14	xxx	n/a	Differential reference station ID

Example:

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

Notes:

(*1) GPS, SBAS, QZSS only. GLONASS is not counted. The upper limit is 12.

5.2 GLL – Geographic Position - Latitude/Longitude

Format:

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

Field	Data type	Range	Description
1	ddmm.mmmm	0000.0000 to 9000.0000	Latitude dd: [degree], mm.mmmm: [minute]
2	a	N,S	"N" (North) or "S" (South)
3	dddmm.mmmm	00000.0000 to 18000.0000	Longitude ddd: [degree], mm.mmmm: [minute]
4	a	E,W	"E" (East) or "W" (West)
5	hhmmss.sss	000000.000 to 235959.999	Coordinated Universal Time (UTC) hh: [hour], mm: [minute], ss.sss: [second]
6	a	A,V ▲0	Status A: Data valid V: Data invalid
7	a	A,D,N	Mode Indication A: Autonomous D: Differential N: Data invalid

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 UTC: 02:54:11.516 Status: Data valid
Mode: Autonomous

5.3 GNS – GNSS Fix Data

Format:

$--GNS	,	hhmmss.sss	,	ddmm.mmmm	,	a	,	dddmm.mmmm	,	a	,	c-c	,	xx	,
		1		2		3		4		5		6		7	

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

Field	Data type	Range	Description
1	hhmmss.sss	000000.000 to 235959.999	Coordinated Universal Time (UTC) hh: [hour], mm: [minute], ss.sss: [second]
2	ddmm.mmmm	0000.0000 to 9000.0000	Latitude dd: [degree], mm.mmmm: [minute]
3	a	N,S	"N" (North) or "S" (South)
4	dddmm.mmmm	00000.0000 to 18000.0000	Longitude ddd: [degree], mm.mmmm: [minute]
5	a	E,W	"E" (East) or "W" (West)
6	c-c	A,D,N	Mode Indicator for each satellite system (GPS, GLONASS, Galileo) A: Autonomous D: Differential N: Data invalid
7	xx	00 to 32	Number of satellites in use
8	x.x	Null, 0.0 to 50.0	Horizontal dilution of precision (HDOP) A null field is output while positioning is interrupted.
9	x.x	-	Altitude above/below mean sea-level (Geoid) [meter]
10	x.x	-	Geoidal height [meter]
11	x	n/a	Age of differential GPS data
12	x	n/a	Differential reference station ID
13	x	V	Navigation status indicator V: Not valid

Example:

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

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

Status: Data valid (GPS: Differential, GLONASS: Differential, Galileo: Invalid)

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

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

5.4 GSA – GNSS DOP and Active Satellites

Format:

$--GSA	,	a	,	a	,	xx	,	xx	,	xx	,	・・・	,	xx	,	x.x	,	x.x	,	x.x	,	h	*hh	<CR>	<LF>
		1		2		3		4		5		6-13		14		15		16		17		18			

Field	Data type	Range	Description
1	a	M,A	Operational mode M: 2D/3D fixed mode A: 2D/3D auto-switching mode
2	a	1,2,3	Mode 1: No fix 2: 2D fix 3: 3D fix
3-14	xx	Null, 01 to 99	Satellite numbers used in positioning A null field is output unless a satellite is available.
15	x.x	Null, 0.0 to 50.0	PDOP A null field is output unless 3D-positioning is performed.
16	x.x	Null, 0.0 to 50.0	HDOP A null field is output while positioning is interrupted.
17	x.x	Null, 0.0 to 50.0	VDOP A null field is output unless 3D-positioning is performed.
18	h	1,2	GNSS System ID 1: GPS (involve SBAS and QZSS) 2: GLONASS

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
Operation mode: 2D/3D auto-switching mode Position fix mode: 3D fix
Satellite used: 09, 15, 26, 05, 24, 21, 08, 02, 29, 28, 18, 10, 79, 69, 68, 84, 85, 80, 70, 83
PDOP: 0.8 HDOP: 0.5 VDOP: 0.5 ▲0

Notes:

- To add extra fields to the GPGSA NMEA string to show more than 12 satellites used in the fix, please input “$PERDAPI,EXTENDGSA,num*hh<CR><LF>”. “num” is Number of fields for satellites used in the fix. Acceptable values are: 12-16. The default is 12. By creating more fields for satellites used in the fix, the PDOP/HDOP/VDOP values shift by num12 fields.
- Satellite number means the below.
  Satellite number from 01 to 32 indicates GPS (01 to 32)
  Satellite number from 33 to 51 indicates SBAS (120 to 138)
  Satellite number from 65 to 92 indicates GLONASS (slot 01 to slot 28)
  Satellite number from 93 to 99 indicates QZSS (193 to 199)

5.5 GSV – GNSS Satellites in View

Format:

$--GSV	,	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 type	Range	Description
1	x	1 to 4	Total number of messages
2	x	1 to 4	Message number
3	xx	00 to 16 ▲0	Number of satellites in line-of-sight
4	xx	01 to 99	1st satellite ID number
5	xx	00 to 90	1st satellite elevation angle [degree]
6	xxx	000 to 359	1st satellite azimuth angle [degree]
7	xx	00 to 99	1st satellite SNR (Signal/Noise Ratio) [dB-Hz] ▲0
8-11	-	-	2nd satellite details
12-15	-	-	3rd satellite details
16-19	-	-	4th satellite details
20	h	1	Signal ID

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
Sentence Number
Total number of Message

<checksum><CR><LF> is output right after the last satellite data output.

Notes:

- In this sentence, a maximum of four satellite details is indicated per each output. Five or more satellite details are output in the 2nd or 3rd messages. When there is an item which is not fixed in the satellite details, a null field is output. When there are only one to four satellite details, <checksum><CR><LF> is issued immediately after Sat. SV#, Sat. elevation angle, Sat. azimuth angle and SNR.
- Satellite number means the below.
  Satellite number from 01 to 32 indicates GPS (01 to 32)
  Satellite number from 33 to 51 indicates SBAS (120 to 138)
  Satellite number from 65 to 92 indicates GLONASS (slot 01 to slot 28)
  Satellite number from 93 to 99 indicates QZSS (193 to 199)

5.6 RMC – Recommended Minimum Navigation Information

Format:

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

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

Field	Data type	Range	Description
1	hhmmss.sss	000000.000 to 235959.999	UTC time hh: [hour], mm: [minute], ss.sss: [second]
2	a	A,V	Status A: Data valid V: Data invalid
3	ddmm.mmmm	0000.0000 to 9000.0000	Latitude dd: [degree], mm.mmmm: [minute]
4	a	N,S	"N" (North) or "S" (South)
5	dddmm.mmmm	00000.0000 to 18000.0000	Longitude ddd: [degree], mm.mmmm: [minute]
6	a	E,W	"E" (East) or "W" (West)
7	x.xx	-	Speed [knot]
8	x.xx	0.00 to 359.99	True course [degree]
9	ddmmyy	dd: 01 to 31 mm: 01 to 12 yy: 00 to 99	Date dd: [day], mm: [month], yy: [year] (last two digits)
10	x.x	n/a	Magnetic declination
11	a	n/a	Correction direction of magnetic declination
12	a	A,D,N	Mode Indicator A: Autonomous D: Differential N: Data invalid
13	a	V	Navigational Status Indicator V: Not valid

Example:
$GNRMC,012344.000,A,3442.8266,N,13520.1233,E,0.00,0.00,191132,,,D,V*0B
UTC: 01:23:44.000 Differential 34 deg 42.8266 min N 135 deg 20.1233 min E Speed: 0.0 knots
True Course: 0.0 degrees UTC Date: 19th November, 2032

5.7 VTG – Course Over Ground and Ground Speed

Format:

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

Field	Data type	Range	Description
1	x.x	0.00 to 359.99	True course [degree]
2	T	T	"T" (True)
3	x.x	-	Magnetic direction
4	M	M	"M" (Magnetic direction)
5	x.xx	-	Speed [knot]
6	N	N	"N" (knots)
7	x.xx	-	Speed [km/h]
8	K	K	"K" (Kilo meters/ Hour)
9	a	A,D,N	Mode Indicator A: Autonomous D: Differential N: Data invalid

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

5.8 ZDA – Time & Date

Format:

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

Field	Data type	Range	Description
1	hhmmss.sss	000000.000 to 235959.999	UTC time hh: [hour], mm: [minute], ss.sss: [second]
2	xx	01 to 31	UTC Day
3	xx	01 to 12	UTC Month
4	xxxx	1999 to 2099	UTC Year
5	xxx	(+/-) 00 to 23	Local zone hours
6	xx	00 to 59	Local zone minutes

Example:
$GPZDA,014811.000,13,09,2013,+00,00*7B
UTC: 01:48:11.000 13th September, 2013

6 Proprietary NMEA Input Sentences

These sentences are input commands for the protocol of the receiver.

6.1 API – *eRide* GNSS Core Library Interface

6.1.1 ALMSET – Alarm Output Setting ▲0

Format:

$PERDAPI	,	ALMSET	,	alm OR	,	alm AND	*hh	<CR>	<LF>
		1		2		3			

Field	Data type	Range	Default	Description
1	ALMSET	-	-	Command Name
2	alm OR	0x00 to 0xFF	0x00	Output the OR with this field in the alarm field of CRZ(TPS4) sentence.(*1)
3	alm AND	0x00 to 0xFF	0xFF	Output the AND with this field in the alarm field of CRZ(TPS4) sentence.(*1)

(*1) Calculate in the order of OR to AND.

Example:
$PERDAPI,ALMSET,0x80,0x80*75
Output 0x80 in the alarm field of CRZ(TPS4). Not output the other bits. (Pseudo alarm)

$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)

Notes:
- This command is useful when the user outputs a pseudo alarm in the alarm field of CRZ (TPS4) or masks an alarm.
- The response which is inserted a current value to each field is obtained by receiving an effective command for setting or inputting a command which is omitting the fields after Command Name, that is, $PERDAPI,ALMSET,QUERY*13.

6.1.2 ANTSET – Antenna Power Feed Setting

Format:

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

Field	Data type	Range	Default	Description
1	ANTSET	-	-	Command Name
2	antenna status	0,1 (1 byte)	1	Antenna power status to antenna terminal 0: Antenna power OFF 1: Antenna power ON

Notes:
- The response which is inserted a current value to each field is obtained by receiving an effective command for setting or inputting a command which is omitted the fields after Command Name, that is, $PERDAPI,ANTSET,QUERY*08.

6.1.3 CROUT – CR Output Setting

Format:

$PERDAPI	,	CROUT	,	type	,	rate	*hh	<CR>	<LF>
		1		2		3			

Field	Data type	Range	Default	Description
1	CROUT	-	-	Command Name
2	type	W,X,Y,Z	W,X,Y,Z	Output CR sentence [*] Alphabets of outside range are reserved.
3	rate	0 to 255	1	1-255: Update interval of the sentence [second] 0: The sentence(s) is/are stopped.

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.

6.1.4 DEFLS – Default Leap Second Setting

Format:

$PERDAPI	,	DEFLS	,	sec	[,	mode]	*hh	<CR>	<LF>
		1		2		3			

Field	Data type	Range	Default	Description
1	DEFLS	-	-	Command Name
2	sec	0 to 32	17 ▲0	Default leap second
3	mode	AUTO FIXED	AUTO	AUTO: Default leap second is updated automatically after taking leap second from satellites. FIXED: Default leap second is kept as user setting.

Example:
$PERDAPI,DEFLS,16,AUTO*27
Default leap second: 16 second (this value is updated automatically).

Notes:
- This value is used before the leap second is confirmed by the other factors.
- The 3rd field is omissible.
- If the mode of this command is "AUTO", the default leap second is updated when the GNSSDO takes UTC parameter broadcasted from GPS or fixes the position by both GPS and GLONASS.
- Cold restart (time also be cleared) is run when this command is run.

6.1.5 EXTSYNC – External Synchronized Function Setting

Format:

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

Field	Data type	Range	Default	Description
1	EXTSYNC	-	-	Command Name
2	mode	0 to 4	0	External synchronized mode 0: OFF mode 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] This value is available only when mode is "1" or "3". Set to "0" at the other mode.

Example:
$PERDAPI,EXTSYNC,1,100*3A

Notes:
- When changing the mode, it is necessary to set to OFF mode (0) once. ▲0
- EXTSYNC function uses the PPS input from external instead of the PPS generated by GNSS fix. The following table shows the detail of each mode.

mode	EXTSYNC function	EPPS timing delay time setting
0: OFF mode	No use	Invalid
1: ON mode (1)	Always use(*1)	Command setting(*3)
2: ON mode (2)	Always use(*1)	Automatic setting(*4)(*5)
3: Automatic change mode (1)	Use at GNSS position unfixed(*2)	Command setting(*3)
4: Automatic change mode (2)	Use at GNSS position unfixed(*2)	Automatic setting(*4)(*6)

(*1) The GNSSDO always uses EPPS.
(*2) The GNSSDO uses EPPS only when GNSS interrupt. The GNSSDO uses the PPS generated by GNSS fix at GNSS fix. After GNSS interruption, a continuous GNSS fix for 60 seconds is required to use the PPS generated by GNSS. ▲0
(*3) User can set the delay time with the command.
(*4) The GNSSDO automatically calculates the delay time from the PPS generated by GNSS fix.
(*5) The delay time is automatically calculated when the command is input. However, when the frequency mode is not Fine Lock at the time of calculating the delay time, the delay time will be 0. ▲0
(*6) The delay time is automatically calculated when GNSS position is unfixed. However, when the frequency mode is not Fine Lock at the time of calculating the delay time, the delay time will be 0 (at the first calculation) or the same as previous value (after the 2nd calculation).

- The response which is inserted current value to each field is obtained by receiving an effective command for setting or inputting a command which is omitting the fields after Command Name, that is, $PERDAPI,EXTSYNC,QUERY*5F.
- See the status (field 5) in CRZ(TPS4) sentence to check the current synchronization source. ▲0
- The Holdover performance specification is not stipulated in case of transiting from an external synchronization to Holdover. ▲0

6.1.6 FIXMASK – Setting of Positioning and Satellite Mask

Format:

$PERDAPI	,	FIXMASK	,	mode	,	elevmask	,	Reserve1	,	snrmask	,	Reserve2	[,
		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 type	Range	Default	Description
1	FIXMASK	-	-	Command Name
2	mode	USER	-	Fixed value
3	elevmask	0 to 90	0	Elevation mask [degree] Only SVs whose age is within this threshold are used in the position fix calculation.
4	Reserve1	0	0	Reserve field
5	snrmask	0 to 99	0	Signal level mask [dB-Hz] Only SVs above this mask are fixed.
6	Reserve2	0	0	Reserve field
7	Prohibit SVs (GPS)	32BIT (HEX)	0	GPS Satellite number mask Each bit represents one SVID. The GPS satellites indicated by this field are not used in the position fix calculation. Lowest order bit means SV=01. Highest order bit means SV=32.
8	Prohibit SVs (GLONASS)	24BIT (HEX) ▲0	0	GLONASS Satellite number mask Each bit represents one SVID. The GLONASS satellites indicated by this field are not used in the position fix calculation. Lowest order bit means SV=65. Highest order bit means SV=88. ▲0
9	Prohibit SVs (Galileo)	20BIT (HEX)	0	Galileo Satellite number mask Each bit represents one SVID. This field is unimplemented.
10	Prohibit SVs (QZSS)	7BIT (HEX)	0	QZSS Satellite number mask Each bit represents one SVID. The QZSS satellites indicated by this field are not used in the position fix calculation. Lowest order bit means SV=93. Highest order bit means SV=99.
11	Prohibit SVs (SBAS)	19BIT (HEX)	0	SBAS Satellite number mask Each bit represents one SVID. The SBAS satellites indicated by this field are not used in fix. Lowest order bit means SV=33. Highest order bit means SV=51.

Example:
$PERDAPI,FIXMASK,USER,10,0,37,0,0x92,0x01,0x00,0x00,0x20000*50
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) ▲0
GLONASS mask: GLONASS (BIT1 = SVID 65) SBAS mask: SBAS (BIT18 = SVID 50)

Notes:
- It is applied not only to First Fix or the time of a positioning return but to all the positioning.
- It is omissible after the 7th field.
- The response which is inserted current value to each field is obtained by receiving an effective command for setting or inputting a command which is omitting the fields after Command Name, that is, $PERDAPI,FIXMASK,QUERY*52. ▲0

6.1.7 GCLK – GCLK Output Setting

Format:

$PERDAPI	,	GCLK	,	mode	,	rate	[,	reserve	,	reserve]	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Data type	Range	Default	Description
1	GCLK	-	-	Command Name
2	mode	0,1 (1 byte)	0	GCLK output mode 0: Does not output 1: Output
3	rate	00004000 to 40000000 (8 byte)	10000000	GCLK output frequency [Hz]
4	reserve ▲0	50 (2 byte)	50	50 stable
5	reserve ▲0	00 (2 byte)	00	00 stable

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

Notes:
▲0 - GCLK is a clock signal output from GCLK pin. The table below shows about VCLK and GCLK.

Clock type	Description
VCLK	VCLK is a clock output generated by the Voltage Controlled Oscillator (VCO). Accurate frequency is output by using GNSS positioning results. It is coherent to PPS output. The output frequency is 10MHz (fixed value).
GCLK	GCLK is a clock output generated by the Numerical Controlled Oscillator (NCO) which is different from VCLK. Although an accurate frequency is output by using GNSS positioning results, it has a jitter value. It is incoherent to PPS output. The output frequency is variable.

- It is omissible after the 4th field.
- The response which is inserted a current value to each field is obtained by receiving an effective command for setting or inputting a command which is omitting the fields after Command Name, that is, $PERDAPI,GCLK,QUERY*12.

6.1.8 GNSS – Satellite System Configuration

Format:

$PERDAPI	,	GNSS	,	talkerID	,	gps	,	glonass	,	galileo	,	qzss	,	sbas	*hh	<CR>	<LF>
		1		2		3		4		5		6		7			

Field	Data type	Range	Default	Description
1	GNSS	-	-	Command Name
2	talkerID	AUTO GN LEGACYGP	AUTO	AUTO: The talker IDs other than GSV are changed by using satellite system. (Multiple systems: GN, GPS, SBAS and QZSS:GP, GLONASS:GL) GLGSV is omitted in case of no GLONASS. GPGSV is omitted in case of no GPS, SBAS and QZSS. GN: The talker IDs other than GSV are GN. GLGSV is output even if no GLONASS. GPGSV is output even if no GPS, SBAS and QZSS. LEGACYGP: The talker IDs are GP. GLGSV sentence is omitted.
3	gps	0,2	2	GPS Mode
4	glonass	0,2	2	GLONASS Mode
5	galileo	0	0	Galileo Mode (unimplemented)
6	qzss	0,2	2	QZSS Mode
7	sbas	0,1,2	1	SBAS Mode

Example:
$PERDAPI,GNSS,AUTO,2,2,0,2,2*41
Use: GPS, GLONASS, QZSS, SBAS Mask: Galileo

Notes:
- This command controls which Global Navigation Satellite Systems are used by the receiver. The mode can be set to 0 or 2 for each satellite system. User can also set SBAS mode to 1.
  Mode 0 means to disable the system.
  Mode 1 means to enable tracking only (do not use in position fix).
  Mode 2 means to enable tracking and use in position fix calculation.
- The response which is the inserted current value to each field is obtained by receiving an effective command for setting or inputting a command which omits the fields after Command Name, that is, $PERDAPI,GNSS,QUERY*18.
- In the GNSSDO, the default setting of SBAS mode is 1, because using SBAS calculated data causes reduced 1PPS accuracy. Therefore although the GNSSDO acquires differential SBAS fix, it is not available in the GSA sentence when using default setting.
- “SBAS only configuration” and “No tracking configuration” are not acceptable configurations.
  $PERDAPI,GNSS,AUTO,0,0,0,0,2*43
  $PERDAPI,GNSS,AUTO,0,0,0,0,1*40
  $PERDAPI,GNSS,AUTO,0,0,0,0,0*41
- 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.
- QZSS is operational on only one satellite as of March 2015. Therefore, there are some time zones in which QZSS satellite is not within a field of view. Or an increased error is caused by receiving the QZSS signal from a low elevation angle. Please note the above when 1PPS is output by using QZSS only fix or using QZSS and SBAS. ▲0
- In case of selecting GPS and GLONASS, the GNSSDO uses GLONASS in position fix after the time is fixed by GPS. Therefore, when the GNSSDO cannot track the required number of GPS satellites for position fix, the GNSSDO may not track GLONASS satellites. ▲0

- In case of selecting GLONASS and QZSS, the GNSSDO uses GLONASS in position fix after the time is fixed by QZSS only. Also, the position mode should be TO mode to fix the time by QZSS only. Therefore, the GNSSDO may not use GLOASS in position fix when the position mode is other than TO mode or QZSS signal is not received. ▲0

6.1.9 HOSET – Holdover Setting ▲0

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 type	Range	Default	Description
1	HOSET	-	-	Command Name
2	ho set flag	0,1	0	Set flag 0: Default 1: Manual setting
3	learning time set0	0 to 9999999	259200	[sec] (259200 [sec] = 72 [hour])
4	available time set0	0 to 999999	86400	[sec] (86400 [sec] = 24 [hour])
5	learning time set1	0 to learning time set0	0	[sec]
6	available time set1	0 to available time set0	0	[sec]
7	learning time set2	0 to learning time set1	0	[sec]
8	available time set2	0 to available time set1	0	[sec]

Example:
$PERDAPI,HOSET,0*2E
$PERDAPI,HOSET,1,259200,86400,0,0,0,0*19
$PERDAPI,HOSET,1,259200,86400,172800,57600*21
$PERDAPI,HOSET,1,259200,86400,172800,57600,86400,28800*29

Notes:
- It is omissible after the 3rd field or the 5th field or the 7th field.
- “0” is set to the omitted field.
- When the “ho set flag” is set to 0, the default values are set after the 3rd field. (Even if fields after the 3rd field are set, they are ignored.)
- See the definition of each counter in Section 7.3.4 about the details of the set values.
- The response which is inserted a current value to each field is obtained by receiving an effective command for setting or inputting a command which is omitting the fields after Command Name, that is, $PERDAPI,HOSET,QUERY*54.
- For details, see “5 Holdover Operation with HOSET” in GF-870x series User’s Guide (Document #: SE17-900-005).

6.1.10 MODESET – Transition Condition Setting for Status

Format:

$PERDAPI	,	MODESET	,	Lock port set	[,	Coarse lock PPS timing	,
		1		2		3	

phase skip PPS timing	[,	reserve]]	*hh	<CR>	<LF>
4		5			

Field	Data type	Range	Default	Description
1	MODESET	-	-	Command Name
2	Lock port set	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 ▲0 5: Always Logic H ▲0
3	Coarse lock PPS timing	0 to 999999	GF-8701: 50000 GF-8702: 50000 GF-8703: 10000 GF-8704: 5000 GF-8705: 1500	PPS timing accuracy for changing the frequency mode from "Pull-In" to "Coarse Lock" [nsec] GF-8701: <+/- 50 usec GF-8702: <+/- 50 usec GF-8703: <+/- 10 usec GF-8704: <+/- 5 usec GF-8705: <+/- 1.5 usec
4	phase skip PPS timing	0 to 999999	0	Threshold of PPS timing error for running phase skip when phase skip flag setting is automatic execution. [nsec] 0: Phase skip is always run when frequency mode is "Pull-In". 999999: Phase skip is not run.
5	reserve	50	50	Not supported except 50

Notes:

- It is omissible after the 3rd field.
- The response which is inserted a current value to each field is obtained by receiving an effective command for setting or inputting a command which is omitted the fields after Command Name, that is, $PERDAPI,MODESET,QUERY*50.
- See CRZ (TPS4) sentence about the frequency mode and the phase skip.
- For details, see “6 Phase Skip Operation with PHASESKIP and MODESET” in GF-870x series User’s Guide (Document #: SE17-900-005).

6.1.11 PHASESKIP – Phase Skip Setting

Format:

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

Field	Data type	Range	Default	Description
1	PHASESKIP	-	-	Command Name
2	phase skip flag	1 (1 byte)	1	1: Sets the phase skip flag

Notes:

- The default phase skip flag is "1 (run the phase skip)". When the frequency mode changes to "Pull-In", the phase skip is run and the flag is automatically changed to "0 (Automatic judgment)".
- See CRZ (TPS4) sentence about the frequency mode and the phase skip.
- For details, see “6 Phase Skip Operation with PHASESKIP and MODESET” in GF-870x series User’s Guide (Document #: SE17-900-005).

6.1.12 PPS – Setting of PPS (Pulse per Second)

Format:

$PERDAPI	,	PPS	,	type	,	mode	,	period	,	pulse width	,	cable delay	,
		1		2		3		4		5		6	

polarity	*hh	<CR>	<LF>
7			

Field	Data type	Range	Default	Description
1	PPS	-	-	Command Name
2	type	VCLK	VCLK	VCLK stable
3	mode	0 to 3	1	PPS output mode 0: Always stop 1: Always output 2: Output only during positioning by one satellite and more 3: Output only when TRAIM is valid
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]
7	polarity	0 to 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)

Notes:

▲0 - The table below shows the detailed PPS output mode.

PPS output mode	Description
Mode 0 (Always stop)	Stop the PPS output.
Mode 1 (Always output)	PPS is always output. Until position fix: Synchronization source of PPS is RTC. After position fix: Synchronization source of PPS is depend on the time information obtained from GNSS satellites. (*1)
Mode 2 (Output only during positioning by one satellite and more)	PPS output is available when the number of tracking satellites is one and more. (*2) PPS reliability is higher than mode 1.
Mode 3 (Output only when TRAIM is OK)	PPS output is only available when TRAIM solution is valid. (*3) PPS reliability is higher than mode 2.

(*1) The synchronization source can be select by TIMEALIGN command.
(*2) In TO mode, the required number of tracking satellites is one and more excluding SBAS. In NAV mode, the required number of tracking satellites is four or more excluding SBAS.
(*3) TRAIM solution is output in field 7 of TPS3 sentence. See Chapter 9 about TRAIM function.

- The Cable delay is a time delay due to the cable length between an antenna element and the antenna input terminal of the GNSSDO. Setting the proper cable delay makes the PPS accuracy more accurate.
- User can choose GPS, UTC (USNO) and UTC (SU) as alignment of PPS by TIMEALIGN command. The default is UTC (USNO). As for details, please refer to the page of TIMEALIGN command.
- The condition of PPS synchronization is as follows:

[1] GPS alignment

PPS mode	Before first fix	After first fix
0	OFF	OFF
1	Sync with RTC	Sync with GPS
2 to 3	OFF	Sync with GPS

[2] UTC (USNO) alignment (default)

PPS mode	Before first fix	After first fix	After taking UTC (USNO) parameter from GPS
0	OFF	OFF	OFF
1	Sync with RTC	Sync with GPS	Sync with UTC (USNO)
2 to 3	OFF	Sync with GPS	Sync with UTC (USNO)

[3] UTC (SU) alignment

PPS mode	Before first fix	After first fix	After taking UTC (SU) parameter from GLONASS
0	OFF	OFF	OFF
1	Sync with RTC	Sync with GPS	Sync with UTC (SU)
2 to 3	OFF	Sync with GPS	Sync with UTC (SU)