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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The following satellite systems are operated and controlled by the authorities of each government.
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- GLONASS (Russia)
- Galileo(Europe)
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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.

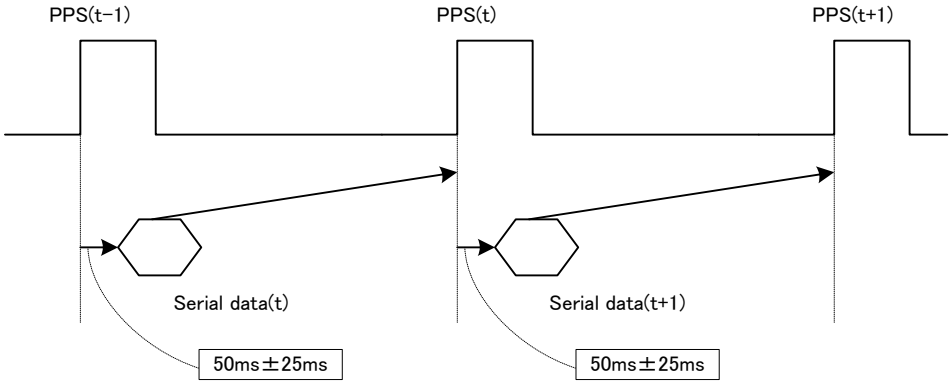
2 Communication Specifications

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)

6.1.13 RESTART – Restart Command

Format:

$PERDAPI	,	RESTART	,	restart mode	*hh	<CR>	<LF>
		1		2			

Field	Data type	Range	Default	Description
1	RESTART	-	-	Command Name
2	restart mode	HOT WARM COLD FACTORY	-	Restart mode

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

Notes:
- As for the differences depending on the restart mode, please refer to the page of "Backup of the Receiver Parameters (for BBRAM)".

6.1.14 SURVEY – Position Mode Setting

Format:

$PERDAPI	,	SURVEY	,	position mode	[,	sigma threshold	,	time threshold
		1		2		3		4

,	latitude	,	longitude	,	altitude]	*hh	<CR>	<LF>
	5		6		7			

Field	Data type	Range	Default	Description
1	SURVEY	-	-	Command Name
2	position mode	0 to 3	1	Position mode 0: Normal NAV (navigation) mode 1: Hold position survey ▲0 SS (self survey) mode 2: Hold position survey ▲0 CSS (continual self survey) mode 3: Position-hold TO (time only) mode
3	sigma threshold	0 to 255	0	Sigma threshold which changes automatically to position-fixed. [m] (When the threshold value is 0, it is not used.)
4	time threshold	0 to 10080	0	Time threshold which changes automatically to position-fixed. [minute] (When the threshold value is 0, it is not used.)
5	latitude	-90 to 90	0	Latitude for hold position in TO mode. [degree] 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.
6	longitude	-180 to 180	0	Longitude for hold position in TO mode. [degree] 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.
7	altitude	-1000 to 18000	0	Altitude above sea level for hold position in TO mode. [m] This field can be set only when position mode is 3.

Example:
$PERDAPI,SURVEY,1,10,1440*74
Mode: SS mode Sigma threshold: 10 Time threshold: 1440

$PERDAPI,SURVEY,3,0,0,37.78700,-122.45100,31.5*53
Mode: TO mode Sigma threshold: 0 Time threshold: 0
Fixed position: 37.78700 degrees north 122.45100 degrees west Altitude: 31.5 m

Notes:
- It is omissible after the 3rd field.

▲0 - The table below shows details about the position mode.

Position mode(*1)	Description
Normal NAV (navigation) mode	- Available information by GNSS: 3D position, velocity, time and PPS. - Operating condition: Minimum number GNSS satellites required is four except SBAS. - Application: Timing solution for mobility system.
Hold position survey SS (self survey) mode (*2)(*3)	- Available information by GNSS: 3D position time and PPS. The position is calculated on the assumption that it is a hold position. The estimated position accuracy will increase as time elapses. - Operating condition: 3D position: Minimum number GNSS satellites required is four except SBAS. Time and PPS: Minimum number GNSS satellites required is one except SBAS.
Hold position survey CSS (continual self survey) mode (*2)(*3)	- Available information by GNSS: Same as SS mode. - Operating condition: Same as SS mode. Unlike SS mode, the hold position is backed up to the BBRAM (*4). Since the hold position is calculated with the previous hold position at the next power on, the estimated accuracy of hold position does not degrade after the power on.
Position-hold TO (time only) mode	- Available information by GNSS: Time and PPS. It is required to set the hold position by this command. (*5) - Operating condition: Minimum number GNSS satellites required is one except SBAS.

(*1) In case the location of antenna is changed in a position mode other than NAV mode, it is necessary to reset by RESTART command. Otherwise no position issue may be caused with certain conditions.
(*2) Once TO mode is available, the hold position and the position mode is backed up to the BBRAM. Therefore, TO mode is available with the backup position data after power off/on sequence.
(*3) Even in SS or CSS mode, the same PPS accuracy as TO mode can be obtained by estimating the hold position for one hour at an open sky (more than 50% of the number of satellites in use with signal level of over 40 dB-Hz) or for eight hours in a weak signal environment.
(*4) Refer to the page of "Backup of the Receiver Parameters (for BBRAM)".
(*5) The hold position is also set when the position mode transitions from SS or CSS mode to TO mode automatically. When the hold position has been calculated in SS or CSS mode, the current estimated hold position can be set by omitting the 3rd field and after. The displayed position may differ a little from the configured position due to a conversion error.

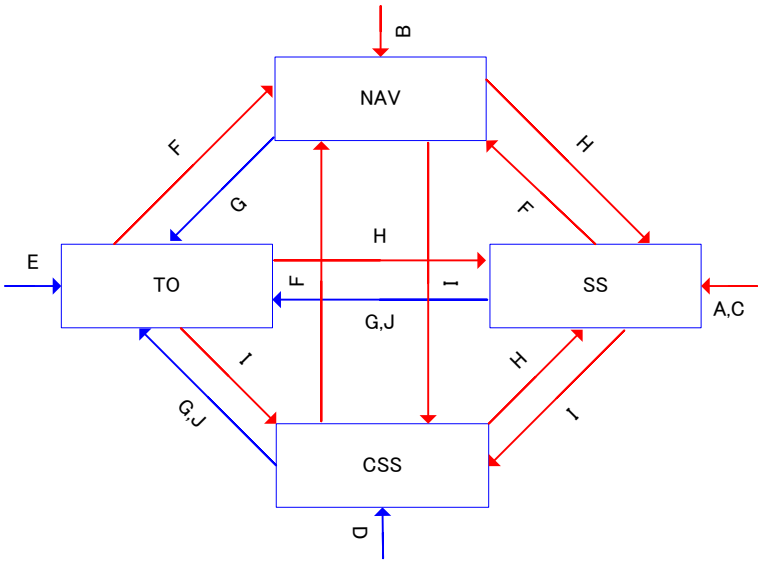


Figure 6.1 Flow Chart about Position Mode

	Transition condition	Whether keep or not 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 “SURVEY,0”.	Discard
C	After power on in case that last mode is “SURVEY,1”.	Discard
D	After power on in case that last mode is “SURVEY,2”.	Keep
E	After power on in case that last mode is “SURVEY,3”.	Keep
F	“SURVEY,0” command	Discard
G	“SURVEY,3” after self survey position is fixed. “SURVEY,3” with user’s hold position.	Keep
H	“SURVEY,1” command	Discard
I	“SURVEY,2” command	Discard
J	The condition of survey is satisfied. **Note:** The GNSSDO starts in TO mode when the position mode changes to TO mode by satisfying the transition condition before power off.	Keep

- Hot start is occurred when the position mode is shifted to the NAV mode.
- In order to change automatically to the Position-hold mode, it is necessary to set to the Survey mode (SS or CSS).
- If both sigma threshold and time threshold are configured, the position mode changes to the Position-hold mode when either is fulfilled. When the threshold value is 0, it is not used.

6.1.15 TIME – Initial Time Setting

Initial time is configured. The setting of time is effective only when time is not decided by the other factors. A setting of a millennium which is the GPS week rollover times is also received after the time decision.

Format:

$PERDAPI	,	TIME	,	time of date	,	day	,	month	,	year	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Data type	Range	Default	Description
1	TIME	-	-	Command Name
2	time of date	00 to 23 00 to 59 00 to 59	0	UTC (Hour) UTC (Minute) UTC (Second)
3	day	1 to 31	22	UTC (Date)
4	month	1 to 12	8	UTC (Month)
5	year	2013 to 2099	1999	UTC (Year)

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

Notes:
- This command is needed to input correct date within +/- 1 year.
- As for GPS week rollover timing and the GNSSDO week rollover timing, please refer to the follow.

event	date	GPS week
GPS week rollover timing (1st) **Default time**	**1999/08/22**	**1024**
GPS week rollover timing (2nd)	2019/04/07	2048
Rollover timing **(After repower on + GLONASS No fix)**	**2032/08/15**	**2745**
GPS week rollover timing (3rd)	2038/11/21	3072
…		
Operating upper limit time	**2099/12/31**	**6260**

[Case A: Not fixed with GLONASS]
- The GNSSDO can keep outputting a correct date until 2099/12/31 at the following conditions:
  - The GNSSDO continues to power on.
  - The backup power is supplied.
- The GNSSDO can keep outputting a correct date until 2032/08/15 even if the GNSSDO powers OFF/ON or restart without the backup power supply. After 2032/08/15, the date returns to 2012/12/30. In this case, the GNSSDO can correct the date until 2099/12/31 with “PERDAPI,TIME” command.

[Case B: Fixed with GLONASS]
- The GNSSDO can adjust the millennium automatically in the timing of first fix of GLONASS and outputs a correct date until 2099/12/31 without the user setting even if the GNSSDO powers OFF/ON or restart without the backup power supply.

6.1.16 TIMEALIGN – Time and PPS Alignment Setting

Format:

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

Field	Data type	Range	Default	Description
1	TIMEALIGN	-	-	Command Name
2	mode	1 to 3	2	1: GPS alignment 2: UTC (USNO) alignment 3: UTC (SU) alignment

Example:
$PERDAPI,TIMEALIGN,2*31
UTC (USNO) alignment

Notes:
- Please note that mode 0 is invalid value.

- The details of each time alignment mode are as follows:

[1: GPS alignment]
・ Leap second is not applied to the output time and GPS time is output.
・ PPS is output in synchronization with GPS.
・ In GLONASS only fix, it is necessary to set the correct default leap second for outputting correct time by DEFLS command.

[2: UTC (USNO) alignment]
・ Leap second is applied to the output time.
・ PPS is output in synchronization with UTC (USNO) after taking the UTC (USNO) parameter from GPS.
・ In GLONASS only fix, because the GNSSDO cannot take the UTC (USNO) parameter from GLONASS, PPS is kept to output in synchronization with GPS.

[3: UTC (SU) alignment]
・ Leap second is applied to the output time. And, GMT offset is set to as +3:00.
・ PPS is output in synchronization with UTC (SU) after taking the UTC (SU) parameter from GLONASS.
・ In GPS only fix, because the GNSSDO cannot take the UTC (SU) parameter from GPS, PPS is kept to output in synchronization with GPS.

- In the above, QZSS is treated as GPS.

6.1.17 TIMEZONE – Local Zone Time Setting

This sentence is reflected to ZDA sentence (not only local zone field but also UTC time field).

Format:

$PERDAPI	,	TIMEZONE	,	sign	,	hour	,	minute	*hh	<CR>	<LF>
		1		2		3		4			

Field	Data type	Range	Default	Description
1	TIMEZONE	-	-	Command Name
2	sign	0 to 1	0	GMT sign 0: Positive 1: Negative
3	hour	0 to 23	0	GMT (Hour)
4	minute	0 to 59	0	GMT (Minute)

Example:
$PERDAPI,TIMEZONE,0,9,0*69
As GMT offset, display time is carried out +9:00.

Notes:
- In UTC (SU) alignment, GMT offset is changed to +3:00 automatically.

6.2 CFG – Setting of Application Software

6.2.1 NMEAOUT – Standard NMEA Output

Format:

$PERDCFG	,	NMEAOUT	,	type	,	interval	*hh	<CR>	<LF>
		1		2		3			

Field	Data type	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 255	-	Update interval of the sentence [sec] When the value is “0”, the sentence is stopped.

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

$PERDCFG,NMEAOUT,GSV,0*56
GSV sentence is stopped.

6.2.2 UART1 – Serial Communication Port

Format:

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

Field	Data type	Range	Default	Description
1	UART1	-	-	Command Name
2	baud	4800, 9600, 19200, 38400, 57600, 115200	38400	Baud rate [bps]

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

Notes:
- When the setting of the serial communication port is changed by this command, ACK sentence is output by the baud rate which was being used.
- When using a low baud rate, please adjust the size of output sentence by NMEAOUT command and CROUT command to output all sentence within one second.

6.3 SYS – PVT System

6.3.1 ANTSEL – Antenna Input Setting ▲0

Format:

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

Field	Data type	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
$PERDSYS,ANTSEL,FORCE2*34

Notes:
- **Set the GNSS antenna input ((RF PIN) or #RF (RF_COAX)). This setting is only available for GF-8701, GF-8702 and GF-8703. Do not use the command for GF-8704 and GF-8705.**
- 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,ANTSEL,QUERY*11.

6.3.2 VERSION – Software Version

Format:

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

Field	Data type	Range	Default	Description
1	VERSION	-	-	Command Name

Example:
$PERDSYS,VERSION*2C

7 Proprietary NMEA Output Sentences

This sentence is a protocol only for our company. It starts from “$PERD” which shows that it is an original sentence.

7.1 ACK – Output the Command Reception Check

Format:

$PERDACK	,	command	,	sequence	,	subcommand	*hh	<CR>	<LF>
		1		2		3			

Field	Data type	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.
3	subcommand	-	-	Second field of received command

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

Notes:
- As for the command, the checksum must be effective before ACK is sent.

7.2 API – eRide GNSS Core Library Interface

7.2.1 EXTSYNC – External Synchronized Output

Format:

$PERDAPI	,	EXTSYNC	,	mode	,	delay set	,	delay calculate	*hh	<CR>	<LF>
		1		2		3		4			

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	Setting value of EPPS timing delay time [nsec]
4	delay calculate	-999999 to +999999	0	EPPS timing delay time calculated from the PPS generated by GNSS fix [nsec] The value is set only when the external synchronized mode is "2" or "4". The value is "0" at other mode.

Example:
$PERDAPI,EXTSYNC,2,0,20*15
External synchronized mode: ON mode (2)
EPPS timing delay time calculated from the PPS generated by GNSS fix: 20 nsec

Notes:
- See EXTSYNC command about the external synchronized function.

7.3 CR – *eRide* GNSS Core Library Interface

7.3.1 CRW (TPS1) – Time Transfer Info per Second (Date and Leap Second)

Format:

$PERDCRW	,	TPS1	,	Date & Time	,	time status	,	update date	,	present LS	,
		1		2		3		4		5	

future LS	,	pps status	,	reserve	,	reserve	*hh	<CR>	<LF>
6		7		8		9			

Field	Data type	Range	Default	Description
1	TPS1	-	-	Command Name
2	Date & Time	14-byte fixed length	19990822000000	Present date and time year, month, day, hour, minute, second
3	time status	0 to 2 (1 byte)	0	Present time status of output sentence 0: RTC 1: GPS (The GNSSDO does not apply leap second or has only default leap second) 2: UTC (The GNSSDO has confirmed leap second and applies it.)
4	update date	14-byte fixed length	00000000000000	Leap second update schedule year, month, day, hour, minute, second This date indicates zero when no leap second update schedule.
5	present LS	-31 to +32 (3 byte)	+17 ▲0	Present leap second received from satellites
6	future LS	-31 to +32 (3 byte)	+00	Future leap second received from satellites
7	pps status	0 to 3 (1 byte)	0	Present pps is synced with the follow. 0: RTC 1: GPS 2: UTC (USNO) 3: UTC (SU)
8	reserve	(10 byte)	-	Reserve field
9	reserve	(5 byte)	-	Reserve field

Example:
$PERDCRW,TPS1,20120303062722,2,20120701000000,+15,+16,2,+00000.000,+0000*27
Present date: 2012/03/03 06:27:22 Time status: Present time of output sentence is sync with UTC.
Leap second update schedule: 2012/7/1 00:00:00 Current leap second: +15 Future leap second: +16
PPS status: Present pps is sync with UTC (USNO)

Notes:
- This command is output every second.

▲0
- $PERDAPI,CROUT,W,0*4F stops outputting this command.
- The update date indicates zero when no update schedule.

Restriction:

About time status

alignment	Before first fix	After first fix	Leap second of GNSS available
GPS	RTC	GPS	GPS
UTC (USNO)	RTC	GPS	UTC
UTC (SU)	RTC	GPS	UTC

About leap second which is used to adjust output time

alignment	Before first fix	After first fix	Leap second of GNSS available
GPS	0	0	0
UTC (USNO)	Default leap second	Default leap second	Leap second of GNSS
UTC (SU)	Default leap second	Default leap second	Leap second of GNSS

The GNSSDO takes confirmed leap second when the GNSSDO takes UTC (USNO) parameter which is broadcasted from GPS or takes time both GPS and GLONASS.

7.3.2 CRX (TPS2) – Time Transfer Info per Second (PPS)

Format:

$PERDCRX	,	TPS2	,	pps status	,	pps mode	,	pps period	,	pulse width	,	cable delay	,
		1		2		3		4		5		6	

polarity	,	reserve	,	reserve	,	reserve	,	reserve	,	reserve	,	reserve	*hh	<CR>	<LF>
7		8		9		10		11		12		13			

Field	Data type	Range	Default	Description
1	TPS2	-	-	Command Name
2	pps status	0,1 (1 byte)	1	PPS output status 0: 1PPS OFF 1: 1PPS ON
3	pps mode	0 to 3 (1 byte)	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 OK
4	pps period	0 (1 byte)	0	PPS output interval 0: 1PPS (A pulse is output per second)
5	pulse width	001 to 500 (3 byte)	500	PPS pulse width [msec]
6	cable delay	-100000 to +100000 (7 byte)	+000000	PPS cable delay [nsec]
7	polarity	0,1 (1 byte)	0	PPS polarity 0: Rising edge 1: Falling edge
8	reserve	(1 byte)	-	Reserve field
9	reserve	(4 byte)	-	Reserve field
10	reserve	(6 byte)	-	Reserve field
11	reserve	(4 byte)	-	Reserve field
12	reserve	(8 byte)	-	Reserve field
13	reserve	(7 byte)	-	Reserve field

Example:
$PERDCRX,TPS2,1,1,0,200,+000000,0,1,0005,-0.876,0000,00000000,+000000*0F
PPS output status: PPS ON (1) PPS output mode: Always output (1) PPS output interval: 1PPS (0)
PPS pulse width: 200 msec PPS cable delay: +000000 nsec PPS polarity: Rising edge ▲0

Notes:
- This sentence is output every second.
- $PERDAPI,CROUT,X,0*40 stops outputting this command.

7.3.3 CRY (TPS3) – Time Transfer Info per Second (Survey & TRAIM)

Format:

$PERDCRY	,	TPS3	,	pos mode	,	sigma	,	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 type	Range	Default	Description
1	TPS3	-	-	Command Name
2	pos mode	0 to 3 (1 byte)	1	Positioning mode 0: Normal NAV (navigation) mode 1: Hold position survey ▲0 SS (self survey) mode 2: Hold position survey ▲0 CSS (continual self survey) mode 3: Position-hold TO (time only) mode
3	sigma	0000 to 1000 (4 byte)	1000	Current variance value of survey position [m]
4	sigma threshold	000 to 255 (3 byte)	000	Sigma threshold which changes automatically to position-hold. [m]
5	time	000000 to 999999 (6 byte)	000000	Current update times of survey position [sec] It is not updated at the time of positioning interruption.
6	time threshold	000000 to 604800 (6 byte)	000000	Survey time threshold which changes automatically to position-hold. [sec]
7	TRAIM solution	0 to 2 (1 byte)	2	TRAIM solution 0: OK 1: ALARM 2: UNKNOWN, due to a. Alarm threshold set too low b. Insufficient satellites being tracked
8	TRAIM status	0 to 2 (1 byte)	2	TRAIM status 0: Detection and isolation possible 1: Detection only possible 2: Neither possible
9	Removed SVs	(2 byte)	00	Number of satellites removed by TRAIM
10	Receiver status	(10 byte)	-	Internal field for FURUNO engineer.
11	reserve	(10 byte)	-	Reserve field

Example:
$PERDCRY,TPS3,2,0003,001,002205,086400,0,0,00,0x00000000,0x00000000*0C
Positioning mode: Hold position survey (CSS) (2) Current variance value of survey position: 3 [m]
Survey sigma threshold: 1 [m] Current update times of survey position: 2205 [seconds]
Survey time threshold: 86400 [seconds] TRAIM solution: OK (0) TRAIM status: OK (0)
Number of the satellites removed by TRAIM: 0

Notes:
- This command is output every second.
- $PERDAPI,CROUT,Y,0*41 stops outputting this command.

7.3.4 CRZ (TPS4) – Output Time Transfer Info per Second (Frequency)

Format:

$PERDCRZ	,	TPS4	,	frequency mode	,	phase skip flag	,	alarm	,	status	,	PPS timing error	,
		1		2		3		4		5		6	

frequency error	,	reserve	,	learning time	,	available time	,	reserve	*hh	<CR>	<LF>
7		8		9 ▲0		10		11			

Field	Data type	Range	Default	Description
1	TPS4	-	-	Command Name
2	frequency mode	0 to 5 (1 byte)	0	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 0: Automatic judge 1: Execute
4	alarm	00 to FF (2 byte)	00	Alarm (Hexadecimal form) 00: Normal 01: Antenna current error (open) 02: Antenna current error (short) 04: Oscillator error 08: Oscillator control range error The multiple alarm shows as OR value.
5	status	00 to FF (2 byte)	01	Status (Hexadecimal form) 0x00: Other than the following status 0x01: Power supply to antenna pin 0x02: Use EPPS signal ▲0 0x04: Reserve 0x80: Reserve ▲0 The multiple status shows as OR value.
6	PPS timing error	-999999999 to +999999999 (10 byte)	-	PPS timing error [nsec]
7	frequency error	-99999 to +99999 (6 byte)	-	Frequency deviation of VCLK [ppb]
8	reserve	(4 byte)	-	Reserve field
9	learning time ▲0	0000000 to 9999999 (7 byte)	0	Learning time for Holdover [sec]
10	available time	000000 to 999999 ▲0 (6 byte)	0	Holdover available time [sec]
11	reserve	(7 byte)	-	Reserve field

Notes:

- This command is output every second.
- $PERDAPI,CROUT,Z,0*42 stops outputting this command.

- The following figure and table show the transition status of the frequency mode.

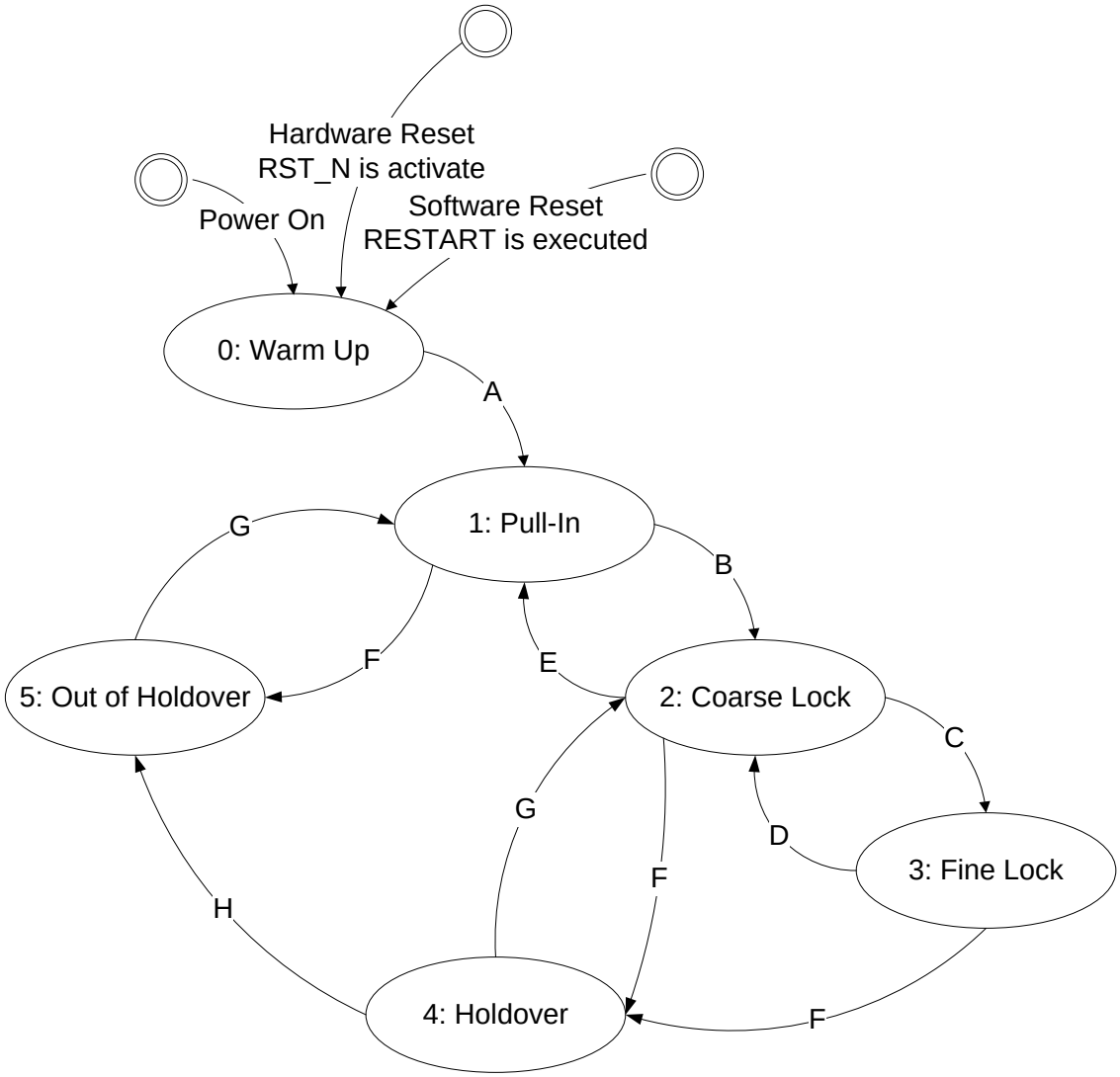


Table 7.1 Frequency Mode State Diagram

Table 7.2 Definition of Frequency Mode

Frequency mode	Description
0: Warm Up	This is a period until the frequency of the equipped VCO is stabilized. The stabilization is judged by using the GNSS positioning results.
1: Pull-In	This is a period while the GNSSDO performs a phase synchronization of the PPS generated by VCO and the PPS generated by GNSS positioning results. The phase skip is conducted only in this mode.
2: Coarse Lock	This is a period while the GNSSDO outputs PPS synchronizing with GNSS and controls the VCO with the PLL. In this mode, the GNSSDO does not start learning the process of VCLK frequency. The transition condition to Coarse Lock is determined by the PPS timing and can be changed by MODESET command. Even if a phase difference is large when GNSS fix again from Holdover, the GNSSDO controls the PPS phase difference smaller by changing the frequency without the phase skip. If the user needs to change the mode to Fine Lock quickly, set the phase skip flag and conduct the phase skip in Pull-In mode.
3: Fine Lock	The frequency is more accurate than Coarse Lock. The GNSSDO learns for Holdover. Descriptions which are simply described as “Lock” in data sheets means Fine Lock state. The PPS timing specification and the VCLK frequency specification are described in the hardware specifications.
4: Holdover	This is a period the GNSSDO controls the VCO based on the learning during Fine Lock mode after GNSS fix interruption. The PPS timing specification and the VCLK frequency specification are described in the hardware specifications.
5: Out of Holdover	This is a period of “out of Holdover” after a GNSS fix interruption. The PPS timing accuracy and the VCLK frequency accuracy are not satisfied per the specifications described in the hardware specifications.

Table 7.3 Transition Condition

Transition	Transition condition
(A)	GNSS fix and the oscillator has already warmed-up.
(B)	Coarse Lock condition is fulfilled.(*1)
(C)	Fine Lock condition (*2) is fulfilled.
(D)	Fine Lock condition is not fulfilled by interference and etc. or phase skip flag is "1".
(E)	Coarse Lock condition is not fulfilled by recovery from Holdover and etc. or phase skip flag is "1".
(F)	GNSS fix interrupts. (If the mode changes from "Coarse Lock" or "Fine Lock", the mask span, the mode does not change for 10 seconds even if GNSS fix interrupts (*3).)
(G)	GNSS fix again (More than 2 seconds GNSS fix is necessary for judgment)
(H)	Holdover available time has become "0".

(*1) The conditions for changing to "Coarse Lock" are set by MODESET command.

▲0 (*2) Fine Lock is a state to learn for Holdover. In Fine Lock, the PPS timing error and the frequency error is small enough.

(*3) When the GNSSDO cannot receive GNSS signals due to temporal jamming signals and/or temporal shielding of GNSS antenna, it does not give notice of a non-operational status to host system immediately. There is a time lag so that it does not change to Holdover mode immediately.

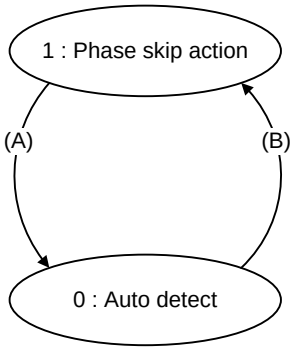
- “phase skip flag” is the flag which represents a phase skip operation status. Phase skip means that the number of VCLK frequency pulses between successive PPS is changed and that the output PPS is adjusted. Phase skip is conducted to shorten the Pull-In time. Phase skip is not conducted in the frequency mode other than “Pull-In”.

  In case of “0” (Automatic judge), the GNSSDO judges the phase skip flag based on the threshold set by MODESET command. The judgment is conducted when the frequency mode is “Pull-In” only. As a result of judgment and in case of Phase skip is conducted, the phase skip flag transits to “1” (Execute) and then conduct Phase skip. After the completion of Phase skip, the phase skip flag transitions to “0” (Automatic judge).

In case of “1” (Execute), once the GNSSDO transits to “Pull-In” at the frequency mode, Phase skip is conducted. After the completion of Phase skip, the phase skip flag transitions to “0” (Automatic judge).

The GNSSDO can set the phase skip flag with PHASESKIP command. When the command is set to "1" (Execute) at the frequency mode other than "Pull-In", the frequency mode changes to "Pull-In" sequentially and the phase skip is executed. Please use the command if user wants to execute the phase skip at user's timing.

Transition diagram and the condition of phase skip flag are as follows.



Transition	Transition condition
(A)	Phase skip has been completed. (The status transfer only when the frequency mode is "Pull-In".)
(B)	The GNSSDO judges that the phase skip is necessary. (The status transfer only when the frequency mode is "Pull-In".) The phase skip flag is set to "1" by "PERDAPI,PHASESKIP" command.

▲0- Since the “PPS timing error” is a time difference between the Reference PPS and the output PPS (frequency-divided from 10MHz), it is not calculated while the Reference PPS is interrupted.

▲0- The Reference PPS is a PPS generated by GNSS positioning result. In case of using EPPS, it is EPPS. The Reference PPS is interrupted while GNSS positioning is interrupted. However, in case of using EPPS, the Reference PPS is not interrupted if the EPPS is input.

▲0- The “frequency error” is calculated by a differential of “PPS timing error”. Without the Reference PPS, it cannot be calculated.

▲0- The table below shows the definition of each counter.

frequency mode	learning time	available time
0: Warm Up	“0”	“0”
3: Fine Lock	“++” (Upper limit: learning time set0 + 3600)	Larger value of (1) and (2) (1) “0” (2) 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
1: Pull-In	“0”	“0”
2: Coarse Lock		“--“
4: Holdover		
5: Out of Holdover		“0”

“++”: Add every second “--“: Subtract every second (until 0) “0”: 0 clear
(*) The learning time returns to 0 when the synchronization source changes by the external synchronization function.

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. Please note that the Holdover performance is not changed though the transition condition to Holdover is changed by the command setting.

Contents	Default
learning time set0	259200
available time set0	86400
learning time set1	0
available time set1	0
learning time set2	0
available time set2	0

7.4 SYS – Answer of PVT System

7.4.1 ANTSEL – Antenna Selecting ▲0

Format:

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

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

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

Notes:
- This string is sent when the following event occur:
  - Initialization at power on
  - Reception of $PERDSYS,ANTSEL,QUERY command

7.4.2 FIXSESSION – Fix Session

Format:

$PERDSYS	,	FIXSESSION	,	reserve1	[,	reserve2	,	reserve3]	*hh	<CR>	<LF>
		1		2		3		4			

Field	Data type	Range	Default	Description
1	FIXSESSION	-	-	Command Name
2	reserve1	-	-	Reserve field
3	reserve2	-	-	Reserve field
4	reserve3	-	-	Reserve field

Example:
$PERDSYS,FIXSESSION,ON,19015,19.015*7C

Notes:
- This string is sent when certain events occur.
- This is a sentence for FURUNO engineer use only.

7.4.3 VERSION – Software Version

Format:

$PERDSYS	,	VERSION	,	device	,	version	,	reserve1	,	DO type	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Data type	Range	Default	Description
1	VERSION	-	-	Command Name
2	device	-	-	Device name
3	version	-	-	Version number
4	reserve1	-	-	Reserve field
5	DO type	GF-8701 GF-8702 GF-8703 GF-8704 GF-8705	-	GNSSDO product type

Example:
$PERDSYS,VERSION,OPUS7_SFLASH_MP_64P,ENP627A1430301T,QUERY,GF8703*1F

Notes:
- Character string of the device and the version is a free format.

▲0

7.5 MSG – Event Driven Message

Format:

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

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

Example:
$PERDMSG,1A*06

Notes:
- This string is sent when certain events occur.
- This is a sentence for FURUNO engineer use only.

8 Backup of the Receiver Parameters (for BBRAM)

The GNSSDO 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 GNSSDO 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 performs 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. ▲0

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
Receiver's present position	Latitude	YES	YES	YES	NO	YES
	Longitude	YES	YES	YES	NO	YES
	Altitude	YES	YES	YES	NO	YES
Receiver's 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

Table 8.2 Backup of the Receiver Parameter of Command

COMMAND NAME	PARAMETER	HOT	WARM	COLD	FACTORY	POWER OFF/ON
ALMSET ▲0	Alarm output setting	NO	NO	NO	NO	NO
ANTSET ▲0	ANTSET setting	NO	NO	NO	NO	NO
CROUT	CROUT setting	YES	YES	YES	NO	YES
DEFLS	Default leap second	YES	YES	YES	NO	YES
EXTSYNC ▲0	EXTSYNC setting	NO	NO	NO	NO	NO
FIXMASK	FIXMASK setting	YES	YES	YES	NO	YES
GCLK	GCLK output timing	YES	YES	YES	NO	YES
GNSS	GNSS setting	YES	YES	YES	NO	YES
HOSET ▲0	Holdover setting	NO	NO	NO	NO	NO
MODESET ▲0	MODESET setting	NO	NO	NO	NO	NO
PHASESKIP ▲0	PHASESKIP setting	NO	NO	NO	NO	NO
PPS	PPS setting	YES	YES	YES	NO	YES
SURVEY	position mode	YES	YES	YES	NO	YES
	Sigma threshold for survey	YES	YES	YES	NO	YES
	Time threshold for survey	YES	YES	YES	NO	YES
	Current sigma for survey	YES (*3)	YES (*3)	YES (*3)	NO	YES (*3)
	Current time for survey	YES (*3)	YES (*3)	YES (*3)	NO	YES (*3)
TIME (*5) ▲0	Initial time setting	YES	YES	YES	NO	YES
TIMEALIGN	Time alignment	YES	YES	YES	NO	YES
TIMEZONE	GMT setting	YES	YES	YES	NO	YES

Table 8.3 Backup of the Configure Parameter of Command

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

Notes:

(*1) The GNSSDO has calculated the survey position or set the position mode to TO (Time only) mode with "$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. ▲0

(*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. ▲0

(*5) The TIME setting is valid only when the time is not decided by the other factors. ▲0

9 TRAIM (Time Receiver Autonomous Integrity Monitoring) ▲0

The GNSSDO can properly reject un-healthy tracking satellites "time fix" information using the TRAIM function. TRAIM is not only used for rejection of unstable satellite(s) but is also useful for making PPS output condition decisions. Table 9.1 and Table 9.2 show the number of necessary satellites for TRAIM function.

Table 9.1 In Case that Position Mode is SS, CSS or TO Mode

Number of necessity satellite	Detect un-health satellite	Reject un-health satellite
3 and more	●	●
2	●	N/A
0 or 1	N/A	N/A

Table 9.2 In Case that Position Mode is NAV Mode

Number of necessity satellite	Detect un-health satellite	Reject un-health satellite
6 and more	●	●
5	●	N/A
4 or less	N/A	N/A

Notes:

- A maximum of up to three (3) satellites can be rejected.
- TRAIM supports only GPS and GLONASS satellites. QZSS is not supported.

10 Determination and Insertion of Leap Second ▲0

The GNSSDO determines the leap second using steps (A) through (E) described below to shorten the time synchronized with UTC (USNO) or UTC (SU).

(A) Back up leap second information
The leap second information is backed up to BBRAM. When the leap second is backed up to BBRAM, the GNSSDO can output the correct time after power OFF/ON.

(B) Extract leap second from UTC parameter broadcasted from GPS satellites
The leap second is obtained from the almanac information broadcasted from the GPS satellites. It takes up to 12.5 minutes to determine the leap second due to position timing and required almanac acquisition time.

(C) Obtain leap second from time difference by position fix with GPS and GLONASS
The time information broadcasted from GPS does not include leap second information. The time information broadcasted from GLONASS is included a leap second. The GNSSDO obtains the leap second from the time difference between GPS and GLONASS. This takes about 1 or 2 minutes in a good GNSS reception environment.

(D) Set leap second by command
When the user already has the correct leap second information, the GNSSDO can synchronize with UTC (USNO) or UTC (SU) immediately. This is done by setting the default leap second. The default leap second is set by DEFLS command.

The leap second will be updated when the leap second is determined by information obtained from the satellites even if a wrong default leap second is set. Otherwise the leap second is updated after the default leap second is set, the leap second will be updated.

(E) Position fix with GLONASS only
The GNSSDO can output UTC (USNO) or UTC (SU) without a determination or setting of the leap second since the time information broadcasted from GLONASS satellites already includes the leap second.

Notes:
GLONASS satellite leap second broadcasting is not guaranteed. In addition, there is no regulation specifying navigation message behavior at a leap second insertion. Please note the following when using GLONASS only positioning.

1) A determination or a setting of leap second is not necessary to output UTC (USNO) or UTC (SU). However the leap second should be known in order to synchronize with GPS time when using GLONASS only positioning. After the leap second is determined by (A) through (D) above the GNSSDO can synchronize with GPS time when using GLONASS only positioning.
2) The GNSSDO cannot obtain or update the correct leap second when using GLONASS only positioning. However since GLONASS satellites broadcast a future leap second update time and the update value (+1, 0, -1), the GNSSDO can use steps (A) through (D) above to update the leap second relative to the GLONASS broadcasted information. In this case it is necessary to set the leap second in advance and to obtain the future leap second update time before the actual update time.
3) GLONASS tracking or positioning may be interrupted due to the behavior of navigation message broadcasted from GLONASS at the insertion time of leap second. This can occur because there is no regulation of navigation message behavior during the leap second insertion. In addition a restart may be necessary for proper positioning.

The GNSSDO 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	Leap second
1009411213	December 31, 2011	23:59:58	15
1009411214	December 31, 2011	23:59:59	15
1009411215	December 31, 2011	23:59:60	16
1009411216	January 1, 2012	00:00:00	16
1009411217	January 1, 2012	00:00:01	16
1009411218	January 1, 2012	00:00:02	16

[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	Leap second
1056672013	June 30, 2013	23:59:57	16
1056672014	June 30, 2013	23:59:58	16
1056672015	July 1, 2013	00:00:00	15
1056672016	July 1, 2013	00:00:01	15
1056672017	July 1, 2013	00:00:02	15

11 Instructions and Directions for Use ▲0

The software of this product is thoroughly tested and qualified. Please contact us directly with any questions or concerns regarding any operational issues of this product. We will review, provide feedback and new software as required. FURUNO always strives to improve our products and therefore may provide future updates of product software to address compatibility issues or for new features.

If new software versions become available you may need to update. Therefore we strongly recommend access of the product serial port from your system for easy software updates.

In addition a remote network connection to your system for software updates is highly recommended.

For software version updates please contact us and refer to document.

Host Base FlashROM Programming User's Guide (Document No. SE13-900-010)