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FURUNO

FURUNO GNSS Receiver

Model GT-87

eSIP Protocol Specifications

(Document No. SE17-600-002-01)

FURUNO ELECTRIC CO., LTD.

www.furuno.com

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Revision History

Version	Changed contents	Date
0	Changed document number from G13-000-11-005-11.	2017.01.17
1	3 “Serial Data Output Timing” Added descriptions.	2017.04.21
	6.1.3 “PPS” Added Notes.	
	6.1.7 “SURVEY” Corrected the range of “latitude” and “longitude”.	
	10 “FAQ” Added.	

Table of Contents

1 Purpose

This document describes the *eRide* Serial communications Interface Protocol (eSIP) for GT-87.

2 Communication Specifications

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

Notes:

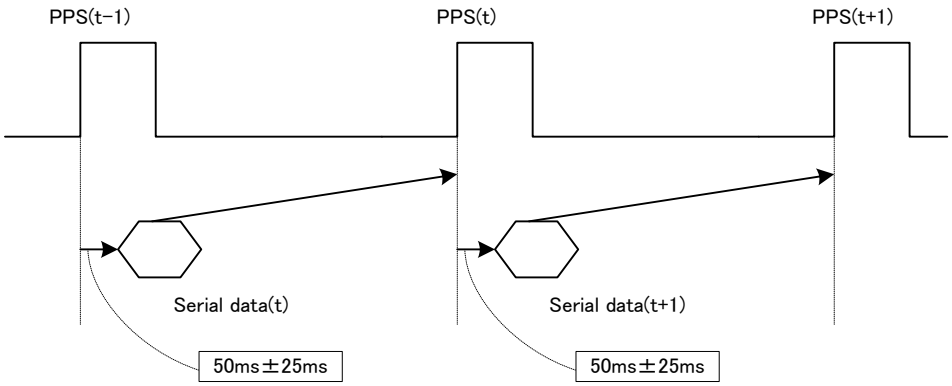
[*1] Communication speed can be changed into 4800, 9600, 19200, 38400, 57600 or 115200 bps. Please refer to section "UART1 – Serial Communication Port" for how to configure the communication speed. In case of using low baud rate, please adjust size of output sentence by NMEAOUT command and CROUT command to output all sentence within one second.

[*2] "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 synchronous with PPS output timing. Serial data is begun to output in the 25ms to 75ms range after PPS is output. The time of serial data indicates the next PPS output timing. The positioning information other than the time is generated based on the positioning results of the previous second. This synchronous is started after acquisition of time information by satellite positioning.

▲1



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 do a sentence formatter. All output sentences must begin with a “$” followed by a TalkerID. The relevant Talker IDs are GP for GPS, GN for GNSS, GL for GLONASS and GA for Galileo. For the sentences received from external equipment, the GT-87 accepts any talker ID. Talker ID “--” found on the succeeding pages is a wildcard meaning “any valid talker ID”.
<data field>	Variable or fixed-length fields preceded by delimiter “,”(comma). Comma(s) are required even when valid field data are not available i.e. null fields. Ex. “,,,,,” In a numeric field with fixed field length, fill unused leading digits with zeroes.
*<checksum field>	8 bits data between “$” 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. GT-87'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 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.

FURUNO does populate all the fields described in the NMEA specification. Uncalculated fields are indicated as "Not Supported".

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. Galileo and GLONASS are not counted. 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	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	S,C,U,V	Navigation status indicator S: Safe C: Caution U: Unsafe 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	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	n/a	GNSS System ID

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
2D/3D Auto-switching 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

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. Default num 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	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]
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	-	Magnetic declination A null field is output unless magnetic declination information is available.
11	a	-	Correction direction of magnetic declination A null field is output unless magnetic declination information is available.
12	a	A,D,N	Mode Indicator A: Autonomous D: Differential N: Data invalid
13	a	S,C,U,V	Navigational Status Indicator S: Safe C: Caution U: Unsafe 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 kts
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 A null field is output unless magnetic direction information is available.
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 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 LEGACYGP GN	AUTO	AUTO: GLGSV is omitted in case of no glonass. GPGSV is omitted in case of no GPS, SBAS and QZSS. LEGACYGP: GL and GN sentence is omitted. GN: GLGSV is output even if no glonass. GPGSV is output even if no GPS, SBAS and QZSS.
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 etc).
  Mode 2 means to enable tracking and use in position fix calculation.
- In GT-87, default setting of SBAS mode is 1, because to use calculation data of SBAS tends to reduce the accuracy of 1PPS. Therefore although GT-87 becomes to differential fix, SBAS is not appeared in GSA sentence in default setting. Improvement of 1PPS precision can be expected by acquiring the differential information of SBAS at GPS positioning. ▲1
- 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 omitted the fields after Command Name, that is, $PERDAPI,GNSS,QUERY*18.
- “SBAS only configuration” and “No tracking configuration” are not accepted.
  $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 be cleared) is run when satellite system configuration is changed from/to GLONASS only fix configuration. In the others configuration, hot restart is run.

6.1.2 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 (in 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 90	0	Signal level mask (in 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)	28BIT (HEX)	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=92.
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)
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 omitted the fields after Command Name, that is, $PERDAPI,FIXMASK,QUERY*52.

6.1.3 PPS – Setting of PPS (Pulse per Second)

Format:

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

polarity	[,	PPS accuracy threshold]	*hh	<CR>	<LF>
7		8			

Field	Data type	Range	Default	Description
1	PPS	-	-	Command Name
2	type	LEGACY GCLK	LEGACY	PPS type
3	mode	0 to 4	4	PPS mode 0: Always stop 1: Always output 2: Output only during positioning more than one satellite 3: Output only when TRAIM is OK 4: Output only when estimated accuracy is less than estimated accuracy threshold which is 8th field on this command.
4	period	0 to 1	0	PPS output interval 0: 1PPS (A pulse is output per second) 1: PP2S (A pulse is output per two seconds)
5	pulse width	1 to 500	200	PPS pulse width [ms]
6	cable delay	-100000 to 100000	0	PPS cable delay [ns] Plus brings delay PPS. Minus brings forward PPS.
7	polarity	0 to 1	0	PPS polarity (LEGACY PPS is rising edge only) 0: rising edge 1: falling edge
8	PPS accuracy threshold	5 to 9999	1000	PPS estimated accuracy threshold This threshold is used for mode 4.

Example:
$PERDAPI,PPS,LEGACY,1,0,200,0,0,25*29
Type: LEGACY PPS Mode: Always output 1PPS Pulse width: 200 ms cable delay: 0 ns
Polarity: rising edge of PPS is synchronous with UTC time.
PPS estimated accuracy threshold is 25nsec.

Notes:
- LEGACY PPS setting is output legacy PPS which is not synchronized with frequency which is output from GCLK pin, but which is output immediately after first fix in case of cold start.
- GCLK PPS setting is output GCLK PPS which synchronized with frequency which is output from GCLK pin, but it takes some to become GCLK PPS steady after first fix (typically, 1~2 minutes after fist fix). User can confirmed whether GCLK PPS is steady by GCLK accurate field of TPS4 sentence.
- 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 the follow.

[1] GPS alignment

PPS mode	Before first fix	After first fix
0	OFF	OFF
1	Sync with RTC	Sync with GPS
2~4	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)
2~4	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)
2~4	OFF	Sync with GPS	Sync with UTC (SU)

- About PPS estimated accuracy, please refer to the page of CRX (TPS2) sentence.
- TRAIM is applied to GPS and GLONASS. ▲1

6.1.4 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)".
- The data which is stored by FLASHBACKUP command in Flash is not cleared even if FACTORY restart is occurred.
- Power off/on of GT-87 corresponds to hot restart when it is within 4 hours after the last fix.
- Power off/on of GT-87 corresponds to warm restart when it is over 4 hours after the last fix.

6.1.5 TIME – Setting of Time Information

Initial time is configured. The setting of time is effective only within the case that the time is not decided by the other factors. A setting of a millennium which is the times of GPS week rollover is received also after 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.
- Under normal conditions, user needs not to set initial time because time is decided by satellite navigation data.
- As for GPS week rollover timing and GT-87 week rollover timing, please refer to the follow.

event	date	GPS week
GPS week rollover timing (1st) **default time of date of GT-87**	**1999/08/22**	**1024**
GPS week rollover timing (2nd)	2019/04/07	2048
rollover timing of GT-87	**2032/08/15**	**2745**
GPS week rollover timing (3rd)	2038/11/21	3072
…		
operable time limit of GT-87	**2099/12/31**	**6260**

[In case that GT-87 does not have GLONASS]
GT-87 can keep outputting a correct date after 2032/08/15 during power distribution. GT-87 will output 2012/12/30 after 2032/08/15 unless the user sets a correct date by TIME command after the user turns off GT-87 and also turns off the backup current for BBRAM.

[In case that GT-87 has GLONASS]
GT-87 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 user turns off GT-87 and the backup current.

6.1.6 TIMEZONE – Local Zone Time

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.

6.1.7 SURVEY – Position Mode

Format:

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

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

Field	Data type	Range	Default	Description
1	SURVEY	-	-	Command Name
2	position mode	0 to 3	2	0: Normal NAV (navigation) mode 1: Position Survey SS (self survey) mode 2: Position Survey CSS (continual self survey) mode 3: Position-hold TO (time only) mode
3	sigma threshold	0 to 255	0	Sigma threshold [m] which changes automatically to position-fixed. (When the threshold value is 0, it is not used.)
4	time threshold	0 to 10080	480 (8 hours)	Time threshold [minute] which changes automatically to position-fixed. (When the threshold value is 0, it is not used.)
5	latitude	-90.0000 to 90.0000 ▲1	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	-180.0000 to 180.0000 ▲1	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 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,3,0,0,37.7870,-122.4510,31.5*48 ▲1
Mode: TO mode Sigma threshold: 0 Time threshold: 0
Fixed position: 37.7870 degrees north 122.4510 degrees west Altitude: 31.5 m

Notes:
- It is omissible after the 3rd field.
- When the position mode is “1”, a position is re-calculated after the power supply OFF/ON. Please use it, when the antenna position may change before the power supply OFF.
- When the position mode is “2”, after the power supply OFF/ON, the estimated position that calculated before the power supply OFF is kept, and the position is updated. By using it when the antenna position does not change after the power supply OFF, the time for changing to the Position-hold mode can be shortened.
- In order to change automatically to the Position-hold mode, it is necessary to set to the Survey mode.
- 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.

- The displayed position may differ a little from the configured position due to conversion error.
- Hot start is occurred when the survey mode is shift to the NAV mode.

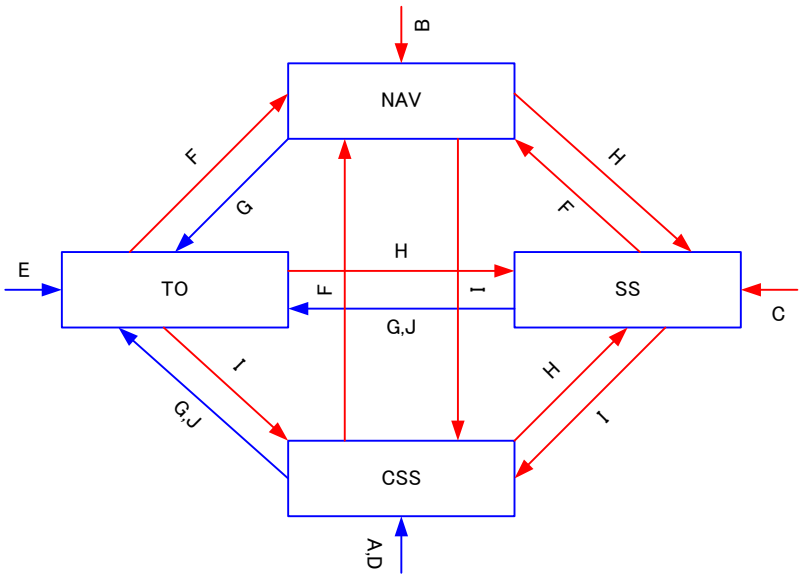


Figure 6.1 Flow Chart about Position Mode

	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. [*] Position mode is always started by time only mode if TO mode by this condition and power off.	Keep

6.1.8 FREQ – Setting of GCLK Frequency

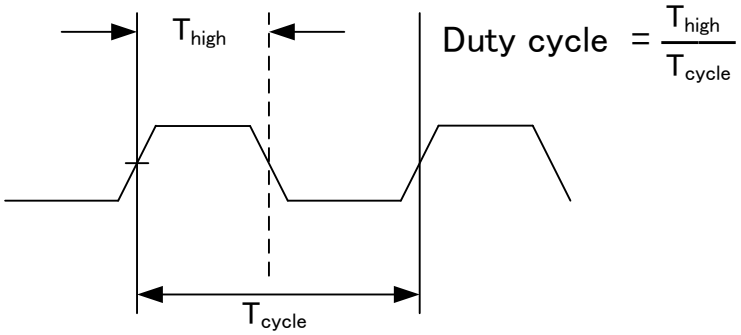
Format:

$PERDAPI	,	FREQ	,	mode	,	freq	[,	duty	,	offset]	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Data type	Range	Default	Description
1	FREQ	-	-	Command Name
2	mode	0 to 1	0	0: Stop 1: Output
3	freq	4000 to 40000000	10000000 (10MHz)	Frequency [Hz]
4	duty	10 to 90	50	Duty cycle [%]
5	offset	0 to 99	0	Phase delay in cycle [%] from GCLK-PPS edge

Example:
$PERDAPI,FREQ,1,10000000*47
Mode: output Frequency: 10MHz

Notes:
- 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 omitted the fields after the Command Name, that is, $PERDAPI,FREQ,QUERY*11.
- Duty cycle is derived from T_{high}/T_{cycle} in the follow figure.
- User can stock the current FREQ command setting on the Flash by FLASHBACKUP command.



6.1.9 DEFLS – Setting of Default Leap Second

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	16	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:
- The 3rd field is omissible.
- This value is used before the leap second is confirmed by the other factors which are to take the UTC (USNO) parameter which is broadcasted from GPS or to take a time difference between GPS and GLONASS.
- GT-87 can store the current DEFLS command setting in the Flash by FLASHBACKUP command.
- Cold restart (time also be cleared) is run when this command is run.

6.1.10 TIMEALIGN – Setting of Time Alignment

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.
- User can store the current TIMEALIGN command setting on the Flash by FLASHBACKUP command.
- This command is used to set the output time alignment and the 1PPS alignment.

[1: GPS alignment]
- Leap second is not applied to the output time even if GT-87 already has the leap second.
- PPS is output in synchronization with GPS even if GT-87 already has the UTC parameter.
- In GLONASS only mode, the correct default leap second is needed to output the correct time.

[2: UTC (USNO) alignment]
- Leap second is applied to the output time.
- PPS is output in synchronization with GPS before taking the UTC (USNO) parameter from GPS.
- PPS is output in synchronization with UTC (USNO) after taking the UTC (USNO) parameter from GPS.
- In GLONASS only fix, because GT-87 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 GPS before taking the UTC (SU) parameter from GLONASS.
- PPS is output in synchronization with UTC (SU) after taking the UTC (SU) parameter from GLONASS.
- In GPS only fix, because GT-87 cannot take the UTC (SU) parameter from GPS, PPS is kept to output in synchronization with GPS.

Restriction:
Output time

	GPS only fix setting	GLONASS only fix setting	GPS + GLONASS setting
GPS alignment	OK	**accurate default leap second is required [*1]**	OK
UTC (USNO) alignment	OK	OK	OK
UTC (SU) alignment	OK	OK	OK

PPS

	GPS only fix setting	GLONASS only fix setting	GPS + GLONASS setting
GPS alignment	OK	OK	OK
UTC (USNO) alignment	OK	**NG**	OK
UTC (SU) alignment	**NG**	OK	OK