FURUNO

FURUNO GNSS Receiver

Model: GN-8720

Protocol Specifications

(Document No. SE14-600-033-00)

FURUNO ELECTRIC CO., LTD.

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- QZSS(Japan)
- SBAS(USA: WASS, Europe: EGNOS, Japan: MSAS, India: GAGAN)

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Revision History

Version	Changed contents	Date
0	Initial release	2016.01.12

Table of Contents

1 Purpose

This document describes the eRide Serial communications Interface Protocol (eSIP) for controlling GN-8720.

2 Approval Software Version

This document applies to GN-8720. The associated Platform software version is ENP6.51A and newer.

3 Communication Specification

Table 3.1 shows the communication interface of the eSIP protocol.

Table 3.1 Communication Interface

	NMEA Protocol (eSIP)		RTCM SC-104 (Input Only)	
Communication Port	UART1 (TXD1, RXD1)		UART2 (RXD2)	
Communication Type	Asynchronous full duplex communication method (no control sequence)			
Transfer Rate (*1)	**Baud rate [bps]**	**Deviation Error [%]**	**Baud rate [bps]**	**Deviation Error [%]**
	4,800	+0.00	**4,800 (Default)**	+0.00
	9,600	+0.11	9,600	+0.11
	19,200	-0.11	19,200	-0.11
	38,400 (Default)	+0.32	38,400	+0.32
	57,600	-0.54	57,600	-0.54
	115,200	-0.54	115,200	-0.54
	230,400	+2.08	230,400	+2.08
Data Length (*1)	8 bit			
Stop Bit (*1)	1 bit			
Parity (*1)	None			
Output Rate	**1000 ms (1 Hz) (Default)**(*2) 500 ms (2 Hz) 200 ms (5 Hz) 100 ms (10 Hz)		-	
Character Code	NMEA-0183 Ver. 4.10 data based ASCII code (*3)		RTCM SC-104 (Ver. 2.3) (*4) (*5)	
Protocol Contents	Input Data NMEA Proprietary Sentence Output Data NMEA Standard Sentence NMEA Proprietary Sentence		Input Data Message Type 1 Message Type 3 Message Type 9	

(*1) These setting can be changed. Please refer to Section 13.2.6 for details.
(*2) These setting can be changed. Please refer to Section 13.1.8 for details.
(*3) ”NMEA 0183 STANDARD FOR INTERFACING MARINE ELECTRONIC DEVICES Version 4.10” (NATIONAL MARINE ELECTRONICS ASSOCIATION, June, 2012)
(*4) ”RTCM RECOMMENDED STANDARDS FOR DIFFERENTIAL NAVSTAR GPS SERVICE Version 2.3” (DEVELOPED BY RTCM SPECIAL COMMITTEE NO.104, August 20, 2001)
(*5) This code is the standard code for the differential GPS correction data.

4 NMEA Sentence Format

4.1 Standard Sentence

$	<Address field>	,	<Data field>	・・・	*<Checksum field>	<CR>	<LF>
	5 bytes						

"$" 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.
The talker IDs are GN of GNSS, GP for GPS, GL for GLONASS and GA for Galileo. (*1)

<Data field>
Mainly, they are variable-length fields and are delimited by delimiter "," (comma).
The valid data character set is all characters from ASCII 0x20-0x7D, except "!" (0x21), "$" (0x24), "*" (0x2A), "¥" (0x5C), and "^" (0x5E).
When there are not applicable data, they were expressed in null field.
The fields inside [ ] are optional fields.

<Checksum field>
8 bits data between "$" and "*" (excluding "$" and "*") are XORed, and the resultant value is converted to 2 bytes of hexadecimal letters.

<CR><LF> End-of-Sentence marker
<CR>: 0x0D
<LF>: 0x0A

Notes:
(*1) Talker IDs are changed by GNSS command setting and used satellite systems. The following table shows the talker ID of standard NMEA sentences.

Standard NMEA Sentence		Talker ID Configuration with PERDAPI,GNSS (*2)		
		AUTO	GN	LEGACYGP
RMC	Recommended Minimum Navigation Information	GN/GP/GL/GA	GN	GP
GNS	GNSS Fix Data	GN/GP/GL/GA	GN	GP
GGA	Global Positioning System Fix Data	GN/GP/GL/GA	GN	GP
GLL	Geographic Position - Latitude/Longitude	GN/GP/GL/GA	GN	GP
VTG	Course Over Ground and Ground Speed	GN/GP/GL/GA	GN	GP
GST	GNSS Pseudo range Error Statistics	GN/GP/GL/GA	GN	GP
GBS	GNSS Satellite Fault Detection	GN/GP/GL/GA	GN	GP
GFA	Integrity Data	GN/GP/GL/GA	GN	GP
GSA	GPS DOP and Active Satellites	GN/GP/GL/GA	GN/GP/GL/GA	GP
ZDA	Time & Date	GN/GP/GL/GA	GN	GP
GSV (*3)	Satellites in View (GPS, SBAS, QZSS)	GP	GP	GP
	Satellites in View (GLONASS)	GL	GL	x
	Satellites in View (Galileo)	GA	GA	x

GN/GP/GL/GA: shows that the talker ID changes to the following talker IT by using satellite system.
GN: Multi satellite system, GP: Only GPS (involve SBAS and QZSS), GL: Only GLONASS, GA: Only Galileo
x: The satellite system is used for positioning through the sentence is not output.

(*2) See Section 13.1.9 for talker ID configuration.
(*3) The sentences are output when they are used for position fix and GN-8720 corresponds to the satellite.

4.2 Proprietary Sentence

$	P	<maker code>	<Sentence type>	,	<Data field>	・・・	*<Checksum>	<CR>	<LF>
		3 bytes	3 bytes						

"$" Start-of-Sentence marker

"P" Proprietary Sentence ID

<Maker code>
It indicates the maker and it is "ERD".

<Sentence Type>
It indicates the type of sentence.

<Data field>
Mainly, they are variable-length fields and are delimited by delimiter ","(comma).
The valid data character set is all characters from ASCII 0x20-0x7D, except "!" (0x21), "$" (0x24), "*" (0x2A), "¥" (0x5C), and "^" (0x5E).
When there are not applicable data, they were expressed in null field.

<Checksum field>
8 bits data between "$" and "*"(excluding "$" and "*") are XORed, and the resultant value is converted to 2 bytes of hexadecimal letters.

<CR><LF> End-of-Sentence marker
<CR>: 0x0D
<LF>: 0x0A

5 Configurable Parameters List

Table 5.1 shows the configurable parameters and default values.

Table 5.1 Configurable Parameters List

eSIP Command		Configurable Item		Range	Default
API	ANTIJAM	Anti-Jamming function		GP: GPS (1.575 GHz band) Priority GL:GLONASS (1.602GHz band) Priority USER: User setting	GP
	CROUT	Original CR sentence output		E: CRE output F: CRF output L: CRL output P: CRP output Q: CRQ output ALLOFF: All CR sentence output off	ALLOFF
	DATUM	Geodetic Datum		001: WGS-84 172: Tokyo Datum	WGS-84
	DEFLS	Default leap second		00 to 32 [sec]	17
	EXTENDGSA	Number of fields for satellites used in the fix in the GSA sentence		12 to 16 [satellites]	12
	FIRSTFIXFILTER	First Fix Filter		STRONG: FF position accuracy Priority MEDIUM: TTFF and FF position accuracy balanced OFF: TTFF Priority	MEDIUM
	FIXMASK	Mask Satellite	Mask Elevation	0 to 90 [degree]	0
			Ephemeris age mask	0 to 28800 [sec]	14400
			SNR mask	0 to 49 [dB-Hz]	0
			Tracking status	0: tracking SVs which have available ephemeris are used in the position fix calculation. 1: only SVs with TSM measurements are used in the position fix calculation	0
	FIXPERSEC	Number of fixes per second		1, 2, 5, 10 [Hz]	1
	GNSS	Used satellite systems	Standard NMEA sentence talker ID	AUTO, GN, LEGACYGP (See the notes in Section 4.1 about talkerID.)	GN
			GPS	-1, 0, 1, 2, 3	2
			GLONASS	-1, 0, 1, 2, 3	2
			Galileo	-1, 0, 1, 2, 3	0
			QZSS	-1, 0, 1, 2, 3	2
			SBAS	-1, 0, 1, 2, 3	2
	LATPROP	Position propagation time		-1 to 2000 [msec] (step: 1msec)	0 (800msec)
	OUTPROP	Number of seconds to propagate the last valid position fix when the GNSS signal is lost.		0 to 10 [sec]	10
	PIN	Pinning strength		OFF: Pinning OFF STRONG: Pinning ON	STRONG
	POS	Position	Latitude	-90.0000 to 90.0000 [degree]	North 00000.0000
			Longitude	-180.0000 to 180.0000 [degree]	East 00000.0000
			Altitude	0 to 18300 [m]	-18.0
			Uncertainty	1 to 8000000	-
	PPS	Pulse per second	Output type	FINE: PPS output ON OFF: PPS output OFF	FINE
			Output mode	1: Always Output 2: Output after position fix	1
			Pulse Interval	1000, 2000 [msec]	1000
			Width PPS pulse	1 to 500 [msec]	200
			Cable compensation	-100000 to 100000 [msec]	0
	RAIM	RAIM	ON/OFF	ON: RAIM function ON OFF: RAIM function OFF	OFF
			Accuracy Level	1 to 999	-

eSIP Command		Configurable Item		Range	Default
	SBASBLS	Priority of Searched SBAS Satellite and Query		0: WAAS 1: EGNOS 2: MSAS 3: GAGAN 255: Blind search in ascending order of PRN QUERY: Request the setting	2: MSAS
	SELFEPH	Self-Ephemeris mode ON/OFF		ON: The satellites which have available Self-Ephemeris™ are used in position fix calculation. OFF: Self-Ephemeris™ is not used in position fix calculation.	ON
	STATIC	Static mode transition condition setting	Velocity threshold for entering the mode	0 to 20480 [m/sec/2^{-12}] (1.1 [m/sec] ≒4506 [m/sec/2^{-12}])	4506
			Time threshold for entering the mode	0 to 100 [sec]	2
			Velocity threshold for exiting the mode	0 to 20480 [m/sec/2^{-12}] (1.1 [m/sec] ≒4506 [m/sec/2^{-12}])	4506
			Time threshold for entering the mode	0 to 100 [sec]	2
	TIME	Time	Time of day ((UTC))	000000 to 235959 (HHMMSS HH: hour, MM: min, SS: sec)	000000
			Day (UTC day)	1 to 31	22
			Month (UTC mouth)	1 to 12	8
			Year (UTC year)	2015 to 2099	1999
			Uncertainty	0 to9 [sec] (Error between the setting time and actual time)	-
CFG	FORMAT	Protocol format		FECBIN,ESIP	ESIP
	NMEAOUT	Standard NMEA output	Output sentence	GBS, GFA, GGA, GLL, GNS, GSA, GST, GSV, RMC, VTG, ZDA	RMC, GNS, GST, GSA, ZDA, GSV
			Interval of output sentence	0 to 60	1
	SILENTSTART	SILENT START mode		-	-
	UART1	Communication port 1 setting	Baud rate	4800, 9600, 19200, 38400, 57600, 115200, 230400 [bps]	38400
			Data length	8 [bit]	8
			Parity	NONE, EVEN, ODD	NONE
			Stop bit	1, 2 [bit]	1
	UART2	Communication port 2 setting	Baud rate	4800, 9600, 19200, 38400, 57600, 115200, 230400 [bps]	4800
			Data length	8 [bit]	8
			Parity	NONE, EVEN, ODD	NONE
			Stop bit	1, 2 [bit]	1
SYS	ANTSEL	Antenna mode selection		FORCE1H, FORCE1L, FLEXFS, QUERY	The mode is selected by the hardware setting
	ERRACT	Receiver's state processing at abnormal status		HALT: Transfer to fix session off state IGNORE: Remain fix session state.	IGNORE
	FIXSESSION	GNSS session query		0: Not output autonomously 1: output autonomously	1
	RECPLAY	Diagnostic mode ON/ OFF		ON : Diagnostic data output ON OFF: Diagnostic data output ON	OFF
	SELFEPH	Self-Ephemeris Calculation setting	Hours of model availability.	OFF, 8 to 72 [hour]	OFF
			Accuracy	0: Low Accuracy mode 1: High Accuracy mode	-
	SELFTEST	Self test		-	-

Notes:

The configuration parameters with eSIP command are returned to the default values by the following events.

(1) Command beginning with $PERDAPI (exclude position and time)
- Power OFF
- Hardware Reset
- PERDAPI,STOP command, PERDAPI,STOPNOFPR command
- PERDAPI,RESTART command, PERDAPI,RESTARTNOFPR command
- PERDCFG,FACTORYRESET command

(2) Command beginning with $PERDCFG and $PERDSYS
- Power OFF
- Hardware Reset
- PERDCFG,FACTORYRESET command

The position by PERDAPI,POS command and the time by PERDAPI,TIME command are stored into the backup area of Backup RAM when these data are uncertain. When the receiver determines these data with GNSS satellite, these data are updated and stored into the area again. In case of no position fixed, the position by configured with PERDAPI,POS command and the time by PERDAPI,TIME command are stored into the backup area of backup RAM. When time and position are fixed by GNSS information, these data are updated and stored into the backup area again.

If it is necessary to automatically set up with these parameters, without having the host sending commands to the GNSS receiver, using the ESIPLIST function is ideal. See Section 8.11 and Section 13.2.1 about the ESIPLIST.

6 Receiver State

Table 6.1 shows the receiver's operating state and Figure 6.1 shows the state transition diagram.

Table 6.1 Receiver State List

State	Description
Power off	The receiver shuts off the power. It inputs and outputs nothing.
Fix session	Calculate PVT (Position, Velocity and Time) the continuously and outputs the result in a cycle. This receiver transfers to this state from power off at power on. The receiver transfers changes to this state when PERDAPI,START command is sent at fix session off state.
Fix session off	Stop calculating PVT and idles. The receiver transfer to this state when PERDAPI,STOP or PERDAPI,STOPNOFPR command is sent at fix session state. If the receiver detects self test error or error status, the receiver transfers this state from fix session state. (*1) The receiver transfers to this state from power off at power on when this mode is silent start mode. (*2) In terms of invalid command (*) at fix session state, It is necessary to input commands after transferring to this state. (*): See Table 6.3 for details.
BBDATA input	The receiver is inputting the backup data with PERDSYS,BBRAM command.
Flash ROM program rewriting	Update process of the position calculation programming is active with Flash ROM reprogramming tool.
ESIPLIST writing	Initial configuration process in Flash ROM area by eSIP commands list in ESIPLIST is activating with PERDCFG,ESIPLIST command.

Notes:

(*1) It needs to set PERDSYS,ERRACT command to “HALT”.

(*2) It needs to register PEREDCFG,SILENTSTART command into ESIPLIST.

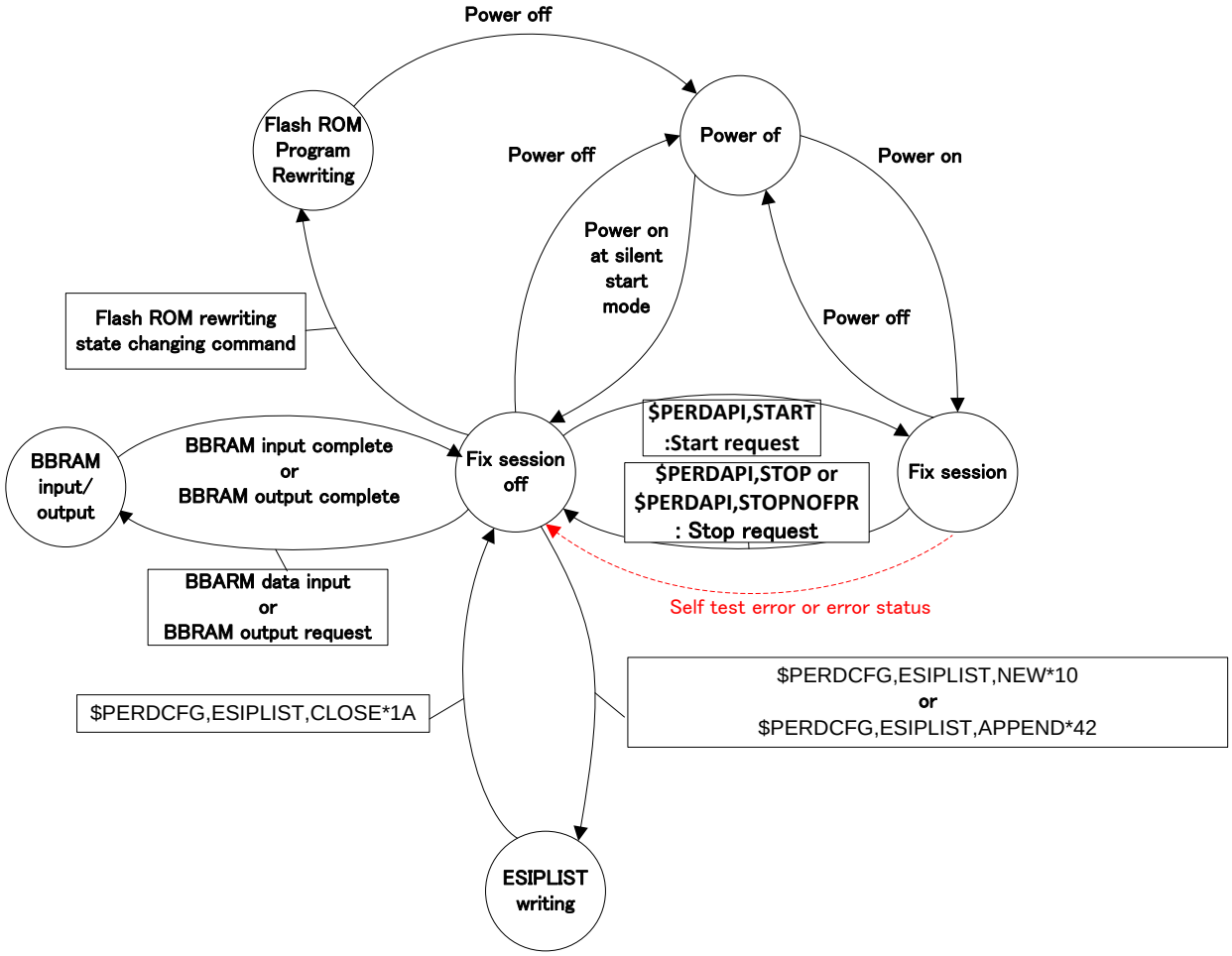


Figure 6.1 Receiver State Diagram

Table 6.2 shows input / output of communication port (UART1(Output) , UART1(Input) and I2C/ UART2) at each states.

Table 6.2 UART Input/Output at Each State

State	UART1 (Output)	UART1 (Input)	UART2 (Output)
Power off	The transmission function is invalid.	The reception function is invalid.	The reception function is invalid.
Fix session	The output data is either position fix data or input data.	The input data are all commands except the valid commands only when the state is fix session off.	The communication function for RTCM SC-104 is valid.
Fix session off	The output data is response of input command.	The input valid data are all commands except the valid commands only when the state is fix session.	The reception function is invalid.
BBDATA input/ output	Not applicable	PERDSYS,BBRAM command is valid at fix session off.	Not applicable
Flash ROM program reprogramming	The sentences based on Flash ROM reprogramming procedure are output. (*1)	It only inputs the sentences for Flash ROM programming procedure. (*1)	Not applicable
ESIPLIST writing	Responses to input are output.	Input commands are recorded into ESIPLIST during this state.	Not applicable

Notes:

(*1) See "Flash ROM Programming Procedures with WinUppg" (Doc # SE13-900-009) about Flash ROM program rewriting.

Table 6.3 shows input commands/ output sentences at fix session state / fix session off state.

Table 6.3 Input Command / Output Sentence at Each State

Standard NMEA Output

Output sentence	Output contents	Fix session	Fix session off
RMC	Recommended Minimum Navigation Information	O	-
GNS	GNSS Fix Data	O	-
GGA	Global Positioning System Fix Data	O	-
GLL	Geographic Position - Latitude/Longitude	O	-
VTG	Course Over Ground and Ground Speed	O	-
GST	GNSS Pseudo range Error Statistics	O	-
GBS	GNSS Satellite Fault Detection	O	-
GFA	Integrity Data	O	-
GSA	GPS DOP and Active Satellites	O	-
ZDA	Time & Date	O	-
GSV	Satellites in View	O	-

O: Output is available. It is possible to control output function (ON/ OFF) and output period by PERDCFG,NMEAOUT command.

-: Output is not available.

Proprietary NMEA Input

Input command	Input contents	Fix session	Fix session off
PERDAPI			
ANTIJAM	Anti Jamming	I	I
CROUT	CR original sentence output	I	I
DATUM	Geodetic datum	I	I
DEFLS	Default leap second	I(*1) / q	I / q
EXTENDGSA	GSA sentence re-definition	I	I
FIRSTFIXFILTER	First fix filter parameters	I	I
FIXMASK	Satellite Mask	I	I
FIXPERSEC	Multiple fixes per second	I	I
GNSS	GNSS satellite system configuration	I	I
LATPROP	Enable latency position propagation	I	I
OUTPROP	Enable position outage propagation	I	I
PIN	Static pinning strength set	I	I
POS	Position aiding	I	I
PPS	PPS (Pulse per second)	I	I
RAIM	RAIM	I	I
RESTART/RESTARTNOFPR	Restart request	I	I
SBASBLS	SBAS priority search select	I	I
SELFEPH	Self-Ephemeris mode ON/OFF	I	I
START	Start request	NACK	I
STATIC	Static entry/exit parameters	I	I
STOP/STOPNOFPR	Stop request	I	NACK
TIME	Time aiding	I	I
PERDCFG			
ESIPLIST	Save/query ESIP commands to FLASH	q	I / q
FACTORYRESET	Clear non-volatile memory	NACK	I
FORMAT	Protocol format	I (*1)	I
NMEAOUT	Configure the standard NMEA outputs	I	I
SILENTSTART	SILENTSTART mode	E	E
UART1/UART2	Serial communication port configuration	I (*1)	I
PERDSYS			
ANTSEL	Antenna selection control	I / q	I / q
BBRAM	Backup data output query	q(*2)	q
	Backup data input	NACK	I
ERRACT	Receiver's state processing at abnormal status	I	I
FIXSESSION	GNSS session query	I / q	I / q
GPIO	GPIO output query	q	q
RECPLAY	Diagnostic mode ON/ OFF	I (*1)	I
SELFEPH	Self-Ephemeris models calculation	I	I
SELFTEST	Self test	q	q
VERSION	Software version query	q	q

I: Input is available. q: Query is available. NACK: Not related to internal process.
E: Please register this command into ESIPLIST. (See Section 8.11 and Section 13.2.1 about ESIPLIST.)

Notes:

(*1) Input this command at fix session off state, though it is possible to input.
(*2) Request to output backup data at fix session off state to avoid mix transmission with back up and other data.

Proprietary NMEA Output

Output sentence	Output contents	Fix session	Fix session off
PERDACK			
ACK	Command acknowledgement	A	A
PERDCFG			
ADDON	Start status	S	-
ESIPLIST	ESIP command list query	Q	Q
PERDCRx			
CRE	GNSS ephemeris data	O	-
CRF,GxACC	GNSS accuracy	O	-
CRF,GxANC	GNSS health	O	-
CRL	LTCSM / Self-Ephemeris™ availability	O	-
CRP	PPS status	O	-
CRQ	Galileo SAR/RLM data	O	-
PERDMSG			
MSG	Event message	E	E
PERDRPx			
RPx	Diagnostic data	O	-
PERDSYS			
ANTSEL	Antenna selection control status	S/ Q	Q
BBRAM	Backup data output	Q(*1)	Q
FIXSESSION	GNSS session	Q/ R/ S/ E	Q
GPIO	GPIO status	Q	Q
SELFEPH	Self-Ephemeris™ Calculation state	E	E
SELFTEST	Self test	Q	Q
VBKERR	VBK error report	E	E
VERSION	Software version	S/ Q	Q

O: Output is available.
Q: This sentence is output when the query command is input.
R: This sentence is output at the following conditions:
- The state transfers from fix session off state to fix session state by PERDAPI,START command.
- The state transfers from fix session state to fix session off state by PERDAPI,STOP or PERDAPI,STOPNOFPR command.

S: This sentence is output at power on.
A: This sentence is output as ACK or NACK for input command.
E: This sentence is output when certain events occur.
-: Output is not available.

Notes:
(*1) Please output backup data at fix session off state to avoid mix transmission with back up and other data.

7 Backup Data

The receiver backs up the last updated position, the last updated time, the ephemeris, the almanac, the CSM, the LTCSM and the Self-Ephemeris™. These backup data are used for shortening the position fix time at the next start-up.

(1) Last updated position
This data shows the last position data calculated by the receiver. It shows the position data in GGA, GLL, GNS and RMC sentence. This data is backed up every position fix.

(*) GGA, GLL, GNS and RMC sentences are output by PERDCFG,NMEAOUT command, or GLL, GNS and RMC sentences are output by default.

(2) Last updated time
This data shows the last UTC calculated by the receiver and the RTC counter value. It shows the UTC data in GGA, GLL, GNS and RMC sentence. This data is backed up after fixing the time at first.

(*) GGA, GLL, GNS and RMC sentences are output by PERDCFG,NMEAOUT command, or GLL, GNS and RMC sentences are output by default.

When the receiver's state is power off state and a backup power is supplied to the receiver, the time at power on can be calculated from the delta between the last updated time and RTC counter value.

This document defines the time calculated from the delta between the last updated time and the RTC counter value as RTC time. RTC time is valid when the receiver can calculate it and RTC time is invalid when the receiver cannot calculate it because backup power is not supplied.

(3) Ephemeris
These data show the ephemeris data broadcasted from GNSS satellites. These are backed up, when the receiver gets these and updates these.

(4) Almanac
These data show the almanac data broadcasted from GNSS satellites. These are backed up, when the receiver gets these and updates these.

(5) CSM
These data shows the all GPS satellites ephemeris model downloaded from an assist server. (These are FURUNO original format.) These are backed up into a backup RAM at downloading the data.

(6) LTCSM
These data shows the extended satellites ephemeris model which the receiver can use for one week. (These are FURUNO original format.) These are backed up into Flash ROM area at downloading the data.

(7) Self-Ephemeris™
These data shows the extended ephemeris model made from received satellites ephemeris. The time is max 3 days. These are backed up into Flash ROM area at downloading the data.

Notes:
Because the data from (1) to (5) of above are saved into a backup RAM, these are continued to save whiling a backup power is supplied to the receiver. The receiver can also save these into Flash ROM, when PERDAPI,STOP command is sent.
Data (6) and (7) of above are saved into the Flash ROM area for LTCSM.

7.1 Flash ROM Data Area

Table 7.1 shows the data area contents in Flash ROM.

Table 7.1 Flash ROM Data Area Constitution Diagram

Data Area	Identification Name	Contents	Writing Timing
Data Area 1	FBINMFG	Area for manufacturing test	Manufacturing test
Data Area 2	GLOLTCSM1	Main area for GLONASS LTCSM(*1)	GLONASS LTCSM from an assist server is received.
Data Area 3	GLOLTCSM2	Sub area for GLONASS LTCSM(*1)	Data Area 2 is deleted.
Data Area 4	SELFEPH1	Main area for Self-Ephemeris™(*1)	Self-Ephemeris model has been calculated.
Data Area 5	SELFEPH2	Sub area for Self-Ephemeris™(*1)	Data Area 4 is deleted.
Data Area 6	LTCSM1	Main area for GPS LTCSM(*1)	GPS LTCSM from an assist server is received.
Data Area 7	LTCSM2	Sub are for GPS LTCSM(*1)	Data Area 6 is deleted.
Data Area 8	PREVRUN	Area for saving Backup RAM data	PERDAPI,STOP command is received.
Data Area 9	ESIPLIST	Area for saving ESIPLIST	PERDCFG,ESIPLIST command is received.
Data Area 10	ESIPROM	Area for saving ESIPROM (Any user cannot delete this area.)	At only writing the program into Flash ROM.

Notes:

(*1) The backup data is stored at main area first. When the main area is full of the data and the data in Flash ROM area should be deleted, the valid backup data is moved to the sub area.

8 Transmission and Reception Sequence

This chapter shows the transmission and reception sequences between the receiver and the host system. The receiver outputs the response sentence ($PERDACK...) or the requested data when the commands written in the chapter 13 are input.

If the receiver does not return a response though the correct command is input, an error may be occurred on transmitting line. Please input the command again.

8.1 Startup Sequence

The receiver outputs the version message ($PERDSYS,VERSION...), the configuration data (*1) and the fix session start message ($PERDSYS,FIXSESSION,ON) and do start process soon after power on. Until finishing the start process, the receiver cannot receive an input command. It takes max 600 msec to be able to input the command.

Figure 8.1 shows the sequence from power on to command input available.

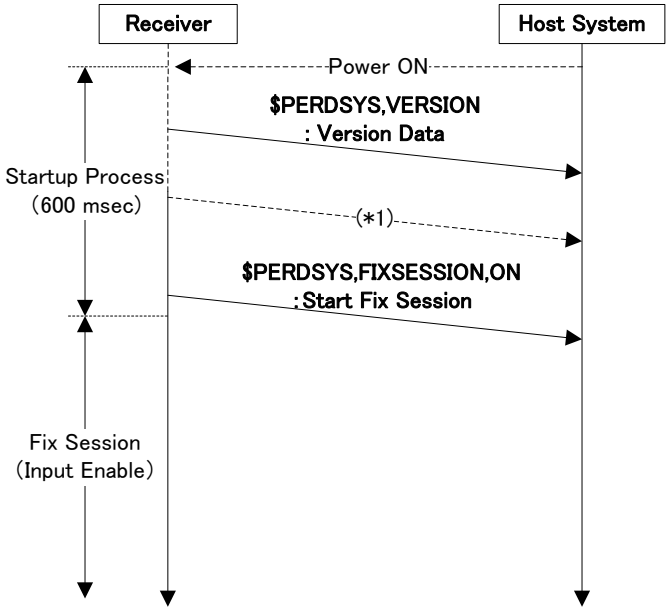


Figure 8.1 Communication Sequence from Power On to Command Input Available

Notes:
(*1) The configuration data are output.

8.2 Sequence from Fix Session OFF to Fix Session

Figure 8.2 shows the transition sequence from fix session off state to fix session state.

The receiver's state will change to fix session state after PERDACK sentence and PERDSYS,FIXSESSION,ON sentence are output, when PERDAPI,START command is input at fix session off state.

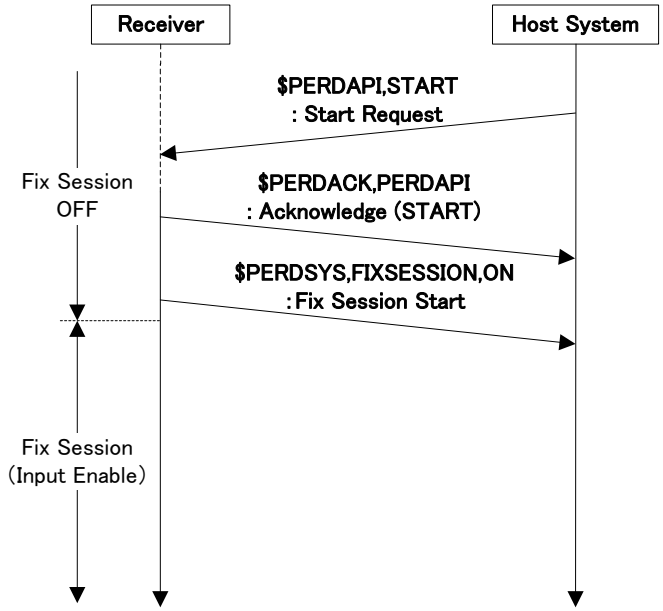


Figure 8.2 Communication Sequence from Fix Session OFF to Fix Session

8.3 Periodical Output Sentence (Example 1)

Figure 8.3 shows the periodical output sequence when the following NMEA sentences are output synchronized with positioning interval which is 1Hz.

(Output NMEA sentences)
RMC, GNS, GST, GSA, ZDA and GSV (Talker ID other than GSV are GN and Talker ID for GSV is GP.)

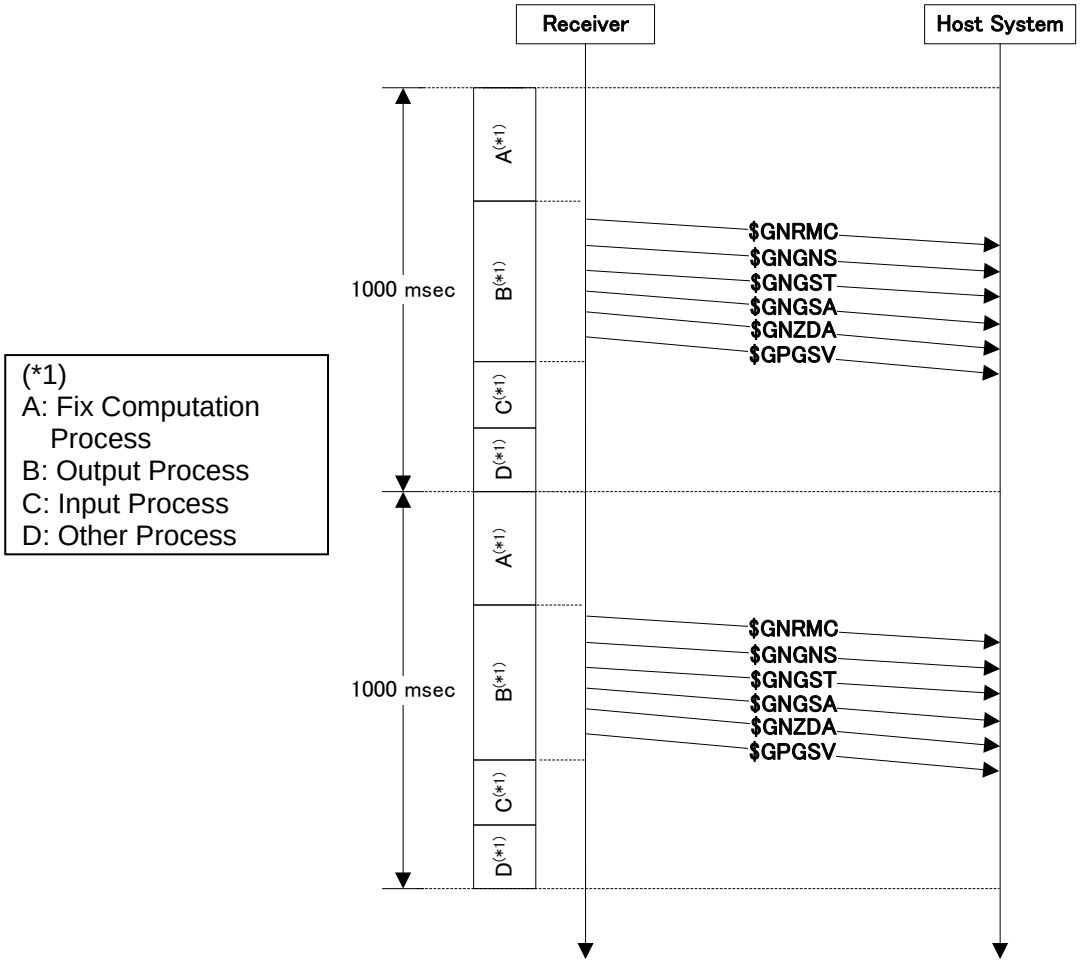


Figure 8.3 Communication Sequence (Periodical Output Example 1)

8.4 Periodical Sentence (Example 2)

Figure 8.4 shows the sequence under the following output conditions.

(Output conditions)

- Positioning interval: 2Hz
- Output NMEA sentence: GNS, RMC and GSV
- Output interval: GNS and RMC are output every positioning interval GSV is output once every 2 positioning interval.

The following commands are input to change from default output to above output conditions.

(Input commands)

$PERDAPI,FIXPERSEC,2*2C	: Positioning interval is 2Hz.
$PERDCFG,NMEAOUT,GST,0*54	: GST sentence is not output.
$PERDCFG,NMEAOUT,ZDA,0*4B	: ZDA sentence is not output.
$PERDCFG,NMEAOUT,GSV,2*54	: GSV sentence is output every 2 positioning.

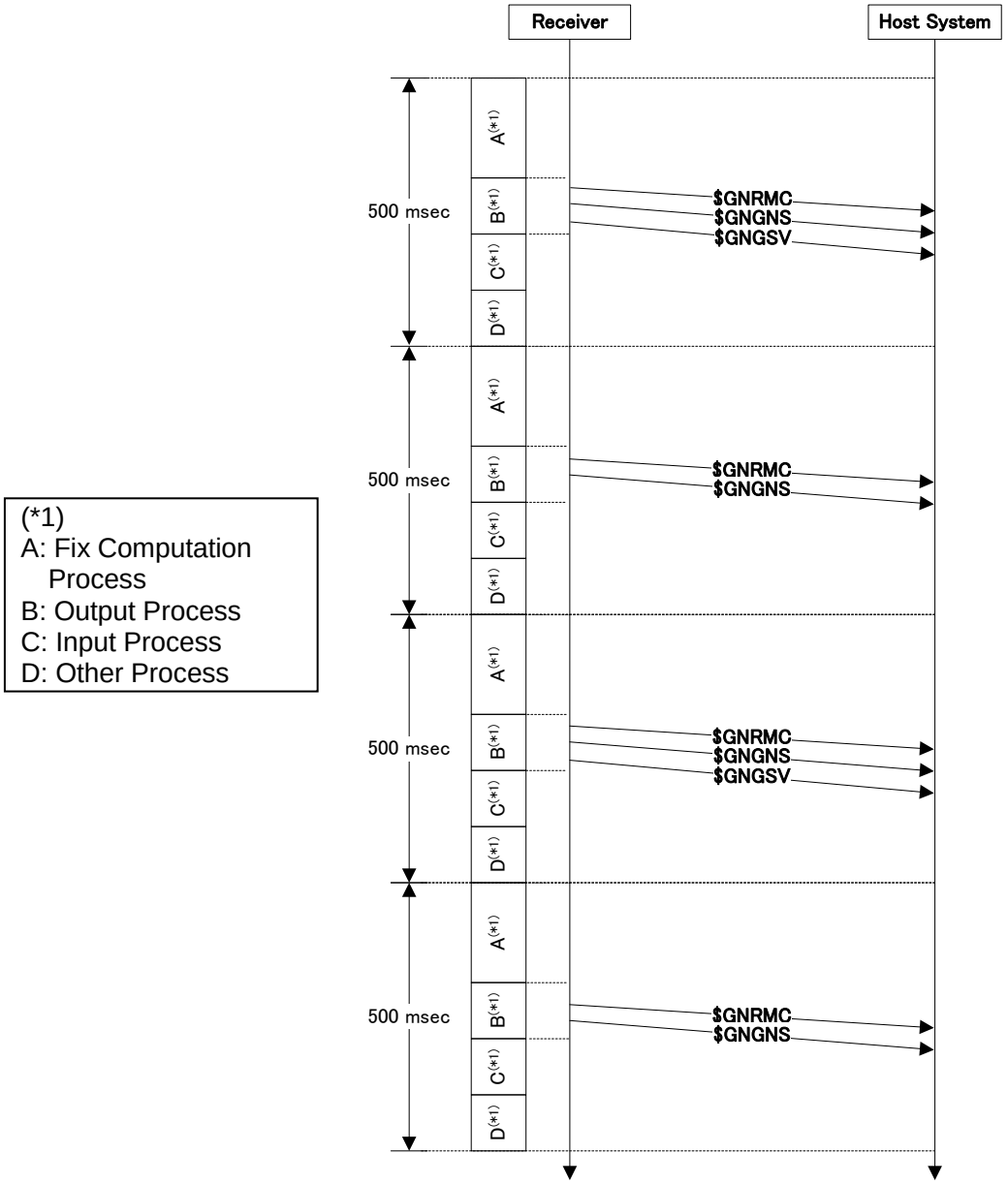


Figure 8.4 Communication Sequence (Periodical Output Example 2)

8.5 Receiver Configuration Setting Sequence

Figure 8.5 shows the communication sequence for the receiver which is update rate 1Hz and output positioning data synchronized with positioning cycle of RMC, GNS and GSV sentences when the receiver setting is changed by sending the following commands.

- PERDAPI,FIXMASK command
- PERDAPI,PIN command

The following figure shows the difference in response time which is a response of each input of command by input timing and the time which is reflected to positioning results against input command setting by input timing.

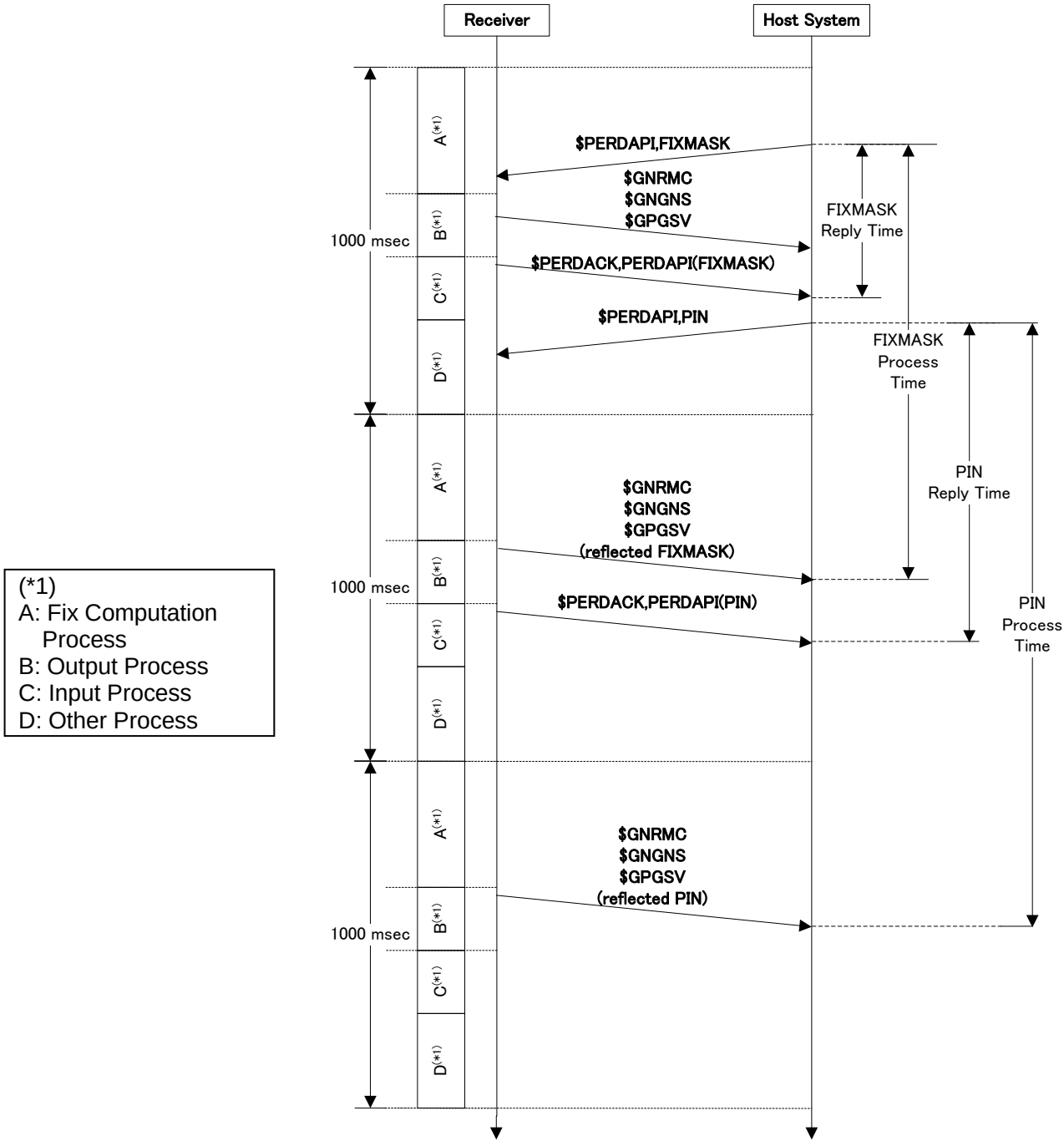


Figure 8.5 Communication Sequence Example in Case of Changing Receiver Setting (1 Hz)

Notes:

1. Maximum response time from data Input to data output

The receiver needs **maximum 1000 msec** to output requested data since data output request command which is input just behind input processing will be accepted at next input processing of completion of positioning calculation processing and output processing when the receiver is in Fix session state and update rate 1Hz.

Table 8.1 shows the maximum response time from data input to data output for each state and each update rate.

Table 8.1 Maximum Response Time from Data Input to Data Output

State	Update rate [Hz]	Maximum response time [msec]
Fix session	1	1000
	2	500
	5	200
	10	100
Fix session off	-	100

2. Maximum response time from setting data input to positioning data output

The receiver needs **maximum 2000 msec** to output positioning data which is reflected setting data input by sending command when the receiver is in Fix session state and update rate 1Hz.

Table 8.2 shows the maximum response time to output positioning data after input of setting data for each state and each update rate.

Table 8.2 Maximum Response Time from Setting Data Input to Positioning Data Output

State	Update rate [Hz]	Maximum response time [msec]
Fix session	1	2000
	2	1000
	5	400
	10	200

3. Number of commands which is able to input at one time

The receiver can accept input command once per second in principal. The receiver can accept multiple input commands per 1 second when it has low load depending on setting of receiver and positioning status.

20 commands can be input to the receiver in a row when the receiver is in Fix session off state. It is able to input next command at the timing of finishing output of receiver response against command group which are input first.

8.6 Receiver Data Output Request

The following is the sequence when the receiver data output is requested. Figure 8.6 shows the sequence from input of PERDSYS,GPIO command and PERDSYS,VERSION command to the receiver 1Hz positioning to output requested data.

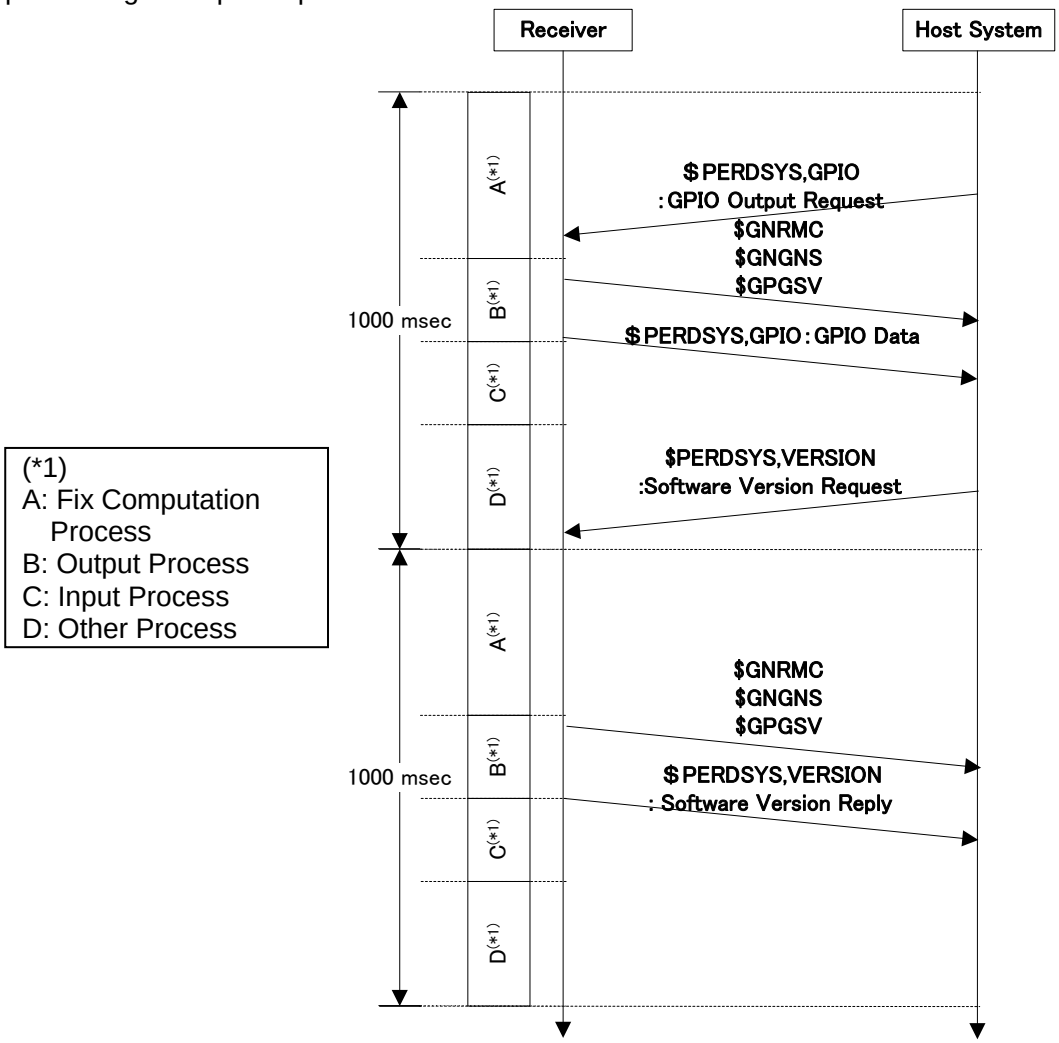


Figure 8.6 Communication Sequence Example in Case of Requesting Receiver Output Data (1 Hz)

Notes:

1. Maximum response time to output requested data after input of receiver data output request

The receiver needs **maximum 1000 msec** to output requested data by sending command since data output request command which is input just behind input processing will be accepted at next input processing of completion of positioning calculation processing and output processing when the receiver is in Fix session state and update rate 1Hz.

Table 8.3 shows the maximum response time to output requested data after input of data output request command for each state and each update rate.

Table 8.3 Maximum Response Time to Output Requested Receiver Data

State	Update rate [Hz]	Maximum response time [msec]
Fix session	1	1000
	2	500
	5	200
	10	100
Fix session off	-	100

8.7 Backup Data Input/Output

The following is the explanation of sequence to output and to input the receiver backup data in MULTIB64 format and ESIP64 format.

Since the capacity of backup data exceeds transmission capacity in one sentence, the backup data is divided when the backup data is input or output.

Figure 8.7 shows the outline of process of backup data input/output.

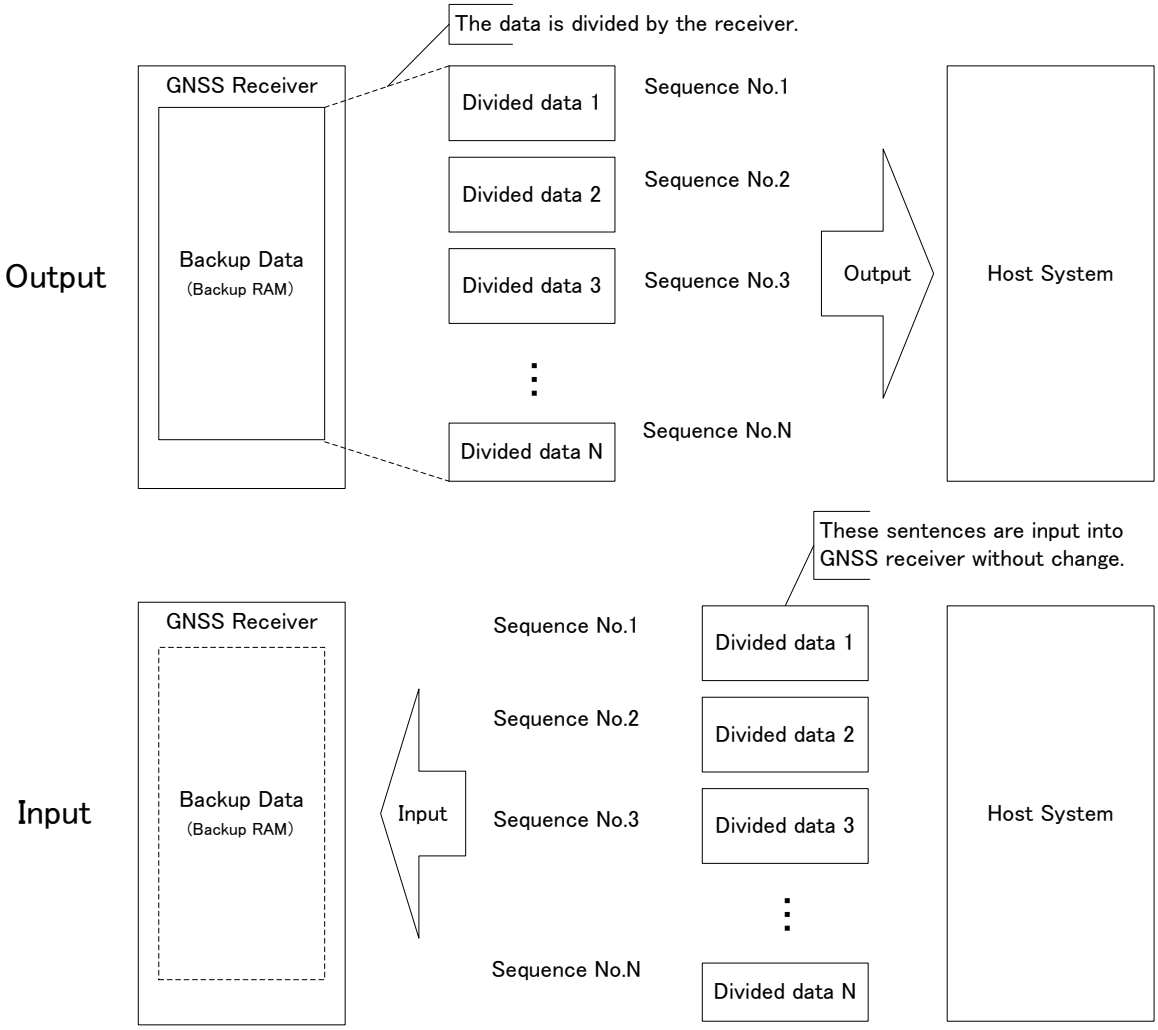


Figure 8.7 Outline of Backup Data Input/Output

8.7.1 Backup Data Output Request Sequence

To request a backup data output, input PERDAPI,STOP or PERDAPI,STOPNOFPR command to move Fix session off state. Input PERDSYS,BBRAM,QUERY command and output PERDSYS,BBRAM,xxx sentence in a row after the receiver status is Fix session off.

Figure 8.8 shows the backup data output sequence.

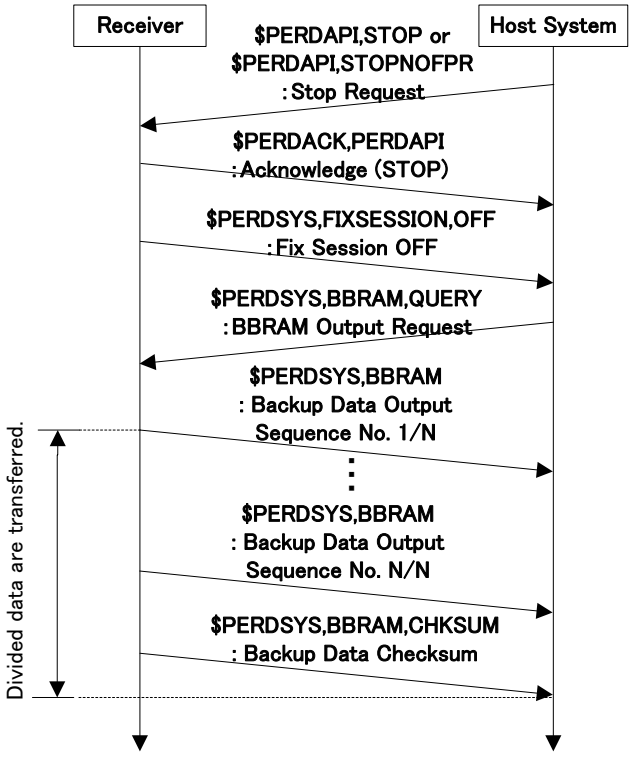


Figure 8.8 Backup Data Output Sequence

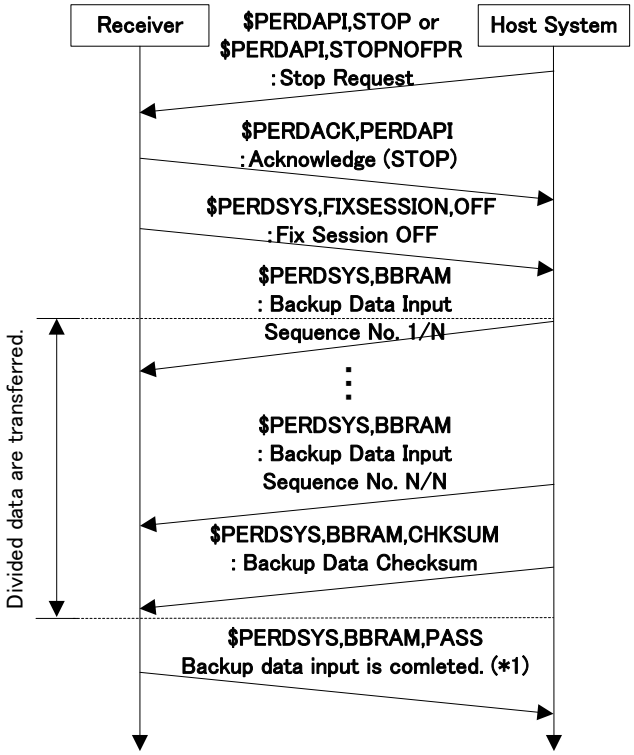
Notes:

When a command are input during the backup data is output, the receiver will process the command after completion of the backup data output.

8.7.2 Backup Data Input Sequence

To request a backup data input, input PERDAPI,STOP or PERDAPI,STOPNOFPR command and input the data requested backup data output in numerical sequence after the receiver status is Fix session off.

Figure 8.9 shows the backup data input sequence.



(*1) **"$PERDSYS,BBRAM,PASS*15:Backup data input is completed"** is output when the backup data can be input to the receiver. **"$PERDSYS,BBRAM,FAIL,MISSING, ...: Backup data input is failed"** is output when the backup data cannot be input to the receiver.

Figure 8.9 Backup Data Input Sequence

Notes:

1. Backup data is available in receiver before input of backup data

Once the receiver receives the backup data with sequence number 1, the existing backup data in backup RAM is invalid.

2. Receiver which is able to input backup data

The backup data can be input to the same receiver which output the existing backup data.

3. Backup data invalid

The receiver will not reflect the input backup data in the following cases:

a) Any commands except backup data are input during input of backup data.
b) A sequence number does not start from 1 or a sequence number is a lack of continuity.
c) There is a check sum error in input data.
d) There is a check sum error in backup data.

4. Recovery method when backup data cannot be input

Input PERDCFG,FACTORYRESET command and delete all backup data stored in the receiver. And then, input again backup data.

(*) Note: All backup data including ESIPLIST will be deleted by PERDCFG,FACTORYRESET command. When ESIPLIST is used, set ESIPLIST again.

8.8 Change Serial Communication Configuration

Figure 8.10 shows the sequence when the receiver changes the serial communication configuration. The serial communication configuration should be changed at Fix session off state.

The receiver outputs PERDACK,PERDCFG sentence and reflect the configuration when PERDCFG,UART1 command is input at fix session off.

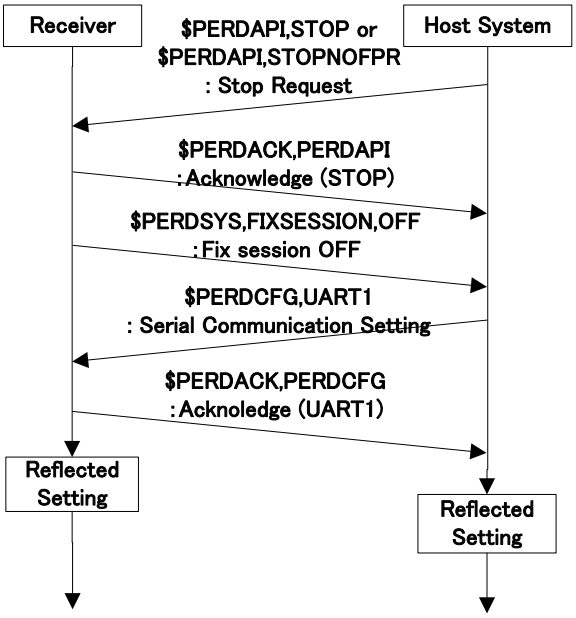


Figure 8.10 Sequence at Changing Serial Communication Configuration

Notes:
The receiver reflects the serial communication configuration after sending ACK sentence.

8.9 Time Setting

PERDAPI,TIME command is used to set a time. It is necessary to the following conditions to set a time:
- RTC time is invalid.
- The receiver does not get any time from GNSS satellites.

Figure 8.11 and Figure 8.12 show time setting sequences when the receiver conditions meet the above.

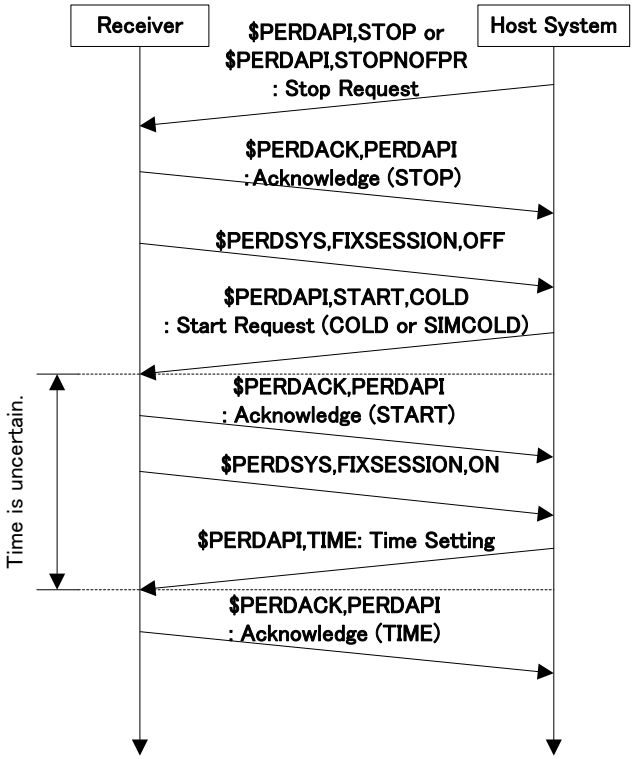


Figure 8.11 Time Setting Sequence (Using START command)

In Figure 8.11, the time can be set by sending PERDAPI,TIME command during the time is unknown after sending PERDAPI,START command.

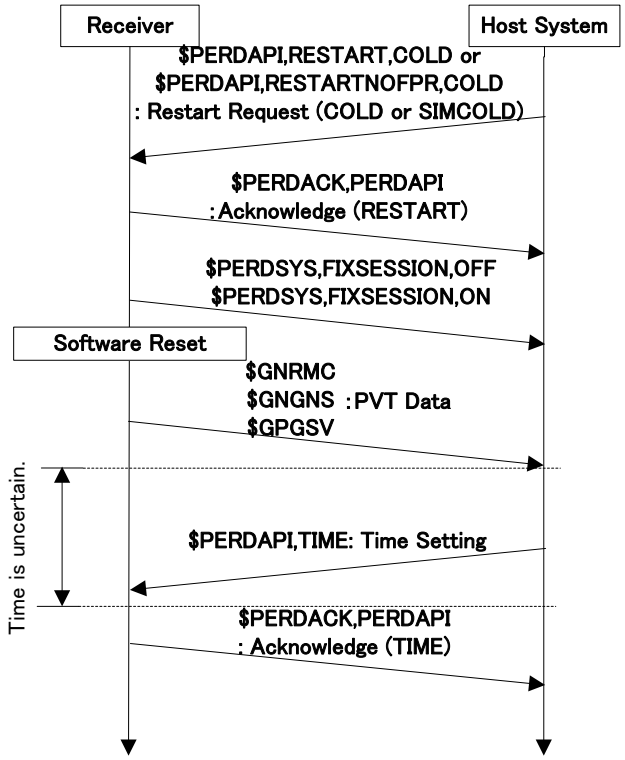


Figure 8.12 Time Setting Sequence (Using RESTART command)

In Figure 8.12, the time can be set by sending PERDAPI,TIME command during the time is unknown after sending PERDAPI,RESTART command or PERDAPI,RESTARTNOFPR command and outputting PERDSYS,FIXSESSION,ON sentence and outputting PVT data ($GNRMC, $GNGNS, $GNGSV and etc.).

Notes:

1. Input of time setting command is delayed

When the receiver time is fixed, input time with PERDAPI,TIME command is not reflected because the receiver does not satisfy the condition that the receiver does not get any time from the satellites.

2. Wrong time (YYMMDD) is set

When the difference between the actual date (YYMMDD) and the input date (YYMMDD) with PERDAPI,TIME command is less than +/-512 weeks, the receiver outputs a correct date (YYMMDD) once time data is obtained from the satellites.

When the difference between the actual date (YYMMDD) and the input date (YYMMDD) with PERDAPI,TIME command is more than +/-512 weeks, the receiver will set a wrong rollover number of GPS week number starting from January 6th, 1980.

The receiver will calculate the date based on rollover number of GPS week number regardless of satellite used. When an error date which is more than +/-512 weeks is set, output date will have an error in increments of 1024 weeks. The wrong rollover number of GPS week number which set wrongly will not be corrected even if time data is obtained from the satellites.

The rollover number of GPS week number will be corrected by resetting the date which is less than +/-512 weeks, Figure 8.13 shows an example of setting of wrong rollover number of GPS week number.

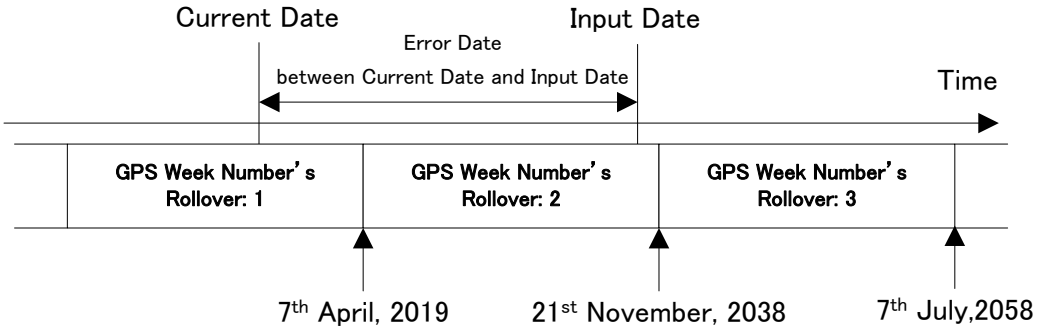


Figure 8.13 Relation between Current Date and Input Date

The receiver sets "2" as rollover number of GPS week number if the difference between the actual date (YYMMDD) and the input date (YYMMDD) is more than +/-512 weeks (Correct value is "1").

Once time data is obtained from the satellites, the receiver will output date based on wrong rollover number of GPS week number:2 starting from 7th April, 2019, GPS week number and GPS week time calculated by a time obtained from the satellites. (In this example, actual date plus 1024 weeks)

3. Input wrong time (HHMMSS)

Even if a wrong time (HHMMSS) is input, the receiver will output a correct time (HHMMSS) once time data is obtained from the satellites.

8.10 Position Setting

This section shows the position setting sequence when the receiver's position is unknown.

PERDAPI,POS command is used for setting a position. It is necessary that the position of receiver has not been fixed (no position fix) to input the position.

Figure 8.14 and Figure 8.15 show position setting sequences when the conditions above are met.

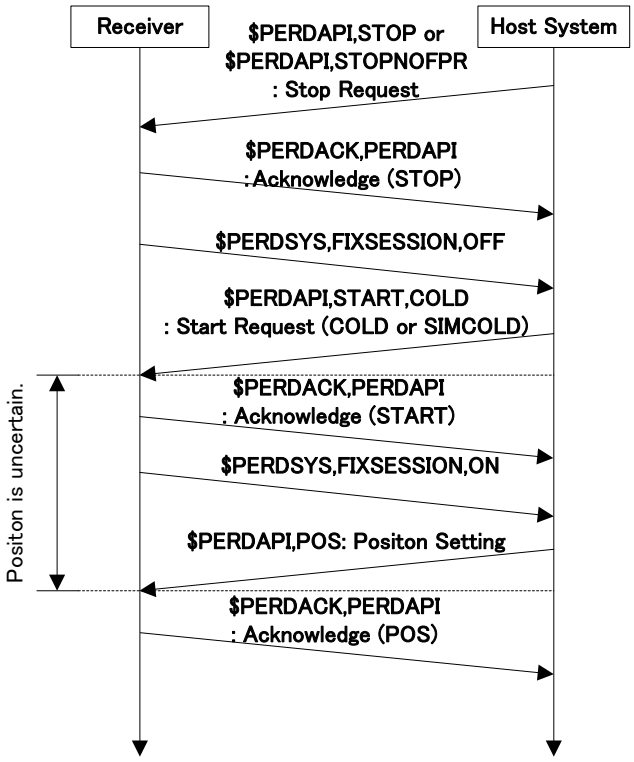


Figure 8.14 Position Setting Sequence (Using START command)

In Figure 8.14, the position can be set by PERDAPI,POS command during the position is not fixed after sending PERDAPI,START command.

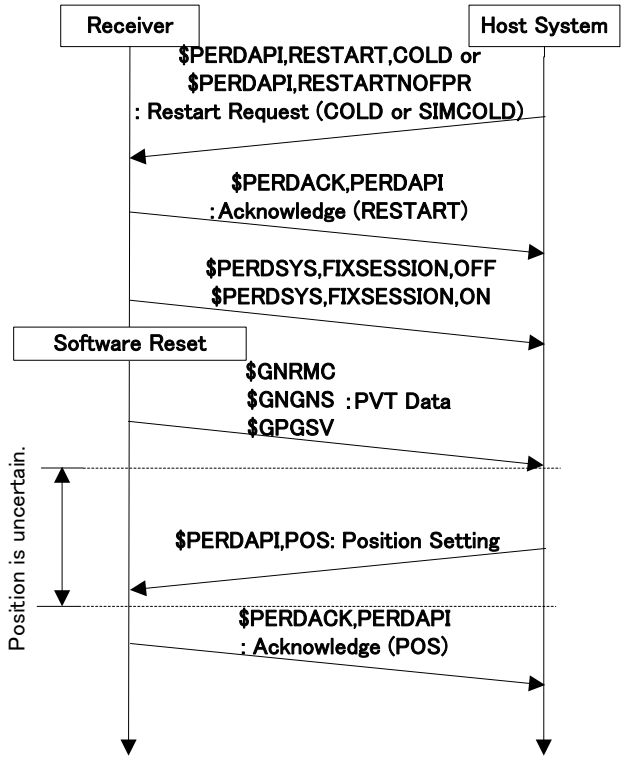


Figure 8.15 Position Setting Sequence (Using RESTART command)

In Figure 8.15, the time can be set by sending PERDAPI,POS command during the position is not fixed after sending PERDAPI,RESTART command or PERDAPI,RESTARTNOFPR command and outputting PERDSYS,FIXSESSION,ON sentence and outputting PVT data ($GNRMC, $GNGNS, $GNGSV and etc.).

Notes:

1. Input of position setting command is delayed
If the position has been fixed already, the condition “no position fix” is not met and the position set by PERDAPI,POS command will not be reflected.

2. Wrong position is set
The position error at the time of setting will be corrected once the positioning with satellite information is started.

8.11 ESIPLIST

ESIPLIST is the function to program the command into Flash ROM and to send commands programmed at start-up automatically.

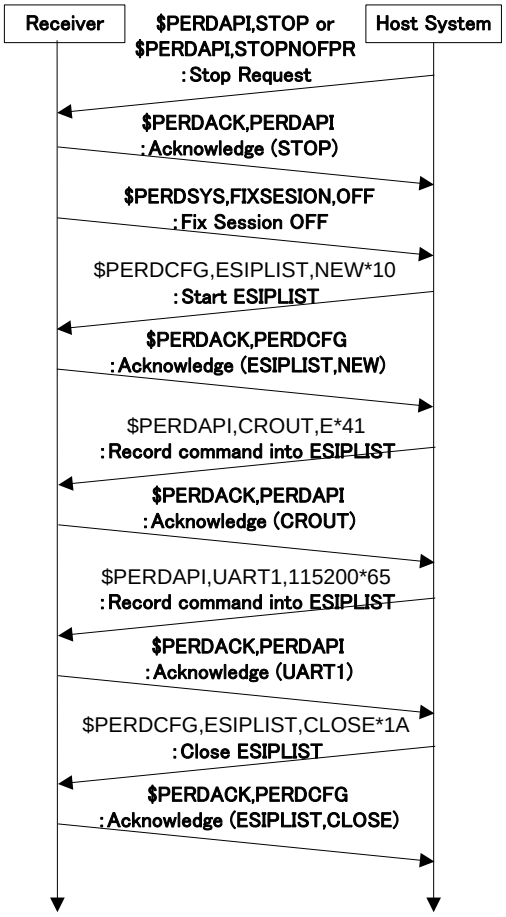
8.11.1 New ESIPLIST Create

Follow the procedures below to create new ESIPLIST:

1. Stop positioning by sending PERDAPI,STOP or PERDAPI,STOPNOFPR command.
2. Send $PERDCFG,ESIPLIST,NEW*10 to start programming ESIPLIST.
3. Input commands to be sent automatically at start-up. (Max. 20 commands can be set at the same time)
4. Send $PERDCFG,ESIPLIST,CLOSE*1A to finish programming ESIPLIST.

New ESIPLIST Create Example

Register the setting below in ESIPLIST newly.
- Output CRE sentence
- Set baud rate at 115200 bps



(1) $PERDAPI,STOP*6F or
$PERDAPI,STOPNOFPR*2A
Send STOP command

(2) $PERDCFG,ESIPLIST,NEW*10
Start creating new ESIPLIST

(3-1) $PERDAPI,CROUT,E*41
Register “CRE sentence output”

(3-2) $PERDCFG,UART1,115200*65
Register “Configure Serial Communication port 1”

(4) $PERDCFG,ESIPLIST,CLOSE*1A
Close creating ESIPLIST

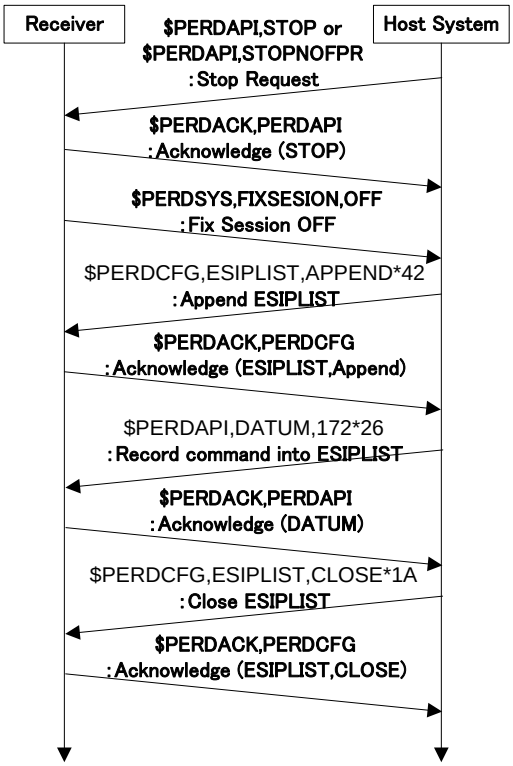
8.11.2 ESIPLIST Append

Follow the procedures below to add the commands in the created ESIPLIST:

1. Stop positioning by sending PERDAPI,STOP or PERDAPI,STOPNOFPR command.
2. Send $PERDCFG,ESIPLIST,APPEND*42 to start adding commands to ESIPLIST
3. Register the commands to be sent automatically at start-up.
4. Send $PERDCFG,ESIPLIST,CLOSE*1A to finish programming ESIPLIST.

ESIPLIST Append Example

Add the setting below to the ESIPLIST created at Section 8.11.1.
- Set “Tokyo Datum”



(1) $PERDAPI,STOP*6F or
$PERDAPI,STOPNOFPR*2A
Send STOP command

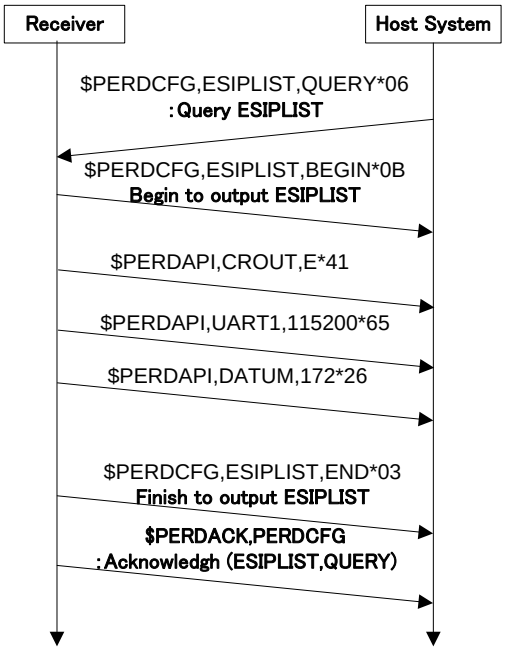
(2) $PERDCFG,ESIPLIST,APPEND*42
Start adding command to ESIPLIST

(3) $PERDAPI,DATUM,172*26
Register “Set Tokyo Datum”

(4) $PERDCFG,ESIPLIST,CLOSE*1A
Close creating ESIPLIST

8.11.3 ESIPLIST Query

The contents of ESIPLIST can be confirmed by sending "$PERDCFG,ESIPLIST,QUERY*06". The example below shows the procedures to confirm the contents of ESIPLIST set at Section 8.11.1 and 8.11.2 when the receiver stops positioning.



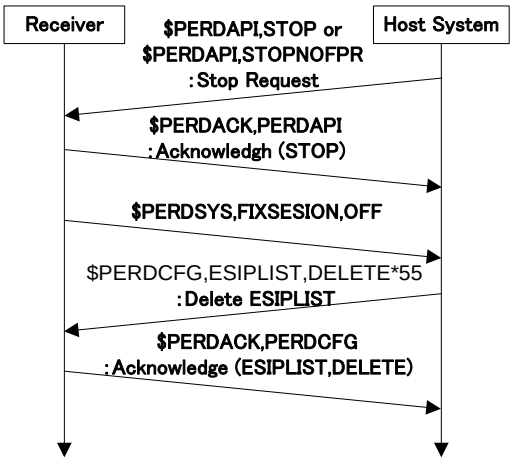
(1)$PERDCFG,ESIPLIST,QUERY*06
Request output of contents of ESIPLIST

(2) Following data are output when the Query ESIPLIST is received.
$PERDCFG,ESIPLIST,BEGIN*0B : Start outputting the contents
$PERDAPI,CROUT,E*41
$PERDCFG,UART1,115200*65 } : Registered commands
$PERDAPI,DATUM,172*26
$PERDCFG,ESIPLIST,END*03 : Stop outputting the contents

(3) Acknowledgement (ACK) of Query ESIPLIST is output after outputting the contents of ESIPLIST.

8.11.4 ESIPLIST Delete

Procedures to delete the ESIPLIST are below.



(1) $PERDAPI,STOP*6F or
$PERDAPI,STOPNOFPR*2A
Send STOP command

(2) $PERDCFG,ESIPLIST,DELETE*55
Delete ESIPLIST

(*) Check if the ESIPLIST has been deleted with $PERDCFG,ESIPLIST,QUERY*06. The data below are output in case no command is registered in ESIPLIST.

$PERDCFG,ESIPLIST,BEGIN*0B
$PERDCFG,ESIPLIST,END*03

8.11.5 ESIPLIST Configurable Command

Command Name		Contents	Configurability
API	ANTIJAM	Anti Jamming	O
	CROUT	Original sentence output	O
	DATUM	Geodetic Datum	O
	DEFLS	Default leap second	O
	EXTENDGSA	GSA sentence re-definition	O
	FIRSTFIXFILTER	First fix filter	O
	FIXMASK	Satellite mask	O
	FIXPERSEC	Multiple fixes per second	O
	GNSS	GNSS satellite system configuration	O
	LATPROP	Enable latency position propagation	O
	OUTPROP	Enable position outage propagation	O
	PIN	Pinning	O
	POS	Position aiding	X
	PPS	Pulse per second	O
	RAIM	RAIM	O
	RESTART/RESTARTNOFPR	Restart request	-
	SBASBLS	SBAS priority search select	O
	SELFEPH	Self-Ephemeris™ mode ON/OFF	O
	START	Start request	-
	STATIC	Static entry/exit parameters	O
	STOP/STOPNOFPR	Stop request	-
	TIME	Time aiding	X
CFG	ESIPLIST	Save/query ESIP commands to FLASH	-
	FACTORYRESET	Clear backup data into Backup RAM and Flash ROM	X
	FORMAT	Protocol format change	O
	NMEAOUT	Configure the standard NMEA output	O
	SILENTSTART	SILENTSTART mode	O
	UART1	Serial communication port configuration (UART1)	O
	UART2	Serial communication port configuration (UART2)	O
SYS	ANTSEL	Antenna selection control	O
	BBRAM	Backup data output query	X
	ERRACT	Receiver's state processing at abnormal status	O
	FIXSESSION	GNSS session query	X
	GPIO	GPIO output query	X
	RECPLAY	Diagnostic mode ON/OFF	X
	SELFEPH	Self-Ephemeris™ calculation time	O
	SELFTEST	Self test	O
	VERSION	Software version query	X

O: Registrable, **X: Registrable, but prohibited**, -: Setting disable

Notes:

Do not register the same command multiply with different setting. In case duplicated commands are registered, the last command will be reflected. For example, in case register commands $PERDCFG,NMEAOUT,GGA,1*54 (output GGA sentence in 1 positioning cycle) and $PERDCFG,NMEAOUT,GGA,2*57 (output GGA sentence in 2 positioning cycles) in the ESIPLIST, the latter command $PERDCFG,NMEAOUT,GGA,2*57 is to be set.

8.12 Fix Session OFF Sequence

Figure 8.16 shows the sequence transit from fix session state to fix session off state.

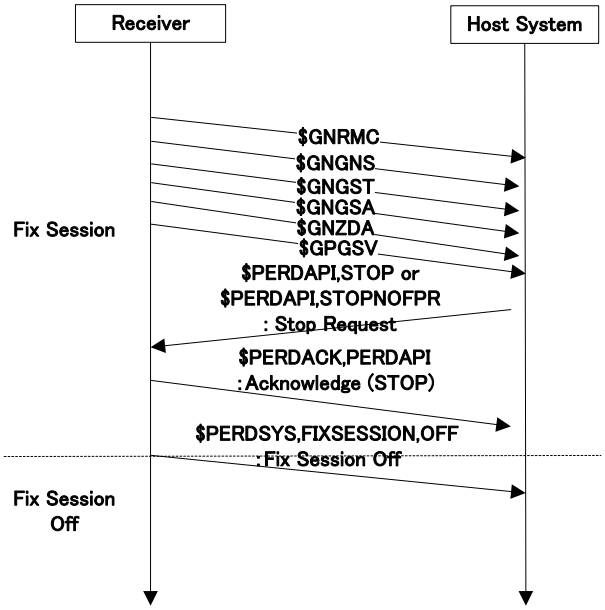


Figure 8.16 Sequence Transit from Fix Session State to Fix Session OFF State

8.13 Power OFF Sequence

Even if the receiver is turned off during positioning, the receiver will be operated properly at restart and user can turn off the receiver at any timing. However, in case the receiver is turned off during writing the backup data in BRAM area, the backup data can be destroyed and not be used. There is no way to know when the backup data is saved in BRAM area from the Host System. Therefore, by sending PERDAPI,STOP or PERDAPI,STOPNOFPR command to stop positioning before turning off the receiver at any timing, the possibility to destroy the backup data can be eliminated. The backup data will be written in Flash ROM other than BRAM when the PERDAPI,STOP command is sent. After sending PERDAPI,STOP command, turn off the receiver after receiving PERDSYS,FIXSESSION,OFF sentence. Figure 8.17 shows the Power OFF sequence.

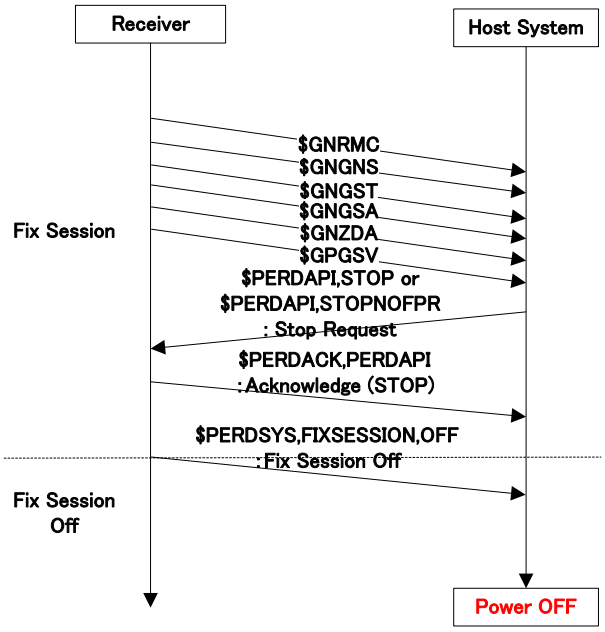


Figure 8.17 Power OFF Sequence

8.14 Flash ROM Reprogramming

See "Flash ROM Programming Procedures with WinUppg" (Doc # SE13-900-009) about Flash ROM reprogramming.

9 Receiving NMEA Sentence

9.1 Receiving Data

Save all data received through UART1 of GN-8720 in receive buffer of Host System.

9.2 Cutout from String

Start analyzing from the beginning buffer storing the received data with Section 9.1. Search for “$” at first to cutout from strings.

When “$” is found, search for “*” next. XOR in every 8 bit by using all the data between “$” and “*” and compare with checksum in 1 byte (convert ASCII 2 character into 1 byte data in binary) followed by “*”.
- If matches with checksum, determine as sentence satisfied and move to splitting the data.
- If mismatched with checksum, determine as sentence not satisfied and discard the data.

Discard <CR>,<LF> followed by checksum.

If checksum is correct, read out 5 characters followed by “$”. The first 2 bytes represent Taker ID (GP, GL, GN).

Identify the sentence by the 3 characters followed by Talker ID. If the sentence is not supposed to be output (not set to be output), abnormal situation is suspected e.g. the command setting sentence output is not reflected properly or the receiver is restarted.

9.3 Cutout from Strings in Fixed Interval

The receiver outputs positioning results with sentence set to be output once per positioning. For example, if the receiver is set to output RMC, GNS, GSV sentences once per positioning, these sentences are output once in a second in case of 1Hz positioning (GSV outputs multiple sentences depending on the number of satellites tracked or used satellite system). The order of sentences to be output is predetermined (see Section 13.2.4). With this example, RMC comes out first, then GNS and GSV to be output. Therefore, it can be regarded to have received a whole sentence for 1 positioning when RMC through GSV sentences are received.

With 1Hz positioning, the interval to output sentence in each positioning is just about 1 second which may vary slightly depending on the time for position calculation. If the interval (the time between first RMC output and next RMC output) becomes more than 2 seconds, abnormal situation is suspected e.g. the baud rate is set improperly or the output from receiver has stopped.

9.4 Cutout from Every Strings

The data fields in the string are split by “,”.

Since the number of “,” is fixed depending on the sentence, abnormal sentence can be detected by checking the number of “,”. If abnormal sentence is detected, discard the sentence data.

9.5 TalkerID

The Talker ID “GP” represents GPS, “GL” represents GLONASS, “GA” represents Galileo and “GN” represents multi-GNSS (use multiple satellite systems).

Except GSA and GSV sentence, only 1 sentence is read out in 1 output. The Talker ID can be discarded except GSA/GSV sentence especially in case separate the process in application by difference of positioning results between GPS, GLONASS or multi-GNSS.

With GSA/GSV sentence, the GNSS system of Talker ID and that of data field in the sentence should be the same. With GSA sentence, the GNSS system can be identified by satellite number and GNSS system ID in the 18th field. With GSV sentence, the GNSS system can be identified by the satellite No.

If the GNSS systems are different in the same sentence, the data may be abnormal data. In this case, discard the data.

9.6 Satellite No.

As described in Section 9.5, abnormal sentence can be detected by checking satellite number corresponding to each Talker ID because the GSA/GSV sentence output satellite number.

GPS: 01 to 32	: Same as PRN No.
SBAS: 33 to 51	: Subtract 87 from PRN No.
QZSS: 93 to 97	: Subtract 100 from PRN No.
GLONASS: 65 to 96	: Same as PRN No.
Galileo: 01 to 36	: Same as PRN No.

9.7 Time in NMEA Sentence

Time information is contained in data field of various sentences. The output sentences containing time information are as below:

GBS, GGA, GLL, GNS, RMC, ZDA

ZDA sentence represents current time (start time of sentence output of each position fix) and other sentences represent position fix time. For example, with the setting to output GNS and RMC sentence, the time of the same position fix in each sentence is correspondent. If not, abnormal situation is suspected e.g. abnormal sentence reception, missing data output from receiver or improper setting of baud rate.

9.8 Delta between Current Time and Position Fix Time

The difference between current time in ZDA sentence and position fix time in other sentences can be roughly estimated from the setting of PERDAPI,LATPROP command. The default setting is set 800ms from GPS time. For example, when the GPS time is xxxx01.000, the time in RMC sentence is output as xxxx01.800. ZDA sentence outputs current time which is xxxx01.500 (observables used for positioning are total for 1 sec in the range of +/-500ms centered at GPS time) + time for position calculation. If the time for position calculation at 1Hz positioning is 150 ms, the time of ZDA sentence is xxxx01.650.

Therefore, the delta between position fix time of RMC and current time of ZDA is 150 ms. During 1Hz positioning, time for position calculation is not more than 1 sec, the maximum current time of ZDA sentence with this example is xxxx02.500. Therefore, the maximum gap from RMC sentence is 700 ms.

Abnormal situation can be detected by monitoring this time gap. If the maximum time gap becomes more than 700ms with the setting of example above, it is suspected that the sentences of different position fix are received as that of the same position fix. Or, abnormal situation is suspected e.g. abnormal sentence reception, missing sentence output from the receiver or improper setting of baud rate.

The maximum gap is changed by PERDAPI,LATPROP command setting.

9.9 Position Fix Status

To confirm if position is fixed with GN-8720, check the position fix state and position fix mode output from several sentences. The sentences outputting position fix state are as below:

GGA, GLL, GNS, GSA, RMC

(*) Please refer to descriptions of each sentence in this manual for status of position fix state and position fix mode.

In each sentence, if the position fix status is not fix or invalid, the positioning data of that position fix cannot be used. With 1 position fix, if the position fix status in each sentence is different, it is suspected that the sentences of different position fix are received as that of the same position fix. Or, abnormal situation is suspected e.g. abnormal sentence reception, missing sentence output from the receiver or improper setting of baud rate.

9.10 The Case Position Fix State Becomes Valid While No Position Fix

When the OUTPROP command setting is other than 0 sec, GN-8720 can perform position calculation during the setting time under environment where the GNSS satellite is not available for positioning. These positions are estimated from the last position, the speed and the direction which are calculated by GNSS satellite.

In this case, the flags in NMEA sentence are as follows.
- (Position) mode indicator: Estimated fix
- (Position) status: Valid
- (Position) mode of GSA: 2D fix
- Number of satellites in use: NULL

9.11 Direction

Direction in RMC and VTG sentence is output in “true direction”. The magnetic direction in VTG sentence is NULL.

The direction while parking is unreliable and cannot be used. Treat the data as invalid.

10 Abnormal Status

The behavior of receiver in accordance with transmission and reception sequence described in Chapter 8 is called "Normal status" and behavior not in accordance with these sequences is called "Abnormal status".

10.1 Assume Abnormal Status Type

From Host System, the abnormal status assumed with GN-8720 is as below:

1. Occurrence of restart

The receiver perform restart by itself when the software processing takes more time than expected to run out of time and the watchdog timer is activated.

2. Running the Mask ROM program

The software installed in Mask ROM may be operated without running program in Flash ROM when the access anomaly to Flash ROM occurs. If the software of Mask ROM is run, following message will be output.

$PERDSYS,VERSION,OPUS6_ROM_ES2_64P,ENP610F1229005R,BOOT*05
$PERDSYS,FIXSESSION,ON*52

The reasons not to be able to access to Flash ROM properly are suspected as below:

- Malfunction of Flash ROM devise
- Abnormal data bus/address bus
- Abnormal contact of Flash ROM terminal
- Interruption of power supply to Flash ROM (Malfunction of BB IC)

3. Abnormal output sentence from receiver

It is possible to occur following abnormal situation regarding output sentence from receiver:
- Missing sentence (sentence is not output which is requested to output)
- Abnormal checksum caused by missing data (e.g. not output in every 1 sec with 1Hz positioning)
- No output from receiver

Those phenomena are caused by following reasons:

- Abnormal output interval occurs since request of sentence output is more than the data size that can be output for the setting of baud rate and fail to output sentence in each position fix.
- Missing data or sentence occurs due to malfunction of communication pathway.
- Infinite loop occurs inside of the receiver.

4. CRASH message output from receiver

When unexpected exception processing occurs with running software inside the receiver, the receiver outputs CRASH message as below to alert CRASH occurrence (exception processing) and perform restart by itself.

<CRASH PC=* SR=* EXCEPTION=**xx** R0=* R1=* R2=* R3=* R4=* R5=* R6=* R7=* R8=* R9=* R10=* R11=* R12=* SP=* LR=*>

In the message, "*" represents the value of register when exception occurs, and "**xx**" represents the type of exception.

Types and contents of exception processing are listed as below.

Type	Contents
UndefInstrException	Running command is not recognized by processor nor any coprocessor.
PrefetchAbort	Processor trying to run the command not fetched due to bad address.
DataAbort	Attempting to load or store the data by data transfer command with bad address.

5. No position fix under good environment to receive the satellite signals
It is supposed not to fix the position for more than 15 min. even if more than 5 satellites with C/No at 40dB-Hz or higher are tracked continuously with good conditions.

The reason not to be able to fix the position is suspected as below:

- Ephemeris data cannot be obtained or updated if there is wide gap between satellite position calculated with almanac data and satellite position calculated with ephemeris data because almanac data in backup has anomaly.

10.2 How to Fix Abnormal Status

In case abnormal status is detected as described in Section 10.1, fix abnormal status as below:

[The way to fix abnormal status 1 and 4]
The receiver has been already restarted for recovery, check if the sentence is output properly after restart. If the sentence is not output properly, conduct power-on reset and check again if the sentence is output properly after reset. If the status is not fixed, there is high possibility of failure of the receiver, stop supplying power to the receiver.

[The way to fix abnormal status 2 and 3]
If the abnormal status is detected, conduct power-on reset and check if the sentence is output properly after reset. If the status is not fixed after power-on reset, there is high possibility of failure of the receiver, stop supplying power to the receiver.

[The way to fix abnormal status 5]
If the abnormal status is detected, stop positioning by sending PERDAPI,STOP or PERDAPI,STOPNOFPR command, then start positioning without backup by sending PERDAPI,START,SIMCOLD command. If the status is not fixed after restart positioning, stop positioning again by sending PERDAPI,STOP or PERDAPI,STOPNOFPR command, then clear the backup data by sending PERDCFG,FACTORYRESET command. After clearing backup data, conduct power-on reset and restart the receiver.

11 Function Exclusion

Table 11.2 shows the exclusion between the functions described in Table 11.1.

Table 11.1 Function List

Function	Description
Self-Ephemeris™	Extended ephemeris model which is made from received satellites ephemeris. The time is max 3 days.
CSM	All GPS satellite ephemeris model sent from an assist server. The format is FURUNO original. The receiver will shorten the first fix time with it.
LTCSM	An ephemeris model whose life span is extended max one week by FURUNO original algorithm. It is sent from an assist server. The receiver will shorten the first fix time with it on long term.
Multi Hz Fix	The receiver enables fixes at greater than once per sec. The rate is 2 Hz, 5 Hz or 10 Hz.
PPS	The receiver outputs pulse synchronized with UTC per second.
RTCM SC-104 Input	The receiver can use RTCM SC-104 message for differential fix.

Table 11.2 Function Exclusion List

	Self-Ephemeris™	**CSM**	**LTCSM**	**Multi Hz Fix**	**PPS**	**RTCM SC-104 Input**
Self-Ephemeris™	-	Available (CSM priority)	Not available	Self-Ephemeris computation time is slow(*1)	Available	Available
CSM	Available (CSM priority)	-	Available (CSM priority)	Available	Available	Available
LTCSM	Not available	Available (CSM priority)	-	Available	Available	Available
Multi Hz Fix	Self-Ephemeris computation time is slow(*1)	Available	Available	-	Available	Available
PPS	Available	Available	Available	Available	-	Available
RTCM SC-104 Input	Available	Available	Available	Available	Available	-

Notes:

(*1) **Multi Hz Fix and Self-Ephemeris™**

When the fix interval is multi Hz, Self-Ephemeris™ computing time will be slower than 1 Hz fix.

12 Standard NMEA Output

GN-8720 supports 11 standard NMEA output sentences (GBS, GFA, GGA, GLL, GNS, GSA, GST, GSV, RMC, VTG, ZDA) per NMEA standard 0183 Version 4.0 (June, 2012). By default, the RMC, GNS, GST, GSA, ZDA and GSV sentences are output every second. The sentences can be independently enabled and disabled using PERDCFG,NMEAOUT command, as well as use differing transmission rates.

12.1 GBS – GNSS Satellite Fault Detection

Format:

$--GBS	,	hhmmss.sss	,	x.x	,	x.x	,	x.x	,	xx	,	x.x	,	x.x	,	x.x	,	x	,	x	*hh	<CR>	<LF>
		1		2		3		4		5		6		7		8		9		10			

Field	Contents	Range	Remark
1	hhmmss.sss	000000.000 to 235959.999	Coordinated Universal Time (UTC) of the associated GGA or GNS fix hh: [hour], mm: [minute], ss: [second]
2	x.x	Null, 000.0 to 999.9	Expected Error in latitude [m]
3	x.x	Null, 000.0 to 999.9	Expected Error in longitude [m]
4	x.x	Null, 000.0 to 999.9	Expected Error in altitude [m]
5	xx	Null, 00 to 32	ID number of most likely failed satellite
6	x.x	Null, 0.05	Probability of missed detection for most likely failed satellite
7	x.x	Null, -999.9 to 999.9	Estimate of bias in meters on most likely failed satellite [m]
8	x.x	Null, 12.5	Standard deviation of bias estimate [m]
9	x	1,2,3	GNSS System ID 1: GPS (involve SBAS and QZSS) 2: GLONASS 3: Galileo
10	x	1,7	Signal ID 1: L1 C/A (GPS), G1 C/A (GLONASS) 7: L1-BC (Galileo)

Example:

$GPGBS,082508.800,4.6,4.5,5.3,0,0.05,0.0,12.5,1,1*66 RAIM function ON
$GPGBS,081707.800,,,,,,,,1,1*5E RAIM function OFF

Notes:

- The data from field 2 to field 8 are output when RAIM function is ON.
- See Section 13.1.15 about RAIM function ON/OFF control.

12.2 GFA – GNSS Fix Accuracy and Integrity

Format:

$--GFA	,	hhmmss.sss	,	x.x	,	x.x	,	x.x	,	x.x	,	x.x	,	x.x	,	x.x	,	a	*hh	<CR>	<LF>
		1		2		3		4		5		6		7		8		9			

Field	Contents	Range	Remark
1	hhmmss.sss	000000.000 to 235959.999	Coordinated Universal Time (UTC) of the associated GGA or GNS fix hh: [hour], mm: [minute], ss.sss: [second]
2	x.x	Null, 000.0 to 999.9	Horizontal protection levels [m]
3	x.x	Null, 000.0 to 999.9	Vertical protection levels [m]
4	x.x	Null, 000.0 to 999.9	Standard deviation of semi-major axis of error ellipse [m]
5	x.x	Null, 000.0 to 180.0	Standard deviation of semi-minor axis of error ellipse [m]
6	x.x	Null, 000.0 to 180.0	Orientation of semi-major axis of error ellipse [degree]
7	x.x	Null, 000.0 to 999.9	Standard deviation of altitude [m]
8	x.x	Null, 000.0 to 999.9	Accuracy level [m]
9	a	S,C,U,V	Integrity Status S: Safe C: Caution (when integrity is not available) U: Unsafe V: Not Valid (RAIM function OFF)

Notes:

- The data from field 2 to field 9 are output when RAIM function is ON.
- See Section 13.1.15 about RAIM function ON/OFF control.
- These fields are null fields when it is impossible to calculate the ellipse error and the accuracy index.

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

Field	Contents	Range	Remark
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	0,1,2,6	GNSS Quality Indication 0: Fix not available 1: GNSS fix 2: Differential fix 6: Estimated fix
7	xx		Number of satellites in use (GPS, SBAS, QZSS)
8	x.x		Horizontal Dilution of precision (HDOP)
9	x.x		Antenna Altitude above/below mean-sea-level (Geoid)
10	M		Units of antenna altitude, meters
11	x.x		Geoidal separation, the difference between the WGS-84 earth ellipsoid and mean sea-level (Geoid), “-” means mean-sea-level below ellipsoid
12	M		Units of Geoidal separation, meters
13	x.x	Null, 0 to 300.0	Age of differential GPS data
14	xxxx	Null, 0 to 1023	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

Notes:

- The field 13 and field 14 only output when RTCM correction data is input into the receiver.
- The field 13 and field 14 are null field when RTCM correction data is not input.
- RTCM is an abbreviation for Radio Technical Commission for Maritime Service.
- The correction data supports Type 1, 3 and 9 of the RTCM SC-104.
- When three and more satellites are corrected by SBAS satellites or RTCM, the receiver becomes to differential fix.

12.4 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	Contents	Range	Remark
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,E,N	Mode Indication A: Autonomous D: Differential E: Estimated N: Data Invalid

Example:

$GPGLL,3442.8146,N,13520.1090,E,025411.516,A,A*5F

Notes:

- When three and more satellites are corrected by SBAS satellites or RTCM, the receiver becomes to differential fix.

12.5 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	,	xxxx	,	xx	*hh	<CR>	<LF>
8		9		10		11		12		13			

Field	Contents	Range	Remark
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,E,N	Mode Indicator for each satellite system (GPS, GLONASS, Galileo) A: Autonomous D: Differential E: Estimated N: Data Invalid
7	xx		Number of satellites in use
8	x.x		Horizontal Dilution of precision (HDOP)
9	x.x		Antenna Altitude above/below mean-sea-level (Geoid) [m]
10	x.x		Geoidal separation, the difference between the WGS-84 earth ellipsoid and mean sea-level (Geoid), “-” means mean-sea-level below ellipsoid [m]
11	x.x	Null,0.0 to 300.0	Age of differential GPS data
12	xxxx	Null,0 to 1023	Differential reference station ID
13	xx	S,C,U,V	Navigational Status Indicator S: Safe C: Caution U: Unsafe V: Not Valid (RAIM function OFF)

Example:

$GNGNS,092356.800,3442.8211,N,13520.1147,E,DDN,20,0.5,36.8,36.7,,,V*6A

Notes:

- The field 11 and field 12 only output when RTCM correction data is input into the receiver.
- The field 11 and field 12 are null field when RTCM correction data is not input.
- The correction data supports Type 1, 3 and 9 of the RTCM SC-104.
- When three and more satellites are corrected by SBAS satellites or RTCM, the receiver becomes to differential fix.
- The field 13 shows always “V” when RAIM function is OFF, and shows “S”, “C” or “U” when RAIM function is ON.

12.6 GSA – GPS DOP and Active Satellites

Format:
(PERDAPI,EXTENDGSA command is the default value (12 satellites))

$--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	Contents	Range	Remark
1	a	M,A	Selection mode M: Manual: forced 2D or 3D A: Automatic 3D/2D
2	a	1,2,3	Mode 1: No fix 2: 2D fix 3: 3D fix
3-14	xx		ID of satellites used for fix
15	x.x		PDOP in meters
16	x.x		HDOP in meters
17	x.x		VDOP in meters
18	h	1,2,3	GNSS System ID 1: GPS (involve SBAS and QZSS) 2: GLONASS 3: Galileo

Example:
$GNGSA,A,3,17,20,28,04,32,01,23,11,13,42,50,93,,,0.8,0.5,0.5,1*39

Notes:
- When the receiver uses multi satellite systems (i.e. GPS and GLONASS), GSA sentence is divided into multiline message.
- The above format is a default setting when PERDAPI,EXTENDGSA command setting is 12 satellites. When this command setting is 16 satellites, the format is as follow.

(PERDAPI,EXTENDGSA command is 16 satellites.)

$--GSA	,	a	,	a	,	xx	,	xx	,	xx	,	・・・	,	xx	,	x.x	,	x.x	,	x.x	,	h	*hh	<CR>	<LF>
		1		2		3		4		5		6-17		18		19		20		21		22			

Field 3-18: ID of satellites used for fix
Field 19: PDOP in meters
Field 20: HDOP in meters
Field 21: VDOP in meters
Field 22: GNSS System ID

12.7 GST – GNSS Pseudo Range Error Statistics

Format:

$--GST	,	hhmmss.sss	,	x.x	,	x.x	,	x.x	,	x.x	,	x.x	,	x.x	,	x.x	*hh	<CR>	<LF>
		1		2		3		4		5		6		7		8			

Field	Contents	Range	Remark
1	hhmmss.sss	000000.000 to 235959.999	Coordinated Universal Time (UTC) of the associated GGA or GNS fix hh: [hour], mm: [minute], ss.sss: [second]
2	x.x	Null, 000.0 to 999.9	Accuracy Index (RMS) [m] This value shows the standard deviation calculated from the variation in pseudo ranges residual errors.
3	x.x	Null, 000.0 to 999.9	Standard deviation of semi-major axis of error ellipse [m]
4	x.x	Null, 000.0 to 999.9	Standard deviation of semi-minor axis of error ellipse [m]
5	x.x	Null, 000.0 to 180.0	Orientation of semi-major axis of error ellipse[degree] (Degrees from true north)
6	x.x	Null, 000.0 to 999.9	Standard deviation of latitude error [m]
7	x.x	Null, 000.0 to 999.9	Standard deviation of longitude error [m]
8	x.x	Null, 000.0 to 999.9	Standard deviation of altitude error [m]

Example:

$GNGST,111904.800,9.2,2.2,1.9,64.0,1.9,1.7,1.5*46
$GNGST,000011.340,,,,,,,*50

Notes:

- These fields are null fields when it is impossible to calculate these standard deviations.

12.8 GSV – Satellites in View

Format:

$--GSV	,	x	,	x	,	x	,	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	Contents	Range	Remark
1	x	-	Total number of messages
2	x	-	Sentence Number
3	x	-	Satellites in view
4	xx	01 to 99	1st satellite number
5	xx	to 89	1st satellite elevation in degrees
6	xxx	000 to 359	1st satellite azimuth in degrees to true
7	xx	-	1st satellite SNR in dB
8-11		-	2nd satellite data (The satellite data like the field #4-#7)
12-15		-	3rd satellite data (The satellite data like the field #4-#7)
16-19		-	4th satellite data (The satellite data like the field #4-#7)
20	h	-	Signal ID 1: L1 C/A (GPS), G1 C/A (GLONASS) 7: L1-BC (Galileo)

Example:

```
$GPGSV,3,1,11,17,66,333,53,20,57,055,51,28,46,217,50,04,33,278,46,1*63
$GPGSV,3,2,11,32,28,045,45,01,26,062,45,23,24,117,47,11,14,083,41,1*66
$GPGSV,3,3,11,13,10,149,40,50,00,000,46,93,84,353,51,,,,,1*5F
```

Unknown items

Sentence Number

Total number of Message

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.
- Unknown items are output as null field.
- $GPGSV sentences shows GPS, SBAS and QZSS satellites data. $GLGSV shows GLONASS satellite data. $GAGSV shows Galileo satellite data. When multi satellite systems are used, GSV sentences are output in order $GPGSV, $GLGSV and $GAGSV.
- The satellite system in GPGSV is output in order of GPS, SBAS and QZSS.
- The output order of satellite data (other than SBAS and QZSS) is as follows:
  - Until calculating satellite position: Ascending order of PRN No.
  - After calculating satellite position: Descending order of satellite elevation.
- The number of each satellite system are as follows:
  GPS: 01 to 32 : Same as PRN No.
  SBAS: 33 to 51 : Subtract 87 from PRN No.
  QZSS: 93 to 97 : Subtract 100 from PRN No.
  GLONASS: 65 to 96 : Same as PRN No.
  Galileo: 01 to 36 : Same as PRN No.
- During no position fix, the receiver moves the reference position internally before the position calculation is converged. In the process, the satellite elevation may show a negative number.
- When the receiver cannot calculate the elevation and the azimuth at SBAS satellite acquisition or tracking, the values may be output as 0 degree (elevation), 0 degree (azimuth).

12.9 RMC – Recommended Minimum Navigation Information

Format:

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

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

Field	Contents	Range	Remark
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 00.0000	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.x		Speed over ground [knot]
8	x.x		Course over ground, degrees True
9	ddmmyy		Date dd: [day], mm: [month], yy: [year] (last two digits)
10	x.x		Magnetic Variation, degrees [not supported]
11	a		Magnetic Variation direction, E or W [not supported]
12	a	A,D,E,N	Mode Indicator A: Autonomous D: Differential E: Estimated N: Data Invalid
13	a	S,C,U,V	Navigational Status Indicator S: Safe C: Caution U: Unsafe V: Not Valid (RAIM function OFF)

Example:

$GNRMC,092406.800,A,3442.8211,N,13520.1148,E,0.01,353.80,230815,,,D,V*0D

Notes:

- When three and more satellites are corrected by SBAS satellites or RTCM, the receiver becomes to differential fix.
- The receiver updatable UTC date is as follow table.

Backup data	UTC upper limit
Backup data is invalid.	August 19th, 2034 23:59:59
Backup data is available.	February 6th, 2106 6:28:15 (Leap second is 17)

- When the backup data is available, the UTC upper limit changes depending on the leap second obtained from the satellites. The default leap second is 17 when the leap second is not obtained.
  Example: In case the leap second is 17.
  The next time of the upper limit (February 6th, 2106 6:28:15) is January 1st, 1970 00:00:00.

12.10 VTG – Course Over Ground and Ground Speed

Format:

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

Field	Contents	Range	Remark
1	x.x		Course over ground, degrees True
2	T	T	"T" (True)
3	x.x		Course over ground, degrees Magnetic [not supported]
4	M	M	"M" (Magnetic)
5	x.x		Speed over ground, [knots]
6	N	N	"N" (knots)
7	x.x		Speed over ground, [km/h]
8	K	K	"K" (Kilo meters/ Hour)
9	a	A,D,E,N	Mode Indicator A: Autonomous D: Differential E: Estimated N: Data Invalid

Example:

$GPVTG,156.27,T,,M,0.00,N,0.01,K,A*3B

Notes:

- When three and more satellites are corrected by SBAS satellites or RTCM, the receiver becomes to differential fix.

12.11 ZDA – Time & Date

Format:

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

Field	Contents	Range	Remark
1	hhmmss.sss	-	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		UTC Year
5	xx		Local Time Zone Hours offset from UTC [not supported]
6	xx		Local Time Zone Minutes offset from UTC [not supported]

Example:

$GNZDA,092406.670,23,08,2015,,*4F

Notes:

- The receiver updatable UTC date is as follow table.

Backup data	UTC upper limit
Backup data is invalid.	August 19th, 2034 23:59:59
Backup data is available.	February 6th, 2106 6:28:15 (Leap second is 17)

- When the backup data is available, the UTC upper limit changes depending on the leap second obtained from the satellites. The default leap second is 17 when the leap second is not obtained.
  Example: In case the leap second is 17.
  The next time of the upper limit (February 6th, 2106 6:28:15) is January 1st, 1970 00:00:00.

13 Proprietary NMEA Input

This chapter describes the proprietary input commands. The receiver can receive valid commands only. When an input command is received, ACK sentence is returned.

13.1 API – eRide GNSS Core Library Interface

13.1.1 ANTIJAM – Anti Jamming

This command configures the Anti Jamming function.

Format:

$PERDAPI	,	ANTIJAM	,	mode	[,	notch]	*hh	<CR>	<LF>
		1		2		3			

Field	Contents	Range	Remark
1	ANTIJAM	-	Command Name
2	mode	GP,GL,USER	Mode (Default: GP)
3	notch	0 to 8	Allocation of notch filters for GPS/GLONASS

Example:

$PERDAPI,ANTIJAM,GP*18
$PERDAPI,ANTIJAM,USER,6*04

Notes:

- Setting mode to GP means that the 8 notch filters are prioritized for GPS/Galileo frequency band and setting mode to GL means that the notch filters are prioritized for GLONASS frequency band.
- In the second example, where mode is USER, 6 notch filters are dedicated for GPS/GALILEO and 2 (8-6) are dedicated for GLONASS.

13.1.2 CROUT – Original Sentence Output

This command controls the output of advanced proprietary ASCII strings (PERDCRx). Some strings are used to output status of different algorithms.

Format:

$PERDAPI	,	CROUT	,	codes	[,	off]	*hh	<CR>	<LF>
		1		2		3			

Field	Contents	Range	Remark
1	CROUT	-	Command Name
2	codes	E,F,L,P,Q ALLOFF	CRx letter codes to output ALLOFF: Disable all PERDCRx strings
3	off	0	Disable individual code

Example:

$PERDAPI,CROUT,E*41
$PERDAPI,CROUT,E,0*5D
$PERDAPI,CROUT,ALLOFF*0A

Notes:

- This command can be sent at any time, and the debug output will immediately begin.
- By default, PERDCRx strings are not automatically output.
- PERDCRx strings are output after the standard NMEA sentences.
- The output order and the timing of PERDCRx strings are as following table.

Output order	Sentence Type	Sub Type	Output Timing
Fast	PERDCRE	GP, GL, GA	When the data is updated
	PERDCRF	GxANC GxACC (*1)	Every fix rate
	PERDCRL	GPS, GLO	When the data is updated
	PERDCRP	-	Every fix rate
Last	PERDCRQ	-	Every 2 seconds

(*1) "x" shows the satellite system. (P: GPS, L: GLONASS, A: Galileo, Q: QZSS, S: SBAS)

13.1.3 DATUM – Geodetic Datum

This command configures the geodetic datum.

Format:

$PERDAPI	,	DATUM	,	nnn	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	DATUM	-	Command Name
2	nnn	001,172	Datum Number (Default: 001) 001: WGS-84 172: Tokyo Datum

Example:

$PERDAPI,DATUM,001*23
$PERDAPI,DATUM,172*26

13.1.4 DEFLS – Default Leap Second

This command configures the default leap second.

Format:

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

Field	Contents	Range	Remark
1	DEFLS	-	Command Name
2	sec	0 to 32, QUERY	Default leap second QUERY: Output request of the current default leap second

Example:

$PERDAPI,DEFLS,18*0A
$PERDAPI,DEFLS,QUERY*49

Notes:

- This command should be sent at fix session off state.
- The default leap second configured by this command is not stored in BBRAM.
- When this command is not sent yet, the default leap second is set to 17.

13.1.5 EXTENDGSA – GSA Re-definition

This command adds extra fields to the GPGSA NMEA string to show more than 12 satellites used in the fix. Using this command will break NMEA compliance.

Format:

$PERDAPI	,	EXTENDGSA	,	num	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	EXTENDGSA	-	Command Name
2	num	12 to 16	Number of fields for satellites used in the fix (Default: 12)

Example:

$PERDAPI,EXTENDGSA,14*0D

Notes:

- By creating more fields for satellites used in the fix, the PDOP/HDOP/VDOP values shift by num12 fields.
- Default num is 12. Send this value to return to the NMEA compliant definition.
- Sending this command also affects the PERDCRE,FIX string.

13.1.6 FIRSTFIXFILTER – First Fix Filter Parameters

This command establishes the integrity applied to the fist position fix.

Format:

$PERDAPI	,	FIRSTFIXFILTER	,	level	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	FIRSTFIXFILTER	-	Command Name
2	level	STRONG, MEDIUM, OFF	The desired first fix performance level. (Default: MEDIUM)

Example:

$PERDAPI,FIRSTFIXFILTER,STRONG*45
$PERDAPI,FIRSTFIXFILTER,MEDIUM*4B
$PERDAPI,FIRSTFIXFILTER,OFF*19

Notes:

- The levels are trade-offs between time-to-first-fix and first fix position accuracy.
- STRONG is a slower, more accurate first fix.
- OFF is to allow for the fastest time to first fix.
- MEDIUM is a balance between time-to-first-fix and first fix accuracy.

13.1.7 FIXMASK – Mask Configuration

This command allows for the configuration of accuracy vs. sensitive fixes.

Format:

$PERDAPI	,	FIXMASK	,	mode	[,	elevmask	,	ephagemask	,	snrmask	,	tsmmask]	*hh	<CR>	<LF>
		1		2		3		4		5		6			

Field	Contents	Range	Remark
1	FIXMASK	-	Command Name
2	mode	SENSITIVITY, ACCURACY, USER	Mode (Default: SENSITIVITY)
3	elevmask	0 to 90	Elevation mask (in degrees). (Default: 0) Only SVs above this mask are used in the position fix calculation.
4	ephagemask	0 to 28800	Ephemeris age mask (in seconds) (Default: 14400) Only SVs whose age is within threshold are used in the position fix calculation.
5	snrmask	0 to 49	SNR mask (in dB-Hz). (Default: 0) Only SVs above this mask are used in the position fix calculation.
6	tsmmask	0,1	Value mask (Default: 0) 0: tracking SVs which have available ephemeris are used in the position fix calculation. 1: only SVs with TSM measurements are used in the position fix calculation.

Example:

$PERDAPI,FIXMASK,ACCURACY*05
$PERDAPI,FIXMASK,USER,10,7200,37,1*38

Notes:

- SENSITIVITY sets the receiver to output more fixes in weaker signal environments.
- ACCURACY requires the receiver to meet a higher integrity standard before declaring a fix valid.
- This command applies to all fix outputs, not just the first session or re-acquisition fix.
- The default mask values are those shown in the USER example.
- A value of 0 in each of the mask field means that particular mask is not applied. This is the default setting for all masks.

13.1.8 FIXPERSEC – Multiple Fixes Per Second

This command enables fixes to be output at greater than once per second.

Format:

$PERDAPI	,	FIXPERSEC	,	Fixrate	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	FIXPERSEC	-	Command Name
2	Fixrate	1,2,5,10	Number of fixes per second. (Default: 1)

Example:

$PERDAPI,FIXPERSEC,5*2B

Notes:

- When setting rates 5Hz or 10Hz, it is highly recommended that the baud rate be changed to a minimum of 115200 with PERDCFG,UART1 command.
- This command should be sent at fix session off state.
- This command takes effect soon after transferring to fix session state.

13.1.9 GNSS – GNSS Satellite System

This command controls which Global Navigation Satellite Systems are used by the receiver.

Format:

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

Field	Contents	Range	Remark
1	GNSS	-	Command Name
2	talkerid	AUTO, GN, LEGACYGP	NMEA Talker ID
3	gps	-1,0,1,2,3	GPS Mode
4	glonass	-1,0,1,2,3	GLONASS Mode
5	galileo	-1,0,1,2,3	Galileo Mode
6	qzss	-1,0,1,2,3	QZSS Mode
7	sbas	-1,0,1,2,3	SBAS Mode

Example:

$PERDAPI,GNSS,GN,2,2,0,2,2*47
$PERDAPI,GNSS,AUTO,2,1,-1,1,1*6E

Notes:

- A talkerid of GN means to always use GN as the prefix for NMEA strings (except for GSV). AUTO means to use GN if multiple systems are used in the fix and the Talker ID of the individual system (i.e. GP) if only a single system is used.
- LEGACYGP means to output using a GP prefix, even if there are multiple systems in the fix. Consequently, non-GPS GSA and GSV strings will not be output.
- The mode can be set to -1,0,1,2,3 for each satellite system. -1 means to keep the current configuration, 0 means to disable the system, 1 means to enable tracking only (do not use in position fix), 2 means to enable tracking and use the in position fix calculation, and 3 means to use only after first fix (do not use in first fix calculation).
- The receiver does not accept the setting not to use GPS, GLONASS and Galileo (i.e. $PERDAPI,GNSS,AUTO,0,0,0,2,2*41).
- The receiver does not accept the setting to use GPS, not to use GLONASS and Galileo (i.e. $PERDAPI,GNSS,AUTO,0,2,2,2,2*41).

13.1.10 LATPROP – Latency Position Propagation

This command controls the latency position propagation feature. The parameter is the number of milliseconds to propagate forward each calculated position fix

Format:

$PERDAPI	,	LATPROP	,	milliseconds	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	LATPROP	-	Command Name
2	milliseconds	-1 to 2000	Number of milliseconds to propagate each calculated position fix. (Default: 800 [msec] at 1Hz) A value of 0 is a default value. A value of -1 will disable the latency propagation.

Example:

$PERDAPI,LATPROP,500*2A
$PERDAPI,LATPROP,-1*03

Notes:

- Above first example sets the number of to propagate each calculated position fix in 1300 (default value (800) + 500) [msec].

13.1.11 OUTPROP – Position Outage Propagation

This command controls the position outage propagation feature. The parameter is the number of seconds that the last calculated position is propagated forward using the last velocity in the event of a loss of satellite signals.

Format:

$PERDAPI	,	OUTPROP	,	seconds	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	OUTPROP	-	Command Name
2	seconds	0 to 10	Number of seconds to propagate the last valid position fix when the GNSS signal is lost. (Default : 10) 0: Disable this feature

Example:

$PERDAPI,OUTPROP,5*3D
$PERDAPI,OUTPROP,0*38

13.1.12 PIN – Static Pinning

This command controls the static pinning.

Format:

$PERDAPI	,	PIN	,	strength	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	PIN	-	Command Name
2	strength	STRONG, OFF	Pinning ON/OFF (Default: STRONG) STRONG: Pinning ON OFF: Pinning OFF

Example:

$PERDAPI,PIN,STRONG*1F
$PERDAPI,PIN,OFF*43

Notes:

- Static pinning forces the core to hold the current position while in static mode.
- When the speed < “vin” continues for the “tin” or longer, the pinning is enabled. When the speed > “vout” continues for the “tout” or longer, the pinning is disabled.
- See Section 13.1.20 about the entry and exit criteria for static mode. Pinning may be disabled by the receiver regardless of the STATIC setting.

13.1.13 POS – Position Aiding

This command provides Position aiding to the receiver.

Format:

$PERDAPI	,	POS	,	latitude	,	longitude	,	altitude	,	uncertainty	,	altsigma	[,	force]	*hh	<CR>	<LF>
		1		2		3		4		5		6		7			

Field	Contents	Range	Remark
1	POS	-	Command Name
2	latitude	-90.0000 to 90.0000	WGS84 Latitude in decimal degrees (<0 for South, >0 North)
3	longitude	-180.0000 to 180.0000	WGS84 Longitude in decimal degrees (<0 for West, >0 East)
4	altitude	0 to 18300	WGS84 altitude in meters
5	uncertainty	1 to 8000000	Uncertainty in meters (horizontal and vertical)
6	altsigma	1 to 1000	Standard deviation for altitude in meters
7	force	1	1 means "always use".

Example:

$PERDAPI,POS,37.78700,-122.45100,30,150000,100*31
$PERDAPI,POS,37.7,-122.45,30,150000,100,1*12

Notes:

- The position setting with this command is available only when the receiver does not fix the position.
- The position provided in the command will not be adopted if the uncertainty is greater than the current internal uncertainty.
- A maximum of 5 significant digits are acceptable for latitude and longitude.

13.1.14 PPS – PPS (Pulse per second)

This command enables the PPS (Pulse per Second) circuit.

Format:

$PERDAPI	,	PPS	,	type	,	[mode	,	period	,	[pulsewidth	,	cabledelay]]	*hh	<CR>	<LF>
		1		2		3		4		5		6			

Field	Contents	Range	Remark
1	PPS	-	Command Name
2	type	OFF, FINE	PPS Output Type (Default: FINE) OFF: PPS output OFF FINE: PPS output ON
3	mode	1,2	PPS Output Mode (Default: 1) 1: Always ON 2: ON After Fix
4	period	1000, 2000	Pulse Interval [msec] (Default: 1000)
5	pulsewidth	1 to 500	PPS pulse Width [msec] (Default: 200)
6	cabledelay	-100000 to 100000	Cable Compensation [nsec] (Default: 0)

Example:

$PERDAPI,PPS,OFF*47
$PERDAPI,PPS,FINE,2,1000,200,0*3D

Notes:

- In On After Fix mode, PPS will not be output until after internal fix thresholds are met.
- When "type" field is OFF, the fields from field 3 to field 6 are omissible.

13.1.15 RAIM

This command enables the RAIM (Receiver Autonomous Integrity Monitoring) algorithm.

Format:

$PERDAPI	,	RAIM	,	mode	[,	accuracy]	*hh	<CR>	<LF>
		1		2		3			

Field	Contents	Range	Remark
1	RAIM	-	Command Name
2	mode	ON, OFF	Mode (Default: OFF)
3	accuracy	1 to 999	Accuracy Level [m]

Example:

$PERDAPI,RAIM,ON,100*50
$PERDAPI,RAIM,OFF*03

Notes:

- When enabling RAIM (mode=ON), an accuracy value must be specified.

13.1.16 RESTART/RESTARTNOFPR – Stop and Start the GNSS Core Library

This command stops the current GNSS fix session and then starts a new one. RESTARTNOFPR command does not write the backup data into the Flash ROM.

Format:

$PERDAPI	,	RESTART RESTARTNOFPR	[,	startmode]	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	RESTART RESTARTNOFPR	-	Command Name
2	startmode	HOT,WARM, COLD,SIMCOLD	Start Mode (Default: Hot)

Example:

$PERDAPI,RESTART*20
$PERDAPI,RESTART,HOT*5F
$PERDAPI,RESTARTNOFPR*65
$PERDAPI,RESTARTNOFPR,HOT*1A

Notes:

- The GNSS core must be on when this command is sent.
- Refer to Section 13.1.19 for details regarding start mode.

13.1.17 SBASBLS – SBAS Search Select

This command controls which SBAS satellite is searched as a priority satellite.

Format:

$PERDAPI	,	SBASBLS	,	provider_id	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	SBASBLS	-	Command Name
2	provider_id	0 to 3, 255, QUERY	Priority of Searched SBAS Satellite (Default: MSAS) 0: WAAS, 1: EGNOS, 2: MSAS, 3: GAGAN, 255: Blind search in ascending order of PRN QUERY: Request a searching provider_id

Example:

$PERDAPI,SBASBLS,0*35	Search from WAAS
$PERDAPI,SBASBLS,1*34	Search from EGNOS
$PERDAPI,SBASBLS,2*37	Search from MSAS
$PERDAPI,SBASBLS,3*36	Search from GAGAN
$PERDAPI,SBASBLS,255*37	Blind search in ascending order of PRN
$PERDAPI,SBASBLS,QUERY*4F	

13.1.18 SELFEPH – Self-Ephemeris™

This command enables the use of Self-Ephemeris models in the fix session.

Format:

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

Field	Contents	Range	Remark
1	SELFEPH	-	Command Name
2	mode	ON, OFF	Self-Ephemeris Mode (Default: ON)

Example:

$PERDAPI,SELFEPH,OFF*55

Notes:

- By default, the value is ON and the fix session uses Self-Ephemeris™.
- When the OFF mode is sent after the start of a fix session, the disabling of Self-Ephemeris model usage does not necessarily occur immediately. Any Self-Ephemeris models loaded from FLASH into runtime memory make take up to 9 hours to expire.

13.1.19 START – Start the GNSS Core Library

This command starts a GNSS fix session.

Format:

$PERDAPI	,	START	[,	mode]	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	START	-	Command Name
2	mode	HOT,WARM, COLD,SIMCOLD	Type of start to perform (Default: HOT)

Example:

$PERDAPI,START*37
$PERDAPI,START,HOT*48
$PERDAPI,START,WARM*12
$PERDAPI,START,COLD*1F
$PERDAPI,START,SIMCOLD*48

Notes:

- The receiver status must be fix session off when this command is sent.
- HOT starts use information from the previous fix sessions, such as time, position and high accuracy satellite models.
- WARM starts emulate the receiver that has been off for more than hours.
- COLD starts emulate the receiver that has been off for more than several days.
- SIMCOLD is a COLD start with all satellite models cleared. This is used primarily when switching between live sky and simulator environments.
- Sending the mode field is optional, the default is HOT.
- The "mode" field is as following table for details.

Receiver Data	Start Mode			
	HOT	WARM	COLD	SIMCOLD
Latitude/Longitude	Backup value used	Backup value used	Return to default	Return to default
Date Time	Backup value used	Backup value used	Return to default	Return to default
Almanac Data	Backup value used。	Backup value used	Backup value used	Deleted
Ephemeris Data	Backup value used	Deleted	Deleted	Deleted

13.1.20 STATIC – Static Entry/Exit Parameters

This command establishes the entry and exit criteria for static mode.

Format:

$PERDAPI	,	STATIC	,	vin	,	tin	[,	vout	,	tout]	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Contents	Range	Remark
1	STATIC	-	Command Name
2	vin	0 to 20480 (≒5[m/sec])	Velocity threshold for entering static mode [m/sec/2^{-12}] (Default : 4506 (≒1.1 [m/sec]))
3	tin	0 to 100	Time threshold (of velocity) for entering static mode [sec] (Default : 2)
4	vout	0 to 20480 (≒5[m/sec])	Velocity threshold for exiting static mode [m/sec/2^{-12}] (Default : 4506 (≒1.1 [m/sec]))
5	tout	0 to 100	Time threshold (of velocity) for exiting static mode [sec] (Default: 2)

Example:

$PERDAPI,STATIC,4096,2,4096,2*6F

Notes:

- Static mode means the output velocity is forced to zero and stronger position filtering is applied. Pinning is only applied when static mode is determined. Dynamic mode means that the raw velocity is output.
- Only one velocity/time pair is required. If the second pair (vout, tout) is left blank or is not sent, the vin and tin values will be used for both the entry and exit thresholds.
- Both “vin” and “vout” should be set to the same value. To set the desired speed threshold, use the following formula: [vin or vout] = (int) round((speed in meters per second) * 4096).

13.1.21 STOP/STOPNOFPR – Stop the GNSS Core

This command ends the current fix session.

Format:

$PERDAPI	,	STOP STOPNOFPR	*hh	<CR>	<LF>
		1			

Field	Contents	Range	Remark
1	STOP STOPNOFPR	-	Command Name

Example:

$PERDAPI,STOP*6F
$PERDAPI,STOPNOFPR*2A

Notes:

- Backup data can be written into Flash ROM by PERDAPI,STOP command. PERDAPI,STOPNOFPR command does not write the backup data into Flash ROM.
- After STOP or STOPNOFPR command is sent, the receiver is restarted by sending a PERDAPI,START command.

13.1.22 TIME – Time Aiding

Provide Time aiding to the receiver.

Format:

$PERDAPI	,	TIME	,	timeofday	,	day	,	month	,	year	,	uncertainty	*hh	<CR>	<LF>
		1		2		3		4		5		6			

Field	Contents	Range	Remark
1	TIME	-	Command Name
2	timeofday	000000 to 235959	UTC Time HHMMSS HH: hour, MM: minute, SS: second
3	day	1 to 31	UTC day
4	month	1 to 12	UTC month
5	year	2015 to 2099	UTC year
6	uncertainty	< 10	Time uncertainty in seconds.

Example:

$PERDAPI,TIME,021322,24,11,2015,10*4F

Notes:

- The time provided in the command will not be adopted if the uncertainty is greater than the current internal uncertainty.
- The acceptable date range is Jan 2, 2015 through Dec 31, 2099.
- See Section 8.9 about time setting.

13.2 CFG – Application Software Configuration

13.2.1 ESIPLIST – Save ESIP Command to FLASH

This command is used to save various ESIP commands in non-volatile FLASH memory, so that they do not have to be resent at each power cycle.

Format:

$PERDCFG	,	ESIPLIST	,	action	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	ESIPLIST	-	Command Name
2	action	NEW,APPEND, CLOSE,DELETE, QUERY,EXECUTE	The type of data to allocate

Example:

$PERDCFG,ESIPLIST,NEW*10
$PERDCFG,ESIPLIST,QUERY*06

Notes:

- Commands to be saved are not applied while in this mode.
- NEW creates a new list and APPEND continues with the current list.
- Individual commands are immediately written to FLASH, not as a set when the CLOSE is given.
- Query replies by sending 1 line per command (exactly as it was input) between "BEGIN" and "END" sentences.
- EXECUTE will immediately apply the saved ESIP commands.
- PERDAPI commands are executed at the start of each fix session. Non-PERDAPIs are executed at power up (or on EXECUTE).
- PERDCFG,ESIPLIST command and GPS fix session control commands (PERDAPI,[START|STOP|RESTARAT]) should not be saved
- This command is not allowed while the fix session in ON.

13.2.2 FACTORYRESET – Clear Non-Volatile Memory

This command is used to erase all non-volatile memory in order to restore the receiver to its factory state.

Format:

$PERDCFG	,	FACTORYRESET	*hh	<CR>	<LF>
		1			

Field	Contents	Range	Remark
1	FACTORYRESET	-	Command Name

Example:

$PERDCFG,FACTORYRESET*6C

Notes:

- This command should be sent at fix session off state.

13.2.3 FORMAT – Protocol Format

This command changes the UART1 protocol format.

Format:

$PERDCFG	,	FORMAT	,	mode	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	FORMAT	-	Command Name
2	mode	FECBIN	FECBIN: FURUNO Binary

Example:

$PERDCFG,FORMAT,FECBIN*47

Notes:

- All eSIP commands are ignored in FECBIN mode.
- To return to eSIP mode from FECBIN, send the raw Binary command:"10 02 00 02 00 C0 C0 10 03".

13.2.4 NMEAOUT – Configure the Standard NMEA Outputs

These commands control which standard NMEA sentences are transmitted by the receiver.

Format:

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

Field	Contents	Range	Remark
1	NEMAOUT	-	Command Name
2	type	GBS, GFA,GGA, GLL, GNS, GSA, GST, GSV, RMC, VTG, ZDA	Three-letter designation for sentence being configured.
3	interval	0 to 60	Number of fixes to output each sentence. 0: disable the output

Example:

$PERDCFG,NMEAOUT,GGA,2*57
$PERDCFG,NMEAOUT,GSV,0*56

Notes:

- This command may be sent at any time and will take effect immediately.
- The output order of standard NMEA is as following table.

Table 13.1 Output Order of Standard NMEA

Output order	Data Type	Data Contents	O: Default output
Fast	RMC	Recommended Minimum Navigation Information	O
	GNS	GNSS Fix Data	O
	GGA	Global Positioning System Fix Data	-
	GLL	Geographic Position - Latitude/Longitude	-
	VTG	Course Over Ground and Ground Speed	-
	GST	GNSS Pseudo range Error Statistics	O
	GBS	GNSS Satellite Fault Detection	-
	GFA	Integrity Data	-
	GSA	GPS DOP and Active Satellites	O
	ZDA	Time & Date	O
Last	GSV	Satellite data	O

13.2.5 SILENTSTART – SILENTSTART Mode Setting

In SILENTSTART mode, the receiver boots up at fix session off state. When this command is saved into ESIPLIST, the receiver's status at power on becomes fix session off state.

Format:

$PERDCFG	,	SILENTSTART	*hh	<CR>	<LF>
		1			

Field	Contents	Range	Remark
1	SILENTSTART	-	Command Name

Example:

$PERDCFG,SILENTSTART*24

Notes:

- When the receiver boots up at SILENTSTART mode, send PERDAPI,START command in order to transfer to fix session state.

13.2.6 UART1 – Configure Serial Communications

This command configures the serial communications port.

Format:

$PERDCFG	,	UART1	,	baud	[,	databits	,	parity	,	stopbits]	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Contents	Range	Remark
1	UART1	-	Command Name
2	baud	4800, 9600, 19200, 38400, 57600, 115200, 230400	Baud rate (Default: 38400)
3	databits	8	Byte size
4	parity	NONE,EVEN,ODD	The parity format (Default: NONE)
5	stopbits	1,2	Number of Stop bit (Default: 1)

Example:

$PERDCFG,UART1,115200*65
$PERDCFG,UART1,230400,8,ODD,2*0E

Notes:

- The receiver sends an ACK to the host in response to this command back at the original baud rate before changing to the new communications settings.
- When setting lower baud rates, it may be necessary to disable other NMEA output strings in order to comply with the lower rate. The PERDCFG,NMEAOUT command is used to do this.

13.2.7 UART2 – Configure Serial Communications

This command configures the secondary serial communications port.

Format:

$PERDCFG	,	UART2	,	baud	[,	databits	,	parity	,	stopbits]	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Contents	Range	Remark
1	UART2	-	Command Name
2	baud	4800, 9600, 19200, 38400, 57600, 115200, 230400	Baud rate (Default: 4800)
3	databits	8	Byte size
4	parity	NONE,EVEN,ODD	The parity format (Default: NONE)
5	stopbits	1,2	Number of Stop bit (Default: 1)

Example:

$PERDCFG,UART2,115200*66
$PERDCFG,UART2,230400,8,ODD,2*0D

13.3 SYS – Control/Query the PVT System

13.3.1 ANTSEL – Antenna Selection Control

This command configures the antenna inputs.

Format:

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

Field	Contents	Range	Remark
1	ANTSEL	-	Command Name
2	mode	FORCE1H, FORCE1L, FLEXFS, QUERY	Mode

Example:

$PERDSYS,ANTSEL,FORCE1H*7F
$PERDSYS,ANTSEL,QUERY*11

Notes:

- The meanings for the mode strings are as follows:
  - FORCE1H uses LNA in High gain mode.
  - FORCE1L uses LNA in Low gain mode.
  - FLEXFS uses LNA with the gain configured by FLNA.
- QUERY is used to ask for the current antenna select setting and will result in a PERDSYS,ANTSEL output string.

13.3.2 BBRAM

This command enables the contents of BBRAM to be passed to the Host Application. It is useful in scenarios where VBK is not powered and the customer would like to maintain HOT start capability.

13.3.2.1 BBRAM – Query Command

Format:

$PERDSYS	,	BBRAM	,	QUERY	[,	format]	*hh	<CR>	<LF>
		1		2		3			

Field	Contents	Range	Remark
1	BBRAM	-	Command Name
2	QUERY	-	Sub-Command Name
3	format	ESIPB64, MULTIB64	Encoding format. (Default: MULTIB64)

Example:

$PERDSYS,BBRAM,QUERY*4E
$PERDSYS,BBRAM,QUERY,ESIPB64*2D

Notes:

- This command should be sent at fix session off state.
- GN-8720 software uses b64: Base-64 Encoding Library. This library copyright (include the discharge) is described at the end of the document.

13.3.2.2 BBRAM – Push Strings

These input strings match the output strings that resulted from the above QUERY command. The Host Application inputs these at the subsequent power up.

Format:

$PERDSYS	,	BBRAM	[,	supportdata,…	] *hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	BBRAM	-	Command Name
2	supportdata	-	

Example:

$PERDSYS,BBRAM,189,001,MQFlMwe73jcDCAMIQnYOtEP+mt0AAA2DAAxR7AAACS8AAAApAAQ/*24
$PERDSYS,BBRAM,CHECKSUM,-962385454*3E

Notes:

- This command should be sent at fix session off state.
- There is no corresponding PERDACK when inputting these strings.
- A PERDSYS,BBRAM,[PASS|FAIL] string is output upon reception of the CHECKSUM substring.
- GN-8720 software uses b64: Base-64 Encoding Library. This library copyright (include the discharge) is described at the end of the document.

13.3.3 ERRACT – Receiver's State Processing at Abnormal Status

This command configures how to process the receiver's state when abnormal states and self test error occur.

Format:

$PERDSYS	,	ERRACT	,	Action	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	ERRACT	-	Command Name
2	Action	HALT IGNORE	Receiver's state processing at abnormal status (Default: IGNORE) HALT: The receiver's state transfers to fix session off state, when abnormal states and self test errors occur. IGNORE: The receiver's state maintains fix session state, even if abnormal states and self test errors occur.

Example:

$PERDSYS,ERRACT,HALT*58

Notes:

- If abnormal status occurs when this setting is HALT, PERDSYS,FIXSESSION,OFF sentence is output before transferring to fix session off state.
- It is available to input eSIP commands even if the receiver's state has became fix session off state because of abnormal status when this setting is HALT.
- Even if the setting is HALT, the receiver's status may not transfer fix session off state from fix session state by the abnormal states.
- See Section 14.6.6 about self test, and Chapter 10 about abnormal status.

13.3.4 FIXSESSION – GNSS Session Query

This command queries the state of the GNSS fix sessions, and configures whether to output PERDSYS,FIXSESSION sentence autonomously.

Format:

$PERDSYS	,	FIXSESSION	[,	ENABLE]	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	FIXSESSION	-	Command Name
2	ENABLE	0,1	Setting of whether to output PERDSYS,FIXSESSION sentence autonomously (Default: 1) 0: Not output autonomously 1: Output autonomously

Example:

$PERDSYS,FIXSESSION*7F
$PERDSYS,FIXSESSION,1*62

Notes:

- When ENABLE field is omitted, query the state of GNSS fix session.

13.3.5 GPIO – General Purpose Input/Output

This command queries the state of the GPIO pins.

Format:

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

Field	Contents	Range	Remark
1	GPIO	-	Command Name

Example:

$PERDSYS,GPIO*67

Notes:

- This query command will return the state of GPIO0 to GPIO8.

13.3.6 RECPLAY – Diagnostics Mode

This command enables diagnostics mode.

Format:

$PERDSYS	,	RECPLAY	,	mode	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Default	Remark
1	RECPLAY	-	-	Command Name
2	mode	OFF,ON	OFF	Output Mode (Default: OFF)

Example:

$PERDSYS,RECPLAY,ON*0B
$PERDSYS,RECPLAY,OFF*45

Notes:

- This command should be sent at fix session off state.
- Setting mode=ON requires the baud rate to be at least 115200.

13.3.7 SELFEPH – Self-Ephemeris™ Models Calculation

This command enables the calculation of Self-Ephemeris models.

Format:

$PERDSYS	,	SELFEPH	[,	hour	[,	accuracy]]	*hh	<CR>	<LF>
		1		2		3			

Field	Contents	Range	Remark
1	SELFEPH	-	Command Name
2	hour	8 to 72, OFF	Hours of model availability. [hour] (Default: OFF)
3	accuracy	0, 1	Model Accuracy 0: Low Accuracy mode, 1: High Accuracy mode

Example:

$PERDSYS,SELFEPH*37
$PERDSYS,SELFEPH,72,0*02
$PERDSYS,SELFEPH,OFF*54

Notes:

- The first example enables Self-Ephemeris calculation with default values of 24 hours and High accuracy.
- The second example enables 72 hours of low accuracy Self-Ephemeris models.
- The hour field represents the minimum number of hours of availability the Self-Ephemeris algorithms attempt to maintain.
- In Low Accuracy mode, the position accuracy is low but calculation speed is fast.
- In High Accuracy mode, the position accuracy is high but calculation speed is slow.

13.3.8 SELFTEST – Self Test Request

This command queries the self test data.

Format:

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

Field	Contents	Range	Remark
1	SELFTEST	-	Command Name

Example:

$PERDSYS,SELFTEST*7C

Notes:

- This command should be sent at fix session off state.
- It is available to run the self test at every start-up, if this command is saved into ESIPLIST.

13.3.9 VERSION – Software Version Information

Query the receiver for software versioning information.

Format:

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

Field	Contents	Range	Remark
1	VERSION	-	Command Name

Example:

$PERDSYS,VERSION*2C

14 Proprietary NMEA Output

The receiver will output proprietary strings to the host system. As with the inputs, standard NMEA format is used. Output strings will start with $PERD to indicate specific communication.

14.1 ACK – Command Acknowledgement

This string is sent in response to most correctly formed inputs to confirm successful receipt. It is up to the host to implement any error handling procedures.

Format:

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

Field	Contents	Range	Remark
1	command		Echoes the initial field of the command received by the client
2	sequence	-1, 0 to 255	Counter that increments with each successful command, starting from 0 and rolling over at 255. Unsuccessful commands will report -1.
3	subcommand		Second token of input command.

Example:

$PERDACK,PERDAPI,16,PIN*6D

Notes:

- Commands must still pass checksum validate before any acknowledgement is sent.
- Input strings that pass checksum, but are incorrect formatted will return a sequence number of -1.
- Subcommand will be "N/A" for strings with inappropriate subcommand tokens.

14.2 CFG – Response to PERDCRG Input Commands

14.2.1 ADDON

This string lists the applicable user and feature set.

Format:

$PERDCFG	,	ADDON	,	name	,	feature	*hh	<CR>	<LF>
		1		2		3			

Field	Contents	Range	Remark
1	ADDON	-	Command Name
2	name		
3	feature		

Example:

$PERDCFG,ADDON,N/A,BASIC*57

Notes:

- This string will also be output at power-up.

14.2.2 ESIPLIST

This string is sent in response to the PERDCFG,ESIPLIST,QUERY command. It lists the commands in the ESIPLIST sector of FLASH.

Format:

$PERDCFG	,	ESIPLIST	,	label	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	ESIPLIST	-	Command Name
2	label	BEGIN, END	Indicates the start and end of the ESIPLIST data

Example:

$PERDCFG,ESIPLIST,BEGIN*0B
$PERDCFG,NMEAOUT,VTG,5*54
$PERDCFG,ESIPLIST,END*03

Notes:

- At least two strings are output, the BEGIN and END labels.
- The data between the BEGIN and END labels are the exact ESIP commands input by the user.

14.3 CRx – Core Library GNSS Strings

14.3.1 CRE – Ephemeris Data

This sentence provides information about the ephclk for all GPS, GLONASS and Galileo PRNs.

Format:

$PERDCRE	,	system	,	sennum	,	iode1	,	toc1	,	fth1	,	iode2	,	toc2	,	fth2	,
		1		2		3		4		5		6		7		8	

iode3	,	toc3	,	fth3	,	iode4	,	toc4	,	fth4	*hh	<CR>	<LF>
9		10		11		12		13		14			

Field	Contents	Range	Remark
1	system	GP, GL, GA	Satellite System GP: GPS, GL: GLONASS, GA: Galileo
2	sennum	1 to 9	Sentence No.
3	iode1		IODE for first ephclk
4	toc1		TOC for first ephclk
5	fth1	Flag: E,A,D,X Type: D,S,L,C,H,X URA: 0 to F, U SISA: 00 to FF,UU,XX	Flag/Type/Health (URA or SISA) for first ephclk URA: GPS, GLONASS SISA: Galileo
6-8	-	-	2nd satellite data (The satellite data like the field #3-#5)
9-11	-	-	3rd satellite data (The satellite data like the field #3-#5)
12-14	-	-	4th satellite data (The satellite data like the field #3-#5)

Example:

```
$PERDCRE,GP,1,007,129600,EH6,006,100800,EH6,007,122400,EH6,006,100800,EH6*78
$PERDCRE,GP,2,006,100800,EH6,007,122400,EH6,007,122400,EH6,007,122400,EH6*7F
$PERDCRE,GP,3,007,122400,EH6,007,115200,EH6,007,122400,EH6,007,122400,EH6*71
$PERDCRE,GP,4,007,115200,EH6,007,122400,EH6,007,122400,EH6,007,108000,EH6*7A
$PERDCRE,GP,5,007,122400,EH6,007,115200,EH6,007,122400,EH6,007,122400,EH6*77
$PERDCRE,GP,6,007,115200,EH6,007,122400,EH6,007,122400,EH6,007,122400,EH6*74
$PERDCRE,GP,7,007,108000,EH6,007,122400,EH6,007,115200,EH6,006,100800,EH6*74
$PERDCRE,GP,8,007,122400,EH6,047,518400,XXU,006,100800,EH6,006,100800,EH6*1F
```

Notes:

- Sentence 1 applies to PRNs 1-4, Sentence 2 applies to PRNs 5-8, Sentence 3 applies to PRNs 9-12, Sentence 4 applies to PRNs 13-16, Sentence 5 applies to PRNs 17-20, Sentence 6 applies to PRNs 21-24, Sentence 7 applies to PRNs 25-28, Sentence 8 applies to PRNS 29-32, Sentence 9 applies to PRNs 33-36.
- Flag values for the fth field are: E=Ephemeris, A=Almanac, D=Downmoded, X=Invalid. Type values for the fth field are: D=Decoded, S=Self-Ephemeris™, L=LTCSM, C=CSM, H=Hybrid, X=Invalid. URA values for the fth field are: 0-F for hexadecimal URA value and U=Unhealthy. SISA values for the fth field are: 00-FF for hexadecimal SISA value, UU=Unhealthy and XX=Invalid.
- SISA is output as XX when SISA is not obtained yet since SISA is broadcasted in a timing independent of the ephemeris.
- SISA is output as XX when the ephemeris is not obtained yet.
- These strings are output on events that trigger Previous Run data savings.

14.3.2 CRF – GNSS Accuracy and GPS Health

14.3.2.1 CRF,GxACC – GNSS Accuracy

This sentence provides GNSS Satellite Accuracy information.

Format:

$PERDCRF	,	GxACC	,	accuracy	*hh	<CR>	<LF>
		1		2			

$PERDCRF	,	GxACC	(,	pageID)	,	accuracy	*hh	<CR>	<LF>
		1		2		3			

Field	Contents	Range	Remark
1	GxACC	-	Sub-Type Key "x" shows the following satellite type. P: GPS, L: GLONASS, A: Galileo, Q: QZSS, S: SBAS
2	pageID	1, 2	Only for GAACC 1: PRN 1 to 18 2: PRN 19 to 36
3	accuracy	0x0 to 0xF, X (GAACC) 0x00 to 0xFF, XX	GNSS accuracy data in ascending PRN No. sequence 0-F=accuracy in hexadecimal, X=not available GPS: 32 satellites, GLONASS: 24 satellites, Galileo: 36 satellites, QZSS: 5 satellites (PRN193 to 197), SBAS: 38 satellites (PRN120 to 138, 139 to 158)

Example:

$PERDCRF,GPACC,X1X10X0100XXXX0XXXXXXXX0X0XX1XXX*6A
$PERDCRF,GLACC,1XXXXX23343XXXXXXXXXX334*76
$PERDCRF,GAACC,1,XXXXXXXXXXXXXXXXXXXXXX0BXXXXXXXXXXXX*7C
$PERDCRF,GAACC,2,0BXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX*7F
$PERDCRF,GQACC,0XXXX*33
$PERDCRF,GSACC,XXXXXXXXX7XXXXXXX7XXXXXXXXXXXXXXXXXXX*59

Notes:

- This sentence is output at 1Hz before first fix. After the first fix, the output rate is fix rate.
- Only the information of satellite system specified by PERDAPI,GNSS command is output.
- PERDCRF,GSACC sentence reports always “X” in latter half of field 2 (PRN139~158).
- GAACC sentence shows the accuracy field with two characters.

14.3.2.2 CRF,GxANC – GNSS Health

This sentence provides information GNSS Almanac Date and GNSS Satellite Health.

Format:

$PERDCRF	,	GxANC	,	almdata	,	health	*hh	<CR>	<LF>
		1		2		3			

Field	Contents	Range	Remark
1	GxANC	-	Sub-Type Key "x" shows the following satellite type. P: GPS, L: GLONASS, A: Galileo, Q: QZSS, S: SBAS
2	almdata		Date/Time of Almanac used to
3	health	0 to 2	Health for all satellites. 0=Almanac not yet collected, 1=Unhealthy, 2=Healthy

Example:

$PERDCRF,GPANC,131220061259,020220222200002000002002020020000*29
$PERDCRF,GLANC,131220061300,222220222222222222222222*3A
$PERDCRF,GAANC,141022060342,000000000002000000200000000000000000*35
$PERDCRF,GQANC,131202050103,20000*14
$PERDCRF,GSANC,131220061139,000000000000000000000000000000000000000000*1F

Notes:

- This sentence is output at 1Hz before first fix. After the first fix, the output rate is fix rate.
- Only the information of satellite system specified by PERDAPI,GNSS command is output.
- ”almdata” is time which last decoded health.
- ”almdata” is Null when the receiver has no health message.
- PERDCRF,GSANC sentence reports always “0” in latter half of field 2 (PRN139~158)

14.3.3 CRL – LTCSM / Self-Ephemeris™ Data

This sentence provides information about availability of Long Term models (LTCSM or Self-Ephemeris™).

Format:

$PERDCRL	,	sys	,	time	,	week	,	gr1	,	gr2	,	gr3	,	gr4	,
		1		2		3		4		5		6		7	

gr5	,	gr6	[,	gr7	,	gr8	],	reserved	,	reserved	*hh	<CR>	<LF>
8		9		10		11		12		13			

Field	Contents	Range	Remark
1	sys	GPS, GLO	Satellite System GP: GPS, GL: GLONASS
2	time		GPS Time
3	week		GPS Week
4	gr1		Model (LTCSM or Self-Ephemeris) availability from PRN 1 to 4.
5	gr2		Model availability from PRN 5 to 8.
6	gr3		Model availability from PRN 9 to 12.
7	gr4		Model availability from PRN 13 to 16.
8	gr5		Model availability from PRN 17 to 20.
9	gr6		Model availability from PRN 21 to 24.
10	gr7		Model availability from PRN 25 to 28. In case of GLONASS, this field is omitted.
11	gr8		Model availability from PRN 29 to 32. In case of GLONASS, this field is omitted.
12	reserved		
13	reserved		

Example:

$PERDCRL,GPS,495489,600,_---,0011,9999,aaAA,bbBB,CCDD,eeff,gGhh,0,5*5A

Notes:

- The numbers of model availability represents hours, letters represent day (lower case means bottom half of the day, upper case means top half of day), '-' means expired, '_' means unavailable
- The alphanumeric codes represent the 'floor' value. In the above example, 0: 0-1 hours of availability, 1: 1-2 hours, 9: 9-10 hours, a: 10-12 hours, A:12-24 hours, b:24-36 hours, B:36-48 hours, C:60-72 hours, d:72-84 hours, D:84-96 hours, e: 96-108 hours, f:120-132 hours, g:144-156 hours, G:156-168 hours, h:168-180 hours.
- This output string is still in beta and will likely change in upcoming releases.

14.3.4 CRP – PPS Status

This sentence provides PPS status.

Format:

$PERDCRP	,	status	*hh	<CR>	<LF>
		1			

Field	Contents	Range	Remark
1	status	0,1	0: PPS output OFF or PPS output free run 1: PPS output controlling the estimated accuracy within the threshold

Example:

$PERDCRP,1*5F
$PERDCRP,0*5E

Notes:

- The value of "status" changes from "1" to "0", when the receiver estimates that the PPS accuracy is over the threshold because non-positioning has continued after first position fix.

14.3.5 CRQ – Galileo SAR/RLM Data

This sentence provides Galileo SAR (Search and Rescue) and RLM (Return Link Message) data.

Format: (Max 57bytes * 2sentences)

$PERDCRQ	,	sentNum	,	sentIndex	,	prn	,	sar	[,	prn	,	sar	,	prn	,	sar	,	prn	,	sar]	*hh	<CR>	<LF>
		1		2		3		4		5		6		7		8		9		10			

Field	Contents	Range	Remark
1	sentNum	1,2	Total number of CRQ sentence
2	sentIndex	1,2	CRQ sentence Number
3,5,7,9	prn	Null, 01 to 36	Galileo decoded satellite No. (These fields are null fields when it is impossible to decode the SAR RLM data.)
4,6,8,10	sar	Null, 000000h to 3FFFFFh	SAR RLM data involved in I/Nav odd page decoded from Galileo E1-B signal (MSB is far leftmost bit) (These fields are null fields when it is impossible to decode the SAR RLM data.)

Example:

(1) The receiver obtains the SAR RLM data from Galileo satellites which PRNs no. are 1, 2, 10, 11, 13 and 35.

Input command	$PERDAPI,CROUT,Q*55
Output sentence	$PERDACK,PERDAPI,0,CROUT*52 . . . $GNZDA,041334.652,01,10,2014,,*4F . . . $PERDCRQ,2,1,01,2AAAAA,02,2AAAAA,10,100000,11,200000*41 $PERDCRQ,2,2,13,2AAAAA,35,2AAAAA,,,,*47 . . .
	$GNZDA,041335.662,01,10,2014,,*4D . . .
	$GNZDA,041336.662,01,10,2014,,*4E . . . $PERDCRQ,2,1,01,2AAAAA,02,2AAAAA,10,100000,11,200000*41 $PERDCRQ,2,2,13,2AAAAA,35,2AAAAA,,,,*47 . . .
	$GNZDA,041337.663,01,10,2014,,*4E

(2) The receiver cannot decode the data from Galileo satellites or does not track Galileo satellites.

Input command	$PERDAPI,GNSS,GN,-1,-1,0,-1,-1*47 $PERDAPI,CROUT,Q*55
Output sentence	$PERDACK,PERDAPI,0,CROUT*52 $PERDACK,PERDAPI,1,GNSS*05 . . . $GNZDA,041334.652,01,10,2014,,*4F . . . $PERDCRQ,1,1,,*43 . . .
	$GNZDA,041335.662,01,10,2014,,*4D . . .
	$GNZDA,041336.662,01,10,2014,,*4E . . . $PERDCRQ,1,1,,*43 . . .
	$GNZDA,041337.663,01,10,2014,,*4E

14.4 MSG – Event Driven Messages

This string is sent when certain events occur. Some strings are for FURUNO use only and contain only an alphanumeric key. Others provide user feedback and contain description of the event.

Format:

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

Field	Contents	Range	Remark
1	key		Alphanumeric event indicator.
2	string		Description of event

Example:

$PERDMSG,1A*06
$PERDMSG,5D,Cannot DELETE until CLOSED*53

14.5 RPx – Diagnostic Output Data

These set of strings are diagnostic output data, used for debugging complex issues.

Format:

$PERDRP<x>	,	data	*hh	<CR>	<LF>
		1			

Field	Contents	Range	Remark
1	data	-	Diagnostic Data

Example:

$PERDRPC,,AAAAAOI1FQBhDF0jeBqc//gGAIYK2QUAlwqSiw1/H9k9dABgCQCQCnE=,*4A
$PERDRPN,W28gTh3ST9/P3qPyac7XD0UmIQFYIjd+*36

Notes:

- The following steps are instructions to enable diagnostics. The output data will contain NMEA sentences, PERDRPx sentences and other proprietary sentences.

1. Send PERDAPI,STOP or PERDAPI,STOPNOFPR command at the current baud rate.
2. If the current baud rate is higher than 115200, go to step 5.
3. Use $PERDCFG,UART1,... to set the baud rate to 115200 bps or higher.
4. On the PC, switch baud rate to matching baud rate.
5. Start logging serial communication data to a file.
6. Send $PERDSYS,RECPLAY,ON*0B.
7. Send PERDAPI,START command.
8. Run the program and accumulate data.
9. Send PERDAPI,STOP or PERDAPI,STOPNOFPR command.
10. Repeat steps 5-9 as many times as desired.
11. Send the data files to FURUNO for analysis.
12. Return to initial baud rate to resume normal operation.

14.6 SYS – PERDSYS Output Commands

The majority of these strings are responses to PERDSYS input commands. Only FIXSESSION is output independent of a PERDSYS query.

14.6.1 ANTSEL – Antenna Selection Control Output

Format:

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

Field	Contents	Range	Remark
1	ANTSEL	-	Command Name
2	input	FORCE1H, FORCE1L, FLEXFS	Mode specified in PERDSYS,ANTSEL input command.
3	lnamode	1AUTO, 1HIGH, 1LOW	LNA Mode

Example:

$PERDSYS,ANTSEL,FORCE1L,1LOW*32

Notes:

- See Section 13.3.1 about the meanings of the field #2 strings.
- The meanings for the lnamode strings are as follows:
  - 1AUTO means gain selection is differed to the hardware.
  - 1HIGH means use High gain mode.
  - 1LOW means use Low gain mode.
- This string is reported at power-up, upon reception of the QUERY command, or when there is a change in configuration.

14.6.2 BBRAM – Backup Data Output

This string is sent in response to the PERDSYS,BBRAM,QUERY command or upon proper initialization of BBRAM using ESIP commands. It represents Base64 encoded Battery-Backed RAM and comes as a series of strings.

Format:

$PERDSYS	,	BBRAM	[,	supportdata,…	] *hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	BBRAM	-	Command Name
2	supportdata	-	Additional data in various formats.

Example:

[MULTIB64 Format]
$PERDSYS,BBRAM,189,001,MQFlMwe73jcDCAMIQnYOtEP+mt0AAA2DAAxR7AAACS8AAAApAAQ/*24

[ESIPB64 Format]
$PERDSYS,BBRAM,ESIPB64,161,*7D
$PERDSYS,BBRAM,MQFlMwe73jcDCAMIQnYOtEP+mt0AAA2DAAxR7AAACS8AAAApAAQ/7AMIHpQB*7C

[CHECKSUM]
$PERDSYS,BBRAM,CHECKSUM,-1817865088*0C

[Pass message]
$PERDSYS,BBRAM,PASS*15

[Fail message]
$PERDSYS,BBRAM,FAIL,CHECKSUM,309253690,1*27

Notes:

- The format specified in the input string drives the look of these output strings.
- If MULTIB64, there are three additional fields: total sentences, sentence number and the Base64 encoded data. See Example [MULTIB64 Format]
- If ESIPB64, the first output sentence indicates how many data sentences are coming. The next set of sentences contains the Base64 encoded data (without the sentence number information). See Examples [ESIPB64 Format].
- The CHECKSUM line is output for all formats and marks the end of the data that needs to be pushed back into the receiver at the subsequent power on.
- After the data is pushed back into the receiver, a PASS or FAIL message will be sent.
- GN-8720 software uses b64: Base-64 Encoding Library. This library copyright (include the discharge) is described at the end of the document.

14.6.3 FIXSESSION – GNSS Fix Session State Information

These strings are output at various points of a fix session to indicate some event occurred.

Format:

$PERDSYS	,	FIXSESSION	,	state	[,	appttff	,	corettff]	*hh	<CR>	<LF>
		1		2		3		4			

Field	Contents	Range	Remark
1	FIXSESSION	-	Command Name
2	state	ON, OFF, INIT, STANDBY	GNSS State
3	appttff		Application TTFF in milliseconds
4	corettff		Core Library TTFF in seconds

Example:

$PERDSYS,FIXSESSION,OFF*1C
$PERDSYS,FIXSESSION,ON,1396,0.925*7F

Notes:

- This sentence is also output when PERDSYS,FIXSESSION,QUERY command is sent.

14.6.4 GPIO – General Purpose Input/Output

This string is the reply to PERDSYS,GPIO command. It indicates the current state of the pins.

Format:

		GPIO 0		8			
$PERDSYS	,	GPIO	,	aaaaaaaaa	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	GPIO	-	State from GPIO0 to GPIO8
2	status	H,L	H: HIGH

Example:

$PERDSYS,GPIO,HHHHLLLLL*07

14.6.5 SELFEPH – Self-Ephemeris™ Calculation State

This string indicates a change in the Self-Ephemeris calculation state machine.

Format:

$PERDSYS	,	SELFEPH	,	state	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	SELFEPH		Command Name
2	state	START, END	Calculation state.

Example:

$PERDSYS,SELFEPH,START*5B
$PERDSYS,SELFEPH,END*54

Notes:

- The START string indicates the state machine is active and computing Self-Ephemeris models.
- The END string indicates the state machine has completed.
- The state machine re-starts if it has been 30 minutes since the last time it re-started. If a cycle of the state machine takes over 30 minutes, then the state machine will re-start immediately upon completion.
- See the section 13.3.7 about Self-Ephemeris calculation setting.

14.6.6 SELFTEST – Self Test Output

This string is the reply to the PERDSYS,SELFTEST command.

Format:

$PERDSYS	,	SELFTEST	,	R1_Rslt	,	R1_Chk	,	R2_Rslt	,	R2_Chk	,	FR_Rslt	,
		1		2		3		4		5		6	

FR_Chk	,	RAM_Rslt	,	RAM_Addr1	,	RAM_Addr2	*hh	<CR>	<LF>
7		8		9		10			

Field	Contents	Range	Remark
1	SELFTEST	-	Command Name
2	R1_rslt	OK, NG	ROM area 1 check sum result OK: Check sum is normal. NG: Check sum is abnormal.
3	R1_Chk	0000 to FFFF	ROM area 1 check sum value
4	R2_rslt	OK, NG	ROM Area 2 check sum result OK: Check sum is normal. NG: Check sum is abnormal.
5	R2_Chk	0000 to FFFF	ROM area 2 check sum value
6	FR_rslt	OK, NG	Flash ROM check sum result OK: Check sum is normal. NG: Check sum is abnormal.
7	FR_Chk	0000 to FFFF	Flash ROM check sum value
8	RAM_Rslt	OK, NG	RAM check sum result OK: Check sum is normal. NG: Check sum is abnormal.
9	RAM_Addr1	00000000 to FFFFFFFF	RAM area check sum result 0: The result is normal. Other than 0: The value shows error occurrence address.
10	RAM_Addr2	00000000 to FFFFFFFF	RAM Read/ Write test result 0: The result is normal. Other than 0: The value shows error occurrence address.

Example:

$PERDSYS,SELFTEST,OK:97A4,OK:4FAE,OK:4AD1,OK:00000000,00000000*5D

Notes:

- The receiver's state transfers to fix session off state, if any of these self test result are error when PERDSYS,ERRCT command is set to HALT.

14.6.7 VBKERR – VBK Error Report

This string is output when an error occurs in the VBK measure process.

Format:

$PERDSYS	,	VBKERR	,	Err_type	*hh	<CR>	<LF>
		1		2			

Field	Contents	Range	Remark
1	VBKERR		Command Name
2	Err_type	SUM_ERR1 SUM_ERR2 FD_ERR1 FD_ERR2 CONT_ERR	**SUM_ERR1:** Check sum error of 1st parameter in Flash ROM **SUM_ERR2:** Check sum error of either 1st parameter or 2nd parameter (reserved) in Flash ROM **FD_ERR1:** The 1st parameter in Flash ROM is in discord with the data read out from VBK **FD_ERR2:** The 2nd parameter in Flash ROM is in discord with the data read out from VBK **CONT_ERR:** Data read out from VBK are abnormal

Example:

$PERDSYS,VBKERR,SUM_ERR1*20

Notes:

- afaf VBK measure process and Err_Type of VBKERR sentence output are as follows:
  1. The receiver reads the first parameter saved in the Flash ROM and verifies the check sum. If the check sum is abnormal, SUM_ERR1 is output.
  2. The receiver reads the second parameter saved in the Flash ROM and verifies the check sum. If the check sum is abnormal, SUM_ERR2 is output.
  3. When both check sums are normal, the check sums are compared with data read from VBK. If the first parameter is different from VBK data, FD_ERR1 is output. If the second parameter is different from VBK data, FD_ERR2 is output. In these cases, the receiver starts the fix session process with Flash ROM data after outputting PERDSYS,VBKERR sentence.
- When the receiver registered the VBK data into Flash ROM at first, it verifies the data pattern status. If the status is abnormal, CONT_ERR is output. Please restart it, because VBK data is not registered into Flash ROM when CONT_ERR is output. It reads VBK data and saves the data into Flash ROM again by restart.
- In the following cases, when a watch dog timeout occurs, the receiver's state becomes "Fix session off" state after this sentence output.
  - PERDSYS,ERRACT command is set to HALT.
  - PERDCFG,SILENTSTART command is saved to ESIPLIST.

14.6.8 VERSION – Software Version Information

This string provides version information to the host application.

Format:

$PERDSYS	,	VERSION	,	device	,	version	,	reason	,	custom	*hh	<CR>	<LF>
		1		2		3		4		5			

Field	Contents	Range	Remark
1	VERSION	-	Command Name
2	device	-	Name of device
3	version	-	Version Number for the Client and HAL
4	reason	BOOT, QUERY, UART1	Reason for outputting version
5	custom	-	Customer Name

Example:

$PERDSYS,VERSION,OPUS7_SFLASH_MP_64P,ENP630C1410403F,QUERY,N/A*23
$PERDSYS,VERSION,OPUS7_SFLASH_MP_64P,ENP630C1410403F,UART1,N/A*4A

Notes:

- The reason field indicates why the string is output.
- This string is always output at power up, indicated by reason=BOOT.
- This string is sent in response to the PERDSYS,VERSION command, indicated by QUERY.
- This string is output when the PERDCFG,UART1 command is send to change the baud rate, indicated by reason=UART1. It will be reported at the new baud rate.
- The device and version strings are both free format. It is not recommended that they be used programmatically.

15 RTCM Correction Data

The receiver can use the RTCM SC-104 (Ver. 2.3) as correction data for differential position fix.

15.1 Configuration Diagram

Figure 15.1 shows combination of FURUNO and RTCM receiver with UART2 as serial port of RTCM message (RTCM SC-104) for both systems.

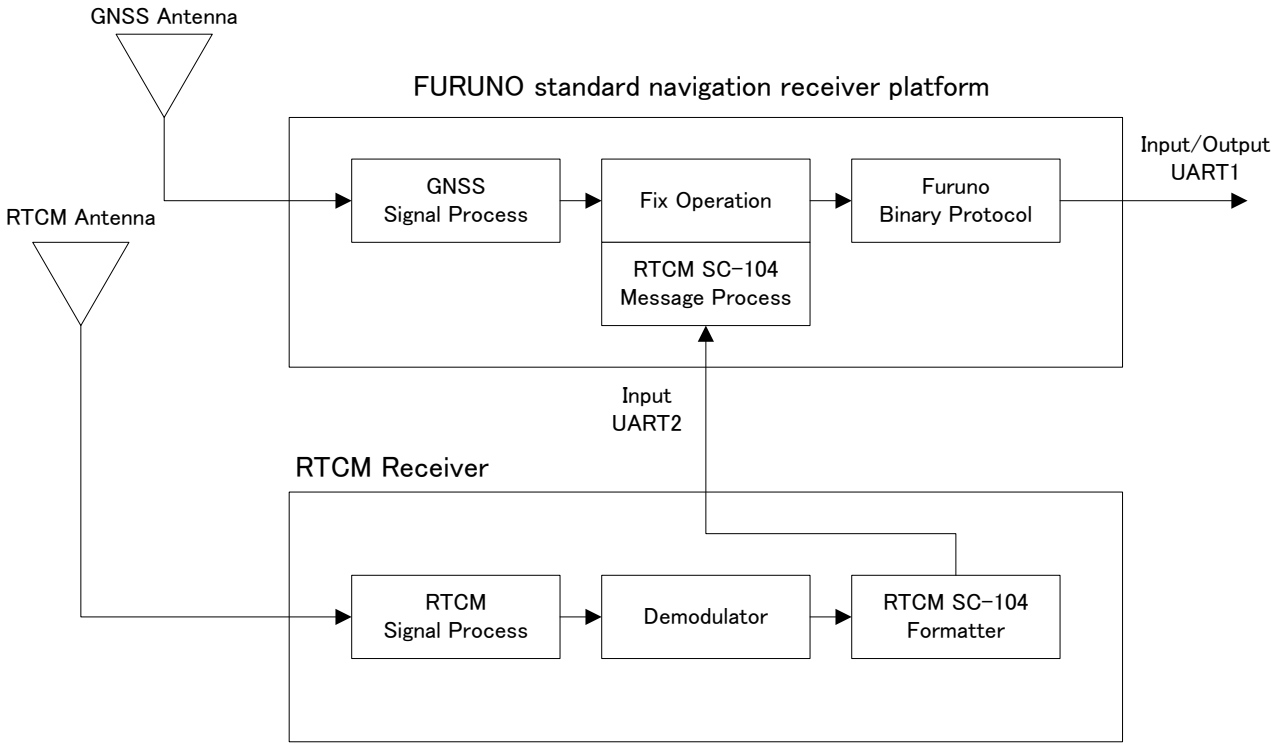


Figure 15.1 Relation Diagram between FURUNO and RTCM Receiver

15.2 RTCM Message Usage

FURUNO receiver uses the following message in RTCM message and ignores other message.

Type 1 message: The correction data of all satellites observed from a station.
Type 3 message: The reference station's geographical location in GPS coordinates.
Type 9 message: This message has the same format as type 1. But unlike type 1, with data for the whole satellite set in view, type 9 messages contain data for smaller groups of satellites, most often three.

FURUNO receiver uses latest information as correction data form satellite.

■GN-8720 Software uses b64: Base-64 Encoding Library. The following shows this library copyright (include the discharge).