April 10, 2003

I/O Protocol Specifications
for
GPS receiver

Model: GT-8031

By Furuno Electric Co., Ltd.
System Products Division

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1. SOFTWARE SPECIFICATION

1.1 PROGRAM NUMBER

Program number : 4850266000

1.2 COMMUNICATION SPECIFICATION

System: **Full Duplex Asynchronous**
Speed: **9600 BPS**
Start Bit: **1 bit**
Data Length: **8 bits (MSB=0)**
Stop Bit: **1 bit**
Parity Bit: **None**

Start Bit	B0	B1	B2	B3	B4	B5	B6	B7	Stop Bit

Flow Control: **None**
Signal Lines used: **TD1 and RD1 only**
Data Output Interval: **0 to 2 seconds**

Character Codes used

NMEA-0183 Sentences: **ASCII (HEX 0D,0A,20 to 7E)**

Differential GPS Data: **Binary (“6-of-8” format)**
(d7=0, d6=1, Only d5 to d0 are used.)

Electrical specification **Similar to RS-232C**

Protocol:

NMEA-0183 Sentences: **NMEA-0183 Ver 2.0 dated January 1, 1992**
(Approved/proprietary sentences)
(Input/Output)
Differential GPS Data: **RTCM SC-104 Ver 2.1 dated January 3, 1994**
(Input only)-

Note: NMEA-0183 sentence and differential GPS data inputs may coexist because the GN80 can distinguish them automatically.

1.3 ABOUT NMEA-0183 PROTOCOL

1.3.1. APPROVED SENTENCES

Approved sentences are those of which formats are defined and fixed within the NMEA 0183 Standard. Any portion within an approved sentence format is NOT user-definable. An approved sentence generally takes the following form:

$<address field>,<data field>.....[*<checksum field>]<CR><LF>

Where:

Field	Description
$	Start-of-Sentence marker
<address field>	5-byte fixed length. First 2 bytes represent a talker ID, and the remaining 3 bytes do a sentence formatter. All sentences transmitted by GT-8031 bear talker ID “GP” meaning a GPS receiver. For the sentences received from external equipment, the GT-8031 accepts any talker ID. Talker ID “XX” found on the succeeding pages is a wildcard meaning “any valid talker ID”.
,<data field>....	Variable or fixed-length fields preceded by delimiter “,”(comma). Comma(s) are required even when valid field data are not available i.e. null fields. Ex. “,,,,,” In a numeric field with fixed field length, fill unused leading digits with zeroes.
*<checksum field>	8 bits data between “$” and “＊”(excluding “$” and “＊”) are XORed, and the resultant value is converted to 2 bytes of hexadecimal letters. Note that two hexadecimal letters must be preceded by “＊”, and delimiter “,” is not required before *<checksum>. Only RMC sentences are transmitted with checksum. All other output sentences do not include *<checksum>. For input sentences, *<checksum> is ignored. For input sentences, the resultant value is checked and if it is not correct, the sentence is treated invalid. No checksum is added to the almanac data, which is up-loaded to or down-loaded from the receiver. The responding sentences to the almanac up-loading or down-loading have no check-sum, either.
<CR><LF>	End-of-Sentence marker

Note: Maximum length from “$” to <CR><LF> is limited to 82 bytes including “$” and <CR><LF>. Every input sentence of 83 bytes and over is ignored. Be careful with entering GPset and Gpint sentences. Recommend that you verify if the input is done correctly by issuing GPsrq, GPirq, GPdrq sentences. Please see 1.4 LIST OF NMEA-0183 SENTENCES.

Examples of Approved Sentences:

$GPGLL,3444.000,N,13521.0000,E <CR><LF>
$XXGLL,3444.000,N,13521.0000,E<CR><LF>
“XX” may be any valid talker ID, such as “LC”(Loran C).

1.3.2 PROPRIETARY SENTENCES

The NMEA-0183 standard allows nav-aid manufacturers to send proprietary sentences if the minimum rules defined by the NMEA are obeyed. Proprietary sentences must take the following form, but it is free to manufacturers what kind of fields are included and in what order they are transmitted out.

$P<manufacturer ID>,<data field>....<CR><LF>

Where:

Field	Description
$	Start-of-Sentence marker
P	Proprietary sentence identifier
<maker ID>	3-byte fixed length. GT-8031's maker ID is "FEC" meaning Furuno Electric Company.
,<data field>....	Variable or fixed-length fields preceded by delimiter ","(comma). (Layout is maker-definable.)
<CR><LF>	End-of-Sentence marker

1.4 LIST OF NMEA-0183 SENTENCES

The following NMEA-0183 sentences are supported by GT-8031.

	INPUT SENTENCE		OUTPUT SENTENCE		
HIGH	XXGGA	Set initial position	GPGGA	Position, time etc.	OO
	XXZDA	Set time, etc.	GPZDA	Time etc.	OO
▲	XXGLL	Set initial position	GPGLL	Position, time, etc.	O
			GPGSA	Status, DOP	O
			GPGSV	Satellite details	OO
			GPVTG	Speed, Course.	OO
	XXRMC	Set initial position, time	GPRMC	Position, time, speed, course	O
PRIORITY			GPanc	Date of existing almanac	O
			GPacc	SV accuracy	O
			GPast	GPS fix (position, local time)	O
			GPtst	Selftest result	O
	GPsrq	Send GPS receiver parameters	GPssd	Answer to GPsrq	A
	GPirq	Send data output interval	GPisd	Answer to GPirq	A
			GPdie	DGPS status	O
	GPclr	Restart			
	GPtrq	Self test			
	GPset	Set receiver parameters			
	GPint	Set sentence output interval			
			GPtlp	UTC forecast	O
			GPtps	Time & 1PPS output flag	OO
			GPgpt	GPS time output	O
	GPrrs	Set TRAIM/1PPS	GPrrm	TRAIM status	
	GPrrq	Send TRAIM/1PPS setting	GPrsd	Answer to GPrrq	A
▼	GPtmq	Get info on autonomous shift from survey to fixed point mode	GPtmd	Answer to GPtmq	
			GPwav	SBAS satellite information	O
	GPstq	Send SBAS/GPS position fixing status	GPstd	Answer ro GPstq	A,O
	GPwas	Set SBAS position fixing parameters			
	GPwaq	Send SBAS position fixing status	GPwas	Answer to GPwaq	A
	GPmge	Set prohibited GEO satellite			
	GPmgq	Send prohibited GEO satellite settings	GPmge	Answer ro GPmgq	A
	GPpsp	Set tracking GEO satellite			
	GPpsq	Send tracking GEO satellite	GPpsp	Answer ro GPpsq	A
	GPprq	Send position fixing method	GPpri	Answer ro GPprq	A
Low	GPgaq	Send GEO almanac	GPgac	Answer to GPgap	A

Note1: Higher priority data is output first, from top to bottom. (Highest priority:GGA for example).
O Sentence output interval is adjustable but if the back up is lost, the sentence will not be output.
OO Sentence output interval is adjustable and if the back up is lost, it goes back to the default value, which is one second interval.
A Sentence is output as an answer.
XX Any talker ID

Note 2: There are constraints in handling the data per second for both input and output. As to the output constraints, please refer to each input sentence of 2.1 Input data and as to the input constraints, please see the Note of 1.3.1. Approved Sentences.

1.5 LIST OF PARAMETERS & BACKED-UP DATA

	Data	Backed-up	Default	Range
GPS Data	Estimated position Lat. Long.	Yes	N34deg.44.0000 min. E135deg.21.0000 min.	S90deg. to N90deg. W180deg. to E180deg.
	Time	Yes	2002 Jan.1 0h.0m.00s	2002 Jan. 1 through 2079 Dec. 31
	Altitude	Yes	0 m	-999.9m to 40000.0m
	Almanac data	Yes	---	---
	Almanac date	Yes	1980 Jan. 6 0h.0m.0s	---
	Ephemeris	Yes	---	---
SBAS Data	Almanac data	Yes	---	---
	Delete GEO satellites	Yes	00000 (No deletion)	00000 to 7FFFF
	Designate GEO satellite/Provider ID	Yes	Auto : from 120 in ascending order	000 (Automatic) 120 to 138 (GEO satellite number) P00 to P02 (Provider ID)
	RTCM/SBAS Validity	Yes	1 (RTCM valid)	0 to 4
	Type 0 message validity	Yes	0: Hold off for 60 seconds	00 to 27, FF
Parameters	Local Zone Time	Yes	+0h	-13h0m to +13h0m
	PDOP value	Yes	6	0 to 6
	Geodetic ID	Yes	1 (WGS84)	1 to 254
	Elevation Angle Mask	Yes	5 deg.	5 to 90 deg.
	Mask by Signal Strength	No	1dBHz (No mask)	1 to 99 dBHz
	1PPS Correction	Yes	0 μ sec	-999.9 μ sec to +999.9 μ sec
	Delete Satellites	No	00000000 (No deletion)	00000000 to FFFFFFFF
	Smoothing Index	No	2	1 to 3
	Dynamic Index	No	2	1 to 3
	Data Output Interval	Yes	GGA,ZDA,GSV,VTG,tps (Every second)	0-60 seconds (Only for those sentences that are adjustable. See 1.4 List of NMEA sentences.)
	DGPS Data validation time	Yes	30 seconds	fixed
	TRAIM Switch	No	1 (On)	0: Off, 1 :On
	1PPS Control mode	No	2 (Normal output)	0 : No output 1 : Always output 2 : Normal output 3 : Output only when no alarm
	Back to fixed position set	Yes	N/A	S90deg. to N90deg. W180deg. to E180deg. -999.9m to 40000.0m

2. INPUT SENTENCES

$XXGLL(in)

Set initial position

This sentence sets the initial latitude/longitude. The position data will be updated when position fixing begins.

Example

$XXGLL	,3444.123,N	,13521,E	,	,		CR LF
Field#	**1**	**2**	**3 4**	**5**	**6**	**7**

#.	**Description**	**Range**	**[Bytes]**
1-2.	Latitude		
	“34”:degree	00-90	[2]
	“44”: minute (integer)	00-59	[2]
	“123”: minute (fraction)	0-9999	[variable] See Note.
	“N”: North/South	N or S	[1]
3-4.	Longitude		
	“135”: degree	000-180	[3]
	“21”: Minute (integer)	00-59	[2]
	“”: Minute (fraction)	0-9999	[variable] See Note
	“E”: East/West	E or W	[1]
	Note: Digits below 1/10000 are ignored.		
5-7.	Null Fields	Any entry is ignored.	

Interpreting Example

34 deg 44.1230 min N
135 deg 21.0000 min E

$XXGGA (in)

Set initial position

This sentence sets the initial latitude/longitude. The position data will be updated when position fixing begins.

Example

$XXGGA	,	,3444,N	,13521,E	, , , , , , , ,	CR LF
Field#	**1**	**2 3**	**4 5**	**6-14**	

#.	**Description**	**Range**	**[Bytes]**
2-3.	Latitude		
	“34”:degree	00-90	[2]
	“44”: minute (integer)	00-59	[2]
	“123”: minute (fraction)	0-9999	[variable] See Note.
	“N”: North/South	N or S	[1]
4-5.	Longitude		
	“135”: degree	000-180	[3]
	“21”: Minute (integer)	00-59	[2]
	“”: Minute (fraction)	0-9999	[variable] See Note.
	“E”: East/West	E or W	[1]
	Note: Digits below 1/10000 are ignored.		
6-14.	Null Fields	Any entry is ignored.	

Interpreting Example

34 deg 44.0000 min N
135 deg 21.0000 min E

$XXZDA (in)

Set date/time

Example

$XXZDA	,123456	,01	,02	,2002	,-09	,00	CR LF
Field#	**1**	**2**	**3**	**4**	**5**	**6**	

#.	**Description**	**Range**	**[Bytes]**
1.	UTC: Time		
	"12": hh	00-23	[2]
	"34": mm	00-59	[2]
	"56": ss	00-59	[2]
2.	UTC: Date		
	"01": DD	01-31	[2]
3.	UTC: Month		
	"02": MM	01-12	[2]
4.	UTC: Year		
	"2002": YYYY	2002-2079	[4]
5.	Local Zone Time (Hour)		
	"-09": hh	-13 ... +00 ... +13 (-/+: East/west of date line)	[3]
6.	Local Zone Time (Minute)		
	"00": mm	00 to 59	[2]

Note: Local zone time setting is used for calculating local time when outputting GPS fix. ($PFEC,GPast): (Local Time)=(UTC)-(Local Zone Time)

Note : Date and time shall be set together for both UTC time and Local Zone time.

Interpreting Example

February 1, 2002
12:34:56
Local Zone Time: -09:00

$XXRMC (in)

Set initial position/UTC

Example

$XXRMC	,123456	,	,3444.123,N	,13521.456,E	,,	,020102	,,,
Field#	**1**	**2**	**3 4**	**5 6**	**7 8**	**9**	**10 11 12**

CR LF

#.	Description	Range	[Bytes]
1.	UTC: Time		
	"12": hh	00-23	[2]
	"34": mm	00-59	[2]
	"56": ss	00-59	[2]
2.	Null Field	Any entry is ignored.	
3-4.	Latitude		
	"34":degree	00-90	[2]
	"44": minute (integer)	00-59	[2]
	"123": minute (fraction)	0-9999	[variable] See Note.
	"N": North/South	N or S	[1]
5-6.	Longitude		
	"135": degree	000-180	[3]
	"21": Minute (integer)	00-59	[2]
	"456": Minute (fraction)	0-9999	[variable] See Note.
	"E": East/West	E or W	[1]
	Note: Digits below 1/10000 are ignored.		
7-8.	Null Fields	Any entry is ignored.	
9.	UTC: Date		
	"02": DD	01-31	[2]
	"01": MM	01-12	[2]
	"02": YY	02-79 (2002-2079)	[2]
10-12.	Null Fields	Any entry is ignored.	

Note : 1.UTC Time and 9.UTC date shall be set together. If any one of them is missing or out of range, no data entry is accepted.

Interpreting Example

January 2, 2002
12:34:56
34 deg. 44.1230 min. N
135 deg. 21.4560 min. E

$PFEC,GPclr (in)

Restart

Example

$PFEC	,GPclr	,1	CR LF
Field#	**1**	**2**	

This sentence clears the data in the GPS receiver and restarts the receiver. The restart works in the same way as the power is first on.

#.	**Description**	**Range**	**[Bytes]**
1.	Command name		[5]
2.	Mode	1-3 "1": Clear mode 1 "2": Clear mode 2 "3": Clear mode 3	[1]

Receiver Data	Clear mode			
	1	2	3	4
Latitude/Longitude	Returned to default	Backed-up value used	Backed-up value used	Backed-up value used
Date Time	Returned to default	Backed-up value used	Backed-up value used	Backed-up value used
Almanac Data	Deleted	Backed-up value used, if valid.	Deleted	Backed-up value used
Ephemeris Data	Deleted	Backed-up value used, if valid.	Deleted	Deleted
Receiver Parameters (Note 1)	All parameters returned to default	Backed-up value used.	Backed-up value used	Backed-up value used

Note 1: Receiver parameters are those set by "$PFEC,GPset" sentence. Refer to the "1.5. List of Parameters & Backed-up data" to see whether the value set by the sentence is backed up or not.

Interpreting Example

Clear mode 1

$PFEC,GPset (in)

Setup receiver parameters

Example

$PFEC	,GPset	,D05	,U00200000	.....	CR LF
Field#	**1**	**2**	**3**	**4.....9 (max)**	

#.	**Description**	**Range**	**[Bytes] (Unit) {Default}**
1.	Command name		[5]
2.	Parameter settings		
	……		
9.			

Up to eight parameters in any order preceded by delimiter ","(comma).
See parameter syntax below:

Note: Do not send same parameter twice within the same sentence.

"An": Almanac validity — 1 - 2 — [2] (n/a) {1}
1 :With expiration
2 : No expiration

"Dnn": PDOP Threshold — D00-D10 — [3] (n/a) {D06}
In 3D positioning mode, 2D positioning is forced when PDOP is higher than this threshold. If D00 is set, 3D positioning is not performed. In 2D positioning, the altitude is not updated and the same altitude is continuously output as set at the first 2D positioning. You can not set this value higher than Maximum DOP for Positioning described above. If necessary, you need to change the Maximum DOP for Positioning value first.

"Gnnn": Geodetic ID — G001-G254 — [4] (n/a) {G001}
For deails of Geiodetic ID, please refer to the list of Geodetic ID of this manual.

"Hnnnnnn.n": Altitude for 2D positioning — H-00999.9 to H040000.0 — [9] (meter) {H000000.0}
Note : This data is updated only when 3D positioning is performed,.

"Mnn": Mask by Elevation Angle — M05-M90 — [3] (degree) {M05}
Satellites below this angle are ignored when positioning.

"Snn": Mask by Signal Strength — S01-S99 — [3] (dBHz) {S01}
Satellites weaker than this level are ignored when positioning. The minimum level is practically limited by the lowest tracking signal level (approx. 38dBHz).

"Tnnnnn": 1PPS Correction — T-9999 to T+9999 — [6] (x0.1 us) {T+0000}
0.1us corresponds 30 meter antenna length. Note that negative setting advances 1PPS pulses.

"Uhhhhhhhh": Delete satellites. — U00000000 - UFFFFFFFF — [9] (n/a) {n/a}
hhhhhhhh means eight hexadecimal letters, representing a bit map of 32 bits. Each bit within the bit map represents one satellite; 0000001 and 8000000, for example, indicate satellite SV#1 and SV#32, respectively.

Example: "PFEC,GPset,U0000000F"<CR><LF> declares unhealthy satellites SV#1 to SV#4.
Satellites declared by this sentence are ignored when positioning. It should be noted that satellites with their bits cleared are declared as "healthy". In the above example, satellites SV#5 to SV#32 are implicitly declared as "healthy".

In the following example, the first sentence declares satellite SV#5 as "unhealthy", and it is restored later by the second sentence.

Example: **"PFEC,GPset,U00000010"<CR><LF>**
"PFEC,GPset,U00000000"<CR><LF>

"Wn": Smoothing Index W1-W3 [2] (n/a) {W2}

Index	Characteristics	Remarks
1	Quick responsive	Quicker response but relatively more zigzag tracking record.
2	Averaged	Averaged tuning (Initial setting)
3	Smoother tracking record	Less responsive (large inertia) but smoother tracking record

"Xn": Dynamic Index X1-X3 [2] (n/a) {X2)

Index	Characteristics	Remarks
1	More accurate positioning	Higher accuracy but less frequent positioning
2	Averaged	Averaged tuning (initial setting)
3	More frequent positioning	More frequent positioning but less accuracy.

"Zn[nn]": Observation Point Mode 1-4 [2-4] (n/a) (Z1)
1 : Estimated Position Observation Point Mode
2 : Fixed Position Observation Point Mode
3 [HH]: Automatic shift to Fixed Position Mode
4 : Back to fixed position set.

At "3", you can set the averaging time by the following two bytes. The range [HH] is 01<=HH<=48. If [HH] is skipped, default of 8 hours are set.

Example : $PFEC,Gpset,Z2<CR><LF> sets Fixed Position Observation Point Mode.
$PFEC,Gpset,Z324<CR><LF> Automatic shift to Fixed Position Obsevation Mode after averaging data for 24 hours.

tnnnnnnn": 1PPS Correction t-999999 to t+999999 [8](xns){T+000000}
You can adjust 1 PPS timing depending on the antenna cable length.

Example : $PFEC,Gpset,t-000300<CR><LF> advances 1PPS output timing by 300 nanoseconds.

$PFEC,GPsrq (in)

Get receiver parameters

Issue this sentence when you need receiver parameters set by $PFEC,GPset. The answer will be output as $PFEC,GPssd sentence.

$PFEC,	**,GPsrq**	**CR LF**
	1	2

#.	**Description**	**Range**	**[Bytes]**
1.	Command name		[5]

$PFEC,GPint (in)

Request output/Set log output intervals

Example

$PFEC	,GPint	,GGA01	,GLL00	.....	CR LF
Field#	1	2	3	4.....	

#.	Description	Range	[Bytes](Unit){Default}
1.	Command name		[5]
2-n.	Sentence name & interval (00-60)		[5]
n+1.	Checksum		

Up to 11 (eleven) parameters in any order preceded by delimiter ","(comma). See parameter syntax below:

"Param": Log Output Sentence <Log Output Sentence Length in bytes>

"GGAnn":	$GPGGA<82 max>	GGA00-GGA60	[5](sec){GGA01}
"ZDAnn":	$GPZDA<36>	ZDA00-ZDA60	[5](sec){ZDA01}
"GLLnn":	$GPGLL<47>	GLL00-GLL60	[5](sec){GLL00}
"GSAnn":	$GPGSA<69 max>	GSA00-GSA60	[5](sec){GSA00}
"GSVnn":	$GPGSV<70 max>	GSV00-GSV60	[5](sec){GSV01}
"VTGnn":	$GPVTG<46 max>	VTG00-VTG60	[5](sec){VTG01}
"RMCnn":	$GPRMC<77 max>	RMC00-RMC60	[5](sec){RMC00}
"ancnn":	$PFEC,GPanc<62>	anc00-anc60	[5](sec){anc00}
"accnn":	$PFEC,GPacc<49>	acc00-acc60	[5](sec){acc00}
"astnn":	$PFEC,GPast<85>	ast00-ast60	[5](sec){ast00}
"tstnn":	$PFEC,GPtst<33>	tst00-tst60	[5](sec){tst00}
"dienn":	$PFEC,GPdie<27>	die00-die60	[5](sec){die00}
"wavnn":	$PFEC,GPwav<72 max>	wav00-wav60	[5](sec){wav00}
"stdnn":	$PFEC,GPstd<18>	std00-std60	[5](sec){std00}
"tlp"	$PFEC,GPtlp<41>	tlp00-tlp60	[5](sec){tlp00}
"tps"	$PFEC,GPtps<76>	tps00-tps60	[5](sec){tps00}
"gpt"	$PFEC,GPgpt<30>	gpt0-gpt60	[5](sec){gpt00}
"rrm"	$PFEC,GPrrm<26>	rrm00-60	[5](sec){rrm00}

Note: If zero interval (nn=00) is specified, that sentence is output once when $PFEC,GPint is executed, then output is disabled.

GT-8031 can output 960 bytes or so per second. Do not set the log sentence output intervals too short, or this capacity will be exceeded. When estimating the output volume, refer to byte count of each sentence enclosed within [ ] in the above list.

Example

$PFEC,GPint,tst00<CR><LF> ..... Output self-test result just once.
$PFEC,GPint,RMC05<CR><LF> ....Output $GPRMC sentence every five seconds.

$PFEC,GPirq (in)

Get log sentence output intervals

Issue this sentence when you need the log sentence output intervals set by $PFEC,GPint. The answer will be output as $PFEC,GPisd sentence.

$PFEC,	,GPirq	CR LF
Field #	1	2

#.	Description	Range	[Bytes]
1.	Command name		[5]

$PFEC,GPtrq (in)

Conduct self-test

Issue this sentence when you need to conduct the receiver's self-test. As soon as the test is finished, the receiver re-start automatically. $PFEC,GPtst….<CR><LF> is continuously output until the receiver receive the sentence for finishing the self-test.

$PFEC,	,GPtrq	,1	CR LF
Field #	1	2	

#.	Description	Range	[Bytes]
1.	Command name		[5]
2.	Model	0-1 "0": Start self-test "1": Finish self-test	[1]

$PFEC,GPrrs (in)

Set TRAIM/1PPS output

Example

$PFEC,GPrrs	,1	,100	,1	CR LF
Field#	2	3	4	

#.	Description	Range	[Bytes]	(UNIT)	{Default}
2	TRAIM switch	0-1 0 : TRAIM OFF 1 : TRAIM ON	[1]	(N/A)	{0}
3	Reserved	100	[3]	(10nanosec)	{100}
4.	1PPS Control Mode	0-3	[1]		{2}

Note: TRAIM functions when Fixed Observation Point Mode is selected.
For TRAIM, refer to **4.3 TRAIM Specification.**

This value is intended to limit value to detect abnormal satellite. It is not fixed at 100.

Value	Mode	Contents
0	No output	1PPS output is completely stopped.
1	Always output	1PPS is always output.
2	Ordinary output	1PPS is output in an ordinary way.
3	Higher reliability	1PPS is output only when number of satellites tracked are sufficient to judge the alarm but still no alarm goes off.

Note : For 1PPS output conditions, please refer to **4.3 TRAIM Specification.**

Interpreting Example
TRAIM ON,
1PPS is always output.

$PFEC,GPrrq (in)

Send TRAIM/1PPS parameters

Example

$PFEC,GPrrq	CR LF
Field# 1	

Data set by **GPrrs** is output.
Note: $PFEC,GPrsd is used to get an answer to $PFEC,GPrrq.

$PFEC,GPtmq (in)

Get info on Auto-transition to fixed observation point mode

Issue this sentence when you need to know the status of autonomous transition from survey mode to fixed observation point (position-hold)mode as well as the position set for fixed observation point. The answer will be output as $PFEC,GPtmd sentence.

$PFEC,	**,GPtmq**	**CR LF**
Field #	1	

#.	Description	Range	[Bytes]
1.	Command name		[5]

$PFEC,GPstq (in)

Send SBAS/GPS position fixing status

Issue this sentence when you need to check the position fixing method either, GPS alone, DGPS with RTCM SC-104 or DGPS with SBAS. The answer will be output as $PFEC,GPstd sentence.

$PFEC	,GPstq	CR LF
Field #	1	

#.	Description	Range	[Bytes]
1.	Command name		[5]

$PFEC,GPwas (in)

Set SBAS position fixing parameters

Issue this sentence to set SBAS position fixing parameters.

$PFEC	,GPwas	,D3	,T02	CR LF	#.
	1	2	3		

Descri ption		Range	[Bytes]
1.	Command name		[5]
2.	SBAS / DGPS setting	0-4 0: GPS only 1: DGPS with RTCM SC-104 2: DGPS/SBAS, RTCM SC-104 preferrable 3: DGPS/SBAS, SBAS preferable 4. RTCM/SBAS, SBAS preferable	[2]
3.	Enable/ignore type 0 message	00-27, FF 00: Ignore type 0 message for 60 seconds 01-27: Enable type 0 message as data FF: Ignore type 0 message	[3]

$PFEC,GPwaq (in)

Send SBAS position fixing status

Issue this sentence when you need SBAS position fixing status set by $PFEC,GPwas. The answer will be output as $PFEC,GPwas sentence.

$PFEC	,GPwaq	CR LF
	1	

#.	Description	Range	[Bytes]
1.	Command name		[5]

$PFEC,GPmge (in)

Set prohibited GEO satellites

Issue this sentenceto set prohibited GEO satellites.

$PFEC	,GPmge	,00201	CR LF
	1	2	

#.	Description	Range	[Bytes]
1.	Command name		[5]
2.	Satellite number	00000-7FFF	[5]

The satellite number will be transformed in 32 bit binary code. Then the code will be expressed in hexadecimal with 8 characters of ASCII code. One bit is assigned to one satellite.

Example

$PFEC,GPmge,7BFFF,*5B<CR><LF> ..... Prohibit all but 134 satellite.

$PFEC,GPmgq (in)

Send prohibited GEO satellites

Issue this sentence when you need prohibited GEO satellite set by $PFEC,GPmge. The answer will be output as $PFEC,GPmge sentence.

$PFEC	,GPmgq	CR LF
	1	

#.	Description	Range	[Bytes]
1.	Command name		[5]

$PFEC,GPpsp (in)

Set tracking GEO satellite

Issue this sentence to set tracking GEO satellite number.

$PFEC	,GPpsp	,P00	CR LF
	1	2	

#.	Description	Range	[Bytes]
1.	Command name		[5]
2.	Specify tracking GEO satellite number	120 - 138 Default: 000	[3]

Note: When the GEO satellite number is set to default “000”, it will search for available satellites starting from satellite number 120.

$PFEC,GPpsq (in)

Send tracking GEO satellite

Issue this sentence when you need tracking GEO satellite set by $PFEC,GPpsp. The answer will be output as $PFEC,GPpsp sentence.

$PFEC	,GPpsq	CR LF
	1	

#.	Description	Range	[Bytes]
1.	Command name		[5]

$PFEC,GPprq (in)

Send position fixing method

Issue this sentence when you need position fixing method set by $PFEC,GPwas. The answer will be output as $PFEC,GPpri sentence.

$PFEC	,GPprq	CR LF
	1	

#.	Description	Range	[Bytes]
1.	Command name		[5]

$PFEC,GPgaq (in)

Send GEO almanac

Issue this sentence when you need GEO almanac. The answer will be output as $PFEC,GPgac sentence.

$PFEC	,GPgaq	CR LF
	1	

#.	Description	Range	[Bytes]
1.	Command name		[5]

3. OUTPUT SENTENCES

$GPGGA (out)

Position, altitude, UTC, etc.

Example

$GPGGA	,123456	,3444.0000,N	,13521.0000,E	,1
Field#	**1**	**2 3**	**4 5**	**6**

,04	,02.00	,000123.0	,M	,0036.0	,M	,13	,0001	CR LF
7	8	9	10	11	12	13	14	

#.	Description	Range	[Bytes]
1.	UTC		
	"12": hh	00-23	[2]
	"34": mm	00-59	[2]
	"56": ss	00-59	[2]
2-3.	Latitude		
	"34": degree	0-90	[2]
	"44": minute (integer)	0-59	[2]
	"0000": minute (fraction)	0000-9999	[4]
	"N": North/South	N or S	[1]
4-5.	Longitude		
	"135": degree	000-180	[3]
	"21": Minute (integer)	00-59	[2]
	"0000": Minute (fraction)	0000-9999	[4]
	"E": East/West	E or W	[1]
6.	GPS Quality Indication	0-2	[1]
		"0": Fix not available or invalid.	
		"1": GPS. SPS fix valid	
		"2": GPS. SPS fix valid	
7.	No. of satellites used for positioning	00-12	[2]
8.	DOP (2D: HDOP 3D: PDOP)	n/a	[5]
	Note: "00.00" is output while positioning is interrupted.		
9.	Altitude	-00999.9 to 04000.0	[8]
10.	Unit for Altitude	M	[1]
11.	Geoide Altitude	-999.9 to 9999.9	[6]
12.	Unit for Geoide Altitude	M	[1]
13.	DGPS Data Time	00-99	[2]
	This value indicates the time elapsed since the last RTCM-SC104 TYPE 1 or 9 data is updated. Unless DGPS mode is selected, a null field is output.		
14.	DGPS Station ID	0000-1023	[4]
	Unless DGPS mode is selected, a null field is output.		

Interpreting Example

UTC 12:34:56
34 deg 44.0000 min N
135 deg 21.0000 min E
Status: Stand-alone GPS
No. of satellites: 4 satellites
DOP: 2.00
Altitude: 123.0 meters high
Geoide Altitude: 36.0 meters high
DGPS Data Time: 13
DGPS Station ID: 1

Example

$GPZDA	,123456	,01	,01	,2002	,+09	,00	CR LF
Field#	**1**	**2**	**3**	**4**	**5**	**6**	

#.	**Description**	**Range**	**[Bytes]**
1.	UTC: Time		
	"12": hh	00-23	[2]
	"34": mm	00-59	[2]
	"56": ss	00-59	[2]
2.	UTC: Day of Month		
	"01": DD	01-31	[2]
3.	UTC: Month		
	"02": MM	01-12	[2]
4.	UTC: Year		
	"1997": YYYY	1997-2040	[4]
5.	Local Zone Time (Hour)		
	"+09": hh	-13 ... +00 ... +13 (-/+: East/west of date line)	[3]
6.	Local Zone Time (Minute)		
	"00": mm	00 to 59	[2]

Note: Local zone time setting is used for calculating local time when outputting $PFEC,GPast: (Local Time)=(UTC) - (Local Zone Time)

Interpreting Example

January 1, 2002
12:34:56
Local Zone Time: +09:00

$GPGLL (out)

Position, UTC, etc.

Example

$GPGLL	,3444.0000,N	,13521.0000,E	,123456	,A	,A	CR LF
Field#	**1**	**2 3**	**4 5**	**6**	**7**	

#.	**Description**	**Range**	**[Bytes]**
1-2.	Latitude		
	“34”:degree	00-90	[2]
	“44”: minute (integer)	00-59	[2]
	“1234”: minute (fraction)	0000-9999	[4]
	“N”: North/South	N or S	[1]
3-4.	Longitude		
	“035”: degree	000-180	[3]
	“21”: Minute (integer)	00-59	[2]
	“0000”: Minute (fraction)	0000-9999	[4]
	“E”: East/West	E or W	[1]
5.	UTC		
	“12”: hh	00-23	[2]
	“34”: mm	00-59	[2]
	“56”: ss	00-59	[2]
6.	Status	A or V “A”: Data Valid (Stand-alone or DGPS) “V”: Navigation receiver warning	[1]
7.	Position System Mode Indication	A: Autonomous mode D: Differential mode N: Data not valid	[1]

Interpreting Example

34 deg 00.0000 min N
135 deg 21.0000 min E
UTC: 12:34:56
Status: Positioning

Example

$GPGSA	,A	,3	,01	,02	,03	.....	,02.00	,03.00	,04.00	CR LF
Field#	**1**	**2**	**3**	**4**	**5**	**6.....**	**15**	**16**	**17**	

#.	**Description**	**Range**	**[Bytes]**
1.	Operational Mode	M or A “M”: 2D-only Mode “A”: 2D/3D Auto-switching Mode	[1]
2.	Mode	1-3 “1”: Fix not available “2”: 2D-positioning “3”: 3D-positioning	[1]
3-14.	Satellite Numbers used for positioning Note : A null field is output unless a satellite is available.	01-32	[2] or [0]
15.	PDOP Note: “00.00” is output unless 3D-positioning is performed.	n/a	[5]
16.	HDOP Note: “00.00” is output while positioning is interrupted.	n/a	[5]
17.	VDOP Note: “00.00” is output unless 3D-positioning is performed.	n/a	[5]

Interpreting Example

2D/3D Auto-switching Mode
3D-Positioning
Satellites used: 01,02,03....
PDOP: 2.00
HDOP: 3.00
VDOP: 4.00

$GPGSV (out)

Satellite details

Example

$GPGSV	,2	,1	,06	,01	,05	,234	,56
Field#	**1**	**2**	**3**	**4**	**5**	**6**	**7**

,04	,11	,223	,44
8	**9**	**10**	**11**

,01	,75	,088	,32
12	**13**	**14**	**15**

,01	,42	,234	,48	CR LF
16	**17**	**18**	**19**	

#.	**Description**	**Range**	**[Bytes](unit)**
1.	Total No. of Messages	1-3	[1](n/a)
2.	No. of Message	1-3	[1](n/a)
3.	No. of satellites in line-of-site (with elevation angle higher than 5 degrees only)	00-12	[2](n/a)
4.	1st Sat. SV#	01-32	[2]
5.	1st Sat. Elevation Angle	05-90	[2](degree)
6.	1st Sat. Bearing Angle	000-359	[3](degree)
7.	1st Sat. SNR(Signal/Noise Ratio)(C/No)	00-99	[2](dBHz)
8-11.	2nd Sat. Details		[9]
12-15.	3rd Sat. Details		[9]
16-19.	4th Sat. Details		[9]

In this sentence, a maximum of four satellite details is indicated per each output. Five or more satellite details are output in the 2nd or 3rd messages. When there is only one to three satellite details, the checksum <CR> <LF> is issued immediately after Sat. SV#, Sat. Elevation Angle, Sat. Bearing Angle and SNR.

$GPVTG (out)

Course and speed

Example

$GPVTG	,012.3,T	,001.1,M	,001.2,N	,0002.2,K	,A	CR LF
Field#	**1 2**	**3 4**	**5 6**	**7 8**	**9**	

#.	**Description**	**Range**	**[Bytes] (unit)**
1-2.	True Course		
	“012.3”	000.0-359.9	[5](degree)
	“T”(meaning TRUE)	T	[1](n/a)
	Note: A null field is output unless true course information is available.		
3-4.	Magnetic Course		
	“001.1”	000.0-359.9	[5](degree)
	“M”(meaning MAGNETIC)	M	[1](n/a)
	Note: A null field is output unless magnetic course information is available.		
5-6.	Speed (kts)		
	“001.2”	000.0-999.9	[5](kts)
	“N”(meaning kNot)	N	[1](n/a)
	Note: A null field is output unless speed information is available.		
7-8.	Speed (km/h)		
	“0002.2”	0000.0-9999.9	[6](km/h)
	“K”(meaning Km/h)	K	[1](n/a)
	Note: A null field is output unless speed information is available.		
9.	Position System Mode Indicator	A: Autonomous mode D: Differencial mode N: Data not valid	[1]

$GPRMC(out)

UTC, position, course, speed, etc.

Example

$GPRMC	,123456	,A	,3444.0000,N	,13521.0000,E		
Field#	**1**	**2**	**3**	**4**	**5**	**6**

,005.6	,123.5	,020102	,001.0,W	,A
7	**8**	**9**	**10**	**11**	**12**

∗08	CR LF
13	

#.	Description	Range	[Bytes]
1.	UTC: Time		
	"12": hh	00-23	[2]
	"34": mm	00-59	[2]
	"56": ss	00-59	[2]
	Until the positioning is completed, a null field is output. If interrupted after positioning is done, the receiver continuously outputs the time when the last positioning is done.		
2.	Status	A or V	[1]
		"A": Data valid (Stand-alone or DGPS)	
		"V": Navigation receiver warning	
3-4.	Latitude		
	"34":degree	00-90	[2]
	"44": minute (integer)	00-59	[2]
	"0000": minute (fraction)	0000-9999	[4]
	"N": North/South	N or S	[1]
5-6.	Longitude		
	"135": degree	000-180	[3]
	"21": Minute (integer)	00-59	[2]
	"0000": Minute (fraction)	0000-9999	[4]
	"E": East/West	E or W	[1]
7.	Speed (kts)		
	"005.6"	000.0-999.9	[5]
	Note: A null field is output unless speed information is available.		
8.	True Course (degree)		
	"123.5"	000.0-359.9	[5]
	Note: A null field is output unless true course information is available.		
9.	UTC: Date		
	"02": DD	01-31	[2]
	"01": MM	01-12	[2]
	"02": YY	02-79	[2]
	Until the positioning is completed, a null field is output. If interrupted after positioning is done, the receiver continuously outputs the time when the last positioning is done.		
10-11.	Magnetic Deviation (degree)		
	"001.0"	000.0-180.0	[5]
	"W"	W or E	[1]
		"W": West (MAG=TRUE-DEV)	
		"E": East (MAG=TRUE+DEV)	
12.	Positioning System Mode Indication	A: Autonomous mode	[1]
		D: Differential mode	
		N: Data not valid	
13.	Checksum		[2]
	8 bits data between "$" and " ∗ "(excluding "$" and " ∗ ") are XORed, and the result is converted to 2 bytes of hexadecimal letters. Only RMC sentences are transmitted with checksum. All other output sentences do not include checksum fields.		

Interpreting Example

UTC Time 12:34:56
Positioning
34 deg. 44.0000 min. N
135 deg. 21.0000 min. E
Speed: 5.6 kts
True Course: 123.5 degrees
UTC Date Jan 2, 2002
Magnetic Deviation: 1.0 degree, West

$PFEC,GPanc (out)

Almanac date and satellite's health condition

Example

		Column 1		32
$PFEC	**,GPanc**	**,020102030405**	**,22222200222222222222000000222221**	**CR LF**
Field#	**1**	**2**	**3**	

#.	**Description**	**Range**	**[Bytes]**
1.	Command name		[5]
2.	Almanac Date/Time (Local Date/Time) "020102030405":	YYMMDDhhmmss	[12]
3.	Heath conditions for 32 satellites Each column represents each satellite.	0-2 "0": Almanac not collected yet, or that satellite is not launched yet. "1": Unhealthy (Not used for positioning). "2": Healthy (Usable for positioning)	[32]

Interpreting Example

Almanac is obtained on Jan. 2, 1997 at 03h:04m:05s

SV#1 healthy
SV#2 healthy
SV#3 healthy
SV#4 healthy
SV#5 healthy
SV#6 healthy
SV#7 unhealthy
SV#8 unhealthy
SV#9 healthy
.....

$PFEC,GPacc (out)

SV(satellite) Accuracy

Example

	Column 1		32
$PFEC	**,GPacc**	**,222222XXXXXXXXX77777XXXXXXXXXXBF**	**CR LF**
Field#	**1**	**2**	

#.	**Description**	**Range**	**[Bytes]**
1.	Command name		[5]
2	SV accuracies for 32 satellites	0-F: SV Accuracy in hexadecimal notation X: SV Accuracy not available	[32]
	Each column represents each satellite.		

Interpreting Example

SV#1 2
SV#2 2
SV#3 2
SV#4 2
SV#5 2
SV#6 2
SV#7 data not available
SV#8 data not available
SV#9 data not available
.....

$PFEC,GPast (out)

Position, altitude, speed, course, local time, etc.

Example

$PFEC	,GPast	,4	,6	,1	,0356
Field#	1	2	3	4	5

,N34431234	,E135211234	,0012347
6	7	8

,020123123456	,01235	,1234	,1345	CR LF
9	10	11	12	

#.	Description	Range	[Bytes]
1.	Command name		[5]
2.	Status		
	"4"	0, 3-6	[1]
		"0": Positioning not performed yet	
		"3": Stand-alone GPS, 2D	
		"4": Stand-alone GPS, 3D	
		"5": DGPS 2D	
		"6": DGPS 3D	
3.	No. of satellites used for positioning (0-9, A-C)		
	"6"	0-9	[1]
		A: 10	
		B: 11	
		C: 12	
4.	Seed/course calculation status		
	"1"	0-1	[1]
		"0": Data invalid (Can't calculate)	
		"1": Data valid	
5.	DOP x100 (2D: HDOP 3D: PDOP)		
	"0356"	0000-9999	[4]
	Note: For actual DOP, divide the above value by 100.		
	"0000" is output while positioning is interrupted.		
6.	Latitude		
	"N": North/South	N or S	[1]
	"34": degree	00-90	[2]
	"43": minute (integer)	00-59	[2]
	"1234": minute (fraction)	0000-9999	[4]
7.	Longitude		
	"E": East/West	E or W	[1]
	"135": degree	000-179	[3]
	"21": Minute (integer)	00-59	[2]
	"1234": Minute (fraction)	0000-9999	[4]
8.	Altitude (x10m)		
	"0012347"	-009999 to 0179999	[7]
	Note: For actual altitude, divide the above value by 10.		
9.	Local Date/Time		
	"020123123456": YYMMDDhhmmss	n/a	[12]
	Note: (Local date/time)=(UTC)-(Local Zone Time)		
	Unless local zone time information is available, UTC is output.		

10. Speed (x10 km/h)
"01235" 00000-18519 [5]
Note: For actual speed, divide the above value by 10.
If speed/course calculation status (field#4) is "0"(invalid), previous output value is held.
11. True Course (x10 degrees)
"1234" 0000-3599 [4]
Note: For actual course, divide the above value by 10.
If speed/course calculation status (field#4) is "0"(invalid), output value is held.
12. Magnetic Course (x10 degrees)
"1345" 0000-3599 [4]
Note: For actual course, divide the above value by 10.
If speed/course calculation status (field#4) is "0"(invalid), output value is held.

$PFEC,GPtst (out)

Self-test results

Example

$PFEC	,GPtst	,0	,4850266000	,1	,8	CR LF
Field#	**1**	**2**	**3**	**4**	**5**	

#.	**Description**	**Range**	**[Bytes](unit)**
1.	Command name		[5]
2.	Status	0-1 "0": Completed "1": Testing now	[1]
3.	Program and Version Numbers		
	"48502660": Program No.	n/a	[7]
	"01": Version No.	n/a	[3]
4.	Self-test Results -1	0-1 "0": Normal "1": GPS data backup error (Including RTC back-up error)	[1]
5.	Self-test Results -2	0 - F "0": Normal "1- F": GPS data backup error	[1]

Code	Rx Param Backup	Antenna connection	RAM	ROM
"1"				error
"2"			error	
"3"			error	error
"4"		error		
"5"		error		error
"6"		error	error	
"7"		error	error	error
"8"	error			
"9"	error			error
"A"	error		error	
"B"	error		error	error
"C"	error	error		
"D"	error	error		error
"E"	error	error	error	
"F"	error	error	error	error

$PFEC,GPssd (Answer to $PFEC,GPsrq)

Receiver parameters set by $PFEC,GPset

Example

$PFEC	,GPssd	,D06	.....	CR LF
Field#	**1**	**2**	**3.....**	

$PFEC	,GPssd	,D08	.....	CR LF
Field#	**1**	**2**	**3.....**	**n+1**

#.	Description	Range	[Bytes]
1.	Command name		[5]
2-n.	Receiver parameters set by $PFEC,GPset are output in two sentences. Each parameter is preceded by delimiter “,” (comma).		

$PFEC,GPisd (Answer to $PFEC,GPirq)

Log output intervals set by $PFEC,GPint

Example

$PFEC	,GPisd	,GGA01	.....	CR LF
Field#	**1**	**2**	**3.....**	**n+1**

$PFEC	,GPisd	,tst00	.....	CR LF
Field#	**1**	**2**	**3.....**	**n+1**

#.	**Description**	**Range**	**[Bytes]**
1.	Command name		[5]
2-n.	Log output intervals set by $PFEC,GPint are output in two sentences. Each parameter is preceded by delimiter “,” (comma).		

Example

$PFEC	,GPdie	,1	,08	,0	,0	,0	CR LF
Field#	**1**	**2**	**3**	**4**	**5**	**6**	

#.	Description	Range	[Bytes]
1.	Command name		[5]
2.	DGPS status	0-1 "0": DGPS data not received yet "1": Receiving DGPS data	[1]
	Note: This flag will be set a few seconds after DGPS data entry. When the differential inpout data entry is done after the DGPS validity time (default value is 30 seconds), "0" will be output.		
3.	No. of DGPS Satellites	n/a	[2]
4.	DGPS Base station's Health Condition	0-1 "0": healthy "1": unhealthy	[1]
	Note: If DGPS station is unhealthy, stand-alone GPS function rather than DGPS is performed.		
5.	DGPS Data Status	0-1 "0": Normal "1": Abnormal	[1]
	Note: If DGPS data is invalid, stand-alone GPS function rather than DGPS is performed.		
6.	DGPS Error Code	0-F	[1]

Error code	Meaning
0	No eeror
1	In Type 1, Type 3 or Type 9 messages, the base station's health field indicates "unhealthy".
2	In Type 1 message, UDRE field indicates "3" meaning not usable due to big error.
3	3 or less satellites are available for differential data input
4 to F	Reserved

Common Errors

If DGPS status (field# 2) can not set to "1"(Receiving DGPS data), or if DGPS fix is not obtainable, suspect:

* Invalid format of incoming DGPS data
* Insufficient number of satellites in DGPS data
* DGPS station is faulty
* DGPS data is too old to correct positioning

$PFEC,GPtlp (out)

Leap second adjustment prediction

Example

$PFEC,GPtlp	,3	,970630123450	,970701000000	CR LF
Field# 1	2	3	4	

#.	Description	Range	[Bytes](Unit){Default}
2.	Currently-used Time Standard	1-3 "1": RTC "2": GPS Time "3": UTC	[1]

Note: For output of UTC, the following conditions must be met:

* Latest almanac is available within GT-8031.
* At least on satellite is acquired by GT-8031.

3. Date/time when the prediction was calculated [12](YYMMDDhhmmss)

   In case of the above example the prediction was calculated at 94/01/01 00:00:00(YY/MM/DD hh:mm:ss).

4. Date/time of leap second adjustment execution [12](YYMMDDhhmmss)

   In case of the above example leap second adjustment is scheduled at 95/01/01 00:00:00(YY/MM/DD hh:mm:ss).

How to enable "$PFEC,GPtlp" output

Example: The following command makes the GT-8031 output "$PFEC,GPtlp" sentence once.

$PFEC,GPint,tlp00<CR><LF>

Example

$PFEC,GPtps	,970630123000	,3	,1	,1

Field# 1 2 3 4 5

,970701000000	,+1	,10	,970626120000

6 7 8 9

,0911	,390610	CR LF

10 11

#.	Description	Range	[Bytes](Unit)
2.	Present Date/Time "970630123000": YYMMDDhhmmss	See Note.	[12]

NOTE: Range for year is 1997 to 2079.
"97" to "99" for 1997 to 1999.
"00" to "40" for 2000 to 2040.

RTC, GPS time or UTC is output as a present date/time. See the succeeding field.

3. Time Standard ID — 1-3 [1]

"1": RTC
"2": GPS Time
"3": UTC

Note: The date/time based on the RTC is output after the GT-8031 is turned on until it starts tracking a satellite.

GPS Time is output after the GT-8031 starts tracking a satellite until it collects a UTC parameter (including UTC offset) in the cold start condition.

UTC is output after the GT-8031 collects a UTC parameter while tracking a satellite. 1PPS is also output under this condition.

4. 1PPS Availability Status Flag — 0-1 [1]

"1": "1PPS will be output following this sentence".
"0": 1PPS is not output.

5. Mode — 1-2 [1]

"1": Estimated Observation Point Mode
"2": Fixed Observation Point Mode

6. UTC Leap Second Adjustment Date/Time — [12](YYMMDDhhmmss)

This field predicts when a leap second adjustment will take place. The example indicates that a leap second adjustment will be executed directly before 97/07/01 00:00:00 (YY/MM/DD hh:mm:ss).

Unless a UTC parameter has been collected, this field will be filled with zeroes. See the following example.

$PFEC,GPtps,940630123000,2,0,1,000000000000,00,00,000000000000,0755,390600<CR><LF>

7. Leap Second — "-1", "00" or "+1" [2] (second)

This field indicates the magnitude of a pending or previous leap second adjustment to UTC. UTC is occasionally adjusted in one-second increments to limit its cumulative deviation from the Earth's rotational time (UT1).

"+1" is reported if a leap second was/will be added to UTC. Inserting a second retards UTC:

June 30	23:59:58	
	23:59:59	
	23:59:60	← 60th second is inserted
July 1	00:00:00	

"-1" is reported if a leap second was/will be subtracted from UTC. Deleting a second advances UTC:

June 30	23:59:58	
July 1	00:00:00	← 59th second is deleted

"00" is reported when the magnitude of a pending or previous adjustment is unknown.

The UTC Leap Second Adjustment Date/Time (field #6) establishes the context of the Leap Second value. When the date of an adjustment is in the future, the Leap Second value is the magnitude of a pending adjustment; when this date is in the past, the value applies to the previous adjustent.

Leap second information can be invalidated by sending the "$PFEC, GPclr, 1" or "$PFEC, GPclr, 3" sentence, or by removing back-up power to the receiver.

Limitation of Leap Second Indication

Leap second adjustments offset UTC from GPS Time, the continuous time scale maintained by GPS that is referenced to an epoch of 0000 UTC, January 6, 1980. Satellites continuously broadcast current and pending cumulative offsets between these time scales.

The GT-8031 calculates the magnitude of an adjustment by subtracting the current offset from the pending offset. The Leap Second field, however, is updated only when these values differ. For example, "+1" will be reported prior to and following the addition of a leap second. It will not revert to "00 ", and can only change to "-1" when a pending subtraction of a leap second is announced.

Accordingly, a GT-8031 that received the announcement of a prior adjustment reports "+1" or "-1". A GT-8031 placed in operation after this adjustment reports "00", since current and pending time scale offsets are identical.

Example: $PFEC,GPtps,950630123000,2,0,1,940701000000,00,10,950626120000,0755,390610<CR><LF>

8. UTC-GPS Time Offset 00-99 [2](second)

This field accumulates leap seconds since the GPS system started operation on January 6, 1980. As of June 1999 this value was 13. This fact means that leap second insertion had been executed 13 times during the period from January 6, 1980 to June, 1999 because only positive ("+1") adjustments were made in that period. Take note that this field will be "00" unless a UTC parameter has been collected.

9. Date/Time stamp of UTC Parameter [12](YYMMDDhhmmss)

   A UTC parameter (UTC correction value) is included in almanac, which the GT-8031 requires to achieve $\pm 1\,\mu$ sec accuracy. This field indicates when the UTC parameter was updated last time. This field will be “000000000000” unless a UTC parameter has been collected. See the following example:

   $PFEC,GPtps,940630123000,2,0,1,000000000000,00,00,000000000000,0755,390600<CR><LF>

10. Count of GPS Weeks 0000-3182 [4](week)

    This field counts up how many weeks have elapsed since the GPS system started operation at 1980/01/06 00:00:00 (YYYY/MM/DD hh:mm:ss).

11. Count of seconds within a GPS week 000000-604799 [6](second)

    This field counts up how many seconds have elapsed in the current GPS week. The count is reset to “000000” every week.

How to enable “$PFEC,GPtps” output

Example: The following command line makes the GT-8031 output “$PFEC,GPtps” sentence every second.

$PFEC,GPint,tps01<CR><LF>

$PFEC,GPgpt (out)

GPS time output

Example

$PFEC,GPgpt	,1	,0816	,100799	10	CR LF
Field# 1	2	3	4	5	

#.	Description	Range	[Bytes](Unit){Default}
2.	Validity Flag	0-1 [1] "1": GPS Time is valid. "0": GPS Time not determined yet.	
3.	Count of GPS Weeks	0000-3182	[4](week)

This field counts up how many weeks have elapsed since the GPS system started operation at 1980/01/06 00:00:00 (YYYY/MM/DD hh:mm:ss).

4. Count of seconds within a GPS week 000000-604799 [6](second)

This field counts up how many seconds have elapsed in the current GPS week. The count is reset to "000000" every week.

5. UTC offset 00-99 [2](second)

This field indicates the offset second between GPS time and UTC.As of June 1999, the offset second is 13. However, if the UTC parameter has not been collected yet, "00" will be indicated.

How to enable "$PFEC,GPgpt" output

Example: The following command line makes the GT-8031 output "$PFEC,GPgpt" sentence every second.

$PFEC,GPint,gpt01<CR><LF>

$PFEC,GPrrm (out)

TRAIM information output

Example

$PFEC,GPrrm	,0	,0	,17	,00	00
Field# 1	2	3	4	5	6

,01	,+000	,+10	CR LF
7	8	9	

#.	Description	Range	[Bytes]
2.	1PPS output result status	0-2	[1]

"0" : Output normally
"1" : Alarm on
"2" : Not sufficient satellites to judge

3.	TRAIM status	0-2	[1]

"0" : Possible both to detect alarm and to delete abnormal satellites
"1" : Possible only to detect alarm
"2" : Not possible either to detect alarm or delete abnormal satellites.

4.	Deleted Satellites Number	00-32	[2]

"00" : No deleted satellites
"01" to "32" : Deleted satellites number.

5	Reserved	[2]
6	Reserved	[2]
7	Reserved	[2]
8.	Reserved	[4]
9.	Output of offset less than 30 nanosec -15 to +14	[3]

$PFEC,GPrsd (out)

TRAIM/1PPS Control mode set by $PFEC,GPrrs

TRAIM/1PPS control mode set by $PFEC,GPrrs is output for verification.

Example

$PFEC,GPrsd	,1	,100	,3	CR LF
Field# 1	2	3	4	

2.-4 These fields indicates the output set by GPrrs sentence for verification purpose.

$PFEC,GPtmd (out)

Info on auto transition to fixed observation mode

Example

$PFEC,GPtmd	,028800	,3444.0000,N	,13521.0000,E	000123.0	CR LF
Field# 1	**2**	**3 4**	**5 6**	**7**	

#.	Description	[Range]	[Bytes]
2.	Remaining data to complete auto-shift to fixed observation point.		[6]

Note : Unless auto shift function is executed, null field is output.
Since only 3D positioning data are used for averaging the position, this field remains unchanged during 2D positioning or no positioning.

3-7 Position data to be used in shifted “fixed observation point” mode.

3-4.	Latitude		
	“34”:degree	00-90	[2]
	“44”: minute (integer)	00-59	[2]
	“0000”: minute (fraction)	0-9999	[4]
	“N”: North/South	N or S	[1]
5-6.	Longitude		
	“135”: degree	000-180	[3]
	“21”: Minute (integer)	00-59	[2]
	“”: Minute (fraction)	0-9999	[4]
	“E”: East/West	E or W	[1]
	Note: Digits below 1/10000 are ignored.		
7.	Altitude	-00999.9 to 04000.0	[8]

$PFEC,GPwav (out)

SBAS satellite information

Example

$PFEC	,GPwav	,4	,120	,35	,234	,42		
Field#	**1**	**2**	**3**	**4**	**5**	**6**		
,121	**,20**	**,144**	**,00**	**,134**	**,05**	**,100**	**,00**	
7	**8**	**9**	**10**	**11**	**12**	**13**	**14**	
,137	**,05**	**,000**	**,00**	**CR LF**				
15	**16**	**17**	**18**					

#.	**Description**	**Range**	**[Bytes]**
1.	Command name		[5]
2.	Numbers of satellite transmitting GEO data	[1]	
3.	First satellite number transmitting GEO data		[3]
4.	Elevation of the satellite	05 - 90	[2]
5.	Azimuth of the satellite	000 - 359	[3]
6.	SNR of the satellite	00 - 99	[2]
7-10	Information for second GEO satellite		[10]
11-14	Information for third GEO satellite		[10]
15-18	Information for fourth GEO satellite		[10]

$PFEC,GPstd (Answer to $PFEC,GPstq)

Log output intervals set by $PFEC,GPint

$PFEC	,GPstd	,3	CR LF
	1	2	

#.	**Description**	**Range**	**[Bytes]**
1.	Command name		[5]
2.	SBAS/GPS position fix method	0-3 0: no position fix 1: GPS only 2: DGPS with RTCM-104 3: DGPS with SBAS	[1]

$PFEC,GPwas (Answer to $PFEC,GPwaq)

$PFEC	,GPwas	,D3	,T02	CR LF	#.
	1	2	3		

	Description	Range	[Bytes]
1.	Command name		[5]
2.	SBAS / DGPS setting	0-4 0: GPS only 1: DGPS with RTCM SC-104 2: DGPS with SBAS 3: DGPS/SBAS, RTCM SC-104 preferrable 4: DGPS/SBAS, SBAS preferrable	[2]
3.	Enable/ignore type 0 message	00-27, FF 00: Ignore type 0 message for 60 seconds 01-27: Enable type 0 message as data FF: Ignore type 0 message	[3]

$PFEC,GPmge (Answer to $PFEC,GPmgq)

$PFEC	,Gpmge	,00201	CR LF
	1	2	

#.	Description	Range	[Bytes]
1.	Command name		[5]
2.	Prohibited satellite number	00000-7FFF	[5]

The satellite number will be transformed in 32 bit binary code. Then the code will be expressed in hexadecimal with 8 characters of ASCII code. One bit is assigned to one satellite.

$PFEC,GPpsp (Answer to $PFEC,GPpsq)

$PFEC	,GPpsp	,P00	CR LF
	1	2	

#.	Description	Range	[Bytes]
1.	Command name		[5]
2.	Specify tracking GEO satellite number	120 - 138 Default: 000	[3]

Note: When the GEO satellite number is set to default “000”, it will search for available satellites starting from satellite number 120.

$PFEC,GPpri (Answer to $PFEC,GPprq)

$PFEC	,GPpri	, 0401040104010401040104010401	CR LF	#.
	1	2		

	Description	Range	[Bytes]
1.	Command name		[5]
2.	Position fix status of satellites		[32]
	One character describes status of one satellite. First digit is for satellite #1 and the last for #32.		
		0: No fix	
		1: GPS only	
		2: DGPS with RTCM-104	
		3: DGPS with SBAS	

$PFEC,GPgac (Answer to $PFEC,GPgaq)

$PFEC	,GPgac	, 2000000000200000100	CR LF	#.
	1	2		

	Description	Range	[Bytes]
1.	Command name		[5]
2.	GEO almanac information		[19]
	One character describes status of one satellite. First digit is for GEO satellite #120 and the last for #138.		
		0: Almanac not available	
		1: Almanac unhealthy	
		2: Almanac healthy	

The example above describes the followings;

Satellite number 120:	Almanac healthy
Satellite numbers 120 to 129:	Almanac not available
Satellite number 130:	Almanac healthy
Satellite numbers 131 to 135:	Almanac not available
Satellite number 136:	Almanac unhealthy
Satellite number 137 to 138:	Almanac not available

4. SUPPLEMENTAL EXPLANATION ON TIME TRANSFER

4.1 ESTIMATED AND FIXED OBSERVATION POINT MODES

The following two operational modes are available:

Estimated Observation Point Mode: (Default mode after power-on reset)	1PPS is obtainable without entry of own position information. The receiver has to locate the position first before outputting the 1PPS.
Fixed Observation Point Mode	Entry of own position information is required for 1PPS output. The accurate position should be entered to get the correct 1PPS.

To selec the estimated or fixed observation point mode, send a "$PFEC,GPset" command. See the following examples.

$PFEC,GPset,Z1<CR><LF>	Select Estimated Observation Point Mode.
$PFEC,GPset,Z2<CR><LF>	Select Fixed Observation Point Mode.

To inquire which mode is selected currently, send command "$PFEC,GPsrq" command, and receive answer "$PFEC,GPssd". See the following example.

$PFEC,GPsrq,<CR><LF>	Send this command sentence.
$PFEC,GPssd.....,Z2<CR><LF>	GT-8031 will return "$PFEC,GPssd" sentence as an answer. "Z2" indicates Fixed Observation Point Mode. If Estimated Observation Point mode is in use, "Z1" rather than "Z2" will be answered.

4.1.1 ESTIMATED OBSERVATION POINT MODE

(DEFAULT M0DE AFTER POWER-ON RESET)

This mode is used when GT-8031's own position is unknown.

In this mode of operation the GT-8031 outputs 1PPS while performing position-fixing. This mode is also usable to collect GT-8031's own position which is used for fixed observation point mode operation. In this case collect own position data by operating the GT-8031 for 12 to 24 hours continually, then use the average as the entry for the fixed observation point mode operation.

Conditions for 1PPS output in the estimated observation point mode are as follows:

1) 1PPS is output after a series of the following operations:

   Tracking four or more satellites
   Starting position fixing
   UTC calculation completes

   NOTE:UTC calculation is performed when the following conditions are met:

   A. A UTC parameter (included within almanac) is available.
   B. Ephemeris is collected from at least one satellite.
      (Required for precise time decision.)
      (Usually collected within 30 seconds.)

2) After own position has been fixed, the GT-8031 outputs 1PPS by using the position data for time correction.

3) If position-fixing is interrupted, the GT-8031 keep on outputting 1PPS so long as at least one satellite is receivable. It stops outputting 1PPS when it can not receive a satellite.

4.1.2 FIXED OBSERVATION POINT MODE

This mode is usable when GT-8031's own position is known.

The GT-8031 must be fixed at the known position. As soon as a satellite becomes receivable, the GT-8031 starts outputting 1PPS based on the position information which you entered. For the details, refer to "4.1 Conditions for 1PPS output".

Bear in mind that the GT-8031 does not perform position fixing in this mode of operation, but it merely outputs the position data which you entered.

- Fixed position entry

  Enter latitude/longitude by sending "$GPGGA", "$GPGLL", or "$GPRMC" sentence, and altitude by sending "$PFEC,GPset" sentence. See the following examples.

$PFEC,GPset,Z2<CR><LF>	Select Fixed Observation Point Mode.
$GPGGA,3444.4700,N,13521.2000,E<CR><LF>	Declare latitude/longitude.
$PFEC,GPset,H000021.0<CR><LF>	Declare altitude.

  You may enter both mode and altitude within a single "$PFEC,GPset" sentence if that is preferred. See the following example.

$PFEC,GPset,Z2,H000021.0<CR><LF>	Always place the "Z2" before altitude declaration.
$GPGGA,3444.4700,N,13521.2000,E<CR><LF>	Declare latitude/longitude.

4.3 TRAIM specification

The GT-8031 has TRAIM function. When it is set in Fixed Obsevation Point Mode with correct position entered, the TRAIM works with 2 satellites that can be used for position calculation. Theare are two such satellites available, the receiver can output alarm detecting the abonormality of either one of those satellites. When there are 3 or more satellites are available, the receiver can isolate the abonormal satellite and exclude it from position calculation. (If there are multiple abnormal satellites, the receiver may not be able to output alarm or may not be able to isolate abnormal satellite.)

1PPS OUTPUT Conditions

1. If 1PPS control mode is set to “0” (no output), naturally it does notoutput 1PPS.
2. If 1PPS control mode is set to “1” (always output), 1PPS is always output as soon as the power gets on. However, this 1PPS comes from receiver internal timing and is not synchronized with UTC.
3. If 1PPS control mode is set to “2” (standard) or “3” (higher reliability), 1PPS will be output when the following two conditions are met:

   ① Valid almanac is available. The almanac including UTC parameters should be collected within 30 days. You may use a command $PFEC,Gpset,A2 to get around the 30 day validity check.

   ② -1 Estimated Observation Point Mode

   1PPS will be output until the first fix is completed. The conditions for first fix is that 4 or more satellites that can be used for position calculation and the PDOP value calculated on those satellites are less than “6”. Once the first fix is completed, 1PPS will be output with just one or more satellites available.

   ② -2 Fixed Observation Point Mode

   If 1PPS control mode is set to “2” (standard) , 1PPS will be output with just one or more satellites available.

   If 1PPS control mode is set to “3” (higher reliability), 1PPS will be output with two or more satellites available.

4.4 GPS Week Roll-over problem (See Note 1 below)

Once this receiver receives GPS week number and get the correct date and time, it will work correctly until **23h:59m:59s of Decemer 31, 2079** as long as the main power is suppled. Also, with back-up power supplied, it will work until the same time/date even if you turn on or off the power. This solution is realized based on backed-up memory. Thus, you need to keep the backed-up power supply. In the following cases, the correct time/date may not be issued by the receiver even after receiving GPS week number:

① After September year 2022, the correct time/date is not backed-up.
② Erroneous time/date is entered externally (if the difference between correct date and entered date is over plus or minus one year).

Note 1 : The week number issued from GPS satellites rolls over to zero every 19.6 year (=1023 weeks). Thus, if the receiver relis on just the week number, it can not output correct date/time after 19.6 years. The roll-over occurs on the following dates.

1st : August 22, 1999 (Already occurred)
2nd : April 7, 2019
3rd : November 21, 2038
and so on.

5. UP-LOAD/DOWN-LOAD OF ALMANAC DATA

$PFEC,GPspe,ANCOUT (in)

Down-load almanac

Issue this sentence when you need the almanac data from GT-8031.

$PFEC	,GPspe	,ANCOUT	CR LF

As an answer to the above sentence, GT-8031 outputs internal almanac data (about 6.0K bytes of ASCII characters) in the following format:

1. Almanac for 32 satellites

Data contents	Scale Factor	Unit [Hex]	Data size (byte)
ID to represent 32 satellites almanac (always 1)			1
PRN (Satellite number)			2
Almanac validity flag			1
Reference week of almanac : week_no			4
Eccentricity : e	LSB 2^{-21}	Semi-circles	4
Reference time of almanac : toa	LSB 2^{4}	Sec	4
Orbital Inclination (rad) : δ i	LSB 2^{-19}	Semi-circles	4
Rate of right ascension :Omega_dot	LSB 2^{-38}	Semi-circles	4
Health			2
Square root of the semi-major axis SQRT (A)$^{1/2}$	LSB 2^{-11}	Meter $^{1/2}$	6
Longitude of ascending node of orbit plane : $Omega_0$	LSB 2^{-23}	Semi-circles	6
Argument of perigee :	LSB 2^{-23}	Semi-circles	6
Mean anomaly at reference time :M0	LSB 2^{-23}	Semi-circles	6
Satellite PRN code phase time offset:Af0	LSB 2^{-20}	Sec	3
Satellite PRN code relative frequency offset :Af1	LSB 2^{-38}	Sec/sec	3

2. Almanac Health

Data contents	Scale Factor	Unit [Hex]	Data size (byte)
ID to represent almanac health (always 2)			1
Collected time 1 (GPS time)			8
Collected time 2 (GPS time)			8
Collection flag 1			1
Collection flag 2			1
Almanac health for Satellite number 1			2
Almanac health for Satellite number 2			2
*			*
*			*
Almanac health for Satellite number 31			2
Almanac health for Satellite number 32			2

3. Ionophere Data

Data contents	Scale Factor	Unit [Hex]	Data size (byte)
ID to represent ionospheric parameters (always 3)			1
Issued time 1 (GPS time)			8
Collection flag			1
Alpha 0		s	2
Alpha 1		S/semi-circle	2
Alpha 2		S/(semi-circle)^2	2
Alpha 3		S/(semi-circle)^2	2
Beta 0		s	2

Beta 1		S/semi-circle	2
Beta 2		S/(semi-circle)^2	2
Beta 3		S/(semi-circle)^2	2

4. UTC parameters

Data contents	Scale Factor	Unit [Hex]	Data size (byte)
ID to represent UTC Parameters (always 4)			1
Issued time (GPS time)			8
Collection flag			1
Collection week number			4
Constant and first order terms of polynomial : A_0	LSB 2^{-30}	Sec	8
Constant and first order terms of polynomial : A_1	LSB 2^{-50}	Sec/sec	6
Reference time for UTC data : t_{0t}	LSB 2^{12}	Sec	2
Current wek number :WNt	1	weeks	2
Delta time due to leap seconds :Δt_{LS}	1	Sec	2
UTC reference week number : WN_{LSF}	1	Weeks	2
UTC reference day number : DN	1	days	2
Delta time due to leap seconds : Δt_{lsf}	1	Sec	2

Note that, after this sentence is received, the GT-8031 stops positioning, receiving data, and outputting the other data than almanac data. After outputting the almanac data, the GT-8031 will restart automatically (Restart clear mode 2).

Example:

#GP, 1, 01,1, 1234	.....	#GP,END	CR LF

You may save the downloaded almanac for future uploading.

$PFEC,GPspe,ANCINP (in)

Up-load almanac

Issue this sentence when you want to send almanac data to GT-8031. This function enables quicker Time-To-First-Fix.

$PFEC,GPspe,ANCINP	**CR LF**

Following the above sentence, send almanac data which you saved by $PFEC,GPspe,ANCOUT before:

#GP, 1, 01,1, 1234	.....	#GP,END	CR LF

Note : This receiver can make use of almanac output by this model only. The almanac data issued by other models can not be used. The almanac data issued by this receiver can not be used in other model either.

If uploading is completed successfully, GT-8031 outputs the following acknowledgment and restarts by itself (Restart clear mode 2).

$ANC, OK	CR LF

If uploading is failed, GT-8031 requests you to send the entire almanac sentence again by outputting the following error message:

$ANC,NG	CR LF

"NG" means No Good.

6. GEODETIC ID

There are many geodetic systems in the world. Enter a right geodetic system ID in accordance with your chart or map in use. If the geodetic ID you entered differs from the geodetic system employed in your chart or map, GPS fixes may be deviated from the actual position on the chart or map.

IDGeodetic System

001: W84:	WGS 84		
002: W72:	WGS 72		
*003:TOY-M:	TOKYO	(Go to 172)	:Mean Value (Japan, Korea & Okinawa)
004:NAS-C:	NORTH AMERICAN 1927		:Mean Value
005:EUR-M:	EUROPEAN 1950		:Mean Value
006:AUG:	AUSTRALIAN GEODETIC 1984		:Australia and Tasmania Island
007:ADI-M:	ADINDAN		:Mean Value (Ethiopia & Sudan)
008:ADI-A:			:Ethiopia
009:ADI-C:			:Mali
010:ADI-D:			:Senegal
011:ADI-B:			:Sudan
012:AFG:	AFG		:Somalia
*013:AIN-A:	AIN EL ABD 1970	(Go to 173)	:Bahrain Islands
014:ANO:	ANNA 1 ASTRO 1965		:Cocos Island
015:ARF-M:	ARC 1950		:Mean Value
016:ARF-A:			:Botswana
017:ARF-B:			:Lesotho
018:ARF-C:			:Malawi
019:ARF-D:			:Swaziland
020:ARF-E:			:Zaire
021:ARF-F:			:Zambia
022:ARF-G:			:Zimbabwe
*023:ARS-M:	ARC 1960	(Go to174)	:Mean Value (Kenya & Tanzania)
*024:ARS-A:		(Go to 175)	:Kenya
*025:ARS-B:		(Go to 176)	:Tanzania
*026:ASC:	ASCENSION ISLAND 1958	(Go to177)	:Ascension Island
027:ATF:	ASTRO BEACON "E"		:Iwo Jima Island
028:TRN:	ASTRO B4 SOR. ATOLL		:Tern Island
029:SHB:	ASTRO POS 71/4		:St. Helena Island
030:ASQ:	ASTRONOMIC STATION 1952		:Marcus Island
031:AUA:	AUSTRALIAN GEODETIC 1966		:Australia and Tasmania Island
032:IBE:	BELLEVUE (IGN)		:Efate and Erromango Islands
033:BER:	BERMUDA 1957		:Bermuda Islands
034:BOO:	BOGOTA OBSERVATORY		:Colombia
035:CAI:	CAMPO INCHAUSPE		:Argentina
036:CAO:	CANTON ISLAND 1966		:Phoenix Islands
037:CAP:	CAPE		:South Africa
*038:CAC:	CAPE CANAVERAL	(Go to 178)	:Mean Value (Florida & Bahama Islands)
039:CGE:	CARTHAGE		:Tunisia
040:CHI:	CHATHAM 1971		:Chatham Island (New Zealand)
041:CHU:	CHUA ASTRO		:Paraguay
042:COA:	CORREGO ALEGRE		:Brazil
043:BAT:	DJAKARTA (BATAVIA)		:Sumatra Island (Indonesia)
044:GIZ:	DOS 1968		:Gizo Island (New Georgia Islands)
*045:EAS:	EASTER ISLAND 1967	(Go to 179)	:Easter Island
046:EUR-A:	EUROPEAN 1950		:Western Europe
047:EUR-E:			:Cyprus
048:EUR-F:			:Egypt

049:EUR-G:			:England, Scotland, Channel, Scotland, & Shetland Islands
050:EUR-K:			:England, Ireland, Scotland, & Shetland Islands
051:EUR-B:			:Greece
052:EUR-H:			:Iran
053:EUR-I:			:Italy--Sardinia
054:EUR-J:			:Italy--Sicily
055:EUR-C:			:Norway and Finland
*056:EUR-D:		(Go to 180)	:Portugal and Spain
057:EUS:	EUROPEAN 1979		:Mean Value
058:GAA:	GANDAJIKA BASE		:Republic of Maldives
059:GEO:	GEODETIC DATUM 1949		:New Zealand
060:GUA:	GUAM 1963		:Guam Island
061:DOB:	GUX 1 ASTRO		:Guadalcanal Island
062:HJO:	HJORSEY 1955		:Iceland
063:HKD:	HONG KONG 1963		:Hong kong
064:INF-A:	INDIAN		:Thailand and Vietnam
065:IND-B:			:Bangladesh, India, and Nepal
066:IRL:	IRELAND 1965		:Ireland
067:IST:	ISTS 073 ASTRO 1969		:Diego Garcia
*068:JOH:	JOHNSTON ISLAND 1961	(Go to 181)	:Johnston Island
069:KAN:	KANDAWALA		:Sri Lanka
070:KEG:	KERGUELEN ISLAN		:Kerguelen Island
071:KEA:	KERTAU 1948		:West Malaysia and Singapore
072:REU:	LA REUNION		:Mascarene Island
073:LCF:	L.C. 5 ASTRO		:Cayman Brac Island
074:LIB:	LIBERIA 1964		:Liberia
075:LUZ-A:	LUZON		:Philippines (Excluding Mindanao Island)
076:LUZ-B:			:Mindanao Island
077:MIK:	MAHE 1971		:Mahe Island
078:SGM:	MARCO ASTRO		:Salvage Islands
079:MAS:	MASSAWA		:Eritrea (Ethiopia)
080:MER:	MERCHICH		:Morocco
081:MID:	MIDWAY ASTRO 1961		:Midway Island
082:MIN-B:	MINNA		:Nigeria
083:NAH-A:	NAHRWAN		:Masirah Island (Oman)
084:NAH-B:			:UnitedArab Emirates
*085:NAH-C:		(Go to 182)	:Saudi Arabia
086:SCK:	NAMIBIA		:Namibia
*087:NAP:	NAPARIMA, BWI	(Go to 183)	:Trinidad and Tobago
088:NAS-B:	NORTH AMERICAN 1927		:Western United States
089:NAS-A:			:Eastern United States
090:NAS-D:			:Alaska
091:NAS-Q:	:Bahamas(Excluding San Salvador Island)		
092:NAS-R:			:Bahamas---San Salvador Island
093:NAS-E:			:Canada (Including Newfoundland Island)
094:NAS-F:			:Alberta and British Columbia
095:NAS-G:	:East Canada		
096:NAS-H:			:Manitoba and Ontario
097:NAS-I:			:Northwest Territories and Saskatchewan
098:NAS-J:			:Yukon
099:NAS-O:			:Canal Zone
*100:NAS-P:		(Go to 184)	:Caribbean
101:NAS-N:			:Central America
102:NAS-T:			:Cuba
103:NAS-U:			:Greenland
104:NAS-L:			:Mexico
105:NAR-A:	NORTH AMERICAN 1983		:Alaska
106:NAR-B:			:Canada
107:NAR-C:	:CONUS		
108:NAR-D:	:Mexico, Central America		

109:FLO:	OBSERVATORIO 1966		:Corvo and Flores Islands (Azores)
110:OEG:	OLD EGYPTIAN 1930		:Egypt
111:OHA-M:	OLD HAWAIIAN		:Mean Value
112:OHA-A:			:Hawaii
113:OHA-B:			:Kauai
114:OHA-C:			:Maui
*115:OHA-D:		(Go to 185)	:Oahu
116:FAH:	OMAN		:Oman
117:OGB-M:	ORDNANCE SURVEY OF GREAT BRITAIN 1936		:Mean Value
118:OGB-A:	:England		
119:OGB-B:	:England, Isle of Man, and Wales		
120:OGB-C:			:Scotland and Shetland Islands
121:OGB-D:			:Wales
122:PLN:	PICO DE LAS NIEVIES		:Canary Islands
123:PIT:	PITCAIRN ASTRO 1967		:Pitcairn Island
124:HIT:	PROVISIONAL SOUTH CHILEAN 1963		:South Chile (near 53° S)
125:PRP-M:	PROVISIONAL SOUTH AMERICAN 1956		:Mean Value
126:PRP-A:			:Bolivia
127:PRP-B:			:Chile---Northern Chile (near 19° S)
128:PRP-C:			:Chile---Southern Chile (near 43° S)
129:PRP-D:			:Colombia
130:PRP-E:			:Ecuador
131:PRP-F:			:Guyana
132:PRP-G:			:Peru
133:PRP-H:			:Venezuela
134:PUR:	PUERTO RICO		:Puerto Rico and Virgin Islands
135:QAT:	QATAR NATIONAL		:Qatar
136:QUO:	QORNOQ		:South Greenland
137:MOD:	ROME 1940		:Sardinia Islands
138:SAO:	SANTA BRAZ		:Sao Miguel, Santa Maria Islands (Azores)
139:SAE:	SANTO (DOS)		:Espirito Santo Island
*140:SAP:	SAPPER HILL 1943	(Go to 186)	:East Falkland Island
141:SAN-M:	SOUTH AMERICAN 1969		:Mean Value
142:SAN-A:			:Argentina
143:SAN-B:			:Bolivia
144:SAN-C:			:Brazil
145:SAN-D:			:Chile
146:SAN-E:			:Colombia
147:SAN-F:			:Ecuador
148:SAN-G:	:Guyana		
149:SAN-H:			:Paraguay
150:SAN-I:			:Peru
151:SAN-K:			:Trinidad and Tobago
152:SAN-L:			:Venezuela
153:SOA:	SOUTH ASIA		:Singapore
154:POS:	SOUTHEAST BASE		:Porto Santo and Madeira Islands
155:GRA:	SOUTHWEST BASE		:Faial, Graciosa, Pico, Sao Jorge and Terceira Islands
*156:TIL:	TIMBALAI1948	(Go to 187)	:Brunei and East Malaysia (Sarawak and Sabah)
*157:TOY-A:	TOKYO	(Go to 188)	:Japan
*158:TOY-B:		(Go to 189)	:Korea
*159:TOY-C:		(Go to 190)	:Okinawa
160:TDC:	TRISTAN ASTRO 1968		:Tristan da Cunha
161:MVS:	VITI LEVU 1916		:Viti Levu Island (Fiji Islands)
*162:ENW:	WAKE-ENIWETOK 1960	(Go to 191)	:Marshall Islands
163:ZAN:	ZANDERIJ		:Suriname
164:BUR:	BUKIT RIMPAH		:Bangka and Belitung Islands (Indonesia)
165:CAZ:	CAMP AREA ASTRO		:Camp McMurdo Area, Antarctica
166:GSE:	G. SEGARA		:Kalimantan Island (Indonesia)
167:HEN:	HERAT NORTH		:Afghanistan

*168:HTN:	HU-TZU-SHAN(Go to 192)	:Taiwan
169:TAN:	TANANARIVE OBSERVATORY 1925	:Madagascar
170:YAC:	YACARE	:Uruguay
171:999:	RT90	:Sweden
172:TOY-M:	TOKYO	:Mean Value (Japan, Korea,and Okinawa)
173:AIN-A:	AIN EL ABD 1970	:Bahrain Island
174:ARS-M:	ARC 1960	:Mean Value (Kenya, Tanzania)
175:ARS-A:		:Kenya
176:ARS-B:		:Tanzania
177:ASC:	ASCENSION ISLAND 1958	:Ascension Island
178:CAC:	CAPE CANAVERAL	:Mean Value (Florida and Bahama Islands)
179:EAS:	EASTER ISLANDS 1967	:Easter Island
180:EUR-D:	EUROPEAN 1950 (Cont'd)	:Portugal and Spain
181:JOH:	JHONSTON ISLAND 1961	:Jhonston Island
182:NAH-C:	NAHRWAN	:Saudi Arabia
183:NAP:	NAPARIMA, BWI	:Trinidad and Tobago
184:NAS-P:	NORTH AMERICAN 1927 (Cont'd)	:Caribbean
185:OHA-D:	OLD HAWAIIAN	:Oahu
186:SAP:	SAPPER HILL 1943	:East Falkland Island
187:TIL:	TIMBALAI 1948	:Brunei and East Malaysia (Sarawak and Sabah)
188:TOY-A:	TOKYO	:Japan
189:TOY-B:	TOKYO	:South Korea
190:TOY-C:	TOKYO	:Okinawa
191:ENW:	WAKE-ENIWETOK 1960	:Marshall Islands
192:HTN:	HU-TZU-SHAN	:Taiwan

* 193 through 200 are reserved

201:ADI-E:	ADINDAN	:Burkina Faso
202:ADI-F:	ADINDAN	:Cameroon
203:ARF-H:	ARC 1950	:Burundi
204:PHA:	AYABELLE LIGHTHOUSE	:Djibouti
205:BID:	BISSAU	:Guinea-Bissau
206:DAL:	DABOLA	:Guinea
207:EUR-T:	EUROPEAN 1950	:Tunisia
208:LEH:	LEIGON	:Ghana
209:MIN-A:	MINNA	:Cameroon
210:MPO:	M'PORALOKO	:Gabon
211:NSD:	NORTH SAHARA 1959	:Algeria
212:PTB:	POINT58	:Mean Solution (Burkina Faso and Niger)
213:PTN:	POINTE NOIRE 1948	:Congo
214:SRL:	SIERRA LEONE 1960	:Sierra Leone
215:VOR:	VOIROL 1960	:Algeria
216:AIN-B:	AIN EL ABD 1970	:Saudi Arabia
217:IND-B:	INDIAN	:Bangladesh
218:IND-I:	INDIAN	:India and Nepal
219:INF-A:	INDIAN 1954	:Thailand
220:ING-A:	INDIAN 1960	:Vietnam (near 16N)
221:ING-B:	INDIAN 1960	:Con Son Island (Vietnam)
222:INH-A:	INDIAN 1975	:Thailand
223:IDN:	INDONESIAN 1974	:Indonesia
224:EST:	CO-ORDINATE SYSTEM 1937 OF ESTONIA	:Estonia
225:EUR-L:	EUROPEAN 1950 (Cont'd)	:Malta
226:EUR-T:	EUROPEAN 1950 (Cont'd)	:Tunisia
227:SPK-A:	S-42 (PULKOVO 1942)	:Hungary
228:SPK-B:	S-42 (PULKOVO 1942)	:Poland
229:SPK-C:	S-42 (PULKOVO 1942) (Cont'd)	:Czechoslovakia
230:SPK-D:	S-42 (PULKOVO 1942) (Cont'd)	:Latvia
231:SPK-E:	S-42 (PULKOVO 1942) (Cont'd)	:Kazakhstan
232:SPK-F:	S-42 (PULKOVO 1942) (Cont'd)	:Albania
233:SPK-G:	S-42 (PULKOVO 1942) (Cont'd)	:Romania
234:CCD:	S-JTSK	:Czechoslovakia
235:NAS-V:	NORTH AMERICAN 1927 (Cont'd)	:East of 180W
236:NAS-W:	NORTH AMERICAN 1927 (Cont'd)	:West of 180W
237:NAR-E:	NORTH AMERICAN 1983	:Aleutian Island
238:NAR-H:	NORTH AMERICAN 1983	:Hawaii
239:SAN-J:	SOUTH AMERICAN 1969 (Cont'd)	:Baltra,Galapagos Island
240:AIA:	ANTIGUA ISLAND ASTRO 1943	:Antigua,Leeward Island
241:DID:	DECEPTION ISLAND	:Deception Island,Antarctica
242:FOT:	FORT THOMAS 1955	:Nevis, St.Kitts,Leeward Island
243:ISG:	ISTS 061 ASTRO 1968	:South Georgia Island
244:ASM:	MONTSERRAT ISLAND ASTRO 1958	:Montserrat, Leeward Island
245:REU:	REUNION	:Mascarene Island
246:AMA:	AMERICAN SAMOA 1962	:American Samoa Island
247:IDN:	INDONESIAN 1974	:Indonesia
248:KUS:	Kusaie ASTRO 1951	:Caroline Island, Fed.States of Micronesia
249:WAK:	Wake Island ASTRO 1952	:Wake Atoll
250:EUR-S:	EUROPEAN 1950	:Iraq, Israel, Jordan, Kuwait, Lebanon, Saudi Arabia and Syria
251:HER:	HERMANNSKOGEL	:Yugoslavia (Prior to 1990) Slovenia, Croatia, Bosnia and Herzegovina Serbia
252:IND-P:	INDIAN	:Pakistan
253:PUK:	PULKOVO 1942	:Russia
254:VOI:	VOIROL 1874	:Tunisia/Algeria