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58534A

GPS TIMING ANTENNA

INSTALLATION AND OPERATION

This manual describes the 58534A GPS Timing Antenna. This product provides a GPS receiver and an antenna together, in a single housing.

This manual primarily describes: 1) hardware and software installation and performance verification, 2) hardware operation, 3) maintenance and upgrades, 4) product specifications and characteristics.

For assistance, contact:

Symmetricom, Inc.
2300 Orchard Parkway
San Jose, CA 95131-1017

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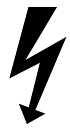
E-mail: ctac@symmetricom.com

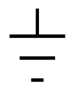
Internet: http://www.symmetricom.com

Warning Symbols That May Be Used In This Book

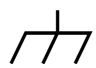
Instruction manual symbol; the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual.



Indicates hazardous voltages.

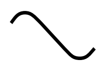


Indicates earth (ground) terminal.



or

Indicates terminal is connected to chassis when such connection is not apparent.



Indicates Alternating current.

Indicates Direct current.

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1

General Information

Description

The 58534A GPS Timing Antenna is a highly-reliable source of precision GPS time. It automatically provides a one pulse per second (1 PPS) signal synchronized to UTC within 110 ns when it is locked to GPS.

58534A GPS Timing Antenna consists of an antenna, a GPS receiver, an RS-422 interface, and a power supply—all integrated into a rugged, weatherproof, easy-to-install package. The receiver is specially designed for this application, to operate at higher data rates than a NMEA-standard receiver, but it can be controlled via NMEA-standard type commands.

Because the receiver and antenna are packaged together, operating power and input and output signals can be sent via a twisted-pair cable, instead of coax, so long cable runs introduce much less signal degradation than might otherwise be the case.

The 58534A GPS Timing Antenna operates from input voltages between +8 and +36 volts, and uses 1.5 watts of power. If power is lost, the RAM (Random Access Memory) which stores the navigation and satellite data continues to be powered by a super-capacitor up to 2 hours. This lets the 58534A GPS Timing Antenna reacquire satellites within 20 seconds after power is restored.

The 58534A GPS Timing Antenna's RS-422 drivers can drive 150 meters of interconnect cable. Please consult Symmetricom for installations requiring longer cable lengths.

Immunity to Noise Interference

The 58534A GPS Timing Antenna's uses three robust dielectric bandpass filters for immunity to RF interference. True 2-bit A/D conversion is used to digitize the GPS signal to reduce noise interference. SAW filtering technology also results in improved interference immunity.

Corrupt satellite data is rejected and multipath is mitigated by the 58534A GPS Timing Antenna's TRAIM (Time Receiver Autonomous Integrity Monitor) algorithm.

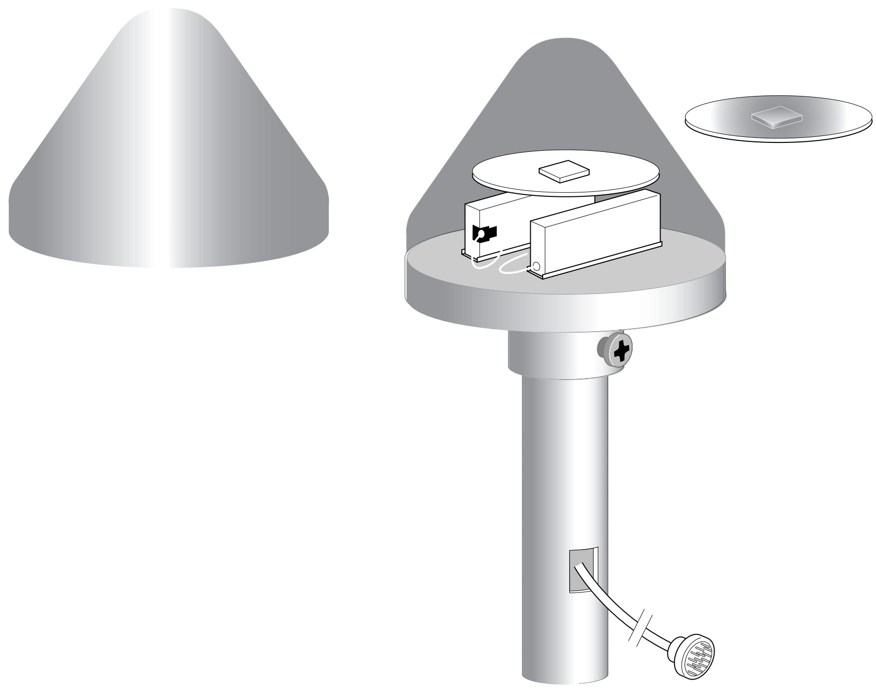


Figure 1-1. 58534A GPS Timing Antenna

Durable and Easy to Install

The waterproof enclosure uses a high-rise dome of molded high-impact UV-stabilized polycarbonate to minimize snow and debris buildup. The bottom part of the housing is durable cast aluminum treated with a polyester powder coat for corrosion resistance.

The cable, composed of bundled twisted pairs, is more flexible and easier to route than RF coaxial cables. Interconnect cables are available in convenient lengths via the 58522A Twisted Pairs Interconnect Cable series.

The 58534A GPS Timing Antenna can be quickly secured to the top of a mast using the high-quality glass-filled nylon clamp that is located in its mounting hub. This mounting approach also prevents unwanted torque on the core of the unit, which can occur with other mounting methods. In addition, the cable connector is sheltered from the environment inside the optional mounting mast (part of 58534A Option AUB Mounting Hardware Kit).

58534A Option AUB Mounting Hardware Kit

This option provides a mounting hardware kit, complete with a galvanized stainless steel mounting mast, mounting brackets, and hardware. For a detailed listing of kit components, see Table 2-1, “58534A Option AUB Mounting Hardware Kit,” on page 2-4.

58534A Option 001 GPS Timing Antenna Evaluation Kit

This kit makes analysis and control of the 58534A GPS Timing Antenna—or any other supported antenna—a simple task.

The 58534A Option 001 GPS Timing Antenna Evaluation Kit includes:

- a copy of the 58531A GPS Timing Receiver Analysis and Control Software,
- an RS-422 to RS-232 PC Interface module,
- a 50-meter length of interconnect cable that is terminated on both ends in order to mate with the 58534A GPS Timing Antenna and the PC Interface box,
- 3-meter DB9 extension cable, 9-pin female-to-9-pin female, with EMI/RFI hoods,
- mounting hardware, and an
- operating manual diskette.

The 58531A GPS Timing Receiver Analysis and Control Software is a PC Windows™-based program (for Windows NT 4.0 or Windows 95) that controls the 58534A GPS Timing Antenna, and processes and displays information received from it. The program has tools to help in analyzing the receiver data, and can log the information to a file for analysis using other tools.

The 58531A GPS Timing Receiver Analysis and Control Software program includes these features:

- real-time information update,
- convenient control and query the 58534A GPS Timing Antenna via menu-driven commands,
- generate a data log file for analysis,
- generate an error log file for analysis,
- plot instant or average position in real time,
- plot satellite history, such as PRN, C/N, elevation, DOP,

- calculate and display average or maximum C/N and associated elevation and azimuth angles,
- Demo Mode capability in case a physical 58534A GPS Timing Antenna is not available.

58534A Option 1GK Extended Operating Temperature Range

58534A Option 1GK Extended Operating Temperature Range provides an 58534A GPS Timing Antenna guaranteed to meet specifications an extended operating temperature range of –40 °C to +80 °C.

58522A Twisted Pairs Interconnect Cable

An 58522A Twisted Pairs Interconnect Cable provides a length of cable composed of bundled twisted pairs. Each cable has a 12-pin female connector on one end to mate with the 58534A GPS Timing Antenna's connector. The other end is unterminated.

The cables are available in various length, listed in Table 1-1, below

Table 1-1. 58522A Twisted Pairs Interconnect Cables

Option	Length
005	5 meters
010	10 meters
050	50 meters

Site requirements

See Chapter 2 for details.

Hardware

- Wide-angle clear view of sky
- Distance from lightning rods
- Distance from transmitting antennas
- Lightning suppression
- Cabling

Software

The 58534A GPS Timing Antenna can be communicated with via NMEA-0183 commands from software running a personal computer (PC) or other supporting electronics.

58531A GPS Timing Receiver Analysis and Control Software must be run on a PC that uses either the Windows 95 or the Windows NT operating system.

Related Literature

Hewlett-Packard Application Note **AN 1272: GPS and Precision Timing Applications** contains an introduction to the Global Positioning System (GPS) and addresses GPS structure and theory of operation as well as non-military user concerns. You may download an Adobe Acrobat PDF version from:

`http://www.tmo.hp.com/tmo/Notes/English/5965-2791E.html`

2

Installation and Verification

Description

This chapter primarily describes installation of the 58534A GPS Timing Antenna using the 58534A Option 001 GPS Timing Antenna Evaluation Kit.

If you are installing the antenna without the Evaluation Kit, you should modify this information as appropriate for your situation. A recommended interface circuit for this situation is provided at the end of this chapter.

Hardware installation

Wide-angle clear view of sky

The 58534A GPS Timing Antenna location should be chosen to provide the widest-possible unobstructed view of the sky. A tree or other obstruction can block the signal from a satellite at the frequencies used for GPS. In this respect, GPS satellite signals behave somewhat like light.

Lightning

Lightning can damage your 58534A GPS Timing Antenna.

Do not install the 58534A GPS Timing Antenna close to a lightning rod.

A lightning rod attracts lightning, which can damage or destroy your 58534A GPS Timing Antenna. Because it is connected to earth ground, a lightning rod can also act as a shield, creating a “shadow” that may block or reduce the signal from a satellite.

Distance from transmitting antennas

Do not install the 58534A GPS Timing Antenna close to a radio or radar transmitting antenna.

A strong radio or radar signal may interfere with operation of the 58534A GPS Timing Antenna.

Distance from supporting electronics

The cable connecting the 58534A GPS Timing Antenna to its supporting electronics should be less than about 150 meters (500 feet) long. See “Specifications” (page 6-3) for exact length values.

Increasing cable-lengths between the antenna and the supporting electronics can degrade the rise time of the pulse. If the separation must be longer than that specified, contact Symmetricom for technical advice—phone numbers and addresses are provided at the front of this manual.

Mast

The mounting mast for the 58534A GPS Timing Antenna should be a non-threaded tube with inner and outer diameters as shown in Figure 2-1. The outer diameter is specified to fit within the antenna's mounting clamp and allow it to be tightened. The inner diameter is specified to provide clearance for the cable connectors. See Figure 2-1 on page 2-5 and "Specifications" (page 6-3 and page 6-5) for these dimensions.

WARNING **INSTALLING AN ANTENNA MAST CAN BE A DANGEROUS ACTIVITY. USE APPROPRIATE MEASURES TO PROTECT YOURSELF AND OTHERS FROM DEATH OR INJURY FROM SUCH THINGS AS CONTACTING A POWER LINE, FALLING, FALLING OBJECTS, ETC.**

CAUTION Use appropriate mounting techniques to ensure that the mast is sturdy and is firmly secured, to reduce spurious movements of the antenna relative to the structure to which it is attached.

The 58534A Option AUB Mounting Hardware Kit provides hardware that may be useful in your installation situation. The kit contents and an illustration of its use are provided in Table 2-1. Individual kit parts are not available from Symmetricom.

Table 2-1. 58534A Option AUB Mounting Hardware Kit

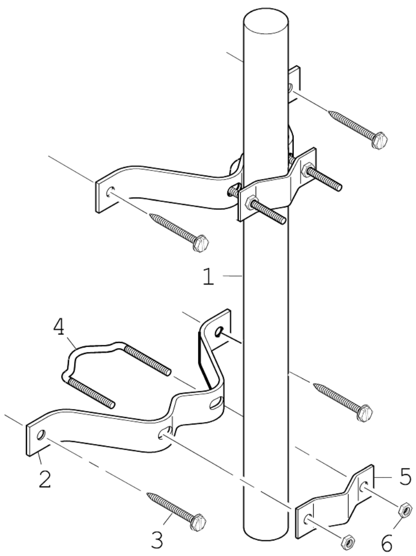


Illustration	Ref #	Description	Qty
	1	Mast OD: 31.5 mm ± 0.125 mm Length: 45.75 cm Material: 10-60 CRS, hot-dipped galvanized steel	1
	2	Bracket	2
	3	Mounting screw	4
	4	U-bolt	2
	5	Clamp	2
	6	Hex nut	4

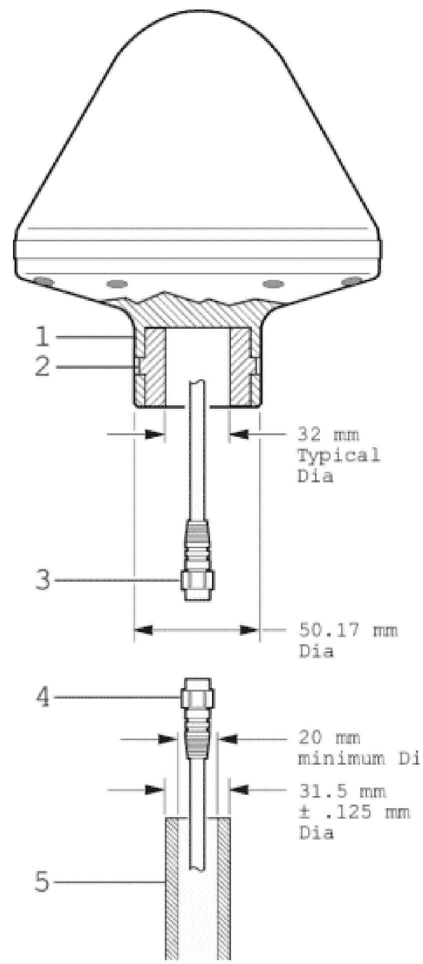
Illustration	Ref #	Description
	1	Antenna housing base
	2	Antenna base clamp
	3	Antenna cable connector
	4	Mating cable connector
	5	Mounting mast

Figure 2-1. 58534A GPS Timing Antenna—mounting dimensions

Cabling

Because the GPS receiver and its antenna are in the same housing, and a coaxial cable is not required for the receiver's output, the 58534A GPS Timing Antenna can be connected to its supporting electronics by a multiple-twisted-pair cable up to 150 meters long. Cables over 150 meters (500 feet) long require special consideration—contact Symmetricom for assistance.

Be sure the cable you use is appropriate for your installation (“plenum-rated”, for example).

Table 2-2, below, shows the pinout for the 58534A GPS Timing Antenna, connector, and the wire colors used in the 58522A Twisted Pairs Interconnect Cables. If you are using one of these cables, enter the appropriate pin numbers for your interface in the column provided. For instructions on attaching a connector to the cable, contact the manufacturer of the connector you are using.

58534A Option 001 GPS Timing Antenna Evaluation Kit RS-422-to-RS-232A Interface Module

The 58534A Option 001 GPS Timing Antenna Evaluation Kit RS-422-to-RS-232A Interface Module, shown in Figure 2-2, provides an easy way to interface the 58534A GPS Timing Antenna to a personal computer (PC). Installation and use instructions for this module are presented here—although you may not need these instructions until later.

Installing

1 Connect the antenna to the RS-422 (round) cable at the left-hand side of the front panel.

2 Connect an RS-232A cable between the rear-panel COM connector and the PC COMM port you want to use.

NOTE Use a straight-through cable. **A null-modem cable should not be used here**, because it will provide incorrect signal connections.

3 The 58534A GPS Timing Antenna can operate from a power source providing anywhere from 8 to 36 Vdc. Connect the black wire from the rear-panel POWER cable to the power supply’s “–” output.

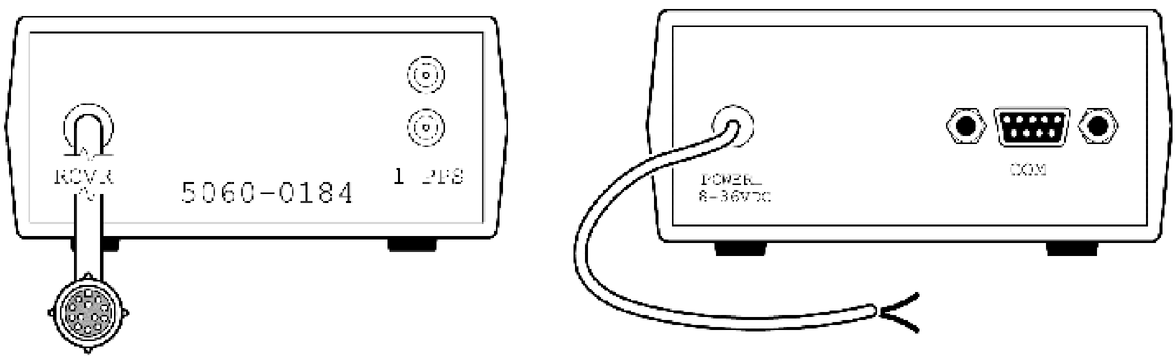
4 Connect the red wire from the rear-panel POWER cable to the power supply’s “+” output.

5 The front-panel 1PPS connector is a BNC connector that provides an output for the 1PPS signal from the 58534A GPS Timing Antenna.

Using

When installed as described above, the 58534A Option 001 GPS Timing Antenna Evaluation Kit's RS-422-to-RS-232A Interface Module's front-panel 1PPS indicator provides these indications, when power is applied:

- **On steadily:** the antenna is not acquiring satellites or outputting 1PPS.
- **Off:** the antenna is acquiring satellites, but not outputting 1PPS.
- **Blinking:** the antenna is outputttting 1PPS.

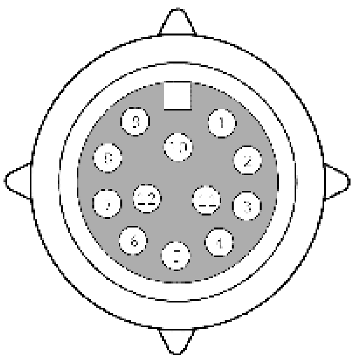


Front **Rear**

Figure 2-2. 58534A Option 001 GPS Timing Antenna Evaluation Kit RS-422-to-RS-232A Interface Module

.

Table 2-2. 58534A GPS Timing Antenna—connector

Pinout Diagram	Pin #	Signal	Wire color	User's Interface Pin #	Note
	1	Power 1	white/ blue		Twisted pair with Common 1 (pin 9)
	2	Receive (–)	white/ gray		Twisted pair with Receive (+) (pin 3)
	3	Receive (+)	gray/ white		Twisted pair with Receive (–) (pin 2)
	4	Transmit (–)	green/ white		Twisted pair with Transmit (+) (pin 5)
	5	Transmit (+)	white/ green		Twisted pair with Transmit (–) (pin 4)
	6	Spare	blue/red		Twisted pair with pin 7
NOTE: Connector viewed from mating-connector (outside) end.	7	Spare	red/blue		Twisted pair with pin 6
	8	Spare	orange/ white		Twisted pair with non-connected wire
	9	Common 1	blue/white		Twisted pair with Power 1 (pin 1)
	10	Drain Wire	shield drain		
	11	1PPS (+)	white/ brown		Twisted pair with 1PPS (–) (pin 12)
	12	1PPS (–)	brown/ white		Twisted pair with 1PPS (+) (pin 11)

Mating Connector:

Description: MMP Series #26C-2212S1 — Connector body only

Manufacturer: Deutsch ECD Defense/Aerospace

url: http://www.deutschdao.com/

Phone: (909) 765-2200 FAX: (909) 922-1544

E-Mail: customerservice@deutschdao.com

Software installation

The basic 58534A GPS Timing Antenna does not include software. The instructions presented here are for the 58531A GPS Timing Receiver Analysis and Control Software that is included in the 58534A Option 001 GPS Timing Antenna Evaluation Kit.

The 58531A GPS Timing Receiver Analysis and Control Software program is provided on an 88.9 mm (3.5-inch) PC-compatible floppy disk.

To install the 58531A GPS Timing Receiver Analysis and Control Software, place the disk in the appropriate drive for your PC, then Run the `Setup.exe` program from that disk.

Verification

The antenna operation may be verified in several ways.

- The preferred verification method is to connect the 58534A GPS Timing Antenna to a PC in which the 58531A GPS Timing Receiver Analysis and Control Software is running.
- The second-choice verification method is to connect the 58534A GPS Timing Antenna to a PC and use the Terminal mode in the PC to communicate with the antenna.
- The least-preferred verification method described here is to use an oscilloscope to view the 58534A GPS Timing Antenna's 1PPS output signal.

Verification using 58531A GPS Timing Receiver Analysis and Control Software

The 58531A GPS Timing Receiver Analysis and Control Software provides a simple and convenient way to verify the performance of your 58534A GPS Timing Antenna, using a personal computer. An illustration of this software's Main window is presented in Figure 2-3 below.

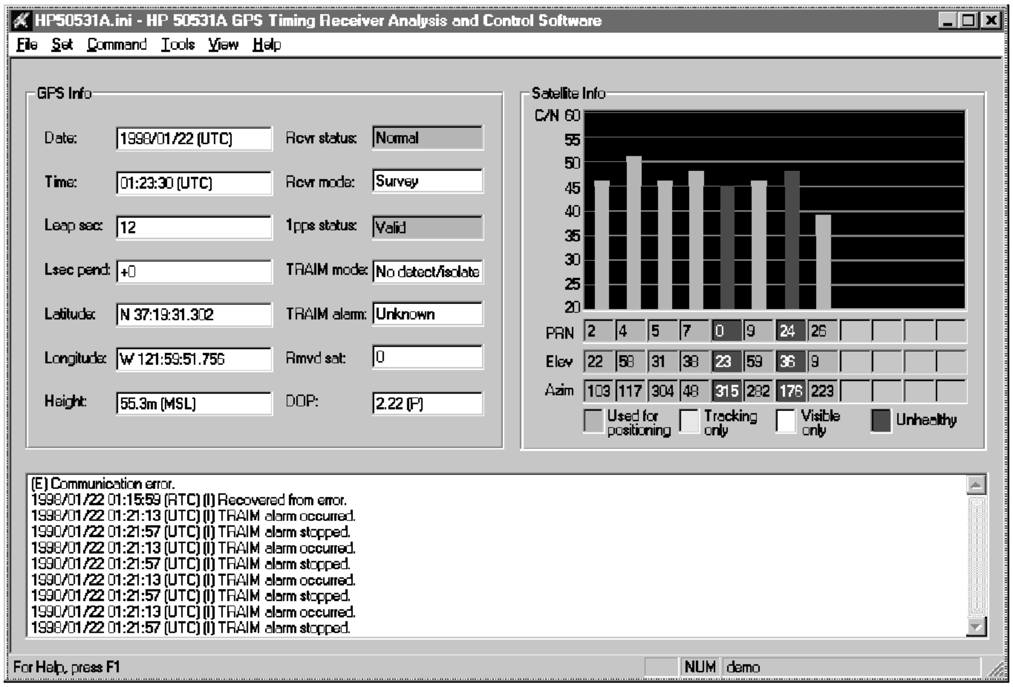


Figure 2-3. 58531A GPS Timing Receiver Analysis and Control Software—Main window

To use this verification method—

1 Install the antenna as described earlier.

2 Connect the antenna to the PC as described above.

3 Install the 58531A GPS Timing Receiver Analysis and Control Software in the PC as described above.

4 Connect the antenna to a source of operating power.

5 Within two minutes after the antenna is connected to operating power, the PC display should show that the antenna is receiving data from satellites.

6 Within 12.5 minutes after the antenna is connected to operating power, the PC display should show that it is providing a 1PPS output.

Verification using other as described earlier

The 58534A GPS Timing Antenna responds to NMEA-0183 Standard commands listed and described in Chapter 4 of this manual. To verify its performance using non-Symmetricom software, check to be sure that the antenna:

- is receiving signals from a suitable number of satellites
- is reporting its position correctly
- is generating the 1PPS output, and that the 1PPS pulse can be adjusted to compensate for cable length
- can be switched between Survey and Position Hold modes

Specific operating instructions are given in Chapter 3 of this manual.

To use this verification method—

1 Install the antenna as described earlier.

2 Connect the antenna to the PC as described above.

3 Install the software you want to use in the PC. If you need information about installing or operating the software, contact the software provider.

4 Connect the antenna to a source of operating power.

5 Send commands to determine if the antenna is receiving data from satellites.

The antenna should begin receiving satellite data within two minutes after it was connected to its power source.

6 Send commands to determine if the antenna is outputting a 1PPS pulse.

The antenna should begin outputting a 1PPS pulse within 12.5 minutes after it was connected to its power source.

Verification when software is not available

If a PC running either 58531A GPS Timing Receiver Analysis and Control Software or other software that can communicate with the antenna is not available, you may be able to verify antenna operation by connecting it to an oscilloscope and power supply.

Be aware, however, that this method is the least-preferred choice, because it does not provide information about whether the antenna is receiving data from satellites.

To use this verification method—

1 Install the antenna as described earlier.

2 Connect the antenna 1PPS outputs to the Oscilloscope.

3 Connect the antenna to a source of operating power.

The antenna should begin outputting a 1PPS pulse within 12.5 minutes after it was connected to its power source.

4 Turn on the oscilloscope power.

5 Adjust the oscilloscope controls to enable display of the antenna's 1PPS output signal.

Initially, your oscilloscope settings should be—

- Vertical amplifier: for a 1.4 Vp-p signal
- Trigger: free-run, so any received signal will be displayed
- Sweep: to display one or more cycles of a 1-Hz square wave.

Alternative user interface circuit

The information presented in this manual presumes that you are using 58534A Option 001 GPS Timing Antenna Evaluation Kit for your interface. If you are not using the Evaluation Kit, you must provide a suitable interface circuit for the 58534A GPS Timing Antenna's signals. One suggested circuit is shown in Figure 2-4.

Alternative user interface circuit

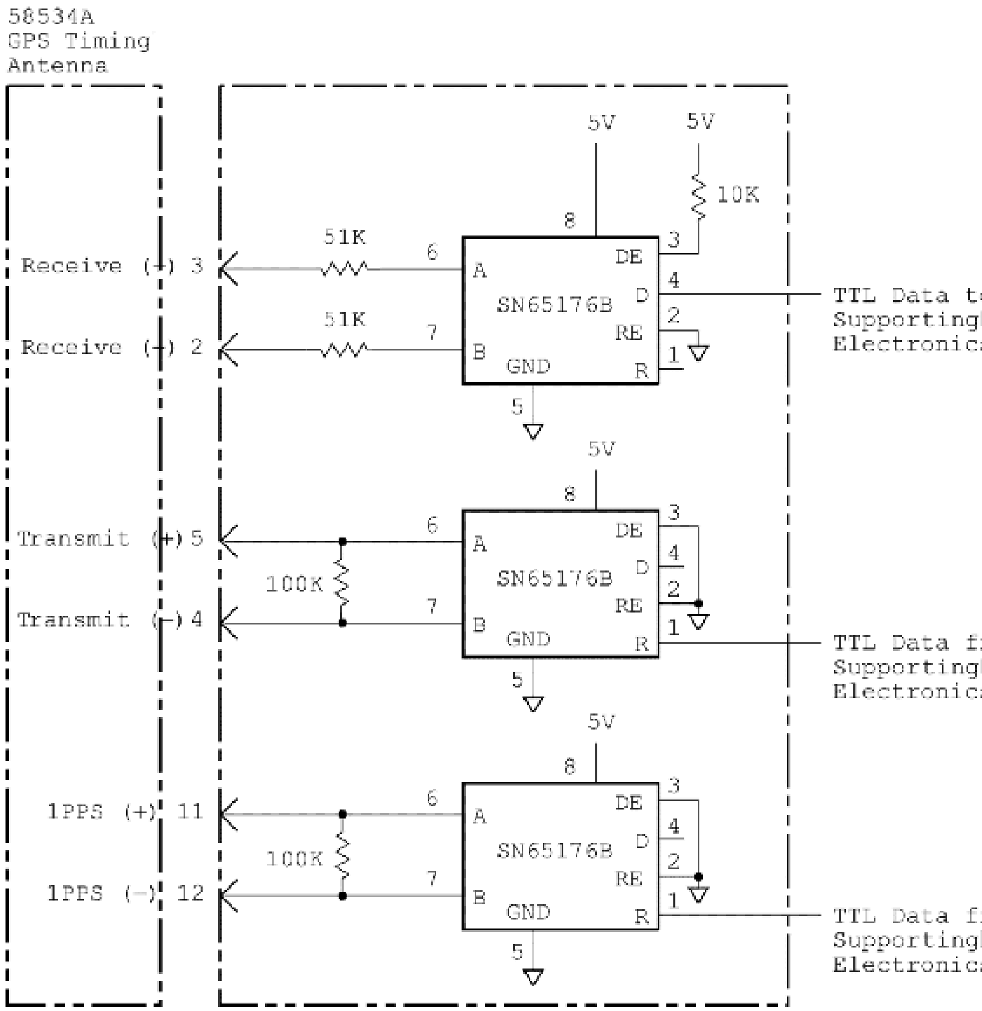


Figure 2-4. Suggested alternative user interface circuit

Alternative user interface circuit

3

Operation

Introduction

Operation of the 58534A GPS Timing Antenna is controlled via commands sent to it from software operating in a PC (Personal Computer) or other control electronics.

The information presented in this chapter assumes that:

- the 58534A GPS Timing Antenna has been installed as described in Chapter 2,
- control software is installed in a PC,
- operating power is being supplied to the 58534A GPS Timing Antenna,

If the control software is installed in electronics other than a PC (such as a UNIX system), you will have to modify these instructions as needed.

Operating Modes

The 58534A GPS Timing Antenna has two operating modes—Survey mode, and Position Hold mode.

Survey mode

In Survey mode, the 58534A GPS Timing Antenna works as a “navigational” device, calculating and reporting its position (Latitude, Longitude, and Altitude), and its 1PPS clock.

Position Hold mode

In Position Hold mode, the 58534A GPS Timing Antenna works as a “timing” device. In this mode, the antenna’s position is fixed. The receiver uses the position information to calculate the timing for its 1PPS clock. Because the receiver’s calculation resources are not needed for position calculation, it can devote them to providing a more accurate resolution of when it should output its 1PPS clock pulse.

Parameters

There are several parameters you can specify for 58534A GPS Timing Antenna receiver operation.

Mask angle

Mask angle is the minimum angle above the horizon a satellite must be in order to be included among those whose signals the receiver uses in making its calculations.

C/N (dB-Hz)

C/N is the carrier-to-noise ratio in a 1-Hz bandwidth. Typical range is 35 to 55, the higher the better.

1PPS correction

The 1PPS signal generated by the receiver is delayed in its arrival at the control electronics by the length of the cable connecting the two. This parameter allows a correction to be applied to the 1PPS pulse signal to compensate for the delay due to cable length, so the pulse seems to arrive at the control electronics at the correct time.

The 1PPS signal is synchronous with the rising edge of the output pulse of the 58534A GPS Timing Antenna's internal receiver. The drawing below shows how timing delays are assigned to determine the required correction.

The corrections due to transit times through the transmitting and receiving electronics (t_x and t_r) are 10 ns and 17 ns, respectively.

The correction due to transit time through the connecting cable (t_c) has two components.

- One component (t_{length}) is directly proportional to the cable length—approximately 5.48 ns/m (1.67 ns/ft).
- The second component ($t_{rise}/2$) is the compensation for rise-time degradation caused by the cable length—approximately 1.0 ns/m (0.3 ns/ft).

  The longer the cable, the longer the rise time will be. The risetime-degradation delay ($t_{rise}/2$) represents the time it takes for the transitioning voltage levels of the differential 1PPS signals (1PPS(+) and 1PPS(–)) to momentarily become identical as they switch states. The 1PPS positioning electronics assigns this as the time when the pulse should have occurred.

The delay (t_c) for a 152-meter (500-foot) cable is about 985 ns (152 × 6.48 ns). The overall delay for the setup shown in Figure 3-1 is about 1012 ns (985+10+17) for a 152-meter cable.

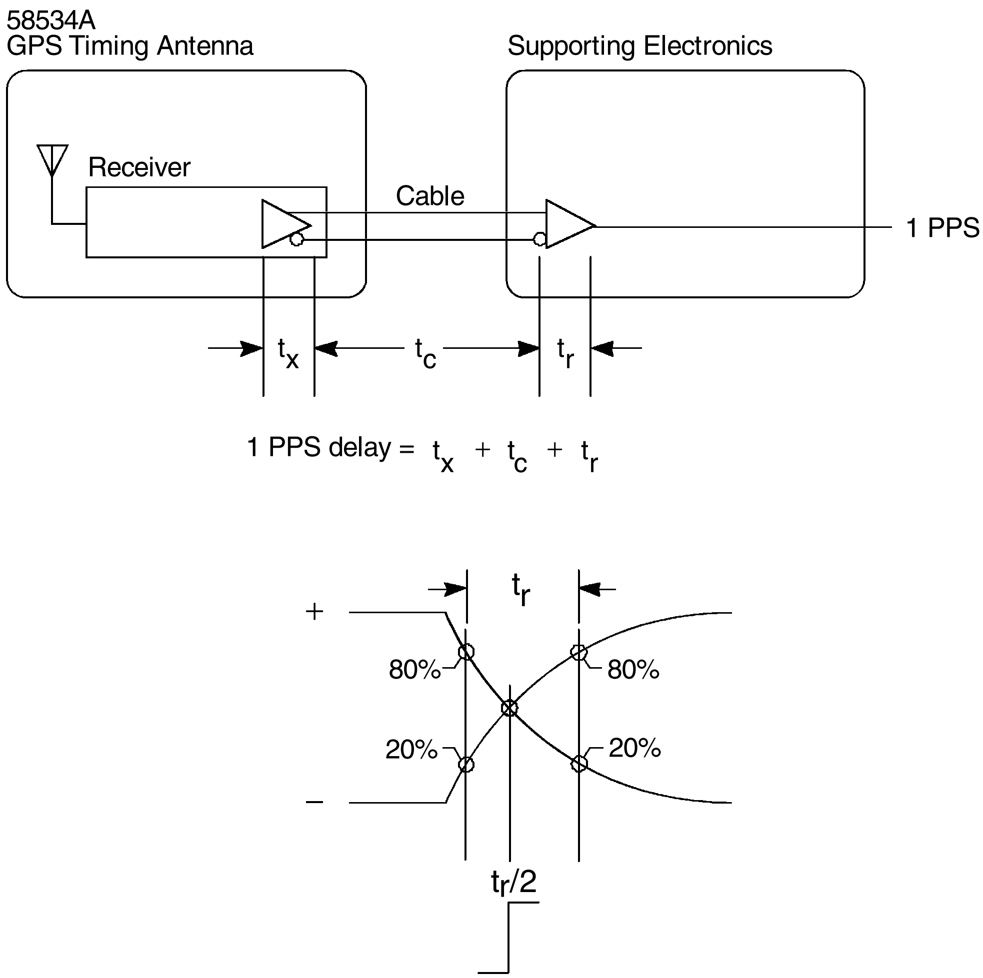


Figure 3-1. 1PPS Correction

TRAIM

TRAIM's main function is to report the integrity of the 1PPS output. Additionally, the TRAIM condition can be used to control availability of the 1PPS output. For detail see "$PFEC,GPrrq (in)" on page 4-61.

TRAIM stands for "Time Receiver Autonomous Integrity Monitoring". When TRAIM is enabled and the receiver is in Position Hold mode, the receiver performs a consistency check on the data from the satellites it is receiving. If data from a satellite does not seem to fit with that from the other satellites, the receiver can reject the data from that satellite and output a TRAIM alarm.

Once a receiver has declared a satellite unusable, it does not check that satellite's performance until the beginning of the next hour. If the satellite is still unusable, the TRAIM alarm will stay on. If the satellite has become usable, its data will be included in the receiver's calculations. The TRAIM alarm will automatically end at the beginning of any hour when there is no anomalous data from any received satellite.

TRAIM can be enabled or disabled via the $PFEC,GPrrs command (page 4-62). Note that even if TRAIM is enabled, it will not be active unless the GPS receiver is in the Position Hold mode.

TRAIM mode: "Detect/Isolate" means both "Detect" and "Isolate" are achievable. "Detect only" means only "Detect" is achievable. "No detect/isolate" means both "detect" and "isolate" are unachievable.

TRAIM alarm: "No alarm" means no alarm occurred. "Alarm" means an alarm occurred. "Unknown" means TRAIM is not enabled or not active.

Reacquisition time

Reacquisition time is the time it takes the 58534A GPS Timing Antenna to reacquire satellites following a power loss.

If power is lost, the RAM (Random Access Memory) which stores the navigation and satellite data continues to be powered by a super-capacitor for up to 2 hours. This lets the 58534A GPS Timing Antenna reacquire satellites within 20 seconds after power is restored.

Be aware that competing products may define reacquisition time differently—for example, as the time to reacquire satellites after blocking GPS signals from reaching the antenna.

4

Software Reference

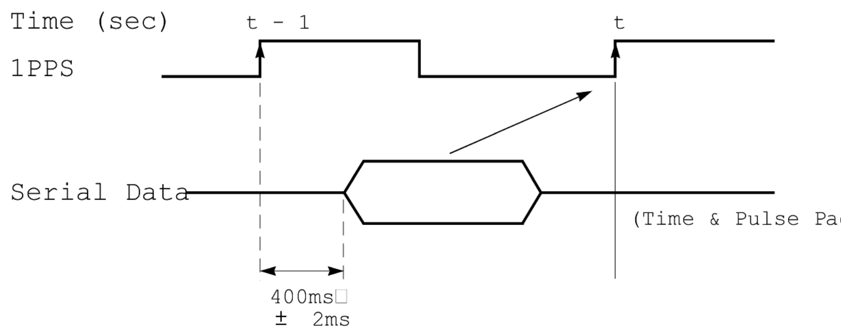
Specifications for 1PPS clock signal

(1PPS = 1 Pulse Per Second.)

Table 4-1. 1PPS Clock Signal—Specifications

Name	Description
Accuracy	± 110 ns referenced to UTC (USNO MC)—95 % probability when unit is properly installed and locked to GPS. (The 58534A GPS Timing Antenna should be placed at a fixed position. This accuracy cannot be expected if the unit is moved during operation.)
Polarity	Rising edge of each pulse
Level	TTL HIGH: 2.4 V (with 0.8 mA flowing out of the 1PPS terminal) LOW: 0.5 V (with 6.0 mA flowing into the 1PPS terminal)
Duty	50 % approx.

Table 4-1. 1PPS Clock Signal—Specifications (Contd)

Name	Description
Conditions for 1PPS output	The almanac must be available within the 58534A GPS Timing Antenna. There are additional conditions which differ between the estimated and fixed observation point modes. For further details see “2. ESTIMATED AND FIXED OBSERVATION POINT MODES” of this document.
Output timing of “tps” (Time and Pulse) serial data packet	 "$PFEC,GPtps" sentence for pulse "t" (76 bytes fixed) **NOTE** The 58534A GPS Timing Antenna transmits a series of data packets directly before the rising edge of each 1PPS pulse. The sum of the characters contained in the series of data packets cannot exceed 480 characters. If there are more than 480 characters in the serial data packets, the last packets may be lost or may corrupt the other packets. The first character of the first serial data packet is transmitted 400 ms (± 2 ms) following the rising edge of a 1PPS pulse. A date/time stamp for a 1PPS pulse is included in the serial data packets which are transmitted by the 58534A GPS Timing Antenna directly before the rising edge of each 1PPS pulse. In a series of data packets, the date/time stamp is normally the last data packet in the series. In the case that a TRAIM status message is included in the series of data packets, the TRAIM data packet will be the last data packet in the series. The date/time stamp data packet will directly precede the TRAIM data packet.

Sample Command Lines to enable “$PFEC,GPtps” output

Example 1: Output only “$PFEC,GPtps” data packet every second

$PFEC,GPint,GGA00,ZDA00,GSV00,VTG00,tps01 <CR><LF>

<u>Example 2:</u> Output both “$GPGGA” and ‘$PFEC,GPtps” data packets every second

$PFEC,GPint,GGA01,ZDA00,GSV00,VTG00,tps01 <CR><LF>

Conditions for 1PPS Output

To output 1PPS, the 58534A GPS Timing Antenna requires the almanac because the almanac includes a UTC parameter (UTC correction factor) which is needed to achieve ± 110 ns accuracy.

Upon initial power-up, the 58534A GPS Timing Antenna must collect information from the satellites for a period of at least 12.5 minutes to determine the almanac.

If power is lost during operation, a super-capacitor in the 58534A GPS Timing Antenna will keep the GPS data RAM powered for typically 2 hours. Thus, the almanac is preserved during this time period, allowing the 58534A GPS Timing Antenna to reacquire satellites within 20 seconds after power is restored.

The date/time stamp of a UTC parameter is in the Time and Pulse data packet “$PFEC,GPtps”. See the following example.

<u>Example: Date/time stamp of a UTC parameter</u>

$PFEC,GPtps,
940630123000,3,1,1,940701000000,+1,10,<u>940626120000</u>,0755,390610
<CR><LF>

The underlined portion indicates that the existing UTC parameter was received at 94/06/26 (yy/mm/dd) 12:00:00 (hh:mm:ss).

OBSERVATION POINT MODES

Table 4-2. Observation Point Modes

Mode	Description
Estimated Observation Point Mode (also known as "Survey" mode)	Default mode after power-on reset 1PPS is obtainable without entry of own position information.
Fixed Observation Point Mode	Entry of own position information is required for 1PPS output

To specify an Observation Point Mode, send a "$PFEC,GPset" command.vm See the following examples.

Table 4-3. Specifying an Observation Point Mode

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

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

Table 4-4. Determining currently-selected Observation Point Mode

Command	Result
$PFEC,GPsrqr<CR><LF>	58534A GPS Timing Antenna returns $PFEC,GPssd .... Z2<CR><LF> where: "Z2" indicates Fixed Observation Point Mode. If Estimated Observation Point mode is in use, "ZI", rather than 'Z2", will be returned.

Estimated Observation Point Mode

This mode

- is the default mode after power-on reset, and
- is used when the 58534A GPS Timing Antenna's own position is unknown.

In this mode, the 58534A GPS Timing Antenna outputs 1PPS while performing position-fixing. This mode is also usable to determine the 58534A GPS Timing Antenna's own position, which is used for Fixed

Observation Point mode operation. To determine the receiver's own position, operate it continuously for 12 to 24 hours, then use the average position as the entry for the fixed observation point mode operation.

Conditions for 1PPS output in the Estimated Observation Point mode are:

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

   Tracking four or more satellites

   Starting position fixing

   UTC calculation completes

   <u>NOTE:</u> UTC calculation is performed when the following conditions are met:

   a. A UTC parameter (included within the 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 58534A GPS Timing Antenna outputs 1PPS by using the position data for time correction.

3) If position-fixing is interrupted, the 58534A GPS Timing Antenna continues outputting 1PPS so long as at least one satellite is receivable. It stops outputting 1PPS when it cannot receive a satellite. When it receives one satellite, it outputs 1PPS.

Fixed Observation Point Mode

This mode

- is the default mode except immediately after power-on reset or when the receiver's own position is unknown
- is usable when the 58534A GPS Timing Antenna's own position is known.

The 58534A GPS Timing Antenna must be fixed at the known position. As soon as a satellite becomes receivable, the 58534A GPS Timing Antenna starts outputting 1PPS based on the position information which you entered.

The 58534A GPS Timing Antenna does not perform position-fixing in this mode, but merely outputs the position data you entered.

1) Fixed-position entry

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

Table 4-5. Fixed position entry

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

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

Table 4-6. Entering latitude, longitude, and altitude in one sentence

Sentence	Effect
$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, and altitude

2) Conditions for 1PPS output

1PPS is output after a series of the following operations have been completed:

58534A GPS Timing Antenna is turned on

58534A GPS Timing Antenna receives a satellite

UTC calculation completes

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

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

BAUDRATE & CHARACTER FORMAT

System:	Asynchronous Full Duplex
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:	TD and RD only
Data Output Interval:	0 to 2 seconds

Character Codes used

NMEA-0183 Sentences:	ASCII (HEX 0D,0A,24,2A,2C,2E, and alphanumeric
Differential GPS Data:	Binary (“6-of-8” format) (B7=0, B6=1, Only B5 to B0 are used.)

PROTOCOLS

NMEA-0183 Sentences:	NMEA-0183 Ver 2.0 (Approved/proprietary sentences) (Input/Output)
Differential GPS Data:	RTCM SC-104 Ver 2.0 (Input only)

NOTE: NMEA-0183 sentences and differential GPS data inputs may coexist because the 58534A GPS Timing Antenna can distinguish them automatically.

ABOUT NMEA-0183 PROTOCOL

Approved Sentences

An approved sentence is one whose format is 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 fieId>]<CR><LF>

where:

Field	Description
$	Start-of-Sentence marker
<address field>	5-byte fixed length. The first 2 bytes represent a talker ID, the remaining 3 bytes are a sentence format identifier. All sentences transmitted by the 58534A GPS Timing Antenna bear talker ID “GP” meaning a GPS receiver. For sentences received from external equipment, the 58534A GPS Timing Antenna accepts any talker ID. Talker ID “XX” found on the succeeding pages is a wild card meaning “any valid talker ID”.
,<data field>	Variable- or fixed-length fields preceded by a comma (“,”) delimiter. A comma is required even when valid field data is not available—that is null fields. Example: . “,,,,” In a numeric field with fixed field length, fill unused leading digits with zeroes. (Do not suppress leading zeroes.)
*<checksum field>	Generally not required, with the exception of an “RMC” sentence. Eight bits of 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 a comma (“,”) delimiter is not required before *<checksum>. Only RMC sentences are transmitted with a checksum. All other output sentences do not include *<checksum>. For input sentences, *<checksum> is ignored.
<CR><LF>	End-of-Sentence marker

Maximum length from “$” to “<CR><LF>” is limited to 82 bytes including “$” and “<CR><LF>”.

Examples of Approved Sentences:

$GPGLL,3444.000,N,13521.00,E,E<CR><LF>

$XXGLL,3444.000,N,13521.00,E,E<CR><LF>

"XX" may be any valid talker ID, such as "LC" (Loran C).

Proprietary Sentences

The NMEA-0183 standard allows nav-aid makers to send proprietary sentences if the minimum rules defined by the NMEA are obeyed. Proprietary sentences must take the following form, but makers may determine what kinds of fields are included and the order in which they are sent.

$P<maker ID>,<data field> <CR><LF>

where:

Field	**Description**
$	Start-of-Sentence marker
P	Proprietary sentence identifier
<maker ID>	3-byte fixed length. The 58534A GPS Timing Antenna's "maker ID" is "FEC", meaning Furuno Electric Company. The receiver is made to Symmetricom specifications by Furuno Electric Company.
,<data field> ...	Variable or fixed-length fields preceded by delimiter ","(comma). (Layout is maker-definable.)
<CR><LF>	End-of-Sentence marker

List of NMEA-0183 Sentences

The following NMEA-0183 sentences are supported by the 58534A GPS Timing Antenna.

Table 4-7. List of NMEA-0183 Sentences

INPUT SENTENCE		See Page	OUTPUT SENTENCE		See NOTE	See Page
$XXGLL	Set initial position	4-15	$GPGLL	Position	O	4-33
$XXGGA	Set initial position	4-16	$GPGGA	Position, time, etc.	OO	4-30
$XXZDA	Set time, etc.	4-17	$GPZDA	Time, etc.	OO	4-32
$XXRMC	Set initial position, time	4-18	$GPRMC	Position, time, speed, course	O	4-37
			$GPVTG	Speed, course	OO	4-36
			$GPGSA	Status, DOP	O	4-34
			$GPGSV	Satellite details	OO	4-35
$PFEC,GPclr	Restart	4-20				
$PFEC,GPset	Set rx parameters	4-21				
$PFEC,GPsrq	Send rx parameters	4-23	$PFEC,GPssd	Answer to $PFEC,GPsrq	A	4-47
$PFEC,GPint	Set sentence output interval	4-24				
$PFEC,GPirq	Send data output interval	4-27	$PFEC,GPisd	Answer to PFEC,GPirq	A	4-48
$PFEC,GPdif	Set DGPS parameters	4-28				
$PFEC,GPdrq	Send DGPS parameters	4-29	$PFEC,GPds d	Answer to PFEC,GPdrq	A	4-49
			$PFEC,GPdie	DGPS status	O	4-50
			$PFEC,GPalt	Number of satellites expected in coming 24 hours	O	4-39
			$PFEC,GPan c	Date of existing almanac	O	4-41
			$PFEC,GPacc	SV accuracy	O	4-42
			$PFEC,GPast	GPS fix (position, local time)	O	4-43
			$PFEC,GPtst	Selftest result	O	4-45
			$PFEC,GPgpt	GPS time output	O	4-56
			$PFEC,GPtlp	UTC prediction	O	4-57

Table 4-7. List of NMEA-0183 Sentences (Contd)

INPUT SENTENCE		See Page	OUTPUT SENTENCE		See NOTE	See Page
$PFEC,GPrrs	Configure TRAIM and 1PPS pulse output	4-62	$PFEC,GPrsd	TRAIM settings (response to $PFEC,GPrrq)	A	4-64
$PFEC,GPrrq	Query settings configured by $PFEC,GPrrs	4-61	$PFEC,GPrrm	TRAIM status	O	4-63

NOTE:	Meaning
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

NMEA-0183 INPUT SENTENCES

$XXGLL (in)

Set initial position

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

Example

$XXGLL	,3444.123,N	,03521.5,E	.	.	<CR><LF>
Field#	1	3	5	6	

#	Description	Range	[Bytes]
1	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	Longitude		
	“035”: degree	000–180	[3]
	“21”: minute (integer)	00–59	[2]
	“5”: minute (fraction)	0–9999	[variable] see NOTE
	“E”: East/West	E or W	[1]
5, 6	Null Fields	Any entry is ignored.	

NOTE: Digits below 1/10000 are ignored.

Interpreting the Example

34 deg 44.123 min N
35 deg 21.5 min E

$XXGGA (in)

Set initial position

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

Example

$XXGGA	,	,3444.123,N	,03521.5,E	. . . .	<CR><LF>
Field #	1	2	4	6–14	

#	Description	Range	[Bytes]
2	Latitude		
	“34”: degree	00–99	[2]
	“44”: minute (integer)	00–59	[2]
	“123”: minute (fraction)	0–9999	[variable] See NOTE
	“N”: North/South	N or S	[1]
4	Longitude		
	“035”: degree	000–180	[3]
	“21”: minute (integer)	00–59	[2]
	“5”: minute (fraction)	0–9999	[variable] See NOTE
	“E”: East/West	E or W	[1]
6–14	Null Fields	Any entry is ignored.	
	NOTE: Digits below 1/10000 are ignored.		

Interpreting the Example

34 deg 44.123 min N
35 deg 21.5 min E

$XXZDA (in)

Set date/time

Example

$XXZDA	,123456	,01	,02	,1995	,-09	,00	<CR><LF>
Field #	1	2	3	4	5	6	

#	Description	Range	[Bytes]
1	UTC Time		
	"12": hour	00–23	[2]
	"34": minute	00–59	[2]
	"56": seconds	00–59	[2]
2	UTC Date		
	"01": day of month	01–31	[2]
3	UTC Month		
	"02": month number	01–12	[2]
4	UTC Year		
	"1995": year	1994–2040	[4]
5	Local Zone Time (hour) (Relative to UTC) See NOTE.		
	"-09": hour	–13 to +13 (– = East, + = West of date line)	[3]
6	Local Zone Time (minute)		
	"00": minute	00–59	[2]
	NOTE: Local zone time setting is used for calculating local time when outputting GPS fix ($PFEC,GPast): (Local Time) = (UTC) – (Local Zone Time)		

Interpreting the Example

February 1, 1995
12:34:56
Local Zone Time: –09:00 (Standard time in Tokyo, Japan)

$XXRMC (in)

Set initial position/UTC

Example

$XXRMC	,123456	,	,3444.123,N	,13521.456,E	. .	,020194	. .	<CR><LF>
Field #	1	2	3	5	7 8	9	10 11	

#	Description	Range	[Bytes]
1	UTC Time		
	"12": hour	00–23	[2]
	"34: minute	00–59	[2]
	"56: second	00–59	[2]
2	Null field	Any entry is ignored	
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]
5	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]
7, 8	Null fields	Any entry is ignored.	
9	UTC Date		
	"02": day of month	02–31	[2]
	"01": month number	01–12	[2]
	"94": year	94–40 (1994–2040)	[2]
10, 11	Null fields	Any entry is ignored.	
	NOTE: Digits below 1/10000 are ignored		

Interpreting the Example

January 2, 1994
12:34:56
34 deg. 44.123 min. N
135 deg. 21.456 min. E

$PFEC,GPclr (in)

Restart

Example

$PFEC,GPclr	,1	<CR><LF>
Field #	2	

#	Description	Range	[Bytes]
2	Mode	1–3 “1”: All Clear Start “2”: Restart “3”: Autonomous Start	[1]

Interpreting the Example

All Clear Start

$PFEC,GPset (in)

Set up receiver parameters

Example

$PFEC,GPset	,DO5	,UO0200000	. . . .	<CR><LF>
Field # 1	2	3	4	

#	Description	Range	[Bytes] (Unit) {Default}
2			
3			
4			
	Up to eight parameters in any order, preceded by delimiter “” (comma). See parameter syntax below. NOTE: Do not send the same parameter twice within the same sentence.		
	“Dnn”: PDOP Threshold	D00–D06	[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.		
	“Enn”: Elevation Angle mask for receivable satellite prediction	E05–E90	[3] (degrees) {E05}
	This parameter affects the $PFEC,GPalt output sentence. Satellites below this angle are excluded from prediction.		
	“Gnn”: Geodetic ID	G001–G171	[4] (n/a) {G001}
	“Hnnnnnn.n”: Altitude for 2D positioning	H-00999.9 to H017999.9	[9] (meters) {H000000.0}
	NOTE: When 3D positioning is performed, this data is updated.		
	“Mnn”: Mask by Elevation Angle	M05–M90	[3] (degrees) {M05}
	Satellites below this angle are ignored when positioning.		
	“Snn”: Mask by Signal Strength	S01–S99	[3] (dB-Hz) {S01}
	Satellites weaker than this level are ignored when positioning.		

#	Description	Range	[Bytes] (Unit) {Default}
	"Tsnnnn": 1PPS Correction	T-9999 to T+9999	[6] ($\times 0.1$ μs) {T+0000}
	0.1 μs corresponds to a 30-meter antenna cable length. Note that negative settings advance 1PPS pulses.		
	"tsnnnnnn": 1PPS Correction	T-999999 to T+999999	[8] (ns) {t+000000}
	Similar to "Tsnnnn", above, except provides two more places of resolution—1 ns corresponds to a 30-cm antenna cable length. This parameter advances ("–") or retards ("+") the 1PPS pulse in one-nanosecond increments. It is equivalent to "Tsnnnn", which can be used if fine adjustment of this offset is unnecessary. The "tsnnnnnn" and "Tsnnnn" settings are coupled. For example, "t+000100" and "T+0001" are equivalent		
	"Wn": Smoothing index	W1–W3	[2] (n/a) {w2}
	"Xn": Dynamic index	X1–X3	[2] (n/a) {X2}
	"Uhhhhhhhh": Delete satellites	U00000000 to UFFFFFFFF	[9] (n/a) {n/a}
	"hhhhhhhh" means eight hexadecimal characters, representing a bit map of 32 bits. Each bit within the bit map represents one satellite; "00000001" and "80000000", for example, indicate satellites SV#1 and SV#32, respectively. Example: "PFEC,GPset,U0000000F"<CR><LF> declares satellites SV#1 to SV#4 as "unhealthy". Note that satellites with their bits cleared are declared as being "healthy". In the above example, satellites SV#5 through SV#32 are implicitly declared as "healthy". In the following example, the first sentence declares satellite SV#5 as "unhealthy". Example: "PFEC,GPset,U00000010"<CR><LF> "PFEC,GPset,U00000000"<CR><LF>		
	"Zn": Positioning Mode "Z1"	Z1–Z2 "Z1": Estimated Observation Point ("survey") "Z2": Fixed Observation Point ("position hold")	[2] (n/a) {Z1}

$PFEC,GPsrq (in)

Get receiver parameters

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

$PFEC,	GPsrq	<CR><LF>

$PFEC,GPint (in)

Request output/Set log output intervals

Example

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

#	Description	Range	[Bytes](unit){Default}
2			
3			
4	Up to thirteen parameters in any order, preceded by delimiter "," (comma). See parameter syntax below:		
	"Param": Log Output Sentence <Log Output Sentence length in bytes>		
	"GGAnn": $GPGGA<79 max>	GGAOO–GGA60	[5](sec){GGA01)
	"ZDAnn": $GPZDA<33>	ZDAOO–ZDA60	[5](sec){ZDA01}
	"GLLnn": $GPGLL<41 >	GLLOO–GLL60	[5](sec){GLL00)
	"GSAnn": $GPGSA<66 max>	GSAOO–GSA60	[5](sec){GSA00}
	"GSVnn": $GPGSV<201 max>	GSVOO–GSV60	[5](sec){GSV0l}
	"VTGnn": $GPVTG<41 max>	VTGOO–VTG60	[5](sec){VTG01}
	"RMCnn": $GPRMC<72 max>	RMCOO–RMC60	[5](sec){RMC00}
	"altnn ": $PFEC,GPalt<49>	alt00–alt60	[5](sec){alt00}
	"ancnn": $PFEC,GPanc<59>	anc00–anc60	[5)(sec){anc00}
	"accnn": $PFEC,GPacc<46>	acc00–acc60	[5](sec){acc00}
	"astnn ": $PFEC,GPast<82>	ast00–ast60	[5](sec){ast00}
	"tstnn": $PFEC,GPtst<29>	tst00–tst60	[5](sec){tst00}
	"rrmnn": $PFEC,GPrrm<38>	rrm00–rrm60	[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.

The 58534A GPS Timing Antenna can output about 480 bytes 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 the bytecount of each sentence, enclosed within "< >", in the above list.

Example

PFEC,GPint,tst00<CR><LF>
Output self-test result once.

$PFEC,G Pint, RMC05<CR><LF>
Output “$GPRMC” sentence every five seconds.

$PFEC,GPint (in)

Request output/Set log output intervals

#	Description	Range	[Bytes]	(unit)	{Default}
	"Param":				
	Log Output Sentence				
	<Log output sentence length in bytes>				
	"tlpnn": $PFEC,GPtlp<41>	tlp00–tlp60	[5]	(second)	{tlp00}
	"tpsnn": $PFEC,GPtps<76>	tps00–tps60	[53]	(second)	{tps01}
	"gptnn": $PFEC,GPgpt<27>	gpt00–gpt60	[153]	(second)	{gpt00}
	"rrmnn": $PFEC,GPrrm<38>	rrm00–rrm60	IN	(second)	{rrm00}

$PFEC,GPirq (in)

Get log sentence output intervals

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

$PFEC,	GPirq	<CR><LF>

$PFEC,GPdif (in)

Set DGPS parameter

Example,

$PFEC,GPdif	,D0	<CR><LF>
Field #1	2	

#	Description	Range	[Bytes]
2	Bit stream direction of RTCM SC-104 DGPS data	D0–D1 “D0”: MSB first “D1”: LSB first	[2]

Interpreting the Example

DGPS data will be transmitted from MSB.

$PFEC,GPdrq (in)

Get DGPS parameter

Issue this sentence when you need the DGPS parameter set by "$PFEC,GPdif". The answer will be output as a "$PFEC,GPdsd" sentence.

$PFEC	GPdrq	<CR><LF>

NMEA-0183 OUTPUT SENTENCES

$GPGGA (out)

Position, altitude, UTC, etc.

Example

	$GPGGA	,123456	,3444.0000,N	13521.0000,E
Field #		1	2	4

,1	,04	,02.00	,000123.0	,M	,0036.0	,M	,13	,001	<CR><LF>
6	7	8	9	10	11	12	13	14	

#	Description	Range	[Bytes]
1	UTC		
	“12”: hour	00–23	[2]
	“34”: minute	00–59	[2]
	“56”: second	00–59	[2]
2	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	Longitude		
	“135”: degree	000–180	[3]
	“21”: minute (integer)	00–99	[2]
	“0000”: minute (fraction)	0000–9999	[4]
	“E”: East/West	E or W	[1]
6	Status	0–2 “0”: Positioning not started yet “1”: Standalone GPS positioning “2”: Differential GPS positioning	[1]
7	Number of satellites used for positioning	00–08	[2]

#	Description	Range	[Bytes]
8	DOP (2D: HDOP, 3D: PDOP)	n/a	[5]
	NOTE: “00.00” is output while positioning is interrupted		
9	Altitude	–000999.9 to 017999.9	[8]
10	Unit for altitude	M	[1]‘
11	Geoid altitude	–999.9 to 9999.9	[6]
12	Unit for geoid altitude	M	[1]
13	DGPS data time	00–99	[variable]
	This value indicates the time elapsed since the last RTCM-SC104 TYPE 1 or 9 data updating. If DGPS mode is not selected, a null field is output.		
14	DGPS Station ID	0000–1023	[4]
	If DGPS mode is not selected, a null field is output.		

Interpreting the Example

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

$GPZDA (out)

Date/Time

Example

$GPZDA	,123456	,01	,02	,1995	,+09	,00	<CR><LF>
Field #	1	2	3	4	5	6	

#	Description	Range	[Bytes]
1	UTC: Time		
	“12”: hour	00–23	[2]
	“34”: minute	00–59	[2]
	“56”: second	00–59	[2]
2	UTC: Day of month		
	“01”: day of month	01–31	[2]
3	UTC: Month		
	“02”: month number	02–12	[2]
4	UTC: Year		
	“1995”: year	1994–2040	[4]
5	Local Zone Time (hour)		
	“+09”: hour	–13 ... +00 ...+13 –/+: East/West of data line	[3]
6	Local Zone Time (minute)		
	“00”: minute	00–59	[2]
	NOTE: Local zone time setting is used for calculating local time when outputting $PFEC,GPast: Local Time = UTC – Local Zone Time		

Interpreting the Example

February 1, 1995
12:34:56
Local Zone Time: +09:00

$GPGLL (out)

Position, UTC, etc.

Example

$GPGLL	,3444.1234,N	,03521.0000,E	,123456	,A	<CR><LF>
Field #	1	3	5	6	

#	Description	Range	[Bytes]
1	Latitude		
	“34”: degree	0–90	[2]
	“44”: minute (integer)	0–59	[2]
	“1234”: minute (fraction)	0000–9999	[4]
	“N”: North/South	N or S	[1]
3	Longitude		
	“135”: degree	000–180	[3]
	“21”: minute (integer)	00–99	[2]
	“0000”: minute (fraction)	0000–9999	[4]
	“E”: East/West	E or W	[1]
5	UTC: Time		
	“12”: hour	00–23	[2]
	“34”: minute	00–59	[2]
	“56”: second	00–59	[2]
6	Status	A or V	[1]
		“A”: Positioning (Standalone or DGPS)	
		“V”: Positioning interrupted	

Interpreting Example

34 deg 44.1234 min N
35 deg 21.0000 min E
UTC: 12:34:56
Status: Positioning

$GPGSA (out)

Positioning status

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 or 3D auto-switching mode	[1]
2	Positioning status	1–3 “1”: Positioning interrupted “2”: 2D positioning “3”: 3D positioning	[1]
3–14	Satellite numbers used for positioning	01–32 NOTE: A null field is output if no satellite is unavailable	[2]
15	PDOP	n/a NOTE: “00.00” is output unless 3D positioning is performed	[5]
16	HDOP	n/a NOTE: “00.00” is output while positioning is interrupted	[5]
17	VDOP	n/a NOTE: “00.00” is output unless 3D positioning is performed	[5]

Interpreting the 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	,254	,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 number of messages	1–3	[1]	n/a
2	Number of message	1–3	[1]	(n/a)
3	Number of satellites in line-of-site (with elevation angle higher than 5 degrees)	00–12	[2]	(n/a)
4	First satellite SV#	01–31	[2]	
5	First satellite Elevation Angle	05–90	[2]	degrees
6	First satellite Bearing Angle	000–359	[3]	degree
7	First satellite SNR (Signal/Noise ratio) (C/N_o)	00–99	[2]	dB-Hz
8–11	Second satellite details (similar to 4–7)			
12–15	Third satellite details (similar to 4–7)			
16–19	Fourth satellite details (similar to 4–7)			

$GPVTG (out)

Course and speed

Example

$GPVTG	,012.3,t	,001.1,M	,001.2,N	,0002.2,K	<CR><LF>
Field #	1	3	5	7	

#	Description	Range	[Bytes]	(unit)
1	True course			
	“012.3”	000.0–359.9	[variable]	(degree)
	“T” (meaning TRUE)	T	[1]	(n/a)
	NOTE A null field is output unless true course information is available.			
3	Magnetic course			
	“001.1”	000.0–359.9	[variable]	(degree)
	“M” (meaning MAGNETIC)	m	[1]	(n/a)
	NOTE A null field is output unless magnetic course information is available.			
5	Speed (kts)			
	001.2	000.0–999.9	[variable]	(kts)
	“N” (meaning kNot)	N	[1]	(n/a)
	NOTE A null field is output unless speed information is available.			
7	Speed (km/h)			
	“0002.2”	0000.0–9999.9	[variable]	(km/h)
	“K” (meaning Km/h)	K	[1]	(n/a)
	NOTE A null field is output unless speed information is available.			

$GPRMC (out)

UTC, position, course, speed, etc.

Example

$GPRMC	,123456	,A	,3444.1234,N	,12521.4567,E
Field #	1	2	3	5

,005.6	,123.5	,020195	,001.0,W
7	8	9	10

*FF	<CR><LF>
Checksum	

#	Description	Range	[Bytes]
1	UTC: Time		
	“12”: hour	00–23	[2]
	“34”: minute	00–59	[2]
	“56”: second	00–59	[2]
2	Status	A or V	[1]
		“A”: Positioning (Standalone or DGPS) “V”: Positioning interrupted	
3	Latitude		
	“34”: degree	0–90	[2]
	“44”: minute (integer)	0–59	[2]
	“1234”: minute (fraction)	0000–9999	[4]
	“N”: North/South	N or S	[1]
5	Longitude		
	“135”: degree	000–180	[3]
	“21”: minute (integer)	00–99	[2]
	“0000”: minute (fraction)	0000–9999	[4]
	“E”: East/West	E or W	[1]

#	Description	Range	[Bytes]
7	Speed (kts)		
	005.6	000.0–999.9	[variable]
	"N" (meaning kNot)	N	[1]
	NOTE A null field is output if speed information is unavailable.		
8	True course		
	"123.5"	000.0–359.9	[variable]
	"T" (meaning TRUE)	T	[1]
	NOTE A null field is output if true course information is unavailable.		
9	UTC Date		
	"02": day of month	02–31	[2]
	"01": month number	01–12	[2]
	"95": year	94–40 (1994–2040)	[2]
10	Magnetic deviation (degree)		
	"001.0"	001.0–180.0	[5]
	"W"	W or E "W": West (Magnetic=True − Deviation) "E": East (Magnetic=True + Deviation)	[1]
*Checksum			
	Eight bits data between "$" and "*" (excluding "$") and are XORed, and the result is converted to two bytes of hexadecimal letters. Only RMC sentences are transmitted with checksum. All other output sentences do not include checksum fields.		

Interpreting the Example

UTC Time 12:34:56
Positioning
34 deg. 44.1234 min. N
135 deg. 21.4567 min. E
Speed: 5.6 kts
True Course: 123.5 degrees
UTC Date Jan 2, 1995
Magnetic Deviation: 1.0 degree, West

$PFEC,GPalt (out)

No. of satellites coming within 24 hours

Example

			Column 1 24	
$PFEC,GPalt	,1	,08300100	,78ABAABBA987777788889999	<CR><LF>
Field #	2	3	4	

#	Description	Range	[Bytes]
2	Status	0 or 1 “0”: Calculating (Prediction data invalid) “1”: Calculation completed	[1]
3	Local Date/Time		
	“08”: month number	01–12	[2]
	“30”: day of month	01–31	[2]
	“01”: hour	00–23	[2]
	“00”: minute	00–59	[2]
4	Number of satellites which come in line of site within 24 hours This field is 24 bytes long. Each byte represents one hour. The number of satellites are output in hexadecimal notation. (A=10, B=11, ... F=15). Note that “tomorrow’s” data come first, then “today’s” data follows. See below.		

Interpreting the Example

Column #	Date	Time	Number of visible satellites
1	Aug. 31	00:00	7
2	Aug. 30	01:00	8
3	Aug. 30	02:00	10
4	Aug. 30	03:00	11
5	Aug. 30	04:00	10
6	Aug. 30	05:00	10
7	Aug. 30	06:00	11
8	Aug. 30	07:00	11
9	Aug. 30	08:00	10
10	Aug. 30	09:00	9
11	Aug. 30	10:00	8
12	Aug. 30	11:00	7
13	Aug. 30	12:00	7
14	Aug. 30	13:00	7
15	Aug. 30	14:00	7
16	Aug. 30	15:00	7
17	Aug. 30	16:00	8
18	Aug. 30	17:00	8
19	Aug. 30	18:00	8
20	Aug. 30	19:00	8
21	Aug. 30	20:00	9
22	Aug. 30	21:00	9
23	Aug. 30	22:00	9
24	Aug. 30	23:00	9

$PFEC,GPanc (out)

Almanac date and satellite's health condition

Example

	Column 1		32
$PFEC,GPanc	,940102030405	,22222200222222222222000000722221	<CR><LF>
Field #	2	3	

#	Description	Range	[Bytes]
2	Almanac Date/Time (Local Date/Time) "940102030405": (YYMMDDhhmmss)		[12]
3	Health conditions for 32 satellites Each column represents one satellite, from SV#1 through SV#32.	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 the Example

Almanac:	Jan. 2, 1994 03:04:05
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

. . . and so forth

$PFEC,GPacc (out)

SV(satellite) Accuracy

Example

Column	1 32	
$PFEC,GPacc	,222222XXXXXXXXX77777XXXXXXXXXXBF	<CR><LF>
Field #	3	

#	Description	Range	[Bytes]
2	SV accuracies for 32 satellites		
	Each column represents each satellite.	0–F: SV accuracy, in hexadecimal notation X: SV accuracy not available	[32]

Interpreting the 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

. . . and so forth

$PFEC,GPast (out)

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

Example

$PFEC,GPast	,4	,8	,1	,0356
Field #	2	3	4	5

,N34431234	,E135211234	,0
6	7	8

,940123123456	,01235	,12341	,1345	<CR><LF>
9	10	11	12	

#	Description	Range	[Bytes]
2	Status		
	"4"	0, 3–6 "0": Positioning not performed yet "3": Standalone GPS, 2D "4": Standalone GPS, 3D "5": DGPS 2D "6": DGPS 3D	[1]
3	Number of satellites used for positioning		
	"6"	0–8	[1]
4	Speed/course calculation status		
	"1"	0–1 "0": Data invalid (Can't calculate) "1": Data valid	[1]
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	0–90	[2]
	"44": minute (integer)	0–59	[2]

#	Description	Range	[Bytes]
	“1234”: minute (fraction)	0000–9999	[4]
7	Longitude		
	“E”: East/West	E or W	[1]
	“135”: degree	000–180	[3]
	“21”: minute (integer)	00–99	[2]
	“0000”: minute (fraction)	0000–9999	[4]
8	Altitude (x10 m)		
	“0012347”	–009999 to 017999	[6]
	NOTE: For actual altitude, divide the above value by 10		
9	Local Date/Time		
	“940123123456”: 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 by 10. If speed/course calculation status (Field #4) is “0” (invalid), output value is held.		
11	True course (x 10 degrees)		
	“1234”	0000–3599	[4]
	NOTE: For actual course, divide the above by 10. If speed/course calculation status (Field #4) is “0” (invalid), output value is held.		
12	Magnetic course (x 10 degrees)		
	“1345”	0000–3599	[4]
	NOTE: For actual course, divide the above 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	,4850113004	,0	,0	<CR><LF>
Field #	2	3	4	5	

#	Description	Range	[Bytes]	(unit)
2	Testing status	0–1 “0”: Power-up testing completed “1”: Testing in progress	[1]	
3	Program and Version numbers			
	“4850113”: Program number	n/a	[7]	
	“001”: Version number	n/a	[3]	
4	“0”: Result of Test 1	0–1 “0”: No errors “1”: Almanac or ephemeris data lost (this can be expected without backup power)	[1]	
5	“0”: Result of Test 2	0–F NOTE: See chart below for detail.	[1]	

Result of Test 2 — Part of Field # 5				
This field is an ASCII-encoded hexadecimal digit representing the value of the four-bit registers listed below. Each bit is set to “1” if the associated test failed.				
Bit	**3**	**2**	**1**	**0**
Code	**Receiver parameter settings**	**Real-time Clock**	**RAM**	**ROM**
“0”	ok	ok	ok	ok
“1”	ok	ok	ok	error
“2”	ok	ok	error	ok
“3”	ok	ok	error	error
“4”	ok	ok	ok	ok
“5”	ok	error	ok	error
“6”	ok	error	error	ok
“7”	ok	error	error	error
“8”	error	error	ok	ok
“9”	error	ok	ok	error
“A”	error	ok	error	ok
“B”	error	ok	error	error
“C”	error	error	ok	ok
“D”	error	error	ok	error
“E”	error	error	error	ok
“F”	error	error	error	error

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

Receiver parameters set by $PFEC,GPset

Receiver parameters set by “$PFEC,GPset” are output in two sentences. Each parameter is preceded by delimiter “,” (comma).

Example

$PFEC,GPssd	,G001	. . . .	<CR><LF>
Field #	2	3	

$PFEC,GPssd	,D08	. . . .	<CR><LF>
Field #	2	3	

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

Log output intervals set by $PFEC,GPint

Log output intervals set by “$PFEC,GPint” are output in two sentences. Each parameter is preceded by delimiter “,” (comma).

Example

$PFEC,GPisd	,GFA01	. . . .	<CR><LF>
Field #	2	3	

$PFEC,GPisd	,tst00	. . . .	<CR><LF>
Field #	2	3	

$PFEC,GPdsd (Answer to $PFEC,GPdrq)

DGPS parameters set by $PFEC,GPdif

DGPS parameters set by “$PFEC,GPdif” are output.

Example

$PFEC,GPdsd	,D0	<CR><LF>
Field #	2	

$PFEC,GPdie (out)

Receiver status

Example

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

#	Description	Range	[Bytes]
2	DGPS Status	0–1 “0”: DGPS data not received yet “1”: Receiving DGPS data	[1]
	NOTE: This flag will be set few seconds after DGPS data entry		
3	Number of DGPS satellites		
	“08”	n/a	[2]
4	DGPS Station’s Health condition		
	“0”	0–1 “0”: healthy “1”: unhealthy	[1]
	NOTE: This flag will be set few seconds after DGPS data entry		
5	DGPS Data status		
	“0”	0–1 “0”: normal “1”: abnormal	[1]
	NOTE: If DGPS data is invalid, standalone GPS function is performed, not DGPS.		
6	DGPS Error code		
	“0”	0–F	[1]

Common Errors

If DGPS status (field# 2) cannot set to “1“ (Receiving DGPS data), or if a 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 use to correct positioning

$PFEC,GPtps (out)

Time and pulse output

Example

$PFEC,GPtps	,940630123000	,3	,1	,1
Field #	2	3	4	5

,940701000000	,+1	,10	,940626120000
6	7	8	9

,0755	,390610	<CR><LF>
10	11	

#	Description	Range	[Bytes] (unit)
2	Current Date/Time		
	"940630123000": YYMMDDhhmmss	Range for year ("YY") is 1994 to 2040, using last two digits of year	[12]
	NOTE: RTC, GPS time, or UTC is output as current date/time. See Field #3 below.		
3	Time Standard ID		
	"3"	1–3 "1": RTC "2": GPS time "3": UTC	[1]
	NOTE: The date/time based on the RTC is output after the 58534A GPS Timing Antenna is turned on until it starts tracking a satellite. GPS Time is output after the 58534A GPS Timing Antenna starts tracking a satellite until it collects a UTC parameter (including UTC offset) in the autonomous start condition. UTC is output after the 58534A GPS Timing Antenna collects a UTC parameter while tracking a satellite. 1PPS is also output under this condition.		
4	1PPS Availability status flag "1"	0–1 "1": "1PPS will be output following this sentence". "0": 1PPS is not output.	[1]

#	Description	Range	[Bytes] (unit)
5	Mode “1”	1–2 “1”: Estimated Observation Point Mode “2”: Fixed Observation Point Mode	[1]
6	UTC Leap Second Adjustment date/time “940701000000”: (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 94/07/01 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>		[12]

#	Description	Range	[Bytes]	(unit)
7	Leap second “+1”	11-111, “00” or 11+111	[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).

11+111 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

11-111 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

110011 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 adjustment.

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 58534A GPS Timing Antenna 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, 11+111 will be reported prior to and following the addition of a leap second. It will not revert to 1100,11 and can only change to “–1” when a pending subtraction of a leap second is announced.

Accordingly, an 58534A GPS Timing Antenna that received the announcement of a prior adjustment reports 11+111 or “–1.” An 58534A GPS Timing Antenna placed in operation after this adjustment reports 1100,11 since current and pending time scale offsets are identical.

#	Description	Range	[Bytes]	(unit)
8	UTC − GPS Time Offset			
	“10”	00–99	[2]	(second)
	This field accumulates leap seconds since the GPS system started operation on January 6, 1980. As of September, 1995, this value was 10. This fact means that leap second insertion had been executed 10 times during the period from January 6, 1980 to September, 1995 because only positive (“+1”) adjustments were made in that period. Note that this field will be “00” unless a UTC parameter has been collected. Additional information about leap seconds is available at many sites on the WorldWide Web. One recommended site is: `http://tycho.usno.navy.mil/leapsec.html`.			
9	Date/Time stamp of UTC Parameter		[12]	
	“940626120000”: (YYMMDDhhmmss)			
	A UTC parameter (UTC correction value) is included in the almanac, which the 58534A GPS Timing Antenna requires to achieve ± 110 ns 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)
	“0755”			
	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 in a GPS week	000000–604799	[6]	(second)
	“390610”			
	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 sentence makes the 58534A GPS Timing Antenna output a “$PFEC,GPtps” sentence every second.

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

$PFEC,GPgpt (out)

GPS Time Output

Example

$PFEC,GPgpt	,1	,0816	,100799	<CR><LF>
Field #1	2	3	4	

#	Description	Range	[Bytes]	(Unit) {Default}
2	Validity flag “1”	0–1 “1”: GPS Time is valid “0”: GOS Time is not valid	[1]	
3	Count of GPS weeks “0755” 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).	0000–3182	[4]	(week)
4	Count of seconds in a GPS week “390610” This field counts up how many seconds have elapsed in the current GPS week. The count is reset to “000000” every week.	000000–604799	[6]	(second)

How to enable “$PFEC,GPgpt” output

Example: The following command line makes the 58534A GPS Timing Antenna output “$PFEC,GPgpt” sentence every second.

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

$PFEC,GPtlp (out)

Leap Second Adjustment Prediction

Example

$PFEC,GPtlp	,3	,941230123450	,950101000000	<CR><LF>
Field #1	2	3	4	

#	Description	Range	[Bytes]	(Unit) {Default}
2	Currently-used Time Standard “3”	1–3 “1“: RTC “2”: GPS Time “3”: UTC (1PPS available)	[1]	
	NOTE: For output of UTC, the following conditions must be met: * Latest almanac is available within the 58534A GPS Timing Antenna. * At least one satellite is acquired by the 58534A GPS Timing Antenna.			
3	Date/time when the prediction was calculated “941230123450” In case of the above example the prediction was calculated at 94/01/01 00:00:00 (YY/MM/DD hh:mm:ss).		[12]	(YYMMDDhhmmss)
4	Date/time of leap second adjustment execution: “950101000000” In case of the above example leap second adjustment is scheduled at 95/01/01 00:00:00 (YYIMM/DD hh:mm:ss).		[12]	(YYMMDDhhmmss)

How to enable “$PFEC,GPtlp” output

Example: The following command makes the 58534A GPS Timing Antenna output “$PFEC,GPtlp” sentence once.

$PFEC,GPint,tIp01 <CR><LF>

$PFEC,GPspe,ANCOUT (in)

Download the almanac

Issue this sentence when you need the almanac data from the 58534A GPS Timing Antenna.

$PFEC,GPspe,ANCOUT	<CR><LF>

As an answer to the above sentence, the 58534A GPS Timing Antenna outputs its internal almanac data (about 5.5K bytes of ASCII characters) in the following format.

Example:

#GP,TYP=GP74,	90A927FDE 980FE3	<CR><LF>

You may save the downloaded almanac for future uploading.

$PFEC,GPspe,ANCINP (in)

Upload the almanac

Issue this sentence first when you want to send almanac data to the 58534A GPS Timing Antenna.

$PFEC,GPspe,ANCINP	<CR><LF>

Following the above sentence, send almanac data which you have saved earlier by sending a “$PFEC,GPspe,ANCOUT” command:

#GP,TYP=GP74,	90A927FDE 980FE3	<CR><LF>

If uploading is completed successfully, the 58534A GPS Timing Antenna outputs the following acknowledgment and restarts by itself.

$ANC, OK	<CR><LF>

If uploading is failed, the 58534A GPS Timing Antenna requests you to send the entire almanac sentence again by outputting the following error message:

$ANC, NG	<CR><LF>

“NG” means “No Good”.

Time RAIM

Operation

The Time RAIM (Receiver Autonomous Integrity Monitoring) algorithm detects and removes potentially faulty satellites from the time solution. It reduces the receiver's susceptibility to satellite clock failures, upload errors or related problems that are not immediately resolved by the GPS Control Segment.

TRAIM identifies inconsistencies in redundant pseudorange measurements deduced from several satellites. Timing error is compared against a user-defined alarm threshold. When this threshold is exceeded, the receiver attempts to silently isolate and remove the inaccurate satellite. If isolation is impossible, an alarm condition is reported.

The alarm threshold establishes the number of tracked satellites required for fault detection and isolation. At the default alarm threshold of 1 microsecond, two or three satellites must be tracked, respectively. Additional satellites must be tracked to ensure reliable TRAIM operation at lower thresholds.

TRAIM is only available while operating in the Fixed Observation Point mode.

Messages

Five sentences are provided to control and monitor TRAIM operation and the status of the 1PPS pulse:

Sentence	Type	Function
$PFEC,GPrrs	input	Configure TRAIM and 1PPS pulse output
$PFEC,GPrrq	input	Query settings configured by $PFEC,GPrrs
$PFEC,GPrsd	output	TRAIM settings (response to $PFEC,GPrrq)
$PFEC,GPrrm	output	TRAIM status

$PFEC,GPrrq (in)

Get Time RAIM and 1PPS Control parameters

Example

$PFEC,GPrrq<CR><LF>

Issue this sentence to query Time RAIM and 1PPS Control parameters set by "$PFEC,GPrrs". The response will be returned by the "$PFEC,GPrsd" sentence.

$PFEC,GPrrs (in)

Set Time RAIM and 1PPS Control parameters

Example

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

#	Description	Range	[Bytes]	(unit)	{Default}
2	Time RAIM Control	0–1 "0": Off "1": On	[1]		
	This parameter only applies to the fixed observation point mode. (Time RAIM is inoperative in the estimated observation point mode.)				
3	Alarm threshold	030–999	[3]	(10 nanoseconds)	{100}
	Time threshold above which a Time RAIM alarm is reported. 100 (1 microsecond) is a typical setting.				
4	1PPS Pulse Control	0–3 "0": 1PPS is never output "1": 1PPS is always output "2": 1PPS is output when one or more satellites are tracked "3": 1PPS is output unless a Time RAIM alarm condition is detected	[1]		{2}
	Note: $PFEC,GPrrs settings are not retained by back-up power.				

$PFEC,GPrrm (out)

Time RAIM status

Example

$PFEC,GPrrm	,0	,0	,20	,00	,00	,00	,+000	,+42	<CR><LF>
Field #	2	3	4	5	6	7	8	9	

#	Description	Range	[Bytes}	(units)
2	Time RAIM status	0–2 “0”: OK—time solution within alarm threshold '1': Alarm: time solution exceeds alarm threshold 2: Unknown, because: (a) Time RAIM function is turned off, or (b) not in fixed observation mode, or (c) alarm threshold is too low, or (d) insufficient number of satellites are tracked	[1]	
	Note: Field 4 (1PPS Availability Status Flag) of the “$PFEC,GPtps” sentence is not coupled to this field; for example, this flag can be set to “1” while a Time RAIM alarm is reported. Both fields should be monitored to assess the validity of the 1PPS pulse.			
3	Detection/Isolation status	0–2 0: Detection and isolation are possible 1: only detection is possible 2: Neither detection nor isolation is possible	[1]	
4–7	List of isolated satellites	00–32	[2 per field]	
	Field 4 reports the PRN code of an isolated satellite. “110011” indicates that no satellite is isolated. Fields 5 through 7 are reserved for future use and are always “1100.11”			
8	(reserved)	+000	[4]	
9	1PPS Offset	+00 to +85	[3]	(nano-second)
	Timing error of the next 1PPS pulse, expressed as a signed two-digit value			

$PFEC,GPrsd (out)

Time RAIM and 1PPS Control parameters set by $PFEC,GPrrs

Example

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

#	Description	Range	[Bytes]	(unit)
2	Time RAIM control	0–1 0: Off 1: On		
3	Alarm Threshold	030–999	[3]	(nanoseconds)
	Time threshold above which a Time RAIM alarm is reported.			
4	1PPS Pulse control	0–3 0: 1PPS is never output 1: 1PPS is always output 2: 1PPS is output when one or more satellites are tracked 3: 1PPS is output unless a Time RAIM alarm condition is detected	[1]	

5

Maintenance

Description

In case of defect

Calibration

No calibration is required

Preventive maintenance

The 58534A GPS Timing Antenna itself requires minimal maintenance, once installed. All active electronic components are enclosed in a sealed housing that is not repairable. If troubleshooting proves the unit to be defective, see “In case of defect”, above.

The cable between the 58534A GPS Timing Antenna and the control electronics is more likely to be the source of difficulties with the 58534A GPS Timing Antenna than the integrated antenna package or its contents. Likely sources of problems with the cable are: 1) problems with its connectors, 2) chafing at points where it is supported or near other objects, 3) environmentally-induced problems, such as moisture, heat, etc.

Troubleshooting

The best troubleshooting tools for the 58534A GPS Timing Antenna are: 1) another 58534A GPS Timing Antenna, to use as a substitute; and 2) 58531A GPS Timing Receiver Analysis and Control Software running in a PC connected to the antenna.

Here are some troubleshooting hints that may help if you are using the 58531A GPS Timing Receiver Analysis and Control Software:

- If you have a problem, the first thing to check is the cable connecting the antenna to the supporting electronics. Be sure the cable’s connector contacts are adequately crimped.

- If the RS-422/RS-232A Interface Box LED is flashing, the 58534A GPS Timing Antenna's 1PPS output is ok—indicating that the unit is locked to GPS—check the software and the computer.
- If you get no indication of 1PPS output from the antenna—including checking with an oscilloscope (see"Verification when software is not available" on page 2-11)—check that the 58534A GPS Timing Antenna is receiving operating power. If you can program the 58534A GPS Timing Antenna to always output 1PPS (regardless of TRAIM condition), then it is receiving power.

Typically, if an 58534A GPS Timing Antenna seems to be performing poorly or not all, it will be the result of one or more of the following—

1. Cabling between the control electronics and the antenna.
2. Software and commands you are using to control the antenna.
3. Power supply.

Some things to consider are—

- Has the setup being used ever worked?
- Has the setup being used been changed in some way?
- Has the setup being used been checked thoroughly—from the supporting electronics to the antenna itself?
- Has there been a nearby lightning strike?
- The antenna's 1PPS output is normally inhibited when the antenna is not receiving enough valid signals from satellites.

  The antenna can be commanded to provide its 1PPS output regardless of the validity of the satellite signals it may be receiving. If a 1PPS signal is available when this is done, you can be reasonably sure that the power and cabling to the antenna are OK.

- You can use a hand-held GPS receiver near the antenna to check to see how many satellites are receivable there at that time.

  One available hand-held receiver is the Garmin[1] GPSII PLUS. This receiver is available from Hewlett-Packard as the

---

[1] Garmin Corporation 1-800-800-1020
http://www.garmin.com/db?MItab=garmin&MIval=splash 1-800-800-1020

HP 59991A-T45; the HP version includes additional accessories that are used in this procedure.

To identify an interference problem using the HP 59991A-T45 receiver:

1. Note the number of satellites acquired by the HP 59991A-T45 receiver.
2. Replace the receiver's standard antenna with the HP 58532A GPS L1 Reference Antenna. Use coaxial adapters to connect the antenna.
3. Note the number of satellites acquired with the setup of step #2.

   If more satellites are tracked using the HP 58532A GPS L1 Reference Antenna than using the standard antenna, there is an interference problem.

6

Specifications and Characteristics

Introduction

Specifications describe the device's performance. Supplemental characteristics (indicated by "TYPICAL", "NOMINAL", or "Characteristics") are intended to provide further performance information useful in applying the device.

58534A Technical Specifications and Characteristics

Electrical Specifications and Characteristics:

Receiver Architecture
- 8 parallel channels
- L1 1575.4 MHz
- C/A code (carrier aided tracking)
- 2-bit A/D conversion
- SAW filtering

Antenna
- Active micro strip patch
- High jamming immunity: triple dielectric bandpass filtering

Update Rate
- 1 Hz

Absolute Timing Accuracy (1 pulse per second, 1PPS), with SA

< 110 ns with respect to UTC (USNO) – 95% probability when unit is properly installed and locked to GPS.

Timing output valid with one satellite acquired in Position Hold mode.

Jitter
- 40 ns (1s, typical) in Position Hold Mode
- 110 ns (1s, typical) in Survey Mode

Position Accuracy
- 25 m SEP* without SA
- 100 m SEP* with SA

*Spherical Error Probable

Acquisition Time to First Fix (TTFF)
Cold Start: < 2 minutes typical

Reacquisition
< 20 seconds typical after loss of power**
**Almanac < 1 month old and Ephemeris < 4 hours old

Power Specifications:

+8 Vdc to +36 Vdc
< 1.5 Watts
Reverse Voltage Protection, <300 V
Back up power provided by super-capacitor to GPS data RAM, 2 hours (typical)

Serial Communications:

Interface
9600 Baud
RS-422 Input/Output
Symmetricom proprietary protocol based on NMEA language

Extended Cable Support
RS-422 differential pair capable of supporting 150 m (500 feet) of cable

Mechanical Specifications and Characteristics:

Dimensions
58534A (without cable and connector): 16.5 cm H × 15.0 cm D
Mounting Mast (Option AUB): 457.5 mm L × 31.5 mm ± 0.125 mm OD

Mounting
Quick-fit clamp (glass-filled, high modulus nylon for secure clamp)

Weight
684 g

Cable and Connector
30.5 cm cable (12 conductor, 6 twisted pairs, shielded)
12 pin round, waterproof connector (Deutsch MMP 21C-2212P1)
Mating connector: Deutsch MMP 26C-221251 connect body only

Environmental Specifications:

Operating Temperature
Standard: -35º C to +75º C
Option 1GK: -40º C to +80º C

Storage Temperature
-40º C to +85º C

Shock
Half Sine Waveform, Velocity Change 404.5 cm/s, <3 ms duration

Waterproof/Humidity
Operating: 15% to <95% R.H. @ 40º C
Non-Operating: <90% R.H./24 hrs. @ 65º C

Altitude
Operating: 4.6 km @ -5º C to +60º C
Non-Operating: 4.6 km @ -40º C

Vibration
Operating: 5-500 Hz, 0.0001 g^2/Hz
Survival: 5-500 Hz, 0.5 g Swept Sine
5-500 Hz, 0.015 g^2/Hz Random

EMC
CE marked
CISPER 11/22 Conducted and Radiated Emission Standards
IEC 801-2 (ESD Immunity, 8 kV air discharge)
IEC 801-3 (Radiated Immunity, 3 V/m)
IEC 801-4 (Fast Transient/Burst Immunity, 500 V)

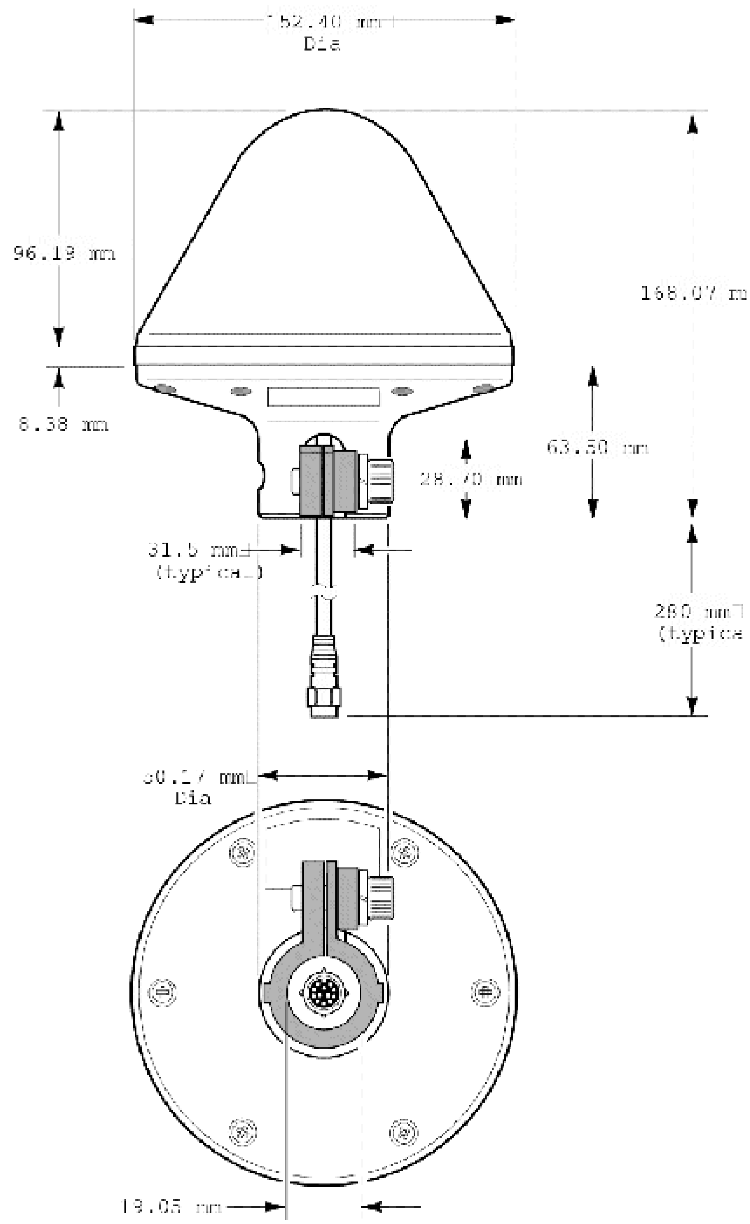


Figure 6-1. 58534A GPS Timing Antenna—dimensions

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