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GPStar*plus*
Model 565

User's Manual

Document 565-8006
Revision H

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This document reflects the specifications and features of the equipment that were current at the time of release of this manual. FEI-Zyfer, Inc. disclaims responsibility for any errors contained herein, and reserves the right to make changes to this manual and related equipment without notice or obligation.

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DATE	REVISIONS
07/28/2000	Rev A. Added “Revision” sheet. Added “Power Supply Option -3 through-out document. Changed “Other Option-1” frequency range. Was: 100 kHz to 15 MHz. Is: 100 kHz to 13 MHz. Moved address information from page i to page iv and added additional contact information
03/07/2001	Rev B: Deleted Zyfer Europe contact information. Added pertinent information regarding DC block special configuration (pages iv, 1, and 49). Changed factory default baud rate from 19200 to 9600 (page 59). Added copyright information in footer of document.
11/08/2001	Rev C: In para 2.4.3, DE-9 connector pin 5 was pin7. In para 5.8.5 buffer size 500 was 256.
11/12/2004	Rev D: Updated to reflect operation with new receivers. Applicable to firmware starting with V1.06.00.
10/12/2005	Rev E: Changed Position solution operation and Leap Second details
10/26/2005	Rev F: Changed holdover specification in par 5.8.2
12/05/2005	Rev G: Changed par 5.8.1, 5.8.1.2, 5.8.1.3, and 5.8.2.
09/13/2006	Rev H: Added Quad Low Noise 10 MHz Output option details

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Please obtain a Return Material Authorization (RMA) number prior to returning a product to FEI-Zyfer, Inc.

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The configuration of the unit is as marked on the following GPStar*plus* Configuration sheet. In this document, the option numbers on the configuration sheet are referenced in *Section 5, Specifications*.

The complete Model Number of the unit is:

565 -

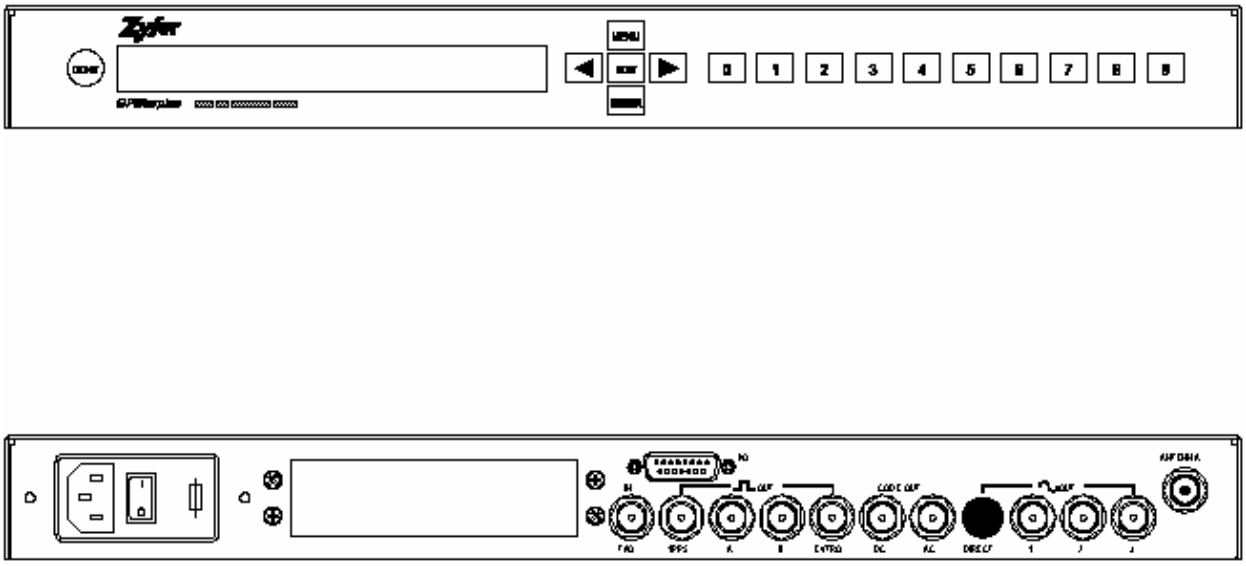
The unit is configured as follows:

GPStar*plus* CONFIGURATION			
INSTALLED OPTION	**AVAILABLE OPTIONS**		**OPTION DESCRIPTION**
OSCILLATOR OPTOINS			
☐	Oscillator	2	High Stability Quartz (Ovenized)
		3	Low Profile Rubidium
POWER SUPPLY OPTIONS			
☐	Power	1	85-264 VAC, 47-440 Hz
		2	20-60 VDC Input (Not compatible with -3 Oscillator Option)
		3	120-350 VDC Input
OTHER OPTIONS			
☐	Other	0	None
		1	High Frequency Direct Digital Frequency Synthesizer (100 kHz-13 MHz)
		2	Quad Low Phase Noise 10 MHz Output
	SPECIAL CONFIGURATIONS		
	Special	-01	None
		-02	External DC Block on Antenna Input

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GPStar*plus* Front and Rear Views
(Typical configuration, shown without mounting ears)

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Section 1 General Information

1.1 INTRODUCTION

The GPStar*plus* is a precision source for time and frequency that can be used as a secondary reference to meet manufacturing, development, and calibration needs. The standard instrument configuration consists of:

- a Global Positioning System (GPS) receiver
- a GPS disciplined ovenized Quartz oscillator
- a front panel LCD display and key pad
- a universal AC input power supply

The standard instrument configuration has the following Input/Output signals:

- One dedicated 1 PPS pulse rate output
- Two independent Pulse Rate output signals with user selected rates
- One Time Tag input
- One user programmable Event Trigger output
- One AC Time Code output with three user selected code formats
- One DC Shift Time Code output (format as selected for AC output)
- Three independent Sinusoid Frequency output signals with user selected signal frequency
- One RS-232 I/0 control and monitor computer interface port
- One dedicated RS-232 Time-Of-Year message output port
- Power input
- Antenna input

Options are available to supplement or replace existing unit functions. The exact configuration is shown on the GPStar*plus* Configuration/Parts List. Some of the available options are:

- High performance Ovenized Quartz Oscillator (SOCXO), and Rubidium oscillator
- DC input power instead of AC Input
- Direct Digital Synthesizer
- Quad Low Phase Noise 10 MHz Output

Special configurations are available to alter the physical attributes such as color, and/or add minor changes from the standard configuration. Presently available special configurations are:

- External DC Block attached to ANTENNA connector.

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1.2 DESCRIPTION

The instrument's internal GPS receiver uses the Coarse Acquisition (C/A) code transmitted by the NAVSTAR GPS satellites as timing reference. The Global Positioning System (GPS) is a constellation of satellites that transmits time and navigation information.

The C/A code is a sequence of 1023 binary, bi-phase, pseudo-random modulation of the GPS carrier. The C/A code is also referred to as the standard or civilian GPS code.

The GPS time is maintained by the United States Air Force and is traceable to the United States Naval Observatory (USNO).

Operation is automatic and self-calibrating. Methods of controlling and monitoring the performance are provided via the front panel display and the RS-232 I/O interface.

A front panel LCD display provides indication of time, position, satellite information, operating status, oscillator performance, and setup. The display is permanently back-lit to enhance readability under varying ambient light conditions.

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Section 2 Installation

2.1 INTRODUCTION

This section contains the GPStar*plus* installation instructions.

2.2 INITIAL INSPECTION

Inspect the shipping container for damage. Remove the unit from its shipping carton. Carefully inspect the unit and its accessories for shipping damage. Any damage must be reported immediately to the carrier. The shipping container and packing material should be kept until the unit and accessories have been checked for mechanical damage or defect and until it has been determined that the unit and accessories operate properly.

2.3 INSTALLATION OVERVIEW

Installation consists of mounting the (optional) antenna at a location that is not shrouded by taller buildings, trees, or other antennas.

The connection of the unit to the antenna is via coaxial cable. The unit supplies a DC voltage on the center conductor of the antenna cable. This voltage source is used to power the low noise amplifier in the antenna (and the optional in-line amplifier, if used).

A weatherproofing compound should be applied to the junction of the cable and antenna after the system has been installed to prevent corrosion of the connectors.

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2.4 INSTALLATION PROCEDURES

WARNING: When installing a unit configured to be powered from a 20 to 60 VDC source, it is important not to exceed these limits. The polarity must be observed for proper operation; however, no damage results when the polarity of the input is inadvertently reversed.

2.4.1 Antenna Installation

The *optional* antenna kit includes the following items:

- Antenna with 33 dBm integral LNA
- Marine thread to 1” OD pole adapter
- 50 ft of antenna cable

Note: Special care must be taken when routing the cable near sources of potential interference, such as a power lines, high frequency antenna couplers, and other transmitting equipment.

CAUTION!

Be careful to avoid contact with overhead power lines when installing the antennas.

The antenna mounting location should be free of any objects that might obstruct satellite visibility within 10^{o} of the horizon. Obstructions that obscure significant areas of the sky will result in degraded performance of the unit. The antenna should be located at least 18 inches away from each other and any other GPS antenna. The antenna must be mounted with the connector side down.

Mount the antenna as desired. At the antenna, connect one end of the antenna cable to the antenna connector. Application of a weatherproofing compound to the antenna/cable connection is recommended to impede corrosion. Connect the other end of the antenna cable to the unit's rear panel connectors labeled ANTENNA.

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2.4.1.1 Antenna Cable

The (optional) antenna kit is supplied with 50-ft. (15 m) of antenna cable, terminated with a TNC male connector at each end. In some applications a longer length of cable may be required.

Other lengths and types of cable can be used as long as the signal loss at 1575 MHz does not exceed 15 dB.

Caution: Not all coaxial cable exhibits the same amount of attenuation or shielding quality. These parameters can vary between manufacturers as well as manufacturer's type.

FEI-Zyfer has evaluated several manufactures and types of cable, and has found that Belden® type 9311 (RG-58), Belden® type 8267 (RG-213), Belden® type 9913 (RG-8), Belden® type 9104 (RG-59), and Times Microwave LMR type cable provide good performance.

The following table indicates the maximum length of recommended cable type when used with the antenna available from FEI-Zyfer.

Cable Type	Max. Length	Comments
RG-58 (Belden® 9311)	75 ft (23 m)	Loss 20 dB per 100 ft (30 m)
RG-213 (Belden® 8267)	125 ft (38 m)	Loss 12 dB per 100 ft (30 m)
RG-59 (Belden® 9104)	150 ft (46 m)	Loss 10 dB per 100 ft (30 m)
RG-8 (Belden® 9913)	250 ft (75 m)	Loss 6 dB per 100 ft (30 m)
LMR400 (Times Microwave)	275 ft (84 m)	Loss 5.4 dB per 100 ft (30 m)

For long runs it is necessary to use an In-Line Amplifier or low loss foam dielectric cable such the Heliax series manufactured by Andrew Corporation, Orland Park, IL, USA.

For extremely long runs a special up/down converter system can be used, such as the downconverter/upconverter system manufactured by Raven Industries (formerly Starlink Incorporated), Austin, TX, USA. Versions are available for use with coaxial cable and also for use with fiber optic cable.

2.4.1.2 In-Line Amplifier

In some cases it may be more cost effective to place an amplifier in the antenna cable system to make up for the signal attenuation caused by long cable runs.

Amplifiers are available from several manufacturers including Raven Industries (formerly Starlink Incorporated), Austin, TX, USA, Sigma 6 Incorporated, San Diego, CA, USA, and FEI-Zyfer.

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2.4.1.3 Lightning Protection

In areas where lightning is present it is recommended to install a surge protector in the antenna system. Surge protectors are available from several manufactures such as: Part number IS-MR50LNZ+6 from PolyPhaser Corporation, Minden, Nevada, USA. The use of this device requires TNC to N-type adapters. Another surge protector, fitted with TNC-type connectors, part number P8AX09TNCWFF is available from Citel, Miami, Florida, USA. In order to be effective, the protector must be connected as close as possible to the point where the antenna cable enters the building, and must be connected to earth ground using a very low-inductance conductor. Contact the manufacturers for installation details.

CAUTION!

When installing grounding electrodes, lightening rods, grounding conductors, etc., comply to all the rules prescribed by local/state electrical building ordinances and codes.

2.4.1.4 Weather Proofing

The antenna enclosure is designed to be exposed to all-weather conditions. However, care should be taken with the connectors and cable couplers, if used. These components should be shielded from the elements, or weather protected using butyl rubber tape. Weather proofing kit P/N 221213 is available from Andrew Corporation, Orland Park, Illinois, USA. This kit includes butyl rubber and plastic tape. Instructions are also included with the kit.

2.4.2 Chassis Installation

To install the chassis perform the following steps:

- Set the rear panel mounted power switch to the OFF position (downward).
- Mount the unit onto a surface that is stable and relative free from vibration.
- Connect the antenna cable to the rear panel connector labeled ANTENNA.
- Connect all output signal cables.
- Connect input power to the unit, using the supplied connector and or power cord.

If the unit is configured to operate from a high voltage DC power source (120 to 350 VDC), use the supplied power cable. (Refer to paragraph 5.5.3)

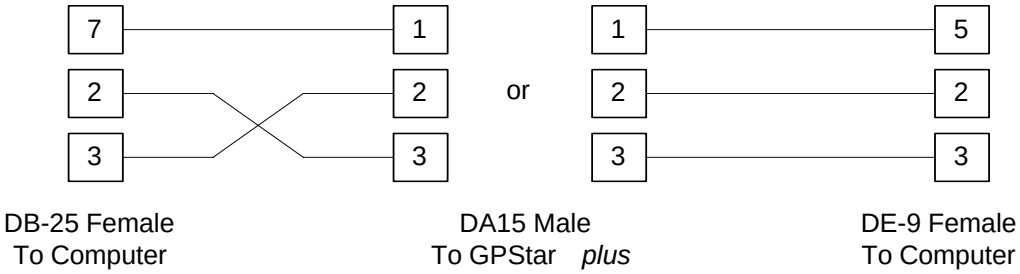
If the unit is configured to operate from a low voltage DC power source (20 to 60 VDC), fabricate the input power cable using the supplied mating connector. The connector pin designation is as follows:

PIN	FUNCTION
A	Chassis Ground
B	+ DC Input
C	- DC Input

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2.4.3 Connecting a Computer or Modem

To connect the GPStar*plus* to a computer or modem, you must fabricate the proper interface cable using the supplied 15 pin D-type mating connector. Connect the unit as follows:



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Section 3 Getting Started

3.1 INTRODUCTION

This section contains the step-by-step procedures to place the GPStar*plus* in operation.

3.2 ASSISTANCE

If you need assistance or have any questions relating to setup or operation, contact Technical Support. Please refer to the CONTACT INFORMATION page for detailed information.

3.3 INITIALIZATION

The physical installation must be completed as described in Section 2 before you attempt to operate the unit.

If the unit has been stored at temperature extremes outside the normal operating temperature range, allow the unit to attain a temperature within the normal operating range before turn-on.

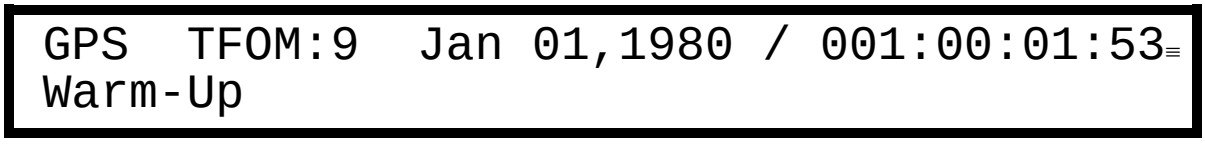
Note: The information shown on the LCD screens in this document is for illustration only.

Verify that an external GPS antenna is connected to the rear panel TNC-type connector identified with ANTENNA.

Note: Do not apply power unless a fully operational antenna system is properly connected to the unit. Application of power without the antenna connected may result in an extended "search-the-sky" for satellites process that may increase the time to reach GPS lock drastically. To terminate the extended search process, cycle the unit's input power.

For instruments configured for AC input power, apply AC power and set the rear panel power switch to ON (upward). For instruments configured for DC input power, connect the DC source and apply power.

When power is applied, the front panel display backlight illuminates, followed shortly thereafter with the *Time, Data, and Status* screen.



Note: The indicated Time Reference GPS *and* TFOM: 9 *are shown for illustration only. The actual Time Reference shown is the one selected during the prior operation of the unit, and the actual* TFOM *value may be different.*

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When power is applied, the instrument enters the Warm-Up mode. During this period the internal GPS receiver initializes in the *Survey* mode (also referred to as *Position Averaging* mode). When the receiver has acquired a minimum of four satellites with good satellite geometry, it resolves the initial position of the antenna connected to the instrument and downloads current satellite almanac data.
I
The receiver continues to operate in the *Survey* mode using data from the receiver to calculate a new accurate position. After this process is finished, the receiver automatically switches to the *Known* position mode, storing the new antenna position in non-volatile memory. The duration of the position averaging process is typically 3 hours, depending on the satellite visibility.

The disciplining of the instrument's oscillator starts as soon as the receiver's timing locks to GPS and the oscillator is determined to be stable. It is not necessary for the instrument to have finished its position survey.

As soon as the instrument has locked to satellites, has enough information, and the internal oscillator has stabilized, the oscillator disciplining process and the alignment of the internal timing starts. When the internal timing is aligned with GPS 1PPS, the instrument's operation mode switches to the *Time Locked* mode, as seen on the following screen.

```
GPS  TFOM 4  Dec 08,2004 / 343:21:54:28≡
Time Locked
```

This screen indicates the unit's internal time and timing are aligned to GPS (and therefore UTC), as indicated by the correct date and time, and the Time Figure Of Merit (*TFOM*) of the unit's timing output.

To monitor the satellite tracking, press key 2 until Menu 1 of 3 is selected: *Satellite Tracking and Status* screen.

```
Satellite Tracking Status:              ≡
SVs:06≡  08≡  09≡  12≡  14a  15a ≡  24a  25s
```

After a short period the screen starts to indicate the exact time, the number of the satellites that are being acquired (a), searched (s), and tracked (≡). The track (≡) symbol also functions as signal strength indicator.

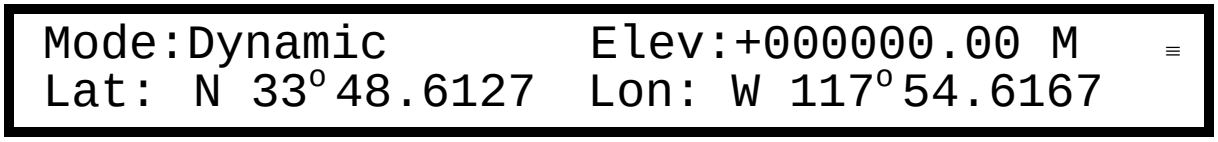
This screen indicates that the unit is tracking satellites 06, 08, 09 and 24, and is acquiring satellite 24, and is searching for satellite 25. Further operation is completely automatic. After approximately fifteen minutes, the unit's operating mode will change from *Warm-Up* to *Time Locked*. During the warm up period, the user can select the operating conditions of the unit, such as: time code output format, pulse rate output, etc.

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3.4 ANTENNA POSITION MODE SELECTION

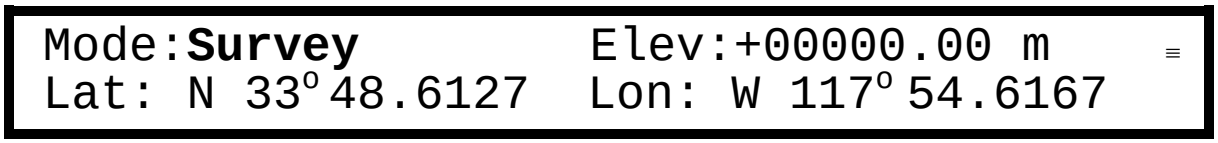
At initial power-up, the unit defaults to *Survey* position mode, and after determining that the stored position data is accurate the mode switches to *Known*. To view the active position solution mode:

- Press key 2 until Position Menu 2 of 3 is selected (**Position Mode and Position** screen).



This screen indicates the antenna position, and that the active position solution mode is *Dynamic*. To change the position solution mode:

- Press the Edit key.
- Press the arrow keys until the desired mode (**Survey** or **Dynamic**) is flashing. The *Known* mode is only for indication, it can not be selected. Select *Survey* if the antenna location is not accurately known to initialize the position survey process. At the end of the survey process, the unit automatically enters the Known mode. Select *Dynamic* if the instrument is on a moving platform.



- Press the Enter key to accept the selected mode.

Survey mode is the mode the receiver is in while running its auto-survey process. The receiver uses 3-D Lat, Lon, and Alt values when the receiver has acquired a minimum of four satellites with good satellite geometry to compute an averaged position. At the end of the survey process, the unit automatically enters the *Known* mode using those computed values.

3.5 ANTENNA CABLE DELAY COMPENSATION SELECTION

For the most accurate timing, it is necessary to compensate for the signal delay caused by the antenna system. The delay is the sum of all satellite signal delays between the antenna and the receiver, including delays due to the antenna cable length and, if used, the in-line amplifier and/or filter. The delay compensation can also be used for to compensate for system offsets external to the unit. The maximum delay compensation (offset) range is 999,999 ns. To view the present internal offset/antenna cable delay compensation settings:

- Press key 1 until Time Menu 2 of 5 is selected (**Time Mode, Local Offset, Internal Offset** screen).

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```
Time Mode:LUTC   Local Offset:-08   hrs≡
Internal Offset:000050 ns
```

This screen indicates the selected Time Mode (reference) is UTC, the Local Offset is set to -8 hours, and the Internal Offset is set to 000050 ns. To alter the amount of internal offset or cable delay compensation:

- Press the Edit key until the most significant digit of the Internal Offset flashing.
- Use the numeric and arrow keys to specify the desired delay compensation (or offset) in nanoseconds.
- Press the Enter key to accept the new value.

The entered offset causes the timing outputs to occur sooner in time in relation to UTC 1 PPS reference.

There are several types of recommended cable to connect the unit to the external antenna: RG-8 (Belden® 9913), RG-58 (Belden® 9311), RG-59 (Belden® 9104), RG-213 (Belden® 8267), and foam dielectric cable such as Heliax manufactured by Andrew Corporation. The propagation delay of these cable types is:

Cable Type	Propagation Delay
RG-58	1.33 ns/ft (4.36 ns/m)
RG-213	1.52 ns/ft (4.99 ns/m)
RG-8	1.19 ns/ft (3.90 ns/m
RG-59	1.22 ns/ft (4.00 ns/m)
LMR400	1.18 ns/ft (3.87 ns/m)
1/2" Heliax	1.34 ns/ft (4.39 ns/m)
7/8" Heliax	1.12 ns/ft (3.67 ns/m)

Using the above delay values per foot (or meter), the delay for the actual cable length used can be calculated.

For example, if the antenna system includes 50 feet of RG-58 cable, the antenna cable delay is computed as follows: 1.33 ns/ft x 50 ft = 67 ns. In this example the user would enter **000067** ns for the Internal Offset.

Note: If the unit is operating in the Time Locked mode a temporary fault may occur when the Internal Offset is changed, resulting in the unit's operating mode switching from Time Locked to Coasting. Should this occur the unit would correct itself in approximately ten minutes.

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Section 4 Display Menus and Controls

4.1 INTRODUCTION

This section provides a description of the GPStar*plus* front panel LCD (Liquid Crystal Display) menu screens, including detailed operation.

4.2 FRONT PANEL GENERAL DESCRIPTION

The front panel contains the LCD, keyboard, and display contrast adjustment control.

4.2.1 LCD Screen

The LCD screen provides information to the user with 2 lines of 40 characters. Several different sets of screen information can be displayed. A representative screen display is shown below:

```
GPS  TFOM 9  May 25,1999 / 145:21:54:28
Warm-Up
```

Screen displays can be menus, which permit the user to access other screens, non-editable screens that display information only, or screens with active data fields that can be changed by the user.

4.2.2 Display Cursor

When a screen parameter is editable, a flashing LCD cursor highlights the display character located at the cursor position. This parameter is changeable by the user.

4.2.3 Display Contrast Adjustment

Pressing the *Contrast* button, located to the left of the LCD screen, allows the user to optimize the contrast and viewing angle of the displayed text. It may be necessary to depress the button for several seconds in order to notice any changes. Releasing the button for a couple of seconds and then depressing it again causes the adjustment direction of the viewing angle to reverse. Repetitive pressing of the button moves the viewing angle in the same direction. The last setting is retained in non-volatile memory, and only needs to be changed when gross changes in ambient temperature occur.

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4.2.4 Keyboard

The keyboard has 15 momentary action keys, consisting of ten numeric keys and four control keys (MENU, EDIT, ENTER, Left and Right arrow). The keys are located on the right side of the LCD.

- The number keys are used for menu selection and data entry.
- The Left and Right arrow keys are used during data entry. Pressing these keys moves the flashing cursor right or left to select the parameter to be modified.
- The EDIT key is used to access the sub-screen of the currently displayed screen and activate the screen editor. It can also be used to move to the next available data field without modifying the current data field.
- The ENTER key is used to load the currently entered data or parameters and move to the next available data field (if any).
- The MENU key, when pressed, allows viewing of the active menu screen title and number. When pressed during an edit operation, the operation is automatically exited.

4.3 MENU/DISPLAY OVERVIEW

The user selects the desired menu screen using the number keys. After being selected, the menu screens will initially only display information. The user can alter the displayed information (if allowed) by pressing the EDIT key. Once the editor is activated, the user may select a data or selection field, enter new data or change selection, and press the ENTER key to load the new data/selection. Sub-menu screens will appear as appropriate if additional related parameters exist for the entry being edited.

If control key EDIT or MENU is pressed instead of the ENTER key, the original information or selection for that field will be retained. After data for the last field of a screen or sub-screen has been accepted with the ENTER key, the display reverts back to the information only (non-editable) screen. This allows the operator to verify the changes that were entered.

Most displayed data and status can be queried through the RS-232 I/O port. Reference commands are included with the following menu/screen display overviews.

Figure 4.1 - GPStar*plus* Standard Menu Tree is included to provide a quick overview of the standard display menus that can be accessed through the number keys. *It does not include the MENU 8, Options. Refer to paragraph 4.5 for details*.

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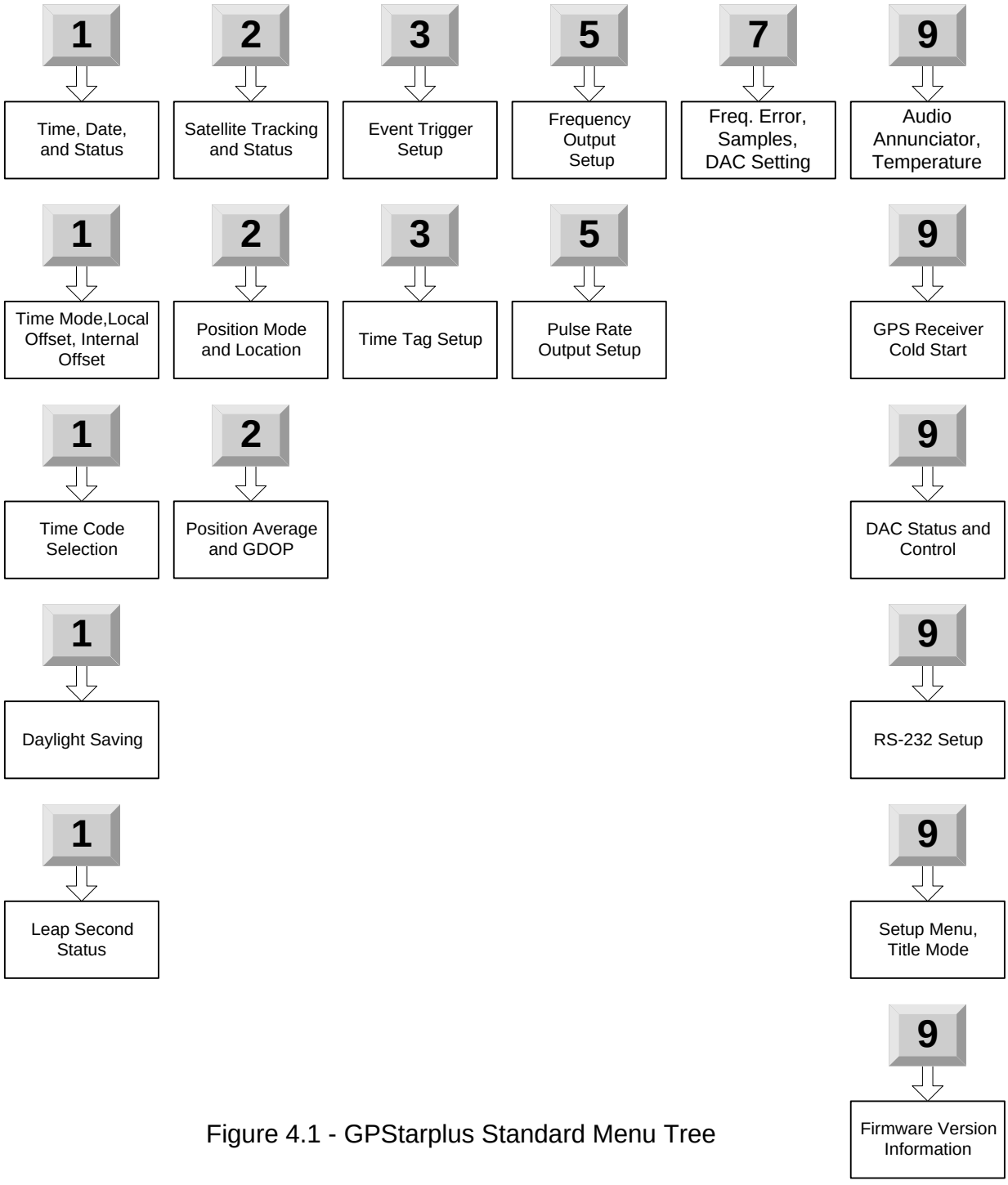


Figure 4.1 - GPStarplus Standard Menu Tree

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4.3.1 MENU 1 - TIME

Reference I/O commands: ANTD, AZEL, LEAP, SIGQ, TIME, TIMM

- **Screen 1 - Time, Date, Status** - Displays the time reference (UTC, Local UTC, GPS, Local GPS, or Manual), the current time and date, the operating status (Warm-Up, Time Locked, Coasting, Recovering, or Manual), and the Time Figure of Merit (TFOM) of the output timing signals. Through this screen the user can:
  - Enable or Disable time transfer from the GPS receiver to the master clock. If time transfer is disabled (Manual mode) the user can also set the time and date.

- **Screen 2 - Time Mode, Local Offset, Internal Offset** - Displays the active time reference, local time zone hours offset, and internal timing offset. Through this screen the user can:
  - Select the time reference of the output time (UTC, Local UTC, GPS, or Local GPS).
  - Specify the local time offset from UTC.
  - Specify the antenna system delay compensation.

- **Screen 3 - Time Code Selection** - Displays the selected format of the time code output. Through this screen the user can:
  - Select the format of the time code output signal (IRIG A, IRIG B, or IRIG G).

- **Screen 4 - Daylight Saving Time Status** - Displays whether the Manual Daylight Saving Time function is enabled or disabled, an hour is to be added or subtracted, and the day of the current month of which an hour is to be added or subtracted to the local time. Through this screen the user can:
  - Enable or Disable the Daylight Saving function.
  - Specify whether an hour is to be added or subtracted at 02:00 hours local time of the selected day of the current month.
  - Specify the day of the current month on which Daylight Saving Time is to occur.

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- **Screen 5 - Leap Second Status** - Displays whether the Automatic Leap Second function has been armed or not (through data from the satellites). While the unit is configured to output UTC or LUTC time and when the Automatic Leap Second is *Armed*, a second will be added or subtracted (as transmitted in the GPS data message) to/from the unit's time output count.

  This screen also indicates the current and future number of leap seconds. If the number of future seconds is lower or higher than the current seconds, a leap second event is scheduled, as indicated by the Automatic Leap Second status. There are no user editable parameters.

4.3.2 MENU 2 - GPS RECEIVER

Reference I/O commands: GDOP, SPOS, TRMO

- **Screen 1 - Satellite Tracking Status** - Displays which satellites are being searched for, acquired, and tracked.

- **Screen 2 - Position Mode and Position** - Displays the active Time Recovery position mode (Known, Survey, or Dynamic), and the Latitude, Longitude, and Elevation calculated by the internal GPS receiver. Through this screen the user can:

  - Change the Time Recovery position mode (Survey or Dynamic).

- **Screen 3 - GDOP** – Displays the Geometric Dilution Of Precision (GDOP) and the current position average. The data field of GDOP is active only when the *Survey* or *Dynamic* mode has been selected and 4 or more satellites are being tracked. After the completion of the position survey, the displayed data field becomes inactive and indicates N/A.

4.3.3 MENU 3 - EVENT TRIGGER/TIME TAG

Reference I/O commands: EVTG, TAGC, TAGL, TAGM, TAGT

- **Screen 1 - Event Trigger Setup** - Displays the Event Trigger output Start Time, Period (repetition rate), Width (pulse duration), and polarity selections. Through this screen the user can:

  - Change all the settings for the Event Trigger output signal.

- **Screen 2 - Time Tag Setup** - Displays the Time Tag input data. Through this screen the user can:

  - Change the mode from Wrap to Burst, and clear the Time Tag data buffer.

4.3.4 MENU 4 - Not active/for future use.

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4.3.5 MENU 5 - FREQUENCY AND PULSE RATE OUTPUT

Reference I/O commands: SETF, ROUT

- **Screen 1 - Frequency Output Ports** - Displays the selected frequency present at each of the output ports. Through this screen the user can:
  - Change the frequency of the signal at each port.
- **Screen 2 - Pulse Rate Output Ports** - Displays the configuration of the pulse rate output ports. Through this screen the user can:
  - Select preprogrammed pulse rates or user programmed pulse rates.
  - Select the default fixed pulse width or 50% duty cycle output.
  - Select the "on-time" edge polarity (Invert or Non-Invert).

4.3.6 MENU 6 - Not active/for future use.

4.3.7 MENU 7 - FREQUENCY STATUS

Reference I/O commands: EFER, ESSD, ESSN, ESTC, ESTP

- **Screen 1 - Frequency Error and Standard Error of Estimate** - Displays the computed frequency error of the internal oscillator, the standard error of measurement of the internal timing, and the control word sent to the digital to analog converter that controls the frequency of the internal oscillator. Through this screen the user can:
  - Manually force the internal timing to re-synchronize to the GPS receiver 1PPS output and restart the disciplining process.

4.3.8 MENU 8 - OPTION

Active only if a special function is installed in the unit that requires set up or monitoring. Refer to paragraph 5.5 for details.

Reference I/O commands: OPDB, SNTH

If the Direct Digital Synthesizer is installed, the following screens can be accessed:

- **Screen 1 - Option Slot Menu** - This screen momentarily displays which option is installed in the unit, and than switches to a permanent screen. Through this screen the user can:
  - Select the frequency of the synthesizer output.
  - Enable or disable the differential output ports.
  - Enable or disable the Sinusoid output port (applies only to HF version of the Synthesizer Option).

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4.3.9 MENU 9 - MAINTENANCE

Reference I/O commands: BEEP, DACV, RSTG, VER

- **Screen 1 - Audio Annunciator, Temperature** - Displays the status of the once per second audible tone synchronized to the unit's 1 PPS timing pulse output, and the internal temperature of the unit. Through this screen the user can:
  - Enable or disable the audible tone.

- **Screen 2 - GPS Cold Start** - Displays the operating status of the internal GPS receiver. Through this screen the user can:
  - Select the Cold Start receiver operation mode.

- **Screen 3 - DAC Status and Control** - Displays the present setting of the DAC that controls the frequency of the internal oscillator, and the status of the master reset. Through this screen the user can:
  - Change the setting of the DAC, or reset the DAC to the factory default value.

  The DAC setting is the control value sent to the digital to analog converter that controls the internal oscillator. The number ranges from 0 to 65535.

  Caution: During normal operation, the DAC value should not be altered. The DAC value is normally used when calibration of the High Stability Quartz Oscillator (Option -2), is necessary to compensate for long term aging of the oscillator.

- **Screen 4 - RS-232 Setup** - Displays the Setup/protocol of the RS-232 I/O interface. Through this screen the user can:
  - Select a rate of 9600, 19200, 38400 baud.

- **Screen 5 - Setup Menu Title Mode** - Displays the status of the automatic Menu Title feature. This feature allows the title of the selected menu to momentarily appear on the screen. Through this screen the user can:
  - Enable/disable the menu title, and select the duration of the menu title.

- **Screen 6 - Version** - Displays the firmware revision of the internal firmware, including that of the GPS receiver. The user cannot change any of the information displayed in this screen.

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4.4 DETAILED SCREEN DESCRIPTIONS

The remainder of this section describes in detail the information displayed on each of the operating screens and how the user can change operating parameters.

4.4.1 MENU 1 - TIME

There are five main screens associated with Menu 1. Several screens are editable.

- Press key 1 until Menu 1 of 5 is selected (**Time, Date, Status**)

```
GPS  TFOM 4  Oct 12,2005 / 285:21:54:28≡
Time Locked
```

This screen displays the general operating status of the unit:

- Synchronization Mode (Manual or synchronized to UTC/GPS time)
- Time Reference Mode
- Accuracy (Time Figure of Merit) of timing output
- Current date and time
- Synchronization status

4.4.1.1 Synchronization Mode Selection

Normal Mode - Under normal operating conditions the time computed by the GPS receiver, if valid, is transferred to internal unit's master clock that is driven by the internal disciplined oscillator.

Manual Time Mode - When Manual Time Mode is enabled, the internal oscillator is allowed to free-wheel (not disciplined). This would only be used if the user suspects that the receiver is providing an invalid time reference.

When Manual Time Mode is enabled, the user can specify the time and date. However, when time transfer is re-enabled, the GPS receiver will automatically set the time and date.

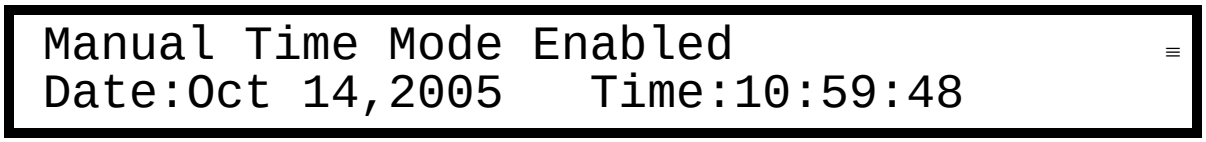
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Change the Synchronization mode from normal to Manual Time Mode as follows:

- Press key 1 until Time Menu 1 of 5 is selected (**Time, Date, Status, Satellites**).
- While viewing the Time Menu 1 of 5 display screen, press the Edit key.



- Press the arrow keys until **Enabled** is flashing.
- Press the Enter key to accept the Manual Time mode.



After the Manual Time Mode is enabled, The *Time Coasting* or *Time Locked* message on Time Menu 1 screen is replaced with *Manual,* and the TFOM value changes to 9.

Note: The Manual Time mode does not support the Leap Second event. The time continues to increment without adding or subtracting a second at a scheduled Leap Second event.

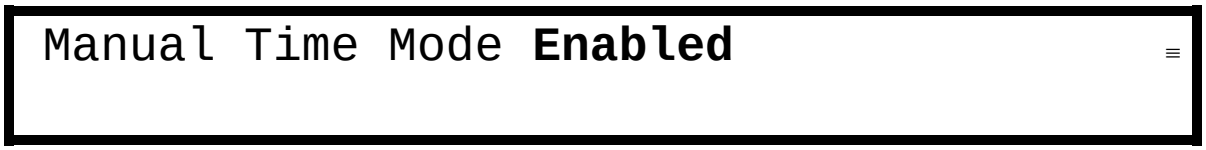
Set the Date and Time as follows:

- Use the numeric keys to set the Year.
- Press the Enter key to accept the selected Year.
- Use the arrow keys to select the Month.
- Press the Enter key to accept the selected Month.
- Use the numeric keys to set the Day of the Month.
- Press the Enter key to accept the selected Day of the Month.
- Use the numeric and arrow keys to set the Time of Day.
- Press the Enter key to accept the selected Time of Day.

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Change the Synchronization mode from Manual Time to normal as follows:

- Press key 1 until Time Menu 1 of 5 is selected (**Time, Date, Status, Satellites**).
- While viewing the Time Menu 1 of 5 display screen, press the Edit key.



- Press the arrow keys until **Disabled** is flashing (selects normal synchronization).
- Press the Enter key to change to normal synchronization.

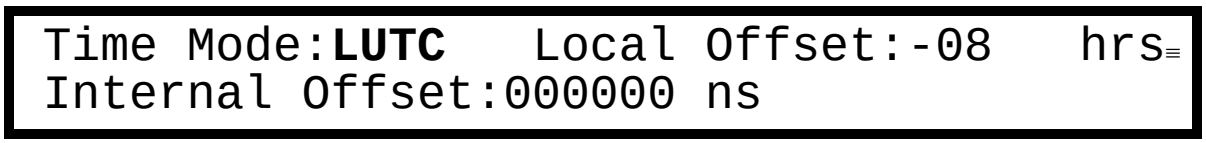
4.4.1.2 Time Reference Selection

Under normal operating conditions, the unit's internal GPS receiver provides the time and date. The time and date can be referenced to either UTC or GPS time.

In order to synchronize to either UTC or GPS time, the unit must operate in the normal synchronization mode; that is: *not in the Manual Time mode*.

Select time reference UTC or GPS as follows:

- Press key 1 until Time Menu 2 of 5 is selected (**Time Mode, Local Offset, Internal Offset**).
- While viewing the Time Menu 2 of 5 screen, press the Edit key.



- Press the arrow keys until desired reference Time Mode (**GPS, UTC, LGPS,** or **LUTC** is flashing.
- Press the Enter key to accept the selected reference Time Mode.
- Press the Menu key to exit the edit mode, or proceed to the next paragraph.

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4.4.1.3 Local Offset Selection

Local Offset can only be selected if LUTC or LGPS has been selected as Time Reference. The local offset can be set with a resolution of 1 hour from -12 hours to + 12 hours.

- Press key 1 until Time Menu 2 of 5 is selected (**Time Mode, Local Offset, Internal Offset**).
- While viewing the Time Menu 2 of 5 screen, press the Edit key until the Local Offset **±** is flashing.

```
Time Mode:LUTC   Local Offset:+08   hrs≡
Internal Offset:000000 ns
```

- Use the arrow keys to select positive (+) or negative (-) Local Offset.
- Press the Enter key to accept the selected Local Offset polarity.
- Use the arrow and numeric keys to select the Local Offset hours.
- Press the Enter key to accept the selected hours of Local Offset.
- Press the Menu key to exit the edit mode, or proceed to the next paragraph.

4.4.1.4 Internal Offset Selection

The internal offset is the sum of all satellite signal delays between the antenna and the receiver, including delays due to antenna cable length and delays due to an in-line amplifier and/or filter (if used in the system). The maximum delay setting is 999999 ns.

Note: *The Internal Offset parameter is only used to align the timing outputs to UTC. If the unit is only being used as a frequency reference the Internal Offset is of no consequence.*

- Press key 1 until Time Menu 2 of 5 is selected (**Time Mode, Local Offset, Internal Offset**)
- While viewing the Time Menu 2 of 5 screen, press the Edit key until the most significant digit of the Internal Offset is flashing.

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```
Time Mode:LUTC   Local Offset:-08   hrs≡
Internal Offset:000000 ns
```

- Use the arrow and numeric keys to select the nanoseconds of Internal Offset.
- Press the Enter key to accept the selected nanoseconds of Internal Offset.

Note: The Operation Mode may temporarily change to Coasting when the Internal Offset is changed. Should this occur the unit would correct itself in approximately ten minutes.

4.4.1.5 Time Code Format Selection

The unit is capable to provide one of the following user selected time code output signals: IRIG-A, IRIG-B, or IRIG-G.

- Press key 1 until Time Menu 3 of 5 is selected (**Time Code Selection**).

```
Time Code Format:IRIG A                ≡
```

- While viewing the Time Menu 3 of 5 screen, press the Edit key.
- Press the arrow keys until the desired Time Code Format (**IRIG A, IRIG B,** or **IRIG G**) is flashing
- Press the Enter key to accept the selected Time Code Format.

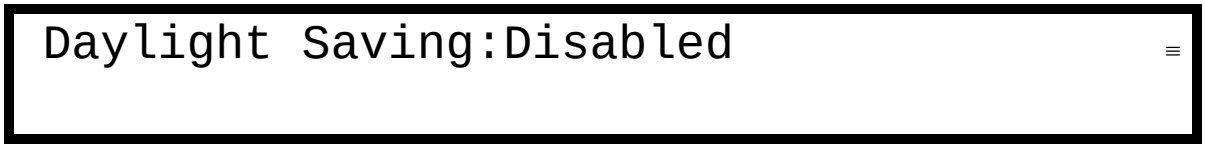
4.4.1.6 Daylight Saving Time Status Selection

The user can enable or disable the manual Daylight Saving Time function. When enabled, the unit to adds or subtracts one hour at 02:00:00 Local Time on the user selected day of the current month. Daylight Saving Time is only applicable when UTC or GPS with Local Time Offset is selected as time reference (LUTC or LGPS).

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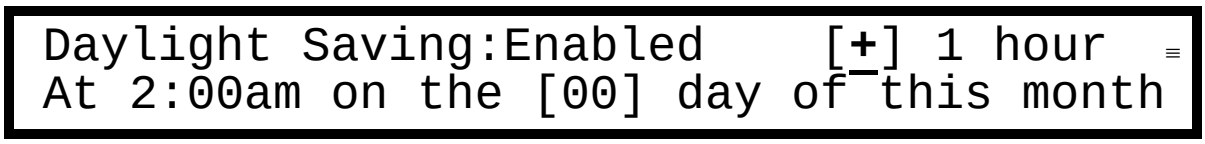
To view the Daylight Saving Time Status:

- Press key 1 until Time Menu 4 of 5 is selected (**Daylight Saving Time Status**)



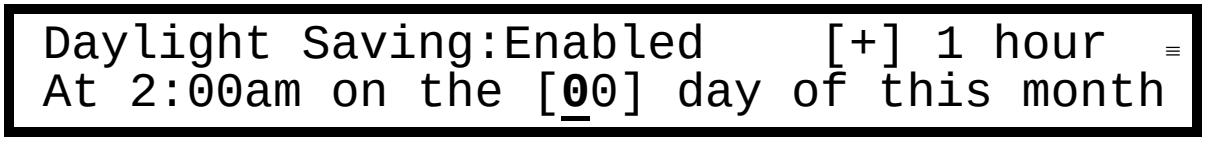
The unit only adds or subtracts one hour if the manual Daylight Saving Time mode is enabled. To enable the manual Daylight Saving Time mode:

- Press the Edit key.
- Press the arrow keys until **Enabled** is flashing.
- Press the Enter key to accept the selected Daylight Saving status.



An hour is normally added on the fourth Sunday of April when Daylight Saving Time goes in effect, and an hour is normally subtracted on the fourth Sunday of October when Standard Time goes in effect. To subtract one hour:

- Press the arrow keys until [**-**] is flashing.
- Press the Enter key to accept the selection.

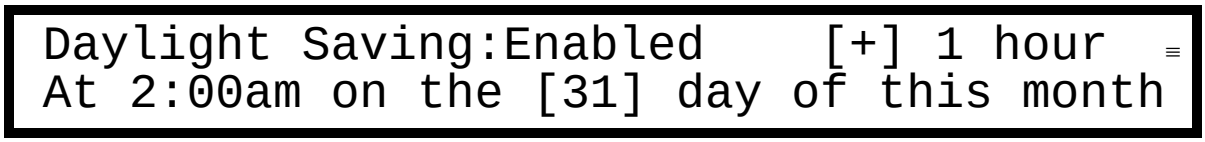


Observe that the cursor is flashing at the tens of day digit.

The day of the month on which the Daylight Saving Time hour change is to go in effect varies each year. To select the day:

- Use the number and arrow keys to select the effective day.
- Press the Enter key to accept the selection.

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When configured to subtract an hour, the unit's time will count as follows on the selected day of the (current) month: 296:01:59:58, 296:01:59:59, 296:01:00:00, 296:01:00:01.

Note: *The Daylight Saving Time mode affects* Local UTC *as well as* Local GPS Time, *even when the Local time offset is set to 00 hours*. *The Daylight Saving Time mode does not affect* UTC *or* GPS Time*.*

4.4.1.7 Leap Second Status

Coordinated Universal Time (UTC) is occasionally adjusted by 1 second to insure that the difference between the International Atomic Time (TAI) does not differ from the Earth's rotational time by more that 0.9 seconds. The first leap second was added on 1 January 1972. The GPStarplus derives its time from the Global Positioning System (GPS). The difference between UTC and GPS time is the number of leap seconds in effect since the start of GPS time at 0 hours on 6 January 1980. GPS time is always ahead of UTC and is not affected by a Leap Second event. The Leap Second pending status is transmitted through the GPS satellites approximately 30 days prior to the event. When operating in the UTC or LUTC mode, the GPStarplus implements the leap second automatically.

Normally, a second is added (+Leap Second). When pending, the event occurs on 30 June or 31 December at Midnight UTC. Leap seconds are always inserted at UTC midnight by altering the second time count only.

To view the Leap Second Status:

- Press key 1 until Time Menu 5 of 5 is selected (**Leap Second Status**).



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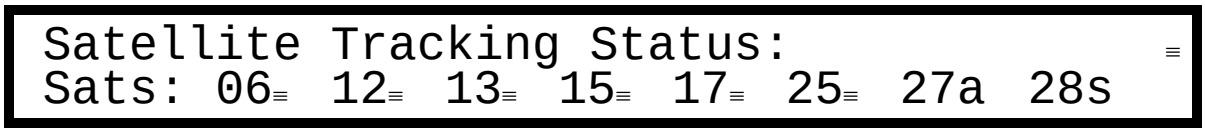
4.4.2 MENU 2 - GPS RECEIVER

This menu provides satellite tracking information, and antenna position information.

4.4.2.1 Satellite Status

To view the satellite tracking:

- Press key 2 until Position Menu 1 of 3 is selected (**Satellite Status**).

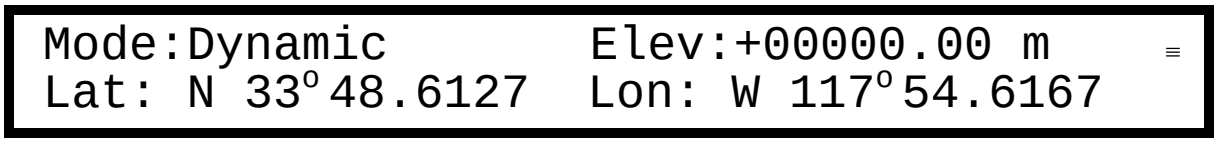


This screen indicates the number of the satellites that are being acquired (a), searched (s), and tracked (≡). The track (≡) symbol also functions as signal strength indicator.

4.4.2.2 Antenna Position Mode and Position Selection

At application of power, the unit defaults to the *Survey* position mode. To view the active position solution mode:

- Press key 2 until Position Menu 2 of 3 is selected (**Position Mode and Position**).



This screen indicates the antenna position, and that the active position solution mode is *Dynamic*. To change the position solution mode:

- Press the Edit key.
- Press the arrow keys until the desired mode (**Survey** or **Dynamic**) is flashing. The *Known* mode is only for indication, it can not be selected. Select *Survey* if the antenna location is not accurately known to initialize the position survey process. At the end of the survey process, the unit automatically enters the Known mode. Select *Dynamic* if the instrument is on a moving platform.



- Press the Enter key to accept the selected mode.

Survey mode is the mode the receiver is in while running its auto-survey process. The receiver uses 3-D Lat, Lon, and Alt values when the receiver acquires a minimum of four satellites with good satellite geometry to compute an averaged position.

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At the end of the survey process, the unit automatically enters the Known mode using those computed values.

Selecting the Survey mode from the Known mode typically results in the unit quickly switching back to the Known mode. This is due to the receiver already having valid position data.

4.4.2.3 Position Average and GDOP Status

The status of the averaged position and the Geometric Dilution Of Precision (GDOP) can be viewed as follows:

- Press key 2 until Position Menu 3 of 3 is selected (**Position Average and GDOP**).



The displayed position data (average latitude, longitude, and elevation) is active only when the *Survey* or *Dynamic* mode is selected and the receiver acquires a minimum of four satellites with good satellite geometry.

GDOP (Geometric Dilution of Precision) is a relative indication of degradation of position and time accuracy due to satellite geometry. Lower numbers represent better accuracy. Typically, the GDOP number is between 2 and 7. The best accuracy (lower GDOP) results when the satellites are spread out across the sky. This is why it is important that the antenna has a clear view of the entire sky. The GDOP data field is always set N/A in the *Known* mode. In the *Survey* or *Dynamic* mode it is set to N/A when the receiver tracks less than 4 satellites.

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4.4.3 MENU 3 - EVENT TRIGGER/TIME TAG

There are two screens associated with Menu 3. One is used to setup the Event Trigger output pulse, and the other is used to configure the Time Tag input port and display the time tag input data.

4.4.3.1 Event Trigger Output Selection

- Press key 3 until Event Trigger/Time Tag Menu 1 of 2 is selected (**Event Trigger Setup**).

```
Start Time:000:00:00:00.0000000 Normal ≡
Period:00:00:00.00   Width:0.000100
```

This screen displays the currently selected parameters of the Event Trigger output pulse. To change the parameters:

- Press the Edit key, and use the arrow keys and the numeric keys to select the Start Time of the output pulse.

  Note: The entered Start Time must be a future time in order for the Event Trigger function properly.

- Press the Enter key to accept the selected Start Time of the output pulse. Press the Menu key to exit the edit screen, or:
- Press the arrow keys to select the polarity of the output pulse (**Normal** or **Invert**).
- Press the Enter key to accept the selected polarity. Press the Menu key to exit the edit screen, or:
- Use the arrow keys, the numeric keys, and the Enter key to enter the Period (repetition rate) of the output pulse. Press the Menu key to exit the edit screen, or:
- Use the arrow keys, the numeric keys, and the Enter key to enter the Width (duration) of the output pulse.

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4.4.3.2 Time Tag Input Configuration

- Press key 3 until Event Trigger/Time Tag Menu 2 of 2 is selected (**Time Tag Setup**).

```
Time Tag:[056] 077:21:54:28.0155148   ≡
Time Tag Mode:Wrap   Clear Buffer:No
```

This screen displays the most recent time tag data, the setup of the Time Tag mode, and the status of the buffer. To view prior events:

- Press the Edit key. Observe that the Time Tag event buffer number changes to location 001.
- Use the right and left arrow keys to scroll up and down the event buffer.
- Press the Menu key to exit, or continue with selecting the Time Tag operation mode.

There are two Time Tag operation modes: Wrap and Burst. In Wrap mode, time tags are stored in a buffer. When the buffer reaches its limit (500), it wraps back to the beginning (001). In the Burst mode, time tags are also stored in a buffer. When the buffer reaches its limit (500), no additional time tags are stored. To select the mode of operation:

- While viewing the Event Trigger/Time Tag Menu 2 of 2 Menu, press the Edit key until Time Tag Mode **Wrap** or **Burst** is flashing.
- Use the arrow keys to select the desired mode.
- Press the Enter key to accept the selection.
- Press the Menu key to exit the edit screen, or continue with clearing the data stored in the buffer.

Up to 500 time tag events can be stored in the time tag data buffer. When operating in the Burst mode and the buffer is full, no new events can be time tagged until the buffer is cleared. To clear the buffer:

- While viewing the Event Trigger/Time Tag Menu 2 of 2 Menu, press the Edit key until Clear Buffer **No** is flashing.
- Use the arrow keys to select Clear Buffer **Yes**. Press the Enter key to accept the selection and clear the buffer.

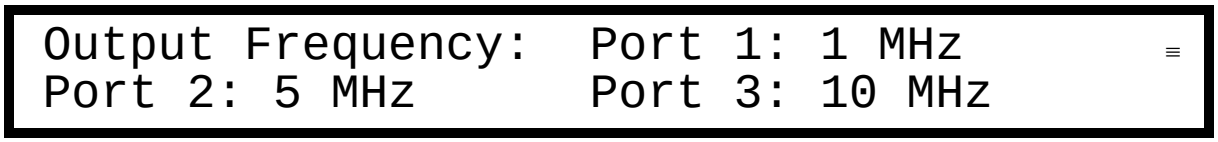
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4.4.4 MENU 5 - FREQUENCY AND PULSE RATE OUTPUT

There are two screens associated with Menu 5. One is used to configure the Frequency Output ports, and the other is used to configure the Pulse Rate output ports.

4.4.4.1 Frequency Output Port Configuration

- Press key 5 until Frequency and Pulse Rate Menu 1 of 2 is selected (**Frequency Output Ports**).



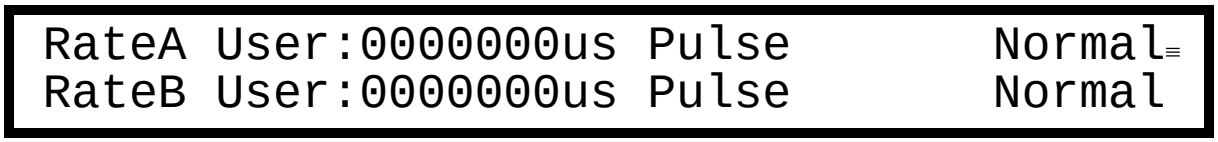
This screen displays the current configuration of the Frequency Output ports. To change the configuration:

- Press the Edit key. Press the arrow keys to select the frequency of Port 1 (**1 MHz**, **5 MHz**, **10 MHz**, or **Off**).
- Press the Enter key to accept the output frequency selection.
- Press the Menu key to exit the edit screen, or continue selecting the signal frequency of Port 2.
- Press the arrow keys to select the frequency of Port 2 (**1 MHz**, **5 MHz**, **10 MHz**, or **Off**).
- Press the Enter key to accept the output frequency selection.
- Press the Menu key to exit the edit screen, or continue selecting the signal frequency of Port 3.
- Press the arrow keys to select the frequency of Port 3 (**1 MHz**, **5 MHz**, **10 MHz**, or **Off**).
- Press the Enter key to accept the output frequency selection.
- Press the Menu key to exit the edit screen.

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4.4.4.2 Pulse Rate Output Port Configuration

- Press key 5 until Frequency and Pulse Rate Menu 2 of 2 is selected (**Pulse Rate Output Ports**).



This screen displays the current configuration of the two Pulse Rate Output ports. To change the configuration of the pulse rate output ports:

- Press the Edit key. Use the arrow keys and the Enter key to select either the pre-programmed or user selected pulse rate option (**PreProg** or **User**).

If the pre-programmed pulse rate option is selected:

- Press the Menu key to exit the edit screen, or continue selecting the pulse repetition rate and/or the pulse polarity. To select the pre-programmed pulse rate:
- Use the arrow keys and the Enter key to select the desired pulse repetition rate.
- Press the Menu key to exit the edit screen, or select the pulse polarity:
- Use the arrow keys to select the desired polarity, **Normal** or **Invert**. Press the Enter key to accept the selected pulse polarity.
- Press the Menu key to exit the edit screen, or continue with the selection of the Pulse Rate B output.

If the user selected pulse rate option is selected:

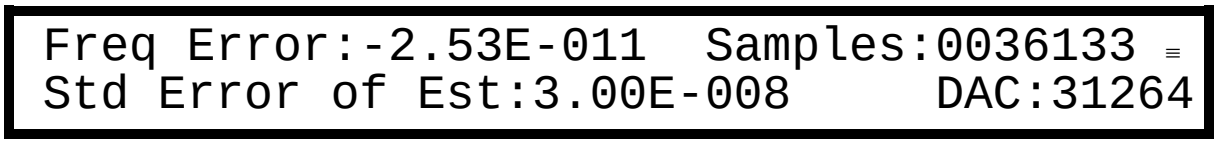
- Press the Menu key to exit the edit screen, or continue selecting the pulse repetition rate and/or the pulse polarity. To select the user programmed pulse rate:
- Use the arrow and numeric keys to select the desired pulse repetition rate. Press the Enter key to accept the selected pulse rate.
- Press the Menu key to exit the edit screen, or select the pulse polarity:
- Use the arrow keys to select the desired polarity, **Normal** or **Invert**. Press the Enter key to accept the selected pulse polarity.
- Press the Menu key to exit the edit screen, or continue with the selection of the Pulse Rate B output.

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4.4.5 MENU 7 - FREQUENCY STATUS

This menu includes a display screen that indicates the frequency disciplining status of the internal oscillator. Through the screen the unit's timing can be re-synchronized and the disciplining can be restarted.

- Press key 7 to view the status screen (**Freq Error and Std Error of Estimate**).



Freq Error - During the initial 24-hour period after application of input power, this screen displays the computed frequency error averaged over the number of measurement *Samples* shown. The sample count increments only when the unit is Time Locked. After the first 24-hour period, the averaged frequency value shown is stored on the display, and updated at the end of each following 24-hour measurement period.

Std Error of Est value represents the standard error of estimate. The value is updated once per second when the unit is Time Locked. For example, if the displayed value is 3.00E-008, it indicates that 67% of the measured differences between the GPS receiver's 1 PPS and the 1 PPS derived from the internal oscillator were less than or equal to the estimated time solution of +/- 3.00E-008 (i.e. +/- 30.0 ns, 1 sigma). Ninety five percent of all estimates occur within 2 sigma. The calculated value is cumulative for the present measurement period, and will fluctuate more in the early part of the period. As the estimation progresses (higher number of samples), the value will become more stable. The value is higher while operating in either the Dynamic or Position Averaging mode.

DAC value is the control value sent to the digital to analog converter that controls the internal oscillator. The number ranges from 0 to 65535.

To manually force the internal timing to re-synchronize to the GPS receiver 1 PPS output and restart the oscillator disciplining process:

- Press the Edit key.



- Use the arrow keys to select **Yes**. Press the Enter key to re-synchronize the unit's timing output signals and restart the disciplining of the oscillator.

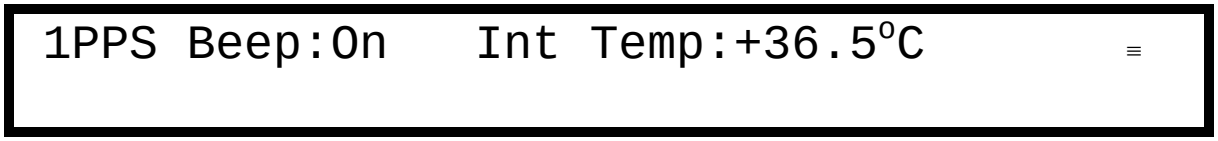
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4.4.6 MENU 9 - MAINTENANCE

There are five screens associated with Menu 9. Most screens are editable.

4.4.6.1 Audio Annunciator Status and Internal Temperature

- Press key 9 until Maintenance Menu 1 of 6 is selected (**Audio Annunciator, Temperature**).

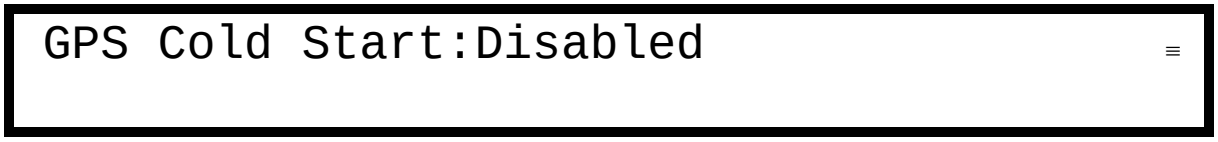


This screen indicates the internal temperature of the unit, and the status of the audio annunciator. When the annunciator is enabled, a once per second tone is generated synchronized to the 1pps output of the unit. To change the annunciator status:

- Press the Edit key. Use the arrow keys to select the 1PPS Beep status (**On** or **Off**).
- Press the Enter key to accept the selected status.

4.4.6.2 Receiver Cold Start and Control

- Press key 9 until Maintenance Menu 2 of 6 is selected (**GPS Cold Start**).



In rare circumstances the receiver's stored data may be corrupted, causing erroneous operation and possibly preventing proper acquisition of satellites. If it is suspected that this condition exists, it is necessary to re-initialize.

- While viewing the Maintenance Menu 2 of 6 press the Edit key until GPS Receiver Cold Start: **Disabled** is flashing.
- Use the arrow keys to select **Enabled**.
- Press the Enter key and observe the following warning message:



- Use the arrow keys to select **Yes**.

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- Press the Enter key to force the receiver into the Cold Start operation mode.

The internal GPS receiver's re-initializes. The receiver defaults to the *Survey* position solution mode, starts the satellite search and acquisition process.

4.4.6.3 DAC Status and Control

- Press key 9 until Maintenance Menu 3 of 6 is selected (**DAC Status and Control**).

```
DAC Value:26538  Oscillator:SOCXO
Reset Unit to Factory Defaults:No
```

This screen displays the present setting of the DAC and the status of the master reset. The DAC value is the control number sent to the digital to analog converter that controls the internal oscillator. The number ranges from 0 to 65535. Also displayed is the oscillator type that is installed in the unit: SOCXO (Oscillator Option -2), or Rubidium (Oscillator Option -3).

Under normal operating conditions it is not necessary to manually alter the DAC value. The value should only be manually changed after a reset of the most recent value occurred caused by a component failure and replacement. The DAC value also resets to the factory default after an upgrade of the unit's firmware has been made. If the most recent value is known, it can be re-entered to speed up the disciplining of the internal oscillator.

- Press the Edit key. Use the arrow and number keys to select a new DAC value.
- Press the Enter key to accept the new DAC value. To exit the edit screen, press the Menu key.

If the most recent DAC value is not known, the value can be set to mid-range as follows:

- While viewing the Maintenance Menu 3 of 6, press the Edit key until Reset Unit to Factory Defaults: **No** is flashing.
- Use the arrow keys to select **Yes**. Press the Enter key to reset the DAC to the factory default value.

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4.4.6.4 RS-232 I/O Port Setup

- Press key 9 until Maintenance Menu 4 of 6 is selected (**RS-232 Setup**).

```
Baud:19200  8 Data, No Parity, 1 Stop  ≡
Control Port RS-232 Configuration
```

This screen displays the default setup/protocol of the control RS-232 I/O interface.

Only the user can select the baud rate. Change the baud rate as follows:

- While viewing the Maintenance Menu 4 of 5, press the Edit key. Observe that the current baud rate selection is flashing.
- Use the arrow keys to select the desired baud rate (**9600, 19200,** or **38400**).
- Press the Enter key to accept the selection.

4.4.6.5 Setup Menu Title Mode

- Press key 9 until Maintenance Menu 5 of 6 is selected (**Setup Menu Title Mode**).

```
Menu Title:Off                         ≡
Menu Title Display Duration:2 Seconds
```

This screen indicates the status of the automatic Menu Title feature. This feature allows the title of the selected menu to momentarily appear on the screen. In the example above, the feature is disabled. To enable this feature:

- Press the Edit key until Menu Title:**Off** is flashing.
- Use the arrow keys to select **On**. Press the Enter key to accept the selection.

```
Menu Title:On                          ≡
Menu Title Display Duration:2 Seconds
```

- Press the Menu key to exit the edit screen, or continue to set the display duration.
- Use the number keys to select the display duration (**1** to **9** seconds).
- Press the Enter key to accept the selection.

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4.4.6.6 Firmware Version Status

- Press key 9 until Maintenance Menu 6 of 6 is selected (**Version**).

```
Unit Ver:1.06.00 Nov  4 2004 11:20:12  ≡
GPS Receiver:Motorola M12  Vers:2.1
```

This screen indicates the version of the internal firmware, including that of the GPS receiver. The user can not change any of the information displayed in this screen.

Note: The Version levels, date shown, and receiver type and version are for Illustration only, and may differ on actual units.

4.5 MENU 8 - OPTION MENU DESCRIPTIONS

The following paragraphs describe in detail the information displayed on each of the operating screens, and how the user can change operating parameters associated with any options installed in the unit. The Option screens are accessed in Menu 8. The screens can only be selected if an option is installed in the unit.

4.5.1 High Frequency Direct Digital Synthesizer (Other Option -1)

If the High frequency Direct Digital Synthesizer is installed, the version of the Synthesizer option is displayed momentarily after the menu is accessed.

- Press key 8 to view the type of option installed in the unit.

```
Option Slot Menu                       ≡
Synthesizer Installed - HF
```

The above information screen is automatically replaced with the following screen.

```
Synthesizer Frequency:1 000 000 Hz     ≡
Sinusoid:On   Differential:Off
```

This screen indicates the Factory Default settings for the HF Synthesizer version: output frequency of 1 MHz (1000000 Hz), the Sinusoid output port enabled (On), and the Differential output port disabled (Off). After subsequent application of input power, the screen indicates the frequency and port setup selected by the user prior to the removal of input power. To change the output frequency or to enable/disable the output ports:

- Press the Edit key to enter the edit mode.

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- Use the arrow and numeric keys to select the output frequency.

Note: The frequency can be selected from 100kHz to 15 MHz in is 5 Hz steps. Any entries made from 0 to 9 Hz (except 5) will be automatically rejected.

- Press the Enter key to accept the selected frequency, or press the Menu key to exit edit mode without making any changes in the output frequency, or:
- Press the arrow keys to enable **(On)** or disable **(Off)** the Sinusoid output port.
- Press the Enter key to accept the selection, or press the Menu key to exit the edit mode without making any selection change, or:
- Press the arrow keys to enable **(On)** or disable **(Off)** the Differential output port.
- Press the Enter key to accept the selection, or press the Menu key to exit the edit mode without making any selection change.

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Section 5 Specifications

5.1 GENERAL

The unit is designed for reliable and maintenance free operation. All connectors are located on the rear panel of the unit for ease of accessibility.

The unit consists of a chassis that can be mounted in a 19-inch equipment cabinet with the supplied removable mounting handles. The standard unit is cooled through convection and conduction. In units configured with the Rubidium oscillator option, an internal cooling fan is used.

5.2 OPERATING DETAILS

5.2.1 Operating Mode Definitions

5.2.1.1 Warm Up

When power is applied, the instrument enters the Warm-Up mode. During this period the internal GPS receiver initializes in the *Survey* mode (also referred to as *Position Averaging* mode). When the receiver has acquired a minimum of four satellites with good satellite geometry, it resolves the initial position of the antenna connected to the instrument and downloads current satellite almanac data. At this point the instrument verifies that the existing position data stored in non-volatile memory is correct. If the position is verified, the receiver automatically switches to the *Known* position mode. The position verification process and automatic switch over takes a few minutes

If the position data indicates that the antenna position has changed, or is otherwise incorrect, the receiver continues to operate in the *Survey* mode using data from the receiver to calculate a new accurate position. After this process is finished, the receiver automatically switches to the *Known* position mode, storing the new antenna position in non-volatile memory. The duration of the position averaging process takes from approximately 3 hours, depending on the satellite visibility.

The disciplining of the instrument’s oscillator starts as soon as the receiver’s timing locks to GPS and the oscillator is determined to be stable. It is not necessary for the instrument to have finished its position survey.

As soon as the instrument has locked to satellites, has enough information, and the internal oscillator has stabilized, the oscillator disciplining process and the alignment of the internal timing starts. When the internal timing is aligned with GPS 1PPS, the instrument’s operation mode switches to the *Time Locked* mode.

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5.2.1.2 Time Locked

In the *Time Locked* mode the instrument's major and minor time is synchronized to UTC. The 1 PPS output from the internal GPS receiver is used as reference to discipline the internal oscillator and the phase of the instrument's 1 PPS output pulse. The accuracy of the 1 PPS output signals is indicated by the Time Figure Of Merit, TFOM. Normally, the TFOM is 4 while operating in the *Known* position mode, and 4 or 5 when operating in the *Dynamic* or *Position Averaging* mode. The TFOM value is displayed on Menu 1 of the front panel display.

5.2.1.5 Coasting

The *Coasting* mode is entered after out of range inconsistencies in the major time (days through seconds) or 1 PPS have been detected, or if the internal receiver has lost lock with all satellites. This mode can only be entered from the *Time Locked* mode.

In the first stage of this mode, the internal oscillator is in holdover (i.e. not being disciplined) to retain the accuracy of the output signals. The timing output accuracy is indicated by the Time Figure Of Merit (TFOM). In the first stage of this mode, the TFOM is the same value as that while operating in the *Time Locked* mode.

When operating in the *Coasting* mode for extended periods, the TFOM value changes according to the estimated time error computed from the following formula: Error = nf; where n = number of seconds since time lock was lost, and f = frequency default error.

In the last stage of the mode, when the conditions needed to start the disciplining and synchronization process are met and then started, the unit will automatically change to the *Recovering* mode if the timing error is greater than 10 µs or, if the timing error is less than 10 µs, directly to the *Time Locked* mode.

At the moment the last stage of the mode is entered, the TFOM indicates the actual measured accuracy of the timing output. The following table lists the TFOM values that could be displayed and provides the corresponding Time Error.

TFOM Value	Time Error	TFOM Value	Time Error
4	To $\leq$ 1 µs	7	> 100 µs to $\leq$ 1 ms
5	> 1 µs to $\leq$ 10 µs	8	> 1 ms to $\leq$ 10 ms
6	> 10 µs to $\leq$ 100 µs	9	> 10 ms

Note: During warm up, TFOM is assigned a value of 9.

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5.2.1.6 Recovering

In the *Recovering* mode the unit adjusts the internal timing and/or the frequency of the internal oscillator until the *Time Locked* mode criteria is met. Expect an eventual transition to the *Time Locked* mode (unless changing conditions prevent this; for instance: loss of tracked satellites, or change of internal offset selection).

5.2.1.7 Disciplining Period

When the unit enters the *Time Locked* mode for the first time after power is applied, the time and output signals are synchronized to GPS, and are phase and frequency corrected as needed to maintain the specified accuracy of the output signals. A hardware/firmware estimator continuously compares the GPS 1 PPS with the internally generated 1 PPS, derived from the unit's oscillator, to determine the correction necessary to discipline the oscillator. The estimator filters out the short-term variations inherent in the GPS 1 PPS.

5.2.2 OPERATING CHARACTERISTICS

Initial Acquisition Time

Receiver in Cold Start ..... < 60 minutes to acquire current almanac, position, and time lock

Receiver in Warm Start

With -2 Oscillator Option..... < 30 minutes to acquire Time Lock

With -3 Oscillator Option..... < 45 minutes to acquire Time Lock

Initial Disciplining Period..... < 24 hours after initial acquisition while operating in the *Known* position time solution mode

Set-Up Data Retention ..... Indefinite, stored in non-volatile memory

Receiver Almanac Data..... 48 hours minimum

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5.3 MECHANICAL

Height .....1.75" (44.5 mm) maximum

Width (without handles) .....17.25" (438 mm) maximum

Depth (excluding protrusions).....12.20" (310 mm) maximum

Weight
with Quartz Oscillator ..... 5.5 LB (2.5-kg) maximum
with Rubidium Oscillator .....6.7 LB (3.1 kg) maximum

Chassis and Panel Color, Fed-Std 595 color 27038 (black) powder coated light texture.

The unit is supplied with removable adapters to fasten the unit in a standard 19" equipment enclosure.

5.4 ENVIRONMENTAL

GPStar*plus*

Operating Altitude..... - 300 m to 4000 m

Storage Altitude..... - 300 m to 9000 m

Operating Temperature .....0^0 C to + 55^0 C

Storage Temperature .....- 40^0 C to + 85^0 C

Temperature Rate of Change..... +/- 10^0 C/Hour maximum

Relative Humidity.....5% to 95%, non-condensing

Antenna (See paragraph 5.7.1)

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5.5 CERTIFICATIONS AND COMPLIANCES

The GPStarplus has been designed to meet international EMC and safety requirements. However, only two versions have been tested, Model 565-210 and 565-310. The following only applies to the tested models.

Declaration of Conformity

EMC	Meets the requirements of FCC Code of Federal Regulations 47 CFR, Part 15, Subpart B, Class B. Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. EN 61326:1998 European Community Product Specification for laboratory and scientific equipment: EN 55011, Class A, Group 1 Radiated Emissions EN 55011, Class A, Group 1 Conducted Emissions EN 61000-3-2 Harmonics EN 61000-3-3 Voltage Flicker EN 61000-4-2 Electrostatic Discharge EN 61000-4-3 Radiated susceptibility EN 61000-4-4 Power line fast transients EN 61000-4-5 Power line surge immunity EN 61000-4-6 Conducted immunity to RF fields EN 61000-4-8 Magnetic immunity EN 61000-4-11 Voltage dips and variations
LVD	Meets intend of Low Voltage Directive 73/23/EEC as amended by 93/68/EEC: EN 61010-1:1993 Safety requirements for electrical equipment for measurement, control and laboratory use.

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5.6 POWER REQUIREMENTS

5.6.1 Power Supply Option -1 (Standard AC Input)

Voltage ..... 85 to 264 VAC (CE rating: 100 to 240 VAC) (universal input)

Isolation ..... 1.5k VAC, input to output

Frequency ..... 47 to 440 Hz

Power ..... 50 Watts (nominal)

Connector ..... IEC 320

On/Off Control ..... On rear panel power entry module

5.6.2 Power Supply Option -2 (DC Voltage)

Note: this configuration is not available for units equipped with a Rubidium oscillator

Voltage ..... 20 to 60 VDC (CE rating: 20 to 53 VDC)

Inrush Current ..... 5 A maximum

Input Over-current Protection ..... Internally fused

Steady State Current (20 VDC input) ..... 1.3 A maximum

Isolation Voltage, Input to ground ..... 500 VDC

Isolation Voltage, Input to Output ..... 500 VDC

Connector ..... RM12BRD-3P (Hirose Electric Co)

Mating Connector (supplied with unit) ..... RM12BPG-3S (Hirose Electric Co)

Input Power Connector Pin Designation

- Pin 1 ..... + DC Input
- Pin 2 ..... Chassis ground
- Pin 3 ..... - DC Input

On/Off Control ..... None

5.6.3 Power Supply Option -3 (High DC Voltage)

Voltage ..... 120 to 350 VDC

Isolation ..... 1.5k VAC, input to output

Power ..... 50 Watts (nominal)

Input Power Cable Conductor Designation

- Green/Yellow ..... Chassis ground
- Blue ..... + DC Input
- Brown ..... - DC Input

Note: The power cable is supplied in the instrument's shipping kit.

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5.7 ANTENNA INTERFACE

The GPStar*plus* is intended to operate from low level RF signals that are normally supplied by a specially designed antenna that includes a low noise amplifier (LNA).

The rear panel connector, identified as ANTENNA, allows connection of the unit to an external antenna. A single coaxial cable is used to provide the RF signals from the antenna to the unit and to supply a dc voltage to the LNA.

Connect Type	TNC (female)
Allowable Cable Loss	15 dB @ 1575 MHz maximum if connected to optional FEI-Zyfer antenna
Power Source for External Antenna	+ 5 VDC, +/- 10% at 100 ma
Protection	short circuit to ground

If the unit is configured with an external DC block connected to the ANTENNA connector, then the antenna power must be supplied by using a "bias-T" or other by other means. It is the responsibility of the installer/user to provide the proper RF input to the unit and to apply the correct DC power to the external antenna.

Note: If the unit has a FEI-Zyfer installed DC block, not exceed the 100 VDC withstanding voltage of the DC block.

5.7.1 Antenna Kit

An optional antenna kit, P/N 0810384, is available from FEI-Zyfer. The kit includes an antenna with internal low noise amplifier, pipe adapter, and a 50-ft. (15 m) length of coaxial cable terminated with a TNC-type connector at both ends. The antenna specifications are as follows:

Connector Type	TNC female
Gain	33 +/- 3 dBi
Filtering/Attenuation	Triple filter/-60 dB @ +/-50 MHz from f_o
Operating Temperature.	-40º C to +85º C
Storage Temperature.	-45º C to +90º C
Humidity	Outdoors / All-weather
Power Requirements	+5 VDC, +/-10% at 30 ma maximum (+5 VDC is supplied by the instrument)

Refer to Section 2 for further information on the antenna system and installation.

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5.8 ELECTRICAL SIGNALS

5.8.1 Reference Frequency Output

Three (3) separate user selected frequency sources are provided.

The instrument's rear panel connector DIRECT OUTPUT is not active. It is intended for future unit enhancement.

Unless otherwise stated, the specifications apply after the internal oscillator has been disciplined for at least three days while the unit is operating in the *Known* position time solution mode with the antenna's geodetic position accurate within 25 meters, the proper antenna cable delay has been selected, and the ambient temperature is constant.

The accuracy of the output signals depends on the oscillator option installed in the unit. Available oscillator options are High Stability Quartz (-2), and Low Profile Rubidium Oscillator (-3).

5.8.1.1 General Characteristics

Connector Identification ..... (~ 1, 2, 3)

Number of Outputs 3

Connector Type ..... BNC female

Wave Shape ..... Sinusoid

Frequency ..... 1, 5, 10 MHz, or Off
Each output is user selected

Accuracy ..... Refer to paragraphs 5.8.1.2 and 5.8.1.3

Amplitude ..... + 12, +/- 0.5 dBm into 50 Ω

Harmonic Distortion (Typical) ..... - 40 dBc

Non-Harmonic Distortion (Typical) ..... - 70 dBc

Coupling ..... AC

Protection
- Applied Voltage (Maximum) ..... +/- 50 VDC
- Terminating Impedance ..... ∞ to short circuit

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5.8.1.2 Oscillator Option -2 Characteristics (High Performance Quartz)

The following additional Reference Frequency Output specification/characteristics pertain to units configured with Oscillator Option -2.

Accuracy Error
Time Locked.....5×10^{-12} (1 day average)
Coasting.....5×10^{-10}/day

Short Term Stability (Time Locked or Coasting)
(Allan Variance) > 1 sec $\leq$ 100 sec .....3×10^{-10}

Phase Noise ..... - 80 dBc @ 1 Hz
(Bandwidth = 1 Hz) - 100 dBc @ 10 Hz
- 105 dBc @ 100 Hz
- 115 dBc @ 1 kHz to 100 kHz

5.8.1.3 Oscillator Option -3 Characteristics (Rubidium)

The following additional Reference Frequency Output specification/characteristics pertain to units configured with Oscillator Option -3.

Accuracy Error
Time Locked.....1×10^{-12} (1 day average)
Coasting.....2×10^{-11} /day

Short Term Stability (Time Locked or Coasting)
(Allan Variance) > 1 sec $\leq$ 100 sec .....5×10^{-11}

Phase Noise (Typical) ..... - 80 dBc @ 1 Hz
(Bandwidth = 1 Hz) - 100 dBc @ 10 Hz
- 105 dBc @ 100 Hz
- 115 dBc @ 1 kHz to 100 kHz

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5.8.2 1 PPS Output

This signal is a highly accurate 1 PPS time standard output for user-specific synchronization applications. In the Time Locked mode, the signal is derived from the unit's internal oscillator, which is locked to Coordinated Universal Time (UTC) through GPS. In the absence of GPS, the unit continues to provide the 1 PPS signal, but the oscillator operates in the Coasting mode. The timing accuracy will degrade as the duration of the Coasting period increases. The degradation also depends on the installed oscillator type. Unless otherwise stated, the specifications apply after the internal oscillator has been disciplined for at least three days while the unit is operating in the *Known* position time solution mode with the antenna's geodetic position accurate within 25 meters, the proper antenna cable delay has been selected, and the ambient temperature is constant.

Connector Identification ..... 1 PPS

Connector Type ..... BNC Female

Rate ..... 1 PPS

Wave Shape ..... Pulse

Pulse Width ..... 2 ms

Synchronization ..... Rising (leading) edge on-time

Time Accuracy

- Time Locked (TFOM 4) ..... 0.3 µs with respect to UTC (0.1 µs at 95% probability)
- Coasting
  - with -2 Oscillator ..... 10 µs per 24 hours
  - With -3 Oscillator ..... 4.3 µs per 24 hours

Output Jitter

- Time Locked and Coasting ..... $\leq$ 1 ns
- Re-sync after Coasting ..... < 5 ns steps between pulses for timing error < 10 µs

  100 ns steps between pulses for timing error $\geq$ 10 µs, < 100 µs

  Single step correction for timing error $\geq$ 100 µs

Output Drive

- High Level ..... $\leq$ + 2.0 V into a 50 Ω load ($\geq$ + 3.0 V open circuit)
- Low Level ..... $\leq$ + 0.5 V into a 50 Ω load

Rise/Fall Time (10% to 90% points) ..... $\leq$ 10 ns

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5.8.3 Pulse Rate Output

Two pulse rate output ports are provided. The rate, duty cycle, and polarity of each output can be independently selected by means of the unit's front panel keypad as well as commands through the RS-232 control interface port.

Twelve (12) fixed (pre-programmed) pulse rates are available for selection. For flexibility, other pulse rate periods can be user selected ranging from 2 µs to 1 second.

5.8.3.1 General Characteristics

Connector Identification ..... OUT A and B

Number of Outputs 2

Connector Type ..... BNC female

Output Drive

High Level .....$\geq$ + 2.0 V into a 50 Ω load ($\geq$ + 3.0 V open circuit)

Low Level .....$\leq$ + 0.5 V into a 50 Ω load

Rise/Fall Time (10% to 90% points) .....$\leq$ 10 ns

Accuracy Error ..... Same as Reference Frequency Output

Synchronization ..... Synchronized within 50 ns to 1 PPS Output at initialization of output

Polarity ..... Rising (Normal) or falling (Inverted) edge on-time, user selected

Output Format ..... Pulse or square wave (50% duty cycle), user selected

Repetition Rate ..... Pre-programmed or user selected

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5.8.3.2 Pre-Programmed Output Characteristics

Repetition Rate.....1 PPM*, 1 PPS*, 10 PPS, 20 PPS, 50 PPS, 100 PPS, 1k PPS, 10k PPS, 100k PPS, 1 M PPS*, 5M PPS, 10M PPS

Output Format ..... Pulse or 50% duty cycle square wave, user selected

Pulse Mode

Rate Selection and Pulse Width

1 PPM.....1 second
1 PPS.....2 ms
10 PPS through 100k PPS.....1 µs
1M PPS.....100 ns
5M PPS..... 100 ns (50% duty cycle)
10M PPS..... 50 ns (50% duty cycle)

Square Wave Mode (50% Duty Cycle)

Rate Selection..... 10 PPS, 20 PPS, 50 PPS, 100 PPS, 1k PPS, 10k PPS, 100k PPS

*Note: The pre-programmed 1 PPM, 1 PPS, and 1M PPS rate can not be selected as a square wave (50% duty cycle) format.

5.8.3.3 User Programmed Output Characteristics

Resolution.....1 µs

Accuracy Error..... Same as Reference Frequency Output

Output Format ..... Pulse or 50% duty cycle square wave, user selected

Pulse Mode

Repetition Rate ..... 2 µs to 1 second (500k PPS to 1 PPS)

Pulse Width.....1 µs

Square Wave Mode (50% Duty Cycle)

Repetition Rate ..... 4 µs to 2 seconds (250k PPS to 0.5 PPS)

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5.8.4 Event Trigger Output

This output provides a single pulse at a programmed time, or a repetitive output pulse with a programmable repetition period. The start of the pulse is synchronized to the unit's selected time reference, UTC or GPS.

Connector Identification ..... EVTRG

Number of Outputs 1

Connector Type ..... BNC female

Output Drive
- High Level .....≥ + 2.0 V into a 50 Ω load (≥ + 3.0 V open circuit)
- Low Level .....≤ + 0.5 V into a 50 Ω load

Rise/Fall Time (10% to 90% points) .....≤ 10 ns

Synchronization Reference..... Synchronized within 100 ns to 1 PPS Output at initialization of output

Polarity .....Rising (Normal) or falling (Inverted) edge on-time, user selected

Output Format ..... Single or repetitive pulse, user selected

Pulse Width ..... 1 µs to 8.999999 seconds, user selected

Pulse Start Time Range .....To 1 year with a resolution of 100 ns, user selected

Repetitive Pulse Period ..... To 99 hrs, 59 min, 59.99 sec, user selected

Repetitive Pulse Stability ..... Same as Reference Frequency Output

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5.8.5 Time Tag Input

This input provides the capability to time tag an event input signal generated by equipment such as: Sequence of Events Recorders, Fault Analyzers, and Phasor Measurement Units (PMU's). The outputs of these devices are typically TTL pulses. An event is time tagged at the time the rising edge of the input pulse exceeds the threshold level. The logged time tag data can be observed on the unit's front panel display, or retrieved through the RS-232 control interface port.

Connector Identification ..... TAG IN

Number of Inputs 1

Connector Type ..... BNC female

Input Voltage Range
- Normal ..... - 0.5 VDC to + 5.0 VDC
- Maximum ..... - 20 VDC to + 25 VDC

Input Impedance ..... 10k Ω (Normal input voltage range)
1k Ω (Input voltage > normal range)

Trigger Edge ..... Rising

Threshold Level ..... + 1.7, +/- 0.4 VDC

Hysteresis ..... 1.0, +/- 0.5 VDC

Input Pulse Width ..... 100 ns minimum, positive to negative edge

Resolution ..... 100 ns

Accuracy ..... Same as Reference 1 PPS Output

Buffer Size 500

Modes ..... Single-Burst up to buffer size or Wrap-Around, user selected

Time Tag Rate ..... 500/sec maximum

Dwell Time between Events ..... 2 ms minimum

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5.8.6 Time Code Output

The time code output signals may be use for general-purpose time distribution, display, and recording tape annotation applications requiring time of year.

Two time code output ports are provided. One port provides a modulated carrier time code output signal, and the second port provides the time code as a dc-shift signal. The format of the time code signal can only be selected by means of the unit's front panel keypad, not by commands through the RS-232 control interface port.

5.8.6.1 Modulated Carrier Output

Connector Identification ..... CODE OUT AC

Number of Outputs 1

Connector Type ..... BNC female

Code Format ..... IRIG A, IRIG B, IRIG G, user selected

Mark Amplitude Level ..... 6 Vpp into a 600 Ω load (nominal)
3 Vpp into a 50 Ω load (nominal)

Mark to Space ratio ..... 3 to 1

Output Impedance ..... 50 Ω nominal

5.8.6.2 DC-Shift Output

Connector Identification ..... CODE OUT DC

Number of Outputs 1

Connector Type ..... BNC female

Code Format ..... Same as selected modulated carrier output

Coherence to 1 PPS Output ..... ≤ 10 ns

Output Drive

High Level ..... ≥ + 2.0 V into a 50 Ω load
(≥ + 3.0 V open circuit)

Low Level ..... ≤ + 0.5 V into 50 Ω load

Rise/Fall Time (10% to 90% points) ..... ≤ 10 ns

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5.8.7 Control/Monitor and TOD Port

A bi-directional full duplex RS-232 interface control port to remotely control and monitor the unit, a Time-Of-Day (TOD) message output-only port, and a Status output is provided.

Each port is designed to communicate with serial asynchronous data communication equipment.

5.8.7.1 Interface Connections

The interface ports are accessible at the rear panel DA15S (socket) D-Subminiature connector labeled CONTROL. A mating connector (DA15P) is supplied in the unit's shipping kit. The following table identifies the connector contact numbers and signals present at each contact.

CONTROL INTERFACE CONNECTOR PIN DESIGNATION		
CONTACT	SIGNAL	DESCRIPTION/COMMENT
1,6,10,12,15	SG	Signal Ground
2	Port 1 Output (TXD1)	GPStar*plus* Control Port Data Output
3	Port 1 Input (RXD1)	GPStar*plus* Control Port Data Input
4	Port 2 Output (TXD2)	GPStar*plus* TOD (Time Of Day) Port Output Message
5	Port 2 Input (RXD2)	Do not connect (For future use)
7,8,13,14		No connection (Open)
9	Not Assigned	Do not connect (For future use)
11	Time Lock	Time Locked/Synchronized to GPS Status Output

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5.8.7.2 Control/Monitor Port Details

Document 365-8005, entitled Generic RS-232 Communication Protocol, contains the detailed description of commands applicable to the unit. A copy of this document is included with each unit at time of shipment.

The baud rate can only be selected by means of the unit's front panel keypad, not by commands through the RS-232 control interface port.

Note: The default Baud Rate is set to 9200 at time of shipment. Subsequent changes in the Baud Rate are stored in non-volatile memory.

Port Designation	Port 1 (Control)
Signal Levels	RS-232 compatible
Baud Rate (user selected)	9600, 19200, 38400
Data Bits	8
Stop Bits	1
Parity	None

5.8.7.3 Time Of Day Port Details

The TOD message is generated every second, and contains the time of the previously generated 1 PPS. The message begins with an "On-Time" ASCI character "!". The rising edge of the first "On-Time" character bit is synchronized to the 1 PPS Output pulse.

Port Designation	Port 2 (TOD)
Signal Levels	RS-232 compatible
Baud Rate	9600
Data Bits	8
Stop Bits	1
Parity	None
Transmit Rate	Every second
Time Tag	Previous 1 PPS
Synchronism of "On-Time" Character	< 1 ms after 1 PPS Output
Time Contents	Days through seconds
Time Reference	Same as unit

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The structure of the Time Of Day output message is as follows:

!TIME,YYYY,DDD,HH,MM,SS,m,T,O

Where:	!		"On-Time" character
	YYYY		Year
	DDD	001 - 366	Day into the year
	HH	00 - 23	Hours into the day
	MM	00 - 59	Minutes into the hour
	SS	00 - 59	Seconds into the minute
	m	1 - 5	Time Mode, where: 1 = GPS Time, 2 = UTC Time, 3 = LGPS (Local GPS) Time, 4 = LUTC (Local UTC) Time, 5 = MAN (Manual) Time
	T	4 - 9	TFOM (Time Figure Of Merit), where the Estimated Time Error (ETE) is: TFOM — ETE 4 — ≤ 1 µs 5 — > 1 µs to ≤ 10 µs 6 — > 10 µs to ≤ 100 µs 7 — > 100 µs to ≤ 1 ms 8 — > 1 ms to ≤ 10 ms 9 — > 10 ms
	O	0 - 4	Operation Mode, where: 0 = Warm Up 1 = Time Locked 2 = Coasting 3 = Recovering 4 = Manual (Manual Time Selection)

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5.8.7.4 Status Output Details

Two "open-drain" hardware output signals are available on the I/0 connector. The signal on connector contact 9 is reserved for future use, and must be left open to prevent accidental damage to the internal driver circuit. The signal on connector pin 11 is active, and can be used by external equipment to indicate the Time Lock status of the unit.

I/0 Connector Contact Number 11

Circuit Type ..... Open drain TMOS FET

Function ..... Time Locked to GPS = "On"
Not Time Locked = "Open Circuit"

Internal Limiting Resistor ..... 100 Ω

Total "On" Resistance ..... 120 Ω maximum

"Open Circuit" Voltage ..... + 55 VDC maximum

Reverse Voltage ..... - 2 VDC maximum

Continuous Sink Current ..... - 20 ma maximum

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5.8.8 Other Options

The instrument can be configured with a Direct Digital Synthesizer providing user programmable output signals. The following paragraphs contain the specifications for this option.

5.8.8.1 High Frequency Synthesizer Output (Other Option -1)

This option provides a reference frequency output that is slaved to the internal disciplined oscillator. The output frequency can be selected in range of 100 kHz to 13 MHz by means of the instrument's front panel keypad as well as commands through the RS-232 control interface port.

One (1) single ended output port, one (1) sinusoid output port, and Four (4) differential output ports are provided. The user can enable or disable the sinusoid and/or the differential output port by means of the front panel keypad as well as through the RS-232 control interface. The single ended output port can not be disabled.

5.8.8.1.1 Single Ended Output

Connector Identification ..... TTL OUT

Number of Outputs 1

Connector Type ..... BNC female

Wave Shape ..... Square wave

Frequency ..... 100 kHz to 13 MHz, user selected in 5 Hz steps

Jitter ..... < 5 ns RMS at > 1 MHz
< 10 ns RMS at $\leq$ 1 MHz

Rise/Fall Time (10% to 90% points) ..... < 10 ns

Output Drive

- High Level ..... $\geq$ + 2.0 V into a 50 Ω load ($\geq$ + 3.0 V open circuit)
- Low Level ..... $\leq$ + 0.5 V into a 50 Ω load

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5.8.8.1.2 Differential Output

Connector Identification ..... DIFFERENTIAL OUT

Number of Outputs ..... 4 Pairs

Connector Type and Pin Designation ..... D-Subminiature (male)

Pin 1 ..... OUT1+
Pin 2 ..... OUT2+
Pin 3 ..... Ground
Pin 4 ..... OUT3+
Pin 5 ..... OUT4+
Pin 6 ..... OUT1-
Pin 7 ..... OUT2-
Pin 8 ..... OUT3-
Pin 9 ..... OUT4-

Mating Connector Type ..... D-Subminiature (DE-9S)

Wave Shape ..... Square wave

Frequency ..... 100 kHz to 13 MHz, user selected in 5 Hz steps

Output Enable/Disable ..... User selected

Jitter ..... < 5 ns RMS at > 1 MHz
< 10 ns RMS at $\leq$ 1 MHz

Rise/Fall Time (10% to 90% points) ..... < 15 ns

Compatibility ..... RS-485 and RS-422

Common Mode Voltage ..... +/- 7 Vdc

Output Current Drive ..... +/- 25 mA maximum when enabled

Recommended Termination ..... 100 Ω or 120 Ω

Recommended Cable ..... 24 to 28 AWG stranded twisted pair

Cable Length ..... Depends on frequency and cable type used

$\leq$ 1 MHz ..... 90 m (300 ft)
$\leq$ 13 MHz ..... 15 m (50 ft)

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5.8.8.1.3 Sine Wave Output

Connector Identification ..... SINE OUT

Number of Outputs 1

Connector Type ..... BNC female

Wave Shape ..... Sinusoid

Frequency ..... 100 kHz to 13 MHz, or Off
user selected in 5 Hz steps

Amplitude into a 50 Ω load ..... Frequency dependent
100 kHz to 9 MHz: + 13, +/- 2 dBm
>9 MHz to 13 MHz: > + 5 dBm, ≤ +13 dBm

Spurious Signals ..... ≤ - 6 dBc at +/- 30 kHz
(Output frequency 500 kHz to 10 MHz) ≤ - 20 dBc at +/- 65 kHz
≤ - 40 dBc at +/- 125 kHz
- 45 dBc (typical) at +/- 500 kHz

Coupling ..... AC

Protection
Applied Voltage (Maximum) ..... +/- 5 VDC
Terminating Impedance ..... ∞ to short circuit

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5.8.8.2 Quad Low Noise 10 MHz Output (Other Options -2)

This option provides a low noise reference frequency source of 10 MHz that is slaved to the internal disciplined oscillator.

Four (4) sinusoid output ports are provided.

Connector Identification	4, 5, 6, 7
Number of Outputs	4
Connector Type	BNC female
Wave Shape	Sinusoid
Frequency	10 MHz
Amplitude	+ 13, + 4, - 1 dBm into 50 Ω
Harmonic Distortion (Typical)	- 40 dBc
Non-Harmonic Distortion (Typical)	- 60 dBc
Coupling	AC
Protection	Short circuit proof
Source Impedance	50 ohm nominal
Accuracy Error (with -1 Oscillator Option) *	
Time Locked	5×10^{-12} (1 day average)
Coasting	5×10^{-10}/day
Short Term Stability (Time Locked or Coasting) *	
(Allan Variance) > 1 sec $\leq$ 100 sec	3×10^{-10} Typical
Accuracy Error (with -3 Oscillator Option) *	
Time Locked	1×10^{-12} (1 day average)
Coasting	1×10^{-11}/day
Short Term Stability (Time Locked or Coasting) *	
(Allan Variance) > 1 sec $\leq$ 100 sec	5×10^{-10} Typical
Phase Noise *	- 90 dBc @ 1 Hz
	- 120 dBc @ 10 Hz
	- 135 dBc @ 100 Hz
	- 145 dBc @ 1 kHz
	- 150 dBc floor

* After three days of locked operation with a fixed antenna location, correct position, and antenna cable delay data entered, and at constant ambient temperature.

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