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GPStar*plus* Model 365
GPS Synchronized
Time and Frequency Source
User's Manual

For units configured with Firmware 365-3003
Version X4.00.03, X4.10.02 and Up

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ALL SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

***Odetics* Telecom**
1585 S. Manchester Avenue, Anaheim CA 92802-2907 USA
Phone: (714) 758-0400 (800) 374-4783 Fax: (714) 780-7696

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Table of Contents

Section 1 General Information

1.1 INTRODUCTION....1-1

1.2 DESCRIPTION....1-1

Section 2 Specifications

2.1 GENERAL....2-1

2.2 OPERATING DETAILS....2-1
2.2.1 Operating Mode Definition....2-1
Warm Up....2-1
Cold Start....2-1
Warm Start....2-1
Time Locked....2-2
Coasting....2-2
Recovering....2-3
Disciplining Period....2-3

2.2.2 Operating Characteristics....2-3

2.3 MECHANICAL....2-4

2.4 ENVIRONMENTAL....2-4

2.5 POWER REQUIREMENTS....2-5
2.5.1 Power Supply Option -1 (Standard AC Input)....2-5
2.5.2 Power Supply Option -2 (+24 VDC / - 48 VDC Input)....2-5
2.5.3 Power Supply Option -3 (120 VDC / 240 VDC Input)....2-5

2.6 ANTENNA INTERFACE....2-6
2.6.1 Antenna Kit....2-6

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2.7 ELECTRICAL SIGNALS....2-7
2.7.1 Reference Frequency Output....2-7
General Characteristics....2-7
Oscillator Option -1 Characteristics (Standard Quartz)....2-8
Oscillator Option -2 Characteristics (High Performance Quartz)....2-8
Oscillator Option -3 Characteristics (Rubidium)....2-9

2.7.2 1 PPS Output....2-11

2.7.3 Pulse Rate Output....2-12
General Characteristics....2-12
Pre-Programmed Output Characteristics....2-13
User Programmed Output Characteristics....2-13

2.7.4 Event Trigger Output....2-14

2.7.5 Time Tag Input....2-15

2.7.6 Time Code Output....2-16
Modulated Carrier Output....2-16
DC-Shift Output....2-16

2.7.7 Control/Monitor and TOD Port....2-17
Interface Connections....2-17
Control/Monitor Port Details....2-18
Time Of Day Port Details....2-18
Status Output Details....2-20

2.7.8 Other Options....2-21
High Frequency Synthesizer Output (Other Option -1)....2-21
Low Frequency Synthesizer Output (Other Option -2)....2-24
ECL Frequency Synthesizer Output (Other Option -3)....2-26
13 MHz Sinusoid Output (Other Option -4)....2-29

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Section 3 Installation

3.1 INTRODUCTION....3-1

3.2 INITIAL INSPECTION....3-1

3.3 INSTALLATION OVERVIEW....3-1

3.4 INSTALLATION PROCEDURES....3-2
3.4.1 Antenna Installation....3-2
Antenna Cable....3-3
In-Line Amplifier....3-4
Lighting Protection....3-4
Weather Proofing....3-4
Antenna Assembly....3-5

3.4.2 Chassis Installation....3-6

3.4.3 Connecting a Computer or Modem....3-6

Section 4 Getting Started

4.1 INTRODUCTION....4-1

4.2 ASSISTANCE....4-1

4.3 INITIALIZATION....4-1

4.4 ANTENNA POSITION/MODE SELECTION....4-3

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Section 5 Display Menus and Controls

5.1 INTRODUCTION....5-1

5.2 FRONT PANEL GENERAL DESCRIPTION....5-1
5.2.1 LCD Screen....5-1
5.2.2 Display Cursor....5-1
5.2.3 Display Contrast Adjustment....5-1
5.2.4 Keyboard....5-2

5.3 MENU/DISPLAY OVERVIEW....5-2

5.4 DETAILED SCREEN DESCRIPTIONS....5-9
5.4.1 MENU 1 - TIME....5-9
Synchronization Mode Selection....5-9
Time Reference Selection....5-11
Local Offset Selection....5-12
Internal Offset Selection....5-12
Time Code Format Selection....5-13
Daylight Saving Time Status Selection....5-13
Leap Second Status....5-15

5.4.2 MENU 2 - POSITION....5-16
Antenna Position/Mode Selection....5-17
Position Average and GDOP Status....5-18

5.4.3 MENU 3 - EVENT TRIGGER/TIME TAG....5-19
Event Trigger Output Selection....5-19
Time Tag Display Configuration....5-20

5.4.4 MENU 5 - FREQUENCY AND PULSE RATE OUTPUT....5-21
Frequency Output Port Configuration....5-21
Pulse Rate Output Port Configuration....5-22

5.4.5 MENU 7 - FREQUENCY STATUS....5-23

5.4.6 MENU 9 - MAINTENANCE....5-24
Audio Annunciator Status and Internal Temperature....5-24
Receiver Operating Status and Control....5-24
DAC Status and Control....5-25
RS-232 I/O Port Setup....5-26
Setup Menu Title Mode....5-27
Firmware Version Status....5-27

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5.5 MENU 8 - OPTION MENU DESCRIPTIONS.....5-28
High Frequency Direct Digital Synthesizer (Other Option -1).....5-28
Low Frequency Direct Digital Synthesizer (Other Option -2).....5-29
ECL Direct Digital Synthesizer (Other Option -3) 5-31

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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 Two, Specifications*.

The complete Model Number of the unit is:

365 -

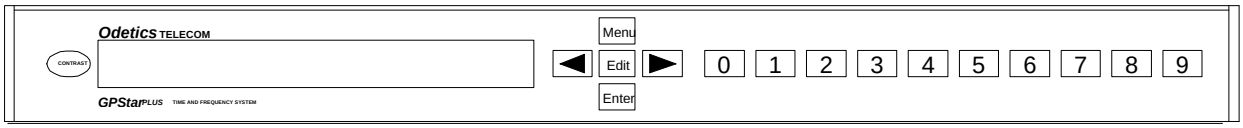
The unit is configured as follows:

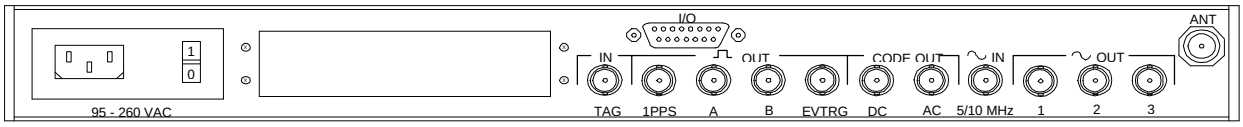
GPStar*plus* CONFIGURATION			
INSTALLED OPTION	**AVAILABLE OPTIONS**		**OPTION DESCRIPTION**
OSCILLATOR CONFIGURATION			
☐	Oscillator	2	High Stability Quartz (Ovenized)
		3	Low Profile Rubidium
POWER/CHASSIS CONFIGURATION			
☐	Power	1	85-264 VAC, 47-440 Hz
		2	20-60 VDC (Not compatible with -3 Oscillator Option)
		3	120-375 VDC
OTHER OPTION			
☐	Other	0	None
		1	High Frequency Direct Digital Frequency Synthesizer (100 kHz-15 MHz)
		2	Low Frequency Direct Digital Frequency Synthesizer (1 kHz-150 kHz)
		3	ECL Direct Digital Synthesizer (100 kHz-15 MHz)
		4	13 MHz Sinusoid Output

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GPStar*plus* Front and Rear Views

(Typical unit 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, and Rubidium oscillator
- Wide input range DC power supply (not available with Rubidium Oscillator option)
- Direct Digital Synthesizer

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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). The accuracy is influenced by Selective Availability (S/A). Selective Availability is the method used by the United States Department of Defense to degrade the accuracy of the C/A code. It is designed to prevent hostile forces from using the GPS system effectively.

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.

Additional information regarding the GPS system, system status, and satellite health can be obtained from:

Civil GPS Information Center
Voice: (703) 313-5907, Computer: (703) 313-5910

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Section 2 Specifications

2.1 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.

2.2 OPERATING DETAILS

2.2.1 Operating Mode Definitions

2.2.1.1 Warm Up

When power is applied, the unit enters a 10-minute warm-up period. During this period the internal oscillator is allowed to stabilize. If the internal GPS receiver is operating in *Warm Start* and has locked-on GPS time, the oscillator disciplining starts immediately after the warm-up period. If the internal GPS receiver is operating in *Cold Start,* the disciplining starts after the receiver has collected a new almanac from the GPS satellites and has locked-on GPS time.

2.2.1.2 Cold Start

In the *Cold Start* mode the internal GPS receiver collects a new Almanac from the GPS satellites. If the user has not entered the antenna position, the receiver automatically determines the position. The major time (days through seconds) is not valid until sufficient data has been collected and the receiver has locked to the GPS time.

2.2.1.3 Warm Start

The *Warm Start* mode is active when the unit has its power applied after the internal receiver collected and saved the satellite Almanac data during prior operation.

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2.2.1.4 Time Locked

In the *Time Locked* mode the unit's major and minor time is synchronized to UTC. The 1 PPS output from the unit's internal GPS receiver is used to discipline the internal oscillator and the phase of the 1 PPS output reference pulse. The effects of Selective Availability are averaged out to minimize errors otherwise caused by Selective Availability. The accuracy of the unit's 1 PPS output 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.

2.2.1.5 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 ≤ 1 µs	7	> 100 µs to ≤ 1 ms
5	> 1 µs to ≤ 10 µs	8	> 1 ms to ≤ 10 ms
6	> 10 µs to ≤ 100 µs	9	> 10 ms

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

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2.2.1.6 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).

2.2.1.7 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.

2.2.2 OPERATING CHARACTERISTICS

Initial Acquisition Time
- Receiver in Cold Start .....< 60 minutes to acquire current almanac, position, and time lock
- Receiver in Warm Start
  - With -1 Oscillator Option..... < 15 minutes to acquire Time Lock
  - With -2 Oscillator Option..... < 30 minutes to acquire Time Lock
  - With -3 Oscillator Option..... < 45 minutes to acquire Time Lock

Automatic Position Solution Period..... 24 hours after acquiring current almanac (assuming 4 satellites are in view)

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

1 PPS Correction after Coasting Mode
- Timing Error < 10 µs..... $\leq$ 1 ns per second step resolution
- Timing Error $\geq$ 10 µs, < 100 µs..... 100 ns per second step resolution
- Timing Error $\geq$ 100 µs.....Single step re-synchronization

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2.3 MECHANICAL

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

Chassis Width.....16.75" (425 mm) maximum

Panel Width (without handles).....16.75" (425 mm) maximum

Panel Width (with handles).....19.00" (483 mm) maximum

Depth (excluding protrusions)..... 12" (305 mm) nominal

Weight .....5-LB (2.3-kg) nominal

Panel Color..... Fed-Std 595 color 26559 (gray)

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

2.4 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 (Optional)

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

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

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

Storage Temperature..... - 45^0 C to + 90^0 C

Humidity..... Outdoors-All Weather

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2.5 POWER REQUIREMENTS

2.5.1 Power Supply Option -1 (Standard AC Input)

Voltage..... 85 to 264 Vac (universal input)

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

Frequency..... 47 to 440 Hz

Power..... 50 Watts (nominal)

2.5.2 Power Supply Option -2 (Low DC Voltage)

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

Voltage..... 20 to 60 Vdc

Inrush Current..... 5 amp 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 MS3102Fl4S-7P

Mating Connector (supplied with unit) MS3106Al4S-7S

Input Power Connector Pin Designation

- Pin A..... Chassis ground
- Pin B..... + DC Input
- Pin C..... - DC Input

On/Off Control..... Rear panel switch

2.5.3 Power Supply Option -3 (High DC Voltage)

Voltage..... 120 to 375 Vdc

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

Power..... 50 Watts (nominal)

Input Power Connector Pin Designation

- Pin A..... Chassis ground
- Pin B..... + DC Input
- Pin C..... - DC Input

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2.6 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 TNC-type (female) 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. The circuitry of the unit's internal receiver is can sustain a short between the antenna interface connector and ground for a period of 10 seconds.

2.6.1 Antenna Kit

An optional antenna kit, P/N 0810137, is available from Odetics Inc. The kit includes an antenna with internal low noise amplifier, mounting hardware, and a 50-ft. (15 m) length of coaxial cable terminated with a TNC-type connector at both ends.

Refer to Section 3 for further information on the antenna system and installation.

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2.7 ELECTRICAL SIGNALS

2.7.1 Reference Frequency Output

Three (3) separate user selected frequency sources are provided. Unless otherwise stated, the specifications apply when the unit is operating in the *Known* position mode, the antenna's geodetic position is known within 25 meters, and the internal oscillator has been disciplined.

The accuracy of the output signals depends on the oscillator option installed in the unit. Currently available oscillator options are: Standard Quartz (-1), High Stability Quartz (-2), and Low Profile Rubidium Oscillator (-3).

2.7.1.1 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

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

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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2.7.1.2 Oscillator Option -1 Characteristics (Standard Quartz)

The following additional Reference Frequency Output specification/characteristics pertain to units configured with Oscillator Option -1.

Accuracy Error
- Time Locked ..... $\leq 5 \times 10^{-12}$ (1 day average)
- Aging During Coasting ..... $\leq 3 \times 10^{-9}$ /day

Short Term Stability (Time Locked or Coasting)
- tau = > 1 sec $\leq$ 100 sec ..... $< 3 \times 10^{-9}$ (typical)

Phase Noise (Typical) ..... - 75 dBc @ 1 Hz
(Bandwidth = 1 Hz) - 95 dB @ 10 Hz
- 110 dBc @ 100 Hz
- 115 dBc @ 1 kHz
- 120 dBc @ 10 kHz

2.7.1.3 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 ..... $< 5 \times 10^{-12}$ (1 day average)
- Aging During Coasting ..... $< 3 \times 10^{-10}$/day

Short Term Stability (Time Locked or Coasting)
- tau = > 1 sec $\leq$ 100 sec ..... $< 3 \times 10^{-10}$ (typical)

Phase Noise (Typical) ..... - 90 dBc @ 1 Hz
(Bandwidth = 1 Hz) - 105 dBc @ 10 Hz
- 110 dBc @ 100 Hz
- 115 dBc @ 1 kHz
- 120 dBc @ 10 kHz

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2.7.1.4 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 ..... $\leq 5 \times 10^{-12}$ (1 day average)
- Aging During Coasting ..... $\leq 2 \times 10^{-11}$ /day

Short Term Stability (Time Locked or Coasting)
- tau = > 1 sec $\leq$ 100 sec ..... $< 5 \times 10^{-11}$ (typical)

Phase Noise (Typical) ..... - 85 dBc @ 1 Hz
(Bandwidth = 1 Hz) - 105 dBc @ 10 Hz
- 115 dBc @ 100 Hz
- 120 dBc @ 1 kHz
- 120 dBc @ 10 kHz

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2.7.2 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 when the unit is operating in the Known position mode, the antenna's geodetic position is known within 25 meters, the internal oscillator has been disciplined, the proper antenna/cable delay has been selected, and Selective Availability (SA) is active.

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 Error

- Time Locked (TFOM 4) ..... ≤ 0.3 µs with respect to UTC (≤ 0.1 µs at 95% probability)
- Coasting
  - With -1 Oscillator ..... ≤ 87 µs per 24 hours
  - With -2 Oscillator ..... ≤ 8.7 µs per 24 hours
  - With -3 Oscillator ..... ≤ 4.3 µs per 24 hours

Output Jitter

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

  100 ns steps between pulses for timing error ≥ 10 µs, < 100 µs

  Single step correction for timing error ≥ 100 µs

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

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2.7.3 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.

2.7.3.1 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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2.7.3.2 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.

2.7.3.3 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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2.7.4 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 ..... $\geq$ + 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

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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2.7.5 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, +/- 0.4Vdc

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 256

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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2.7.6 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.

2.7.6.1 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

2.7.6.2 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 ..... $\leq$ 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 50 Ω load

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

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2.7.7 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.

2.7.7.1 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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2.7.7.2 Control/Monitor Port Details

Document 365-8005, entitled 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 19200 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

2.7.7.3 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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2.7.7.4 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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2.7.8 Other Options

The instrument can be configured with optional functions and output signals. Available options include a Direct Digital Synthesizer providing user programmable output signals, and a precision 13 MHz output. The following paragraphs contain the specifications for these options.

2.7.8.1 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 15 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.

2.7.8.1.1 Single Ended Output

Connector Identification ..... TTL OUT

Number of Outputs 1

Connector Type ..... BNC female

Wave Shape ..... Square wave

Frequency ..... 100 kHz to 15 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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2.7.8.1.2 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 (DE9S)

Wave Shape ..... Square wave

Frequency .....100 kHz to 15 MHz,
user selected in 5 Hz steps

Output Enable/Disable ..... User selected

Jitter ..... < 5 ns RMS at > 1 MHz
< 10 ns RMS at ≤ 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
+/- 250 µA when disabled (high impedance)

Recommended Termination..... 100 Ω or 120 Ω
(depends on cable type used)

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

Cable Length .....Depends on frequency and cable type used
≤ 1 MHz .....90 m (300 ft)
≤ 15 MHz .....15 m (50 ft)

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2.7.8.1.3 Sine Wave Output

Connector Identification ..... SINE OUT

Number of Outputs 1

Connector Type ..... BNC female

Wave Shape ..... Sinusoid

Frequency ..... 100 kHz to 15 MHz, or Off
user selected in 5 Hz steps

Amplitude into a 50 Ω load ..... Frequency dependent
100 kHz to 9 MHz: + 13, +/- 0.5 dBm
9 MHz to 15 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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2.7.8.2 Low Frequency Synthesizer Output (Other Option -2)

This option provides a reference frequency output that is slaved to the internal disciplined oscillator. The output frequency can be selected in range of 1 kHz to 150 kHz by means of the instrument's front panel keypad as well as commands through the RS-232 control interface port.

Two (2) single ended TTL level output ports, and four (4) differential output ports are provided. The user can enable or disable the differential output port by means of the front panel keypad as well as through the RS-232 control interface. The single ended output ports can not be disabled.

2.7.8.2.1 Single Ended Output

Connector Identification ..... TTL 1 OUT, TTL 2 OUT

Number of Outputs 2

Connector Type ..... BNC female

Wave Shape ..... Square wave

Frequency ..... 1kHz to 150 kHz, user selected in 1 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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2.7.8.2.2 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 (DE9S)

Wave Shape ..... Square wave

Frequency ..... 1 kHz to 150 kHz,
user selected in 1 Hz steps

Output Enable/Disable ..... User selected

Jitter ..... < 5 ns RMS at > 1 MHz
< 10 ns RMS at ≤ 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
+/- 250 µA when disabled (high impedance)

Recommended Termination..... 100 Ω or 120 Ω
(depends on cable type used)

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

Cable Length ..... Up to 900 m (3000 ft)
(depends on cable type used)

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2.7.8.3 ECL Synthesizer Output (Other Option -3)

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 15 MHz by means of the instrument's front panel keypad as well as commands through the RS-232 control interface port.

One (1) ECL complementary pair, one (1) sinusoid output port, and one (1) TTL output port is provided. The user can enable or disable the sinusoid output port by means of the front panel keypad as well as through the RS-232 control interface. The ECL and TTL output ports can not be disabled. The ECL output is intended for driving short cable lengths.

2.7.8.3.1 TTL Output

Connector Identification ..... TTL OUT

Number of Outputs 1

Connector Type ..... BNC female

Wave Shape ..... Square wave

Frequency ..... 100 kHz to 15 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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2.7.8.3.2 ECL Output

Connector Identification ..... DIFFERENTIAL OUT

Number of Outputs ..... 1 Pair

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

Pin 1 ..... ECL Output True
Pin 2 ..... N/C
Pin 3 ..... Ground
Pin 4 ..... N/C
Pin 5 ..... N/C
Pin 6 ..... ECL Output Complement
Pin 7 ..... N/C
Pin 8 ..... N/C
Pin 9 ..... N/C

Mating Connector Type ..... D-Subminiature (DE9S)

Wave Shape ..... Square wave

Frequency ..... 100 kHz to 15 MHz, user selected in 5 Hz steps

Coupling ..... AC

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

Rise/Fall Time (10% to 90% points) .... < 4 ns with cable length $\leq$ 1 m (3 ft)

Common Mode Voltage ..... +/- 10 Vdc

Output Current Drive ..... +/- 40 mA

Recommended Termination ..... 470 Ω to Vbb, each signal

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

Cable Length ..... 3 m (10 ft)

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2.7.8.3.3 Sine Wave Output

Connector Identification ..... SINE OUT

Number of Outputs 1

Connector Type ..... BNC female

Wave Shape ..... Sinusoid

Frequency ..... 100 kHz to 15 MHz, or Off
user selected in 5 Hz steps

Amplitude into a 50 Ω load ..... Frequency dependent
100 kHz to 9 MHz: +13, +/- 0.5 dBm
9 MHz to 15 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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2.7.8.4 13 MHz Sinusoid Output (Other Option -4)

Other Option -4 provides a 13 MHz sinusoid output. This output is phase-locked to the unit's internal precision 10 MHz disciplined oscillator. The output is present in all modes of operation.

Connector Identification ..... 13 MHz

Connector Type ..... BNC female

Wave Shape ..... Sinusoid

Frequency Accuracy ..... Same as Reference Frequency Output (Paragraph 2.7.1)

Amplitude ..... +16.8, +/- 1.0 dBm (3.9 Vpp to 4.9 Vpp into a 50 Ω load

Spectral Purity

- 2nd Harmonic ..... - 55dBc
- 3rd Harmonic ..... - 48 dBc
- Other Harmonics and Non-Harmonic - 62 dBc

Phase Noise (Maximum) ..... < - 68 dBc @ 1 Hz

(Bandwidth = 1 Hz) < - 70 dB @ 10 Hz

< - 75 dBc @ 100 Hz

< - 85 dBc @ 1 kHz

< - 110 dBc @ 10 kHz - 100 kHz

Coupling ..... AC

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Section 3 Installation

3.1 INTRODUCTION

This section contains the GPStar*plus* installation instructions.

3.2 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.

3.3 INSTALLATION OVERVIEW

Installation consists of mounting the 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 50-Ohm 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).

CAUTION!

A short circuit of the coaxial antenna cable for a duration longer than 10 seconds can not be sustained without possible damage to the unit.

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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3.4 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.

3.4.1 Antenna Installation

The optional antenna kit includes the following items:

- Quadrifilar antenna with 37 dBm integral LNA
- Threaded pole mount adapter
- Surface mounting ring adapter
- 1"-14 to 5/8"-11 thread adapter
- 50 ft of RG-58 antenna cable
- Various screws and washers for use in assembly

The antenna may be mounted either on a pole or flat surface, hardware to accommodate either method of installation is provided. Figure 3-1 shows an antenna configured for mounting on a pole.

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 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 (pole or surface mount). 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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3.4.1.1 Antenna Cable

The (optional) antenna kit is supplied with 50 ft. (15 m) of RG-58 or RG-59 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 30 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.

Odetics 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), and Belden® type 9104 (RG-59) cable provide good performance.

The following table indicates the maximum length of recommended cable type when used with the antenna supplied in Odetics P/N 0810137 antenna kit.

Cable Type	Max. Length	Comments
RG-58 (Belden® 9311)	150 ft (45 m)	Allows for 1 in-line connector splice. Loss 17 dB per 100 ft (30 m)
RG-213 (Belden® 8267)	250 ft (75 m)	Allows for 1 in-line connector splice. Loss 12 dB per 100 ft (30 m)
RG-59 (Belden® 9104)	300 ft (90 m)	Allows for 1 in-line connector splice. Loss 9 dB per 100 ft (30 m)
RG-8 (Belden® 9913)	500 ft (150 m)	Allows for 1 in-line connector splice. Loss 6 dB per 100 ft (30 m)

For extremely long runs it is necessary to use an In-Line Amplifier and/or low loss cable manufactured by Andrew Corporation, Orland Park, IL, USA, Times Microwave Corporation, Wallingford, CT, USA, and other manufacturers. This cable has a loss of 1 to 3 dB per 30 meters that allows for cable runs in excess of 300 meters.

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3.4.1.2 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. It is recommended to install the amplifier near the center of the cable run length. Amplifiers are available from several manufacturers including Odetics Inc. The following table lists the characteristics of the amplifier available from Odetics Inc.

Amplifier P/N 0810160 Characteristics	
Gain	33 dB minimum
Bandwidth about 1575.42 MHz	20 MHz
Input Power	5 to 25 VDC at 30 mA with voltage pass-through
Noise Figure	2.5 typical
Connector	TNC Female In and Out

3.4.1.3 Lightning Protection

In areas where lightning is present it is recommended to install a lightning protection device to protect the unit from damage in the event the external antenna is struck by lightning. A lightning arrester, part number IS-MR50LNZ+6, is available from PolyPhaser Corporation, Minden, Nevada, USA. In order to be effective, the arrester must be connected to earth ground using a very low-inductance conductor. The arrester should be connected as close as possible to the point where the antenna cable enters the building. The use of this device requires TNC to N-type connector adapters.

CAUTION!

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

3.4.1.4 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.

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3.4.1.5 Antenna Assembly

The optional antenna is supplied with hardware required for pole and flat surface mounting. Figure 3-1 shows the antenna configured for mounting on a pole.

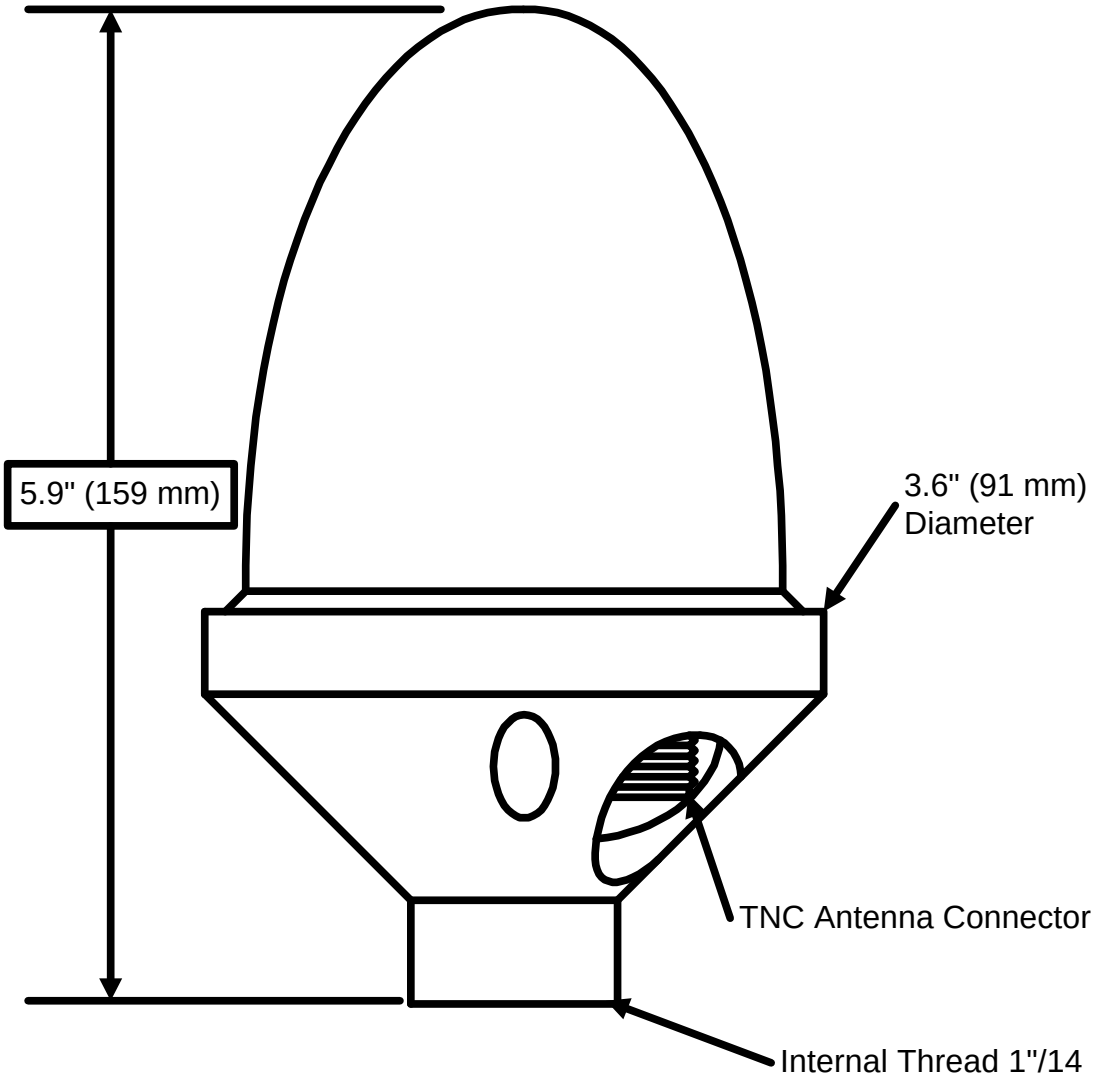


Figure 3.1 Standard Antenna Shown with Pole Mount Adapter Attached

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3.4.2 Chassis Installation

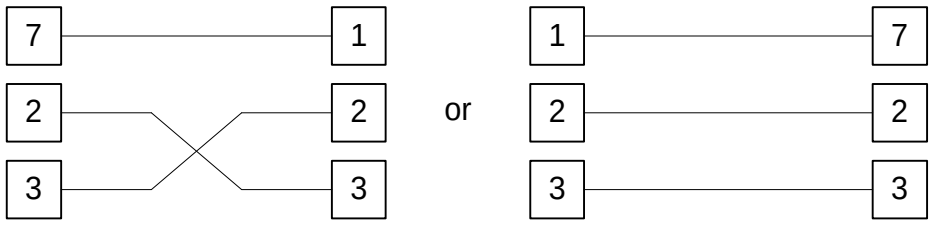
To install the chassis perform the following steps:

- 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 the AC input power to the unit, using the supplied power cord. If the unit is configured to operate from a DC power source, 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

3.4.3 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. Most computers are DTE (Data Terminal Equipment) devices and most modems are DCE (Digital Communication Equipment) devices. Connect the unit as follows:



DB25 Female To Computer | DA15 Male To GPStar *plus* | DB25 Male To Modem

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Section 4 Getting Started

4.1 INTRODUCTION

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

4.2 ASSISTANCE

If you need assistance or have any questions, please do not hesitate to call:

Odetics **Telecom**
714-758-0400 or 800-374-7483
(8:00 A.M. to 5:00 P.M. Pacific Time)

4.3 INITIALIZATION

The physical installation must be completed as described in Section 3 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 the 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.

Set the rear panel power switch to ON (upward).

Cold Start - *At initial* power-up, the unit's internal receiver defaults to the Cold Start mode, and the position solution defaults to the *Position Averaging* mode. During this mode, the unit down loads a current almanac and other pertinent data from the satellites that are searched for and eventually acquired by the unit.

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

```
GPS  TFOM:9  Jan 06,1980 / 006:00:01:53≡
Warm-Up       Sats:01s 02s 17s 24s 29s
```

The above screen indicates the unit's internal GPS receiver is operating in the Cold Start mode (as indicated by the start date of GPS time: *Jan 06, 1980),* the number of the satellite(s) being searched, the selected Time Reference is *GPS*, and the Time Figure Of Merit (*TFOM*) of the unit's time.

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.*

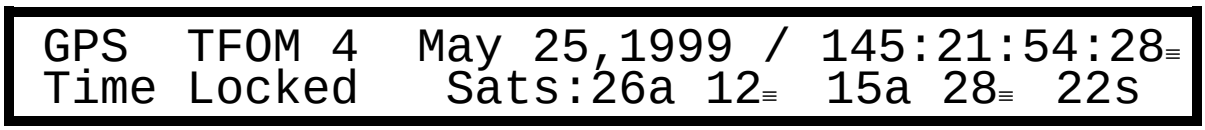
Further operation is automatic. In order to reach steady-state operation, the unit must know the position of the antenna. The unit's internal GPS receiver must track at least 3 satellites to collect enough information to compute the antenna position. During Cold Start, the unit operates in the *Position Averaging* position mode and uses data from the satellites to calculate the antenna position. Although the unit does synchronize to GPS and starts to discipline the internal oscillator during the *Position Averaging* period, it is at a reduced accuracy. After operating in the *Position Averaging* mode for a minimum of 1 day, the unit automatically switches to the *Known* position mode using the calculated averaged antenna position. The greatest accuracy is obtained while operating in the *Known* mode with the exact antenna position information.

The user can shorten the time required to track satellites and achieve synchronization, by selecting the *Known* position mode and entering the actual antenna position accurate to seconds of arc. The Antenna Delay compensation should also be entered. Refer to paragraph 4.5, Antenna Position/Mode Selection, and paragraph 4.6, Antenna Cable Delay Compensation Selection.

Note: An incorrect value for the antenna position can cause the unit to search for the wrong satellites, and will degrade the timing/frequency accuracy of the output signals or even prevent the tracking of any satellite.

Warm Start - At subsequent application of power, after the unit has stored a valid almanac, the unit defaults to the Warm Start mode and the position solution defaults to the mode that was selected during prior operation. If the unit initializes in the Warm Start mode, the following screen appears:

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This screen indicates the unit's internal GPS receiver is operating in the Warm Start mode (as indicated by the correct date and approximate time), the number of the satellite(s) being searched, and the Time Figure Of Merit (*TFOM*) of the unit's timing output.

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 acquiring satellites 26 and 15, tracking satellites 12 and 28, and searching for satellite 22.

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.

4.4 ANTENNA POSITION/MODE SELECTION

At initial power-up, the unit normally defaults to *Cold Start* and *Position Averaging* position mode. At subsequent application of power the unit defaults to *Warm Start* and the position mode selected during the prior operation. To view the active position solution mode:

- Press key 2 until Position Menu 1 of 2 is selected (**Position Mode and Location 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 (**Pos Averaging**, **Known**, or **Dynamic**) is flashing. Select *Pos Averaging* if the antenna location is not accurately known. Select *Known* if the antenna position is accurately known.

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```
Mode:Pos Averaging Elev:+00000.00 m     ≡
Lat: N 33°48.6127  Lon: W 117°54.6167
```

- Press the Enter key to accept the selected mode.

If the *Pos Averaging* mode is selected, the unit will automatically determine the antenna position. However, the acquisition of satellites can be accelerated if the user already knows the approximate position of the antenna.

If the *Known* mode is selected, the unit uses the existing antenna position data. If the existing position data is not accurate the timing accuracy of the unit will be degraded. To change the position data:

- Press the Edit key, and use the arrow keys, the numeric keys, and the Enter key to enter the elevation, latitude, and longitude of the antenna.

Note: It is necessary to press the Enter key at each position element prompted by the flashing cursor to properly load the position, even if only one element has been changed.

4.5 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 +/- 99,999 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**).

```
Time Mode:LUTC   Local Offset:-08   hrs≡
Internal Offset:+00050 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 +00050 ns.

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To alter the amount of cable delay compensation or offset:

- Press the Edit key until Internal Offset **±** is flashing.
- Use the arrow keys to select a positive (+) or negative (-) offset.
- Press the Enter key to accept the selected offset polarity.
- 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.

Negative numbers cause the timing outputs to occur later in time to align the unit's output timing with user's system timing that is offset from GPS or UTC 1 PPS reference. Positive numbers cause the timing outputs to occur sooner in time. **Positive numbers are used to compensate for cable delays.**

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)
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 **+00067** 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 5 Display Menus and Controls

5.1 INTRODUCTION

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

5.2 FRONT PANEL GENERAL DESCRIPTION

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

5.2.1 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       Sats:26a 12≡  15a 28≡  22s
```

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.

5.2.2 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.

5.2.3 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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5.2.4 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.

5.3 MENU/DISPLAY OVERVIEW

The user selects the desired menu screen using the number keys. After being selected, the menu screen 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 5.1 - 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 5.5 for details*.

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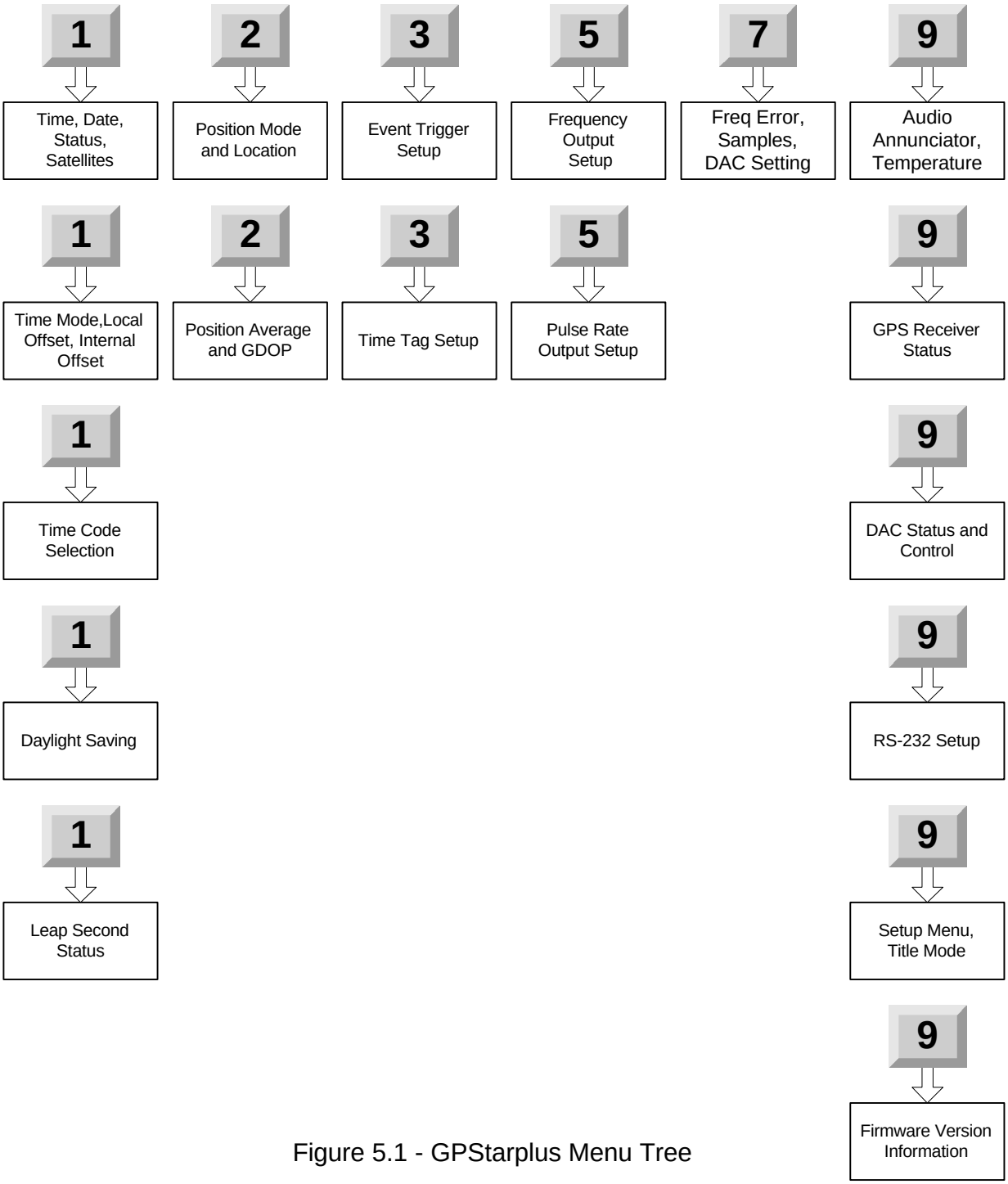


Figure 5.1 - GPStarplus Menu Tree

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5.3.1 MENU 1 - TIME

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

- **Screen 1 - Time, Date, Status, Satellites** - 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), which satellites are being tracked, 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 or internal offset.

- **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). When armed, a second will be added or subtracted (as transmitted in the GPS data message) at 23:59:59 hours UTC of the current month's last day.

  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, it indicates that the Leap Second function is armed. There are no user editable parameters.

5.3.2 MENU 2 - POSITION

Reference I/O commands: GDOP, PAVG, SPOS, TRMO

- **Screen 1 - Position Mode and Location** - Displays the active Time Recovery position mode (Known, Position Averaging, or Dynamic), and the calculated or entered Latitude, Longitude, and Elevation. Through this screen the user can:

  - Change the Time Recovery position mode (Known, Position Averaging, or Dynamic).

  - Change the Latitude, Longitude, and Elevation.

- **Screen 2 - Position Average and GDOP** - Active only when the *Position Averaging* mode has been selected and the GDOP is 5 or less. Displays the Geometric Dilution Of Precision (GDOP), the mode status, the number of samples taken, and the averaged position data. After operating one day in *Position Average*, the mode status automatically changes to *Off*, and the screen becomes inactive.

5.3.3 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.

5.3.4 MENU 4 - Not active/for future use.

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5.3.5 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).

5.3.6 MENU 6 - Not active/for future use.

5.3.7 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 1 PPS output and restart the disciplining process.

5.3.8 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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5.3.9 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 Receiver Status** - Displays the operating status of the internal GPS receiver. Through this screen the user can:
  - Select the Normal, Warm Start, or 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 can not change any of the information displayed in this screen.

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5.4 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.

5.4.1 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, Satellites**)

```
GPS  TFOM 4  May 26,1999 / 145:21:54:28≡
Time Locked   Sats:26a 12≡  15a 28≡  22s
```

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
- Satellite tracking information

5.4.1.1 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.

```
Manual Time Mode Disabled                ≡
```

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

```
Manual Time Mode Enabled                 ≡
Date:May 25,1999   Time:10:59:48
```

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

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.

```
Manual Time Mode Enabled                ≡
```

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

5.4.1.2 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.

```
Time Mode:LUTC   Local Offset:-08   hrs≡
Internal Offset:+00000 ns
```

- 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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5.4.1.3 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:+00000 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.

5.4.1.4 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 +/- 99999 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 Internal Offset **±** is flashing.

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```
Time Mode:LUTC   Local Offset:-08   hrs≡
Internal Offset:+00000 ns
```

- Use the arrow keys to select positive (+) or negative (-) Internal Offset.
- Press the Enter key to accept the selected Internal Offset polarity.
- 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.

5.4.1.5 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.

5.4.1.6 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**)

```
Daylight Saving:Disabled                ≡
```

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.

```
Daylight Saving:Enabled    [+] 1 hour   ≡
At 2:00am on the [00] day of this month
```

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.

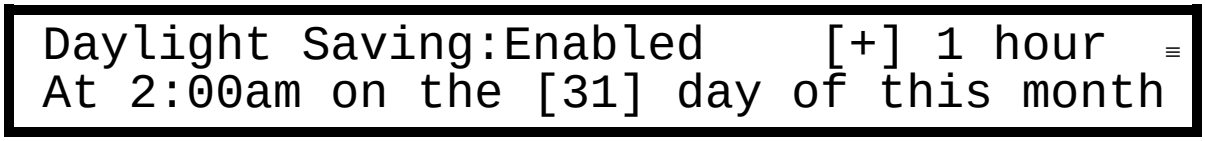
```
Daylight Saving:Enabled    [+] 1 hour   ≡
At 2:00am on the [00] day of this month
```

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 effect* UTC *or* GPS Time*.*

5.4.1.7 Leap Second Status

UTC Leap Second compensation, when determined to be required by USNO, occurs at midnight UTC on the last day in June or December. Leap Second adjustments are automatically implemented in the unit. When the Leap Second occurrence is armed, the unit's UTC time will automatically update within 1 minute after midnight UTC.

When a Leap Second occurs, one second is added or subtracted from the unit's time as transmitted in the GPS data message on the last day of the current month. Leap seconds are only applicable when UTC is selected as time reference. To view the Leap Second Status:

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



Leap seconds are added or subtracted to keep UTC time in synchronization with sidereal time. To date, all leap seconds have been positive (added).

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5.4.2 MENU 2 - POSITION

The unit must know the antenna's position (longitude, latitude, and elevation) before it can obtain accurate time.

The unit is capable of automatically determining the antenna's position; however, to speed up the synchronization process while operating in a stationary location, the user can select the *Known* position solution mode and input the exact position of the antenna (latitude, longitude, and elevation).

If the exact position of the antenna is not known, but the location is stationary, the user can select the *Position Averaging* mode. The unit will determine the antenna's position by averaging the position solution. After 86400 samples, the mode automatically switches to the *Known* position mode, using the calculated refined position solution. The unit needs to track a minimum of three satellites to operate in *Position Averaging* mode. Position solution data is only used when the GDOP is < 5.00.

Note: Timing accuracy will be degraded while operating in the Position Averaging *mode even if the antenna remains stationary. This is due to the fact that the GPS receiver must not only compute time, but position as well.*

The user can select the *Known* mode prior to the automatic switchover. However, this could result in a less accurate antenna position solution, causing reduced accuracy of the internal oscillator disciplining, frequency output, and timing output.

If the antenna is on a moving platform the unit **must** be operated in *Dynamic* mode. Timing accuracy will be degraded in the *Dynamic* mode even if the antenna platform remains stationary. The unit needs to track a minimum of three satellites to operate in *Dynamic* mode.

Note: When being used in a stationary location and the antenna's position is not accurately known, it is recommended to use the Position Averaging *mode. If the position is accurately known, use the* Known *mode and the accurate position data.*

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5.4.2.1 Antenna Position/Mode Selection

At initial application of power, the unit normally defaults to *Cold Start* and *Position Averaging* position mode. At subsequent application of power, the unit defaults to *Warm Start* and the position mode selected during the prior operation. To view the active position solution mode:

- Press key 2 until Position Menu 1 of 2 is selected (**Position Mode and Location**).

```
Mode:Dynamic        Elev:+00000.00 m    ≡
Lat: N 33°48.6127   Lon: W 117°54.6167
```

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 (**Pos Averaging**, **Known**, or **Dynamic**) is flashing. Select *Pos Averaging* if the antenna location is not accurately known. Select *Known* if the antenna position is accurately known.

```
Mode:Pos Averaging  Elev:+00000.00 m    ≡
Lat: N 33°48.6127   Lon: W 117°54.6167
```

- Press the Enter key to accept the selected mode.

If the *Pos Averaging* mode is selected, the unit will automatically determine the antenna position. However, the acquisition of satellites can be accelerated if the user enters the approximate position of the antenna, if available.

If the *Known* mode is selected, the unit uses the existing antenna position data. If the existing position data is not accurate the timing accuracy of the unit will be degraded. To change the position data:

- Press the Edit key, and use the arrow keys, the numeric keys, and the Enter key to enter the elevation, latitude, and longitude of the antenna.

Note: It is necessary to press the Enter key at each position element prompted by the flashing cursor to properly load the position, even if only one element has been changed.

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5.4.2.2 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 2 of 2 is selected (**Position Average and GDOP**).

```
GDOP:02.64    Averaging Mode:On    62440≡
Lt:N33°48.6127  Ln:W117°54.6167    29.52
```

The displayed position data (average latitude, longitude, and elevation) is active only when the *Position Averaging* mode is selected as indicated by *On* and the Geometric Dilution Of Precision (GDOP) is 5 or less. The number in the upper right hand corner of the screen indicates the total number of samples used to calculate the displayed position. After averaging 86400 samples, the mode status automatically changes to *Off*, and the screen becomes inactive. The position mode (refer to paragraph 5.4.2.1) automatically changes to *Known*.

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.

For optimum time and frequency accuracy, the unit is normally configured to operate in the *Known* position mode. When operating in the *Known* position mode no GDOP computation is performed and the number is always displayed as 00.00.

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5.4.3 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.

5.4.3.1 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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5.4.3.2 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, it wraps back to the beginning. In the Burst mode, time tags are also stored in a buffer. When the buffer reaches its limit, 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 256 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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5.4.4 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.

5.4.4.1 Frequency Output Port Configuration

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

```
Output Frequency:  Port 1: 1 MHz          ≡
Port 2: 5 MHz      Port 3: 10 MHz
```

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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5.4.4.2 Pulse Rate Output Port Configuration

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

```
RateA User:0000000us Pulse      Normal≡
RateB User:0000000us Pulse      Normal
```

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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5.4.5 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:-2.53E-011  Samples:0036133 ≡
Std Error of Est:3.00E-008     DAC:31264
```

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.

```
Re-Sync/Start Discipline:No    ≡
```

- 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.

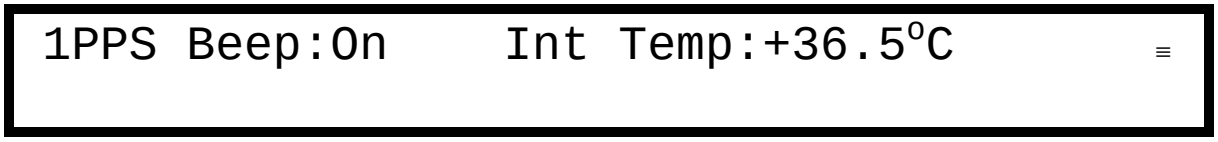
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5.4.6 MENU 9 - MAINTENANCE

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

5.4.6.1 Audio Annunciator Status and Internal Temperature

- Press key 9 until Maintenance Menu 1 of 5 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.

5.4.6.2 Receiver Operating Status and Control

- Press key 9 until Maintenance Menu 2 of 5 is selected (**GPS Receiver Status**).



This screen displays the operating status of the internal GPS receiver. In the Normal mode the receiver is actively tracking, acquiring and/or searching satellites. The mode of operation can be change as follows:

- While viewing the Maintenance Menu 2 of 5, press the Edit key until GPS Receiver Status **Normal** is flashing.
- Press the Edit key. Use the arrow keys to select the **Warm Start** mode. Press the Enter key to accept the selection.



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When the Warm Start operating mode is selected, the receiver stops tracking satellites, and then restarts searching for satellites using its current almanac. After acquiring one or more satellites, the process continues until on or more satellite is tracked. Position information does not need to be re-entered or determined after performing a Warm 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 erase the data used by the receiver, and allow collection of new data from the satellites.

- While viewing the Maintenance Menu 2 of 5, press the Edit key until GPS Receiver Status **Normal** or **Warm Start** is flashing.
- Press the Edit key. Use the arrow keys to select the **Cold Start** mode. Press the Enter key to accept the selection.

```
GPS Receiver Status:Cold Start                ≡
Forces Collection of New Almanac
```

- Press the Enter key and observe the following warning message:

```
THIS COMMAND WILL FORCE THE GPS RECEIVER
INTO COLD START. ARE YOU SURE:No
```

- Use the arrow keys to select **Yes**.
- Press the Enter key to force the receiver into the Cold Start operation mode.

The internal GPS receiver's almanac is deleted, the latitude, longitude, and elevation are set to zero. The receiver defaults to the *Dynamic* position solution mode, starts the satellite search and acquisition process, and collects a new almanac. This process can take up to 30 minutes. Refer to paragraph 5.4.2 for selecting alternate position solution modes to accelerate the acquisition process.

5.4.6.3 DAC Status and Control

- Press key 9 until Maintenance Menu 3 of 5 is selected (**DAC Status and Control**).

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


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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: OCXO (Osc Option -2), or Rubidium (Osc 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 5, 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.

5.4.6.4 RS-232 I/O Port Setup

- Press key 9 until Maintenance Menu 4 of 5 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.

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5.4.6.5 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.

5.4.6.6 Firmware Revision Status

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

```
Unit Ver:4.40.03 Feb 27 1997 14:06:50         ≡
GPS Receiver Magellan:33.1
```

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 shown are for Illustration only, and may differ on actual units.

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5.5 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.

5.5.1 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.

```
Synthesizer Frequency:01 000 000 Hz  ≡
Sinusoid:On    Differential:Off
```

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

Note: The frequency can only be changed 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.

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- 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.

5.5.2 Low Frequency Direct Digital Synthesizer (Other Option -2)

If the Low 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 - LF
```

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

```
Synthesizer Frequency:100 000 Hz ≡
Differential:Off
```

This screen indicates the Factory Default settings for the LF Synthesizer version: output frequency of 1 kHz (100000 Hz), 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 port:

- Press the Edit key to enter the edit mode.

```
Synthesizer Frequency:100 000 Hz ≡
Differential:Off
```

- Use the arrow and numeric keys to select the output frequency.
- 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 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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5.5.3 ECL Direct Digital Synthesizer (Other Option -3)

If the ECL version of the Direct Digital Synthesizer is installed, the HF Synthesizer option is momentarily displayed 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.

```
Synthesizer Frequency:01 000 000 Hz  ≡
Sinusoid:On    Differential:Off
```

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

Note: The frequency can only be changed in 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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1585 S. Manchester Ave.
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