GPS 15H & 15L TECHNICAL SPECIFICATIONS

RECORD OF REVISIONS

Revision	Revision Date	Description	ECO #
A	8/16/02	Initial Release	--

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1. INTRODUCTION

1.1 CAUTIONS

CAUTION

The GPS system is operated by the government of the United States, which is solely responsible for its accuracy and maintenance. Although the GPS 15H & 15L products are precision electronic NAVigation AID (NAVAID), any NAVAID can be misused or misinterpreted, and therefore become unsafe. Use these products at your own risk. To reduce the risk, carefully review and understand all aspects of these Technical Specifications before using the GPS 15H & 15L. When in actual use, carefully compare indications from the GPS to all available navigation sources including the information from other NAVAIDs, visual sightings, charts, etc. For safety, always resolve any discrepancies before continuing navigation.

FCC Compliance

The GPS 15H & 15L products comply with Part 15 of the FCC interference limits for Class B digital devices FOR HOME OR OFFICE USE. These limits are designed to provide reasonable protection against harmful interference in a residential installation, and are more stringent than "outdoor" requirements.

Operation of this device is subject to the following conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

The GPS 15H & 15L products do not contain any user-serviceable parts. Unauthorized repairs or modifications could result in permanent damage to the equipment, and void your warranty and your authority to operate this device under Part 15 regulations.

1.2 LIMITED WARRANTY

This GARMIN product is warranted to be free from defects in materials or workmanship for one year from the date of purchase. Within this period, GARMIN will at its sole option, repair or replace any components that fail in normal use. Such repairs or replacement will be made at no charge to the customer for parts or labor, provided that the customer shall be responsible for any transportation cost. This warranty does not cover failures due to abuse, misuse, accident or unauthorized alteration or repairs.

THE WARRANTIES AND REMEDIES CONTAINED HEREIN ARE EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES EXPRESS OR IMPLIED OR STATUTORY, INCLUDING ANY LIABILITY ARISING UNDER ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, STATUTORY OR OTHERWISE. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, WHICH MAY VARY FROM STATE TO STATE.

IN NO EVENT SHALL GARMIN BE LIABLE FOR ANY INCIDENTAL, SPECIAL, INDIRECT OR CONSEQUENTIAL DAMAGES, WHETHER RESULTING FROM THE USE, MISUSE, OR INABILITY TO USE THIS PRODUCT OR FROM DEFECTS IN THE PRODUCT. Some states do not allow the exclusion of incidental or consequential damages, so the above limitations may not apply to you.

GARMIN retains the exclusive right to repair or replace the unit or software or offer a full refund of the purchase price at its sole discretion. SUCH REMEDY SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.

To obtain warranty service, contact your local GARMIN authorized dealer. Or call GARMIN Customer Service at one of the numbers shown below, for shipping instructions and an RMA tracking number. The unit should be securely packed with the tracking number clearly written on the <u>outside</u> of the package. The unit should then be sent, freight charges prepaid, to any GARMIN warranty service station. A copy of the original sales receipt is required as the proof of purchase for warranty repairs.

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1.3   OVERVIEW

The GPS 15H & 15L are part of GARMIN's latest generation of GPS sensor boards designed for a broad spectrum of OEM (Original Equipment Manufacture) system applications. Based on the proven technology found in other GARMIN 12-channel GPS receivers, the GPS 15H & 15L will track up to 12 satellites at a time while providing fast time-to-first-fix, one-second navigation updates and low power consumption. The GPS 15H & 15L also provide the capability of FAA Wide Area Augmentation System (WAAS) differential GPS. Their far-reaching capabilities meet the sensitivity requirements of land navigation, the timing requirements for precision timing applications, as well as the dynamics requirements of high-performance aircraft.

These GPS designs utilize the latest technology and high-level circuit integration to achieve superior performance while minimizing space and power requirements. All critical components of the system including the RF/IF receiver hardware and the digital baseband are designed and manufactured by GARMIN to ensure the quality and capability of the GPS. The hardware capability combined with software intelligence makes the GPS 15H & 15L easy to integrate and use.

These are complete GPS receivers that require minimal additional components to be supplied by an OEM or system integrator. A minimum system must provide the GPS with a source of power, an active GPS antenna, and a clear view of the GPS satellites. The system may communicate with the GPS 15H & 15L via two RS-232 compatible receive channels, and one transmit channel. The GPS 15H & 15L internal FLASH memory allows the GPS to retain critical data such as satellite orbital parameters, last-known position, date and time. End user interfaces such as keyboards and displays are the responsibility of the application designer.

1.4   FEATURES

- 12-channel GPS receiver tracks and uses up to 12 satellites for fast, accurate positioning and low power consumption.
- Differential DGPS capability utilizing real-time WAAS or RTCM corrections yielding 3-5 meter position accuracy (see Section 1.5.3.4).
- Compact, rugged design ideal for applications with minimal space. May be remotely mounted in an out-of-the-way location. Receiver status information can be displayed directly on a chartplotter or PC.
- User initialization is not required. Once installed, unit will automatically transmit navigation data.
- User-configurable navigation mode (2-dimensional or 3-dimensional fix).
- Highly accurate one-pulse-per-second (PPS) output for precise timing measurements. Pulse width is configurable in 20 millisecond increments from 20 ms to 980 ms.
- Configurable for binary format carrier phase data output on COM 1 port.
- Flexible input voltage levels of 3.3 to 5.0 Vdc (GPS 15L) or 8.0 to 40 Vdc (GPS 15H).
- Built-in backup battery to maintain real-time clock for up to 21 days. Provision for external power to maintain the real-time clock for longer intervals.
- FLASH-based program and non-volatile memory. New software revisions upgradeable through web site download and serial interface. Non-volatile memory does not require battery backup.

1.5   TECHNICAL SPECIFICATIONS

Specifications are subject to change without notice.

1.5.1   Physical Characteristics

1.5.1.1 Size

- GPS 15H & 15L: 1.400" (35.56 mm) wide, 1.805" (45.85 mm) long, 0.327" (8.31 mm) high

1.5.1.2 Weight

- GPS 15H: 0.53 oz. (15.0 g)

- GPS 15L: 0.50 oz. (14.1 g)

1.5.1.3 Available Connector Options

- GPS 15H-F:
  GPS 15L-F: 8-pin LIF connector, 1 millimeter pitch

- GPS 15H-W:
  GPS 15L-W: 8-pin JST connector, 1 millimeter pitch; mating wire harness included
                      (NOTE: available in Asia, or by special order)

1.5.2   Electrical Characteristics

1.5.2.1 Input Voltage

- GPS 15H: 8.0 Vdc to 40 Vdc unregulated

- GPS 15L: 3.3 Vdc to 5.4 Vdc (±100 mV)

1.5.2.2 Input Current

- GPS 15H: 60 mA peak, 50 mA nominal @ 8.0 Vdc
                      40 mA peak, 33 mA nominal @ 12 Vdc
                      15 mA peak, 12 mA nominal @ 40 Vdc

- GPS 15L: 100 mA peak, 85 mA nominal @ 3.3 to 5.0 Vdc

1.5.2.3 GPS Receiver Sensitivity

- -165 dBW minimum

1.5.3 GPS Performance

1.5.3.1 Receiver

- WAAS enabled; 12 parallel channel GPS receiver continuously tracks and uses up to 12 satellites (up to 11 with PPS active) to compute and update your position.

1.5.3.2 Acquisition Times

- Reacquisition: Less than 2 seconds
- Warm: Approximately 15 seconds (all data known)
- Cold: Approximately 45 seconds (initial position, time and almanac known, ephemeris unknown)
- AutoLocate^{TM}:   5 minutes (almanac known, initial position and time unknown)
- SkySearch: 5 minutes (no data known)

1.5.3.3 Update Rate

- 1 second default; NMEA 0183 output interval configurable from 1 to 900 seconds in one-second increments

1.5.3.4 Accuracy

- GPS Standard Positioning Service (SPS)
  Position: < 15 meters, 95% typical (100 meters with Selective Availability on)
  Velocity: 0.1 knot RMS steady state
- DGPS (USCG/RTCM)
  Position: 3-5 meters, 95% typical
  Velocity: 0.1 knot RMS steady state
- DGPS (WAAS)
  Position: < 3 meters, 95% typical
  Velocity: 0.1 knot RMS steady state

- PPS Time   ±1 microsecond at rising edge of PPS pulse (subject to Selective Availability)
- Dynamics: 999 knots velocity (only limited at altitude greater than 60,000 feet), 6g dynamics

1.5.4 Interfaces

1.5.4.1 Electrical Characteristics

- True RS-232 output (Port 2 output not used at time of publication), asynchronous serial input compatible with RS-232 or TTL voltage levels, RS-232 polarity.
- User selectable NMEA 0183 baud rate (300, 600, 1200, 2400, 4800, 9600, 19200, 38400)

1.5.4.2 Port 1 Protocols

- Configurable between NMEA 0183 Versions 2.00 and 3.00
- ASCII output sentences GPALM, GPGGA, GPGLL, GPGSA, GPGSV, GPRMC, GPVTG (NMEA-approved sentences); PGRMB, PGRME, PGRMF, PGRMM, PGRMT, and PGRMV (GARMIN proprietary sentences)
- <u>NMEA 0183 Outputs (see Section 3.2 for full protocol specifications)</u>
  Position, velocity and time
  Receiver and satellite status
  Differential Reference Station ID and RTCM Data age
  Geometry and error estimates
- <u>NMEA 0183 Inputs (see Section 3.1 for full protocol specifications)</u>
  Initial position, date and time (not required)
  Earth datum and differential mode configuration command, PPS Enable, GPS satellite almanac
- Configurable for binary data output including GPS carrier phase data

1.5.4.3 Port 2 Protocols

- Real-time Differential Correction input (RTCM SC-104 message types 1, 2, 3, 7 and 9)

1.5.4.4 PPS

- 1 Hz pulse, programmable width, 1 µs accuracy

1.5.5 Environmental Characteristics

- Temperature: -30°C to +80°C (Operating); -40°C to +90°C (Storage)

2.   PINOUT

2.1   DESCRIPTION

The GPS 15H-F & 15L-F sensors utilize an eight-pin LIF connector. The GPS 15H-W & 15L-W sensors utilize an eight-pin JST connector with mating wire harness included.

Table 1. Signal/Wire Descriptions

| Pin #	Signal Name	Description
1	BACKUP POWER	This input provides external power to maintain the real-time clock. This enables the user to provide backup power if needed for longer than the on-board backup battery will provide (roughly 21 days). Input voltage must be between +2.8 and +3.4 Vdc.
2	GROUND	Power and Signal Ground
3	POWER	**GPS 15L:** +3.3 to +5 Vdc (±100 mV) input. Peak operating current is 100 mA. Nominal operating current is 85 mA. This voltage drives an LDO with a nominal 3.0 Vdc output. **GPS 15H:** Unregulated 8.0 to 40 Vdc input. Peak operating current is 40 mA @ 12 Vdc input. Nominal operating current is 33 mA @ 12 Vdc input. This voltage drives a switching regulator with a nominal 3.3 Vdc output.
4	PORT 1 DATA OUT	Serial Asynchronous Output. RS-232 compatible output normally provides serial data which is formatted per *"NMEA 0183, Version 2.0"*. This output is also capable of outputting phase data information, see Appendix B for details. The NMEA 0183 baud rate is selectable in the range of 300 to 38400 baud. The default baud rate is 4800.
5	PORT 1 DATA IN	First Serial Asynchronous Input. RS-232 compatible with maximum input voltage range of -25 < V < 25. This input may also be directly connected to standard 3 to 5 Vdc CMOS logic that utilizes RS-232 polarity. The low signal voltage requirement is < 0.6 V, and the high signal voltage requirement is > 2.4 V. Minimum load impedance is 500 Ω. This input may be used to receive serial initialization/ configuration data as specified in Section 3.1.
6	RF BIAS	This input allows the user to externally apply a RF bias to the active antenna. Units are shipped with this feature disabled. By default, the unit will use an internal voltage to power the active antenna.
7	PPS	One-Pulse-Per-Second Output. Typical voltage rise and fall times are 100 ns. Impedance is 250 Ω. Open circuit output voltage is low=0 V and high=Vin. The default format is a 100 ms wide active-high pulse at a 1 Hz rate, with the pulse width configurable in 20 ms increments. Rising edge is synchronized to the start of each GPS second. This output will provide a nominal 450 mVp-p signal into a 50 Ω load. The pulse time measured at the 50% voltage point will be about 15 ns earlier with a 50 Ω load than with no load.
8	PORT 2 DATA IN	Second Serial Asynchronous Input. This input may be used to receive serial differential GPS data formatted per *"RTCM SC-104 Recommended Standards For Differential Navstar GPS Service, Version 2.2"* (see Section 3.5 for more details).

2.2 DIAGRAMS
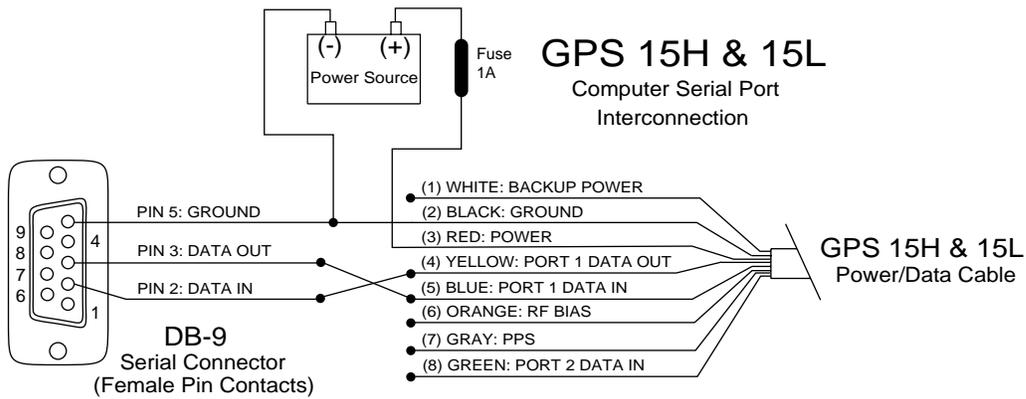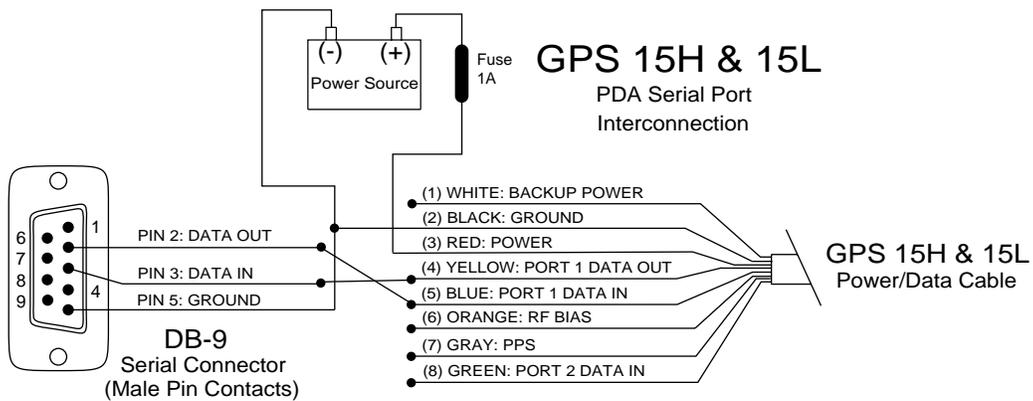

Figure 1. Computer Serial Port Interconnection

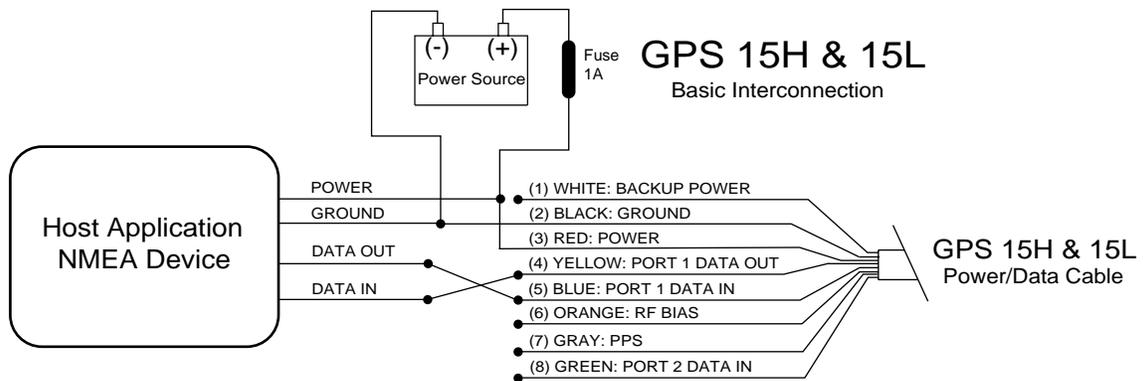
Figure 2. PDA Serial Port Interconnection

Figure 3. Basic NMEA Device Interconnection

3. SOFTWARE INTERFACE

The GPS 15H & 15L interface protocol design on COM 1 is based on the National Marine Electronics Association's NMEA 0183 ASCII interface specification. The COM 2 port can receive differential GPS (DGPS) correction data using the Radio Technical Commission for Maritime Services' RTCM SC-104 standard. These standards are fully defined in *"NMEA 0183, Version 3.0"* (copies may be obtained from NMEA, www.nmea.org) and *"RTCM Recommended Standards For Differential Navstar GPS Service, Version 2.2, RTCM Special Committee No. 104"* (copies may be obtained from RTCM, www.rtcm.org).

The GPS 15H & 15L interface protocol, in addition to transmitting navigation information as defined by NMEA 0183, transmits additional information using the convention of GARMIN proprietary sentences.

Binary phase data information can alternatively be output on the COM 1 port; see Appendix B for details.

The following sections describe the NMEA 0183 data format of each sentence transmitted and received by the GPS 15H & 15L. The baud rate selection, one-pulse-per-second output interfaces and RTCM differential GPS input are also described.

3.1 RECEIVED NMEA 0183 SENTENCES

The subsequent paragraphs define the sentences that can be received on the GPS sensors' COM 1 port. Null fields in the configuration sentence indicate no change in the particular configuration parameter. All sentences received by the GPS sensor must be terminated with <CR><LF>, the ASCII characters for carriage return (0D hexadecimal) and line feed (0A hexadecimal). The checksum *hh is used for parity checking data and is not required, but is recommended for use in environments containing high electromagnetic noise. It is generally not required in normal PC environments. When used, the parity bytes (hh) are the ASCII representation of the exclusive-or (XOR) sum of all the characters between the "$" and "*" characters, non-inclusive. Sentences may be truncated by <CR><LF> after any data field and valid fields up to that point will be acted on by the GPS sensor.

3.1.1 Almanac Information (ALM)

The $GPALM sentence can be used to initialize the GPS sensor's stored almanac information in the unlikely event of non-volatile memory loss, or after storage of greater than six months without tracking GPS satellites.

$GPALM,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>,<15>*hh<CR><LF>

<1>	Total number of ALM sentences to be transmitted by the GPS sensor during almanac download. This field can be null or any number when sending almanac to the GPS sensor.
<2>	Number of current ALM sentence. This field can be null or any number when sending almanac to the GPS sensor.
<3>	Satellite PRN number, 01 to 32
<4>	GPS week number
<5>	SV health, bits 17-24 of each almanac page
<6>	Eccentricity
<7>	Almanac reference time
<8>	Inclination angle
<9>	Rate of right ascension
<10>	Root of semi major axis
<11>	Omega, argument of perigee
<12>	Longitude of ascension node
<13>	Mean anomaly
<14>	af0 clock parameter
<15>	af1 clock parameter

3.1.2   Sensor Initialization Information (PGRMI)

The $PGRMI sentence provides information used to initialize the GPS sensor's set position and time used for satellite acquisition. Receipt of this sentence by the GPS sensor causes the software to restart the satellite acquisition process. If there are no errors in the sentence, it will be echoed upon receipt. If an error is detected, the echoed PGRMI sentence will contain the current default values. Current PGRMI defaults (with the exception of the Receiver Command, which is a command rather than a mode) can also be obtained by sending $PGRMIE to the GPS sensor.

$PGRMI,<1>,<2>,<3>,<4>,<5>,<6>,<7>*hh<CR><LF>

<1>	Latitude, ddmm.mmm format (leading zeros must be transmitted)
<2>	Latitude hemisphere, N or S
<3>	Longitude, dddmm.mmm format (leading zeros must be transmitted)
<4>	Longitude hemisphere, E or W
<5>	Current UTC date, ddmmyy format
<6>	Current UTC time, hhmmss format
<7>	Receiver Command, A = Auto Locate, R = Unit Reset

3.1.3   Sensor Configuration Information (PGRMC)

The $PGRMC sentence provides information used to configure the GPS sensor's operation. Configuration parameters are stored in non-volatile memory and retained between power cycles. The GPS sensor will echo this sentence upon its receipt if no errors are detected. If an error is detected, the echoed PGRMC sentence will contain the current default values. Current default values can also be obtained by sending $PGRMCE to the GPS sensor.

$PGRMC,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>*hh<CR><LF>

<1>	Fix mode, A = automatic, 2 = 2D exclusively (host system must supply altitude), 3 = 3D exclusively
<2>	Altitude above/below mean sea level, -1500.0 to 18000.0 meters
<3>	Earth datum index. If the user datum index (96) is specified, fields <4> through <8> must contain valid values. Otherwise, fields <4> through <8> must be null. Refer to Appendix A for a list of earth datums and the corresponding earth datum index.
<4>	User earth datum semi-major axis, 6360000.000 to 6380000.000 meters (.001 meters resolution)
<5>	User earth datum inverse flattening factor, 285.0 to 310.0 (10^{-9} resolution)
<6>	User earth datum delta x earth centered coordinate, -5000.0 to 5000.0 meters (1 meter resolution)
<7>	User earth datum delta y earth centered coordinate, -5000.0 to 5000.0 meters (1 meter resolution)
<8>	User earth datum delta z earth centered coordinate, -5000.0 to 5000.0 meters (1 meter resolution)
<9>	Differential mode, A = automatic (output DGPS data when available, non-DGPS otherwise), D = differential exclusively (output only differential fixes)
<10>	NMEA 0183 Baud rate, 1 = 1200, 2 = 2400, 3 = 4800, 4 = 9600, 5 = 19200, 6 = 300, 7 = 600, 8 = 38400
<11>	Velocity filter, 0 = No filter, 1 = Automatic filter, 2-255 = Filter time constant (e.g., 10 = 10 second filter)
<12>	PPS mode, 1 = No PPS, 2 = 1 Hz
<13>	PPS pulse length, 0-48 = (n+1)*20 ms. Example: n = 4 corresponds to a 100 ms wide pulse
<14>	Dead reckoning valid time 1-30 (sec)

All configuration changes take effect after receipt of a valid value except baud rate and PPS mode. Baud rate and PPS mode changes take effect on the next power cycle or an external reset event.

3.1.4   Additional Sensor Configuration Information (PGRMC1)

The $PGRMC1 sentence provides additional information used to configure the GPS sensor operation. Configuration parameters are stored in non-volatile memory and retained between power cycles. The GPS sensor will echo this sentence upon its receipt if no errors are detected. If an error is detected, the echoed PGRMC1 sentence will contain the current default values. Current default values can also be obtained by sending $PGRMC1E to the GPS sensor.

$PGRMC1,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>*hh<CR><LF>

<1>	NMEA 0183 output time 1-900 (sec)
<2>	Binary Phase Output Data, 1 = Off, 2 = On.
<3>	Position pinning, 1 = Off, 2 = On
<4>	DGPS beacon frequency – 0.0, 283.5 – 325.0 kHz in 0.5 kHz steps
<5>	DGPS beacon bit rate – 0, 25, 50, 100, or 200 bps
<6>	DGPS beacon scanning, 1 = Off, 2 = On
<7>	NMEA 0183 version 3.00 mode indicator, 1 = Off, 2 = On
<8>	DGPS mode, A = Automatic, W = WAAS Only, R = RTCM Only, N = None (DGPS disabled)
<9>	Power Save Mode, P = Power Save mode, N = Normal

At power up or external reset, a stored beacon frequency other than 0.0 causes the GPS sensor to tune the beacon receiver. Configuration changes take effect immediately, with the exception of Binary Phase Output Data, which takes effect on the next power cycle or a reset event. A reset can be commanded by sending the sentence "$PGRMI,,,,,,,R" (refer to section 3.1.2). If the GPS sensor is in the Binary data mode, it is necessary to send the following eight-byte data stream to the COM 1 input, to temporarily change the data format to NMEA 0183, and then follow by sending a PGRMC1 sentence that turns off the Binary Phase Output Data format:

`10 0A 02 26 00 CE 10 03` (Hexadecimal)

3.1.5   Output Sentence Enable/Disable (PGRMO)

The $PGRMO sentence provides the ability to enable and disable specific output sentences. The following sentences are enabled at the factory: GPGGA, GPGSA, GPGSV, GPRMC, PGRMB, PGRME, PGRMM, PGRMT and PSLIB.

$PGRMO,<1>,<2>*hh<CR><LF>

<1>	Target sentence description (e.g., PGRMT, GPGSV, etc.)
<2>	Target sentence mode, where: 0 = disable specified sentence 1 = enable specified sentence 2 = disable all output sentences (except PSLIB) 3 = enable all output sentences (except GPALM) 4 = restore factory default output sentences

The following notes apply to the PGRMO input sentence:
1. If the target sentence mode is '2' (disable all), '3' (enable all), or '4' (restore defaults), the target sentence description is not checked for validity. In this case, an empty field is allowed (e.g., $PGRMO,,3), or the mode field may contain from 1 to 5 characters.
2. If the target sentence mode is '0' (disable) or '1' (enable), the target sentence description field must be an identifier for one of the sentences that can be output by the GPS sensor.
3. If either the target sentence mode field or the target sentence description field is not valid, the PGRMO sentence will have no effect.
4. $PGRMO,GPALM,1 will cause the GPS sensor to transmit all stored almanac information. All other NMEA 0183 sentence transmission will be temporarily suspended.
5. $PGRMO,,G will cause the COM 1 port to change to GARMIN Data Transfer format for the duration of the power cycle. The GARMIN mode is required for GPS 15H & 15L product software updates.

3.1.6 Tune DGPS Beacon Receiver (PSLIB)

The $PSLIB sentence provides the ability to tune a GARMIN GBR 21, GBR 23 or equivalent beacon receiver.

$PSLIB,<1>,<2>*hh<CR><LF>

<1>	Beacon tune frequency, 0.0, 283.5 – 325.0 kHz in 0.5 kHz steps
<2>	Beacon bit rate, 0, 25, 50, 100, or 200 bps

If valid data is received, the GPS sensor will store it in the EEPROM and echo the PSLIB command to the beacon receiver. If the GPS sensor is using any stored beacon frequency other than 0.0, it will tune the beacon receiver once immediately after power up or external reset.

3.2   TRANSMITTED NMEA 0183 SENTENCES

The subsequent paragraphs define the sentences that can be transmitted on COM 1 by the GPS sensor.

3.2.1   Sentence Transmission Rate

Sentences are transmitted with respect to the user selected baud rate.

Regardless of the selected baud rate, the information transmitted by the GPS sensor is referenced to the one-pulse-per-second output pulse immediately preceding the GPRMC sentence, or whichever sentence is output first in the burst (see Table 2 below).

The GPS sensor will transmit each sentence (except where noted in particular transmitted sentence descriptions) at a periodic rate based on the user selected baud rate and user selected output sentences. The GPS sensor will transmit the selected sentences contiguously. The contiguous transmission starts at a GPS second boundary. The length of the transmission can be determined by the following equation and Tables 2 and 3:

$$\text{length of transmission} = \frac{\text{total characters to be transmitted}}{\text{characters transmitted per second}}$$

Table 2. NMEA 0183 Output Sentence Order and Size

Sentence	Output by Default?	Maximum Characters
GPRMC	✔	74
GPGGA	✔	82
GPGSA	✔	66
GPGSV	✔	70
PGRME	✔	35
GPGLL		44
GPVTG		42
PGRMV		32
PGRMF		82
PGRMB	✔	40
PGRMM	✔	32
PGRMT	Once per minute	50

Table 3. Characters per Second for Available Baud Rates

Baud	Characters per Second
300	30
600	60
1200	120
2400	240
4800	480
9600	960
19200	1920
38400	3840

The maximum number of fields allowed in a single sentence is 82 characters including delimiters. Values in the table include the sentence start delimiter character "$" and the termination delimiter <CR><LF>. The factory set defaults will result in a once per second transmission at the NMEA 0183 specification transmission rate of 4800 baud.

3.2.2 Transmitted Time

The GPS sensor outputs UTC (Coordinated Universal Time) date and time of day in the transmitted sentences. Prior to the initial position fix, the on-board clock provides the date and time of day. After the initial position fix, the date and time of day are calculated using GPS satellite information and are synchronized with the one-pulse-per-second output.

The GPS sensor uses information obtained from the GPS satellites to add or delete UTC leap seconds and correct the transmitted date and time of day. The transmitted date and time of day for leap second correction follow the guidelines in *"National Institute of Standards and Technology Special Publication 432 (Revised 1990)"* (for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, U.S.A.).

When a positive leap second is required, the second is inserted beginning at 23h 59m 60s of the last day of a month and ending at 0h 0m 0s of the first day of the following month. The minute containing the leap second is 61 seconds long. The GPS sensor would have transmitted this information for the leap second added December 31, 1989 as follows:

Date	Time
311289	235959
311289	235960
010190	000000

If a negative leap second should be required, one second will be deleted at the end of some UTC month. The minute containing the leap second will be only 59 seconds long. In this case, the GPS sensor will not transmit the time of day 23h 59m 59s for the day from which the leap second is removed.

3.2.3 Global Positioning System Almanac Data (ALM)

Almanac sentences are not normally transmitted. Almanac transmission can be initiated by sending the GPS sensor a $PGRMO,GPALM,1 command. Upon receipt of this command the GPS sensor will transmit available almanac information on GPALM sentences. During the transmission of almanac sentences other NMEA 0183 data output will be temporarily suspended.

$GPALM,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>,<15>*hh<CR><LF>

<field information> can be found in section 3.1.1.

3.2.4 Global Positioning System Fix Data (GGA)

$GPGGA,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,M,<10>,M,<11>,<12>*hh<CR><LF>

<1>	UTC time of position fix, hhmmss format
<2>	Latitude, ddmm.mmmm format (leading zeros will be transmitted)
<3>	Latitude hemisphere, N or S
<4>	Longitude, dddmm.mmmm format (leading zeros will be transmitted)
<5>	Longitude hemisphere, E or W
<6>	GPS quality indication, 0 = fix not available, 1 = Non-differential GPS fix available, 2 = Differential GPS (DGPS) fix available, 6 = Estimated
<7>	Number of satellites in use, 00 to 12 (leading zeros will be transmitted)
<8>	Horizontal dilution of precision, 0.5 to 99.9
<9>	Antenna height above/below mean sea level, -9999.9 to 99999.9 meters
<10>	Geoidal height, -999.9 to 9999.9 meters
<11>	Differential GPS (RTCM SC-104) data age, number of seconds since last valid RTCM transmission (null if not an RTCM DGPS fix)
<12>	Differential Reference Station ID, 0000 to 1023 (leading zeros will be transmitted, null if not an RTCM DGPS fix)

3.2.5 GPS DOP and Active Satellites (GSA)

$GPGSA,<1>,<2>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<3>,<4>,<5>,<6>*hh<CR><LF>

<1>	Mode, M = manual, A = automatic
<2>	Fix type, 1 = not available, 2 = 2D, 3 = 3D
<3>	PRN number, 01 to 32, of satellite used in solution, up to 12 transmitted (leading zeros will be transmitted)
<4>	Position dilution of precision, 0.5 to 99.9
<5>	Horizontal dilution of precision, 0.5 to 99.9
<6>	Vertical dilution of precision, 0.5 to 99.9

3.2.6 GPS Satellites in View (GSV)

$GPGSV,<1>,<2>,<3>,<4>,<5>,<6>,<7>,...<4>,<5>,<6>,<7>*hh<CR><LF>

<1>	Total number of GSV sentences to be transmitted
<2>	Number of current GSV sentence
<3>	Total number of satellites in view, 00 to 12 (leading zeros will be transmitted)
<4>	Satellite PRN number, 01 to 32 (leading zeros will be transmitted)
<5>	Satellite elevation, 00 to 90 degrees (leading zeros will be transmitted)
<6>	Satellite azimuth, 000 to 359 degrees, true (leading zeros will be transmitted)
<7>	Signal to noise ratio (C/No) 00 to 99 dB, null when not tracking (leading zeros will be transmitted)

NOTE: Items <4>,<5>,<6> and <7> repeat for each satellite in view to a maximum of four (4) satellites per sentence. Additional satellites in view information must be sent in subsequent bursts of NMEA 0183 data. These fields will be null if unused.

3.2.7 Recommended Minimum Specific GPS/TRANSIT Data (RMC)

$GPRMC,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>*hh<CR><LF>

<1>	UTC time of position fix, hhmmss format
<2>	Status, A = Valid position, V = NAV receiver warning
<3>	Latitude, ddmm.mmmm format (leading zeros will be transmitted)
<4>	Latitude hemisphere, N or S
<5>	Longitude, dddmm.mmmm format (leading zeros will be transmitted)
<6>	Longitude hemisphere, E or W
<7>	Speed over ground, 000.0 to 999.9 knots (leading zeros will be transmitted)
<8>	Course over ground, 000.0 to 359.9 degrees, true (leading zeros will be transmitted)
<9>	UTC date of position fix, ddmmyy format
<10>	Magnetic variation, 000.0 to 180.0 degrees (leading zeros will be transmitted)
<11>	Magnetic variation direction, E or W (westerly variation adds to true course)
<12>	Mode indicator (only output if NMEA 0183 version 3.00 active), A = Autonomous, D = Differential, E = Estimated, N = Data not valid

3.2.8 Track Made Good and Ground Speed (VTG)

$GPVTG,<1>,T,<2>,M,<3>,N,<4>,K,<5>*hh<CR><LF>

<1>	True course over ground, 000 to 359 degrees (leading zeros will be transmitted)
<2>	Magnetic course over ground, 000 to 359 degrees (leading zeros will be transmitted)
<3>	Speed over ground, 000.0 to 999.9 knots (leading zeros will be transmitted)
<4>	Speed over ground, 0000.0 to 1851.8 kilometers per hour (leading zeros will be transmitted)
<5>	Mode indicator (only output if NMEA 0183 version 3.00 active), A = Autonomous, D = Differential, E = Estimated, N = Data not valid

3.2.9 Geographic Position (GLL)

$GPGLL,<1>,<2>,<3>,<4>,<5>,<6>,<7>*hh<CR><LF>

<1>	Latitude, ddmm.mmmm format (leading zeros will be transmitted)
<2>	Latitude hemisphere, N or S
<3>	Longitude, dddmm.mmmm format (leading zeros will be transmitted)
<4>	Longitude hemisphere, E or W
<5>	UTC time of position fix, hhmmss format
<6>	Status, A = Valid position, V = NAV receiver warning
<7>	Mode indicator (only output if NMEA 0183 version 3.00 active), A = Autonomous, D = Differential, E = Estimated, N = Data not valid

3.2.10 Estimated Error Information (PGRME)

$PGRME,<1>,M,<2>,M,<3>,M*hh<CR><LF>

<1>	Estimated horizontal position error (HPE), 0.0 to 999.9 meters
<2>	Estimated vertical position error (VPE), 0.0 to 999.9 meters
<3>	Estimated position error (EPE), 0.0 to 999.9 meters

3.2.11 GPS Fix Data Sentence (PGRMF)

$PGRMF,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>,<14>,<15>*hh<CR><LF>

<1>	GPS week number (0 - 1023)
<2>	GPS seconds (0 - 604799)
<3>	UTC date of position fix, ddmmyy format
<4>	UTC time of position fix, hhmmss format
<5>	GPS leap second count
<6>	Latitude, ddmm.mmmm format (leading zeros will be transmitted)
<7>	Latitude hemisphere, N or S
<8>	Longitude, dddmm.mmmm format (leading zeros will be transmitted)
<9>	Longitude hemisphere, E or W
<10>	Mode, M = manual, A = automatic
<11>	Fix type, 0 = no fix, 1 = 2D fix, 2 = 3D fix
<12>	Speed over ground, 0 to 1851 kilometers/hour
<13>	Course over ground, 0 to 359 degrees, true
<14>	Position dilution of precision, 0 to 9 (rounded to nearest integer value)
<15>	Time dilution of precision, 0 to 9 (rounded to nearest integer value)

3.2.12 Map Datum (PGRMM)

The GARMIN Proprietary sentence $PGRMM gives the name of the map datum currently in use by the GPS sensor. This information is used by the GARMIN MapSource real-time plotting application.

$PGRMM,<1>*hh<CR><LF>

<1>	Name of map datum currently in use (variable length field, e.g., "WGS 84")

3.2.13 Sensor Status Information (PGRMT)

The GARMIN Proprietary sentence $PGRMT gives information concerning the status of the GPS sensor. This sentence is transmitted once per minute regardless of the selected baud rate.

$PGRMT,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>*hh<CR><LF>

<1>	Product, model and software version (variable length field, e.g., "GPS 15L/15H VER 2.05")
<2>	ROM checksum test, P = pass, F = fail
<3>	Receiver failure discrete, P = pass, F = fail
<4>	Stored data lost, R = retained, L = lost
<5>	Real time clock lost, R = retained, L = lost
<6>	Oscillator drift discrete, P = pass, F = excessive drift detected
<7>	Data collection discrete, C = collecting, null if not collecting
<8>	GPS sensor temperature in degrees C
<9>	GPS sensor configuration data, R = retained, L = lost

3.2.14 3D velocity Information (PGRMV)

$PGRMV,<1>,<2>,<3>*hh<CR><LF>

<1>	True east velocity, 514.4 to 514.4 meters/second
<2>	True north velocity, 514.4 to 514.4 meters/second
<3>	Up velocity, 999.9 to 9999.9 meters/second

3.2.15 DGPS Beacon Information (PGRMB)

$PGRMB,<1>,<2>,<3>,<4>,<5>,K,<6>,<7>*hh<CR><LF>

<1>	Beacon tune frequency, 0.0, 283.5 – 325.0 kHz in 0.5 kHz steps
<2>	Beacon bit rate, 0, 25, 50, 100, or 200 bps
<3>	Beacon SNR, 0 to 31
<4>	Beacon data quality, 0 to 100
<5>	Distance to beacon reference station in kilometers
<6>	Beacon receiver communication status (0 = Check Wiring, 1 = No Signal, 2 = Tuning, 3 = Receiving, 4= Scanning)
<7>	DGPS fix source (R = RTCM, W = WAAS, N = Non-DGPS Fix)
<8>	DGPS mode, A = Automatic, W = WAAS Only, R = RTCM Only, N = None (DGPS disabled)

3.3 BAUD RATE SELECTION

Baud rate selection can be performed by sending the appropriate configuration sentence to the GPS sensor as described in the $PGRMC section 3.1.3, field <10>.

3.4   ONE-PULSE-PER-SECOND (PPS) OUTPUT

The highly accurate one-pulse-per-second (PPS) output is provided for applications requiring precise timing measurements. The signal is generated after the initial position fix has been calculated and continues until power down. The rising edge of the signal is synchronized to the start of each GPS second.

Regardless of the selected baud rate, the information transmitted by the GPS 15H & 15L is referenced to the pulse immediately preceding the NMEA 0183 RMC sentence.

The accuracy of the one-pulse-per-second output is maintained only while the GPS 15H & 15L can compute a valid position fix. To obtain the most accurate results, the one-pulse-per-second output should be calibrated against a local time reference to compensate for cable and internal receiver delays and the local time bias.

The default pulse width is 100 ms, however; it may be programmed in 20 ms increments between 20 ms and 980 ms as described in $PGRMC section 3.1.3, field <13>.

3.5   RECEIVED RTCM DATA

Position accuracy of less than 5 meters can be achieved with the GPS 15H & 15L by using Differential GPS (DGPS) real-time pseudo-range correction data in RTCM SC-104 format, with message types 1, 2, 3, 7, and 9. These corrections can be received by the GPS 15H & 15L on COM 2. The RTCM data must be received at the same baud rate as the COM 1 port. For details on the SC-104 format, refer to RTCM Paper 134-89/SC 104-68 by the Radio Technical Commission for Maritime Services.

4. MECHANICAL CHARACTERISTICS & MOUNTING

DETAIL A
SCALE 3 : 1

NOTES:
1. DIMENSIONS IN MILLIMETERS [INCHES].
2. DIMENSION TOLERANCES: ±0.25mm [±0.10"].
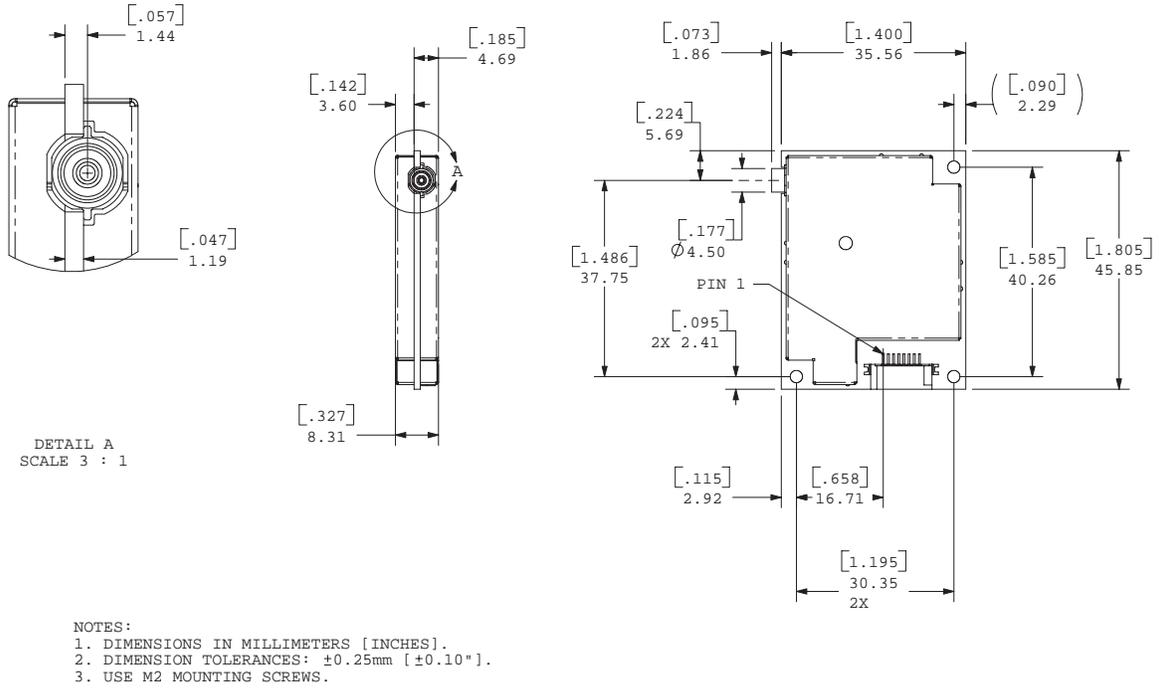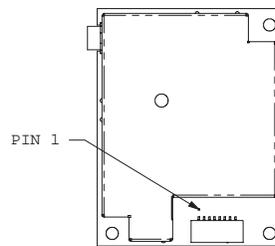3. USE M2 MOUNTING SCREWS.

Figure 4. GPS 15H-F & 15L-F Dimensions

NOTES:
1. DIMENSIONS IDENTICAL TO GPS 15H-F & GPS 15L-F.
2. USE M2 MOUNTING SCREWS.

Figure 5. GPS 15H-W & 15L-W Outline Drawing

Appendix A

Earth Datums

The following is a list of the GARMIN GPS 15H & 15L earth datum indices and the corresponding earth datum name (including the area of application):

0   ADINDAN - Ethiopia, Mali, Senegal, Sudan
1   AFGOOYE - Somalia
2   AIN EL ABD 1970 - Bahrain Island, Saudi Arabia
3   ANNA 1 ASTRO 1965 - Cocos Island
4   ARC 1950 - Botswana, Lesotho, Malawi, Swaziland, Zaire, Zambia,   Zimbabwe
5   ARC 1960 - Kenya, Tanzania
6   ASCENSION ISLAND 1958 - Ascension Island
7   ASTRO BEACON "E" - Iwo Jima Island
8   AUSTRALIAN GEODETIC 1966 - Australia, Tasmania Island
9   AUSTRALIAN GEODETIC 1984 - Australia, Tasmania Island
10   ASTRO DOS 71/4 - St. Helena Island
11   ASTRONOMIC STATION 1952 - Marcus Island
12   ASTRO B4 SOROL ATOLL - Tern Island
13   BELLEVUE (IGN) - Efate and Erromango Islands
14   BERMUDA 1957 - Bermuda Islands
15   BOGOTA OBSERVATORY - Colombia
16   CAMPO INCHAUSPE - Argentina
17   CANTON ASTRO 1966 - Phoenix Islands
18   CAPE CANAVERAL - Florida, Bahama Islands
19   CAPE - South Africa
20   CARTHAGE - Tunisia
21   CHATHAM 1971 - Chatham Island (New Zealand)
22   CHUA ASTRO - Paraguay
23   CORREGO ALEGRE - Brazil
24   DJAKARTA (BATAVIA) - Sumatra Island (Indonesia)
25   DOS 1968 - Gizo Island (New Georgia Islands)
26   EASTER ISLAND 1967 - Easter Island
27   EUROPEAN 1950 - Austria, Belgium, Denmark, Finland, France, Germany, Gibraltar, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland
28   EUROPEAN 1979 - Austria, Finland, Netherlands, Norway, Spain, Sweden, Switzerland
29   FINLAND HAYFORD 1910 - Finland
30   GANDAJIKA BASE - Republic of Maldives
31   GEODETIC DATUM 1949 - New Zealand
32   ORDNANCE SURVEY OF GREAT BRITAIN 1936 - England, Isle of Man, Scotland, Shetland Islands, Wales
33   GUAM 1963 - Guam Island
34   GUX 1 ASTRO - Guadalcanal Island
35   HJORSEY 1955 - Iceland
36   HONG KONG 1963 - Hong Kong
37   INDIAN - Bangladesh, India, Nepal
38   INDIAN - Thailand, Vietnam
39   IRELAND 1965 - Ireland
40   ISTS O73 ASTRO 1969 - Diego Garcia
41   JOHNSTON ISLAND 1961 - Johnston Island
42   KANDAWALA - Sri Lanka
43   KERGUELEN ISLAND - Kerguelen Island
44   KERTAU 1948 - West Malaysia, Singapore

45   L.C. 5 ASTRO - Cayman Brac Island
46   LIBERIA 1964 - Liberia
47   LUZON - Mindanao Island
48   LUZON - Phillippines (excluding Mindanao Island)
49   MAHE 1971 - Mahe Island
50   MARCO ASTRO - Salvage Islands
51   MASSAWA - Eritrea (Ethiopia)
52   MERCHICH - Morocco
53   MIDWAY ASTRO 1961 - Midway Island
54   MINNA - Nigeria
55   NORTH AMERICAN 1927 - Alaska
56   NORTH AMERICAN 1927 - Bahamas (excluding San Salvador Island)
57   NORTH AMERICAN 1927 - Central America (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua)
58   NORTH AMERICAN 1927 - Canal Zone
59   NORTH AMERICAN 1927 - Canada (including Newfoundland Island)
60   NORTH AMERICAN 1927 - Caribbean (Barbados, Caicos Islands, Cuba, Dominican Republic, Grand Cayman, Jamaica, Leeward Islands, Turks Islands)
61   NORTH AMERICAN 1927 - Mean Value (CONUS)
62   NORTH AMERICAN 1927 - Cuba
63   NORTH AMERICAN 1927 - Greenland (Hayes Peninsula)
64   NORTH AMERICAN 1927 - Mexico
65   NORTH AMERICAN 1927 - San Salvador Island
66   NORTH AMERICAN 1983 - Alaska, Canada, Central America, CONUS, Mexico
67   NAPARIMA, BWI - Trinidad and Tobago
68   NAHRWAN - Masirah Island (Oman)
69   NAHRWAN - Saudi Arabia
70   NAHRWAN - United Arab Emirates
71   OBSERVATORIO 1966 - Corvo and Flores Islands (Azores)
72   OLD EGYPTIAN - Egypt
73   OLD HAWAIIAN - Mean Value
74   OMAN - Oman
75   PICO DE LAS NIEVES - Canary Islands
76   PITCAIRN ASTRO 1967 - Pitcairn Island
77   PUERTO RICO - Puerto Rico, Virgin Islands
78   QATAR NATIONAL - Qatar
79   QORNOQ - South Greenland
80   REUNION - Mascarene Island
81   ROME 1940 - Sardinia Island
82   RT 90 - Sweden
83   PROVISIONAL SOUTH AMERICAN 1956 - Bolivia, Chile, Colombia, Ecuador, Guyana, Peru, Venezuela
84   SOUTH AMERICAN 1969 - Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Venezuela, Trinidad and Tobago
85   SOUTH ASIA - Singapore
86   PROVISIONAL SOUTH CHILEAN 1963 - South Chile
87   SANTO (DOS) - Espirito Santo Island
88   SAO BRAZ - Sao Miguel, Santa Maria Islands (Azores)
89   SAPPER HILL 1943 - East Falkland Island
90   SCHWARZECK - Namibia
91   SOUTHEAST BASE - Porto Santo and Madeira Islands
92   SOUTHWEST BASE - Faial, Graciosa, Pico, Sao Jorge, and Terceira Islands (Azores)
93   TIMBALAI 1948 - Brunei and East Malaysia (Sarawak and Sabah)
94   TOKYO - Japan, Korea, Okinawa
95   TRISTAN ASTRO 1968 - Tristan da Cunha
96   User defined earth datum
97   VITI LEVU 1916 - Viti Levu Island (Fiji Islands)

Appendix B

Binary Phase Output Format

Two records are transmitted once per second by the GPS 15H & 15L. One record contains primarily post-process information such as position and velocity information. The second record contains receiver measurement information. The records are sent at a default baud rate of 9600 baud, 8 data bits, and no parity.

Records begin with a delimiter byte (10 hex). The second byte identifies the record type (33 hex for a position record, 34 hex for a receiver measurement). The third byte indicates the size of the data. The fourth byte is the first byte of data. The data is then followed by a checksum byte, a delimiter byte (10 hex), and an end-of-transmission character (03 hex).

Note - If RTCM-104 differential data is sent to the GPS sensor the board will reset the Phase Output Data baud rate to the same baud rate used for RTCM-104 data. If the differential inputs are used on the GPS sensor then the RTCM-104 data must be sent to the GPS sensor at 9600 baud (preferred) or 4800 baud. RTCM-104, baud rates less than 4800 baud are not supported by the GPS sensors since it would limit bus bandwidth past the point where a once per second phase output data rate could be maintained.

Position Record

- 0x10	(DLE is first byte)
- 0x33	(Position record identifier)
- 0x40	(Size of data)
- cpo_pvt_data	(See description below)
- one-byte checksum	(The addition of bytes between the delimiters should equal 0)
- 0x10	(DLE)
- 0x03	(ETX is last byte)

```
typedef struct
    {
    float       alt;
    float       epe;
    float       eph;
    float       epv;
    int         fix;
    double      gps_tow;
    double      lat;
    double      lon;
    float       lon_vel;
    float       lat_vel;
    float       alt_vel;
    float       msl_hght;
    int         leap_sec;
    long        grmn_days;
    } cpo_pvt_data;
```

alt   Ellipsoid altitude (meters)
epe   Est pos error (meters)
eph   Pos err, horizontal (meters)
epv   Pos err, vertical (meters)
fix   0 = no fix; 1 = no fix; 2 = 2D; 3 = 3D; 4 = 2D differential; 5 = 3D differential;
                   6 and greater - not defined
gps_tow   GPS time of week (sec)
lat   Latitude (radians)
lon   Longitude (radians)
lon_vel   Longitude velocity (meters/second)
lat_vel   Latitude velocity (meters/second)
alt_vel   Altitude velocity (meters/ second)
msl_hght   Mean sea level height (meters)
leap_sec   UTC leap seconds
grmn_days   GARMIN days (days since December 31, 1989)

Receiver Measurement Record

- 0x10   (DLE is first byte)
- 0x34   (Receiver record identifier)
- 0xE2   (Size of data)
- cpo_rcv_data   (See below)
- one byte checksum   (The sum of bytes between the delimiters should equal 0)
- 0x10   (DLE)
- 0x03   (ETX)

```
typedef struct
    {
    unsigned long    cycles;
    double           pr;
    unsigned int     phase;
    char             slp_dtct;
    unsigned char    snr_dbhz;
    char             svid;
    char             valid;
} cpo_rcv_sv_data;

typedef struct
    {
    double           rcvr_tow;
    int              rcvr_wn;
    cpo_rcv_sv_data  sv[ 12 ];
} cpo_rcv_data;
```

rcvr_tow   Receiver time of week (seconds)
rcvr_wn   Receiver week number
cycles   Number of accumulated cycles
pr   Pseudorange (meters)
phase   To convert to (0 -359.999) multiply by 360.0 and divide by 2048.0
slp_dtct   0 = no cycle slip detected; non-zero = cycle slip detected
snr_dbhz   Signal strength
svid   Satellite number (0 - 31) Note - add 1 to offset to current svid numbers
valid   0 = information not valid; non-zero = information valid

DLE and ETX bytes:

Sample C code to receive the two records should filter DLE and ETX bytes as described below:

```c
typedef enum
    {
    DAT,
    DLE,
    ETX
    } rx_state_type;

/* Declare and initialize static variables */
static char         in_que[ 256 ];
static int          in_que_ptr = 0;
static rx_state_type rx_state = DAT;

.
.
.

void add_to_que( char data )
{
#define DLE_BYTE 0x10
#define ETX_BYTE 0x03

if ( rx_state == DAT )
    {
    if ( data == DLE_BYTE )
        {
        rx_state = DLE;
        }
    else
        {
        in_que[ in_que_ptr++ ] = data;
        }
    }
else if ( rx_state == DLE )
    {
    if ( data == ETX_BYTE )
        {
        rx_state = ETX;
        }
    else
        {
        rx_state = DAT;
        in_que[ in_que_ptr++ ] = data;
        }
    }
else if ( rx_state == ETX )
    {
    if ( data == DLE_BYTE )
        {
        rx_state = DLE;
        }
    }

if ( in_que_ptr > 255 )
    {
    in_que_ptr = 0;
    }
}
```

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GPS 15H & 15L TECHNICAL SPECIFICATIONS
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