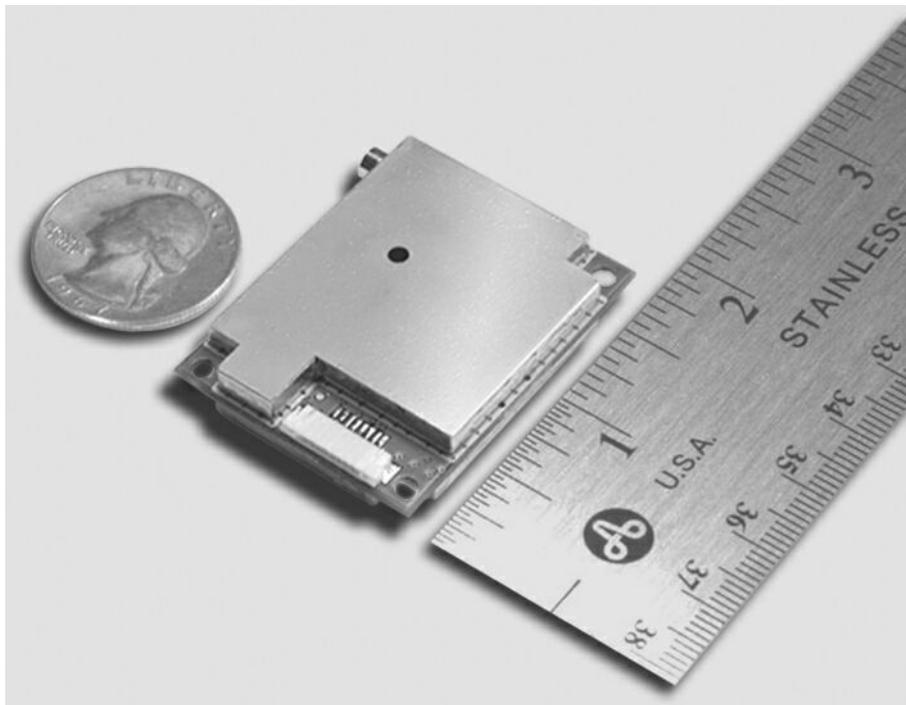


# GPS 15xH/15xL TECHNICAL SPECIFICATIONS



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# **1 INTRODUCTION**

## **1.1 CAUTION**

The GPS system is operated by the government of the United States, which is solely responsible for its accuracy and maintenance. The GLONASS system is operated by the government of Russia, which is solely responsible for its accuracy and maintenance. Although the device is a 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 device. 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.

## **1.2 FCC COMPLIANCE**

This device complies with part 15 of the FCC Rules. Operation is subject to the following two 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 has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and may cause harmful interference to radio communications if not installed and used in accordance with the instructions. 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 of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the 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.

This product does not contain any user-serviceable parts. Repairs should only be made by an authorized Garmin service center. 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.

## **1.3 LIMITED WARRANTY**

The Garmin standard limited warranty applies to this device. For more information, go to [garmin.com/support/warranty](http://garmin.com/support/warranty).

## **1.4 OVERVIEW**

The GPS 15xH and GPS 15xL sensor boards are designed for a broad spectrum of OEM (Original Equipment Manufacturer) system applications. Based on the proven technology found in other Garmin GPS receivers, the GPS 15xH/15xL tracks multiple satellites at a time while providing fast time-to-first-fix, precise navigation updates, and low power consumption. The GPS 15xH/15xL includes the capability of Wide Area Augmentation System (WAAS) differential GPS.

The GPS 15xH/15xL requires 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 15xH/15xL through its RS-232 asynchronous serial port. End-user interfaces, such as keyboards and displays, are the responsibility of the application designer.

## 1.5 FEATURES

- GPS receiver tracks and uses multiple satellites for fast, accurate positioning and velocity estimates.
- Compact, rugged design ideal for applications with minimal space.
- May be remotely mounted in an out-of-the-way location.
- User initialization is not required. Once installed, this device automatically produces navigation data.
- On-board backup battery to maintain the non-volatile SRAM and real-time clock for up to 21 days.
- Provision for external power to maintain the charge on the backup battery.
- Configurable parameters include expected position, current time and date, and preferred position fix type (2D, 3D, or automatic).

## 1.6 TECHNICAL SPECIFICATIONS

Specifications are subject to change without notice.

### 1.6.1 Physical Characteristics

#### 1.6.1.1 Size

1.400in. (35.56 mm) wide x 1.805in. (45.85 mm) long x 0.327in. (8.31 mm) high

#### 1.6.1.2 Weight

- GPS 15xH: 0.53 oz. (15.0 g)
- GPS 15xL: 0.50 oz. (14.1 g)

#### 1.6.1.3 Available Connector Options

GPS 15xH-F and GPS 15xL-F: 8-pin LIF (Low Insertion Force) flex connector, 1-millimeter pitch. For use with common 1-mm pitch, 8-conductor flex cable, available as Garmin Part Number 310-00040-01. This flex cable mates with common 1 mm pitch, 8-pin flex connectors, such as Garmin part number 330-00346-08 or Molex Part Number 52793-0890. Refer to the Molex Web site at [www.molex.com](http://www.molex.com).

GPS 15xH-W and GPS 15xL-W: 8-pin JST connector, 1-mm pitch. Mating wire harness included (Garmin Part Number 325-00118-01). The connector housing used on this harness is equivalent to JST Part Number SHR-08V-S-B. The 8-wire crimp socket is equivalent to JST Part Number SSH-003T-P0.2. Refer to the JST Web site at [www.jst.com](http://www.jst.com).

#### 1.6.1.4 Antenna Connector

The GPS 15xH and GPS 15xL series products provide an MCX female connector for connection to an active GPS antenna. The antenna should be terminated in an MCX male connector. A suitable antenna is Garmin's GA 25 MCX (Garmin Part Number 010-10702-00). Other antennas that are terminated in male BNC connectors may be adapted for use with the GPS 15xH and GPS 15xL series products by using a Garmin MCX to BNC Adapter Cable (Garmin Part Number 010-10121-00).

## 1.6.2 Electrical Characteristics

### 1.6.2.1 Input Voltage

- GPS 15H: 8.0 Vdc to 40 Vdc unregulated
- GPS 15L: 3.3 Vdc to 5.4 Vdc (must have less than 100 mV peak-to-peak ripple)

### 1.6.2.2 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

### 1.6.2.3 GPS Receiver Sensitivity

-185 dBW minimum

## 1.6.3 Environmental Characteristics

- Operating Temperature: From -22° to 176°F (from -30° to +80°C)
- Storage Temperature: From -40° to 194°F (from -40° to +90°C)

## 1.6.4 GPS Performance

### 1.6.4.1 Receiver

WAAS enabled GPS receiver continuously tracks and uses multiple satellites to compute and update your position.

### 1.6.4.2 Acquisition Times

- Reacquisition: Less than 2 seconds
- Hot: Approx. 1 second (all data known)
- Warm: Approx. 38 seconds (initial position, time, and almanac known; ephemeris unknown)
- Cold: Approx. 45 seconds

### 1.6.4.3 Update Rate

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

### 1.6.4.4 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 MPO pulse (subject to Selective Availability)
- Dynamics: 999 knots velocity (only limited at altitude greater than 60,000 feet), 3g dynamics

## 1.6.5 Interfaces

### 1.6.5.1 GPS 15xH/15xL 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.
- Factory setting is 4800 baud. User-selectable baud: 4800, 9600, 19200, 38400.

### 1.6.6 Antenna Specifications

The active antenna used with the GPS 15xH/15xL should have the following specifications:

- Gain: Antenna should provide between 10 dB to 30 dB net gain between the antenna feed point and the connection to the GPS 15xH/15xL. All amplifier gains, filter losses, cable losses, etc. must be considered when calculating the gain.
- RF Connection: GPS 15xH/15xL RF Connection: MCX Female connector (on the GPS 15xH/15xL board)  
Antenna Connection: MCX Male connector (on the end of the antenna cable)
- Garmin Antenna: GA 25 MCX (Garmin Part Number 010-10702-00) provides the required MCX Male connector. Other Garmin antennas terminated in a BNC Male connector may also be used if a Garmin MCX to BNC Adapter Cable (Garmin Part Number 010-10121-00) is used. Place the MCX to BNC Adapter Cable between the connector on the end of the antenna cable and the connector on the GPS 15xH/15xL.
- Noise Figure/Gain: The total noise on the external antenna should be less than 3 dB with a gain between 10 dB and 30 dB.

Should be properly biased by your choice of:

Power from on-board source: 3.0 Vdc minus the voltage drop across a 7.2 ohm series resistance due to the current drawn by the antenna. The antenna must not draw more than 60 mA.

Power from external source: From 3.5 Vdc to 8.0 Vdc bias through the series combination of an on-board ~5.6 Ohm current sensing resistance, a saturated PNP silicon transistor and a Schottky diode. The antenna must not draw more than 60 mA. The external source of antenna bias voltage should not have any significant noise or interference power in the GPS band (20 MHz bandwidth centered at 1.57542 GHz).

## 2 WIRE DESCRIPTIONS AND WIRING DIAGRAMS

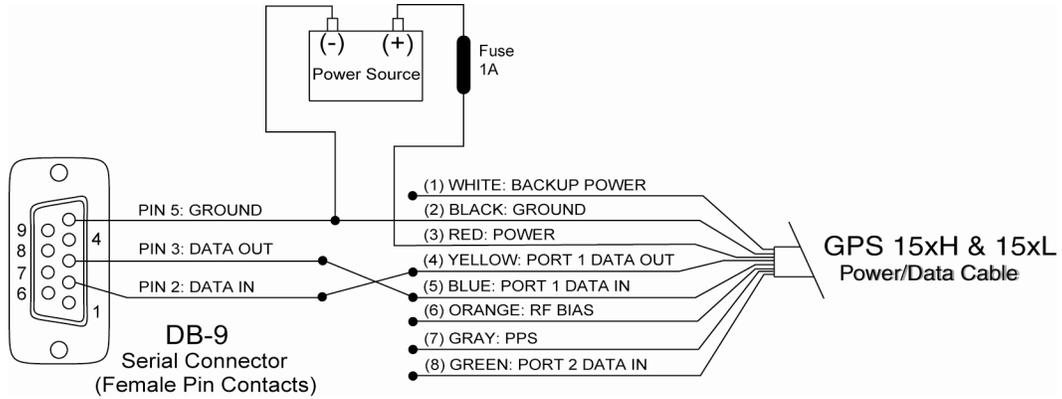
The GPS 15xL-F and GPS 15xH-F use an eight contact flex circuit LIF connector. The GPS 15xL-W and GPS 15xH-W use an eight pin JST connector (mating wire harness included). (See [1.5.1.3](#) for details.)

### 2.1 WIRE DESCRIPTIONS

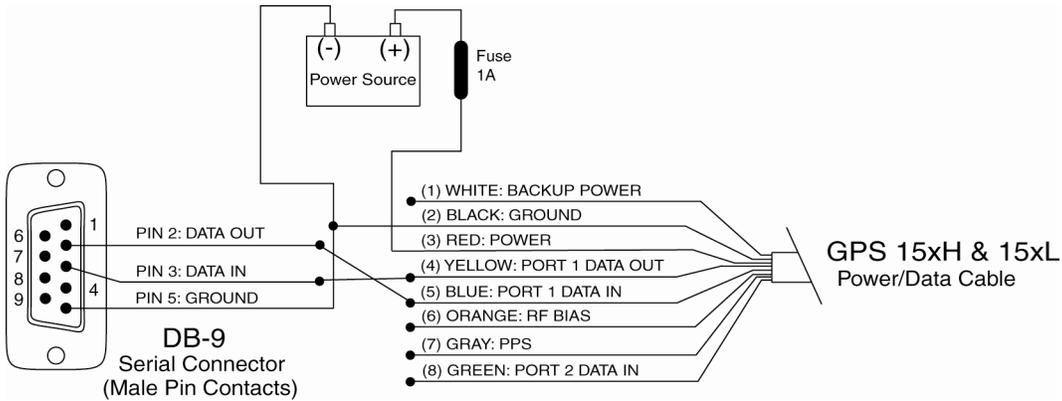
GPS 15xH/15x L Pin #	Signal Name	Description
1	BACKUP POWER	This input provides external power to the battery-backed SRAM and real-time clock. This enables the user to provide backup power if needed for longer than the on-board rechargeable battery will provide (roughly 21 days). Input voltage must be between +2.8 and +3.4 Vdc.
2	GROUND	Power and Signal Ground
3	POWER	<b>GPS 15xL:</b> +3.3 to +5.4 Vdc ( $\pm 100$ mV ripple) 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. <b>GPS 15xH:</b> Unregulated 8.0 to 40.0 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. Although a regulated supply is not required, the peak-to-peak voltage ripple on this line should be kept to less than 100 mV.
4	PORT 1 DATA OUT	<b>Asynchronous Serial Output.</b> RS-232 compatible output normally provides serial data which is formatted per <i>NMEA 0183, Version 2.0</i> . This output is also capable of outputting phase data information; see <a href="#">Appendix B: Garmin Binary Output Format</a> 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	<b>First Asynchronous Serial Input.</b> 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 uses RS-232 polarity. The low signal voltage requirement is $< 0.6$ Vdc, and the high signal voltage requirement is $> 2.4$ V. Minimum load impedance is 500 $\Omega$ . This input may be used to receive serial initialization/ configuration data as specified in <a href="#">Section 4.1 Received NMEA 0183 Sentences</a> .
6	RF BIAS	This input allows the user to externally apply an RF bias to the active antenna. By default, the unit will use an internal voltage to power the active antenna. If an external voltage greater than the internal voltage of the center pin of the antenna (between 3.5 Vdc and 8.0 Vdc) is detected at this input, the GPS 15xH/15xL will automatically changes to the external voltage. The antenna must not draw more than 60 mA.
7	MPO	<b>Measurement Pulse Output.</b> Typical voltage rise and fall times are 300 ns. Impedance is 150 $\Omega$ . Open circuit output voltage is low = 0 Vdc and high = $V_{in}$ in the GPS 15xL, and low = 0 Vdc and high = 5.0 Vdc in the GPS 15xH. The default format is a 100 ms wide active-high pulse at a 1 Hz rate; the pulse width is configurable in 20 ms increments. The rising edge is synchronized to the start of each GPS second. This output provides between 800 mVp-p to 1.7 Vp-p for GPS 15xL and 1.4 Vp-p for the GPS 15xH into a 50 $\Omega$ load. The pulse time measured at the 50% voltage point will be about 50 ns earlier with a 50 $\Omega$ load than with no load.

8	PORT 2 DATA IN	<b>Second Serial Asynchronous Input.</b> This input may be used to receive serial differential GPS data formatted per <i>RTCM SC-104 Recommended Standards For Differential Navstar GPS Service, Version 2.2</i> (see Section 4.5 for more details).
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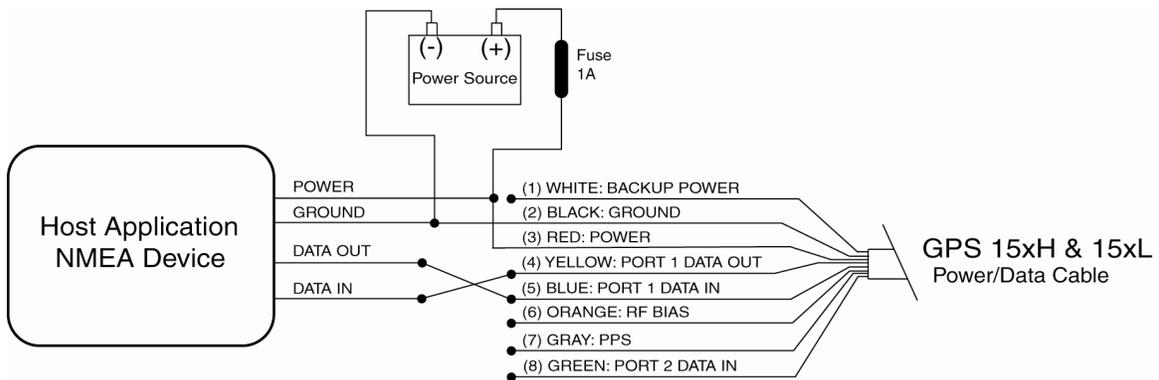
## 2.2 WIRING DIAGRAMS



**Figure 1: Computer Serial Port Interconnection**

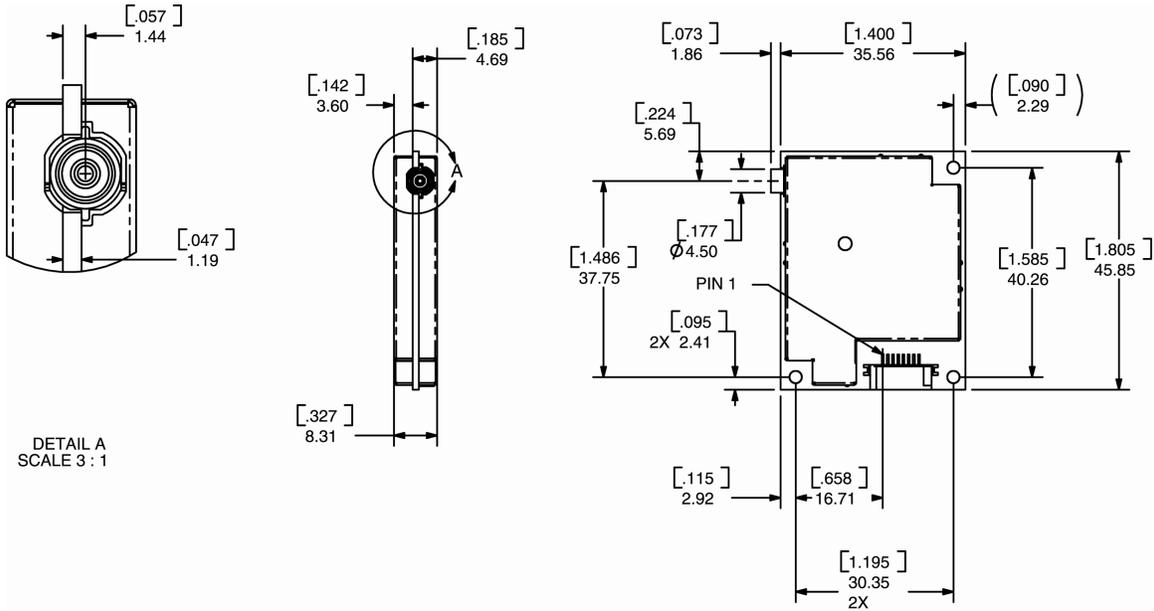


**Figure 2: PDA Serial Port Interconnection**



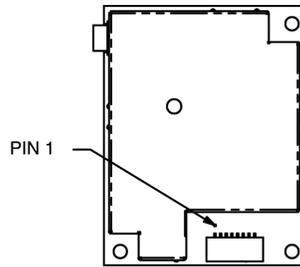
**Figure 3: Basic NMEA Device Interconnection**

## 3 MECHANICAL CHARACTERISTICS & MOUNTING



1. Dimensions in millimeters [inches]
2. Dimension tolerance: +/-0.25 mm [ $\pm 0.01$ in.]
3. Use M2 mounting screws.

**Figure 4: GPS 15xH-F & 15xL-F Dimensions**



1. Dimensions identical to GPS 15xH-F and GPS 15xL-F
2. Use M2 mounting screws.

**Figure 5: GPS 15xH-W & 15xL-W Outline Drawing**

## 4 GPS 15XH/15XL SOFTWARE INTERFACE

The factory default interface protocol of the GPS 15xH/15xL serial com port 1 is based on the National Marine Electronics Association's NMEA 0183 ASCII interface specification. This standard is fully defined in *NMEA 0183, Version 2.30*. Copies may be obtained from NMEA, [www.nmea.org](http://www.nmea.org).

In addition to the standard NMEA 0183 sentences, the GPS 15xH/15xL may also be configured to transmit information over their serial interface using NMEA 0183 compliant Garmin proprietary sentences. These proprietary sentences begin with the characters, "\$PGRM", instead of the characters "\$G" that are typical of the standard NMEA 0183 sentences. The characters "\$P" indicate that the sentence is a proprietary implementation and the characters "GRM" indicate that it is Garmin's proprietary sentence. The character (or characters) that follow the characters "\$PGRM" uniquely identifies that particular Garmin proprietary sentence.

It is also possible to configure the GPS 15xH/15xL to transmit Garmin binary data over their serial com port 1 interface. See [Appendix B: Garmin Binary Output Format](#) for details.

The following sections describe the NMEA 0183 data format of each sentence transmitted and received by the GPS 15xH/15xL.

### 4.1 RECEIVED NMEA 0183 SENTENCES

The following paragraphs define the sentences that can be received on the GPS sensors' 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>. Please note that <CR> and <LF> denote the ASCII characters for carriage return (0D hexadecimal) and line feed (0A hexadecimal), respectively. So, <CR> and <LF> are each transmitted as single bytes.

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 upper and lower nibbles of the exclusive-or (XOR) parity, computed over all of the characters between the "\$" and "\*" characters, non-inclusive. The hexadecimal representation uses capital letters, such as 3D instead of 3d. Sentences may be truncated by <CR><LF> after any data field and valid fields up to that point will be acted on by the sensor.

#### 4.1.1 Almanac Information (ALM)

The \$GPALM sentence can be used to initialize the GPS sensor's stored almanac information in the event of non-volatile memory loss or after storing longer 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

#### 4.1.2 Sensor Initialization Information (PGRMI)

The \$PGRMI sentence provides information used to initialize the GPS sensor's last known position and to set the time on the real time clock. This information is used by the GPS receiver on the next power cycle to predict which satellites will be visible in the sky as an aid for more rapid satellite acquisition. Receipt of this sentence by the GPS sensor during satellite acquisition 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<CR><LF> or \$PGRMIE\*04<CR><LF> to the GPS sensor.

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

<1>	Latitude, ddm.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

#### 4.1.3 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<CR><LF> or \$PGRMCE\*0E<CR><LF> 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, 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: Earth Datum List for a list of earth datum 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 <sup>-9</sup> 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, 3 = 4800, 4 = 9600, 5 = 19200, 8 = 38400
<11>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<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 to 30 seconds

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

#### 4.1.4 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<CR><LF> or PGRMC1E\*3F<CR><LF> to the GPS sensor.

\$PGRMC1,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,<10>,<11>,<12>,<13>\*hh<CR><LF>

<1>	NMEA 0183 output time 1 to 900 (sec).
<2>	Garmin Binary Output, 1 = Off, 2 = On.
<3>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<4>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<5>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<6>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<7>	NMEA 0183 version, 1 = version 2.20 (factory default), 2 = version 2.30
<8>	DGPS WAAS mode, A = Automatic, W = WAAS Only , R = RTCM Only, N = None (DGPS Disabled)
<9>	Power Save Mode, P = Power Save mode, N = Normal
<10>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<11>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<12>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<13>	PPS Auto Off Mode, 1 = Off, 2 = On
<14>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)

Configuration changes take effect immediately, with the exception of Garmin Binary Output, which takes effect on the next power cycle or a reset event. Send the sentence \$PGRMI,,,,,,R<CR><LF> or \$PGRMI,,,,,,R\*3F<CR><LF> to command a reset (refer to 4.1.2). If the GPS sensor is in the Garmin binary data mode, it is necessary to send the following eight-byte data stream to temporarily change the data format to NMEA 0183:

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

Follow by sending a PGRMC1 sentence that turns off the Garmin Binary Output format:

\$PGRMC1,,1<CR><LF> or \$PGRMC1,,1\*4B<CR><LF>

#### 4.1.5 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: GPGGGA, GPGSA, GPGSV, GPRMC, and PGRMT.

This sentence is not intended for turning on and off sentences as a means of polling while the receiver is in use; instead, it is intended to allow systems integrators to initialize the GPS receiver so it produces only the sentences required by the target application.

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

<1>	Target sentence description (for example, PGRMT, GPGSV, etc.)
<2>	Target sentence mode, where: 0 = Disable specified sentence, 1 = enable specified sentence, 2 = Disable all output sentences, 3 = Enable all output sentences (except GPALM), 4 = Restore factory default output sentences

The following notes apply to the PGRMO input sentence:

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 (for example, \$PGRMO,,3), or the mode field may contain from 1 to 5 characters.

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.

If either the target sentence mode field or the target sentence description field is not valid, the PGRMO sentence will have no effect.

\$PGRMO,GPALM,1<CR><LF> will cause the GPS sensor to transmit all stored almanac information. All other NMEA 0183 sentence transmission will be suspended temporarily.

\$PGRMO,,G<CR><LF> will cause the COM port to change to Garmin Binary Output mode for the duration of the power cycle or until 10 0A 02 26 00 CE 10 03 (Hexadecimal) is sent to the GPS receiver in order to return to NMEA 0183 mode as described in Section 4.1.4 . Garmin binary mode is required for GPS 15xH/15xL series product software updates.

## 4.2 TRANSMITTED NMEA 0183 SENTENCES

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

### 4.2.1 Sentence Transmission

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 UTC second boundary immediately preceding the GPRMC sentence, or whichever sentence is output first in the burst (see Table 3 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 length of the transmission can be determined by the following equation and Tables 3 and 4:

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

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 2: NMEA 0183 Output Sentence Order and Size**

Baud	Characters per Second
4800	480
9600	960
19200	1920
38400	3840

**Table 3: Characters per Second for Available Baud Rates**

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 result in a once per second transmission at the NMEA 0183 specification transmission rate of 4800 baud.

#### 4.2.2 Transmitted Time

The GPS sensor outputs Coordinated Universal Time (UTC) date and time of day in the transmitted sentences. Before 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 closest UTC second boundary.

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, one second is inserted at the beginning of the first hour (0h 0m 0s) of the day that the positive leap is occurring. 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, 1998 as follows:

\$GPRMC,235959,A,3851.3651,N,09447.9382,W,000.0,000.0,311298,003.3,E\*65

\$GPRMC,000000,A,3851.3651,N,09447.9382,W,000.0,000.0,010199,003.3,E\*64

\$GPRMC,000000,A,3851.3651,N,09447.9382,W,000.0,000.0,010199,003.3,E\*64

\$GPRMC,000001,A,3851.3651,N,09447.9382,W,000.0,000.0,010199,003.3,E\*65

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 0h 0m 0s (the "zero" second) for the day from which the

leap second is removed. For example, if a negative leap second had been required on December 31, 1998, the result would have been as follows:

```
$GPRMC,235959,A,3851.3651,N,09447.9382,W,000.0,000.0,311298,003.3,E*65
```

```
$GPRMC,000001,A,3851.3651,N,09447.9382,W,000.0,000.0,010199,003.3,E*65
```

```
$GPRMC,000002,A,3851.3651,N,09447.9382,W,000.0,000.0,010199,003.3,E*66
```

#### 4.2.3 Global Positioning System Almanac Data (ALM)

Almanac sentences are not normally transmitted. Send the GPS sensor a \$PGRMO,GPALM,1 command to initiate almanac transmission. 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 is suspended temporarily.

```
$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 [4.1.1 Almanac Information \(ALM\)](#).

#### 4.2.4 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 (WAAS) 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>	Null (Differential GPS)
<12>	Null (Differential Reference Station ID)

#### 4.2.5 GPS DOP and Active Satellites (GSA)

```
$GPGSA,<1>,<2>,<3>,<3>,<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, set to null if unused (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

#### 4.2.6 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 (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 GPGSV sentences. Individual fields may be set to null if the corresponding data is unavailable.

#### 4.2.7 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 2.30 active), A = Autonomous, D = Differential, E = Estimated, N = Data not valid

#### 4.2.8 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 2.30 active), A = Autonomous, D = Differential, E = Estimated, N = Data not valid

#### 4.2.9 Geographic Position (GLL)

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

<1>	Latitude, ddmm.mmmm format (leading zeros must be transmitted)
<2>	Latitude hemisphere, N or S
<3>	Longitude, dddmm.mmmm format (leading zeros must 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 2.30 active), A = Autonomous, D = Differential (WAAS), E = Estimated, N = Data not valid

#### 4.2.10 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

#### 4.2.11 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 to 1023)
<2>	GPS seconds (0 to 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 must be transmitted)
<7>	Latitude hemisphere, N or S
<8>	Longitude, dddmm.mmmm format (leading zeros must 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)

#### 4.2.12 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, for example, "WGS 84")
-----	---

#### 4.2.13

4.2.14

#### 4.2.15 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, for example, "GPS 15xH/15xL VER 2.05")
<2>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<3>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<4>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<5>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<6>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<7>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<8>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<9>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)

#### 4.2.16 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 999.9 meters/second

#### 4.2.17 DGPS Beacon Information (PGRMB)

\$PGRMB,<1>,<2>,<3>,<4>,<5>,K,<6>,<7>,<8>\*hh<CR><LF>

<1>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<2>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<3>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<4>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<5>	Distance to beacon reference station in kilometers
<6>	No Effect (This field is not used on the GPS 15xH/15xL and is included only for compatibility with other models.)
<7>	DGPS fix source: R = RTCM, W = WAAS, N = No DGPS fix available
<8>	Currently selected DGPS mode as specified by the PGRMC1 sentence of Section 4.1.4: A = Automatic (factory default), W = WAAS only, R = RTCM only, N = None (No DGPS enabled)

## **APPENDIX A: EARTH DATUM LIST**

The following is a list of the Garmin GPS 15xH/15xL 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)
- 98 WAKE-ENIWETOK 1960–Marshall Islands
- 99 WORLD GEODETIC SYSTEM 1972
- 100 WORLD GEODETIC SYSTEM 1984
- 101 ZANDERIJ–Surinam
- 102 CH-1903–Switzerland
- 103 Hu-Tzu-Shan
- 104 Indonesia 74
- 105 Austria
- 106 Potsdam
- 107 Taiwan–modified Hu-Tzu-Shan
- 108 GDA–Geocentric Datum of Australia
- 109 Dutch

## **APPENDIX B: GARMIN BINARY OUTPUT FORMAT**

In binary output mode, the GPS 15xH/15xL will transmit packets once per second. The record contains primarily post-process information such as position and velocity information. The default serial port settings in binary output mode is 4800 baud, 8 data bits, 1 start bit, 1 stop bit and no parity. Of those settings, only the baud rate may be changed. Please see Appendix C for details on changing the baud rate in binary output mode.

To enable the binary output mode as a power-on default (powers up with this mode enabled), use the \$PGRMC1 NMEA 0183 sentence as described in [Section 4.1.4](#). (You must currently be operating in NMEA 0183 mode in order for NMEA 0183 configuration sentences to have any effect.) If you wish to enable the binary output mode and you do not wish to alter the setting for which mode (NMEA 0183 or binary output) is enabled at power on, use the \$PGRMO NMEA 0183 sentence as described in [Section 4.1.5](#). Refer to the *Garmin Device Interface Specification* found in the Garmin Device Interface SDK for details on how to form and parse Garmin packets, available at <https://www8.garmin.com/support/commProtocol.html>.

Note that the satellite data information is also enabled when the position record is enabled.

Records sent over RS232 begin with a delimiter byte (10 hex). The second byte identifies the record type (33 hex for a position record and 72 hex for a satellite data record). 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). Additionally, any DLEs (0x10) that appear between the delimiters are escaped with a second DLE. There is sample code at the end of this section that will strip off the DLEs and ETXs.

RS232 Packet:

- 0x10 (DLE is first byte)
- 0x## (Record ID – single byte)
- 0x## (Number of data bytes – single byte)
- data bytes (See descriptions below)
- 0x## (2's complement of the arithmetic sum of the bytes between the delimiters)
- 0x10 (DLE)
- 0x03 (ETX is last byte)

The data bytes of each packet contain the record specified by the record ID. A description of each record follows.

### **Satellite Data Record**

The satellite data has a record ID of 0x72 with 84 (0x54) data bytes. The data bytes contain data for 12 satellites as described below.

```
typedef struct
{
    uint8    svid; //space vehicle identification (1-32 and 33-64 for
WAAS)
    uint16   snr;    //signal-to-noise ratio
    uint8    elev;  //satellite elevation in degrees
    uint16   azmth; //satellite azimuth in degrees
    uint8    status; //status bit-field
} cpo_sat_data;
```

The status bit field represents a set of Booleans described below:

Bit	Meaning when bit is one (1)
0	The unit has ephemeris data for the specified satellite.
1	The unit has a differential correction for the specified satellite.
2	The unit is using this satellite in the solution.

This pattern is repeated for 12 satellites for a total of  $12 \times 7$  bytes = 84 (0x54) bytes.

RS-232 Packet for the Satellite Record:

- 0x10 (DLE is first byte)
- 0x72 (Record ID – single byte)
- 0x54 (Number of data bytes – single byte)
- 12 cpo\_sat\_data records:
  - 0x## (2's complement of the arithmetic sum of the bytes between the delimiters)
  - 0x10 (DLE)
  - 0x03 (ETX is last byte)

### **Position Record**

The Position Record has a record identifier of

```
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	Estimated position error (meters)
eph	Position error, horizontal (meters)
epv	Position error, 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	Height (mean sea level) (meters)
leap_sec	UTC leap seconds
grmn_days	Garmin days (days since December 31, 1989)

## DLE and ETX bytes:

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

```
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;
    }
}
```

## **APPENDIX C: CHANGING THE BAUD RATE IN GARMIN MODE**

In certain cases, you may need to change the default baud rate of your Garmin GPS receiver while in Garmin mode. Follow these steps to temporarily change the baud rate.

Refer to the *Garmin Device Interface Specification* found in the Garmin Device Interface SDK for details on how to form and parse Garmin packets, available at <https://www8.garmin.com/support/commProtocol.html>.

1. Turn off all requests by transmitting packet:  
id = IOP\_RQST\_DATA (0x1C)  
data = 0 (16-bit unsigned integer )
2. The GPS unit will respond by sending a packet with id = IOP\_ACK\_BYTE (0x06)
3. After you receive the above packet, transmit packet:  
id = IOP\_BAUD\_RQST\_DATA (0x30)  
data = baud rate to change to (32-bit unsigned integer; for example, 38400)
4. The GPS unit will respond by sending a packet:  
id = IOP\_BAUD\_ACPT\_DATA (0x31)  
data = highest acceptable baud rate closest to what was requested (32-bit unsigned integer; for example, 38361 decimal)
5. Determine the actual baud rate value from the data sent in step 4. This value will be within +/- 5% of the actual baud rate. (For example, the GPS unit might send a baud rate of 38361, which correlates to a baud rate of 38400).
6. If the baud rate in step 5 is acceptable, transmit packet:  
id = IOP\_ACK\_BYTE (0x06)  
data = IOP\_BAUD\_ACPT\_DATA (0x31)
7. Sleep for a small amount of time, about 100 milliseconds, to make sure the packet in (6) was successfully transmitted to the GPS unit.
8. Close the current connection to the GPS unit and immediately open a new connection with the new baud rate obtained in step 5.
9. Immediately after establishing a connection, transmit packet:  
id = IOP\_CMND\_DATA (0x0A)  
data = IOP\_ACK\_PING (0x3A)
10. The GPS will respond by sending a packet:  
id = IOP\_ACK\_BYTE (0x06)  
data = IOP\_CMND\_DATA (0x0A)
11. After you receive the above packet, transmit the same packet in step 9 again.  
id = IOP\_CMND\_DATA (0x0A)  
data = IOP\_ACK\_PING (0x3A)
12. The GPS will respond again with the same packet in step 10.  
id = IOP\_ACK\_BYTE (0x06)  
data = IOP\_CMND\_DATA (0x0A)
13. The baud rate has been successfully changed upon receiving the above packet. If the GPS unit does not receive these two IOP\_CMND\_DATA packets within two seconds, it will reset its baud rate to 9600.

## **APPENDIX D: EPHEMERIS DATA DOWNLOAD (PROGRAMMING EXAMPLE)**

### **Synopsis**

This section describes, using an example, how to download ephemeris information from a Garmin 15, 15x, 16, 16x, 17, 18 or 18x family GPS unit with the exception of the GPS 15-W and the GPS 15-F.

### **Garmin Binary Format Review**

To download the ephemeris data, you must first command the unit to output information in Garmin Binary Format (Garmin mode) instead of the default NMEA output format. To put the unit in Garmin mode, connect to the unit using a terminal program and send the following NMEA sentence: \$PGRMO,,G\*hh<CR><LF>

The checksum \*hh is used for parity checking data and generally is not required in normal PC environments, but is recommended for use in environments containing high electromagnetic noise. 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. See [Section 4 Software Interface](#). The unit will stay in Garmin mode until the next power cycle.

Now that the unit is in Garmin binary format, transmitted and received packets are structured as follows:

<b>Byte Description</b>	<b>Name</b>	<b>Notes</b>
Packet Delimiter	DLE	0x10
Packet ID (type)	ID	Packet type
Data Size	SIZE	Number of bytes in data portion(not including escaped DLEs. See below)
Data bytes	DATA	Not to exceed 256 bytes
.	.	.
.	.	.
.	.	.
Checksum	CHKSUM	2's complement of the arithmetic sum of all the bytes from the Packet ID byte to the last DATA byte(inclusive) not counting escaped DLEs. See below
Packet Delimiter	DLE	0x10
End of Packet	ETX	0x03

The DLE (0x10) is a delimiter byte used in conjunction with the ETX byte to determine beginning and ending of a packet. However, a 0x10 could appear in the data itself; if this occurs, the byte is escaped with another DLE byte (sometimes referred to as DLE stuffing). In other words, if a DLE occurs in the data, another DLE is transmitted immediately after to indicate that it is a data byte and it is not being used as a delimiter. Note that the size byte of the packet does not count the second DLE byte in an escaped DLE pair in the data field. Since a DLE that is a part of the data will have a second DLE to escape it, a single DLE followed by an ETX byte means that the end of a packet has been reached.

To interpret these packets properly, remove the escaped DLE bytes. This can be achieved using an algorithm similar to the [Sample C code](#) fragment on page 29.

## Ephemeris Download Procedure

The following is the sequence of events that occurs when downloading ephemeris.

Send a packet containing the command that requests ephemeris data (IOP\_DOWN\_LOAD\_EPH). The packet should look like this:

### ***TX Packet: Ephemeris Data Request***

<b>Byte Description</b>	<b>Name</b>	<b>HEX Value</b>
Delimiter	DLE	0x10
Command Data ID	IOP_CMND_DATA	0x0A
Number of bytes in data	SIZE	0x02
Request to D/L ephemeris	IOP_DOWN_LOAD_EPH	0x5D
Pad to 2 bytes	DATA	0x00
Checksum calculation	CHKSUM	0x97*
Delimiter	DLE	0x10
End	ETX	0x03

\* From now on, checksum calculation will not be shown for every packet example

The unit will return an acknowledgement packet that will look like this:

### ***RX Packet: Acknowledgement***

<b>Byte Description</b>	<b>Name</b>	<b>HEX Value</b>
Delimiter	DLE	0x10
Acknowledgement ID	IOP_ACK_BYTE	0x06
Number of bytes in data	SIZE	0x02
Request to D/L ephemeris	IOP_CMND_DATA	0x0A
Pad	DATA	0x00
Checksum calculation	CHKSUM	----
Delimiter	DLE	0x10
End of packet	ETX	0x03

Then, the unit will immediately send a packet communicating how many data packets to expect for the ephemeris download (a maximum of twelve):

### ***RX Packet: Number of Data Packets to Expect***

<b>Byte Description</b>	<b>Name</b>	<b>HEX Value</b>
Delimiter	DLE	0x10
Record ID	IOP_RECORDS	0x1B
Number of bytes in data	SIZE	0x02
Number of records	NUM_SV	0x0C
Pad	DATA	0x00
Checksum calculation	CHKSUM	----
Delimiter	DLE	0x10
End of packet	ETX	0x03

This packet requires acknowledgement, as shown below (note that the data field contains the IOP\_RECORDS ID to indicate the acknowledgement of the IOP\_RECORDS packet):

### ***TX Packet: Acknowledgement***

<b>Byte Description</b>	<b>Name</b>	<b>HEX Value</b>
Delimiter	DLE	0x10
Record ID	IOP_ACK_BYTE	0x06
Number of bytes in data	SIZE	0x02
Pad	DATA	0x00
ID of packet being ACK'd	IOP_RECORDS	0x1B
Checksum calculation	CHKSUM	----
Delimiter	DLE	0x10
End of packet	ETX	0x03

Next, the unit will send the specified number of packets containing the ephemeris information. An example packet is shown below. Each packet should be acknowledged as before. (Be sure to modify the ACK packet to indicate what type of packet being acknowledged. For ephemeris data, the ID is 0x35.)

### ***RX Packet: Ephemeris Data***

<b>Byte Description</b>	<b>Name</b>	<b>HEX Value</b>
Delimiter	DLE	0x10
Ephemeris data ID	IOP_SPC_EPH_DATA	0x35
Number of bytes in data	SIZE	0x78
Ephemeris data	DATA	----
.	.	.
.	.	.
.	.	.
Checksum calculation	CHKSUM	----
Delimiter	DLE	0x10
End of packet	ETX	0x03

The data portion of each packet can then be parsed into an instance of the following structure. Each of these structures represents data from a single satellite.

```
typedef struct      /* ephemeris data record for SPC          */
{
  sint16 wn;        /* week number (weeks)                                     */
  float  toc;       /* reference time of clock parameters (s)                 */
  float  toe;       /* reference time of ephemeris parameters (s)            */
  float  af0;       /* clock correction coefficient - group delay (s)         */
  float  af1;       /* clock correction coefficient (s/s)                    */
  float  af2;       /* clock correction coefficient (s/s/s)                  */
  float  ura;       /* user range accuracy (m)                               */
  double e;         /* eccentricity (-)                                      */
  double sqrta;    /* square root of semi-major axis (a) (m**1/2)           */
  double dn;       /* mean motion correction (r/s)                          */
  double m0;       /* mean anomaly at reference time (r)                   */
  double w;        /* argument of perigee (r)                               */
  double omg0;     /* right ascension (r)                                   */
  double i0;       /* inclination angle at reference time (r)               */
  float  odot;     /* rate of right ascension (r/s)                         */
  float  idot;     /* rate of inclination angle (r/s)                       */
  float  cus;      /* argument of latitude correction, sine (r)             */
  float  cuc;      /* argument of latitude correction, cosine (r)           */
  float  cis;      /* inclination correction, sine (r)                     */
  float  cic;      /* inclination correction, cosine (r)                   */
  float  crs;      /* radius correction, sine (m)                          */
  float  crc;      /* radius correction, cosine (m)                        */
  unsigned char iod; /* issue of data                                         */
} SDM_spc_eph_type;
```

An example function to do the parsing is shown below. Note that the double data types are converted by the function `cnvt_ieee_double()`. This function merely swaps the upper and lower words of the double. This is necessary for GPS 15, 15x, 16, 16x, 17, 18 and 18x series sensors due to a compatibility issue with the IEEE floating point standard. In this example, the array `m_TempArray` contains the data portion of the ephemeris packet (with DLE stuffing removed).

```

/*****
*
*   PROCEDURE NAME:
*   copyData - ephemeris data unpacker
*
*   DESCRIPTION:
*   unpacks data from ephemeris packet DATA field after extraneous DLEs
*   have been removed. Note that sint16 refers to a signed 16-bit
*   integer type.
*
*****/
void GPM_ephList::copyData      /* ephemeris data unpacker          */
(
    GPM_ephData* pTemp          /* pointer to ephemeris data array */
)
{
    pTemp->EphStruct.wn = *(sint16*)&m_TempArray[IDX_EPH_WN];
    pTemp->EphStruct.toc = *(float*)&m_TempArray[IDX_EPH_TOC];
    pTemp->EphStruct.toe = *(float*)&m_TempArray[IDX_EPH_TOE];
    pTemp->EphStruct.af0 = *(float*)&m_TempArray[IDX_EPH_AF0];
    pTemp->EphStruct.af1 = *(float*)&m_TempArray[IDX_EPH_AF1];
    pTemp->EphStruct.af2 = *(float*)&m_TempArray[IDX_EPH_AF2];
    pTemp->EphStruct.ura = *(float*)&m_TempArray[IDX_EPH_URA];

    cnvt_ieee_double((long *)&m_TempArray[IDX_EPH_E]);
    pTemp->EphStruct.e = *(double*)&m_TempArray[IDX_EPH_E];

    cnvt_ieee_double((long *)&m_TempArray[IDX_EPH_SQRTA]);
    pTemp->EphStruct.sqrta = *(double*)&m_TempArray[IDX_EPH_SQRTA];

    cnvt_ieee_double((long *)&m_TempArray[IDX_EPH_DN]);
    pTemp->EphStruct.dn = *(double*)&m_TempArray[IDX_EPH_DN];

    cnvt_ieee_double((long *)&m_TempArray[IDX_EPH_M0]);
    pTemp->EphStruct.m0 = *(double*)&m_TempArray[IDX_EPH_M0];

    cnvt_ieee_double((long *)&m_TempArray[IDX_EPH_W]);
    pTemp->EphStruct.w = *(double*)&m_TempArray[IDX_EPH_W];

    cnvt_ieee_double((long *)&m_TempArray[IDX_EPH_OMG0]);
    pTemp->EphStruct.omg0 = *(double*)&m_TempArray[IDX_EPH_OMG0];

    cnvt_ieee_double((long *)&m_TempArray[IDX_EPH_I0]);
    pTemp->EphStruct.i0 = *(double*)&m_TempArray[IDX_EPH_I0];

    pTemp->EphStruct.odot = *(float*)&m_TempArray[IDX_EPH_ODOT];
    pTemp->EphStruct.idot = *(float*)&m_TempArray[IDX_EPH_IDOT];
    pTemp->EphStruct.cus = *(float*)&m_TempArray[IDX_EPH_CUS];
    pTemp->EphStruct.cuc = *(float*)&m_TempArray[IDX_EPH_CUC];
    pTemp->EphStruct.cis = *(float*)&m_TempArray[IDX_EPH_CIS];
    pTemp->EphStruct.cic = *(float*)&m_TempArray[IDX_EPH_CIC];
    pTemp->EphStruct.crs = *(float*)&m_TempArray[IDX_EPH_CRS];
    pTemp->EphStruct.crc = *(float*)&m_TempArray[IDX_EPH_CRC];
    pTemp->EphStruct.iod = *(unsigned char*)&m_TempArray[IDX_EPH_IOD];

    return;
} /* copyData */

```

Each data member of the ephemeris data structure is indexed into the data array of the ephemeris packet and cast as the appropriate data type. The indices are as follows (note that they correlate to the data members of the structure respectively):

```
#define IDX_EPH_WN          0
#define IDX_EPH_TOC        4
#define IDX_EPH_TOE        8
#define IDX_EPH_AF0        12
#define IDX_EPH_AF1        16
#define IDX_EPH_AF2        20
#define IDX_EPH_URA        24
#define IDX_EPH_E           28
#define IDX_EPH_SQRTA       36
#define IDX_EPH_DN          44
#define IDX_EPH_M0          52
#define IDX_EPH_W           60
#define IDX_EPH_OMG0        68
#define IDX_EPH_IO          76
#define IDX_EPH_ODOT        84
#define IDX_EPH_IDOT        88
#define IDX_EPH_CUS         92
#define IDX_EPH_CUC         96
#define IDX_EPH_CIS        100
#define IDX_EPH_CIC        104
#define IDX_EPH_CRS        108
#define IDX_EPH_CRC        112
#define IDX_EPH_IOD        116
```

The last packet will be a “download complete” packet that will look like this:

***TX Packet: Download Complete***

<b>Byte Description</b>	<b>Name</b>	<b>HEX Value</b>
Delimiter	DLE	0x10
Download Complete ID	IOP_DL_CMPLT	0x0c
Number of bytes in data	SIZE	0x02
Ephemeris Download ID	IOP_DOWN_LOAD_EPH	0x5D
Pad	DATA	0x00
Checksum calculation	CHKSUM	----
Delimiter	DLE	0x10
End of packet	ETX	0x03

After properly acknowledging this packet (ACK the IOP\_DL\_CMPLT ID), the ephemeris download is complete.

## **APPENDIX E: GPS 15XH/15XL WINDOWS SERIAL MOUSE ISSUE**

**Problem:** It is possible for Windows to incorrectly interpret the NMEA 0183 output of the GPS 15xH/15xL as the output of a Microsoft Serial BallPoint Mouse. When that happens, Windows loads drivers for the Serial BallPoint Mouse. This causes the cursor to move erratically about the display, clicking, right-clicking, double-clicking, and dragging and dropping displayed items as it goes. On Windows 2000 and newer versions of Windows, you may not experience the problem if you wait until after the computer is booted before connecting the GPS 15xH/15xL to the serial communications port. This problem is not specific to the GPS 15xH/15xL. Any NMEA 0183 device connected to a Windows computer's serial port is likely to cause this problem. Below are several possible solutions to this problem.

If you wish to use a different navigation software application with your GPS 15xH/15xL, you will need to de-select the Garmin Binary Output option that is discussed in Solution 3 below.

**Solution 1:** The easiest solution is to disable the Serial BallPoint mouse in the Device Manager. This solution assumes that you do not need to use a Serial BallPoint mouse with your computer. When erratic mouse movements occur, follow the steps below.

1. Unplug the DB9 connector.
2. Right-click the **My Computer** icon on your desktop, and select **Properties** to open Device Manager.
3. Go to the hardware tab of the resulting pop-up window, and click on the **Device Manager** button.
4. Right-click on **Serial BallPoint Mouse**, and choose the option to **Disable** (NOT uninstall) this device.

**Solution 2:** Do not plug the DB9 connector into the computer until the computer is turned on and the operating system is completely booted up and running. Every time you use the GPS 15xH/15xL, you will need to start the computer and operating system before making the connection between the GPS 15xH/15xL and the computer. This solution usually works on computers running Windows 2000 and newer versions of Windows.

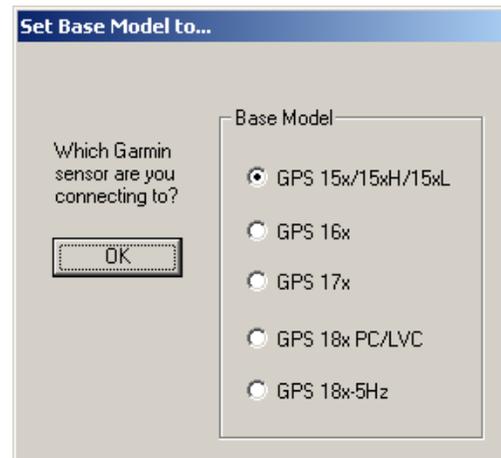
**Solution 3:** Change the default output of the GPS 15xH/15xL so that it does not automatically send NMEA 0183 data to the computer (change the default configuration to enable Garmin Binary Output). Use the Garmin Sensor Configuration Software, named SNSRXCFG.EXE, provided on the Web site to enable "Garmin Binary Output. To download the software, go to [https://www8.garmin.com/support/download\\_details.jsp?id=4053](https://www8.garmin.com/support/download_details.jsp?id=4053), and click **Download**.

**NOTE:** By enabling "Garmin Binary Output," the device will no longer appear as a NMEA 0183 device to your computer. As a result, mapping applications that expect to hear NMEA 0183 data will not recognize your GPS 15xH/15xL until you re-enable the NMEA 0183 output, disabling the Garmin Binary Output in the process.

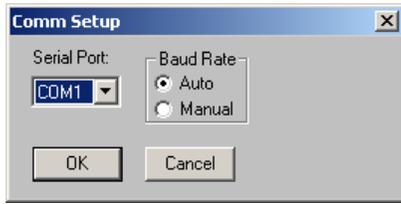
Refer to [Appendix F: Sensor Configuration Software](#) for complete information about downloading the Sensor Configuration Software application.

After the Sensor Configuration Software is installed and running on your computer, follow the steps below to change the default data output of the GPS 15xH/15xL.

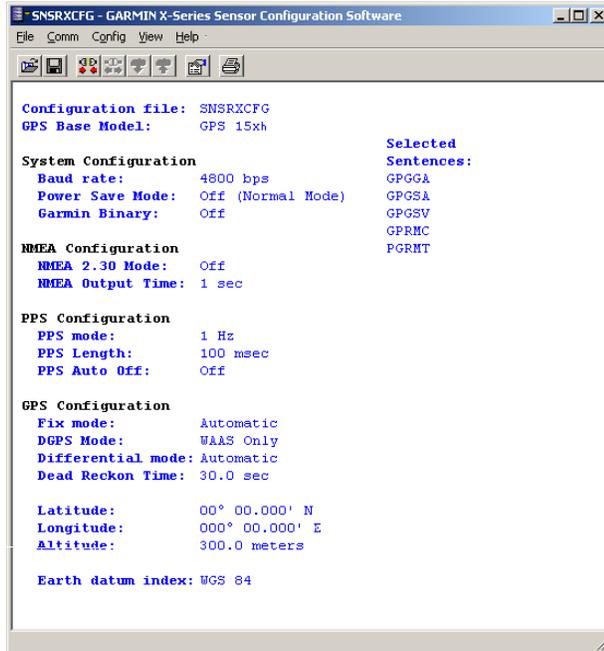
1. Select the **GPS 15x/15xH/15xL** from the list of sensors, and click **OK**. The Sensor Configuration Software opens with the default configuration file for the 15xH/15xL, as shown on the next page.
2. Select **Config > Switch to NMEA Mode** (or press the F10 key).
3. Select **Comm > Setup** to open the Comm Setup Window.



- Select the serial port to which the 15xH/15xL is connected. Select **Auto** to have the program automatically determine the baud rate, or select **Manual** to manually select the baud rate of the GPS 15xH/15xL. Click **OK** when done.



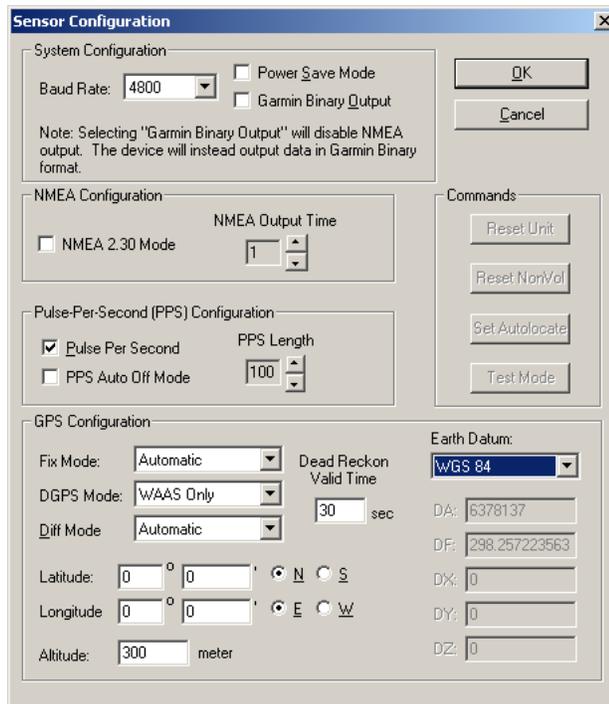
- Click  **Connect**, or select **Comm > Connect** to connect to the GPS 15xH/15xL.
- To view the current programming of the GPS 15xH/15xL, select **Config > Get Configuration from GPS** (or press the F8 key). The current programming of the GPS 15xH/15xL is displayed in the window, as shown on the previous page.



- Open the Sensor Configuration Window by pressing the F6 key or selecting **Config > Sensor Configuration**.
- Place a check mark in the box next to **Garmin Binary Output** to change the GPS 15xH/15xL to Garmin Mode. The unit will keep this change in the programming until you change it again in the software.

**Note:** Selecting **Config > Switch to Garmin Mode** (or pressing the F11 key) only changes the unit to work in Garmin Mode until power is cycled through the unit again. For a more permanent change, refer to step 8 above.

- Click **OK**.
- When you are ready to upload the changes into the GPS 15xH/15xL, select **Config > Send Configuration to GPS** (or press the F9 key). The new configuration is then loaded into the GPS 15xH/15xL.



- You may disconnect and close the software when finished. The software configuration can also be saved for future reference.

Refer to [Appendix F: Sensor Configuration Software](#) for complete information about downloading the Sensor Configuration Software application.

## APPENDIX F: SENSOR CONFIGURATION SOFTWARE

The Garmin Sensor Configuration Software (SNSRXCFG.exe) configures the GPS sensors based on user-selected parameters. Some application features include the ability to download GPS sensor configuration, maintain different configurations in files, and perform GPS sensor configurations quickly with the use of one function key.

This section provides a brief overview of the Sensor Configuration Software. Refer to this section when using the software to configure your Garmin sensor.

### Downloading the Sensor Configuration Software

The SNSRXCFG software is available from the Garmin website. To download the software, go to [https://www8.garmin.com/support/download\\_details.jsp?id=4053](https://www8.garmin.com/support/download_details.jsp?id=4053), and click **Download**.

### Selecting a Model

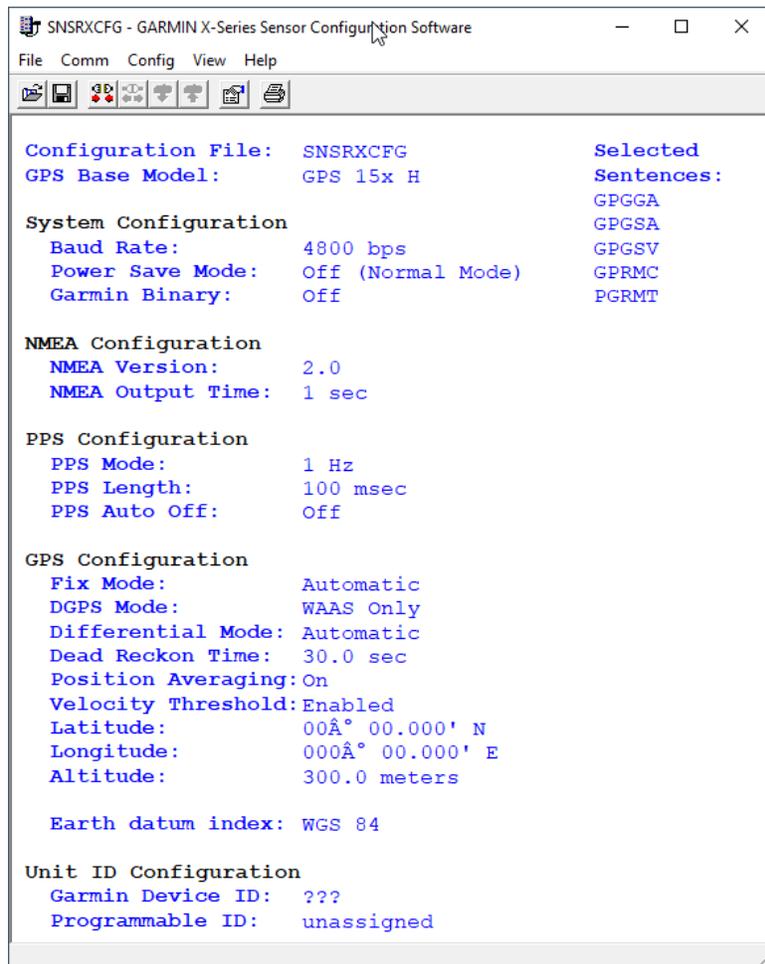
1. Double-click **SNSRXCFG.exe**.
2. Select the radio button next to the type of Garmin sensor you are configuring.
3. Select **OK**.

### Connecting to the Sensor

After selecting the type of sensor, the following window opens. This is the main window for the program.

To configure your sensor, you must first connect to the sensor.

12. Select **Config > Switch to NMEA Mode** (or press the F10 key).
13. Select **Comm > Setup** to open the Comm Setup window.
14. Select the serial port to which the sensor is connected: select **Auto** to have the program automatically determine the baud rate, or select **Manual** to manually select the baud rate.
15. Click **OK**.
16. Click the **Connect** icon , or select **Comm > Connect**.
17. To view the current programming of the sensor, select **Config > Get Configuration from GPS** (or press the F8 key). The current programming of the sensor appears as shown in the example to the right.



## Menus

### File Menu

The File Menu allows you to open, save, and print sensor configurations. The items in the File Menu work like most Windows-based programs.

### Comm Menu

The Comm (Communication) Menu allows you to set the port number and baud rate, as well as connect to the sensor and disconnect from the sensor.

**Setup:** Opens the Comm Setup window. Select the serial port to which the sensor is connected from the drop-down list. Select **Auto** (the program determines the baud rate on its own) or **Manual** (you enter the baud rate) for the baud rate entry.

**Connect:** Select **Connect** to connect to the sensor in order to change or view the configuration.

**Disconnect:** Select **Disconnect** to disconnect from the sensor.

### Config Menu

The Config (Configuration) Menu allows you to configure the sensor as it is connected.

**Sensor Configuration (F6):** Opens the Sensor Configuration window, shown to the right. Many of the fields in this window should not be changed. Refer to the beginning of this manual for information on many of these fields. This window is used to enter a new latitude, longitude, and altitude for the sensor. This is especially helpful when you are programming the sensor for use in a particular geographic location.

Click **Reset Unit** to perform a reset on the unit, much like cycling the power.

Resetting the non-volatile memory (**Reset NonVol**) clears all of the data from the non-volatile memory.

**NMEA Sentence Selections (F7):** Displays the NMEA Sentence Selections window. If the sentence is enabled, a check mark appears in the box to the left of the sentence name. Click the box to enable or disable to the sentence.

**Get Configuration From GPS (F8):** Retrieves the current programming from the sensor. The programming is then displayed in the Main Interface window.

**Send Configuration To GPS (F9):** Sends your updated configuration programming to the sensor.

**Switch to NMEA Mode (F10):** Switches the unit to NMEA Mode. The sensor must be in NMEA Mode when connected to this software.

**Switch to Garmin Mode (F11):** Switches the unit to Garmin Mode.

The screenshot shows the 'Sensor Configuration' dialog box with the following sections and settings:

- System Configuration:** Baud Rate: 4800; Power Save Mode: ; Garmin Binary Output: . Note: Selecting "Garmin Binary Output" will disable NMEA output. The device will instead output data in Garmin Binary format.
- NMEA Configuration:** NMEA: 2.0; NMEA Output Time: 1; Talker ID: GP.
- Pulse-Per-Second (PPS) Configuration:** Enable Pulse Per Second: ; PPS Auto Off Mode: ; PPS Length: 100.
- GPS Configuration:** Fix Mode: Automatic; DGPS Mode: WAAS Only; Diff Mode: Automatic; Low Velocity Threshold: Enable; Dead Reckon Valid Time: 30 sec.; Position Averaging: ; Earth Datum: WGS 84; Latitude: 0° 0' 0" N; Longitude: 0° 0' 0" E; Altitude: 300 meter; Update Rate: 1; Dynamics Mode: LOW.
- GNSS Source:** GPS: ; GLONASS: ; BDS: ; GALILEO: .
- Configuration Profile:** Accessory-ON resistor:  Installed  NOT Installed.
- Output Mode:** GPS17x compatible: .
- Commands:** Reset Unit, Reset NonVol, Set Autolocate, Test Mode.
- Buttons:** OK, Cancel.

**Update Software (F12):** After you have downloaded a new software version for the sensor, you can update the sensor with the new software. Select **Update Software** and then select the file using the Open dialog box. You must locate both the .rgn file and the updater.exe file.

**View Menu**

The View Menu allows you to view the NMEA sentences transmitted by the sensor. You can also customize how the program looks by showing and hiding the Toolbar and Status Bar.

**Help Menu**

The Help Menu displays the software version and copyright information.