



GPS 35/36 TracPak™

GPS SMART ANTENNA

TECHNICAL SPECIFICATION

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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 35/36 is a precision electronic NAVigation AID (NAVAID), any NAVAID can be misused or misinterpreted, and therefore become unsafe. Use the GPS 35/36 at your own risk. To reduce the risk, carefully review and understand all aspects of this Technical Manual before using the GPS 35/36. When in actual use, carefully compare indications from the GPS 35/36 to all available navigation sources including the information from other NAVAIDs, visual sightings, charts, etc. For safety, always resolve any discrepancies before continuing navigation.

NOTE

This device has been tested and found to comply with the limits for a Class B digital device, pursuant to 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 device 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 device does cause harmful interference to radio or television reception, which can be determined by turning the device off and on, you are 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 this device and the receiver.

- Connect this device to an outlet on a different circuit than that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This device contains no user-serviceable parts. Repairs should only be performed by an authorized GARMIN service center. Unauthorized repairs or modifications to this device could void your warranty and your authority to operate this device under Part 15 regulations.

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SECTION 1

INTRODUCTION

1.1 OVERVIEW

The GARMIN GPS 35/36 is a complete GPS receiver, including an embedded antenna, designed for a broad spectrum of OEM (Original Equipment Manufacturer) system applications. Based on the proven technology found in other GARMIN 12 channel GPS receivers, the GPS 35/36 will track up to 12 satellites at a time while providing fast time-to-first-fix, one second navigation updates and low power consumption. Its far reaching capability meets the sensitivity requirements of land navigation as well as the dynamics requirements of high performance aircraft.

The GPS 35/36 design utilizes 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 35/36. This hardware capability combined with software intelligence makes the GPS 35/36 easy to integrate and use.

The GPS 35/36 is designed to withstand rugged operating conditions and is completely water resistant. The GPS 35/36 is a complete GPS receiver that requires minimal additional components be supplied by an OEM or system integrator. A minimum system must provide the GPS 35/36 with a source of power and a clear view of the GPS satellites. The system may communicate with the GPS 35/36 via a choice of two RS-232 compatible full duplex communication channels. Internal memory backup allows the GPS 35/36 to retain critical data such as satellite orbital

parameters, last position, date and time. End user interfaces such as keyboards and displays are added by the application designer.

1.2 FEATURES

The GPS 35/36 provides a host of features that make it easy to integrate and use.

- 1) Full navigation accuracy provided by Standard Positioning Service (SPS)
- 2) Compact design ideal for applications with minimal space
- 3) High performance receiver tracks up to 12 satellites while providing fast first fix and low power consumption
- 4) Differential capability utilizes real-time RTCM corrections producing 3-10 meter position accuracy
- 5) Internal clock and memory are sustained by a memory backup battery or optional external standby power
- 6) User initialization is not required
- 7) Navigation mode (2D or 3D) may be configured by the user
- 8) Two communication channels and user selectable baud rates allow maximum interface capability and flexibility

1.3 TECHNICAL SPECIFICATIONS

Specifications are subject to change without notice.

1.3.1 Physical Characteristics

- 1) Single construction integrated antenna/receiver.
- 2) Weight: 4.4 oz, (124.5 g), not including cable
- 3) Size: 2.230" (w) x 3.796" (l) x 1.047" (h), (56.64 mm

x 96.42 mm x 26.60 mm)

1.3.2 Environmental Characteristics

- 1) Operating temperature: -30°C to +85°C (internal temperature)
- 2) Storage temperature: -40°C to +90°C

1.3.3 Electrical Characteristics

- 1) Input voltage: 10 to 30 VDC, unregulated.
- 2) Typically draws 150 mA @ 12 VDC
- 3) Backup power: Internal 3V Lithium coin cell battery, up to 10 year life

1.3.4 Performance

- 1) Tracks up to 12 satellites
- 2) Update rate: 1 second
- 3) Acquisition time
 - 15 seconds warm (all data known)
 - 45 seconds cold (initial position, time and almanac known, ephemeris unknown)
 - 5.0 minutes AutoLocate™ (almanac known, initial position and time unknown)
 - 5 minutes search the sky (no data known)
- 4) Position accuracy:
 - Differential GPS (DGPS): 5 meters RMS
 - Non-differential GPS: 15 meters RMS (100 meters with Selective Availability on)
- 5) Velocity accuracy: 0.2 m/s RMS steady state (subject to Selective Availability)
- 6) Dynamics: 999 knots velocity, 6g dynamics

1.3.5 Interfaces

- 1) Dual channel RS-232 compatible with user selectable baud rate (1200, 2400, 4800, 9600)
- 2) NMEA 0183 Version 2.0 ASCII output (GPALM, GPGGA, GPGSA, GPGSV, GPRMC, GPVTG, PGRME, PGRMT, PGRMV, PGRMF, LCGLL, LCVTG)

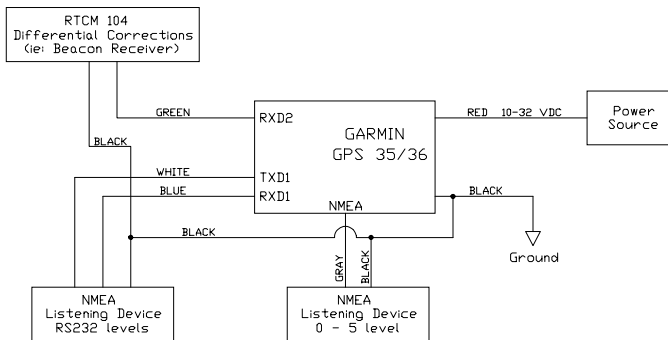
Inputs

- Initial position, date and time (not required)
- Earth datum and differential mode configuration command, almanac.

Outputs

- Position, velocity and time
 - Receiver and satellite status
 - Differential Reference Station ID and RTCM Data age
 - Geometry and error estimates
- 3) Real-time Differential Correction input (RTCM format)

1.4 APPLICATION



TYPICAL APPLICATION ARCHITECTURE

SECTION 2

OPERATIONAL CHARACTERISTICS

This section describes the basic operational characteristics of the GPS 35/36. Additional information regarding input and output specifications are contained in Section 4.

2.1 SELF TEST

After input power has been applied to the GPS 35/36 and periodically thereafter, the unit will perform critical self test functions and report the results over the output channel(s). The following tests will be performed:

- 1) RAM check
- 2) ROM test
- 3) Receiver test
- 4) Real-time clock test
- 5) Oscillator check

In addition to the results of the above tests, the GPS 35/36 will report software version information.

2.2 INITIALIZATION

After the initial self test is complete, the GPS 35/36 will begin the process of satellite acquisition and tracking. The acquisition process is fully automatic and, under normal circumstances, will take approximately 45 seconds to achieve a position fix (15 seconds if ephemeris data is known). After a position fix has been calculated, valid position, velocity and time information will be transmitted over the output channel(s).

Like all GPS receivers, the GPS 35/36 utilizes initial data such as last stored position, date and time as well as satellite orbital data to achieve maximum acquisition performance. If significant inaccuracy exists in the initial data, or if the orbital data is obsolete, it may take 5.0 minutes to achieve a navigation solution. The GPS 35/36 Autolocate™ feature is capable of automatically determining a navigation solution without intervention from the host system. However, acquisition performance can be improved if the host system initializes the GPS 35/36 following the occurrence of one or more of the following events:

- 1) Transportation over distances further than 1500 kilometers
- 2) Failure of the internal memory battery without system standby power
- 3) Stored date/time off by more than 30 minutes

See Section 4 for more information on initializing the GPS 35/36.

2.3 NAVIGATION

After the acquisition process is complete, the GPS 35/36 will begin sending valid navigation information over its output channels. These data include:

- 1) Latitude/longitude/altitude
- 2) Velocity
- 3) Date/time
- 4) Error estimates
- 5) Satellite and receiver status

Normally the GPS 35/36 will select the optimal navigation mode (2D or 3D) based on available satellites and geometry considerations. The host system, at its option, may

command the GPS 35/36 to choose a specific mode of navigation, such as 2D. The following modes are available:

- 1) 2D exclusively with altitude supplied by the host system (altitude hold mode)
- 2) 3D exclusively with altitude computed by the GPS 35/36
- 3) Automatic mode in which the board set determines the desired mode based on satellite availability and geometry considerations

When navigating in the 2D mode (either exclusive or automatic), the GPS 35/36 utilizes the last computed altitude or the last altitude supplied by the host system, whichever is newer. The host system must ensure that the altitude used for 2D navigation is accurate since the resulting position error may be as large as the altitude error. See Section 4 for more information on altitude control.

The GPS 35/36 will default to automatic differential corrections, attempting to apply them to the satellite data, in order to produce a differential (DGPS) solution. The host system, at its option, may also command the GPS 35/36 to choose differential only mode. When navigating in the differential only mode, the GPS 35/36 will output a position only when a differential solution is available.

2.4 SATELLITE DATA COLLECTION

The GPS 35/36 will automatically update satellite orbital data as it operates. The intelligence of the GPS 35/36 combined with its hardware capability allows these data to be collected and stored without intervention from the host system. A few key points should be considered regarding this process:

- 1) If the GPS 35/36 is not operated for a period of six (6) months or more, the unit will “search the sky” in order to collect satellite orbital information. This process is

fully automatic and, under normal circumstances, will take about 5 minutes to achieve a navigation solution. However, the host system should allow the GPS 35/36 to remain on for at least 12.5 minutes after the first satellite is acquired (see Section 4 for more information on status indications).

- 2) If the internal memory backup battery fails or is not installed while the host system power is off and not connected to standby power, the GPS 35/36 will search the sky as described above. The system designer should be aware of the availability of standby power input to the GPS 35/36 to prevent this situation.
- 3) If the initial data is significantly inaccurate, the GPS 35/36 will perform an operation known as AutoLocate™. This procedure is fully automatic and, under normal circumstances, will require about 5 minutes to calculate a navigation solution. AutoLocate™, unlike search the sky, does not require that the GPS 35/36 continue to operate after a fix has been obtained.

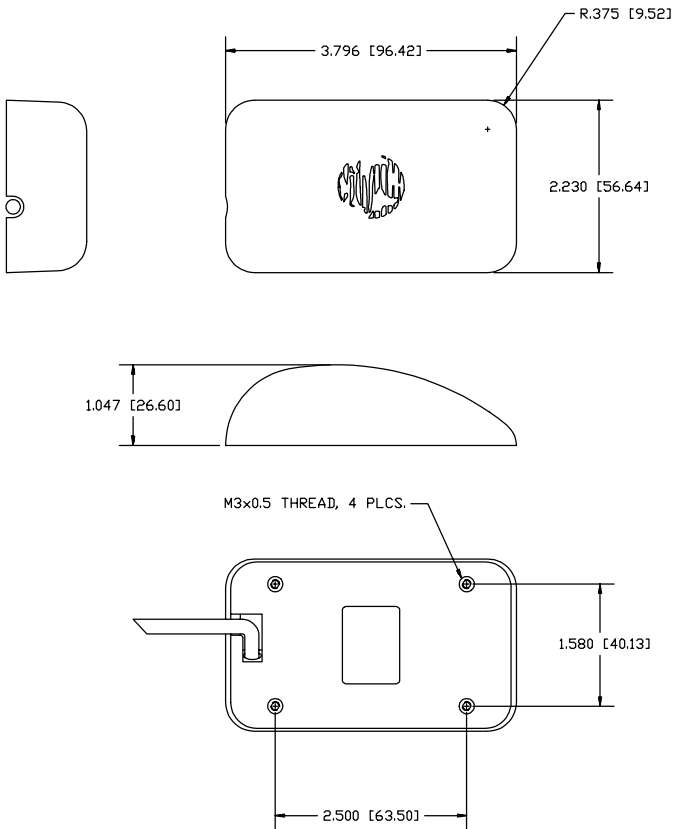
SECTION 3

HARDWARE INTERFACE

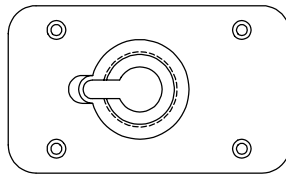
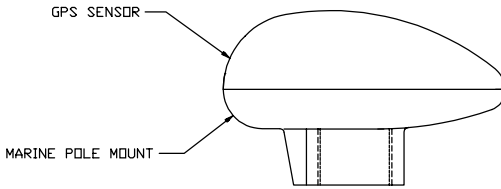
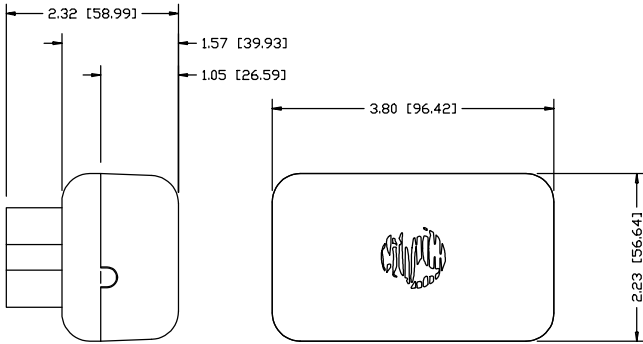
3.1 MECHANICAL DIMENSIONS

The GPS 35 is a complete GPS receiver including antenna in a uniquely styled waterproof package.

3.1.1 GPS 35 Dimensions



3.1.2 GPS 36 Dimensions

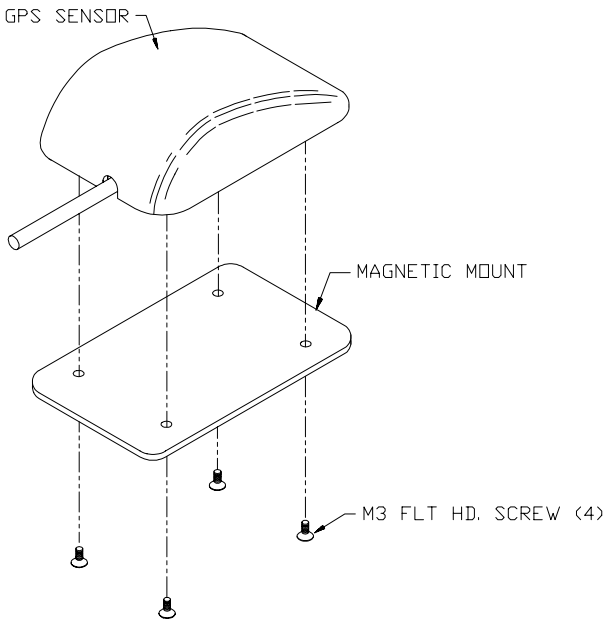


3.2 MOUNTING CONFIGURATIONS AND OPTIONS

The following mounting options are available for the GPS 35. Mounting is user configurable.

3.2.1 Magnetic Mount

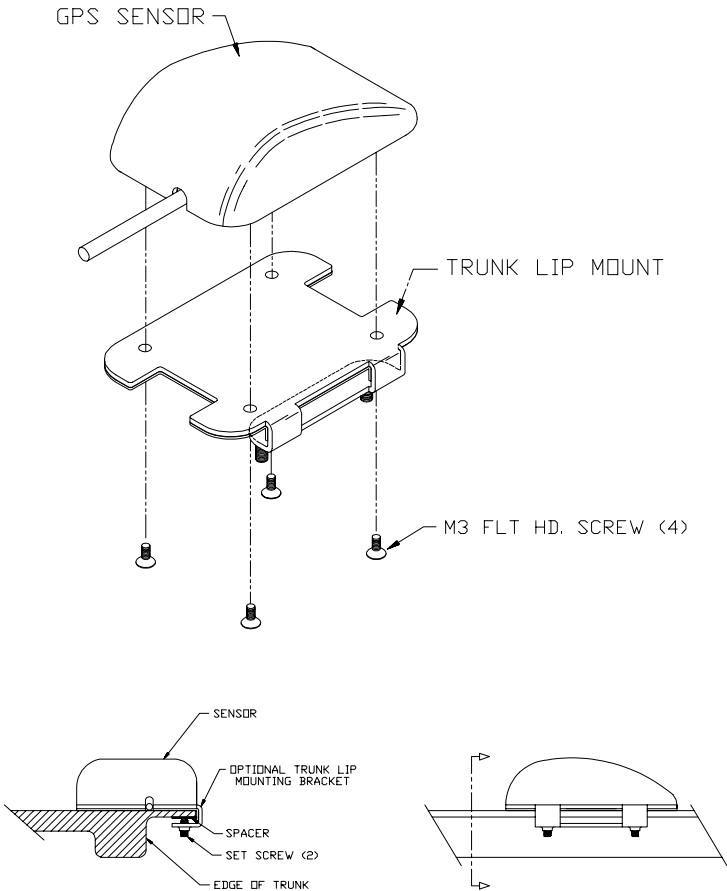
The magnetic mount provides a firm, removable mounting attachment to any ferrous metal surface.



GPS 35 ONLY

3.2.2 Trunk Lip Mount

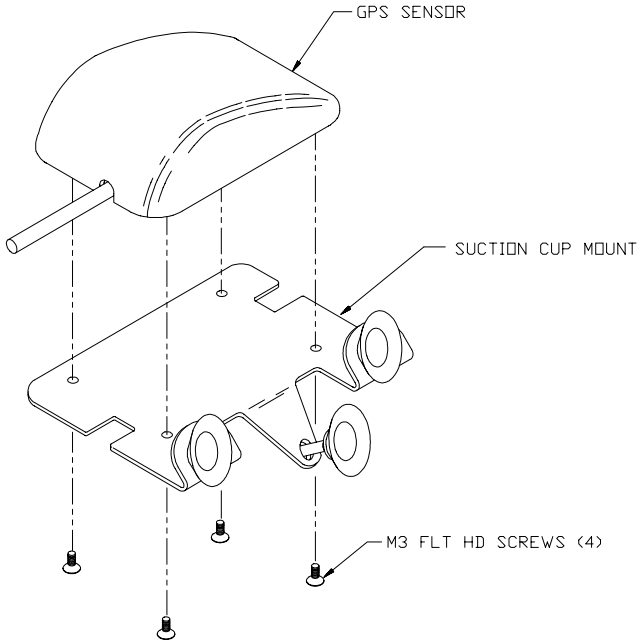
The trunk lip mount provides a semi-permanent attachment to the trunk lip of most automobiles.



GPS 35 ONLY

3.2.3 Suction Cup Mount

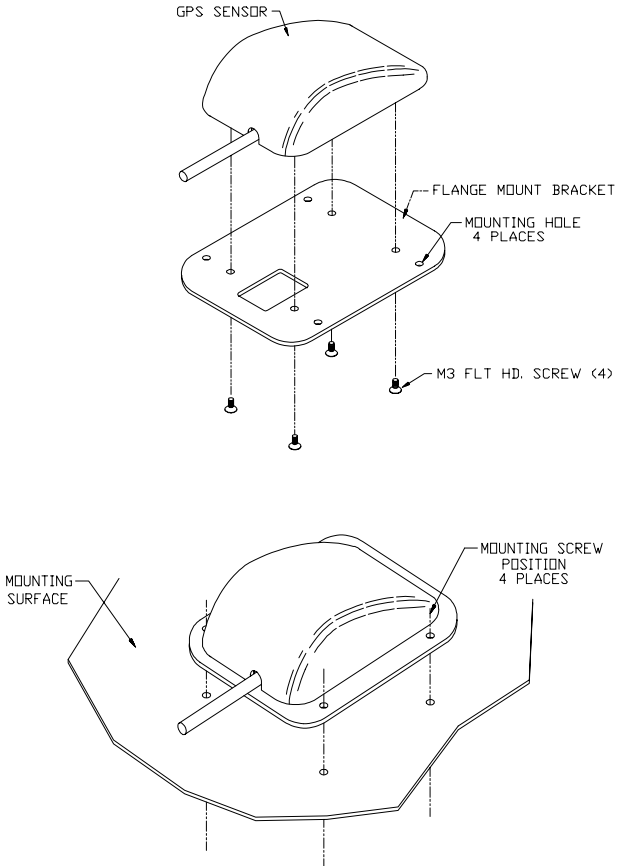
The suction cup bracket provides a removable mounting surface attached to the inside of a vehicle's windshield.



GPS 35 ONLY

3.2.4 Flange Mount

The flange mount allows for a permanent installation on a flat surface. This mounting configuration is ideal in applications in which the far side of the mounting surface is inaccessible.



GPS 35 ONLY

3.3 CONNECTION WIRING DESCRIPTION

The GPS 35/36 features a stripped and pre-tinned cable assembly for the greatest connection flexibility. The following is a functional description of each wire in the cable assembly.

- Red: VIN - Unregulated 10 - 30VDC 200 mA (maximum). Typical operating current is 150 mA.
- Black: GND - Power and Signal Ground
- White: TXD1 - First Serial Asynchronous Output. RS-232 compatible electrical specification. This output normally provides serial data which is formatted per "*NMEA 0183, Version 2.0*". Switchable to 1200, 2400, 4800 and 9600 BAUD. This output functions in parallel with the NMEA output.
- Blue: RXD1 - First Serial Asynchronous input. RS-232 compatible with maximum input voltage range $-25 < V < 25$. This input may be used to receive serial initialization/configuration data, as specified in Section 4.1.
- Purple: TXD2 - Second Serial Asynchronous Output. Electrically identical to TXD1.
- Green: RXD2 - Second Serial Asynchronous Input. Electrically identical to RXD1. This input may be used to receive serial differential GPS data formatted per "*RTCM Recommended Standards For Differential Navstar GPS Service, Version 2.0*" (see Section 4 for more details).
- Gray: NMEA-NMEA0183, Version 1.5 electrical specification compatible serial output. This output is also CMOS compatible with

a no load voltage swing of 0.2Vdc to 4.8Vdc. This output normally provides ASCII sentences formatted per "NMEA 0183, Version 2.0". User selectable baud rates of 1200, 2400, 4800, and 9600 are available. The data output on this pin is identical to the data output on TXD1.

Yellow: VAUX - Optional External Backup Power Connection. This is an optional connection. Internal battery capacity is 180 mA hour. Typical current requirement is 65 μ A @ 5VDC. If used, a 4VDC to 30 VDC power source is required.

SECTION 4

SOFTWARE INTERFACE

The GPS 35/36 interface protocol design is based on the National Marine Electronics Association's NMEA 0183 ASCII interface specification, which is fully defined in "NMEA 0183, Version 2.0" (copies may be obtained from NMEA, P.O. Box 50040, Mobile, AL, 36605, U.S.A.) and the Radio Technical Commission for Maritime Services' "RTCM Recommended Standards For Differential Navstar GPS Service, Version 2.0, RTCM Special Committee No. 104" (copies may be obtained from RTCM, P.O. Box 19087, Washington, D.C., 20036, U.S.A.). The GPS 35/36 interface protocol, in addition to transmitting navigation information as defined by NMEA 0183, transmits additional information using the convention of GARMIN proprietary sentences.

The following sections describe the data format of each sentence transmitted and received by the GPS 35/36. The baud rate selection and RTCM differential GPS input are also described.

4.1 NMEA RECEIVED SENTENCES

The subsequent paragraphs define the sentences which can be received on RXD1 by the GPS 35/36. These sentences are echoed upon receipt to provide handshaking that the appropriate information was received by the GPS 35/36.

hh = 1 byte checksum

4.1.1 Almanac Information (ALM)

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

The \$GPALM sentence can be used to initialize the sensor board's stored almanac information if battery back-up has failed.

- <1> Total number of ALM sentences to be transmitted by the sensor board during almanac download. This field can be null or any number when sending almanac to the sensor board.
- <2> Number of current ALM sentence. This field can be null or any number when sending almanac to the sensor board.
- <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> afo clock parameter
- <15> af1 clock parameter

4.1.2 Initialization Information (\$PGRMI GARMIN proprietary format)

The \$PGRMI sentence provides information used to initialize the GPS 35/36 set position and time used for satellite acquisition. Receipt of this sentence by the GPS 35/36 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 can also be obtained by sending \$PGRMIE, to the board.

\$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> Acquisition Reset, A = begin autolocate, R = restart acquisition

4.1.3 Configuration Information (\$PGRMC GARMIN proprietary format)

The \$PGRMC sentence provides information used to configure the GPS 35/36 operation. Configuration parameters are stored in non-volatile memory and retained between power cycles. The GPS 35/36 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 board.

\$PGRMC,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9><10>,<11>
*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, 6360000.0 to 6380000.0 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 Baud Rate, 1 = 1200, 2 = 2400, 3 = 4800, 4 = 9600
- <11> Velocity filter, 1 = Automatic filter, 2-255 = Filter time constant (10 = 10 second filter)
- <12> Not used. Null field

All configuration changes take effect after receipt of a valid value except baud rate which takes effect on the next power cycle or external reset event. Null fields in the configuration sentence indicate not change in the particular configuration parameter.

4.1.4 Output Sentence Enable/Disable (\$PGRMO GARMIN proprietary format)

The \$PGRMO sentence provides the ability to enable and disable specific output sentences.

The following sentences are enabled at the factory: GPGSA, GPGSV, GPRMC, PGRME, PGRMT and PGRMV.

\$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
 - 3 = enable all output sentences (except GPALM)

The following notes apply to the PGRMO input sentence:

- 1) If the target sentence mode is '2' (disable all) or '3' (enable all), 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 being output by the GPS 35/36.
- 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,GPLAM,1 will cause the sensor board to transmit all stored almanac information. All other NMEA sentence transmission will be temporarily suspended.

4.2 NMEA TRANSMITTED SENTENCES

The subsequent paragraphs define the sentences which can be transmitted on TXD1 by the GPS 35/36.

4.2.1 Sentence Transmission Rate

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

The GPS 35/36 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 35/36 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:

$$\text{Length of transmission} = \frac{\text{total characters to be transmitted}}{\text{characters transmitted per sec}}$$

Baud	characters_transmitted_per_sec
1200	120
2400	240
4800	480
9600	960
Sentence	max_characters
GPGGA	72
GPGSA	73
GPGSV	210
GPRMC	70
GPVTG	34
PGRME	36
PGRMT	47
PGRMV	26
PGRMF	79
LCGLL	36
LCVTG	34

The factory set defaults will result in a once per second transmission at the NMEA specification transmission rate of 4800 baud.

4.2.2 Transmitted Time

The GPS 35/36 outputs UTC (Coordinated Universal Time) date and time of day in the transmitted sentences. Prior to the initial position fix, the date and time of day are provided by the on-board clock. After the initial position fix, the date and time of day are calculated using GPS satellite information.

The GPS 35/36 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 35/36 would have transmitted this information for the leap second added December 31, 1989 as follows:

<u>Date</u>	<u>Time</u>
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 35/36 will not transmit the time of day 23h 59m 59s for the day from which the leap second is removed.

4.2.3 Global Positioning System Almanac Data (ALM)

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

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

<field information> can be found in section 4.1.1.

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 (DGPS) fix available
- <7> Number of satellites in use, 00 to 12 (leading zeros will be transmitted)
- <8> Horizontal dilution of precision, 1.0 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-SC104) data age, number of seconds since last valid RTCM transmission (null if non-DGPS)
- <12> Differential Reference Station ID, 0000 to 1023 (leading zeros will be transmitted, null if non-DGPS)

4.2.5 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, 1.0 to 99.9

- <5> Horizontal dilution of precision, 1.0 to 99.9
- <6> Vertical dilution of precision, 1.0 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, 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 sentences. These fields will be null if unused.

4.2.7 Recommended Minimum Specific GPS/TRANSIT Data (RMC)

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

- <1> UTC time of position fix, hhmmss format
- <2> Status, A = Valid position, V = NAV receiver warning
- <3> Latitude, ddm. mmm format (leading zeros will be transmitted)
- <4> Latitude hemisphere, N or S
- <5> Longitude, dddmm. mmm format (leading zeros will be transmitted)

- <6> Longitude hemisphere, E or W
- <7> Speed over ground, 0.0 to 999.9 knots
- <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)

4.2.8 Track Made Good and Ground Speed with GPS Talker ID (GPVTG)

The GPVTG sentence reports track and velocity information with a checksum:

\$GPVTG,<1>,T,<2>,M,<3>,N,<4>,K*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, 00.0 to 99.9 knots (leading zeros will be transmitted)
- <4> Speed over ground, 00.0 to 99.9 kilometers per hour (leading zeros will be transmitted)

4.2.9 Geographic Position with LORAN Talker ID (LCGLL)

The LCGLL sentence reports position information.

\$LCGLL,<1>,<2>,<3>,<4>,<5>,<CR><LF>

- <1> Latitude, ddm.mmm format (leading zeros will be transmitted)
- <2> Latitude hemisphere, N or S
- <3> Longitude, dddmm.mmm format (leading zeros will be transmitted)
- <4> Longitude hemisphere, E or W
- <5> UTC time of position fix, hhmmss format

4.2.10 Track Made Good and Ground Speed with LORAN Talker ID (LCVTG)

The LCVTG sentence reports track and velocity information.

\$LCVTG,<1>,T,<2>,M,<3>,N,<4>,K<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, 00.0 to 99.9 knots (leading zeros will be transmitted)
- <4> Speed over ground, 00.0 to 99.9 kilometers per hour (leading zeros will be transmitted)

4.2.11 Estimated Error Information (\$PGRME GARMIN proprietary format)

The \$PGRME sentence reports estimated position error information.

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

- <1> Estimated horizontal position error (HPE), 0.0 to 9999.9 meters
- <2> Estimated vertical position error (VPE), 0.0 to 9999.9 meters
- <3> Estimated position error (EPE), 0.0 to 9999.9 meters

4.2.12 GPS Fix Data Sentence (\$PGRMF GARMIN proprietary format)

\$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, ddm.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 999 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)

4.2.13 Sensor Status Information (\$PGRMT GARMIN proprietary format)

The \$PGRMT sentence gives information concerning the status of the GPS 35/36. This sentence is transmitted once per minute regardless of the selected baud rate.

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

- <1> Product, model and software version, this is a variable length field. (NOTE: Since the GPS 35/36 utilizes a GPS 25 sensor board, the GPS 25 model description will appear in this field.)
- <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 almanac, null if almanac is current
- <8> Unit temperature in degrees C
- <9> Board configuration data, R = retained, L = lost

4.2.14 3D velocity information (\$PGRMV GARMIN proprietary format)

The \$PGRMV sentence reports three-dimensional velocity information.

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

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

4.3 BAUD RATE SELECTION

Baud rate selection can be performed by sending the appropriate configuration sentence to the GPS 35/36 as described in the NMEA Received Sentences Section, sentence \$PGRMC.

4.4 RTCM RECEIVED DATA

Position accuracy of 3-10 meters can be achieved with the GPS 35/36 by using Differential GPS (DGPS) real-time pseudo-range correction data in RTCM SC-104 format. These corrections can be received by the GPS 35/36 on RXD2. Correction data at speeds of 300, 600, 1200, 2400, 4800 or 9600 baud can be utilized, as the GPS 35/36 automatically detects the incoming baud rate. For details on the SC-104 format, refer to *RTCM Paper 134-89/SC 104-68* by the Radio Technical Commission for Maritime Services.

APPENDIX A

EARTH DATUMS

The following is a list of the GARMIN GPS 35/36 earth datum indexes 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

GPS 35/36 Rev. 2.08 or later:

- 105 Austria
- 106 Potsdam
- 107 Taiwan (modified Hu-Tzu-Shan)



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