

DGPS 53

*integrated
GPS/DGPS receiver*

owner's
manual
and
reference
guide



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To obtain warranty service, contact your GARMIN dealer or call the GARMIN Customer Service department (913-397-8200) for a returned merchandise tracking number. The unit should be securely packaged with the tracking number clearly marked on the outside of the package and sent freight prepaid and insured to a GARMIN warranty service station. A copy of the original sales receipt is required as the proof of purchase for warranty repairs. GARMIN retains the exclusive right to repair or replace the unit or software or offer a full refund of the purchase price at its sole discretion. SUCH REMEDY SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.

Limited Warranty



The GARMIN DGPS 53 has no user-serviceable parts. Should you ever encounter a problem with your receiver, please contact your GARMIN dealer or the GARMIN Customer Service department (913-397-8200 or 800-800-1020) for repairs. Any attempt to open the case to change or modify the unit in any way will void your warranty and may result in permanent damage to the equipment.

Cautions

All differential beacon receivers decode correction data determined at the beacon transmitter site via a GPS receiver(s). The GPS system is operated by the government of the United States which is solely responsible for their accuracy and maintenance. The DGPS beacon transmitters are operated by the U.S. Coast Guard (or similar government agency in other countries) which is responsible for their accuracy and maintenance. The Global Positioning System and the Differential Global Positioning System are under development and are subject to changes which could affect accuracy and performance of all GPS/DGPS equipment. Although a GPS/DGPS system is a precision electronic NAVigation AID (NAVAID), any NAVAID can be misused or misinterpreted, and therefore become unsafe. Use the GPS/DGPS system at your own risk. To reduce this risk, carefully review and understand all aspects of this Owner's Manual and carefully compare indications from your display 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 complies with Part 15 of the FCC rules. Operation of this device is subject to the following conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

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Product Registration



Why should you register your GARMIN GPS unit?

- Notification of Product Updates
- Notification of New Products
- Lost or Stolen unit tracking

Customer Service Product Registration

Help us better support you by completing our on-line registration today! Have the serial number of your DGPS 53 handy and connect to our website (www.garmin.com). Look for the Product Registration link on the Home page.

If you have previously registered a GARMIN product purchase using a mail-in registration card, we invite you to reregister using our NEW on-line system. Many services provided by our new product registration system are now being automated and reregistering your purchase ensures you the best possible support from GARMIN.

Serial Number

Use this area to record the serial number (8-digit number located on the bottom of the unit) in case it is lost, stolen, or needs service. Be sure to keep your original sales receipt in a safe place or attach a photocopy inside the manual.

Serial Number:

* *



The GARMIN DGPS 53 has no user-serviceable parts. Should you ever encounter a problem with your unit, please contact your GARMIN dealer or GARMIN Customer Service (913-397-8200 or 800-800-1020) for repairs.

Repairs should only be made by an authorized GARMIN service center. Unauthorized repairs or modifications could void your warranty and authority to operate this device under FCC Part 15 regulations. See page 1 of this manual for further service details.

Capabilities

The DGPS 53 offers a host of powerful capabilities for enhanced performance and accuracy:

- **Performance**— 12-channel GPS receiver tracks and uses up to 12 satellites for fast, accurate positioning. Single channel DGPS receiver has high-sensitivity automatic and manual tuning throughout the beacon broadcast band.
- **Ease of Use**— Once installed, unit will automatically transmit navigation data.
- **Convenience**— May be remotely mounted in an out-of-the-way location. Receiver status information is displayed directly on the chartplotter or PC.
- **Low Power Consumption**— Draws approximately 170 milliamps during normal operation.
- **Accuracy**— 1-5 (2DRMS) meters (typical).

Package Contents

Your GARMIN DGPS 53 package includes:

- DGPS 53 unit
- 30' Power/Data Cable
- Owner's Manual & Reference Guide
- Beacon Reference Card

If any parts are missing or damaged, please contact your GARMIN dealer immediately.

Capabilities & Package Contents

Mounting the DGPS 53



Note: As a general rule, mount the receiver at least three feet from all other antennas and the vessel's electrical system components (alternator/ignition system).

Mounting the Receiver

Please read through these instructions thoroughly before attempting installation. Make sure you completely understand these instructions before you begin. When in doubt, seek professional assistance.

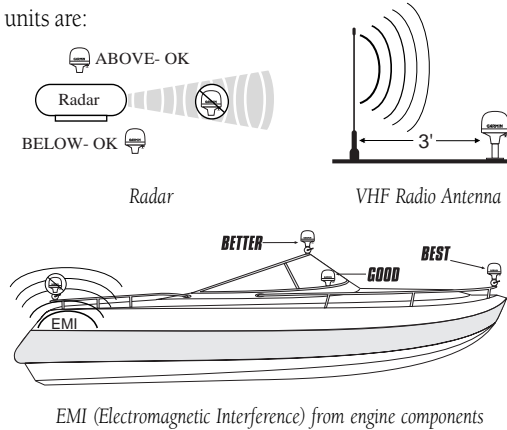
The following additional items are needed or optional to complete the installation of your DGPS 53:

- **Antenna mount**— Since antenna mounting locations and methods vary, you will need to obtain an antenna mount to install the DGPS 53. The receiver base fits a standard 1-inch, 14 threads-per-inch mount. Check with your GARMIN dealer or a marine supply retailer for this item.
- **On/Off switch (optional)**— Power to the receiver may be controlled by an on/off switch, such as an accessory switch on the control console. Check with your GARMIN dealer or a marine/electric supply retailer for this item.
- **GARMIN 60' Power/Data Cable**— for cable installation lengths greater than 30'. Part number 010-10284-00

It is recommended that the system be temporarily hooked up with the wiring and the unit placed at the desired installation location. Then, check operation with potential interfering equipment turned on and off. (For example, other electronic equipment, fan motors, engine ignition, alternators, generators, radars and VHF radio transmissions can be sources of interference.)

Position the receiver so that the clearest possible view of the sky and horizon in all directions is obtained. Avoid mounting the antenna next to large areas of conductive material (metal, aluminum, etc.) as this may cause poor signal reception. The DGPS 53 is supplied with a 30 feet power/data cable. When routing the wiring to the DGPS 53, avoid routing the cable near the vessel's alternator or ignition system components or parallel to other power lines.

Three common sources of interference for DGPS units are:



If a problem is found, try altering the location of the unit or wiring. Often moving the antenna a few feet away from the source of interference will solve the problem. When a suitable configuration is found, a permanent installation should be made. Select the mounting location according to your preferences. Keep in mind that from this mounting location cables will be routed to the antenna and to the GPS unit.

1. Once a suitable mounting location has been determined and tested, secure the antenna mount at the desired mounting location.
2. Make sure the DGPS 53 is aligned properly to avoid thread damage. Thread the DGPS 53 onto the antenna mount and hand tighten clockwise until snug (Fig. 1). Do not overtighten.
3. Align the notches on the power/data cable and DGPS 53 connector and push the connector in until it seats. Turn the locking ring clockwise until the power/data cable is firmly locked into position.
4. Route the power/data cable from the DGPS 53 to the GPS unit. Excess cable may be shortened or coiled together and secured in an inconspicuous location. If additional cable is needed you may use GARMIN's optional 60' cable (010-10284-00) or similar 24 AWG shielded wiring. The entire length of the power/data cable should not exceed 150' (45.7m).

Mounting the Receiver



When routing the power/data cable, try to avoid:

- Sharp edges which may cut the cable
- Routing the cable parallel to other power lines
- Excessively twisting, straining or bending the cable

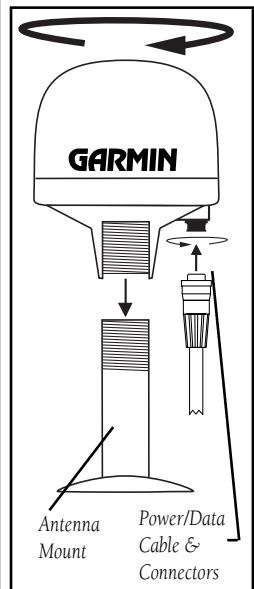
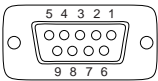


Figure 1: Mounting the DGPS 53

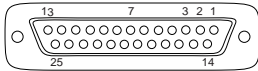
Connecting the DGPS 53



If the DGPS 53 is being connected to a PC, a DB9 or DB25 serial connector (normally female) will be needed. Check with a PC or electronics supplier for this item.



DB9 Female Serial Connector



DB25 Female Serial Connector



Some non-GARMIN devices may have a separate data line labeled "RETURN", "DATA GROUND" or "DATA -". If one of these lines exist, connect the BLACK wire from the power/data cable to it.

Connecting the DGPS 53

The final step in installing the DGPS 53 is to connect the receiver's DATA IN, DATA OUT, REMOTE ON/OFF and GROUND (Return) lines to your chartplotter or PC. The DGPS 53 is designed to transmit/receive data at 4800-19200 baud (bits per second), which is suitable for use with most devices and PCs.

For reliable communication, it is essential that the DGPS 53 and the receiving device share the same ground. This ground connection acts as the (current) Return line. It is recommended to wire the unit to it's own circuit to avoid interference from other electronics.

1. You may reference Figures 3 or 4 on the following page for the wiring: Connect the BLUE (Data Out) wire from the DGPS 53's power/data cable to the DATA INPUT line of the chartplotter or to pin 2 on the DB9 (pin 3 on DB25).
2. Connect the BROWN (Data In) wire to the DATA OUTPUT line of the chartplotter or pin 3 on the DB9 (pin 2 on DB25).
3. Connect the BLACK (-) wire to the GROUND wire of the chartplotter or pin 5 on the DB9 (pin 7 on DB25). If the BLACK wire is already connected to the same ground terminal as the GPS unit, no additional connection is required (unless a separate RETURN line is provided by the GPS unit).
4. Connect the RED (+) wire from the power/data cable to a 8-35 VDC power source.
5. If a remote power switch is being installed, reference Figure 5 for wiring the switch. This will allow the DGPS 53 to remain connected to a power source, but manually powered on and off. Otherwise, if the receiver is being wired to a circuit which is already switched, (with the chartplotter for example) connect the WHITE wire to the same place as the BLACK wire. When the BLACK and WHITE wires are combined, the DGPS 53 will turn on/off when power is applied/removed to the RED (+) and BLACK (-) wires.
6. If one-pulse-per-second (PPS) output is being used, connect the YELLOW (+) and BLACK (-) wires to your desired device inputs. See page 18 for more information on PPS.

Connecting the DGPS 53

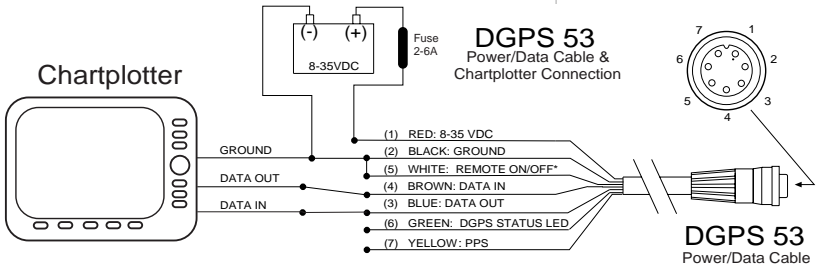


Figure 3: Wiring a Chartplotter To the DGPS 53

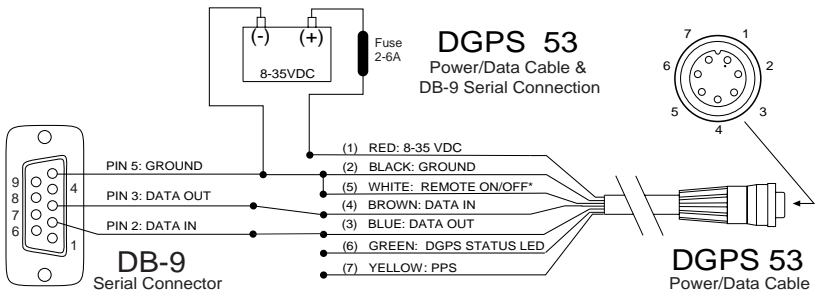


Figure 4: Wiring a DB9 Serial Connector To the DGPS 53

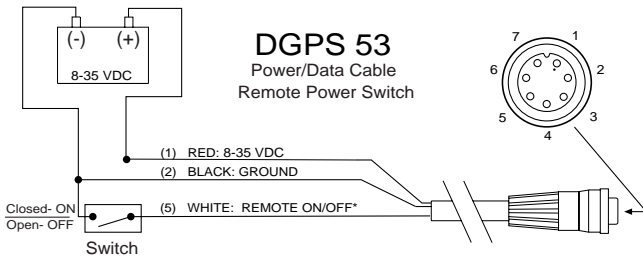


Figure 5: Wiring a Remote Power Switch For the DGPS 53

Using the DGPS 53

First Time Fix

Once the DGPS is installed and powered on, it will begin to search for satellites and a DGPS beacon signal. Initially, it may take longer than normal to scan through the DGPS beacon frequencies. The DGPS 53 will output corrected navigation data once it has calculated an initial position fix and successfully received a DGPS signal. The following data will be output in NMEA 0183, Version 2.0 format:

- Latitude/Longitude/Altitude
- Velocity
- Date/Time
- Error Estimates
- Satellite and Receiver Status
- DGPS Beacon Information

Auto-Tuning

Without external commands, the DGPS 53 will automatically scan frequencies between 283.5-325.0 kHz @ 0.5kHz steps for 100 and 200 bps stations only. To use 25 & 50 bps, you will need to manually tune the DGPS 53 (pg.13) via the chartplotter, PC or other compatible source. The DGPS 53 should tune into a DGPS station within about 10 minutes. The unit will store the last used frequency in non-volatile memory and default to that frequency on next use. If you lose DGPS signal, the unit will attempt to reconnect to the last frequency and if necessary, tune to another station.

Interfaces

The DGPS 53 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" and the Radio Technical Commission for Maritime Services "RTCM Recommended Standards For Differential Navstar GPS Service, Version 2.1, RTCM Special Committee No. 104". Contact information to obtain copies of these specifications may be found on page 24. The DGPS 53 interface protocol also transmits additional information using the convention of GARMIN proprietary sentences (\$PGxxx).

Using the DGPS 53

NMEA Received sentences:

GPALM
 PGRMI
 PGRMC
 PGRMO
 PSLIB

The following sections describe the NMEA data format of each sentence transmitted and received by the DGPS 53. The baud rate selection and one-pulse-per-second output interfaces are also described.

NMEA Received sentences

This section defines the sentences which can be received by the DGPS 53. Null fields in the configuration sentence indicate no change in the particular configuration parameter.

All sentences received by the DGPS 53 must be terminated with <CR><LF> (press ENTER), but do not require the checksum *hh. The checksum is used for parity checking data and it is recommended that the checksum be used in environments containing high electromagnetic noise. It is generally not required in normal PC environments. Sentences may be truncated by <CR><LF> after any data field and valid fields up to that point will be acted on by the DGPS 53.

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 replace the DGPS 53'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> af0 clock parameter
- <15> af1 clock parameter

Using the DGPS 53

Sensor Initialization Information (PGRMI)

The \$PGRMI sentence provides information used to initialize the position and time used for satellite acquisition. Receipt of this sentence by the DGPS 53 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> Receiver Command, A = Auto Locate, R = Unit Reset

Sensor Configuration Information (PGRMC)

The \$PGRMC sentence provides information used to configure the DGPS53. Configuration parameters are stored in non-volatile memory and retained between power cycles. The DGPS 53 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>,<12>,<13>,<14>*hh<CR><LF>

- <1> Fix mode, A = automatic, 2 = 2D exclusively (host 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 res.)
- <7> User earth datum delta y earth centered coordinate, -5000.0 to 5000.0 meters (1 meter res.)
- <8> User earth datum delta z earth centered coordinate, -5000.0 to 5000.0 meters (1 meter res.)
- <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, 5 = 19200, 6 = 300, 7 = 600
- <11> Velocity filter, 0=No filter, 1=Automatic filter, 2-255=Filter time constant (10 = 10 second filter)
- <12> PPS mode, 1 = No PPS, 2 = 1 Hz
- <13> PPS pulse length, 0-48 = (n+1)*20msec. Example n = 4 -> 100 msec pulse
- <14> Dead reckoning valid time 1-30 (sec)

Using the
DGPS 53

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

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.

\$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 DGPS 53.
- 3) If either the target sentence mode field or the target sentence description field is not valid, the PGRMO sentence will have no effect.
- 4) \$PGRMO,GPALM,1 will cause the sensor board to transmit all stored almanac information. All other NMEA sentence transmission will be temporarily suspended.

Tune DGPS Beacon Receiver (PSLIB)

The \$PSLIB sentence provides the ability to manually tune the DGPS 53.

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

<1> Beacon tune frequency, 0.0, 283.5 – 325.0 kHz in 0.5 kHz steps

<2> Beacon bit rate, 0, 25, 50, 100, or 200 bps

If valid data is received, the DGPS 53 will store it in the EEPROM and echo the PSLIB command to the beacon receiver. At power up or external reset, any stored frequency other than 0.0 causes the DGPS 53 to automatically tune.

Using the DGPS 53

NMEA Transmitted Sentences

This section defines the sentences which can be output by the DGPS 53. (GPALM, GPGGA, GPGSA, GPGSV, GPRMC, GPVTG, PGRME, PGRMT, PGRMV, PGRMF, LCGLL, LCVTG)

Sentence Transmission Rate

Sentences are transmitted with respect to the user selected baud rate. Regardless of the selected baud rate, the information transmitted by the DGPS 53 is referenced to the one-pulse-per-second output pulse immediately preceding the GPRMC sentence.

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

Transmitted Time

The DGPS 53 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 and are synchronized with the one-pulse-per-second output. The DGPS 53 uses information obtained from the GPS satellites to add or delete UTC leap seconds and correct the transmitted date and time of day.

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.

Reference the Alamanac (ALM) sentence on page 11 for <field information>.

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

GPS DOP and Active Satellites (GSA)

\$GPGSA,<1>,<2>,<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, up to 12 transmitted (leading zeros will be transmitted)
- <4> Position dilution of precision, 0.5 to 99.9
- <5> Horizontal dilution of precision, 0.5 to 99.9
- <6> Vertical dilution of precision, 0.5 to 99.9

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.

Using the DGPS 53

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.mmmmm format (leading zeros will be transmitted)
- <4> Latitude hemisphere, N or S
- <5> Longitude, dddmm.mmmmm 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 course over ground)
- <12> Mode indicator (only output if NMEA 2.30 active), A = Autonomous, D = Differential, E = Estimated, N = Data not valid

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

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

\$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 2.30 active), A = Autonomous, D = Differential, E = Estimated, N = Data not valid

Geographic Position with LORAN Talker ID (LCGLL)

The LCGLL sentence reports position information.

\$LCGLL,<1>,<2>,<3>,<4>,<5>,<6>,<7><CR><LF>

- <1> Latitude, ddmm.mmmmm format (leading zeros will be transmitted)
- <2> Latitude hemisphere, N or S
- <3> Longitude, dddmm.mmmmm format (leading zeros will be transmitted)
- <4> Longitude hemisphere, E or W
- <5> UTC time of position fix, hhmmss format
- <6> Status, A = Valid position, V = NAV receiver warning
- <7> Mode indicator (only output if NMEA 2.30 active), A = Autonomous, D = Differential, E = Estimated, N = Data not valid

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,<5><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 2.30 active), A = Autonomous, D = Differential, E = Estimated, N = Data not valid

Using the DGPS 53**Estimated Error Information (PGRME)**

The GARMIN Proprietary sentence \$PGRME reports estimated position error information.

\$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

GPS Fix Data Sentence (PGRMF)

The sentence \$PGRMF is GARMIN Proprietary format; reporting time, position, speed and course information

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

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

Sensor Status Information (PGRMT)

The GARMIN Proprietary sentence \$PGRMT gives information concerning the status of the DGPS 53. This sentence is transmitted once per minute regardless of the selected baud rate.

Using the DGPS 53

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

- <1> Product, model and software version
- <2> ROM checksum test, P = pass, F = fail
- <3> Receiver failure discrete, P = pass, F = fail
- <4> Stored data lost, R = retained, L = lost
- <5> Real time clock lost, R = retained, L = lost
- <6> Oscillator drift discrete, P = pass, F = excessive drift detected
- <7> Data collection discrete, C = collecting, null if not collecting
- <8> Board temperature in degrees C
- <9> Board configuration data, R = retained, L = lost

3D velocity Information (PGRMV)

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

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

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

DGPS Beacon Information (PGRMB)

The GARMIN proprietary sentence \$PGRMB reports DGPS beacon information.

\$PGRMB,<1>,<2>,<3>,<4>,<5>,K*<CR><LF>

- <1> Beacon tune frequency, 0.0, 283.5 – 325.0 kHz in 0.5 kHz steps
- <2> Beacon bit rate, 0, 25, 50, 100, or 200 bps
- <3> Beacon SNR, 0 to 31
- <4> Beacon data quality, 0 to 100
- <5> Distance to beacon reference station in kilometers

One-Pulse-Per-Second Output

The highly accurate (within 1ms) one-pulse-per-second (PPS) output is provided for applications requiring precise timing measurements. The signal is generated after the initial position fix has been calculated and continues until power down. The rising edge of the signal is synchronized to the start of each GPS second.

Regardless of the selected baud rate, the information transmitted by the DGPS 53 is referenced to the pulse immediately preceding the NMEA 0183 RMC sentence.

The accuracy of the PPS output is maintained only while the DGPS 53 can compute a valid position fix. To obtain the most accurate results, the one-pulse-per-second output should be calibrated against a local time reference to compensate for cable and internal receiver delays and the local time bias.

The default pulse width is 100 msec, however; it may be programmed in 20 msec increments between 20 msec and 980 msec as described in \$PGRMC on page 12.

GPS: How It Works

The global positioning system is a satellite-based navigation system consisting of a network of 24 orbiting satellites that are twelve thousand miles in space and in six different orbital paths. The satellites are constantly moving and you can receive satellite signals anywhere in the world, at any time.

The GPS signal contains a ‘pseudo-random code’, ephemeris (pronounced: ee-fem-er-is) and almanac data. This code identifies which satellite is transmitting—in other words, an I.D. code. We refer to satellites by their PRN (pseudo-random number), from 1 through 32.

Ephemeris data is constantly transmitted by each satellite and contains important information such as status of the satellite, current date, and time.

The almanac data tells the GPS receiver where each GPS satellite should be at any time throughout the day. Each satellite transmits almanac data showing the orbital information for that satellite and for every other satellite in the system.

Each satellite transmits a message which essentially says, “I’m satellite #X, my position is currently Y, and this message was sent at time Z.” Of course, this is a gross oversimplification, but you get the idea. The GPS receiver reads the message and saves the data for continual use.

Now, to determine your position the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received by the GPS receiver. The time difference tells the GPS receiver how far away that particular satellite is. If we add distance measurements from a few more satellites, we can determine our position. This is what a GPS receiver does. With a minimum of three or more satellites, your GPS receiver can determine a latitude/longitude position—what’s called a 2D position fix. With four or more satellites, a GPS receiver can determine a 3D position which includes latitude, longitude, and altitude. By continuously updating your position, a GPS receiver can also accurately provide speed and direction of travel.

GPS: How It Works

DGPS: How It Works



The DGPS 53 has the GPS and DGPS receivers combined within the same housing.

DGPS: How It Works

Differential GPS (DGPS) is a technique used to improve the accuracy of the Global Positioning System. DGPS reduces the effects of ionospheric variations and can improve position accuracy typically to 1-5 meters.

The DGPS Beacon Transmitter is placed at a known location (i.e., the exact position of the site has been previously determined). At the beacon transmitter site, the GPS satellites are monitored using a GPS receiver. This receiver is equipped to calculate corrections for each satellite received. The correction is the difference between the distance to the satellite (from the beacon site) as measured by the GPS receiver, and the actual distance to the satellite based on the known location of the beacon site. These corrections are communicated to the DGPS 53 through the DGPS Beacon Station. The DGPS 53 then uses the corrections to remove errors from its own measurements.

Satellites received by the DGPS 53, but not by the GPS receiver at the beacon transmitter site, will not have corresponding corrections. When four or more satellites received by the DGPS 53 have corresponding corrections, the result is a highly accurate position reading. The more satellites with corrections, the more accurate the position.

The DGPS 53 receives RTCM SC-104 format signals from ground based DGPS Beacon Stations operating in the 283.5 kHz to 325.0 kHz frequency band and data rates of 25, 50, 100, or 200 bits per second. These stations are typically operated by government agencies such as the U.S. Coast Guard.

Generally, the closest DGPS station will provide the most accurate correction data. Individual stations vary and the user may wish to verify the suitability of the signal for the intended application with the station operator. The station power is normally set to provide a usable range somewhere near 300 km. Other factors such as local interference, lightning, time of day and season, and if the path to the station is over ground or water, and antenna selection or installation affect the usable signal range.

Sources of Error

Using a DGPS Beacon Receiver with your existing GPS Receiver can provide substantial improvements in accuracy; however, there may be occasions when the best possible accuracy will not occur. Several factors can contribute to a degraded DGPS accuracy.

Loss of DGPS Beacon Signal— Obviously, the lack of DGPS correction data will result in reduced accuracy. Accuracy will be the same as if no beacon receiver was being used. Several conditions can cause a loss of the beacon signal:

- Poor data exchange between DGPS receiver and the GPS receiver can result in intermittent or nonexistent correction data.
- The range of a DGPS beacon transmitter (see the accompanying Beacon Reference Card) is typically a few hundred miles, or less. Beyond this range, the beacon signal cannot be reliably received.
- Interference to the beacon signal can be experienced during periods of thunderstorm activity. Other sources of interference, such as alternator motors, ignition systems and VHF, can also affect signal reception. Alternator/ignition interference can be minimized through proper shielding of the ship's wiring, by using an EMI/RFI filter, and by mounting the beacon receiver's antenna away from these sources of interference.

Multipath— Multipath error occurs when the GPS signal is reflected before it reaches the GPS receiver. The reflected signal takes slightly longer to reach the GPS receiver than a non-reflected signal. This added time delay results in position error. (The distance to each satellite is calculated based upon the time it takes the GPS signal to reach the GPS receiver.) Multipath error can be minimized by mounting the GPS antenna at a location which minimizes the potential for reflected signals. Generally, the GPS antenna should be mounted on a large, flat horizontal surface and away from any vertical structure (cabin walls, large mast, etc.) which could reflect the GPS signal.

Sources of Error

Sources of Error

Number of Satellites Visible— As previously stated, the number of satellites available can affect position accuracy. To apply the corrections provided for the satellites received at the beacon transmitter station, the same satellites (at least in part) must be received by your GPS receiver. And, certainly, if there aren't enough satellites to determine a GPS position, there aren't enough satellites to calculate a DGPS position.

Atmospheric Conditions— Differences in the ionosphere and/or troposphere between the DGPS broadcast station and the DGPS receiver can result in decreased position accuracy. Although this does not cause significant error, the amount of error can increase as you get further away from the DGPS broadcast station.

Satellite Geometry— A minimum of 4 satellites are required to determine a 3D position. At times, additional satellites are required due to their placement with respect to each other. This relative placement is referred to as "satellite geometry". Ideal satellite geometry exists when the satellites are located at wide angles with respect to each other. When satellites are located in a line or a close group, satellite geometry is considered poor.

This same requirement applies to DGPS. If corrections are available for four different satellites, but they are all located in the same general area or in a line, the DGPS corrections will be minimal. However, if the same four satellites are placed farther apart, in several very different directions from our position, the corrections will have a much greater effect and the position accuracy will be greatly improved.

Troubleshooting
Chart

Problem	Possible Cause
1) Beacon signal weak or not received.	Interference from ship's electrical system, thunderstorm activity, or another source is inhibiting signal lock on. Wrong frequency or bit rate selected.
2) Accuracy not as expected	Poor satellite geometry exists or too few satellites are visible. Interference to GPS antenna and/or beacon antenna exists. Multipath signals being received by GPS unit. Too far from DGPS transmitter or not tuned to closest station.
3) No output from DGPS 53.	Unit not wired properly. Check wiring. Receiving device not properly configured.

DGPS 53 Specifications



Complete information concerning NMEA & RTCM formats and sentences is available for purchase at:

National Marine Electronics
Association (NMEA)
PO Box 3435
New Bern, NC 28564-3435
USA
252-638-2626
252-638-4885 FAX.
www.nmea.org

Radio Technical Commission For
Maritime Services (RTCM)
1800 Diagonal Road, Suite 600
Alexandria, VA 22314-2480,
USA
703-684-4481 (Info Only)
703-836-4229 FAX
www.rtcn.org

Physical

Size:	4.6"W x 5.3"H (117mm x 135mm)
Weight:	23.9 ounces (0.678 kg)
Operating Range:	-68°F to +158°F (-20°C to +70°C)
Waterproof:	-1 meter submersion for 30 minutes IPX7 rating for IEC529
Mount Thread Size:	1" diameter at 14 threads/inch

Power

Voltage:	8 - 35 vDC using supplied power/data cable. Surge and reverse polarity protected for up to 80 vDC.
Current Drain:	95 mA @ 12 vDc

Signal Processing

Frequency Range:	283.5 - 325.0 kHz @ 0.5kHz
Data Rates:	200/100/50/25 BPS
Auto Tuning:	All 200 & 100 BPS Channels
Minimum Signal:	10 µV

Data Processing

Demodulation:	MSK (Minimum Shift Keying)
MSK Bit Rates:	25, 50, 100, 200 bps

Interfaces

Input:	RS-232 or NMEA 0183, 4800 baud
Input Sentences:	Binary (Magnavox), \$PSLIB (Starlink)
Output:	RS-232 4800 baud
Output Sentence:	RTCM SC-104 (6 of 8 bit format) NMEA 0183 version 2.0
Pulse Per Second:	One-Pulse-Per-Second accuracy; ±1 microsecond at rising edge of PPS pulse

Earth Datums

The following is a list of the GARMIN DGPS 53 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

Earth Datums

- 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

Earth Datums

- 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
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