ComNav®
marine ltd

G2 & G2B
Satellite Compasses
(Third Generation)

Installation & Operation Manual

Welcome

Congratulations on your purchase of a ComNav Marine G2/G2B Satellite Compass! At ComNav, we are dedicated to reliability & quality in all our products, these products are a good example of that. We promise to do our best to ensure your satisfaction with your new G2/G2B Satellite Compass.

Warranty Notice

Prior to the installation and/or operation of the equipment, ensure that you read, understand, and accept the conditions of the warranties as detailed in the **Warranty Information** section of this manual.

General Notice

This document, ComNav part number 29010093 Version 1 Revision 5, is the approved Installation and Operation Manual for use with G2 & G2B Satellite Compasses. Where versions of this manual exist in other languages, the English version shall be considered authoritative.

Special note

The beacon configuration information in Appendix 3 and Appendix 4 applies ONLY to G2B with a firmware version 1.2.17 or later.

Document History

Revision	Date	Description
1R0	19 November 2013	Initial revision as 29010093
1R1	22 November 2013	Add the firmware license agreement
1R2	30 October 2014	Correct the baud rate command; add TSS1 to the data message list
1R3	3 November 2014	Add information for G2B beacon configuration Add information for using Vector G2 cable
1R4	26 November 2016	Revise mounting instruction Revise system overview Revise description about GPS and GLONASS Revise instructions for changing the configuration; remove reference to G series Desktop program
1R5	7 December 2016	Correct wire diagrams for connecting G2/G2B to P series autopilot (Figure 14, Figure 17 and Table 2) Add description to NMEA 0183 alarm output Add PGN126993 to NMEA 2000 output list Add description of version dependent port default baud rates Change COGTAU and HTAU recommendation
1R6	18 January 2017	Editorial changes
1R7	7 September 2017	Correct maximum baud rate in Appendix 1 & 3

About this Manual

This manual provides essential information for the safe and reliable operation of the ComNav's G2 Satellite Compass. Read this manual in its entirety before using the G2 Satellite Compass for the first time. Keep the manual handy until you become thoroughly familiar with the operation of the compass.

> ***Note:*** *most of the information in this manual applies to both models of the G2 Satellite Compasses: the G2 and the G2B.*
>
> *For easier reading, most references in the text use "G2" – but that should always be understood as referring to both models. Whenever a particular item applies only to the G2 or the G2B, it will be so stated in the text of that item.*
>
> *When using this manual with the G2, please ignore the sections which discuss Radiobeacon signals, Beacon receiver operation and related installation details. Those sections apply only to the G2B.*

Manual Format

This manual has been formatted to be printed on both sides of the pages of the manual, and on standard Letter-sized paper (8.5" x 11").

If you have obtained this manual as a soft-copy, please note that it is in Adobe® Portable Document Format ("pdf"), and so may be viewed & printed with Adobe Reader®, or compatible pdf-format viewers.

When printing this manual with Reader, you should select "duplex printing" (or the equivalent term used by your printer's software driver), in order to print it double-sided on the paper. If your printer does not have built-in duplexing capability, you can still print this manual double-sided by following the instructions that came with your printer for doing "hand duplexing".

You should also select the Auto-Rotate and Centre option in the Print Dialog box, de-select the Choose Paper Source by PDF page size option; as well, you should set Page Scaling to None – Reader's default setting is Shrink to Printable Area, and is printer-dependant (usually set at ~97%), but that is not needed here.

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Introduction

Overview

The G2 Satellite Compass is a state-of-the-art electronic navigation data device. It is capable of providing highly accurate, high-precision position and heading data to a wide variety of marine Navigation equipment, such as autopilots, sonar, radar, chart-plotters, AIS receivers & transponders, and many other types of marine devices & systems.

The G2 features fast start-up and signal re-acquisition times, heading & position updates at up to 20 times per second, and can operate at sustained turn rates up to 90° per second.

The G2 is a complete Satellite Compass in a single rugged, marine-grade enclosure. It needs only one single power/data cable, which greatly simplifies installation.

The G2 operates in both NMEA 0183 and NMEA 2000 environments, giving users more freedom of installation, with the ability to interface with multiple variations of navigation systems.

The images below depict a typical installation of the NMEA 2000 G2 system (Figure 1) and NMEA 0183 (Figure **2**).
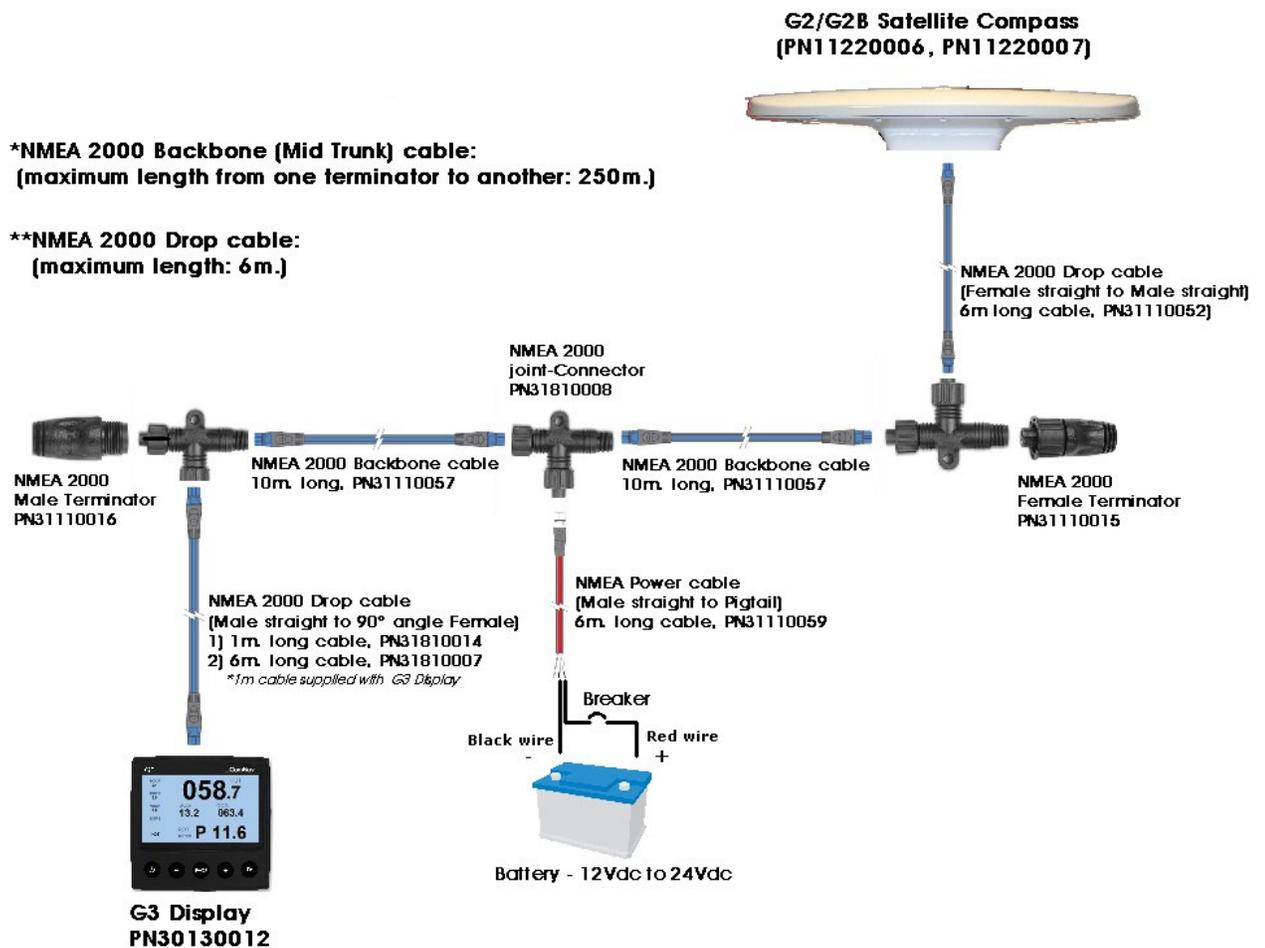
Figure 1 – Typical NMEA 2000 G2 system setup
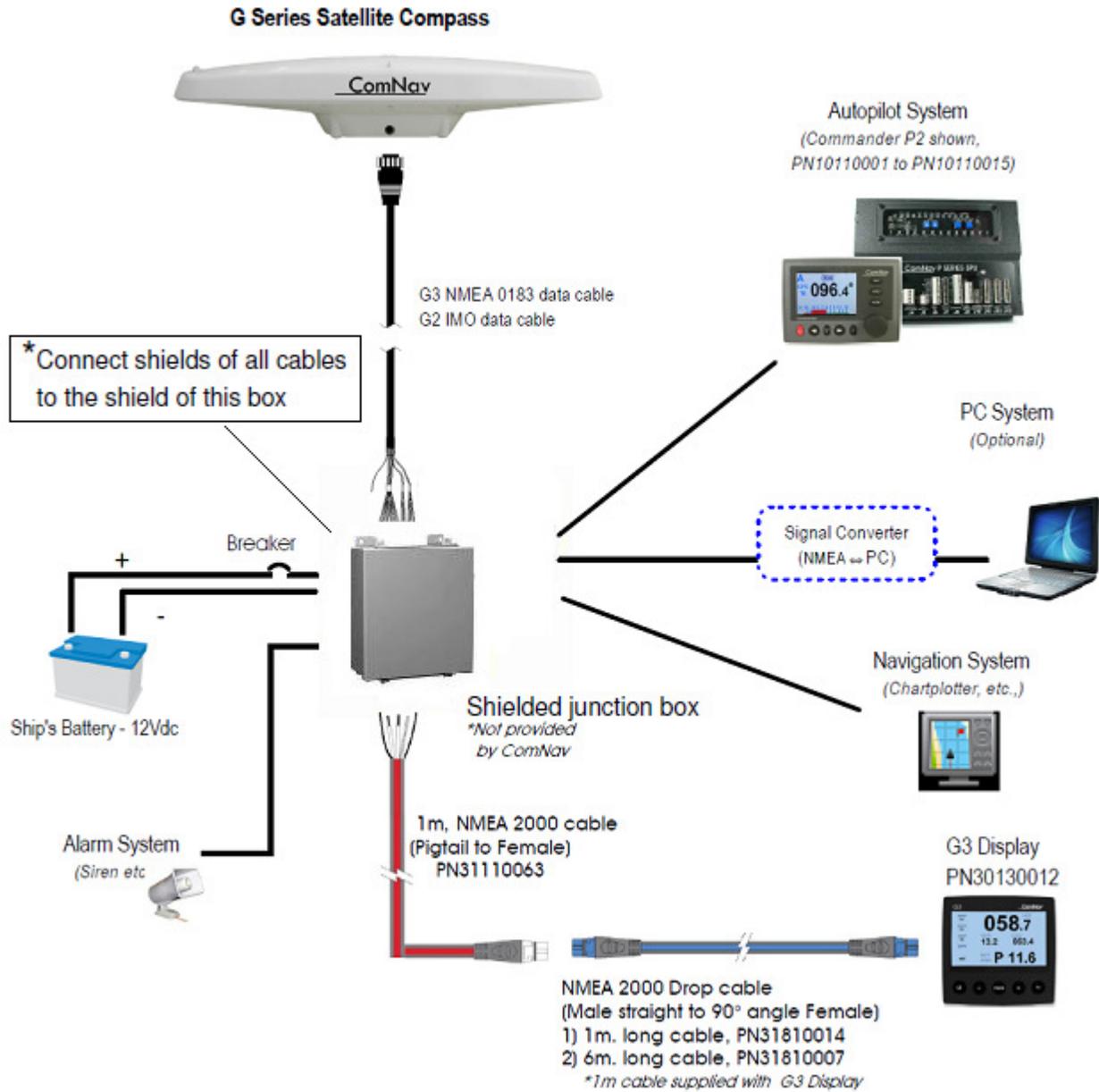
Figure 2 – Typical NMEA 0183 G2 System setup

G2 and G2B they are very similar, except for the Differential GPS (DGPS) correction features:

- The G2 can obtain DGPS information from many Space-Based Augmentation System (SBAS) sources (in areas where compatible sources are available & operational), including WAAS, EGNOS, MSAS, and GAGAN. The G2 can also accept DGPS information from an external data source.
- The G2B has an additional integrated beacon receiver module, which allows it to use conventional terrestrial DGPS Radio beacon signals to obtain DGPS information, in addition to SBAS sources & external DGPS data sources.

The G2 contains a ComNav receiver module (containing two GNSS receivers, a 3-axis gyro, a 3-axis accelerometer and a 3-axis magnetometer), dual GNSS antennas and a power supply. The G2B also contains a DGPS Radio beacon receiver module, and an H-field beacon signals antenna.

When using DGPS corrections (SBAS, external, or Radio beacon), the G2 is capable of under one metre precision for position sensing. The GPS antennas inside the G2's enclosure are separated by approximately 0.5 metres, which provides better than 0.25 degrees of heading sensing precision.

The gyro accelerometer and magnetometer enhance system performance by providing heading information for up to 1 minute whenever the G2's normal GPS-based heading is not available due to signal blockage, or other temporary factors.

The G2 has default settings for easy use in typical marine configurations, as illustrated in Figure **2**. ComNav's goal is to be able to use the G2 unit "right out of the box" for most marine applications, without a need to change system configuration settings.

Information in this manual will guide you in adjusting the G2 unit to operate in the best possible configuration which suits your needs.

The internal beacon receiver in G2B is configured to operate automatically. However in certain circumstance a user may want to change its configuration. Refer to Appendix 4 for instructions of the beacon configuration.

Installation

Installation

Please refer to the Warranty Information section of this manual before proceeding with installation of the G2.

Tools Required

General-purpose tools such as a portable drill, pliers, wire cutters, screwdrivers, wire, mounting bolts and wrenches will be required. An accurate voltmeter or multi-meter would also be useful.

Hazard warning!

Extreme caution is advised when using tools powered by alternating current (AC) from main supply circuits, regardless of whether those circuits are rated for "indoor", "outdoor", "marine" or "industrial" use. Water, especially sea water, is an excellent conductor of electricity, and can complete a path to AC Ground through your body, causing injury or death, if a tool malfunctions or short-circuits.

ⓘ Battery powered tools are STRONGLY recommended ⓘ

If AC tools are used, they must be plugged into a circuit that is adequately protected against Ground Faults and other safety hazards, in accordance with local electrical codes.

Power Supply

NMEA 2000 setup: G2 Satellite Compass is to be connected to the NMEA2000 network power. For a reliable operation, the network power must be capable to provide the current for the total LEN specified by all connected network devices. Refer to the specifications on page 65 for G2 power rating.

NMEA 0183 setup: Unit is powered by the vessel's power supply system and must have an adequate circuit breaker or fuse. Power supply must be in voltage range of 9 to 36 volts DC. It is recommended to connect the unit to power via an on/off switch.

ⓘ *If you are using a Navigator G2 Display with your G2, please note that the Navigator G2 Display and its DU box only work at 12VDC*

Ensure adequate wire sizes are used to handle the expected maximum currents (see 19).

Environmental Considerations

- Ensure that the G2's Operating & Storage Temperature Ranges are not exceeded (see Specifications,

Mechanical, on page 64).
- The G2 unit operates in an environment with up to 100% relative humidity. The G2 unit and cable are waterproof – but are **not** submersible.

GNSS Reception Considerations

GNSS reception considerations must be considered as follows:

- If possible, mount the G2 elevated above all obscuration. Ensure that there is an unobstructed clear view of the sky when the unit is mounted in order to avoid blocking of satellites signals.
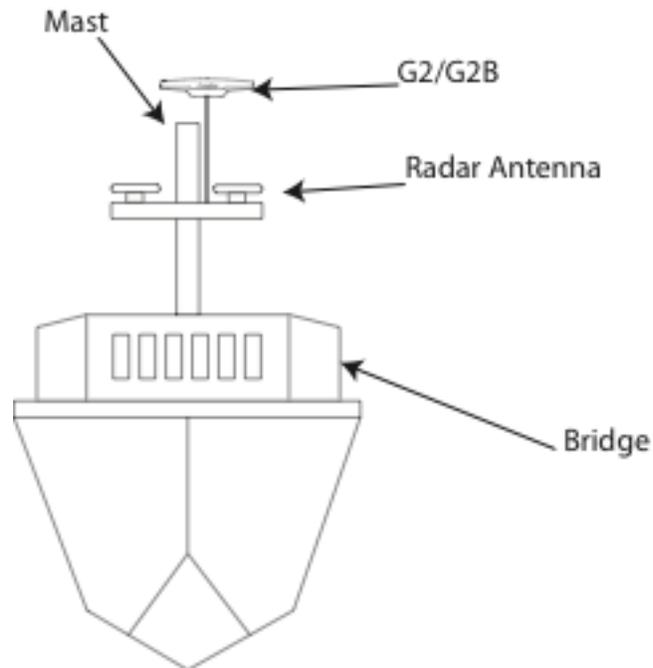
Figure 3 – Choose a mounting location

- If G2 cannot be mounted above all objects, mount it where it has a clear view of the sky ±85° from zenith.
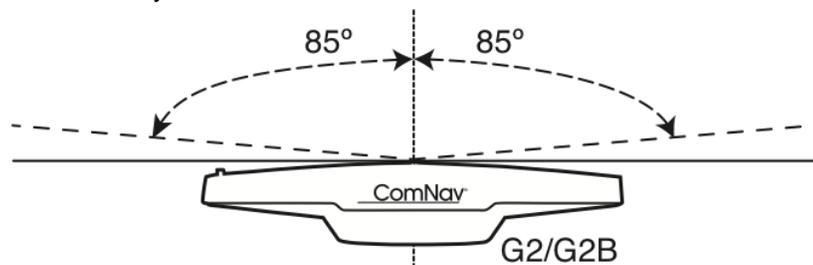
Figure 4 - Clear view required for the compass

- If ±85° zenith sky view is not possible, mount it where its view of sky is blocked no more than 10° horizontally.
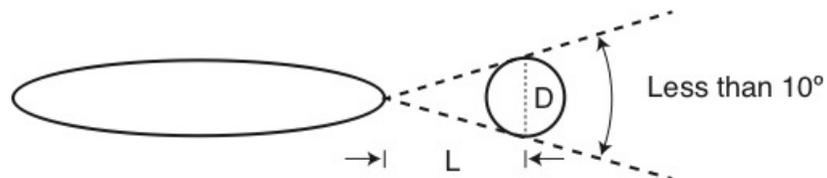
Figure 5 - Mast pole blocked G2G2B skyview (view from top)

- It is important to position the G2 as far away as possible from any metallic or magnetic surfaces which could reflect the GNSS satellites signals.

– There must not be any metallic surfaces located above the horizontal plane of the enclosure, within a radius of 2 metres around the G2.

– If G2 is above a large metallic surface, its distance to the metallic surface must be at least 0.8m.
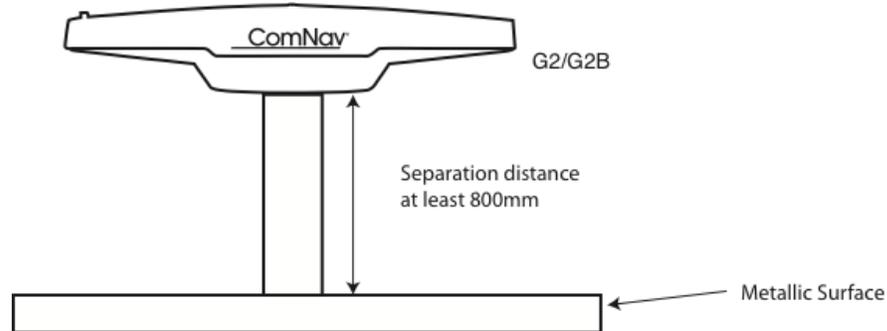
Figure 6 - Mounting distance to large metallic surface

- Avoid positioning the G2 within a few meters of any RF signal transmitting antennas (e.g., VHF, SSB, Radar, etc.). This ensures that the G2's internal electronic circuits have a reduced exposure to RF noise, Thus, reducing the change of degraded performance.
  - Where Radar system is present, make sure to mount the G2 outside the direct path of the radar beam – typically, Radar beam has a conical shape which extends outwards from the Radar emitter, and sweeps a full 360° horizontal circle.
  - Mount G2 at least 3m away from an open-type antenna, and position G2 at least 0.8m above the antenna top.
  - Mount G2 at least 3m away from other antennas
- The G2 should be mounted as leveled as possible (ideally, when the boat is at rest in calm water – e.g., at dockside). This ensures that the G2's internal sensors can determine the attitude of the mounted unit.
  - Compensation for any horizontal offset bias can be configured if necessary (see PBIAS on page 68 table 19).
- The G2 computes its position as the geographic location of its internal Primary GNSS antenna; that antenna is in the end of the enclosure opposite the end which has a recessed arrow on the underside & the long-sight alignment post on the top-side (see Figure 8 & Figure 13). Thus, you should mount the G2 so that the Primary antenna's end is at the location on the vessel where you desire the vessel's "reported GNSS position" to be.

Radiobeacon Reception Considerations

Consider a mounting location to minimize Electromagnetic Interference (ambient electrical and radio-frequency noise) in the Terrestrial DGPS Radiobeacon band, in order to maximize the Beacon receiver's performance.

- The optimal location for the G2B will be a position where it receives the strongest average Radiobeacon signal, with the lowest average EMI.
- Ensure that the G2B is located as far as possible from all other equipment emitting EMI – in particular: DC motors, alternators, solenoids, radios, power cables, display units and other electronic devices.
- The G2B calculates the Signal to Noise Ratio (SNR) of the Beacon signals; the larger the SNR value, the better the signal quality is. If you are able to monitor the G2B SNR values, have all equipment & accessories that you intend to use

during normal operation turned on to observe the full effect of other electronics on the unit.

Location & Orientation

There are two primary mounting orientations for the G2:

- Normally, the G2 will be mounted so that the longitudinal axis is aligned with vessel's fore-aft centreline, or is parallel to that centreline. In this orientation, the G2 can output both the Heading and the Pitch of the vessel.
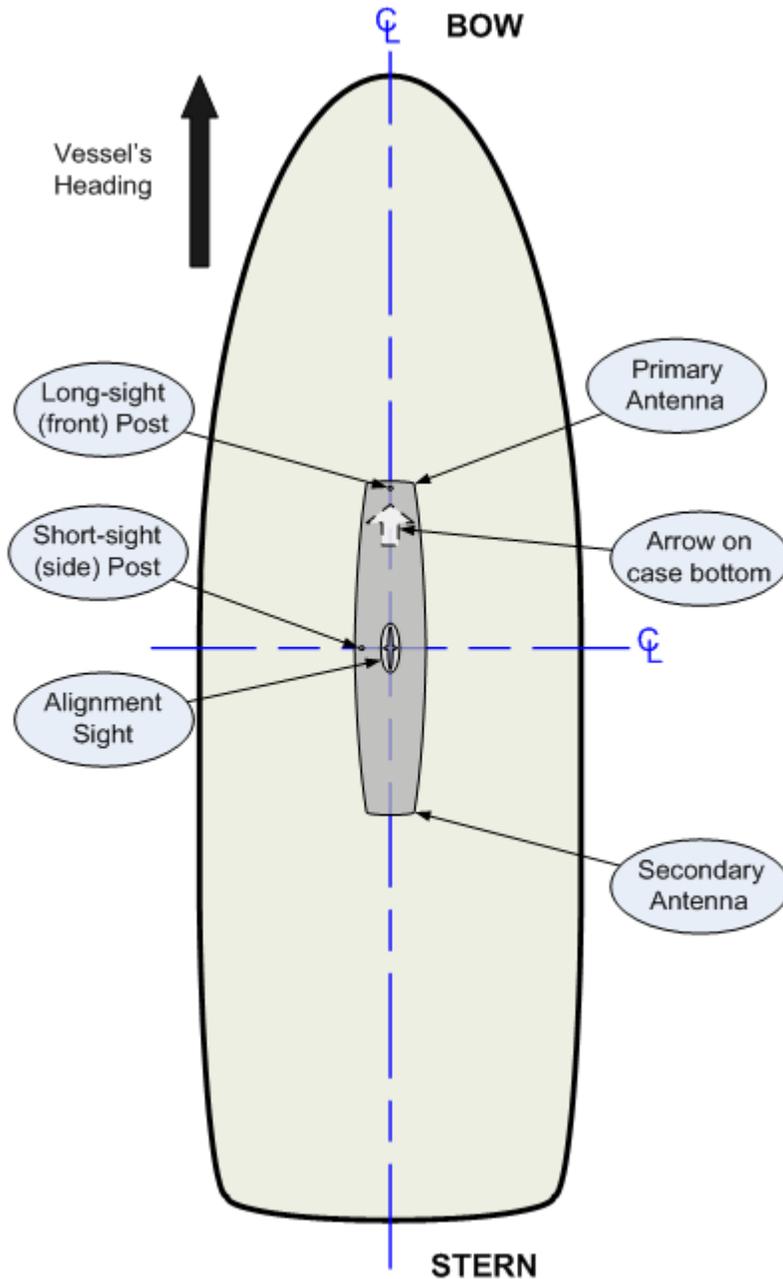
Figure 7 – Heading & Pitch Installation (viewed from above). Heading bias is 0° at this orientation

- If you wish, you can instead install the G2 perpendicular to the vessel's fore-aft centerline, i.e., on or parallel to the athwartships centerline. In this orientation, the G2 can output both the Heading and the Roll of the vessel.
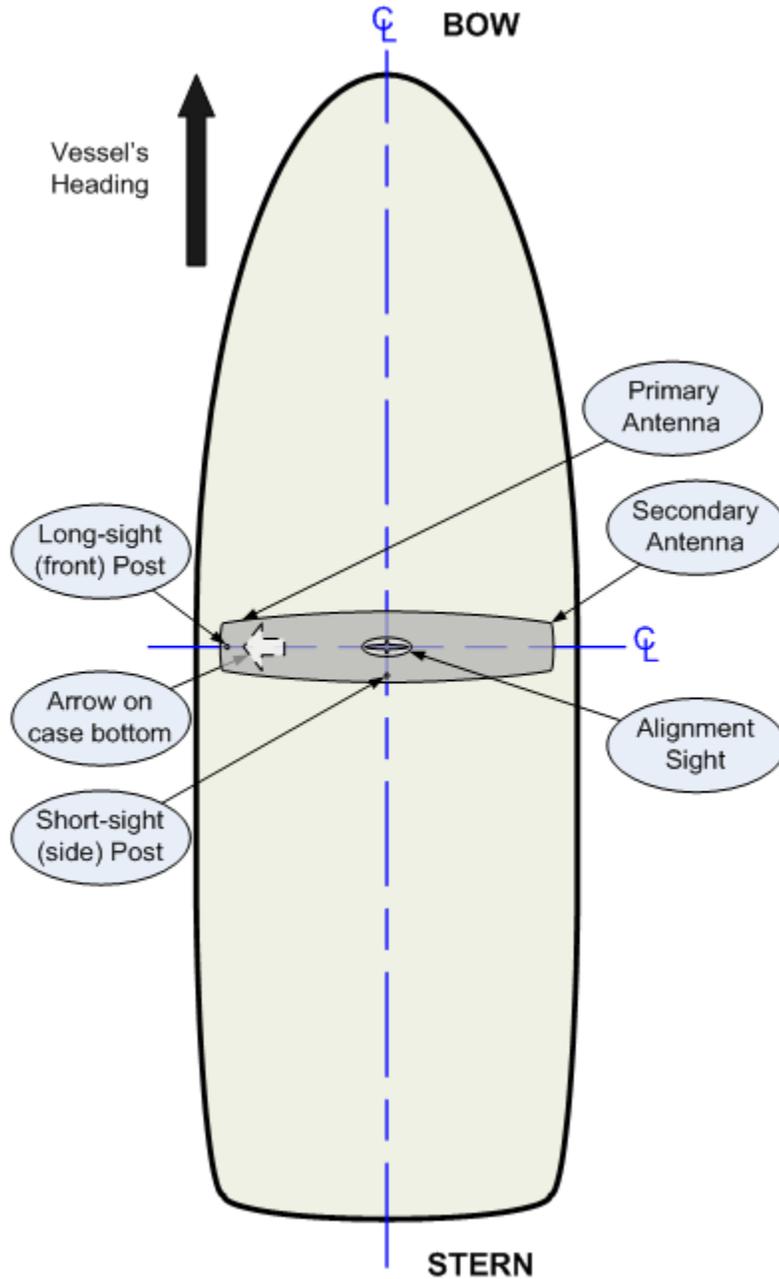
Figure 8 – Heading & Roll Installation (viewed from above). Heading bias is 90° at this orientation

The heading from a GPS mounted as in Figure 8 and that from a GPS mounted as in Figure 7 have 90° difference. This can be compensated by the parameter of heading bias. Heading bias value is adjusted through proprietary sentence. At factory default, G2

antenna's heading bias is set to 0°, allowing the mounting as shown in Figure 3. If you mount the antenna as in Figure 4, you need to set the heading bias to 90°.

Mounting

The G2 allows for Surface mounting options:

- Surface mount for mounting the G2 on a flat surface such as a cabin's roof, a mounting plate on the mast, and so on.
  .

When mounting, ensure that the mounting location accommodates the cable length in routing as required into the vessel (see Cables & Extensions on page 29 for more details).
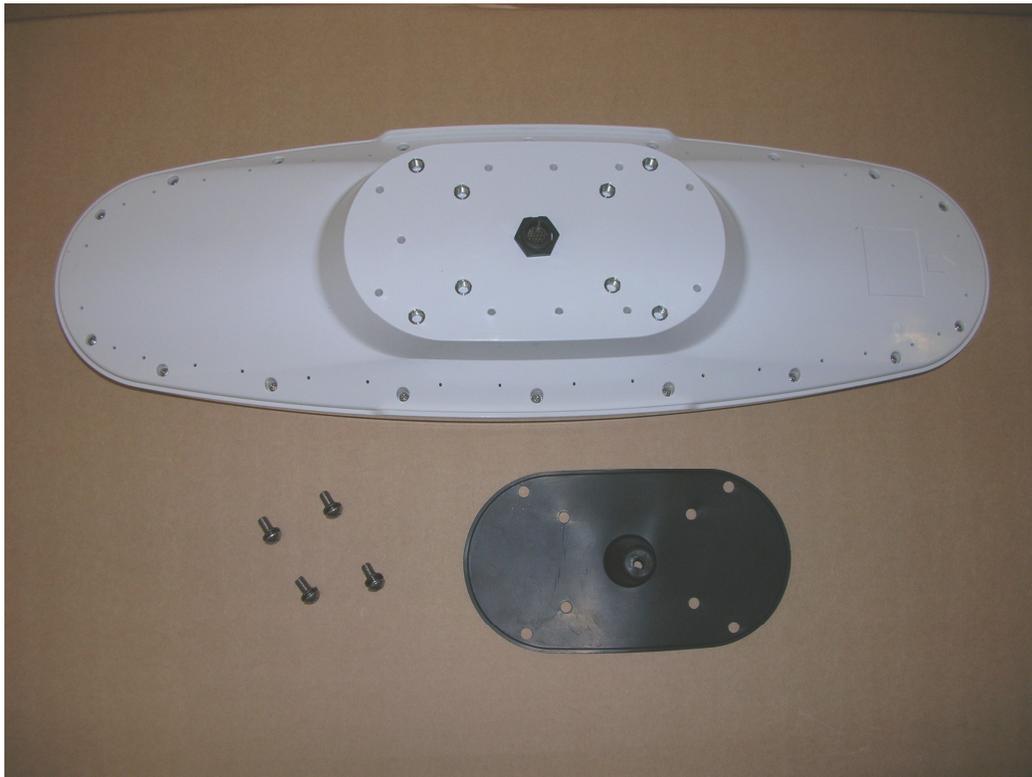
Figure 9 - Deck mount bracket assembly
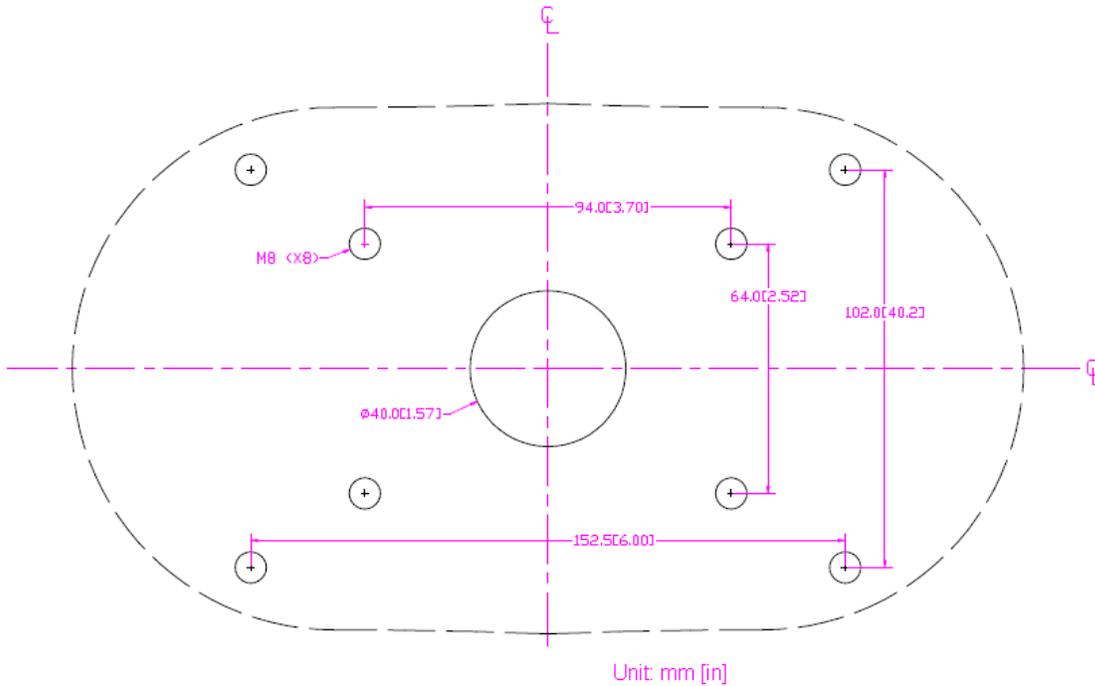
Figure 10 -Surface mount hole measurements

1) Use the mounting gasket as your drill template to drill the holes to surface mount the antenna
2) Push the flying lead end of the cable through the center opening of the mounting gasket (Figure 6).
3) Align the connector key tab to the slot of the receptacle mounted on the unit and press the connector on. Rotate the connector locking ring clock wise to secure the connector to the unit.

Figure 11 – Deck Mount gasket assembly- customer supplied bracket

4) Push the cable through the center 1.5" hole of the mounting surface before placing the unit in its position

5) Place the G2 on the surface, aligning each drill hole with a respective bolt hole on the unit. Push the M8 bolts from the bottom through the surface and hand tighten all 8 bolts.

6) Once all the M8 bolts are placed, tighten the bolts with a ratchet to fully secure the unit to the surface. Take care to avoid over tightening.

Figure 12 - Assembled Deck Mount (bracket not included)

🐞 Note: it is important to place a locking compound such as Loctite on the threads of the bolts prior to fastening them.

7) Push 8 M8 bolts from the bottom through the gasket and hand tighten all 8 bolts. Once all the M8 bolts are placed, tighten the bolts with a ratchet to fully secure the unit to the surface. Take care to avoid over tightening.

Alignment

Adjust the orientation of the G2 as necessary, and then secure it when complete:

The top of the G2's enclosure incorporates two small positioning posts and an alignment sight, to assist in aligning the unit's orientation. Perform the following steps to align the unit:

- look along the top of the unit's top cover & across the sight:
  - from the end without a post:
    - ◆ centre the other end's post (the Long-sight shown in Figure 8, Figure 7 and Figure 13) in the length-wise groove in the Alignment sight
  - from the middle of the long side without a post:
    - ◆ centre the other edge's post (the Short-sight, shown in the same figures) in the width-wise groove in the Alignment sight
- The sight-line you see is the centreline of the unit.
- adjust the direction of the unit's sight-line to be parallel to the vessel's centreline:
  - either the fore-aft or athwart ships line, whichever you have chosen to use
  - or perpendicular to one of those centrelines
- alignment accuracy when using the Long-sight method is approximately ± 1°
- using the Short-sight method, alignment is accurate to approximately ± 2.5°
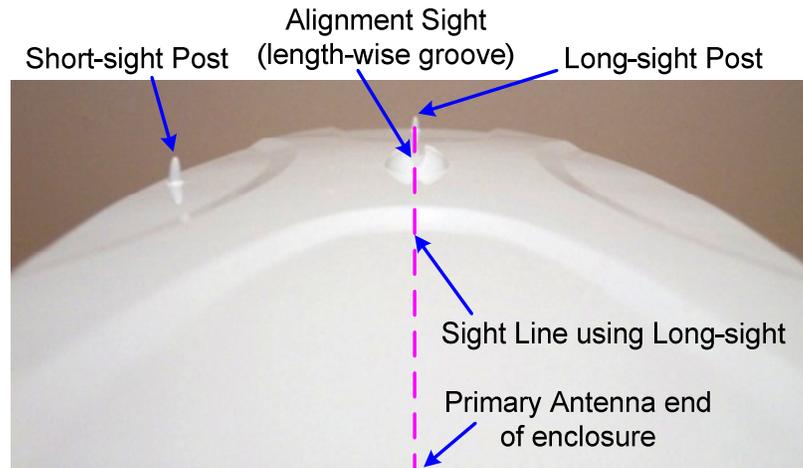
Figure 13 – Long-sight Alignment

If another accurate source of heading data is available on your vessel, you may record and correct any bias in the G2's alignment difference between the G2's initial reported heading and that of the other accurate heading device. To do so, enter the difference value in the G2's heading bias parameter. A bias value can also be obtained by doing a traditional "box the compass" run.

Alternatively, you may wish to physically adjust the direction of the G2's enclosure, by that other heading device bias value, so that the G2 does not have any bias in its alignment.

> 🔌 Using the G2's heading bias parameter is usually the easier to achieve

Wiring for NMEA 0183 system

A single 18 pin cable allows power and NMEA data & control signals from & to the unit. The terminated connector side of the cable is an environmentally sealed, mechanically-keyed/locking connector; the other end is un-terminated, and requires field stripping and tinning for connection to a distribution box.

The cable can be wired to other equipment using NMEA 0183 input as navigation data.

When routing the cable, it is recommended to:

- Keep the cable well away from rotating machinery;
- Avoid running the cable in areas of excessive heat;
- Keep the cable away from corrosive chemicals;
- Do not run the cable through door or window jams;
- Do not excessively bend, or crimp, the cable;
- Avoid running the cables in close proximity to areas known to be of high electromagnetic emissions;
- Secure the cable along the route using plastic tie wraps as necessary.

Cables & Extensions

Standard supplied cable length is 15 meters. 30 meters cable Part Number 31110062 is available if needed, and can be ordered from ComNav. In installations here there seems to be a significant excess of cable left after routing, the cable can be shortened by cutting the extra length off the unterminated end.

Cable can be routed into a customized break-out box with internal terminal strips, or use soldered or crimped, marine-grade and standards, wire-to-wire connection techniques.

If you are using the G2 unit with a Navigator G2 GPS Compass Display, the Navigator G2's Distribution Unit contains a terminal strip for extension cable connection.

Cable Colour Codes

Standard Cable (15 and 30 meters)		
Wire Color	**Signal Description**	**Note**
Red	Power (+)	
Black	Power (-)	
Brown	Port 1 Tx RS232	
White/brown	Port 1 Rx RS232	
Yellow	Port 2 Rx RS422 A	
White/yellow	Port 2 Rx RS422 B	
Green	Port 2 Tx RS422 A	
White/green	Port 2 Tx RS422 B	
Violet*	1PPS+ / Port 3 Tx RS422 A	Shared wires
White/violet*	1PPS- / Port 3 Tx RS422 B	
Blue	CAN_L	
White	CAN_H	
Pink	NET_S	
Pink/black	NET_C	
Orange	Alarm 1	
White/orange	Alarm 2	
Gray	Port1 GND RS232	
	Drain	

Table 1 - Cable colour code

* Shared wires can only be used for one function. Only available in units with the optional port.

Power Input

A 3 Amp fast-blow fuse or circuit breaker (not supplied) should be installed in series with the Power Input wire. An in-line On/Off switch (not supplied) capable of handling 3 Amps should also be installed. The breaker/fuse/switch and all the power wiring must be

completed in accordance with the applicable safety standards for "low-voltage DC" wiring at your locale.

> **Note:** The G2's internal power supply is protected against reverse polarity connection. Nevertheless, care must be taken when wiring and connecting the unit to a power source.

Data Connections (Autopilot, GPS Display, Chart plotter, PC, etc.)

There are a number of ways to make the data connections required between the G2 and other equipment on the vessel. See Figure 14, Figure 16 and Figure 17 for common examples:

- The G2 is typically used with an autopilot system (e.g., Commander P2, Admiral P3, 2001, 5001, etc.), an optional ComNav Navigator G2 GPS Compass Display System, and a generic Chart plotter.
- The G2 may be connected to other types of *Navigation System*.

> ⇒ A PC can be used, instead of the Navigator G2Display, to configure the G2 and/or monitor its status.
>
> ⇒ A PC can be used, instead of a Chartplotter or other type of NMEA Navigation equipment, to perform the "Navigation display & control" functions – setting waypoints, etc.

Each of those connection schemes is described in more detail below. Other schemes may also be possible on your vessel, or in your application of the G2.

All data communications from/to the G2 is done with serial data signals; there is also a separate Alarm signal from the G2, using the contacts of a relay.

> 🛈 **In an IMO system, you must connect an audible alarm device to the G2!**

Signal Grounds

Whether or not to connect the G2's Signal Ground to the Signal Ground (or the Main or Power Ground, if there is no Signal Ground) of the other device or devices on your vessel depends on how your vessel, and any other equipment, is wired.

- RS-422: per the NMEA 0183 Standard, the Listener will have optically (or galvanically) isolated RS-422 inputs; thus, it is usually not strictly necessary – and sometimes it is not even possible – to connect the Grounds.

> ⇒ For example, the Commander P2's NAV1/2 inputs (NMEA 0183 Listeners) are optically isolated – no Signal Ground pin for those inputs is provided.

  In contrast, for the P2's NAV output (which is an NMEA Talker), there *is* a Ground pin – but that is a "current-controlled, AC-coupled" ground, not the P2's main Signal Ground.

- RS-232: the G2's RS-232 Signal Ground **MUST** be connected to the other device's Signal Ground, when using the RS-232 ports.
- On the other hand, it is sometimes better – from the perspective of signal integrity and/or electrical noise-reduction – to connect some or all of the Grounds in a system.

Consult your ComNav Dealer for help, if you are unsure what will work best on your vessel.

Serial Port Settings

Both ports use ordinary asynchronous serial data formatting, as specified in the NMEA 0183 Standard; the formatting is fixed, and can not be changed:

- • 1 Start Bit, 8 Data bits, No Parity Bit & 1 Stop Bit (commonly described as "8-N-1").

The baud rates of the G2's serial ports must be the same as the device(s) to which they are connected. The factory-default configuration is 4800 Baud on both ports – per the NMEA 0183 Standard.

The baud rates can be changed, if you need to; also, Port 1, 2, and 3 may have different Baud rates.

Interfacing to a ComNav Autopilot

Commander P2 or Admiral P3

Shows the typical connections used with a ComNav Commander P2 Autopilot System (an Admiral P3 would be wired identically), a Navigator G2 GPS Compass Display System, and a generic Chartplotter or other type of *Navigation System*.

> **Note:** *this wiring information assumes that the G2 is in its factory-default configuration: Autopilot data on Port 2 and General Navigation data on Port 1 & 3 (see pages 47 & 49).*

The wiring from the G2 is to the P2's **J9 – NAV I/O** connector, as follows (a small image of the connector's label is shown to the left of the table):

> **Note**: *1) The signal polarities on P2/P3 SPUs are labeled based on NMEA 0183 protocol, with an "A" for negative and "B" for positive. The signal polarities on G series are labeled based on RS422 with an "A" for positive.*
>
> *2) some P2/P3 SPUs have an error on this label – but the image below is correct.*
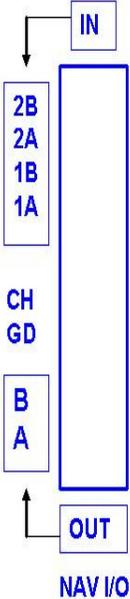
J9 Pin	Wire Color	Signal	Signal	Data Carried
IN-2B	user-supplied ①	RS-422, 'A'	from Chartplotter, etc.	Navigation: Waypoints, Position, etc.
IN-2A	user-supplied ①	RS-422, 'B'		
IN-1B	White/Green	RS-422, 'A'	from G2, Port 2 Transmit	Heading, Speed
IN-1A	Green	RS-422, 'B'		
OUT-1B	user-supplied ①	RS-422, 'B'	to Chartplotter, etc.	Autopilot status
OUT-1A	user-supplied ①	RS-422, 'A'		

Table 2 – Commander P2 Connection Details

> ① *These wires are supplied by the user, thus colours are not specified here.*

In addition to the above wiring, the Commander P2 must be configured to look for both heading and speed data from its NAV1 input port, and for Navigation data from NAV2; for

details, see the respective Source selection descriptions for the Standby, Auto & Nav menus, in the P2 Installation & Operation manual.

5001 System

The wiring for a 5001 is similar to that of a Commander P2: two RS-422 NAV input ports, and one RS-422 output port (the 5001 also has an RS-232 I/O port, but that should not be used with a G2).

All G2 wiring connections to a 5001 must be made at the 5001's Processor Card – see page 4-24 in the 5001's Installation & Operation manual. You must then select the Compass, Speed, and NAV sources (from NAV1, NAV2, according to how you have done the wiring from the G2, a Chartplotter, etc.) – see page 5-15 in the 5001 manual.

It may also be necessary to configure the 5001's COMM port to transmit NMEA output signals, if you need those – see page 5-6 in the 5001 manual.

Other ComNav Autopilot Systems

All other ComNav autopilots require the use of an optional Sine-Cosine Interface Box (ComNav PN 21010004), with matching interface cable (PN 31110023 or 31110051), to use them with a G2.

See the instructions included with the Sine-Cosine Box for wiring and setup information. Note that the G2's Port 2 RS-422 wires are the ones to be connected to the Convertor.

Interfacing to a Navigator G2 Display System

See Figure 14.

Wiring of the Navigator G2 is fully described in the Navigator G2's Installation & Operation manual. Note that there is some flexibility in how the wiring between the satellite compass & the Navigator can be arranged, since part of the function of the Navigator's Distribution Unit is to be a simple, convenient "terminal strip" for the Navigator G2 Display /G2 Satellite Compass.
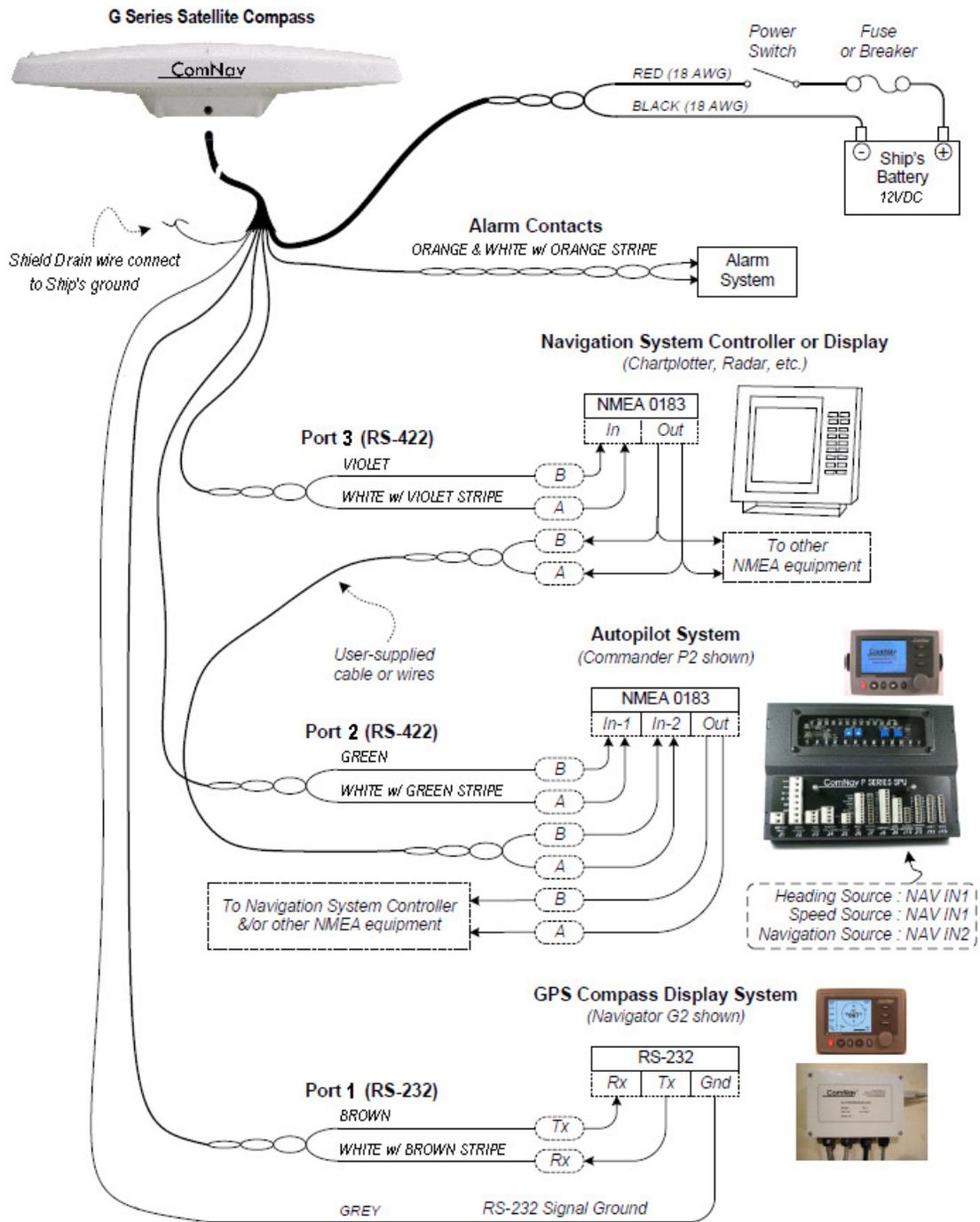
Figure 14 - Typical Wiring Diagram of a G2 System with Autopilot and Compass Display

Interfacing to a PC

PC COM Ports

PC serial ports – commonly referred to as "COM ports" – always use RS-232 signal levels, and so the only possible direct connection to the G2 is via the G2's RS-232 signals.

*If it is necessary to connect a PC to any RS-422 signals (for example, when the PC is being used to run a Navigation program, which sends steering commands to an NMEA 0183 autopilot – i.e., at RS-422 levels), a signal level convertor **will** be required (see page 35).*

PC COM ports typically use a DE9 male (a "pin type", aka DE9-P) connector; older PCs may use a DB25 (aka DB25-P) connector instead.

- Desktop PCs sometimes have 2 (or more) COM ports, although newer models usually only have one COM port. It is possible to add COM ports to most desktop PCs, by adding a suitable "COM Port Expander" card.
- Laptop PCs usually have only one COM port.
- Many newer PCs – desktops & especially laptops – do not have a real "COM port". Instead, they only have one or more USB ports, and use driver software to allow application programs to access the USB ports as "virtual COM ports".

  ⇒ If the PC only has USB ports, an external USB-to-Serial adapter will be required, since the G2 does not have a USB interface. These adapters typically have a USB 'A' size plug at one end, and a DE9 male connector at the other end.

  Most brands of adapters should work fine. A number of different ones have been tried at ComNav, all with success (in fact, a "USB to 4 Serial Ports" adapter is used by our Production & Testing staff when working on G2s).

D Connector Pinouts

The figure below shows the pin-numbering scheme for a PC COM port's DE9 & DB25 connectors. This figure can be looked at in two ways:

- It is the view from the outside of the PC, looking at the pins of the male connector in the PC, typically located somewhere on the back panel of the PC.
- It is also the view of matching female connector (aka a "socket type" – a DE9-S or a DB25-S) when looking at the *back* – i.e., wire side – of that connector, on the cable that plugs into the PC's male connector (DE9-P or DB25-P).
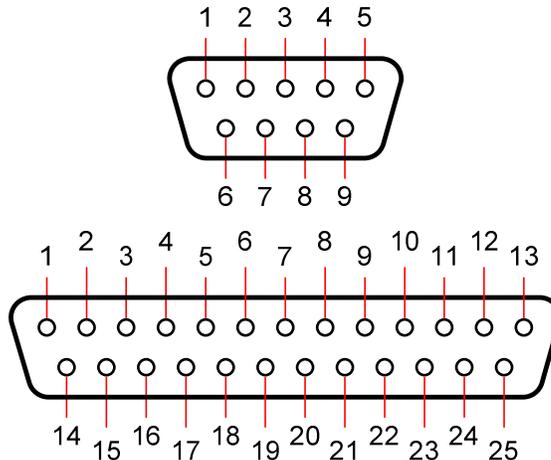
Figure 15 – DE9 & DB25 Pin Numbering

DE9 Connectors

To connect the G2's RS-232 port to a PC serial port (or to the DE9-P end of a USB-to-Serial adapter); connect the wires to a DE9 female connector (a "socket type", aka DB9-S) as follows:

DE9 Pin	Wire Color	G2 Signal	COM Port Signal
2	Brown	Port 1 Transmit data	Receive Data
3	White/Brown stripe	Port 1 Receive data	Transmit Data
5	Grey	Signal Ground	Signal Ground

Table 3 – PC COM Port (DE9) to G2's RS-232 Port A

DB25 Connectors

If the PC has a DB25 COM port connector, connect the wires from the G2 to a DB25 female connector (aka DB25-S) as follows:

DB25 Pin	Wire Color	Signal	COM Port Signal
3	Brown	Port 1 Transmit data	Receive Data
2	White/Brown stripe	Port 1 Receive data	Transmit Data
7	Grey	Signal Ground	Signal Ground

Table 4 – PC COM Port (DB25) to G2's RS-232 Port 1

Note: *none of the other RS-232 signals that are normally available on PC COM ports (& sometimes used by the ports &/or equipment connected to them), such as the "status" & "flow control" signals (RTS, CTS, DSR, DCD, etc.), are available on, nor used by, the G2's serial port.*

Using a PC for G2 Control & Display

Figure 16 shows the typical connections when using a PC, instead of a Navigator G2 Display, to configure the G2, and/or monitor its status.

> *Note: the PC is not necessary, if the G2's factory-default configuration (see page 49) meets your needs, and if you do not wish to monitor any of the G2's various status values.*
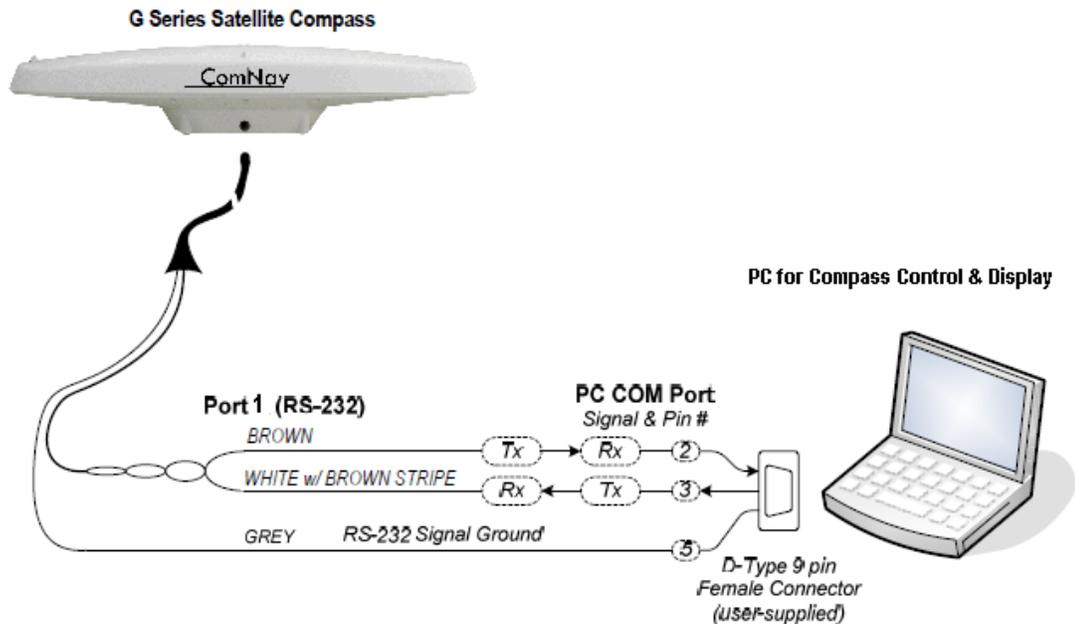
Figure 16 – Typical wiring with a PC for G2 Control & Display

The PC would typically be running a "dumb terminal" program (e.g., the Hyperterminal® program that comes with Windows® on PCs).

Using a G2 with a PC Navigation Program

Figure 17 shows the typical connections when using a PC, instead of a Chartplotter or some other type of NMEA Navigation equipment, to perform "Navigation display &/or control" functions – viewing the vessel's position on a chart, setting waypoints and so on.

This wiring scheme uses the G2's Port 1 RS-232 output (and input, if the PC is also going to be used to control the G2), and the Port 2 RS-422 output.

G Series Satellite Compass

PC for Navigation Control & Display
(using suitable software)

Port 1 (RS-232)
BROWN

PC COM Port *n**
Signal & Pin #

Tx → Rx → ②

WHITE w/ BROWN STRIPE

Rx ← Tx ← ③

GREY   RS-232 Signal Ground

⑤

*D-Type 9 pin
Female Connector
(user-supplied)*

** COM Ports used for
G2 & NMEA connections
are user-selected,
but MUST be different*

*Use one or the other wire pair
into the Convertor inputs*

**NMEA 0183 ⇔ RS-232
Convertor**

*From other
NMEA equipment*

RS-422   RS-232

B → In B

A → In A

B → Out B

A → Out A

Pwr   Gnd

PC COM Port *n**
Signal & Pin #

Tx → Rx → ②

Rx ← Tx ← ③

Sig Gnd   ⑤

*D-Type 9 pin
Female Connector
(user-supplied)*

*To other
NMEA equipment*

Ship's Battery **

*This connection is needed only if
the Navigation program requires
"autopilot status" information*

** may not be needed – depends on convertor

*User-supplied
cables or wires*

Autopilot System
(Commander P2 shown)

NMEA 0183

In-1 | In-2 | Out

Port 2 (RS-422)
GREEN

B

WHITE w/ GREEN STRIPE

A

B

A

B

A

*Heading Source : NAV IN1
Speed Source : NAV IN1
Navigation Source : NAV IN2*

Figure 17 – Typical wiring with a PC based Navigation Program

The PC would typically be running a Navigation program (e.g., programs from Fugawi™, Jeppesen®/Nobeltec®, Rose Point Navigation, or similar), replacing the Navigation control functions of (or as a backup to) the Chartplotter.

In this connection scheme, the PC will need to be hooked to the G2 via the latter's RS-232 connections – but it will also usually be necessary to connect the PC to the autopilot and/or other NMEA 0183 equipment, at the NMEA Standard's RS-422 signal levels.

$\Rightarrow$ Since very few PCs have built-in RS-422 ports, an RS-232 ⇔ RS-422 Convertor will usually also be needed (as shown in Figure 17).

Alternatively, if your PC has USB ports, a USB-to-422 adapter could be used for the PC-to-autopilot/etc. connection.

Contact your ComNav Dealer for ordering information.

Note: *it is sometimes possible to mix the RS-232 electrical levels of a PC's COM port with the NMEA 0183 Standard's RS-422 levels – driving into an RS-422 input from the PC's RS-232 output, and/or vice-versa.*

For an example, see the section describing NMEA connections to the Commander P2 SPU's NAV ports, in the P2's Installation & Operation Manual. This method usually works fine … on the P2 (& also on the Admiral P3), at any rate.

But it depends largely on the electrical drive capabilities of the PC's COM port circuits. As well, in a technical sense, it violates the rules of the NMEA 0183 Standard, since the voltage levels, signal rise/fall times and circuit impedances of RS-232 and RS-422 are different. It may also cause electrical noise problems – RS-232 is "single-ended" wiring, whereas RS-422 is "differential" (i.e., twisted-pair wires) and thus withstands RFI & EMI electrical noise better.

For those reasons, ComNav strongly recommends against mixing RS-232 & RS-422!.

However, if you wish to try it with a P2 or P3 SPU:

- *Wire the G2's Port A RS-232 Tx signal to the PC COM port's Rx signal, and wire the RS-232 Signal Ground, both as shown in* Figure 17.
- *Wire the PC COM port's RS-232 Tx signal to the IN-2A pin of the P2/P3 SPU's J9, and the PC's RS-232 Signal Ground to the SPU's IN-2B pin.*
- *If the PC has only one COM port, but you need to run both "Navigation" & "G2 Control" programs on the PC (see below), you can also connect the PC's Tx signal & Ground to the G2's Port A RS-232 Rx & Signal Ground wires, in parallel to connecting them to a P2/P3.*

> **Caution!** *You can* **NOT** *do the same for the Rx signal – i.e., connect both the G2's Tx signal and the P2/P3's NAV OUT signal to the PC's Rx pin. Doing so will damage either the G2 or the P2/P3 … or both.*
> *If you encounter any problems with this wiring scheme, use of an RS-232 ⇔ RS-422 Convertor will then be required.*

Use a G2 with the CAN-bus based G3 Display in IMO installation

> ***Note***: *Installation described here is optional and only applies to IMO enabled device. Contact your ComNav dealer if you are not sure about your G2.*

Figure 18 shows how a G2 works with a G3 Display or multiple G3 Displays. Please be aware that this installation is not NMEA 2000 compliant, and should not be connected to an NMEA 2000 network without isolation.

The total distance from G2 to the far-end G3 Display should not exceed 35 meters.
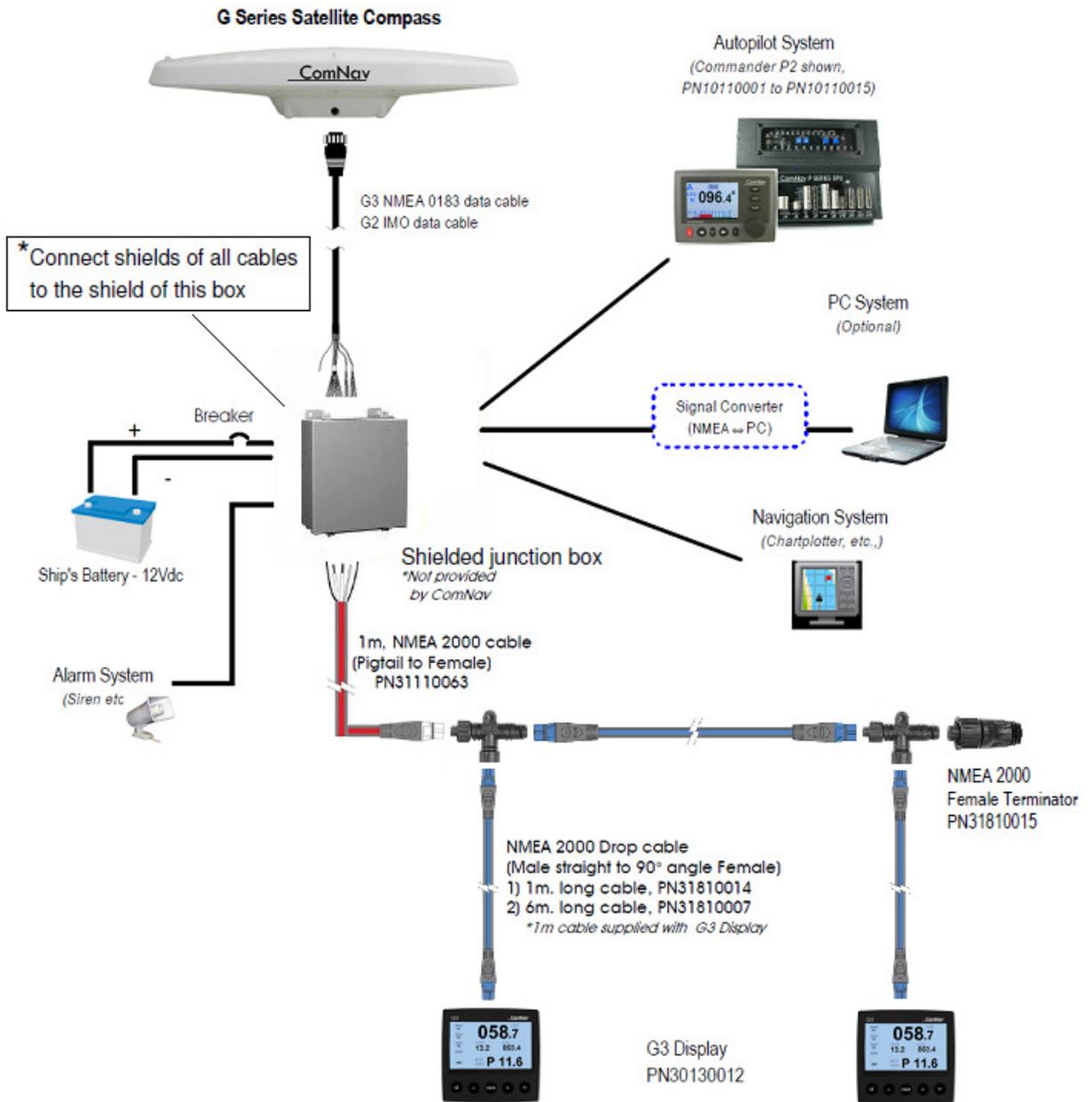
Figure 18 – G2 with G3 Displays in an IMO G2 System

Wire connections in the Junction Box between G2 and the NMEA 2000 free-leads cable are give in Table 5.

Standard Cable (15 meters)		NMEA 2000 cable		Note
Wire Colour	Signal	Wire Colour	Signal	
Pink	NET_S	Red	NET_S	Connect to G2 power or a separate power, positive
Pink/Black stripe	NET_C	Black	NET_C	Connect to G2 power or a separate power, negative
Blue	CAN_L	Blue	CAN_L	
White	CAN_H	White	CAN_H	
Bare	**Drain**	**Clear**	**Shield**	***!!If a separate power NMEA 2000 power is used,*** ***Do NOT connect NMEA 2000 shield to the standard cable shield, or the junction box***

Table 5 – connect G2 to CAN Bus

Wiring for NMEA 2000 system

When used in a NMEA 2000 network, the G2 is a "plug & play" device. See Figure 1 for a connection example.

Operation

Operation

The G2 Satellite Compass provides accurate, reliable, high-precision position and heading data. It is intended to be used with a wide variety of marine Navigation equipment.

The G2 is a very good example of a classic "Black Box":

- There are no switches or indicators on the case … not even a power light …
- It begins to operate as soon as it is powered on …
- But … there is NO way to tell if it is working!!

As mentioned in the Overview chapter, the factory-default configuration settings are meant to allow most users, in typical marine applications, to install and use the G2, with no changes needed … *Plug and Play*, in other words!

So, in that sense, there's really no need for an "Operating the G2" chapter in this manual.

On the other hand, since the G2 really is a "Black Box" (despite the case being white …), there is *no way* to tell if it is working properly, or to control it, if it is not connected to at least one suitable external device … such as a GPS Compass Display, or a PC running a suitable program.

And so, the information in this chapter is meant to show how to monitor the operation & status of the G2, and to control it and/or re-configure it, when necessary.

The first part of this chapter will help you gain some understanding of how the G2 works.

The second part describes monitoring & controlling & configuring the G2, and other performance & setup information.

Understanding How the G2 Works

The first thing to do, in order to "operate" a G2, is to turn it on …

Power should always be applied to the G2 by means of a power switch (in series with a suitable fuse or circuit breaker, see page 29).

Automatic & Continuous Operation

When first powered up, the G2 performs a "cold start" – which involves determining which satellites are in view, and then acquiring signals from all that are in view.

The DGPS data source is also automatically acquired, if the G2 has been set to use DGPS data.

Once sufficient satellite signals are acquired, the G2 begins to generate navigational data, which is then sent out on the G2's two serial ports, according to what it has been configured to output.

While the G2 remains powered, its satellite receivers & processors are always operating.

GPS and GLONASS

United States' Global Positioning System, commonly referred as GPS, is the first global navigation satellite system in operation. It used to be the only navigation satellite system with global coverage and high precision. However by 2010 alternative system with global coverage and comparable precision became widely available for civilian use, which is the Russian GLONASS. Both GPS and GLONASS are Global Navigation Satellite Systems.

The G2 employs GNSSS receivers that can work with both GPS and GLONASS systems

Acquisition Time

Although initial satellite signal lock may be reached in as little as 30 seconds, it may also take as several minutes, depending on the current positions of the visible navigation satellites and their relative signal strength. During this acquisition time, the position, heading, and other data output may be transmitted on an intermittent basis, causing an "Invalid heading" or similar alarms on navigation devices (such as autopilots and radar displays).

Thus, it is best to turn on the G2 and run it for a few minutes, before turning on your other equipment.

Determining Position

The Global Positioning Systems are essentially timing-based position trilateration systems.

The G2's GNSS receivers automatically and continuously try to receive RF signals from all GPS and GLONASS satellites that are visible in the sky. To determine its own geographic position, the G2's GNSS receivers use a complex algorithm incorporating satellite locations and ranges to each satellite. The ranges are calculated by determining how long it takes for the RF signals transmitted from each visible satellite to reach the G2's two antennae, using information carried on those RF signals.

If the signal from a visible satellite is of sufficient quality (i.e., strong enough, and with low noise & errors), the G2's receivers are able to decode the information on the RF signals, and thus to calculate the range to that satellite.

Reception of good-quality signals from at least four GNSS satellites allows the G2's GNSS receivers to compute accurate, high-precision 3-dimensional position coordinates.

Positions computed by the G2 are based on the RF phase centre of the Primary antenna (see page 45).

Differential Corrections

There is usually some error in GNSS positions, from any brand of GNSS receiver. Errors can be caused by many things: Selective Availability, atmospheric effects, timing errors and satellite orbit perturbations are some examples.

But, to improve the accuracy of position computations even more, the G2 can also acquire and use Differential GPS (DGPS) correction data, from one of several possible sources:

- Space-Based Augmentation System (SBAS) satellites, if the G2 is located where one (or more) operational SBAS satellites are visible to it, and if the SBAS data being transmitted by those satellite(s) is valid for the G2's location.

    The G2 automatically scans for and tracks SBAS satellites. It has two-channel tracking capability, which enhances its ability to maintain a lock on a specific SBAS satellite when more than one satellite is in view, and thus provides more consistent tracking.

    Current SBAS systems that the G2 can use include WAAS, EGNOS and MSAS; other compatible systems may be operational in future – SNAS, GAGAN, etc.

- An external data source sending RTCM SC-104 DGPS data to the G2 (via its RS-422 Port 2 or RS232 Port 1).

The G2B can also use:

- Conventional terrestrial DGPS Radiobeacon signals.

    Marine authorities in many countries around the world have installed networks of Radiobeacon transmitters, which broadcast DGPS corrections valid in the vicinity of each such transmitter.

Determining Heading

Satellite visibility & signal quality are again important to how well the G2 operates, in computing heading. Signals from *all* visible satellites are used – even any not being used in the position computations described above.

In other words … the more satellites which are visible, the better!

The G2's GPS engine uses both the data carried on the RF signal from GPS satellites, and measurements of the RF carrier wave's phase, to compute the location of the Secondary

GPS antenna in relation to the Primary GPS antenna, with a very high (sub-centimetre) level of precision.

Each of the GPS receivers measures the phase of the RF signal carrier wave, at its own antenna, from each of the GPS satellites it can see in the sky. The phase of the RF waves at each receiver's antenna depends on the distance, and the horizontal & vertical angles, between the satellite and that individual antenna (this can be demonstrated easily with a simple sketch of the physical geometry relationships).

The G2's computed heading is the direction from the phase centre of the Primary antenna to the Secondary antenna's phase centre.

(Please review if this installation is provided)

Similarly, if the G2 is not installed exactly parallel to the vessel's centreline – or not quite athwartships – a user-set heading offset parameter is applied.

> **Note:** because the actual phase of the RF waves from the satellites is used, reflections of those waves from nearby surfaces can have a significant adverse effect on the heading performance of the G2
>
> The effect can be thought of as being similar to the "ghost" effect (a faint copy of the image, shifted slightly on the screen) that can sometimes be seen on over-the-air TV signals from distant stations.
>
> On the G2, such "ghosting" – from reflections – can cause the heading computation to become inaccurate, or to fail completely.

That is why it is so important to mount the G2 as far away as possible from "reflecting surfaces" (see page 21).

Moving Base Station RTK

The technique of computing the location of the Secondary GPS antenna with respect to the Primary antenna, when the Primary antenna is moving, is often referred to as *Moving Base Station Real-Time Kinematic* (or as *Moving-base-station RTK*, or just *RTK*).

RTK technology is very sophisticated and requires a significant amount of real-time computation – in essence "searching" for the correct solution, within a large number of possible solutions, to the mathematical equations which represent the physical relationships of the G2's two antennae and each visible satellite. The GNSS heading solution is derived from the measured phase difference between the two receiving antennas. We refer to this as the differential phase derived heading.

> **Note**: The G2's Moving-base-station RTK algorithm uses only GNSS signals to calculate heading. No Differential corrections are used in this calculation, and thus the current DGPS source & signal conditions never affect heading accuracy.

Determining Speed and Other Navigation Information

The balance of the information that the G2 can output is in general computed from the position and heading data, or obtained directly from data or other information provided by the GNSS satellites.

For example, speed (1) is determined from the measured Doppler of the primary antennas Phase (2)

In contrast, time & date are obtained from data carried on the RF signals from the satellites.

As well, the G2 can output a wide variety of information on the status of the GPS satellites – e.g., how many are currently in view – and on its own status.

Supplemental Sensors

Integrated inside the G2's enclosure, on the main printed circuit board, are three sensors. An accelerometer, which measures the tilt of the G2's enclosure; a solid-state gyro, which measures the rate of turn, and a magnetometer that may be used to measure the rate of turn and provide heading guidance.

There are ambiguities associated with the differential phase measurements, and knowing where to look, can help to eliminate some of the ambiguity.

All sensors act to reduce the heading search even further, which improves heading start-up and reacquisition times, and also improve the reliability & accuracy of selecting the correct heading solution, by eliminating other possible but erroneous solutions.

The tilt sensor is factory calibrated.

The gyro and the magnetometer together can provide an accurate substitute heading for a short period (depending on the Roll and Pitch motions of the vessel), during instances of momentary obstruction of GPS satellite signals at either antenna; this may occur, for example, when passing close to high vertical walls, or underneath bridges.

When such obstructions occur, the gyro and magnetometer are automatically used to provide an alternate source of heading, accurate to within 1.5°, for up to 1 minutes. Ideally, the gyro and magnetometer based heading will see the system through to reacquisition.

If the outage lasts longer than 1 minute, the gyro is deemed to have drifted too far and the G2 will begin outputting NULL fields in the heading output sentences, which in turn will typically cause a "lost heading" alarm on navigation devices.

Normal heading output will return automatically once satellite signals are re-acquired.

As well, the gyro helps improve and smooth (filter) the heading and rate of turn data output by the G2.

Operation in NMEA 0183 environment

Once the G2 has successfully acquired a sufficient number of GNSS signals, of high enough quality, it begins to generate navigational data – position, heading, speed and so on.

It's up to you what you do with that data, of course!

The G2 is configured at the factory with a specific set of output data settings … enabled output data "sentences", update rates and Baud rates. All those are described in this section.

The suggested standard wiring diagrams (see Figure 14 and Figure **13**) are based on that factory-default output configuration. But you may change the G2's configuration as required, and even wire it differently than shown in the standard diagrams.

Output Ports

Typically, the user of a G2 wants it to output certain navigational data, updated at rates that are suitable for the other equipment connected to the G2, and for what the overall "navigation" system is supposed to be doing.

As well, the "bit rate" (i.e., Baud rate) at which the G2's two output ports are transmitting data (& receiving data, if necessary) must match the device(s) to which each is connected.

The G2's 3 output ports – Port 1, 2 and 3 – allow for different sets of navigation data to be output from the G2. Each port can be configured with its own combination of enabled output data sentences, sentence update rates, and Baud rate.

- For example: when a ComNav autopilot is being used with the G2, heading and speed from the G2 are needed by the autopilot, in order for it to be able to steer the vessel *safely* on the course that the user wants to follow.
    - All ComNav autopilots need heading to be updated at a rate of about 10 Hz or more; any slower causes the autopilot's steering control algorithm to respond too

     slowly to changes in the vessel's actual heading (from wind, waves, current, etc.).

    – Speed is only needed at 1 Hz (or less), since it is not used in the steering algorithm, but only to select which set of steering parameters is being used by the autopilot.

    – Baud rate is always 4800.

  • When used with other types of equipment – e.g., a Chartplotter, a Navigation program on a PC, a Radar set – typically there is other information needed: position, course over ground, time & date, the GPS satellites' status and so on. Update rates required are usually slow – 1 Hz or less.

As mentioned previously, the G2 is configured at the factory for easy use in typical marine situations, such as illustrated in Figure **2**.

Output Data Formats

NMEA 0183 Output

Many of the NMEA 0183 Standard's "navigation & GPS data" sentences are available on the G2.

Of those, the sentences enabled in ComNav's factory-default configuration are denoted **like this**, with the update rate shown in the corresponding column. Sentences not enabled in the factory-default configuration are indicated with an X. Maximum output rates are shown in the far right column, for convenience.

To make changes, see pages 54 for command and sentences structures.

Sentence	Description	Enabled			Max Rate
		Port 1	**Port 2**	**Port 3** ①	
DTM	Datum Reference	X	X	X	1
GGA	**Global Positioning System Fix Data**	**1**	X	X	20
GLL	**Geographic Position (Latitude & Longitude)**	**1**	X	X	20
GNS	GNSS Fix Data	X	X	X	20
GRS	GNSS Range Residuals	X	X	X	20
GSA	**GNSS DOP & Active Satellites**	**0.2**	X	X	1
GST	**GNSS Pseudorange Error Statistics**	**0.2**	X	X	1
GSV	**GNSS Satellites in View**	**0.2**	X	X	1
HDG	True Heading, Variation & Deviation	X	X	X	20
HDM	Magnetic Heading ②	X	X	X	20
HDT	**True Heading ③**	**1**	**10**	X	20
THS	**True heading and status ③**	**50**	X	X	50
HEV	**Heave in meters**	**x**	x	X	20
RMC	**Recommended Minimum Specific GNSS Data**	**0.2**	X	1	20
ROT	**Rate of Turn**	**1**	X	X	20
VTG	**Course and Speed Over Ground**	**1**	**1**	X	20
PZDA	**Time and Date**	**1**	X	X	20

Table 6 – Default NMEA Output Sentences Configuration

① *In units with Port 3*

② *Not approved by the IEC for Marine use*

③ *G2 with software version below 1.6.0 outputs HDT; G2 outputs THS in later versions*

Proprietary Output

A number of proprietary output sentences are available on the G2/G2B.

Maximum output rates are shown in the far right column, for convenience.

Sentence	Description	Enabled			Max Rate
		Port 1	Port 2	Port 3	
PCMN,HPR	**Time, True Heading, and RTK-based Pitch (or Roll)**	*1*	X	X	10
TSS1	Heave, pitch, and roll	X	X	X	20

Table 7 – Default Proprietary Output Sentences Configuration

> **Note:** none of the proprietary sentences are approved by the IEC for marine use.

For full details on the G2's ComNav proprietary sentences, please refer to Appendix 2.

Baud Rate

Each of the G2's output ports can be configured, independent of each other, to communicate at all conventional Baud rates from 4800 up to 38400 Baud.

- For software versions below 1.6.0, the factory-default configuration of Ports 1, 2 and 3 is 4800 Baud
- For software versions from 1.6.0, the factory-default configuration of Ports 1 is 38400 and for Port 2 and 3 4800 Baud.

> **Note:** for operation with all ComNav autopilots, the G2's baud rate must be 4800. For operation with other equipment, other Baud rates may be allowable, depending on the equipment.

Electrical Interface

Another factor in using the G2 is what type of the electrical interface (i.e., signal levels, rise/fall times, circuit impedances) the other equipment uses for its Input/Output "navigation data" connections.

All marine equipment which is fully compliant with the NMEA 0183 Standard (e.g., ComNav autopilots) uses RS-422 levels only.

Other on-board "NMEA compatible" equipment – e.g., PCs – often uses RS-232 levels.

Alarm Output

G2G2B provides 2 types of alarm output for 3 conditions: Audible alarm output (audible device drive output) and NMEA 0183 alert management sentences

Audible Alarm output

An Alarm relay is located on the G2's circuit board. The relay's contacts are isolated from all circuitry in the G2 – the G2's internal processor controls the coil side of the relay, but the contacts of the relay are connected only to the two Alarm pins on the G2's I/O connector.

If the G2 is unpowered, or if it is powered but is not able to compute valid heading data (for example, when it does not have good satellite signals at one of the two antennae. See the alert condition definition in the next section), the relay coil is de-powered. This causes the

relay contacts to open – which can then activate whatever system you wish to use to indicate a Loss-of-Heading condition.

When the G2 is powered, and when its heading output data is valid, the relay coil is powered by the G2's processor, which closes the relay contacts; this indicates that the G2 is operating correctly.

> 📌 Note: Wheelmark/US Coast approved systems require a Power Failure alarm. In such installations an audible alarm device must be connected to the Alarm Output.

ISO 22090-3 compliant NMEA 0183 Alarm Output

ISO 22090-3 requires that the compass keeps updating its alert condition status through a IEC 61162 port.

At power fault, G2 will shut down itself. Therefore the Audible alarm is the only available output.

There are 2 alert conditions that will trigger **Audible Alarm output** and NMEA 0183 alarm output. The 2 conditions are defined in Table 8.

Alert Condition	Alert Id
No position for more than 60 seconds	10001
No heading for more than 60 seconds	10002

Table 8 - Alert conditions

G2 broadcast ALC and ALR at a regular base. When an alert condition changes, G2 outputs ALR and ALF to provide the details of alert condition. All alert sentences are list in Table 9.

Devices that connected to G2's serial ports can detect a power fault by monitoring HBT sentence. HBT is also listed in Table 9.

Sentence	Name	Function	Message direction
ALC	*Cyclic alert list*	Output at every 30 seconds when all alert conditions are cleared. Output when an alert condition changes state. For example, when GNSS signal is lost for more than 60 seconds.	Output
ALF	*Alert sentence*	When an alert condition is triggered or is cleared	Output
ACN	Alert command	Change the alert state as requested by ACN.	Input
ALR	Set Alarm State	30 when no active alarm	Output
ACK	*Acknowledge alarm*	Change the alert state as requested by ACK	Input
HBT	*Heartbeat supervision sentence*	Output at every 60 seconds. This sentence can be used as an indicator of an active connection to G2	Output

Table 9 - Alarm handling sentences

Operate in NMEA 2000 Environment

The CAN port NMEA 2000 uses is a bi-direction half-duplex port. G2 outputs data through standard NMEA 2000 PGNs, and receives proprietary PGNs for system configuration.

NMEA 2000 data output

The data PGNs G2 provides are listed in Table 10.

PGN	Description	Max. update rate	Default update rate (Hz)
126992	System time	10	1
127250	Vessel heading	20	10
127251	Rate of turn	20	10
127257	Attitude	10	1
127258	Magnetic variation	10	1
129025	Position, rapid update	20	10
129026	COG & SOG, rapid update	20	4
129029	GNSS position data	10	1
129033	Time & date	10	1
129538	GNSS control status	(on request)	n/a
129539	GNSS DOPs	5	1
129545	GNSS RAIM output	(on request)	n/a
126993	System heartbeat	1	0.0167

Table 10 - List of data PGNs and default update rates

Changing the Configuration

You may change the factory-default configuration of the G2, if you wish!

- Many other output sentences can be enabled, and/or the factory-default ones disabled, to suit the requirements of any specific installation.
- The output update rate of each enabled sentence may be changed as required.
  - If a given sentence is enabled on both ports, the output rate on each port may the same, or different, if desired.
- The port Baud rates can be changed, as required.
  - There may be different Baud rates on each port, if desired.

These changes, as well as numerous other characteristics of the G2's operation, are done by means of a set of proprietary NMEA sentences or PGNs. These sentences or PGNs must be sent to the G2 from a suitable "control" device, such as the Navigator G2 GPS Compass Display System, or a PC, via the Receive wire on the RS-232 side of the Port 1, or through the CAN port.

For an overview of how to configure the G2's NMEA 0183 output sentences, and tables of the G2's available command sentences, see section under Care & Maintenance Appendix 3.

For an overview G2's NMEA 2000 PGNs, see page 52.

Making Changes

To make changes, a suitable control device must be connected to the G2:

- A PC running suitable software – i.e., HyperTerminal, RealTerm or some other "dumb terminal" program.
- a Navigator G2 GPS Compass Display
- in the IMO model, or in an NMEA 2000 installation, a G3 Compass Display

Using a Terminal Program

If you have a terminal program already installed in your computer, you can use it to customize your G2 Satellite Compass. Tera Term, RealTerm and Hyperterminal are some of the examples of this type of common programs.

You need a serial port to communicate with G2. If your computer does not have a COM port, you can easily find a USB-to-serial-port adapter at a low cost from your local electronics store. The system should be wired as shown in Figure 16 or Figure 17.

G2 configuration is done through pure text commands as listed in Appendix 3. Once you have connected to your G2 through any terminal program, you can send a text command to G2 to change the settings as you want.

Output a command file through a terminal program

You may want to change more than one configuration settings and you want to apply the same configuration to more than one compass. In such case it is a common practise people put all commands into one text file, and send the file to the compass all at once.

Because the communication port has very limited bandwidth, and the compass has a limited memory buffer, sending out too many commands out may result in commands been lost. To prevent the command lost from happening, you should configure the terminal program so that when the text file is sent there is a small pause after each line. Figure 19 shows an example of how to add a 100-ms pause between command lines for Tera Term. Other terminal programs have similar settings.
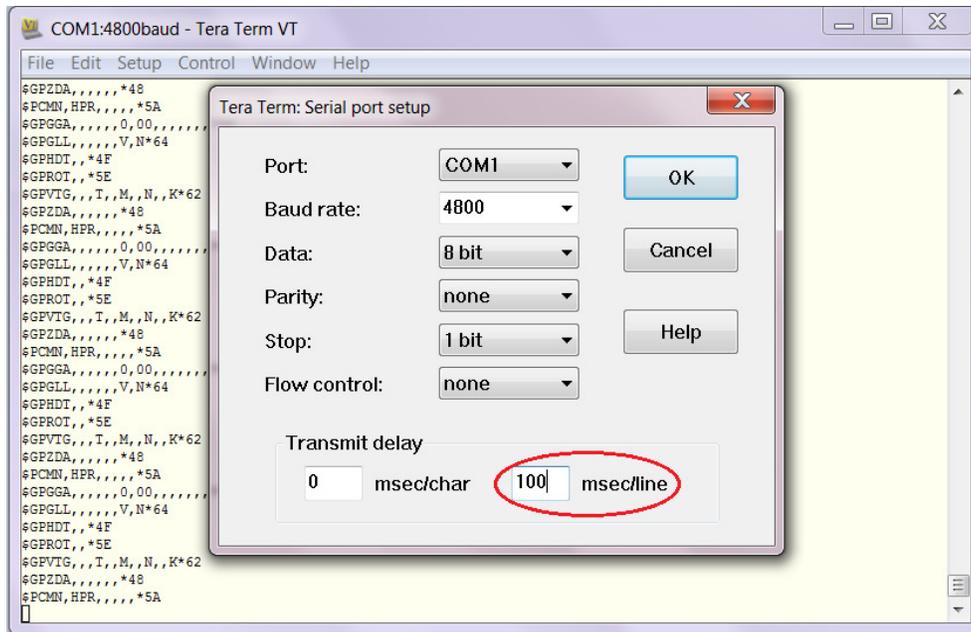
Figure 19 – Setup Tera Term to add a 100ms pause between command lines in a file

Using a Navigator G2

The Navigator G2 GPS Compass Display System is the easiest & *best* way to monitor and control a G2 Satellite Compass.

Full instructions are in the Navigator G2 Installation & Operation Manual.

The system must be wired as shown in Figure 14.

> 📌 ***Navigator G2 only works in 12VDC system. If your system uses 24VDC power supply, you should not use Navigator G2 GPS Compass Display.***

Using a G3 Compass Display

Using G3 Compass Display to configure the G2 satellite compass is the easiest way for an IMO model, or a G2 in a NMEA 2000 network. For the full descriptions please refer to G3 Compass Display's user manual.

However, G3 compass display **cannot** be used to configure NMEA 0183 ports, or change NMEA 0183.

The system must be wired as shown in Figure 1 (for NMEA 2000 network), or as shown in Figure 18 following the connection details in Table 5.

Customising & Fine-tuning the Configuration

There are a number of situations where you might want to change the G2's factory-default configuration settings in ways other than simply enabling or disabling the specific sentences that your system requires, or changing the update rates of the enabled sentence(s).

Smoothing Output Data with Time Constants

The G2 incorporates user-configurable time constants which can provide a degree of smoothing to the course over ground, heading, pitch, rate of turn, and speed outputs.

Each time constant – called "something" TAU – is a value that sets the length of a simple averaging filter for that specific output. For example, the default value of HTAU tells the G2 to smooth heading outputs with a filter that is 2.0 seconds in length.

Table 11 (on the next page) describes all the time constants.

Changing the Time Constants

The G2's default time constant settings are fine for most users.

But you can set the time constants to be a better match to the dynamics of your vessel, if you like.

- For instance, if the vessel is very large and is not able to turn quickly, increasing the heading time constant (HTAU) might be useful. The resulting heading values would have less apparent jitter[1], and be more consistent – both from moment to moment and over longer periods of time as the vessel moves – with the vessel's "real" heading.

- On the other hand, increasing a time constant also increases the G2's time lag in responding to actual changes in the value being measured – i.e., it takes longer for a "real change" in the value being measured to show up in the G2's output data.

  Worse, increasing a time constant too far could create an unacceptable lag in the measurement – to the point where the navigation equipment that is receiving data from the G2 would begin to be adversely affected.

  – For example, an autopilot will begin to appear sluggish in its steering performance, if the heading time constant is increased too far. That's because the time lag on heading will become so large that the autopilot cannot "see" small changes in heading quickly (or perhaps even not at all).

Measurement	Time Constant	Sentences Affected	Usage
Course Over Ground	COGTAU	$GPVTG	• If the vessel is resistant to quick changes in its motion, increase it.
Heading	HTAU	$GPHDT, HDG, HDM	• If vessel does not turn quickly, increase it.
Rate Of Turn	HRTAU	$GPROT	• If vessel does not turn quickly, increase it.
Pitch (or Roll)	PTAU	$PCMN,HPR	• If vessel does not pitch (roll) quickly, increase it.
Speed	SPDTAU	$GPRMC, VTG	• If the vessel does not change speed quickly, increase it.

Table 11 – Smoothing Time Constants

If your vessel is small and highly manoeuvrable, or if you are unsure of how changing these values will affect your vessel (and the other navigation equipment you have on-board), it is probably best to be conservative and leave the time constants at the default settings.

But, if you do wish to change any of the G2's time constants, the next table provides some formulae for figuring out an optimal value of each constant.

Time Constant	Range (seconds)	Formula ①
COGTAU	0.02 to 60 • default: 2.0	$$\frac{20}{\text{max rate of turn (in }°/\sec)}$$

---

[1] There will always be some residual jitter in computed-heading data, even with the G2's sophisticated RTK algorithms. It's an unavoidable effect of the physics & underlying mathematics of the overall GPS system.

HTAU	0.02 to 60.0 • default: 2.0	$$\dfrac{20}{\text{max rate of turn (in }°/\sec)}$$
HRTAU	0.02 to 60 sec • default: 2.0	$$\dfrac{\text{max rate of rate of turn (in }°/\sec^2)}{10}$$
PTAU	0.02 to 60 sec • default: 0.5	$$\dfrac{10}{\text{max rate of pitch (in }°/\sec)}$$
SPDTAU②	0.02 to 60 sec • default: 4.0	$$\dfrac{\text{max rate of acceleration (in metres}/\sec^2)}{10}$$

Table 12 – Time Constant Formulae

① *Speed conversions: 1 Knot = 0.51444 metres/sec & 1 Km/H = 0.53996 Knots*
② *For Radar application, it is suggested to change SPDTAU to 1.0 or lower*
CAUTION! *COG is computed using the Primary GPS receiver only, and its accuracy is dependant upon the speed of the vessel (noise in the COG measurement is inversely proportional to speed).*

When the vessel is stationary, the value of COG is invalid!!

DGPS Source

The factory-default DGPS correction source in the G2 is SBAS. You can turn off differential correction by using $PCMNDIFF, 0.

Baud Rates & Data Bandwidth

If you are going to change the enabled sentences and/or update rates that the G2 is outputting (on one or both ports), you may need to change the Baud rate, with the PCMNBAUD command.

The factory-default Baud rate for all ports in the G2 is 4800 Baud; this complies with the NMEA 0183 Standard. The G2's serial data is always formatted 8-N-1, which means that there are 10 bits sent per byte, and so the factory-default transmit/receive data bandwidth is 480 bytes/second, on each port.

In any serial communications system, the total number of bytes sent per second must not exceed the data bandwidth. A good rule of thumb when setting up serial communications systems is that the total bytes/sec should be less than ~90% of the bandwidth:

• The NMEA & proprietary sentences enabled in the factory defaults fit within the data bandwidth of the factory-default 4800 Baud: 417.4 bytes/sec on Port 1, 2, and 445 bytes/sec on Port 3.

If the Baud rate is too low – i.e., bandwidth less than the total bytes/sec that the G2 is configured to transmit – the data will be corrupted, in random & unpredictable ways. The result will typically be "Invalid Data" errors on the equipment that is connected to the G2.

Care & Maintenance

Care & Maintenance

The G2 & G2B Satellite Compasses haves been designed to provide many years of reliable service. The following care and maintenance tips will help to ensure the longevity of your compass.

Protection of Wires and Cabling

After installation, ensure that the system components are securely mounted and will not shake loose due to the vibrations that can be expected in a marine vessel.

Ensure that the cable to the G2 is well secured with clamps or alternative fasteners.

Many potential problems can be avoided by ensuring that cabling and wiring do not cause any strain on the connectors.

Periodic Checks

After the first six months of operation, a thorough examination of the entire G2 system MUST BE UNDERTAKEN. Verify that all electrical connections, cables, clamps, mounting brackets, and mechanical connections are secure.

An ANNUAL inspection should be undertaken thereafter.

General Precautions

A few precautions will keep the unit in prime condition:

- The G2's enclosure does not require any special maintenance. An occasional cleaning is suggested; use a damp cloth and mild soap.

   Do not use abrasive cleaners or chemicals.

- Avoid exposing the enclosure to solvents, acids, and bases – some of these may weaken the plastic.
- The G2's enclosure is designed to be weatherproof and splash resistant, but it should not be immersed in water for a prolonged period of time.
- Environments exceeding a maximum temperature of 85°C or below a minimum temperature of -40°C MUST BE AVOIDED.

Repair

There are no user-serviceable parts or adjustments inside the G2's enclosure. Should the unit become damaged in any way, return it to an authorized ComNav Dealer.

Fuse Replacement

There are no fuses used inside the G2 itself. However, it is strongly recommended that a fuse (or circuit breaker) be installed in the G2's Power wiring (see page 19).

If the fuse/breaker blows, determine the cause before replacing/resetting!!

Appendices

Appendices

Appendix 1

Specifications

GPS Receiver

Parameter	Specification
Receiver Type	• Twin receivers, 0.5m antenna separation • L1, C/A code, with carrier phase smoothing • 1.575 GHz carrier frequency
Channels	Two x 32 parallel tracking GPS, GLONASS, SBAS
Update Rate	• position: adjustable, 20 Hz max • heading: adjustable, 20 Hz max
Horizontal Accuracy ①	• < 0.3m 95% confidence when using DGPS corrections • < 2.5 m 95% confidence when autonomous (no SA) • Datum: WGS 84
Heading Accuracy ②	< 0.25° rms (Magnetic Variation computations are based on the World Magnetic Model 2005)
Heave accuracy ③	< 30 cm rms Normal operation: GPS Coasting (no GPS): Gyro
Pitch accuracy ③	< 1° rms
Roll accuracy ③	< 1° rms
Rate of Turn	45° per second max.
Start Up time	< 60 seconds typical
Heading Fix	< 10 seconds typical
Satellite Reacquisition	< 1 second
Compass Safe Distance	25cm

Table 13 – GNSS Receiver Specifications

① *Accuracy depends on multipath environment, number of satellites in view and satellite geometry*

② T*he quality of DGPS corrections has no impact on heading performance.*

③ *Based on a 40 second time constant*

Note: *the performance figures above are based on a minimum of four visible satellites, HDOP less than 4, PDOP less than 6, high-quality DGPS corrections and otherwise normal conditions.*

📌 **Excessive multipath, GPS signal obstructions and/or interference may reduce the performance.**

DGPS Beacon Receiver (G2B only)

Parameter	Specification
Channels	2, parallel tracking
Frequency Range	283.5 to 325.0 KHz
Operating Modes	Automatic (signal strength or range) and manual
Sensitivity	2.5 dBµV for 5 dB SNR @ 200 bps
Dynamic Range	100 dB

Adjacent Channel Rejection	61 dB @ ±400 Hz offset
Compliance	IEC 61108-4 Beacon Standard

Table 14 – DGPS Beacon Receiver Specifications

System Interface

Parameter	Specification
Ports	• Port 1 – RS-232 full duplex • Port 2 – RS-422 full duplex, isolated • Port 3 – RS-422 output, isolated. Optional
Baud Rate	4800 – 38400
Data Output Protocol	NMEA 0183, proprietary ASCII (see Table 7) NMEA 2000
Data Input Protocol	NMEA 0183 proprietary NMEA 2000
Timing Output ①	1 PPS, 50 ns accuracy (CMOS level, active Hi, rising edge) Optional
Heading warning I/O	Open relay system indicates invalid heading

Table 15 – System Interface Specifications

① *The 1 PPS Timing output is **NOT** available for those units with Port 3.*

Power

Parameter	Specification
Main Supply Voltage	10 to 36 VDC
Network Power	9 to 27 VDC
Power Consumption	< 3 W nominal, 250 mA (max) @ 12 VDC
NMEA 2000 LEN	1 (Interface only)
	6 (when powered by the network power)

Table 16 – Power Specifications

Mechanical

Parameter	Specification
Dimensions	67 cm x 21.3 cm x 12.2 cm (26.37 in. x 8.37 in. x 4.80 in.), not including mount
Weight	2.2 Kg (G2) 2.7 Kg (G2B)
Enclosure Rating	IP 67
Operating Temperature	-32℃ to +74℃
Storage Temperature	-40℃ to +85℃
Humidity	0 to 95%

Data cable length	• standard:
	  ○ 15 metres (50 feet),
	    or 30 metres (100 feet)
	(custom lengths are available)

Table 17 – Mechanical Specifications

Appendix 2

ComNav Proprietary NMEA 0183 sentences descriptions

GPHPR Message   - Heading, Pitch, Roll; This is a proprietary message

Request:

    $PCMNASC,GPHPR,Rate,<Port>

    Where

- Rate is the message rate in Hz of (10, 2, 1, 0.2, 0)
- Port is the optionally provided port of (1,2,3 or 4)

Response:

```
              1     2        3     4     5     6
              |     |        |     |     |     |
$PCMN,HPR,time,heading,pitch,roll,type*hh
1) UTC time(HHMMSS.SS)
2) Heading (degrees)
3) Pitch (degrees)
4) Roll (degrees)
5) Type N for GPS derived, G for Gyro Heading
6) Hexadecimal Checksum
```

Appendix 3

NMEA 0183 Configuration Commands

If you are not using ComNav's G Series tools and devices, you can still control your G2 using a general serial port communication tool to configure G2. In such case you need to know the commands G2 recognizes; they are listed from Table 18 to Table 22

All commands must end with an END OF LINE sequence (i.e., ASCII <CR><LF> codes).

Some of the commands have optional parameters (shown in square brackets in the tables). The optional parameters, if used, should be entered with the comma shown below, but without the square brackets.

In many cases, it is possible to query the current value, or status, of one of the G2's operating parameters or sensors, by sending the associated command without a value for the parameter (e.g., send $PCMNATT,HBIAS to query the Heading Bias value).

- Some of these commands enable or disable the G2's output sentences. The G2 responds by beginning to output the specified sentence at the specified update rate on the specified port (or by ceasing to output the sentence, if you specify that).
    – When an output sentence can be set to different update rates, the range of valid update rates is shown in parentheses in the Description column. A rate of "0" disables output of a sentence. All rates are in Hz.
    – For output sentences which can only be enabled or disabled, the control parameter is either "0/1" (where 0 disables output of the sentence, and 1 enables it), or the specific words (e.g., "NO/YES") to be used.
    – The units of the various "value" parameters depend on the affected function or setting in the G2 (e.g., rates in Hz, time in seconds, angles in degrees, and so on). All the units are implicit, and are not required in the command.
- Other commands control some aspect of the G2's operation – for example, the Baud rate that the specified port will run at. The G2 responds by making the specified change, and (in most cases) outputs a reply (e.g., "$>PCMNaaa,OK").
- Other commands request some specific information from the G2. The G2 responds with that information – but it only does so one time … i.e., the reply does not "update" on a repeated basis, unlike the NMEA & other outputs.

All changes that you make are "temporary", unless you send a $PCMNSAVE command to the G2. If you power-cycle the G2 before doing that, all your changes will be lost, and the G2 will power-up with the configuration that was last Saved.

*On the other hand, if you **do** send a $PCMNSAVE while the G2 has some changes in settings that you meant to be "temporary" (for example, shutting off all normal data output, so you can query & inspect status more easily), then those changed settings will be the "permanent" power-up settings (until you change things again, and do another $PCMNSAVE).*

*Caution! You **MUST** wait until the G2 responds with a "SAVE OK" reply, after sending a $PCMNSAVE, before you power-down the G2.*

ⓘ Caution ⓘ

Many of the commands in the tables below will affect the performance of the G2. Improper settings may result in degradation of system output, which can affect the overall safety of the vessel and personnel.

Command	Sentence	Rate (Hz)	Port ID
$PCMNASC,GPDTM,rate,port_id	DTM	0, 0.2, 1	1, 2, 3
$PCMNASC,GPGGA,rate, port_id	GGA	0, 0.2, 1, 5, 10 or 20	1, 2, 3
$PCMNASC,GPGLL,rate, port_id	GLL	0, 0.2, 1, 5, 10 or 20	1, 2, 3
$PCMNASC,GPGNS,rate, port_id	GNS	0, 0.2, 1, 5, 10 or 20	1, 2, 3
$PCMNASC,GPGRS,rate, port_id	GRS	0, 0.2, 1, 5, 10 or 20	1, 2, 3
$PCMNASC,GPGSA,rate, port_id	GSA	0, 0.2, 1	1, 2, 3
$PCMNASC,GPGST,rate, port_id	GST	0, 0.2, 1	1, 2, 3
$PCMNASC,GPGSV,rate, port_id	GSV	0, 0.2, 1	1, 2, 3
$PCMNASC,GPTHS,rate, port_id	THS	0, 0.2, 1, 5, 10, 20, 50	1, 2, 3
$PCMNASC,GPHDG,rate, port_id	HDG	0, 0.2, 1, 5, 10 or 20	1, 2, 3
$PCMNASC,GPHDM,rate, port_id	HDM ①	0, 0.2, 1, 5, 10 or 20	1, 2, 3
$PCMNASC,GPHDT,rate, port_id	HDT	0, 0.2, 1, 5, 10 or 20	1, 2, 3
$PCMNASC,GPRMC,rate, port_id	RMC	0, 0.2, 1, 5, 10 or 20	1, 2, 3
$PCMNASC,GPROT,rate, port_id	ROT	0, 0.2, 1, 5, 10 or 20	1, 2, 3
$PCMNASC,GPVTG,rate, port_id	VTG	0, 0.2, 1, 5, 10 or 20	1, 2, 3
$PCMNASC,GPZDA,rate, port_id	ZDA	0, 0.2, 1, 5, 10 or 20	1, 2, 3

Table 18 – Commands for the NMEA Output Sentences

① *Not approved by the IEC for Marine use*

Command	Sentence	Rate (Hz)	Port ID
$PCMNASC,GPHPR,rate,port_id	PCMN,HPR	0, 0.2, 1, 5 or 10	1, 2, 3
$PCMNASC,PTSS1,rate,port_id	TSS1	0, 0.2, 1, 5, 10 or 20	1, 2, 3

Table 19 – Commands for the Proprietary Output Sentences

Command	Action & Time Constant Affected	Range (seconds)
$PCMNATT,COGTAU,cogtau	Query or Set the Course-Over-Ground Constant	cogtau = 0.05 to 200.0
$ PCMNATT,HTAU.htau	Query or Set the Heading Constant	htau = 0.05 to 3600.0
$ PCMNATT,HRTAU,hrtau	Query or Set the Rate of Turn Constant	hrtau = 0.05 to 3600.0
$ PCMNATT,SPDTAU,spdtau	Query or Set the Speed Constant	spdtau = 0.05 to 200.0

Table 20 – Commands for the Smoothing Time Constants

> **Note:** see Smoothing Output Data with Time Constants on page 54 for full details of the TAU time constants.

Command	Description
$ PCMNATT,HBIAS[,hbias]	• Query or Set Heading Output Offset • hbias range is −180° to +180°
$ PCMNATT,PBIAS[,pbias]	Query or Set the Pitch Output Offset • pbias range is −15° to +15°
$ PCMNATT,RBIAS[,rbias]	Query or Set the Roll Output Offset • rbias range is −15° to +15°
$PCMNBAUD,rate,port_id	Query or Set the Baud rate • rate = 4800, 9600, 19200, 38400 for port_id=2, 3 • rate = 4800, 9600 for port_id = 1 *(If you change the G2's Baud rate, you **must** change the other device(s) to match!)*

Table 21 – Commands for Output Biases and port baud rates

Command	Description
$PCMNATT, CSEP	Query current antenna separation. Returns the currently set separation in mm in an $PCMNATT,MSEP message
$PCMNATT,MSEP,sep	Set the actual separation between the antennae ⓘ *In the G2 & G2B, the physical antenna separation is fixed at 0.5 metres – so this command should only be used to check that the MSEP value is set correctly (to 0.5m)!*
$PCMNATT,SUMMARY	Query current settings of several parameters
$PCMNDIFF[,mode]	Query or Set differential corrections on or off: • Mode = 0 (Off) or 1 (On)
$PCMNMASK,angle	Set the satellite tracking elevation cut-off angle. Satellite measurement below this angle will not be used for navigation processing
$PCMNOFF	Turn off all NMEA & Proprietary data output. This wipes out the stored NMEA configuration data
$PCMNSAVE	Save current operating configuration

Table 22 – Commands for Status & Configuration

Command	Description
$PCMNBC,COMMAND	Enter beacon configuration mode
$PCMNBC,DATA	Exit beacon configuration mode
$PCMNBC,SAVE	save the beacon configuration to non-volatile memory
$PCMNBC,SEND,command [parameter name][parameter list]	Send a beacon configuration command

Table 23 - Commands for G2B beacon configuration

Command	Description	Parameter Name	Parameter List
MAP	To create, modify and save the frequency channel map	C	Channel number (1-32)
		F	Carrier frequency in Hz
		SAVE	Saves the channel map
SCAN		FREQ	Sets/gets the scanning mode 1 – Full range scanning at 500 Hz steps 2 – Channel map scanning. Up to 32 channels are available in the channel map
		SIGTYPE	Sets/gets the signal type for scanning 1 – 100 bps signals are scanned 2 – 200 bps signals are scanned 3 – 50 bps signals are scanned 4 – all signal types (200 bps, 100 bps, 50 bps) are scanned

Table 24 - G2B Beacon configuration command details

Appendix 4

Configure Beacon stations for G2B

G2B compass has an internal beacon receiver. The internal beacon receives pseudo range corrections from Radiobeacon stations with a carrier frequency from 283.5 kHz to 325 kHz. The beacon receiver can scan beacon signals from that range automatically, or it can search for specific frequencies depending on the configuration. Out of factory the beacon receiver is configured to automatically search for a beacon reference station within the frequency range at a step of 500 Hz once the G2B is powered on. This default configuration allows G2B to work at different locations worldwide.

At some locations, automatic scan for a beacon station may take a long time (up to 35 minutes). If you know the information of a beacon station or stations close to the G2B, you can significantly reduce the lengthen search time by limiting the frequencies to be scanned. The next section describes how to do so.

The information you must know about the beacon station is its frequency.

You communicate to G2B's internal beacon model the same way you configure the G2B through its RS232 Port1. Connecting the port a PC COM port, and through a general hyperterminal style program, you can check the beacon receiver status and change its configuration easily.

Enter and exit the beacon configuration mode

Before you can change the beacon configuration, you must enter the beacon configuration mode. This command will place G2B into the beacon configuration mode:

> $PCMNBC,COMMAND<CR><LF>

After entering the configuration, you can exit it by issuing:

> $PCMNBC,DATA<CR><LF>

Send a configuration command to the beacon

In the beacon configuration mode, you can send a command to the beacon through the following sentence:

> $PCMNBC,SEND,command[parameter name][parameter list]<CR><LF>

The commands the G2B internal beacon supports are summarized in Table 22.

Change the beacon scanning mode

The beacon has 2 scanning modes, AUTOMATIC scan and MAPPED scan. In AUTOMATIC scan mode, the beacon scans the full frequency range from 328.5 kHz to 325 kHz at 500 Hz steps. In MAPPED scan mode, the beacon looks for the frequencies from a frequency table and scans each frequency circularly.

Create and/or modify Channel Map Table

The frequency table is called Channel Map Table; each item in the table has 2 columns. One is named Channel, and the other Frequency. You can check the content of the table in your unit by issuing:

> $PCMNBC,SEND,MAP<CR><LF>

Figure 20 shows an example of Channel Map Table output. The table has 4 frequencies that occupy from channel 1 to channel 4.
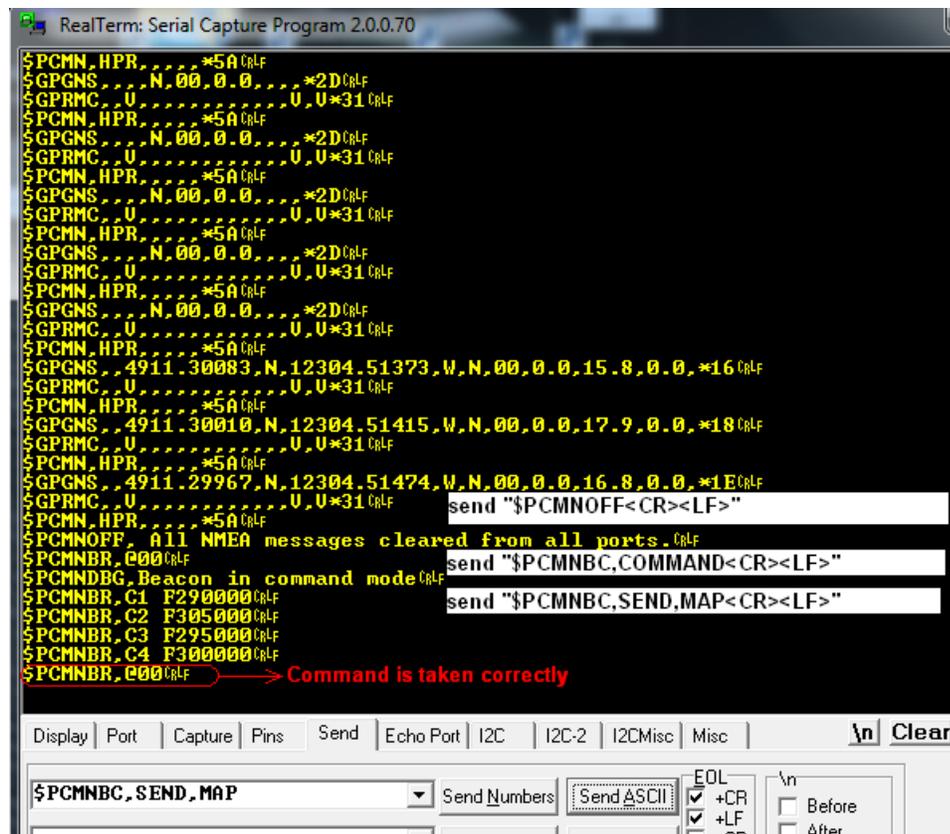
Figure 20 - G2B beacon configuration interface screenshot

To change the frequency for channel 1 from 290 kHz to 325 kHz, you can type in:

$PCMNBC,SEND,MAP C1 F325000<CR><LF>

The above command will create Channel 1 if the channel is not already exists, or modify the frequency if the channel exists. It is recommended that you always modify the existing channel when possible instead of adding a channel. This is because the more channels you add into the table, the longer the beacon start up time will be.

If the command is taken, you will see a response $PCMNBR,@00. If you see the return parameter is not @00 but @01 or any other number led by @, the beacon receiver is too busy to take the input. In such case you should send the command again. This applies all commands you send to the beacon (Note response values without the leading @ symbol do not follow this convention).

You **MUST** save your Channel Map by $PCMNBC,SEND,MAP SAVE<CR><LF>, otherwise the beacon will restore the previous channel map once the G2B is powered off.

Change the Scanning mode

To enquire the current scanning mode, you can type in:

$PCMNBC,SEND,SCAN FREQ<CR><LF>

The response should be $PCMNBR,1 or $PCMNBR,2. Returning of 1 indicates that the beacon is in the full range automatic scanning mode; returning of 2 indicates that it is in the channel map scanning mode.

To set the scanning mode to a particular mode, add the frequency mode value to the above command. For example, this command set the beacon to the channel map scanning mode:

$PCMNBC,SEND,SCAN FREQ 2<CR><LF>

You **MUST** save your scanning configuration by $PCMNBC,SAVE<CR><LF>, otherwise the beacon will return to the previous scanning mode once you power off.

A beacon configuration example

We are giving a step-by-step example to configure the beacon for a particular location here.

In this example, we assume that there are 3 beacon stations close to where your G2B is installed, and the frequencies of these stations are 215.5 kHz, 305 kHz and 276 kHz.

1. Turn off all NMEA 0183 sentences by
        $PCMNOFF<CR><LF>

   Note we do not save this configuration so that you can return to your previous settings in the next power cycle

2. Place the beacon in the command mode
        $PCMNBC,COMMAND<CR><LF>

3. Create the 3 channels in the channel map table and save the channel map
        $PCMNBC,SEND,MAP C1,215500<CR><LF>
        $PCMNBC,SEND,MAP C2,305000<CR><LF>
        $PCMNBC,SEND,MAP C3,276000<CR><LF>
        $PCMNBC,SEND,MAP SAVE<CR><LF>

   Note by always use the lowest channel numbers, you are more likely to replace an existing channel thus to keep the number of total table items low.

   If you have more than a couple of frequencies to enter, you can put all commands to a text file (including the SAVE command) and send the file to G2B.

4. Set the beacon mode to channel map scanning. If you are already in that mode, the command will have no effect
        $PCMNBC,SCAN,FREQ 2<CR><LF>

5. Save the beacon configuration for the next power cycle
        $PCMNBC,SAVE<CR><LF>

6. Exit the beacon command mode
        $PCMNBC,DATA<CR><LF>

7. Turn off and turn on the unit to recover the previous sentence settings

Note 1: if you are at a location where there is no satellite in view, and it takes awhile for you to finish the configuration, the device may attempt to reset the system, causing the NMEA 0183 sentence outputs. In such situation, you can repeat the step 1 to turn off all sentences again.

Note 2: if you have not sent a command to the beacon for over 1 minute after step 2, the G2B may stop responding to $PCMNBC commands. In such case you can use $PCMNBC,DATA to exit the beacon command mode and re-start your configuration all again.

Appendix 5

Retrofit G2/G2B to Vector G2/G2B

G2/G2B uses a better shielded cable than ComNav's previous Vector G2/G2B system. It is recommended you always change your cable when you replace a Vector G2/G2B by a G2/G2B.

However there are circumstances when re-cabling is impossible or too costly that you just have to use your old Vector cable for the new G2/G2B. In such cases, you may use a G2 cable converter (Part Number 31220020) to connect the G2/G2B and the Vector cable. Note your Vector cable must have a part number 051-0157-002 or 0510158-001.

There are several limitations if you choose to use the Vector cable with this converter:

1. The converter can only be used in flush mount, not pole mount. You will get a new mounting gasket different from the G2 standard one.
2. You don't have access to the NMEA 2000 port when you use the Vector cable
3. The color code of the vector cable changes slightly after using this converter. You have to rewire your devices based on Table 25.

Vector B2/G2B cable Supports New ComNav G serial Compass With the Convertor Cable		
Vector Cable 051-0157-002, 0510158-001		
Wire Color	**G Serial Signal Description**	**Note**
Red	Power (+)	
Black	Power (-)	
Blue	Port 1 Tx RS232	
Black/Blue	Port 1 Rx RS232	
Brown	Port 2 Rx RS422 A	
Black/Brown	Port 2 Rx RS422 B	
Yellow	Port 2 Tx RS422 A	
Black/Yllow	Port 2 Tx RS422 B	
Green	1PPS+ / Port 3 Tx RS422 A	Shared wires
Black/Green	1PPS- / Port 3 Tx RS422 B	
	CAN_L	NC
	CAN_H	
Orange	NET_S	Not to use
Black/Orange	NET_C	
White	Alarm 1	
White/Red	Alarm 2	
Gray	Port1 GND RS232	
	Drain	
Note	User has to reconnect external devices following this table for support the new ComNav G serial compass when keep using Vector cable with the cable convertor. .	

Table 25 - Vector G2/G2B color code when used with G series G2/G2B

If you encounter any EMC problem after using the Vector cable, it is suggested you replace it with the new G2/G2B cable.

Wheelmark Compliance Certificate

Bundesrepublik Deutschland
Federal Republic of Germany
BSH-Cert
Benannte Stelle – Navigations- und Funkausrüstung
beim Bundesamt für Seeschiffahrt und Hydrographie
*Notified Body – Navigation and Radiocommunication Equipment
at the Federal Maritime and Hydrographic Agency*

NOTIFIED
BODY
0735

EC TYPE EXAMINATION (MODULE B) CERTIFICATE

This is to certify that:

BSH-Cert specified as a 'notified body' under the terms of „Schiffssicherheitsgesetz" of 09 September 1998 (BGBl. I, p. 2860) modified last 08 March 2012 (BGBl. I, p. 483), did undertake the relevant type approval procedures for the equipment identified below which was found to be in compliance with the Navigation requirements of Marine Equipment Directive (MED) 96/98/EC and the last modification by Directive 2012/32/EU.

Manufacturer	ComNav Marine Ltd.
Address	#15-13511 Crestwood Place, Richmond, BC, V6V 2G1, CANADA
Applicant	ComNav Marine Ltd.
Address	#15-13511 Crestwood Place, Richmond, BC, V6V 2G1, CANADA
Annex A.1 Item (No & item designation)	4.41 Transmitting Heading Device THD (GNSS method)
Product Name	G2 Satellite Compass, G3 Satellite Compass System
Trade Name(s)	G2 Satellite Compass, G3 Satellite Compass System

Specified Standard(s)

IMO Resolution MSC.116(73)	ISO 22090-3 Ed. 1.0, 2004 incl. Corr. 1, 2005
IMO Resolution A.694(17)	IEC 60945 Ed. 4.0, 2002 incl. Corr. 1,2008
IMO Resolution MSC.191(79)	IEC 62288 Ed. 1.0, 2008
	IEC 61162-1 Ed. 4.0, 2010
	IEC 61162-2 Ed. 1.0, 1998

Based on the Directive 2011/75/EU, additional applied version: Directive 2012/32/EU
This certificate remains valid unless cancelled, expired or revoked.

Date of issue:	23 October 2013	Issued by: BSH-Cert
		Bernhard-Nocht-Str. 78, 20359 Hamburg, Germany
Expiry date:	22 October 2018	Notified body 0735

Certificate No.:   **4581/001/4412488/13**

This certificate consists of 2 pages.

Kai/Jens Schulz-Reifer

This certificate is issued under the authority of the „Bundesministerium für Verkehr, Bau und Stadtentwicklung". V V 2013-06-21

EC TYPE EXAMINATION CERTIFICATE No. 4601/001/4412466/13   Page 2 of 2

Components necessary for operation:

G2

Component	Type designation	Part. No.	Software
Antenna and receiver	G2	21220001	1.2.x

Or:

G3 GNSS System (Part No. 10130001)

Component	Type designation	Part. No.	Software
Antenna and receiver	G2	21220001	1.2.x
Display	G3 Display	30130012	0.33.x

Approval Documentation:

BSH Test Report No.: BSH/4612/4412671/13
BSH Test Report No.: BSH/4612/4412671/13-1
LabTest Test Report 11121-1E Rev. 0 of May 28, 2013
LabTest Test Report 11121-1S Rev. 0 of August 2, 2013
Installation & Operation Manual PN 29010078 V1.3
(actual version:
 G2 & G2B Satellite Compasses Installation & Operation Manual PN 29010093 V 1.0)

Places of production:

—

Limitations on the acceptance or use of the product:

This equipment is able to provide position data on the serial output

This certificate does not cover approval of the equipment as GPS (A.1/4.14)

Conditions on the acceptance or use of the product:

All displays, which are used for the presentation of the THD indications shall be approved and in compliance with the requirements of:

IEC 60945 Ed. 4.0, 2002 incl. Corr. 1, 2008

IEC 61162-1 Ed. 4.0, 2010 and/or

IEC 61162-2 Ed. 1.0, 1998

IMO Resolution MSC.191(79) + IEC 62288 Ed. 1.0, 2008

Notes:

The manufacturer shall inform BSH-Cert, as the notified body, of any modifications to the type-tested product(s) that may affect compliance with the requirements or conditions laid down for use of the product(s).

In case the specified regulations or standards are amended during the validity of this certificate, the product(s) must be re-certified before being placed on board vessels to which such amended regulations or standards apply.

The Mark of Conformity (wheelmark) may only be affixed to the type approved equipment, and a Manufacturer's Declaration of Conformity may only be issued, if the product quality system fully complies with the Marine Equipment Directive and is certified by a notified body against ANNEX B module D, E, or F of the Directive.

Notice on legal remedies available:

Objection to this document may be filed within one month after notification. The objection must be filed in writing to, or put on record at, Federal Maritime and Hydrographic Agency, Bernhard-Nocht-Str. 78, 20359 Hamburg, Germany

CE Compliance
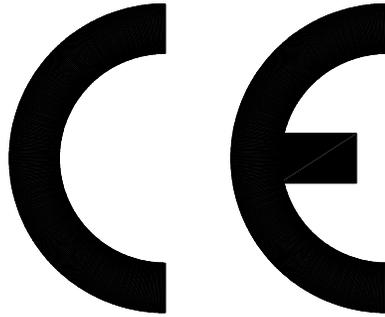
This product has been tested and is in compliance with the Navigation requirements of Marine Equipment Directive 96/98/EC and the last modification by Directive 2012/32/EU, and therefore bears the CE-marking.

It has been tested according to the applicable sections outlined under:

> ISO 22090-3 Ed. 1.0, 2004 incl. Corr. 1, 2005
>
> IEC 60945 Ed. 4.0, 2002 incl. Corr. 1, 2008
>
> IEC 62288 Ed.1.0, 2008
>
> IEC 61162-1 Ed. 4.0, 2010
>
> IEC 61162-2 Ed. 1.0, 1998

License Agreement

COMNAV MARINE LTD. FIRMWARE LICENSE AGREEMENT

BEFORE USING LICENSED FIRMWARE, CAREFULLY READ THIS LICENSE AGREEMENT.

This document is an agreement ("Agreement") between the end user (the "Licensee") and ComNav Marine Ltd, ("ComNav") that sets forth the Licensee's rights and obligations with respect to the ComNav software and firmware, including without limitation any accompanying documentation, hardware or media (the "Firmware") and prevails over any additional, conflicting or inconsistent terms and conditions appearing on any purchase order or other document submitted by the Licensee. "Affiliate" means any person, partnership, corporation, limited liability company, other form of enterprise that directly or indirectly through one or more intermediaries, controls, or is controlled by, or is under common control with the party specified. In this Agreement, any ComNav Product that has Firmware embedded in it or included with it at the time of sale to the Licensee shall be referred to as the "Product". This Agreement constitutes the entire understanding between the parties, with respect to the subject matter of this Agreement.

BY USING OR OTHERWISE ENABLING THE PRODUCT, THE LICENSEE REPRESENTS IT IS AUTHORIZED TO ACCEPT THESE TERMS ON BEHALF OF THE END USER (IF THE END USER IS AN ENTITY ON WHOSE BEHALF THE LICENSEE IS AUTHORIZED TO ACT, THE LICENSEE SHALL BE DEEMED TO REFER TO THE END USER) AND THAT THE LICENSEE AGREES TO BE BOUND BY THE TERMS OF THIS AGREEMENT, WHICH INCLUDES, AMONG OTHER PROVISIONS, THE LICENSE, THE DISCLAIMER OF WARRANTY AND THE LIMITATION OF LIABILITY. IF THE LICENSEE DOES NOT AGREE TO THE TERMS OF THIS AGREEMENT OR ARE NOT AUTHORIZED TO ENTER INTO THIS AGREEMENT, COMNAV IS UNWILLING TO LICENSE THE FIRMWARE TO THE LICENSEE AND THE LICENSEE AGREES THAT THE LICENSEE IS NOT AUTHORIZED TO ENABLE OR USE SAID LICENSED FIRMWARE.

The Licensee and ComNav agree as follows:

1. **LICENSE**. The Licensee has the non-exclusive and non-transferable license to enable the Firmware on each Product that the Licensee has purchased subject to the terms and conditions of this Agreement.

2. **RESTRICTIONS.** Except as otherwise authorized in writing by ComNav, the Licensee may not, nor may the Licensee permit any third party to:
    a. Reverse engineer, decompile, disassemble or modify the Firmware, in whole or in part, except to the extent expressly permitted by applicable law and to the extent the parties shall not be permitted by that applicable law, such rights are expressly excluded.
    b. Incorporate the Firmware in whole or in part, in any other product or create derivative works based on the Firmware, in whole or in part.
    c. Publish, disclose, copy reproduce or transmit the Firmware, in whole or in part.
    d. Assign, sell, license, sublicense, rent, lease, encumber by way of security interest, pledge or otherwise transfer the Firmware, in whole or in part.
    e. Remove any copyright, trademark, proprietary rights, disclaimer or warning notice included on or embedded in any part of the Firmware

3. **UPDATES**. At ComNav's discretion ComNav may make Updates available to the Licensee. An update ("**Update**") means any update to the Firmware that is made available to the Licensee including error corrections, enhancements and other modifications. All Updates that the Licensee downloads, installs or uses shall be deemed to be Firmware and subject to this Agreement. ComNav reserves the right to modify the Product without any obligation to notify, supply or install any improvements or alterations to existing Firmware.

4. **OWNERSHIP.** ComNav owns all rights, title and interest in and to the Firmware and related materials, including all intellectual property rights. The Firmware is licensed to the Licensee, not sold.

5. **LIMITED WARRANTY**. ComNav warrants solely to the Licensee, subject to the exclusions and procedures set forth herein, that for a period of two (2) years from the original date of purchase of the Product in which it is embedded (the "Warranty Period"), the Firmware, under normal use and maintenance, will conform in all material respects to the documentation provided with the Firmware and any media will be free of defects in materials and workmanship. For any Update, ComNav warrants, for 90 days from performance or delivery, or for the balance of the original Warranty Period, whichever is greater, that the Update, under normal use and maintenance, will conform in all material respects to the documentation provided with the Update and any media will be free of defects in materials and workmanship. Notwithstanding the foregoing, ComNav does not warrant that the Firmware will meet Licensee's requirements or that its operation will be error free.

6. **WARRANTY EXCLUSIONS**. The warranty set forth above will not apply to any deficiencies caused by (a) the Product not being used as described in the documentation supplied to the Licensee, (b) the Firmware having been altered, modified or converted in any way by anyone other than ComNav, (c) any malfunction of the Licensee's equipment or other firmware or software, or (d) damage occurring in transit or due to any accident, abuse, misuse, improper installation, lightning (or other electrical discharge) or neglect. ComNav does not warrant or guarantee the precision or accuracy of positions obtained when using the Firmware. The Product and the Firmware is not intended

and should not be used as the primary means of navigation or for use in safety of life applications. The potential positioning and navigation accuracy obtainable with the Firmware as stated in the Product or Firmware documentation serves to provide only an estimate of achievable accuracy based on specifications provided by the US Department of Defense for GPS positioning and DGPS and GNSS service provider performance specifications, where applicable.

7. **WARRANTY DISCLAIMER.** EXCEPT AS EXPRESSLY SET OUT IN THIS AGREEMENT, COMNAV MAKES NO REPRESENTATION, WARRANTY OR CONDITION OF ANY KIND TO THE LICENSEE, WHETHER VERBAL OR WRITTEN AND HEREBY DISCLAIMS ALL REPRESENTATIONS, WARRANTIES AND CONDITIONS OF ANY KIND INCLUDING FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, ACCURACY, RELIABILITY OR THAT THE USE OF THE FIRMWARE WILL BE UNINTERRUPTED OR ERROR-FREE AND HEREBY DISCLAIMS ALL REPRESENTATIONS, WARRANTIES AND CONDITIONS ARISING AS A RESULT OF CUSTOM, USAGE OR TRADE AND THOSE ARISING UNDER STATUTE.

8. **LIMITS ON WARRANTY DISCLAIMER.** Some jurisdictions do not allow the exclusion of implied warranties or conditions, so some of the above exclusions may not apply to the Licensee. In that case, any implied warranties or conditions which would then otherwise arise will be limited in duration to ninety (90) days from the date of the license of the Firmware or the purchase of the Product. The warranties given herein give the Licensee specific legal rights and the Licensee may have other rights which may vary from jurisdiction to jurisdiction.

9. **CHANGE TO WARRANTY.** No employee or agent of ComNav is authorized to change the warranty provided or the limitation or disclaimer of warranty provisions. All such changes will only be effective if pursuant to a separate agreement signed by senior officers of ComNav.

10. **WARRANTY CLAIM.** In the event Licensee has a warranty claim the Licensee must first check for and install all Updates that are made available by ComNav. The warranty will not otherwise be honored. Proof of purchase may be required. ComNav does not honor claims asserted after the end of the Warranty Period.

11. **LICENSEE REMEDIES.** In all cases which involve a failure of the Firmware to conform in any material respect to the documentation during the Warranty Period or a breach of a warranty, ComNav's sole obligation and liability, and Licensee's sole and exclusive remedy, is for ComNav, at ComNav's option, to (a) repair the Firmware, (b) replace the Firmware with Firmware conforming to the documentation, or (c) if ComNav is unable, on a reasonable commercial basis, to repair the Firmware or to replace the Firmware with conforming Firmware within ninety (90) days, to terminate this Agreement and thereafter Licensee shall cease using the Firmware. ComNav may also issue a refund for the price paid by Licensee less an amount on account of amortization, calculated on a straight-line basis over a deemed useful life of three (3) years.

12. **LIMITATION OF LIABILITY**. IN NO EVENT WILL COMNAV OR ITS SUPPLIERS BE LIABLE FOR ANY DAMAGES WHATSOEVER INCLUDING WITHOUT LIMITATION DAMAGES FOR ANY INCIDENTAL, CONSEQUENTIAL, SPECIAL OR INDIRECT DAMAGES ARISING IN RELATION TO ANY LOSS OF DATA, INCOME, REVENUE, GOODWILL OR ANTICIPATED SAVINGS EVEN IF COMNAV HAS BEEN INFORMED OF THE POSSIBILITY OF SUCH LOSS OR DAMAGE. FURTHER, IN NO EVENT WILL COMNAV'S TOTAL CUMULATIVE LIABILITY HEREUNDER, FROM ALL CAUSES OF ACTION OF ANY KIND, EXCEED THE TOTAL AMOUNT PAID BY LICENSEE TO COMNAV TO PURCHASE THE PRODUCT. THIS LIMITATION AND EXCLUSION APPLIES IRRESPECTIVE OF THE CAUSE OF ACTION, INCLUDING BUT NOT LIMITED TO BREACH OF CONTRACT, NEGLIGENCE, STRICT LIABILITY, TORT, BREACH OF WARRANTY, MISREPRESENTATION OR ANY OTHER LEGAL THEORY AND WILL SURVIVE A FUNDAMENTAL BREACH.

13. **LIMITS ON LIMITATION OF LIABILITY.** Some jurisdictions do not allow for the limitation or exclusion of liability for incidental or consequential damages, so the above limitation or exclusion may not apply to Licensee and Licensee may also have other legal rights which may vary from jurisdiction to jurisdiction.

14. **BASIS OF BARGAIN.** Licensee agrees and acknowledges that ComNav has set its prices and the parties have entered into this Agreement in reliance on the limited Warranties, warranty disclaimers and limitations of liability set forth herein, that the same reflect an agreed-to allocation of risk between the parties (including the risk that a remedy may fail of its essential purpose and cause consequential loss), and that the same forms an essential basis of the bargain between the parties. Licensee agrees and acknowledges that ComNav would not have been able to sell the Product at the amount charged on an economic basis without such limitations.

15. **PROPRIETARY RIGHTS INDEMNITY**. ComNav shall indemnify, defend and hold harmless Licensee from and against any and all actions, claims, demands, proceedings, liabilities, direct damages, judgments, settlements, fines, penalties, costs and expenses, including royalties and attorneys' fees and related costs, in connection with or arising out of any actual infringement of any third party patent, copyright or other intellectual property right by the Firmware or by its use, in accordance with this Agreement and documentation, PROVIDED THAT: (a) ComNav has the right to assume full control over any action, claim, demand or proceeding, (b) Licensee shall promptly notify ComNav of any such action, claim, demand, or proceeding, and (c) Licensee shall give ComNav such reasonable assistance and tangible material as is reasonably available to the Licensee for the defense of the action, claim, demand or proceeding. Licensee shall not settle or compromise any of same for which ComNav has agreed to assume responsibility without ComNav's prior written consent. Licensee may, at its sole cost and expense, retain separate

counsel from the counsel utilized or retained by ComNav.

16. **INFRINGEMENT.** If use of the Firmware may be enjoined due to a claim of infringement by a third party then, at its sole discretion and expense, ComNav may do one of the following: (a) negotiate a license or other agreement so that the Product is no longer subject to such a potential claim, (b) modify the Product so that it becomes non-infringing, provided such modification can be accomplished without materially affecting the performance and functionality of the Product, (c) replace the Firmware, or the Product, with non-infringing Firmware, or product, of equal or better performance and quality, or (d) if none of the foregoing can be done on a commercially reasonable basis, terminate this license and Licensee shall stop using the Product and ComNav shall refund the price paid by Licensee less an amount on account of amortization, calculated on a straight-line basis over a deemed useful life of three (3) years. The foregoing sets out the entire liability of ComNav and the sole obligations of ComNav to Licensee in respect of any claim that the Firmware or its use infringes any third party rights

17. **INDEMNIFICATION**. Except in relation to an infringement action, Licensee shall indemnify and hold ComNav harmless from any and all claims, damages, losses, liabilities, costs and expenses (including reasonable fees of lawyers and other professionals) arising out of or in connection with Licensee's use of the Product, whether direct or indirect, including without limiting the foregoing, loss of data, loss of profit or business interruption.

18. **TERMINATION**. The Licensee may terminate this Agreement at any time without cause. ComNav may terminate this Agreement upon 30 days' notice to Licensee if Licensee fails to materially comply with each provision of this Agreement unless such default is cured within the 30 days. Any such termination by a party shall be in addition to and without prejudice to such rights and remedies as may be available, including injunction and other equitable remedies. Upon receipt by Licensee of written notice of termination from ComNav or termination by Licensee, Licensee shall at the end of any notice period (a) cease using the Firmware; and (b) return to ComNav (or destroy and provide a certificate of a Senior Officer attesting to such destruction) the Firmware and all related material and any magnetic or optical media provided to Licensee. The provisions of Sections 4, 5, 6, 7, 12, 17, 21 and 23 herein shall survive the expiry or termination of this Agreement for any reason.

19. **EXPORT RESTRICTIONS**. The Licensee agrees that the Licensee will comply with all export control legislation and regulations of Canada, the United States, Australia, the European Union and all other applicable laws and regulations as may be applicable to the relative countries or jurisdictions.

20. **FORCE MAJEURE.** Neither party will have the right to claim damages as a result of the other's inability to perform or any delay in performance due to unforeseeable circumstances beyond its reasonable control, such as labor disputes, strikes, lockouts, war, riot, insurrection, epidemic, Internet virus attack, Internet failure, supplier failure, act of God, or governmental action not the fault of the non-performing party.

21. **DISPUTES**. The parties agree that the courts located in Vancouver, British Columbia and the courts of appeal there from will have exclusive jurisdiction to resolve any disputes between the Licensee and ComNav concerning this Agreement or the Licensee's use or inability to use the Firmware and the parties hereby irrevocably agree to attorn to the jurisdiction of those courts. Notwithstanding the foregoing, either party may apply to any court of competent jurisdiction for injunctive relief.

22. **APPLICABLE LAW**. This Agreement shall be governed by the laws of the Province of British Columbia, Canada, exclusive of any of its choice of law and conflicts of law jurisprudence.

23. **CISG.** The United Nations Convention on Contracts for the International Sale of Goods will not apply to this Agreement or any transaction hereunder.

24. GENERAL. This is the entire agreement between Licensee and ComNav relating to the Product and Licensee's use of the same, and supersedes all prior, collateral or contemporaneous oral or written representations, warranties or agreements regarding the same. No amendment to or modification of this Agreement will be binding unless in writing and signed by duly authorized representatives of the parties. Any and all terms and conditions set out in any correspondence between the parties or set out in a purchase order which are different from or in addition to the terms and conditions set forth herein shall have no application and no written notice of same shall be required. In the event that one or more of the provisions of this Agreement is found to be illegal or unenforceable, this Agreement shall not be rendered inoperative but the remaining provisions shall continue in full force and effect.

25.

Warranty Information

Limited Warranty

This Limited Warranty (the "Warranty") covers all G Series Satellite Compass products & accessories (the "Equipment") sold by ComNav Marine Ltd. ("ComNav").

LIMITED TWO YEAR WARRANTY

ComNav warrants to the Purchaser, provided that the recommended installation and maintenance procedures set forth in the manual (the "Manual") that has been provided with the Equipment have been followed, and subject always to the other provisions of this Warranty, that the Equipment is free from defects in workmanship and materials under normal use and service for a period of two (2) years from the date of purchase of the Equipment by the Purchaser.

EXCLUSIONS

This Limited Warranty is null and void if:

1. The serial number of the Equipment has been removed, altered or mutilated;
2. Any of the anti-tamper seals covering case-screw holes, or other mechanisms for opening the Equipment's case, have been removed, broken or otherwise tampered with;
3. There are any defects in it, or damages to it, caused by:
    a. Faulty installation or hook-up of the Equipment;
    b. Abuse, misuse, or any use of the Equipment in violation of the instructions set forth in the Manual;
    c. Shipping, alterations, or incorrect and/or unauthorized service;
    d. Accident, exposure of the Equipment to excessive heat, fire, lightning or other electrical discharge, or water immersion;
    e. Water damage due to failure to fully fasten the plug connected into the Equipment's power/signal receptacle;
    f. Improper or inadequate ancillary or connected equipment.

OTHER LIMITATIONS AND EXCLUSIONS

1. ComNav does not warrant or guarantee the precision or accuracy of positions, heading, or other GPS-based navigation data obtained when using the Equipment. The potential accuracy of the Equipment, as stated in the Manual, associated ComNav literature and/or Product specifications, provides only an estimate of the highest achievable accuracy based on:
    a. Specifications provided by the US Department of Defence for GPS Positioning;
    b. GPS Receiver specifications provided by the OEM manufacturer;
    c. DGPS service provider performance specifications.
2. The Equipment is not intended for primary navigation or for use in safety of life applications; ComNav does not warrant or guarantee that the Equipment will perform in accordance with the requirements of such usage;
3. ComNav reserves the right to modify the Equipment without any obligation to notify, supply or install any improvements or alterations to existing Equipment.

NO OTHER WARRANTIES

THE FOREGOING WARRANTY IS EXCLUSIVE OF ALL OTHER WARRANTIES AND CONDITIONS, WHETHER WRITTEN, ORAL OR IMPLIED, ARISING BY STATUTE OR OTHERWISE, WITH RESPECT TO THE DESIGN, SALE, INSTALLATION OR USE OF THE EQUIPMENT, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OR CONDITIONS OF MERCHANTABILITY AND FITNESS FOR THE ORDINARY PURPOSES FOR WHICH THE EQUIPMENT IS USED OR FITNESS FOR A PARTICULAR PURPOSE, AND ANY OTHER OBLIGATIONS ON THE PART OF ComNav, ITS EMPLOYEES, SUPPLIERS, AGENTS, OR REPRESENTATIVES.

LIMITATION OF LIABILITY

The extent of ComNav's liability for damages of any nature to the end purchaser or any other person or entity whether in contract or tort, and whether to persons or property, shall in no case exceed, in the aggregate, the cost of correcting the defect in the equipment or, at ComNav's option, the cost of replacing the defective item. In no event will ComNav be liable for any loss of production, loss of profits, loss of use or for any special, indirect, incidental, consequential or contingent damages, even if ComNav has been advised of the possibility of such damages. Without limiting the foregoing, ComNav shall not be liable for any damages of any kind resulting from installation, use, quality, performance or accuracy of the equipment.

NOTICE OF DEFECT

The Limited Warranty will not apply with respect to any defective Equipment unless written notice of such defect is given to ComNav, by mail to the address for ComNav set forth below, or by facsimile to ComNav at 604-207-8008, and unless that written notice is received by ComNav within ten (10) days of the date upon which the defect first became known to the Purchaser.

Notices sent by mail from within North America will be deemed to be received by ComNav on the seventh (7th) day first following the date of posting. Notices sent by mail from anywhere else in the world will be deemed to be received by ComNav on the tenth (10th) day next following the date of posting. Notices sent by facsimile will be deemed to be received by ComNav on the date of transmission with appropriate answerback confirmation.

REMEDIES NOT TRANSFERABLE

The Purchaser's remedies under this Warranty apply only to the original end-user of the ComNav Equipment, being the Purchaser, and apply only to the original installation of the Equipment. The Purchaser's remedies under this Warranty are not transferable or assignable by the Purchaser to others in whole or in part.

CUSTOMER SERVICE

1. **If you encounter problems during the installation or operation of this product, or cannot find the information you need, please contact ComNav Customer Service**

2. If the Equipment, or any part thereof, proves to be defective within the warranty period, the Purchaser shall do the following:

> Contact Information
> TEL: 604 207 1600
> Fax: 604 207 8008
> Service Email: service@comnav.com

> and,

    a.   prepare a detailed written statement of the nature and circumstances of the defect, to the best of the Purchaser's knowledge, and including the date of purchase of the Equipment, the place of purchase, the name and address of the installer, and the Purchaser's name, address and telephone number, all to be sent, along with proof of purchase, to ComNav at the address set out below, and within the time limits set out above for Notice of Defect.

ComNav Marine Ltd.
13511 Crestwood Place, Ste 15
Richmond, BC V6V 2G1

WARNING

The Equipment is an aid to navigation only. It is not intended or designed to replace the person on watch. A qualified person should always be in a position to monitor the vessel's heading, and to watch for navigational hazards, and should be prepared to revert to manual steering immediately if an undesired change of heading occurs, if the heading is not maintained within reasonable limits, or when navigating in a hazardous situation.

ALWAYS REMEMBER:
WHENEVER UNDER WAY, A QUALIFIED PERSON ON WATCH IS REQUIRED BY LAW.

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User Notes

User Notes & Settings

User Settings

Once your G2 has been installed and configured correctly, you can make a record of all the settings you have chosen, in the tables below.

Sentences	Range	Port 1 Default	Port 1 Yours	Port 2 Default	Port 2 Yours	Port 3 Default	Port 3 Yours
GPDTM	0, 0.2, 1	0		0		0	
GPGGA	0, 0.2, 1, 5, 10 or 20	1		0		0	
GPGLL	0, 0.2, 1, 5, 10 or 20	1		0		0	
GPGNS	0, 0.2, 1, 5, 10 or 20	0		0		0	
GPGRS	0, 0.2, 1, 5, 10 or 20	0		0		0	
GPGSA	0, 0.2, 1	0.2		0		0	
GPGST	0, 0.2, 1	0.2		0		0	
GPGSV	0, 0.2, 1	0.2		0		0	
GPHDG	0, 0.2, 1, 5, 10 or 20	0		0		0	
GPHDM	0, 0.2, 1, 5, 10 or 20	0		0		0	
GPTHS ①	0, 0.2, 1, 5, 10, 20, 50	50		0		0	
GPHDT	0, 0.2, 1, 5, 10 or 20	1 ②		10		0	
GPRMC	0, 0.2, 1, 5, 10 or 20	0.2		0		1	
GPROT	0, 0.2, 1, 5, 10 or 20	1		0		0	
GPVTG	0, 0.2, 1, 5, 10 or 20	1		1		0	
GPZDA	0, 0.2, 1, 5, 10 or 20	1		0		0	
PCMN,HPR	0, 0.2, 1, 5 or 10	1		0		0	
PTSS1	0, 0.2, 1, 5, 10 or 20	0		0		0	
BAUD rate	4800 to 38400	4800		4800		4800	

Table 26 – User Settings (NMEA 0183 Ports)

① Only in software version 1.6.0 and above

② Only in software version before 1.6.0. For software version 1.6.0 and above, HDT is not defaulted in Port 1

Parameter	Range		Default	Yours
Alignment	Fore-Aft or Athwart ships		Fore-Aft	
ROLL	NO, YES		NO	
HBIAS	-180.0° to 180.0°		0.0	
PBIAS	-15.0° to 15.0°		0.0	
DIFF	NONE, WAAS, EXTERNAL (G2B: also BEACON)	G2	NONE	
		G2B	BEACON	
NMEAHE	0, 1		0	
COGTAU	0.02 to 200.0		0.0	
HTAU	0.02 to 3600.0		2.0	
HRTAU	0.02 to 3600.0		2.0	
PTAU	0.02 to 3600.0		0.5	
SPDTAU	0.02 to 200.0		0.0	

Table 27 – User Settings (Alignment & Operational)

Notes