LD7

Operations Manual

Veripos

REVISION	DATE	DESCRIPTION	ORIGINATOR	CHECKED	APPROVED
A10	15.12.2020	Recommended settings for COM1 & COM2 updated	ND	RR	RR
A9	26.01.2017	Default settings updated	AR	RR	RR
A8	01.08.2016	Updated Disclaimer & WEEE sections. Data logging information removed	AR	RR	RR
A7	13.11.2015	Antenna offset information updated	AR	RR	RR
A6	19.02.2015	Default settings amendment	AR	EM	EM
A5	23.06.2014	GNSS and L-Band on Ethernet Port	EM	RR	EM
A4	18.03.2014	Updates	AW	AR	RR
A3	11.03.2014	New LED panel and on / off switch.	AW	AR	EM
A2	06.11.2013	Browser interface	AW	EM	EM
A1	07.05.2013	Review amendments	AW	RR	EM
A	25.04.2013	First issue	AW	RR	EM

CONTENTS

1. INTRODUCTION

Veripos specialise in providing robust data broadcast services for precise positioning applications to the offshore industry.

Veripos was formed in 1989 to supply GPS augmentation services, in the form of differential GPS corrections, to vessels in the offshore oil and gas industry. Veripos product line operates worldwide, providing data broadcast and support services for precise positioning applications.

At Veripos it is our mission is to be a market leader in the supply of precise navigation and positioning services and solutions, through innovative application of technology, continuous product development and operational excellence, whilst creating maximum value for both our customers and stakeholders.

The mainstay of Veripos is the provision of data broadcast services for the purpose of enhancing accuracy, reliability and integrity of precise navigation and positioning. Veripos offers a range of such services to meet different client requirements, providing accuracy of up to 10cm.

The greatest products will not, by themselves, ensure the best solution for the client. Many factors contribute to optimum operational and commercial effectiveness, from the provision of fit-for-purpose products maintained at a high level of operability to rapid, reliable delivery and a high standard of user support.

Veripos aims to meet all of these requirements without compromise. At the centre of our business philosophy is an unwavering commitment to provide superior quality while giving appropriate consideration to health, safety and the protection of the environment. From project planning to preventative maintenance, every aspect of our service is designed towards delivering products to our clients in the most professional manner possible.

1.1 VERIPOS LD7

The LD7 Integrated Mobile Unit utilizes Septentrio 272-channel GNSS receiver technology. It provides multi-frequency GNSS capability together with GNSS Heading, Veripos high accuracy positioning and wireless communications all within a ruggedized IP67 housing for a broad range of applications.

This document provides the information required to operate an LD7.

When working with the IMU it will help the user to have the following items available:

- A printed version of this LD7 Operations Manual
- The System Software on CD ROM
- Equipment Packing List included with the equipment packing sent to site
- The Veripos document Antenna & Coaxial Cable Installation Guide

For updates of this document and to access related Veripos documentation referenced please visit the Veripos online support system (VOSS): http://help.Veripos.com

1.2 LD7 INTEGRATED MOBILE UNIT

The Veripos LD7 is a small, lightweight and economical unit which may be configured as an Integrated Mobile Unit, complete with internal dual L1/L2 GPS and GLONASS receiver.

For maximum flexibility, the design includes dual frequency Heading capability and all tiers of Veripos positioning accuracy.

It can receive Veripos L-Band transmissions from geostationary satellites and output RTCM correction data which may be used by external equipment. The LD7s' internal dual-frequency GNSS receiver can be used with Verify QC software to provide the full range of Veripos GNSS augmentation services.

The unit can compute DGPS position solutions using single or multiple reference stations. When subscribed to Veripos PPP corrections the unit is capable of computing position solutions with 10cm accuracy. Positions are computed within the GNSS receiver and are output in NMEA format for use by the user's equipment.

At the same time the GNSS engine can be used to compute a baseline between the 2 antennas installed and generate a heading value output in NMEA format.

1.3 WHAT THIS DOCUMENT COVERS

This manual will:

1) Familiarise the operator with the appearance of the LD7 and the status indicators used during normal operation. Provides the operator with interconnection details and basic fault finding procedures.

2) Provide the necessary information to use Chrome browser software on a PC to configure the unit. This will be of help when commissioning the LD7.

REQUIREMENTS

Note: ***A PC with internet browser and fitted with an RJ45 LAN port can cable(s) is required to configure the LD7.***

Use a PC running Microsoft Windows 7 / XP. Veripos recommend Google Chrome browser version 30.0.1559.101 or above.

This manual contains information required to install and operate the following software:

- Internet browser interface. Used to configure the key elements of the LD7 IMU

1.4 EQUIPMENT SUPPLIED WITH LD7

The LD7 is supplied with;

- Operation Manual
- The Veripos Antenna & Coaxial Cable Installation Guide
- CD ROM with relevant software for enable/disable use with Veripos services for configuration of the GNSS receiver.
- Interface cables, coaxial cable and antenna(s) (as specified)

Veripos recommends the use of Verichart software to create local service coverage charts. This software will help when selecting stations for the work area. A copy of this can be downloaded from the Veripos Online Support Service (VOSS) http://help.Veripos.com together with update files detailing the Veripos stations.

1.5 VERIPOS HELPDESK REQUESTS FOR SERVICE ENABLE / DISABLE

Throughout this manual reference will be made to the Veripos Helpdesk.
The Helpdesk is a service provided by Veripos as first point of contact for all technical enquiries and fault reports. It is manned 24 hours per day, 365 days per year.
Contact details are in the Appendix.

Except in emergency situations Veripos recommend that initial contact is made by email to the Helpdesk or raising a fault ticket on the VOSS Web site.

Veripos encourage all users to report problems or operating queries to the Helpdesk so that they may receive immediate personal assistance.

The duty operator is trained to provide direct assistance with the most common queries and problems. They refer enquiries to technical staff that provide support for complex issues.

This will ensure that the users contact details and the basic description of the fault are correctly recorded.

See the Troubleshooting section for further details.

VERIPOS ONLINE SUPPORT SYSTEM (VOSS)

Throughout this manual reference will be made to the Veripos Online Support System (VOSS).

VOSS provides the user with a source of frequently updated technical data reference guides and FAQ's for all Veripos services and equipment.

The site includes a facility for raising fault tickets which are then automatically submitted to the Veripos Helpdesk.

See the Contacts in the Appendix and visit http://help.Veripos.com

1.6 ENABLING THE LD7 FOR USE

Before a unit can be enabled a Service Access License (SAL) must be in place.

For the LD7 to decode Veripos corrections and output positions it must first be enabled. Veripos correction signals are provided as a chargeable service.

This is achieved by the user advising the Veripos Helpdesk of the LD7 unit ***Veripos User code***. The procedure is detailed in this manual in the Configuration section.

N.B. The Helpdesk cannot issue a code unless an active SAL exists. To avoid delay the user should keep a record of the SAL number associated with the LD7 unit and ***User Code***.

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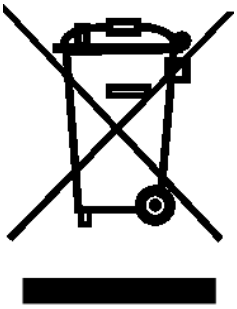
1.8 WASTE ELECTRICAL AND ELECTRONIC EQUIPMENT

The Waste Electrical and Electronic Equipment Directive (hereinafter referred to as the "WEEE directive") places an obligation on EU-based manufacturers, distributors, retailers and importers to take back electronic products at the end of their useful life. A sister directive, RoHS (Restriction of Hazardous Substances) complements the WEEE directive by banning the presence of specific hazardous substances in the products at the design phase. The WEEE directive covers all VERIPOS products imported into the EU as of August 13 2005. EU-based manufacturers, distributors, retailers and importers are obliged to finance the costs of recovery from municipal collection points, reuse, and recycling of specified percentages per the requirements contained in the WEEE Directive.

Instructions for disposal of WEEE by users in the European Union

Products which have the undernoted symbol located on either the product itself or its packaging indicates that the product must not be disposed of with other waste. Instead, it is the user's responsibility to dispose of the product by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment (hereinafter referred to as "WEEE").

The separate collection and recycling of your WEEE at the time of disposal will help to conserve natural resources and ensure that it is recycled in a manner that protects human health and the environment. For more information about recycling centres, please contact the local city office, the household waste disposal service or the product supplier.



2. OVERVIEW AND DESCRIPTION OF THE LD7

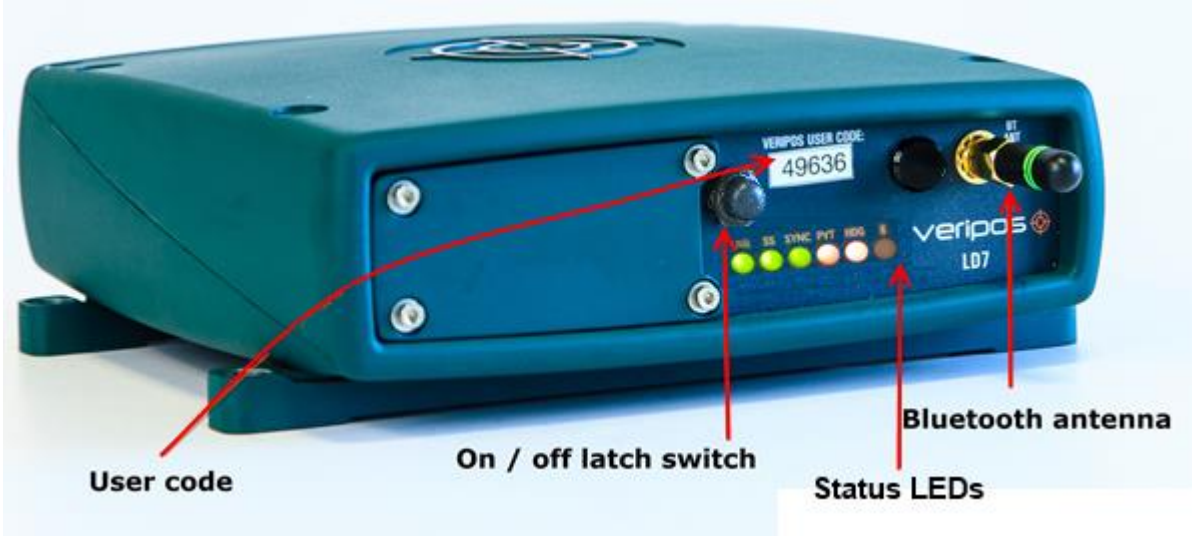
The LD7 supplied by Veripos offers benefits to the user in terms of economy, small size, ease of operation and low power dissipation.

Power input to the unit is on a 4 pin LEMO connector with 12V VDC.
Veripos supply an AC to DC Power supply.

The unit incorporates front panel LED indicators for status monitoring.

Configuration is performed using an external PC running the recommended Web Interface browser (Google Chrome).

A Technical Specification for the LD7 is in the Appendix section.



2.1 FRONT PANEL

2.1.1 LED's

ENB	Shows the enabled/disabled status of the unit. The LED will be solid Green if the unit is enabled for Veripos services and flashing green if disabled.
SS	Shows signal strength of the selected Veripos beam in three states: *Red* – Signal strength is poor (less than 33db) and service delivery will not be possible. *Amber* – Signal strength is moderate (33 – 36db) and service delivery may be intermittent. *Green* – Signal strength is good (>36 db) and optimal for service delivery.
SYNC	Shows the status of the synchronisation to the selected Veripos beam. The LED will be solid Green if the unit has achieved synchronisation and off if not synchronised. The LED will flash green when attempting to synchronise.
PVT	Shows the accuracy level that is being achieved in the solution in three states: Red – Solution is uncorrected and accuracy will be greater than 1m. Amber – Solution is corrected using DGNSS or SBAS corrections, sub meter level accuracy can be expected. Green – Solution is corrected using PPP or RTK corrections, decimetre level accuracy can be expected.
HDG	Shows the availability of a heading solution. The LED will be green if a heading solution is available for output (HDT) and Red if a heading solution is not available.
BLUETOOTH	This LED shows the connection status of the Bluetooth interface. The LED will be Blue if an administrator is connected to the LD7 via Bluetooth. The LED will be off if no connection is established

2.2 LD7 CONNECTIONS

2.2.1 Coaxial Connections

The LD7 rear back plate is fitted with 2 coaxial antenna connectors.

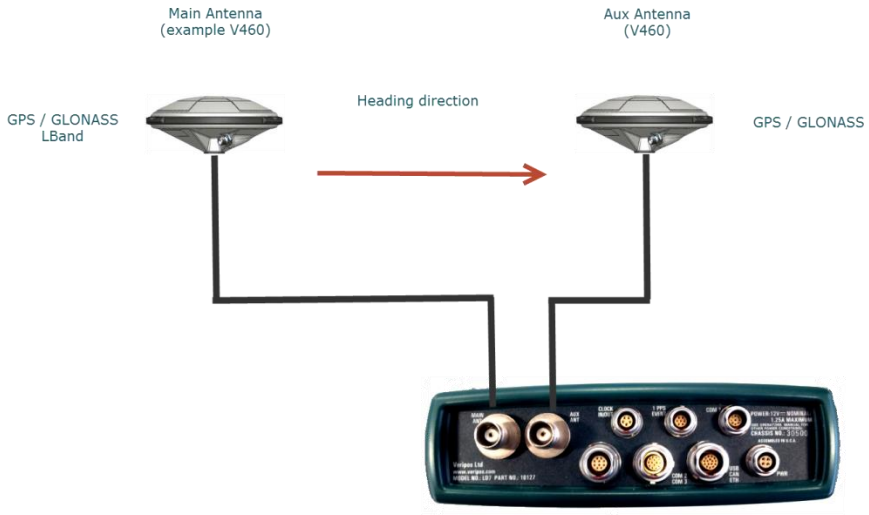
2.2.1.1 Dual Antenna / Coaxial connections

The combined GNSS and L-Band antenna is connected to the **MAIN ANT** GNSS Antenna connection.

Where the LD7 is used to derive a heading output, a second GNSS antenna is connected to the Auxiliary Antenna (**AUX ANT**) connection of the LD7.

This two antenna option will require the user to install 2 antennas and 2 cable runs. More details of this configuration are in the Appendix.

A schematic example is shown below:



This option uses two antennas to derive high accuracy position with output of heading information.

The combined LBand / GNSS antenna is connected to the **MAIN ANT** TNC connector. A second GNSS antenna is connected to the **AUX ANT** TNC connector.

Note that the greater the baseline between the antennas, the better the heading accuracy will be. For example:

- 1m baseline = 0.3° accuracy with RTK fixed quality
- 3m baseline = 0.1° accuracy with RTK fixed quality
- 10m baseline = 0.03° accuracy with RTK fixed quality

2.2.1.2 Three Coaxial connections

There is an optional configuration to use a separate L-Band antenna to receive the Veripos Corrections. This can be used when masking may cause a problem or when working at high latitudes where the satellites are low on the horizon.

To utilize a 3 three antenna combination a conversion kit can be fitted to the LD7 unit. This can be installed by a Veripos technician.

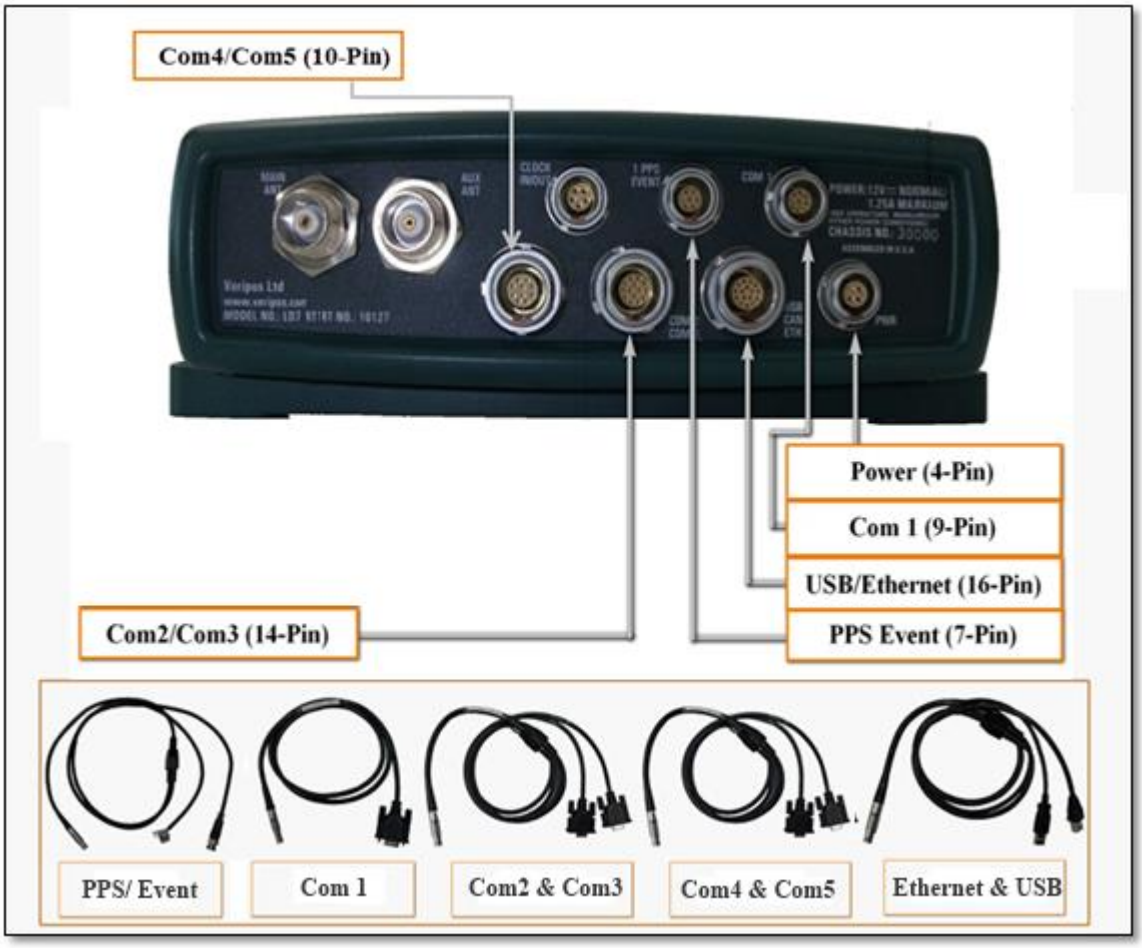
A schematic example is shown below:

Survey Requirement

After equipment installation it is recommended that a calibration survey is carried out to compute any heading C-O and establish any offsets for the *Main* GNSS antenna position. These values can then be entered in to the navigation or DP software if required.

Further guidance regarding antenna installation can be found within the LD7 Installation Manual.

2.2.2 Data Cables and output



One LD7 system includes the following items:

Items	Purpose
Bluetooth Antenna	Bluetooth communication (CURRENTLY NOT UTILISED)
Serial Cables	Single serial connectivity (COM1) Dual RS232/Serial connectivity (COM2/COM3) and (COM4/COM5)
Power Cable	12 VDC external power input
USB & Ethernet Cables	Configuration via Ethernet only using PC & browser

2.2.2.1 Data output

Data cables are LEMO style and are **specific** to each port labelled on the LD7 rear panel. The LD7 ports output messages.

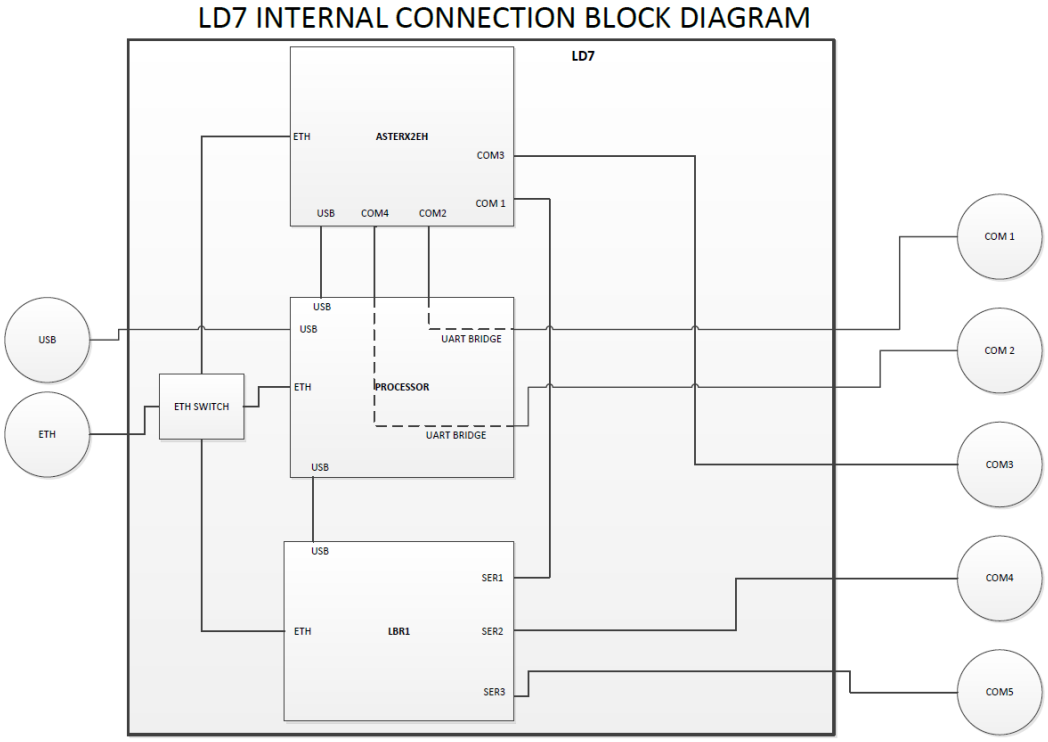
Should you require other message output, configurations, etc. contact Veripos for assistance.

COM	Recommended settings for serial ports	Internal COM Port Mapping
1	NMEAa **Position** output – GGA 9600,8,N.1	To AsteRx2eH card COM2
2	NMEAb **Heading** output – HDT 9600,8,N.1	To AsteRx2eH card COM4
3	GNSS Raw to **Verify QC** PC – Requires a receiver initialization command 115200,8,N.1 Also: Use with a PC running **Septentrio RXControl** software to connect COM3 to a PC serial port to view the GNSS and Heading status.	To AsteRx2eH Card COM3
4	RTCMb output – 9600,8,N,1	To L-Band card Serial 2
5	Verify QC demodulator status messages – 115200,8,N,1	To L-Band card Serial 3
-	**Internal Comms**	**Mapping**
-	RTCMa - used by LD7 for internal calculation of a corrected position	From L-Band card (Serial 1) to AsteRx2eH (COM1)

2.3 LD7 LOGIC FLOW DIAGRAM

The diagram shows the data connection port mapping relating to the GNSS and L-Band cards to the external COM ports of the LD7

LD7 INTERNAL CONNECTION BLOCK DIAGRAM



3. CONFIGURATION

Before starting, connect the antenna(s) and power cables, referring to the information in the LD7 Installation Manual (AB-V-MA-00559). For guidance on siting of antennas and cabling, please refer to the ***Veripos Antennas and coaxial cabling Guide*** (available from VOSS).

An external PC, with an RJ45 LAN port and loaded with the Chrome web browser is required to configure the unit for operation.

This software is pre-loaded on Veripos PC's when issued with the LD7.

LD7 browser software access and updates require a PC with Microsoft Windows XP / Windows 7 operating system with an RJ45 LAN port, RJ45 cables and (optionally) LAN hub.

> Note: Under instruction from Veripos the unit can be configured using serial ports. Instructions for using this method can be found in the appendix.

3.1 BROWSER INTERFACE

Use the LD7's browser interface to carry out all essential functions when working with the LD7.

Veripos recommend the **Chrome** browser on a PC to configure the LD7. This is the only browser supported (Chrome ***version 30.0.1559.101*** or above).

The default fixed IP address of the LD7 is **192.168.0.126.**

3.1.1 Connecting the LD7

Use a Windows 7 /XP PC loaded with Google Chrome browser together with the (supplied) LD7 RJ45 and USB cable harness that connects to the rear 16 pin USB/Ethernet port. Connect cables, antennas, etc. and power up the LD7 and PC.

Example – Windows 7 PC

Amend the PC's IP address range to match the LD7:

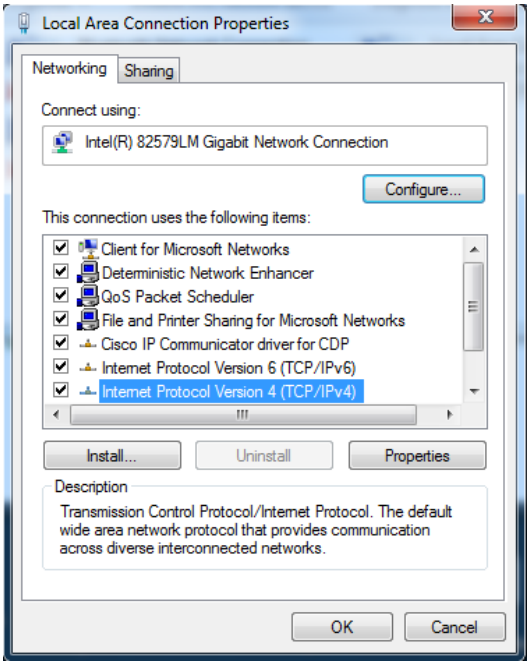
On the PC, open *Control Panel*.

Select ***Networks and Sharing Center***.

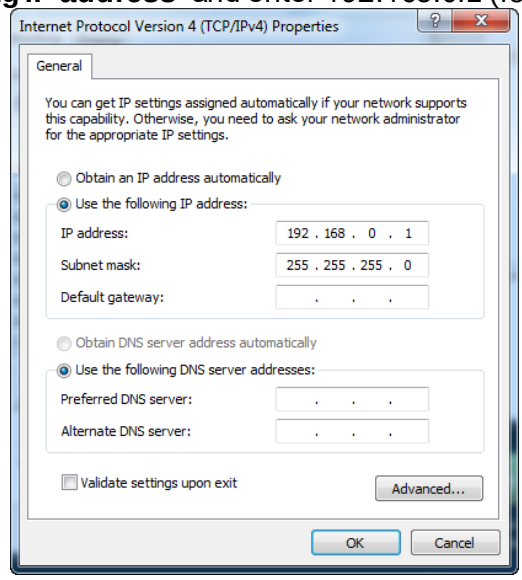
On the Left hand side of the screen box, select ***Change Adapter Settings***.

Highlight the Local Area connection and right click and select Properties.

Highlight IPV.4 (TCP/IPv4) and select ***Properties***.



Select "**Use the following IP address**" and enter 192.168.0.1 (for example).



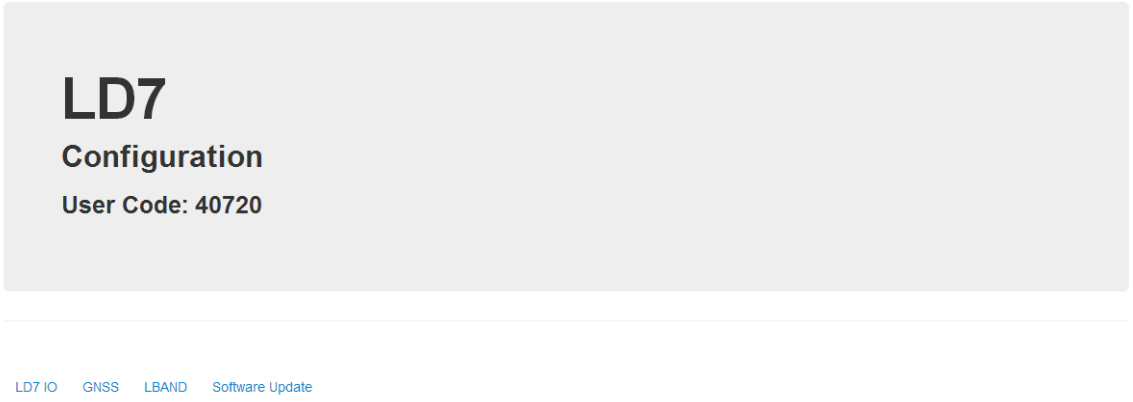
Select Tab then OK.

<u>Chrome browser</u>

Connect the LD7 RJ45 connector either via an Ethernet hub or directly to the PC. (NOTE: some PC's require a hub to be used.)

On the PC open Chrome browser and enter the LD7 IP address (default **192.168.0.126)** and enter the unique LD7 User code (on front of LD7 unit).

Once connected the main browser page is shown which allows access to the configuration of the LD7 IO, GNSS card and L-Band card settings.

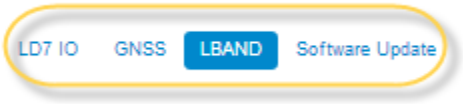


LD7 Main browser page – default / recommended settings shown

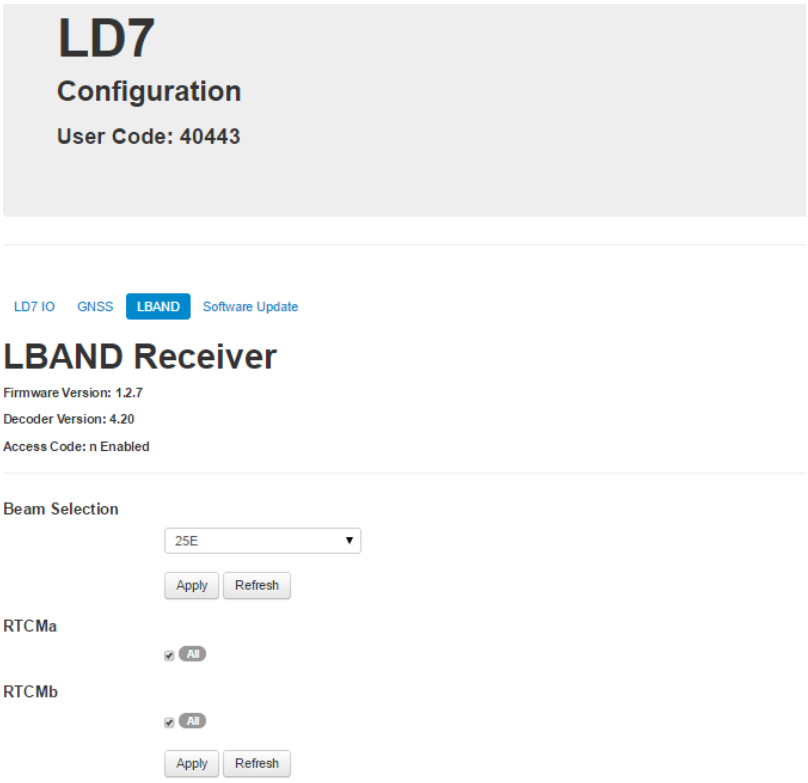
To set up the LD7 for use, follow the sequence of browser tab screens listed below.

3.2 L-BAND

To access the LD7 L-Band configuration page, click on L-BAND at the top of the main page:



The following page will appear:



3.2.1 Beam Selection

To select desired Beam, use the drop down list in Beam Selection.

Select the desired Beam from the list.

Click ***Apply***.

Note:

A Beam is selected relative to the vessel location and for purposes of diversity, (where more than one receiver using Veripos corrections is on-board).

In most instances more than one beam with acceptable elevation will be available in the work area. Vessels may have more than one LD7 system installed. For system redundancy, different Veripos receiver units on the same vessel should be configured on different beams.

Veripos correction data are currently broadcast on the following beams:

Beam	Coverage
143.5E	*Asia, Australasia, Indian Ocean*
POR	*East Asia, Australasia, Alaska*
IOR	*Asia, Indian Ocean, East Africa, Persian Gulf, Caspian Sea*
25E	*North Sea, Mediterranean Sea, Africa, Persian Gulf, Caspian Sea*
AORW	*North America, Gulf of Mexico, South America*
98W	*North America, Gulf of Mexico, South America*
AORE	*North Sea, Mediterranean Sea, Africa*

The above information may change from time to time. Visit VOSS (http://help.Veripos.com) for the latest listing. Verichart a Veripos software application can be used to create global and region coverage charts and is available from the same location.

All the above beams broadcast on high power with an Omni-directional antenna used to receive the signals.

Note: It can take up to 2 hours for all the reference stations to be available. If the data is required before this time please contact the Veripos Helpdesk to re-issue the control message and update the station list.

3.2.2 Enable/ Disable

The L-Band page is also used to view the status of using Veripos corrections (enabled or disabled for corrections).

To enable, disable or change the active service on the LD7, contact the Veripos Helpdesk quoting the Vessel SAL (Service Access Licence) number and unit code.

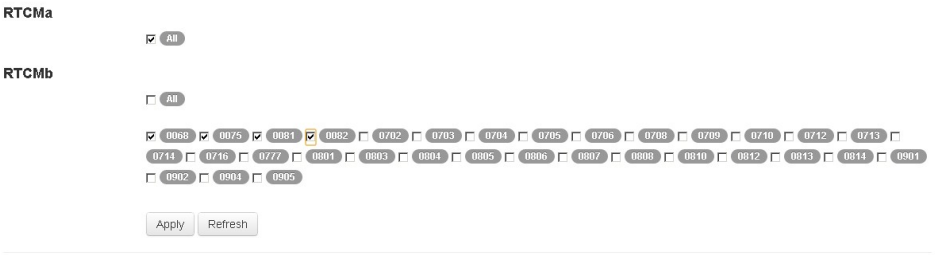
Once Veripos receive the SNF form containing the SAL number and current Unit Code with your service requirements, the Helpdesk can enable services over the air.

After service changes please allow a few minutes for the control message to be received.

If you have problems please contact the Veripos Helpdesk.

3.2.3 REFERENCE STATION SELECTION

The list of reference stations available for selection is determined by the satellite beam, selected in **Satellite Beams** selection menu.



To enable **All** reference stations on a data stream (RTCMa or RTCMb) click the All box and select ***Apply***.

To enable a single station or selection of stations uncheck the All box, this provides a list of available reference stations. Selected reference stations can be ticked and select Apply.

Note:

Please refer to VOSS for a list of Veripos reference stations. This shows the IDs and indicates which satellites broadcast which station corrections.

Corrections from selected stations on RTCMa are channelled to the internal GNSS receiver and also to the RTCM output port.

- When an RTCM output from the LD7 is interfaced to a computer running Verify QC, Veripos recommends all stations to be enabled. This is the default setting on the LD7.

- When the RTCM output is interfaced to third party equipment the user should consult the equipment documentation to determine the optimum number of reference stations.

Reference stations closest to the work area will normally provide the greatest accuracy. To achieve the specified system accuracies a range limit (maximum baseline) of 1500km should be observed. The LD7 internal calculation sets this range limit automatically.

Veripos supply the "Verichart" utility program to assist the user in selecting stations.
It is supplied with all LD7 units and is also available (with database updates) as a download from the Veripos Online Support Site (VOSS). URL is in the Contacts List in the Appendix.

3.2.4 Veripos Ultra and APEX Services

Veripos Ultra and Apex services are PPP solutions that produce decimetre accuracy positions. They have no range limitations and may be used at any location.

When used, the Ultra or Apex ID must be enabled in the station list.

Across all seven Veripos beams the station IDs are:

ULTRA ID	ULTRA² IDs	APEX ID	APEX² IDs
068	068 + 075	081	081 + 082

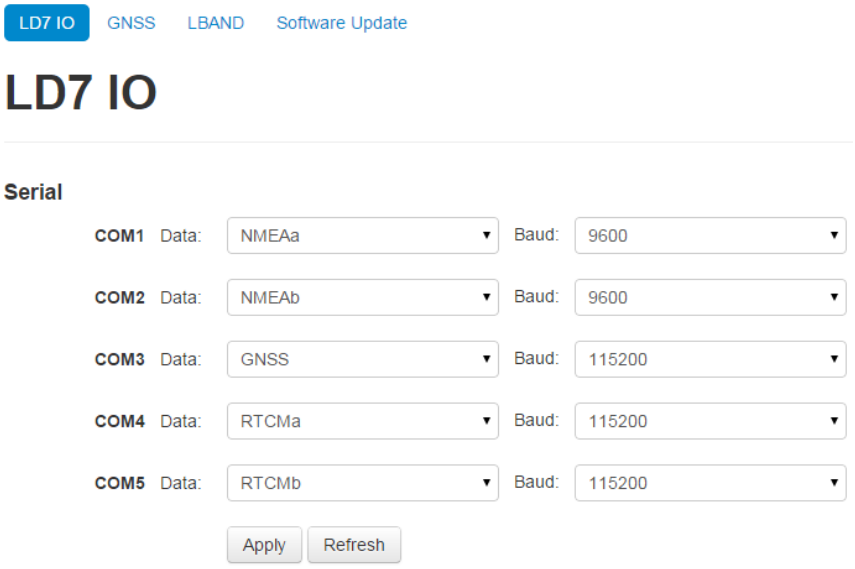
Note: Ultra² available only when using LD7 with Verify QC.
Please specify your requirement when contacting the Helpdesk to enable the LD7.

When requesting an enable the user must specify which services are required.
The choice of services affects both pricing and system accuracy
A list of available services is given on the Signal Notification form.

3.3 IO (INPUTS / OUTPUTS)

Use the **IO** (Inputs / Outputs) page to configure the serial ports (COM1 – 5) and Ethernet addresses.

3.3.1 Serial Ports



If changes are required to available output data streams or baud rates, select the desired data stream and Baud Rates from the drop down lists and click on ***Apply***.

Note. When outputting GNSS on COM3 due to the amount of data output a lowest baud rate of 38400 is recommended. The recommended GNSS output baud is 115200.

3.3.2 Ethernet

The Ethernet port can be used to configure the LD7 via web browser and output data streams from the GNSS and L-Band receivers.

The IO page allows changes to the IP address of the LD7 processor, GNSS and L-Band receivers. DHCP is possible however is not recommended.

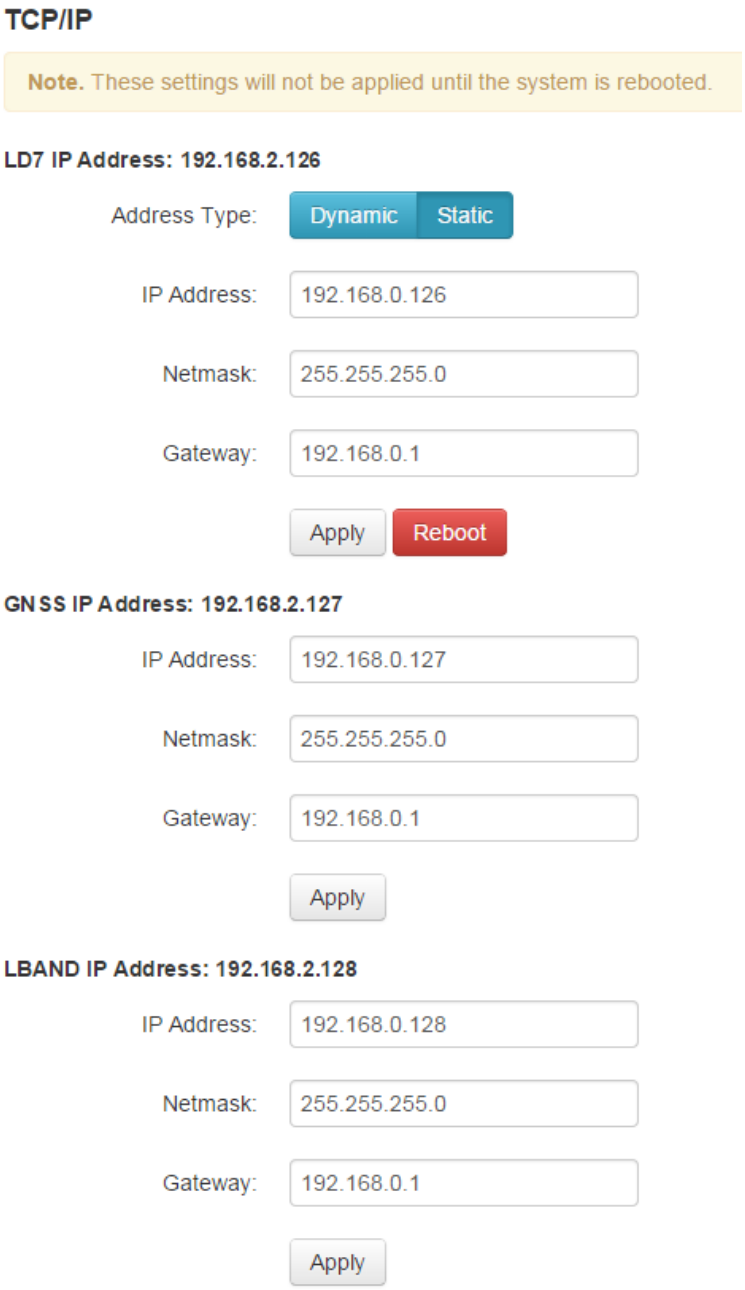
Note: A unit reboot is required to effect any changes made.

If changes are required to the IP Address then IP Address and Netmask are mandatory fields and cannot be left blank.

If using RTCM or GNSS messages over the Ethernet port the IP address of the GNSS and L-Band receivers must be set to a unique address on the network.

Units provided by Veripos will have their IP addresses set as default to:

LD7: 192.168.0.126
GNSS: 192.168.0.127
L-BAND: 192.168.0.128

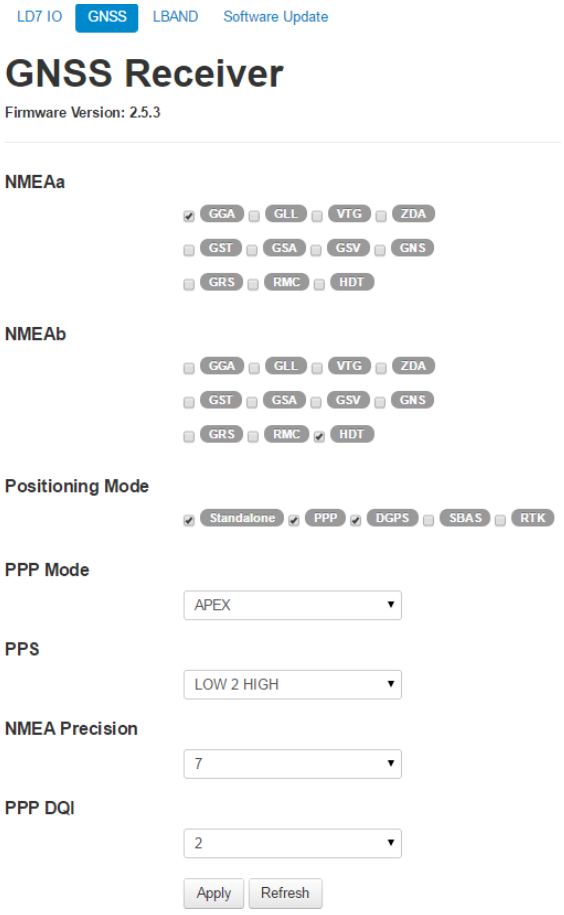


The ports for the data streams available on the LD7 Ethernet are:

Data stream	Port
RTCMa	9001
RTCMb	9002
L-Band Config	9003
NMEAa	9011
NMEAb	9012
Raw GNSS	9013

3.4 GNSS

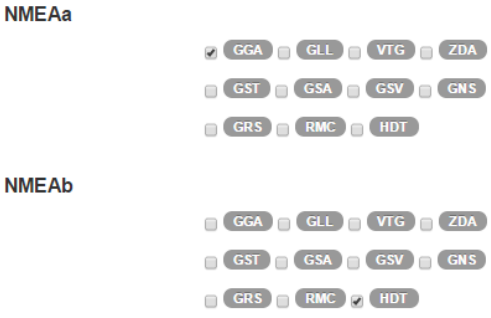
To access the LD7 GNSS configuration page click on GNSS at the top page tabs:



Typical LD7 settings are shown above.

3.4.1 NMEA Output

This allows a combination of NMEA messages to be set on either 2 data streams (NMEAa and NMEAb) from the LD7. This should match the requirements of the receiving system.

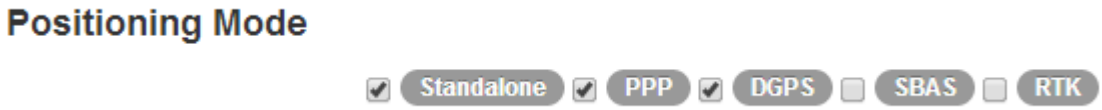


In the example above, NMEAa is set to GGA and is output on LD7 Com1, NMEAb is set to output HDT and is output on LD7 Com2.

To enable different messages on NMEAa or NMEAb, select the boxes for the desired messages and select ***Apply***.
For details of NMEA messages please refer to Appendices.

3.4.2 Positioning Mode

Positioning Mode sets the solutions that will be computed by the receiver and the fallback sequence should a calculation fail.



Select / amend which positioning is required and that aligns from those available on your GNSS card. Note that RTK is unlikely to be available at present.

3.4.3 PPP mode

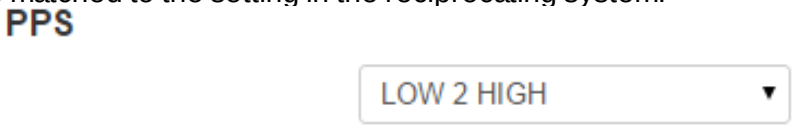
The LD7 can only compute an Apex **or** Ultra at any time. This setting sets the PPP computation that will be used.

Select from the drop – down which of the two Precise Point Positioning services is required to be used by the LD7.

Note: This should match the Veripos corrections enabled on the unit. When changing PPP Mode a reboot of the LD7 must be carried out.

3.4.4 PPS

The Pulse per Second can be set to Off, High to Low or Low to High.
This should be matched to the setting in the reciprocating system.



Where required select the pulses per second to be output. Default is LOW 2 HIGH
A cable harness assembly is provided with the LD7.

3.4.5 NMEA Precision

This setting changes the number of decimal minutes reported in the Latitude and Longitude fields in the NMEA GGA message.

Select from the drop down to amend the decimal place precision for the position output. Default is 7 decimal places.

3.4.6 PPP DQI

This setting changes the Differential Quality Indicator (DQI) reported in the GGA message. It can be set to 2 or 5. If it is set to 2 the DQI will report 2 for all corrected solutions (PPP and DGNSS). If it is set to 5 the DQI will report 2 for DGNSS solutions and 5 for PPP solutions.

Select from the drop down the value for the required Differential Quality indicator for the Precise Point Positioning solution used. Default is 2 decimal places.

When finished selecting, click on ***Refresh*** to update screen before ***Apply*** to apply changes.

4. SYSTEM OPERATION

The LD7 is designed to function with minimal user intervention during operations. The unit performance can be monitored by referring to the GNSS ***RXTools*** software described in the Appendix of this manual.

There are no user-adjustable controls or serviceable items within the receiver.

For normal operation, the front panel LED's should be as follows:

- ENB – Solid green if the unit is enabled and flashes green is the unit is disabled for Veripos services.
- SS – Green when L-BAND signal strength is high, Amber when moderate, Red when signal strength is poor
- SYNC – Solid green if the unit has locked to L-BAND satellite, flashing green when attempting to synchronise
- PVT – Green when solution is corrected by using PPP or RTK corrections, Amber when using DGNSS or SBAS corrections, Red when solution is uncorrected
- HDG – Green if heading solution is available, Red if no heading solution is available
- Bluetooth symbol – Should be off for normal operation. Will be Blue if an administrator is connected to the LD7 via Bluetooth

Configuration changes require the use of the Web interface in the following circumstances:

1) When enabling or disabling the unit.

Note: The unit will not output a corrected position where it is disabled. Use the web interface to determine status.

2) When moving to a new operating area. Please note that:

a. Downlink beam must be selected according to the operating region.
b. Reference stations must be selected relative to work area. Veripos recommend **ALL** stations are made available from the receiver.

3) During commissioning of unit.

a. The NMEA Output port must be configured to output the telegram(s) and baud rate required by the external equipment.
b. The RTCM output port must be a baud rate compatible with the external equipment.

****** If further checks required as to whether the Heading and AUX antenna is in working condition Rx Control can be used, check Appendix VII for further details.***

5. TROUBLESHOOTING

Use this section to assist any problems encountered.

The equipment is designed and manufactured to exacting standards.
Once installed and operating it should provide prolonged trouble-free service.

Veripos encourage all users to promptly report problems or queries to the Veripos Helpdesk.

The Helpdesk is manned 24 hours per day, 365 days per year. Contact details are given in the Appendix.

The duty operator is trained to provide direct assistance with common queries and problems. In addition they can call on a range of technical staff to provide support for more complex issues.

Except in emergencies please email the Helpdesk or raise a fault ticket on the VOSS Web site.

Note: Before contacting the Helpdesk please check the brief fault-finding in this manual. This lists common conditions and actions to take.

To ensure a rapid response initial communication with the Helpdesk should provide the following information:

- User's name
- Telephone number
  If possible choose a phone near the equipment
- Email address
- Full vessel name
  Correct identification is important; Veripos may have installation drawings
- Name of parent company
- Current Access Code/Count of LD7 (from L-Band Control Software 2)
- Current status of the front panel indicators on the LD7
- User code of LD7 (as displayed on Front Panel)
- Brief Description of other Veripos hardware and software installed
- Vessel's current operating region
- Vessel's status.
  Is it alongside, in transit, in operation, or shut down due to fault?
- History of fault.
  Is this a new installation which has not yet been fully commissioned?
  Did a problem suddenly arise with a system which was previously working?
  Did the system cease working after moving to a new region?
- Description of fault

Once this information has been received the Helpdesk will raise a fault ticket.
This will record the details and will be updated with all subsequent communications. Users may access the ticket details from the Veripos Online Support Site for updates.

5.1 POWER FAULTS

Fault	Reason	Remedy
All indicators extinguished	External supply disconnected or switched off	Check connection between the "Power" cable harness and the external PSU. Check the AC power to the external PSU.
	External supply faulty.	Check the power LED indicator on the external PSU. If AC power is confirmed but the PSU LED is not illuminated, the PSU is likely to be faulty. Contact Veripos for a replacement.
	LD7 fault	If AC power and PSU are confirmed to be OK, contact Helpdesk.

5.2 ENABLE / DISABLE FAULTS

Fault	Reason	Remedy
After requesting a new Access Code all entries remain unchanged. (Access code shows unchanged).	Time to transmit codes over the air	Wait up to 15 minutes after requesting the Access Code. If still not enabled request a resend from the Helpdesk.
	No L-BAND Sync	Ensure a suitable L-BAND beam is selected for your worksite and confirm that the LD7 has locked on and has a good signal strength.

5.3 L – BAND SIGNAL FAULTS

Fault	Reason	Remedy
No SYNC with geostationary satellite.	The vessel has moved to a new region but the demodulator has not been re-configured	Launch the LD7 Web Browser and check a suitable Channel (Beam) is selected. Use the Global coverage chart in the appendix to confirm whether this is correct for the current location and change where required.
	Antenna blockage	Visually check whether the path between the antenna and satellite is subject to blockage. This can occur when the vessel is in port or alongside a large structure. Blockage can also be caused by the vessel's own superstructure. This can usually be eliminated by changing the vessel heading.

	Interference	Investigate any source of L-band transmissions. Also high power transmissions of other frequencies. If possible, shut down possible sources to eliminate them.
	Antenna disconnected or inoperative	Visually check antenna and cable for possible damage. Check coaxial connections.

5.4 HEADING FAULTS

Fault	Reason	Remedy
No GNSS heading solution output	Incorrect serial port configuration	Check serial port configuration in the LD7 Web page. Ensure that HDT format is selected in either NMEAa or NMEAb. Ensure that the NMEA stream which has HDT enabled is selected on the relevant serial port.
	No GNSS data.	Using the Rx Control software, check that both the main and auxiliary GNSS inputs show valid GNSS data Details of how to check this can be found in Appendix VII of this manual.
		Visually check antenna and cable for possible damage. Check coaxial connections.
Poor heading accuracy	Insufficient antenna separation	Relocate antennas ensuring that the baseline between the two is sufficient to produce the required heading accuracies. Details of the expected heading accuracies can be seen in Section 2.1.2 of this manual.

APPENDIX I.

CONTACT INFORMATION

Veripos CONTACT INFORMATION

All initial contacts regarding technical or support issues should be initially addressed to the Veripos Helpdesk. Where appropriate, the Helpdesk will refer issues to the regional operations and engineering teams.

Veripos Helpdesk Telephone: +44 (0) 1224 965900

Veripos Helpdesk E-mail: helpdesk@Veripos.com

Veripos Online Support Site (**VOSS**): http://help.veripos.com

If shipping equipment back to Veripos, please contact the Helpdesk who will provide the current shipping address, according to your area of operations.

UK Veripos office address:

	Veripos House, 1B Farburn Terrace, Dyce, Aberdeen. AB21 7DT Scotland UK

For other sites visit www.veripos.com

APPENDIX II.

ABBREVIATIONS

ABBREVIATIONS

BER	Bit Error Rate
CoG	Course over Ground
CR	Carriage Return
DGNSS	Differential GNSS
DGPS	Differential GPS
DOP	Dilution of Precision
DP	Dynamic Positioning
DQI	Differential Quality Indicator
EGNOS	European Geostationary Navigation Overlay System
GDOP	Geometry Dilution of Precision
GLONASS	GLObal NAvigation Satellite System – Russian equivalent to GPS
GPS	Global Positioning System
GNSS	Global Navigation Satellite System
HDOP	Horizontal Dilution of Precision
IMU	Integrated Mobile Unit
KPH	Kilometres per Hour
LAN	Local Area Network
LF	Line Feed
LNA	Low Noise Amplifier
L-Band	Methods of transmitting Correction data to mobile users
LCD	Liquid Crystal Display
LD6	Unit containing GPS card, demodulator and PC processor
LVTTL	Low Voltage Transistor Transistor Logic
MF	Medium Frequency Radio used to Transmit Correction Data
MPH	Miles per Hour
m/s	Metres per Second
MSAS	Multi-functional Satellite Augmentation System
NMEA	National Marine Electronics Association
PDOP	Positional Dilution of Precision
PPP	Precise Point Positioning
PPS	Pulse per Second
PRN	Pseudo Random Noise
RMS	Root Mean Square
RTCM	Radio Technical Commission for Maritime Services
SBAS	Satellite Based Augmentation System
SD	Standard Deviation
SDRAM	Synchronous Dynamic Random Access Memory
SNF	Signal Notification Form
SNR	Signal to Noise
Spotbeam	High Power L-Band Signal
Standard	Veripos Single frequency DGPS system
SV	Space Vehicle
Ultra	Veripos High accuracy positioning systems
USB	Universal Serial Bus
UTC	Coordinated Universal Time
VDOP	Vertical Dilution of Precision
VGA	Video Graphic Array
VOSS	Veripos Online Support System
WAAS	Wide Area Augmentation System
WEEE	Waste Electrical and Electronic Equipment

APPENDIX III.

VERIPOS REFERENCE STATIONS

Veripos reference stations.

The latest Veripos Station listing can be found on the Veripos Online Support System via the following link:

http://help.veripos.com/ics/support/default.asp?deptID=4494&task=knowledge&questionID=3

A list of available reference stations (up-to-date 23rd June 2014) is listed below:

Stn ID	Name	Type	Beam			Service Type		Comments
			1	2	3	Standard	Standard[2]	
HF Stations								
12	Lagomar	HF				x		
14	Carmen	HF				x		
North & Central American Stations								
501	Houston	GPS	98W	AORW		x		
502	Baton Rouge	GPS,GLO	98W	AORW		x	x	
503	Carmen	GPS	98W	AORW		x		
504	Trinidad	GPS,GLO	98W	AORW		x	x	
505	St Johns	GPS,GLO	98W	AORW		x	x	
506	Halifax	GPS	98W	AORW		x		
509	Tamps	GPS	98W	AORW		x		
510	Tampico	GPS,GLO	98W	AORW		x	x	
511	Costa Rica	GPS	98W	AORW		x		
512	Curacao	GPS	98W	AORW		x		
513	Fairbanks	GPS,GLO	98W	POR		x	x	
South American Stations								
601	Rio de Janeiro	GPS	AORW	98W		x		
602	Macae	GPS,GLO	AORW	98W		x	x	
603	Catu	GPS	AORW	98W		x		
604	Belem	GPS	AORW	98W		x		
605	Natal	GPS,GLO	AORW	98W		x	x	
606	Port Alegre	GPS	AORW	98W		x		
607	Buenos Aires	GPS	AORW	98W		x		
608	Lima	GPS	AORW	98W		x		
609	Chiclayo	GPS	AORW	98W		x		
610	Falklands	GPS	AORW	98W		x		

Stn ID	Name	Type	Beam			Service Type		Comments
			1	2	3	Standard	Standard[2]	
NWECS Stations								
701	Wick	GPS	AORE			x		
702	Netherlands	GPS	25E	AORE		x		
703	Bodo	GPS	25E	AORE		x		
704	Kristiansund	GPS,GLO	25E	AORE		x	x	
705	Tananger	GPS	25E	AORE		x		
706	Falmouth	GPS,GLO	25E	AORE		x	x	
708	Bologna	GPS	25E	AORE		x		
709	Cyprus	GPS	25E	AORE		x		
710	Marbella	GPS	25E	AORE		x		
712	Vardo	GPS	25E	AORE		x		
713	Ny Alesund	GPS	25E	AORE		x		
714	Malta	GPS,GLO	25E	AORE		x	x	
716	Stockholm	GPS	25E			x		
717	Hammerfest	GPS	AORE			x		
777	Aberdeen	GPS	25E	AORE		x		
African Stations								
801	Luanda	GPS	25E	AORE		x		
804	Lagos	GPS	AORE			x		
805	Accra	GPS	25E	AORE		x		
806	Las Palmas	GPS	25E	AORE		x		
807	Cape Verde	GPS,GLO	25E	AORE		x	x	
808	Cape Town	GPS,GLO	25E	AORE		x	x	
809	Gabon	GPS	AORE			x		
810	Walvis Bay	GPS	25E	AORE		x		
812	Mozambique	GPS	25E	IOR		x		
813	Dar es Salaam	GPS,GLO	25E	IOR		x	x	
814	Sao Tome	GPS,GLO	25E	AORE		x	x	

Stn ID	Name	Type	Beam			Service Type		Comments
			1	2	3	Standard	Standard[2]	
Caspian & Middle East Stations								
901	Baku	GPS,GLO	IOR	25E		x	x	
902	Aktau	GPS	IOR	25E		x		
904	Bahrain	GPS	IOR	25E		x		
905	Dubai	GPS,GLO	IOR	25E		x	x	
906	Mumbai	GPS,GLO	IOR	143.5E		x	x	
907	Kolkata	GPS	IOR	143.5E		x		
908	Chennai	GPS,GLO	IOR	143.5E		x	x	
Far East Stations								
301	Singapore	GPS,GLO	143.5E	POR	IOR	x	x	
302	Labuan	GPS	143.5E	POR	IOR	x		
303	Jakarta	GPS	143.5E	POR	IOR	x		
304	Balikpapan	GPS	143.5E	POR	IOR	x		
305	Bangkok	GPS	143.5E	POR	IOR	x		
306	Shenzen	GPS	143.5E	POR	IOR	x		
307	Shanghai	GPS	143.5E	POR	IOR	x		
309	Kushiro	GPS	143.5E	POR		x		
310	Sakhalin	GPS,GLO	143.5E	POR		x	x	
311	Kemamam	GPS	POR			x		
313	Manila	GPS,GLO	143.5E	POR	IOR	x	x	
315	Seoul	GPS	143.5E	POR		x		
Australia & NZ Stations								
401	Darwin	GPS	143.5E	POR	IOR	x		
402	Broome	GPS,GLO	143.5E	POR	IOR	x	x	
403	Dampier	GPS	143.5E	POR	IOR	x		
404	Perth	GPS	143.5E	POR	IOR	x		
406	Melbourne	GPS	143.5E	POR		x		
408	Hobart	GPS,GLO	143.5E	POR		x	x	
409	Auckland (New Plymouth)	GPS,GLO	143.5E	POR		x	x	
411	Dunedin	GPS	143.5E	POR		x		

VERPOS Ultra, APEX and APEX² ID's

Service	Station ID	NMEA Station ID
Ultra	68	0068
Ultra²	68 + 75	0268
Apex	81	0081
Apex²	81 + 82	0281

Note: Ultra² available only when using LD7 with Verify QC.
Please specify your requirement when contacting the Helpdesk to enable the LD7.

APPENDIX IV.

QUALITY STANDARDS

QUALITY STANDARDS

A number of standards offer marine satellite navigation system users DGNSS (DGPS/DGPS+DGLONASS) quality information. The most well-known and frequently referred to standards are:

1. UKOOA
2. NMEA-0183

Each standard is explained in more detail in the following sections.

NMEA have recently introduced the NMEA-2000 interface standard. This standard falls outside the scope of this document. See www.nmea.org for further information.

References

[1] Guidelines for the use of Differential GPS in offshore surveying, UKOOA, 1994

[2] NMEA 0183 Standard for interfacing marine electronic devices, version 3.01, January 1, 2002

[3] Guidelines on the use of DGPS as a positioning reference in control systems, IMCA M 141, October 1997

UKOOA STANDARD

The UK Offshore Operator Association (UKOOA) issued 'Guidelines for the use of Differential GPS in offshore surveying' in 1994. These guidelines set out what is generally regarded as good practise in the offshore industry. They are not mandatory and operators are free to adopt different guidelines or standards.

These guidelines are now dated in certain areas due to advancements in positioning technology and algorithms. However, they contain useful suggestions for quality monitoring as indicated below [see 1]: -

> *"To assist DGPS operators and client representatives to monitor the quality of the DGPS system in real-time the following information should be continuously available:*
> - *Pseudo-range residuals of all SV's and observation weight values used*
> - *Unit variance*
> - *Number of satellites in view and number used in solution*
> - *Redundancy of least squares solution*
> - *DOP values (HDOP, PDOP and VDOP)*
> - *Latency of differential correction data*
> - *Position comparisons derived from different reference stations*
> - *Derived antenna height with respect to "known" height*
> - *Monitor station information, especially position error measured at the monitor station. All data should be time tagged*
> - *Maximum external reliability figure and observation carrying it"*

The UKOOA guidelines present a set of test statistics and quality measures recommended for use with DGPS. In its final recommendations [see 1] it states: -

"It is essential to assess the precision and reliability of each position in order to ensure the quality of the DGPS measurements. Thus is recommends that the following processing steps be implemented: -

- *w-test for outliers carried out for each position fix*
- *F-test for unit variance carried out for each position fix*
- *When no more outliers are identified in any fix, precision and reliability measures will be calculated:*
  - *Precision: a-posteriori error ellipse*
  - *Reliability: external reliability (positional MDE using a power of test of 80%)"*

Where accuracy and precision statistical parameters are generated these all represent a 95% (2σ) confidence region.

Appendix A of the UKOOA guidelines emphasises this by listing 'Suggested parameters to be specified by a system user for typical marine survey operations' and states that 'In order to carry out rigorous QC, the covariance matrix generated by the least squares computation should be used to generate test statistics and quality measures'.

It recommends the following Test Statistics:

1. w-test — used to detect outliers
2. F-test — used to verify the model which is being used to account for 'errors' in the DGPS observations

It recommends also the following Quality Measures:

1. Error Ellipse — an approximate graphical representation of the positional standard deviation in two dimensions
2. External Reliability — the effect of the maximum MDE (Marginally Detectable Error) on the computed position

These recommendations are particularly aimed at survey applications but could be applied equally to DP applications.

NMEA-0183 STANDARD

The National Marine Electronics Association (NMEA) has developed a specification defining the interface between various pieces of marine electronic equipment. The standard permits marine electronics to send information to computers and to other marine equipment via a serial interface. A full copy of this standard is available for purchase at their web site (www.nmea.org). The current version of the standard is 3.01.

GPS receiver communication is defined within this specification. The idea of NMEA is to send a line of data called a sentence that is totally self-contained and independent from other sentences. There are standard sentences for each device category and in addition NMEA permits hardware manufactures to define their own proprietary sentences for whatever purpose they see fit. All standard sentences have a two letter prefix defining the device using that sentence type. For GPS receivers the prefix is GP followed by a three letter sequence defining the sentence contents. All proprietary sentences begin with the letter P and are followed with 3 letters identifying the manufacturer controlling that sentence.

NMEA consists of sentences, the first word of which, called a data type, defines the interpretation of the rest of the sentence. Each data type has its own unique interpretation and is defined in the NMEA standard. Each sentence begins with a '$' and ends with a carriage return/line feed sequence no longer than 80 characters of visible text (plus the line terminators). The data is contained within this single line with data items separated by commas. The data itself is ASCII text and may extend over multiple sentences in certain specialized instances but is normally fully contained in one variable length sentence. The data may vary in the amount of precision contained in the sentence. For example time might be indicated to decimal parts of a second or location may be shown with 3 or even 5 digits after the decimal point. Programs reading the data should only use the commas to determine the field boundaries and not depend on column positions. There is a provision for a checksum at the end of each sentence which may or may not be checked by the unit reading the data. The checksum field consists of a '*' and two hex digits representing the exclusive OR of all characters between, but not including, the '$' and '*'. A checksum is required on some sentences.

There have been several changes to the standard but for GPS use the only ones that are likely to be encountered are 1.5 and 2.0 through 2.3. Version 2.3 added a mode indicator to several sentences used to indicate the kind of fix the receiver currently has. The value can be A=autonomous, D=differential, E=Estimated, N=not valid, S=Simulator. Sometimes there can be a null value as well. Only the A and D values correspond to an active and reliable sentence. This mode character has been added to the RMC, RMB, VTG, and GLL, sentences and optionally some others including the BWC and XTE sentences.

The hardware interface for GPS receivers is designed to meet the NMEA requirements. They are compatible also with most computer serial ports using RS232 protocols, however strictly speaking the NMEA standard is not RS232. They recommend conformance to EIA-422. The interface speed generally can be adjusted but the NMEA standard is 4800 baud with 8 bits of data, no parity, and one stop bit. All GPS receivers supporting NMEA should support this speed. Note that, at a baud rate of 4800, you can easily send enough data to more than fill a full second of time.

At 4800 baud 480 characters per second can be sent. As an NMEA sentence can be as long as 82 characters this can be limited to less than six different sentences. The actual limit is determined by the specific sentences used and it is easy to overrun the capabilities for rapid sentence response.

A cable is required to connect to the GPS receiver output. Data can be output also via Ethernet or wireless connection. For general NMEA use with a GPS receiver only two wires are required in the cable, data out from the GPS receiver and ground.

APPENDIX V.

NMEA SENTENCES

NMEA SENTENCES

This section describes the message structure of the following advanced positioning and QC output messages: -

GGA	GLL
GST	VTG
ZDA	GNS
GSV	GRS
GSA	RMC
HDT	

NMEA GGA Sentence

The NMEA GGA sentence contains time and position fix related data for a GPS system. It includes basic quality information, which is limited to 'Fix Quality', 'Number of Satellites in Use', 'HDOP' and 'Age of Differential GPS Data'.

Structure and Example: -

$GPGGA,hhmmss.ss,ddmm.mmmmm,a,dddmm.mmmmm,b,q,xx,p.p,a.b,M,c.d,M,x.x,nnnn*hh<CR><LF>
$GPGGA,123519,4807.0378783,N,01131.0054784,E,1,08,0.9,545.4,M,46.9,M,,*47

GGA sentence defined: -

GGA	Global Positioning System Fix Data
hhmmss.ss	UTC of position
ddmm.mmmmm	latitude of position
a	N or S, latitude hemisphere
dddmm.mmmmm	longitude of position
b	E or W, longitude hemisphere
q	GPS Quality indicator (0 = invalid, 1 = GPS SPS, 2 = DGPS fix, 3 = GPS PPS, 4 = Fixed RTK, 5 = Float RTK, 6 = Estimated (dead reckoning), 7 = Manual Input Mode, 8 = Simulation Mode
xx	number of satellites in use
p.p	horizontal dilution of precision
a.b	antenna altitude above mean-sea-level
M	units of antenna altitude, meters
c.d	Geoidal height
M	units of geoidal height, meters
x.x	age of differential GPS data
nnnn	Differential reference station ID, 0000 to 1023
*hh<CR><LF>	checksum, carriage return and line feed

NOTE: The number of decimal places in the Latitude and Longitude values is configurable via the LD7 Web Interface in the **GNSS page** under **NMEA Precision**. Between 5 and 8 decimal places are selectable.

NMEA GST Sentence

The NMEA GST sentence provides error statistics of the position fix. These statistics follow from the position calculation process.

Structure and Example:

$GPGST,hhmmss.ss,a.a,b.b,c.c,d.d,e.e,f.f,g.g*hh<CR><LF>
$GPGST,024603.00,3.2,6.6,4.7,47.3,5.8,5.6,22.0*58

GST sentence defined:

GST = GNSS Pseudo-range Error Statistics

hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
a.a	RMS value of the standard deviation of the range inputs to the navigation process. Range inputs include pseudo-ranges and differential DGNSS corrections
b.b	Standard deviation of semi-major axis of error ellipse (meters)
c.c	Standard deviation of semi-minor axis of error ellipse (meters)
d.d	Orientation of semi-major axis of error ellipse (meters)
e.e	Standard deviation of latitude error (meters)
f.f	Standard deviation of longitude error (meters)
g.g	Standard deviation of altitude error (meters)
*hh<CR><LF>	checksum, carriage return and line feed

NMEA ZDA Sentence

The NMEA ZDA sentence provides time and time zone information.

Structure and Example:

$GPZDA,hhmmss.ss,dd,mm,yyyy,xx,yy*hh<CR><LF>
$GPZDA,201530.00,04,07,2002,00,00*6E

ZDA sentence defined:

ZDA = Time & Date

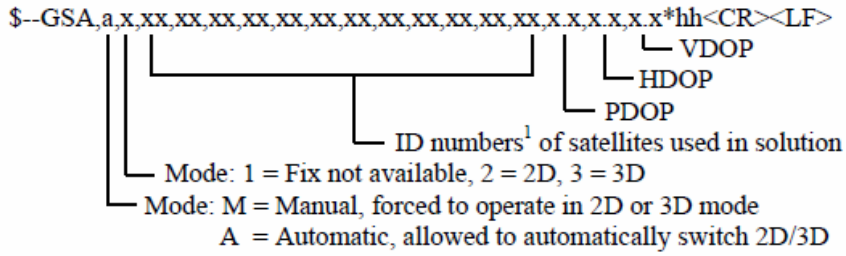
hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
dd,mm,yyy	Day,Month,Year (UTC)
xx	local zone hours (00 to +/-13 hrs)
yy	local zone minutes (00 to 59)
*hh<CR><LF>	checksum, carriage return and line feed

NMEA GSA Sentence

GSA sentence defined:

GNSS DOP and Active Satellites
GNSS receiver operating mode, satellites used in the navigation solution reported by the GGA or GNS sentence, and DOP values.

If only GPS, GLONASS, etc. is used for the reported position solution the talker ID is GP, GL, etc. and the DOP values pertain to the individual system. If GPS, GLONASS, etc. are combined to obtain the reported position solution multiple GSA sentences are produced, one with the GPS satellites, another with the GLONASS satellites, etc. Each of these GSA sentences shall have talker ID GN, to indicate that the satellites are used in a combined solution and each shall have the PDOP, HDOP and VDOP for the combined satellites used in the position.



Notes:

1) Satellite ID numbers. To avoid possible confusion caused by repetition of satellite ID numbers when using multiple satellite systems, the following convention has been adopted:

a) GPS satellites are identified by their PRN numbers, which range from 1 to 32.
b) The numbers 33-64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120-138. The offset from NMEA WAAS SV ID to WAAS PRN number is 87. A WAAS PRN number of 120 minus 87 yields the SV ID of 33. The addition of 87 to the SV ID yields the WAAS PRN number.
c) The numbers 65-96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64+satellite slot number. The slot numbers are 1 through 24 for the full GLONASS constellation of 24 satellites, this gives a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

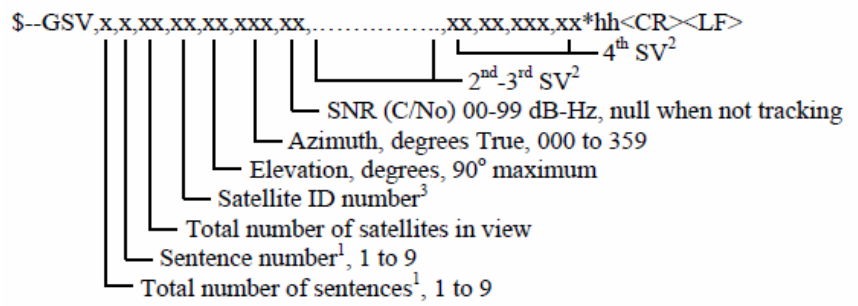
NMEA GSV Sentence

GSV sentence defined:

GNSS Satellites In View

Number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value. Four satellites maximum per transmission. Total number of sentences being transmitted and the number of the sentence being transmitted are indicated in the first two fields.

If multiple GPS, GLONASS, etc. satellites are in view, use separate GSV sentences with talker ID GP to show the GPS satellites in view and talker GL to show the GLONASS satellites in view, etc. The GN identifier shall not be used with this sentence.



Notes:

1) Satellite information may require the transmission of multiple sentences all containing identical field formats when sending a complete message. The first field specifies the total number of sentences, minimum value 1.

The second field identifies the order of this sentence (sentence number), minimum value 1. For efficiency it is recommended that null fields be used in the additional sentences when the data is unchanged from the first sentence.

2) A variable number of "Satellite ID-Elevation-Azimuth-SNR" sets are allowed up to a maximum of four sets per sentence. Null fields are not required for unused sets when less than four sets are transmitted.

3) Satellite ID numbers. To avoid possible confusion caused by repetition of satellite ID numbers when using multiple satellite systems, the following convention has been adopted:

a) GPS satellites are identified by their PRN numbers, which range from 1 to 32.
b) The numbers 33-64 are reserved for WAAS satellites. The WAAS system PRN numbers are 120-138. The offset from NMEA WAAS SV ID to WAAS PRN number is 87. A WAAS PRN number of 120 minus 87 yields the SV ID of 33. The addition of 87 to the SV ID yields the WAAS PRN number.
c) The numbers 65-96 are reserved for GLONASS satellites. GLONASS satellites are identified by 64+satellite slot number. The slot numbers are 1 through 24 for the full GLONASS constellation of 24 satellites, this gives a range of 65 through 88. The numbers 89 through 96 are available if slot numbers above 24 are allocated to on-orbit spares.

NMEA HDT Sentence.

The NMEA HDT sentence provides heading information derived from the receiver.

Structure and example:

$GPHDT,xxx.xx,T*hh<CR><LF>

where:

$GPHDT – is the message name stating it is a GPS heading (true) message

xxx.xx – this is the heading

T – states the heading is true

*hh – is the check sum for the message

NMEA GLL Sentence

The NMEA GGL sentence provides 2D position data.

Structure and Example:

$GPGLL,ddmm.mmmmmmm ,a, dddmm.mmmmmmm ,b,hhmmss.ss,S,I*cc<CR><LF>
$GPGLL,5708.7104685,N,00217.1169613,W,062859.00,A,D*72

GLL sentence defined:

GLL = Geographic position - Latitude and Longitude

ddmm.mmmmmmm	latitude of position
a	N or S
dddmm.mmmmmmm	longitude of position
b	E or W
hhmmss.ss	UTC of position
S	status (A = data valid ; V = data not valid)
I	mode indicator (A = Autonomous, D = Differential, E = Estimated, M = Manual, S = Simulator, N = data Not valid)
*cc<CR><LF>	checksum, carriage return and line feed

NMEA VTG Sentence

The NMEA VTG sentence provides the actual course and speed relative to the ground.

Structure and Example:

```
$GPVTG,p.p,T,q.q,M,r.r,N,s.s,K,u*hh<CR><LF>
$GPVTG,054.7,T,034.4,M,005.5,N,010.2,K*33
```

VTG sentence defined:

VTG = Course over ground and ground speed

p.p	course over ground
T	degrees True
q.q	course over ground
M	degrees Magnetic
r.r	speed over ground
N	knots
s.s	speed over ground
K	km/hr
U	mode indicator (A = Autonomous, D = Differential, E = Estimated)
*hh<CR><LF>	checksum, carriage return and line feed

Note that, as of the 2.3 release of NMEA, there is a new field in the VTG sentence at the end just prior to the checksum. Receivers that don't have a magnetic deviation (variation) table built in will null out the Magnetic track made good.

NMEA GNS Sentence

The NMEA GNS sentence contains time and position fix related data for a single or combined satellite navigation system. Separate $GPGNS and $GLGNS sentences are used to report data calculated from individual systems if a combined GPS+GLONASS position is output. A single string will be output if no GLONASS data is in use.

Structure and Example:

$GPGNS,hhmmss.ss,ddmm.mmmmmmm,a,dddmm.mmmmmmm,b,Q,ss,p.p,h.h,g.g,l.l,nnnn*cc<CR><LF>
$GNGNS,104601.00,5707.7332018,N,00204.7778500,W,DD,12,0.71,24.743,50.284,,*45
$GPGNS,104601.00,,,,,,09,,,,3.0,0001*44
$GLGNS,104601.00,,,,,,03,,,,3.4,0001*56

GNS sentence defined:

GNS = GNSS Fix Data	
hhmmss.ss	UTC of position
ddmm.mmmmmmm	latitude of position
a	N or S, latitude hemisphere
dddmm.mmmmmmm	longitude of position
b	E or W, longitude hemisphere
Q	Mode Indicator. First character is for the GPS system, the second character for the GLONASS system. (N = No Fix, A = Autonomous, D = Differential, P = Precise, R = Real Time Kinematic, F = Float RTK, E = Estimated, M = Manual Input Mode, S = Simulation Mode)
ss	number of satellites in use
p.p	horizontal dilution of precision
h.h	antenna altitude above mean-sea-level
g.g	Geoidal height
l.l	age of differential GPS data
nnnn	Differential reference station ID, 0000 to 1023
*cc<CR><LF>	checksum, carriage return and line feed

NMEA GRS Sentence

GNSS Range Residuals

This sentence is used to support Receiver Autonomous Integrity Monitoring (RAIM). Range residuals can be computed in two ways for this process. The basic measurement integration cycle of most navigation filters generates a set of residuals and uses these to update the position state of the receiver.

These residuals can be reported with GRS, but because of the fact that these were used to generate the navigation solution they should be recomputed using the new solution in order to reflect the residuals for the position solution in the GGA or GNS sentence.

The MODE field should indicate which computation method was used. An integrity process that uses these range residuals would also require GGA or GNS, GSA, and GSV sentences to be sent.

If only GPS, GLONASS, etc. is used for the reported position solution the talker ID is GP, GL, etc. and the range residuals pertain to the individual system. If GPS, GLONASS, etc. are combined to obtain the position solution multiple GRS sentences are produced, one with the GPS satellites, another with the GLONASS satellites, etc. Each of these GRS sentences shall have talker ID "GN", to indicate that the satellites are used in a combined solution. It is important to distinguish the residuals from those that would be produced by a GPS-only, GLONASS-only, etc. position solution. In general the residuals for a combined solution will be different from the residual for a GPS-only, GLONASS-only, etc. solution.

$--GRS,hhmmss.ss,x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x,x.x*hh<CR><LF>

Range residuals in meters for satellites used in the navigation solution1,2.
Order must match order of the satellite ID3 numbers in GSA.
When GRS is used GSA and GSV are generally required.

Mode: 0 = residuals were used to calculate the position given in the matching GGA or GNS sentence
1 = residuals were recomputed after the GGA or GNS position was computed

UTC time of the GGA or GNS fix associated with this sentence

Notes:

1) If the range residual exceeds +99.9 meters, then the decimal part is dropped, resulting in an integer (-103.7 becomes -103). The maximum value for this field is +999.

2) The sense or sign of the range residual is determined by the order of parameters used in the calculation.
The expected order is as follows: range residual = calculated range - measured range.

3) When multiple GRS sentences are being sent then their order of transmission must match the order of corresponding GSA sentences.
Listeners shall keep track of pairs of GSA and GRS sentences and discard data if pairs are incomplete.

NMEA RMC Sentence

NMEA has its own version of essential gps pvt (position, velocity, time) data. It is called RMC, The Recommended Minimum, which will look similar to:

$GPRMC,123519,A,4807.038,N,01131.000,E,022.4,084.4,230394,003.1,W*6A
Where:

RMC	Recommended Minimum sentence C
123519	Fix taken at 12:35:19 UTC
A	Status A=active or V=Void.
4807.038,N	Latitude 48 deg 07.038' N
01131.000,E	Longitude 11 deg 31.000' E
022.4	Speed over the ground in knots
084.4	Track angle in degrees True
230394	Date - 23rd of March 1994
003.1,W	Magnetic Variation
*6A	The checksum data, always begins with *

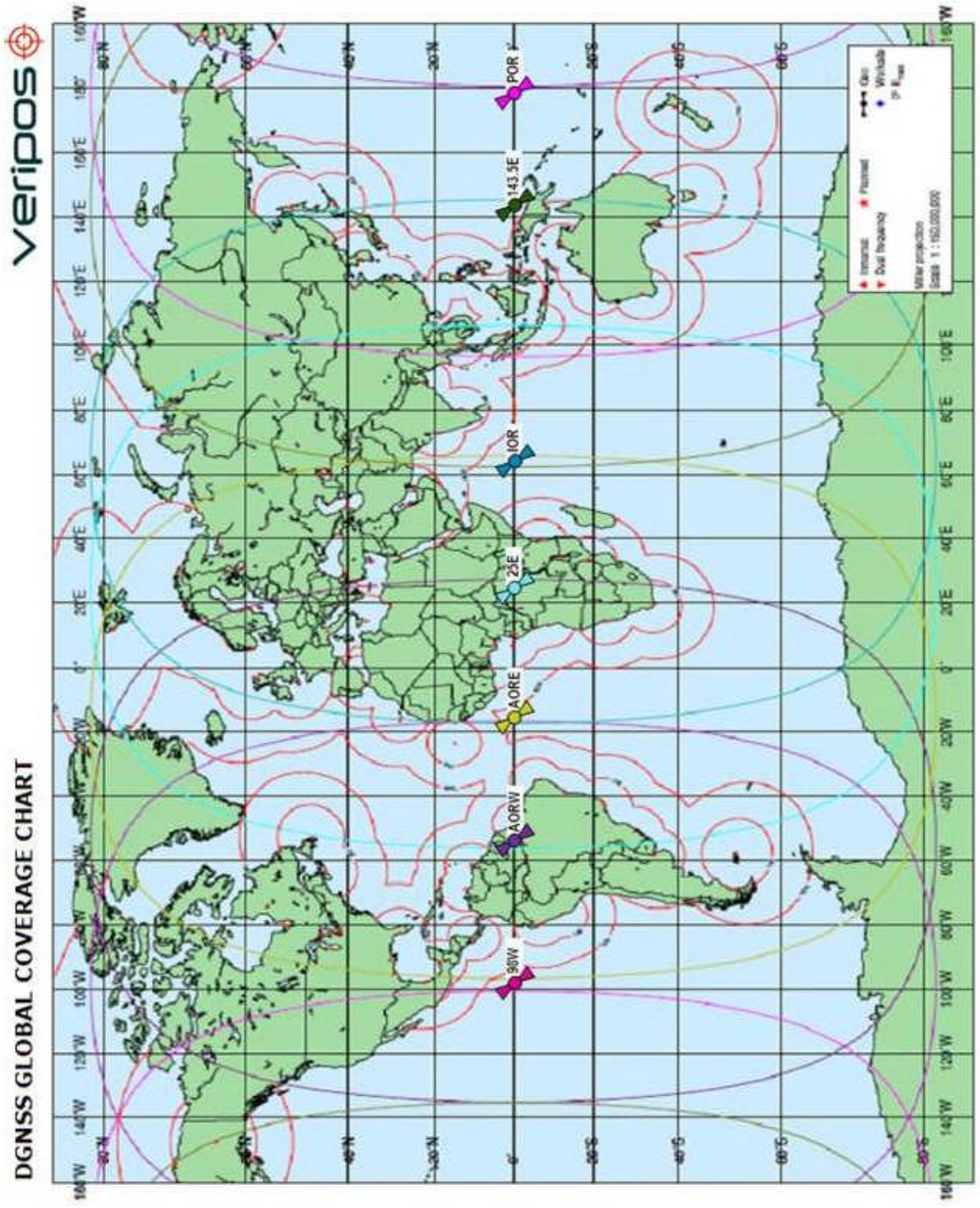
Note that, as of the 2.3 release of NMEA, there is a new field in the RMC sentence at the end just prior to the checksum. For more information on this field.

APPENDIX VI.

GLOBAL COVERAGE CHART

Veripos Inmarsat Global Coverage chart showing footprints of Geostationary Satellites broadcasting Veripos corrections.

Updated charts, Verichart software and updates can be downloaded from the Knowledge Base on VOSS at http://help.Veripos.com



APPENDIX VII.

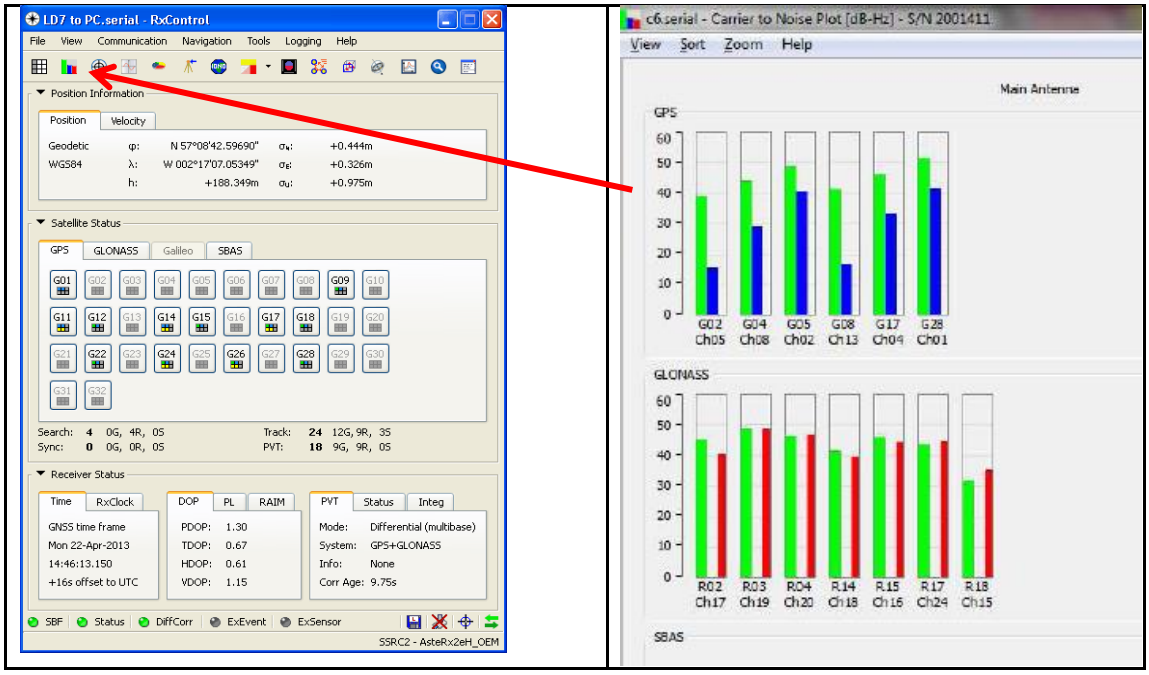
HEADING ANTENNA GUIDE

Confirm Heading or Aux antenna is working:
Heading Calibration methods for Septentrio AsteRx2eH GNSS card

This document has some recommended checks (using RxTools software) of the heading quality, in order to compute the GNSS Heading Vector. Contact Veripos if you require the RxTools software.

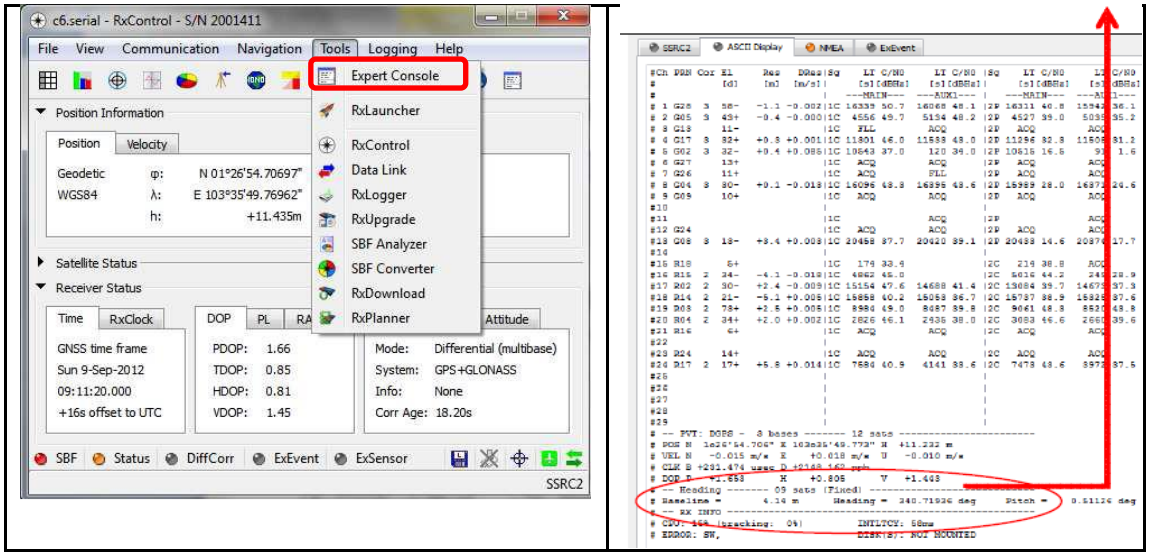
Step 1

Connect RxTools to the receiver in order to check the AUX antenna Signal to Noise Ratio (SNR). Both Main and Aux antenna should lock in the same GPS and GLONASS SV for both L1L2 SNR values.



Step 2

Connect RxTools to the receiver in order to check the ASCII Display for Heading and no. of SV's used with Quality indicator, (Fixed) indicates that the heading solution should be within specification based on the baseline between antenna.



Receiver Heading calibration methods

Typical accuracy will be (With heading mode **fixed)**:-

- At ***1m separation***, expected heading accuracy to be better than 0.3 deg with RTK fixed quality
- At ***3m separation***, expected heading accuracy to be better than 0.1 deg with RTK fixed quality
- At ***10m separation***, expected heading accuracy to be better than 0.03 deg with RTK fixed quality

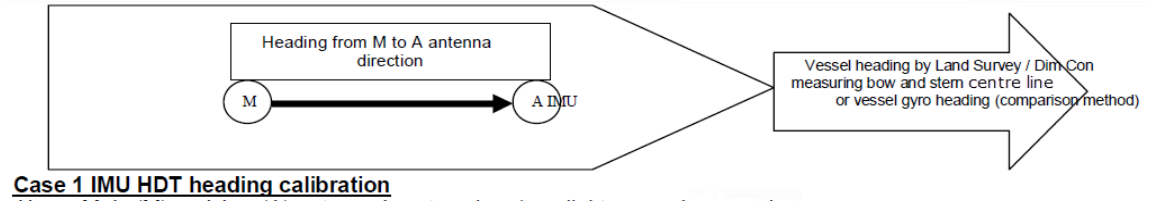
The NMEA HDT output string is the Azimuth from Main to Aux antenna direction.
If both the antennas cannot be setup directly on the vessel heading line, a standard gyro calibration can be carried out on vessel's bow and stern centreline position by land survey method to derive the Computed minus Observe (C-O) corrections.

If both the antenna X, Y are measured accurately relative to the vessel centreline (within a few cm), you can compute the C-O or biased angle based on arc Tan ((Xm-Xa)/(Ym-Ya)) where m=main and a=aux antenna X and Y value.

The quickest way to derive the C-O is to line up the GNSS heading unit to the ship's heading (ship's gyro reading minus GNSS HDT). If accuracy is OK to few degrees for purely positioning purposes e.g. for general barge moves, setting for anchor handling tug etc.

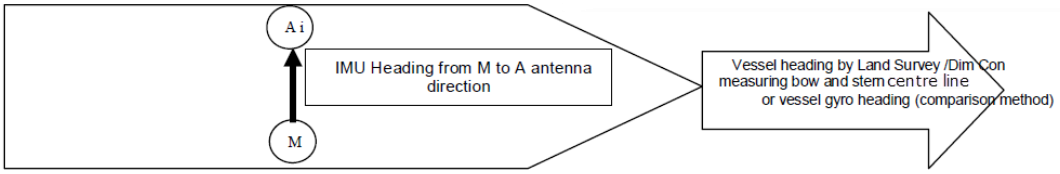
Below are two examples for deriving the C-O or biased angle corrections for the IMU HDT heading -

1) Where antennas parallel to vessel centre line



Case 1 IMU HDT heading calibration
Above Main (M) and Aux (A) antenna is setup close/parallel to vessel centre line
Observed HDT heading = 60 deg
Vessel Heading derived by Land Survey method = 65 deg
Computed minus Observed (C-O)=65-60**= plus 5 deg** to be applied in the Navigation software

1) Where antennas parallel / close to vessel centre line



Case 2 IMU HDT heading calibration
Above Main (M) and Aux (A) antenna is setup perpendicular to vessel centre line
Observed HDT heading = 60 deg
Vessel Heading derived by Land Survey method = 155 deg
Computed minus Observed (C-O)=155-60**= plus 95 deg** to be applied in the Navigation software

APPENDIX VIII

SERVICES NOTIFICATION FORM

SIGNAL ACCESS INSTRUCTIONS

1.0 CLIENT is to obtain sufficient SIGNAL ACCESS LICENCES (SAL's) to cover the total number of vessels, barges, mobile drilling units or other offshore installations simultaneously accessing SERVICES.

2.0 SAL's are available for the following Veripos SIGNALS either singly or in combination:
- Standard (single or dual-beam satellite delivery)
- Standard^2 (single or dual-beam satellite delivery)
- Ultra (single or dual-beam satellite delivery)
- Ultra^2(single or dual-beam satellite delivery)
- Apex (single or dual-beam satellite delivery)
- Apex^2 (single or dual-beam satellite delivery)
- NTRIP (internet delivery of Veripos SIGNAL(S)

Veripos SIGNALS are encrypted and receiving EQUIPMENT and HARDWARE must be programmed 'over-the-air' in order to receive the SIGNALS. Note that where a SAL for combined SIGNALS has been procured, it is not permissible to split the SIGNALS across different vessels.

CLIENT may also, subject to EQUIPMENT/HARDWARE configuration and compatibility, make use of third party services such as:
- IALA HF/MF DGPS signal
- Locally transmitted UHF augmentation signal
- External RTCM input

and should contact Veripos Helpdesk in such instances to ensure that the EQUIPMENT and/or HARDWARE is suitably configured.

3.0 Following execution of the CONTRACT the CLIENT will be allocated a unique SAL number for each vessel aboard which SERVICES are to be provided. To activate the SIGNAL, the SAL ID number must be entered onto the SERVICES Notification Form (SNF), together with all other required details.

4.0 To activate / deactivate SIGNAL, the user must submit a completed SNF to the Veripos Helpdesk.

Note. Veripos NTRIP – additional documentation on the use of this service will be provided upon request.

5.0 Upon receipt of a completed SNF, the Veripos Helpdesk will initiate the relevant enable or disable procedures and where appropriate, update the service over-the-air.

6.0 It remains the responsibility of the CLIENT to ensure that the SERVICE has been enabled or disabled. Delay in notification of SIGNAL disablement may have commercial implications.

SERVICES NOTIFICATION FORM

Email to: helpdesk@Veripos.com Website: http://www.Veripos.com
24Hr Helpline: +44 (0)1224 965900

SIGNAL ACCESS LICENCE Number [see note 1, 3 & 4]	

Company / Project Name	

Vessel Name	

Vessel / Rig / Offshore Installation Details			
Geographic Location:		Telephone:	
Contact Name:		Fax:	
Authorised Person		Email:	

Service	**Single or Dual Beam**	**Enable (dd/mm/yy)**	**Disable (dd/mm/yy)**
STANDARD (GPS)			
STANDARD^2 (GPS+Glonass)			
ULTRA (Precise Point Position)			
ULTRA^2 (Precise Point Position, GPS+Glonass)			
APEX (Precise Point Position)			
APEX^2 (Precise Point Position, GPS+Glonass)			
VERIFY DP DISPLAY (Software feature) [Specify correction signals separately]			
NTRIP			

	Equipment Details	
	Serial No./ User Code	Equip Type (e.g. LD2 G2)
1		
2		
3		
4		

NTRIP Details			
	Vessel IP/IOLAN IP	Username	Password
1			
2			

NCC Use Only			
Date Received:		Processed By:	
Date Confirmation Issued:		Issued By:	