LD900

Installation and Operations Manual

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1 Introduction

1.1 General information

To assist with LD900 installation and operation, it will help to have the following items available when consulting this document:

- LD900 and associated equipment shipped to the site.
- The Delivery note provided within the shipment from Veripos.
- Veripos document Antenna and Coaxial Cable Installation.
- LD900 Quick Guides, available from https://veripos.com/support/technical-documents/ld900.
- LD900 FAQs, available from https://help.veripos.com.

1.2 LD900 receiver

The LD900 is a scalable integrated positioning sensor, operable as a basic L-band demodulator or configurable to meet demanding offshore positioning requirements as a fully integrated mobile positioning unit with a multi-frequency GNSS receiver. Key system features:

- Supports decimetre-level multi-constellation positioning with Veripos APEX and Ultra PPP correction services
- Compatible with Veripos Quantum software
- EN60945 Marine Certified
- 555 channels, all constellations, multi-frequency tracking
- Simultaneously track up to three Veripos correction service satellites
- Advanced signal filtering when used with Quantum, mitigating interference and spoofing effects.
- Supports RTK operations
- Multiple communication interfaces for easy installation
- Optional ALIGN® GNSS heading solution
- Optional SPAN® INS solution
- Optional MSK Beacon receive corrections from IALA marine radio beacon network
- Optional UHF receiver for reception of corrections
- Optional 7 Port expansion unit
- 19 Inch rack mount options (for single or dual LD900 systems)

1.3 Preamble

The purpose of this manual is to provide the information necessary to install and operate the LD900.

This manual includes the following sections:

1. Introduction - Details the purpose of the manual, conventions and abbreviations.
2. Hardware overview - Describes the LD900 interface panel and provides technical data.
3. LD900 installation - Covers the installation of the LD900 and provides antenna & cabling guidelines.
4. Configuration and operations - Details system configuration and operations via the MMI.
5. Troubleshooting - Provides steps to rectify system issues that a user may encounter.
6. Reference information - Provides detailed technical specifications.
7. Contact information - Contains contact information for Veripos Support.
8. Appendix - Provides additional supplementary material.

1.4 Veripos Support

Veripos Support is a service provided as the first point of contact for all Veripos technical support and fault reports. It is available 24 hours a day, 365 days per year. Full contact details are available in the Contact information section, on the LD900 product label located on the top of the unit or the LD900 MMI Help & Support page.

For support cases, contact support.veripos@hexagon.com or raise a ticket at https://help.veripos.com. Either method will immediately notify Veripos Support, who will then assist.

Veripos Support will provide initial help and may, if necessary, escalate tickets to regional on-call engineers to provide more in-depth technical support.

To aid support, upon first contact, please provide the following:

- Details of the issue or question
- Vessel name
- Company name
- Telephone number
- Unit user code
- Veripos hardware type
- Veripos software type
- Operating area
- Is this issue holding up operations?
- Any other relevant information

1.5 Activating Veripos correction services

Veripos correction signals are provided on a subscription basis by Veripos.

Activation of the LD900 is necessary for the system to decode corrections and output a corrected position. Users may request activation of services from support.veripos@hexagon.com, who will send the activation signal to the unit via an L-band satellite.

When not in use, some service agreements may allow for service deactivation.

NOTE
To use Veripos correction signals, a contract with Veripos **must** first be in place. Veripos refers to this as a Service Access License (SAL).

To avoid delays, users should record the SAL number associated with the Veripos equipment. Veripos Support is unable to activate any equipment unless an active SAL exists.

1.6 Terms and abbreviations

AC	Alternating Current
ALIGN	GNSS heading solution
APEX	Veripos high accuracy positioning solution
Baud	Unit of signal transmission rate
BEIDOU	Chinese commissioned GNSS
COM	Communication Port
dB	Decibel
EGM96	Earth Gravitational Model 1996
DHCP	Dynamic Host Configuration Protocol
DOP	Dilution of Precision
DP	Dynamic Positioning
DQI	Differential Quality Indicator
EU	European Union
GALILEO	European commissioned GNSS
GLONASS	GLObal NAvigation Satellite System - Russian commissioned GNSS
GNSS	Global Navigation Satellite System
GP	Global Positioning
GPS	Global Positioning System - United States commissioned GNSS
HDOP	Horizontal Dilution of Precision
Hz	Hertz
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
ID	Identification
INS	Inertial Navigation System
IP	Internet Protocol
IPv4	Internet Protocol version 4
LAN	Local Area Network
L-band	Signal transmitted to carry correction data to mobile users
LED	Light Emitting Diode
NMEA	National Marine Electronics Association
MSK	Minimum Shift Keying
PDOP	Position Dilution of Precision
PPP	Precise Point Positioning
PPP-AR	Precise Point Positioning-Ambiguity Resolution
PPS	Pulse Per Second
PRN	Pseudo Random Noise
PSN	Product Serial Number
PTP	Precision Time Protocol
PWR	Power
Quantum	LD900 compatible visualisation software

RAIM	Receiver Autonomous Integrity Monitoring
RS232	Recommended Standard 232
RS422	Recommended Standard 422
RJ45	A physical network interface standard used in telecommunications
RTCM	Radio Technical Commission for Maritime Services
RTK	Real-Time Kinematic
SAL	Service Access License
SBAS	Satellite Based Augmentation System
SD	Standard Deviation
SMA	SubMiniature version A
Standard	Veripos Single frequency DGNSS system
TCP	Transmission Control Protocol
UDP	User Datagram Protocol
Ultra	Veripos high accuracy position solution
USB	Universal Serial Bus
UTC	Coordinated Universal Time
VDC	Volts Direct Current
VDOP	Vertical Dilution of Precision
VOSS	Veripos Online Support System
WAAS	Wide Area Augmentation System
WebUI	Web User Interface
WEEE	Waste Electrical and Electronic Equipment
Wi-Fi	IEEE 802.11 (wireless) standard

1.7 Document conventions

1.7.1 Typographical conventions

Italic or **bold** text is used to emphasize certain information. *Italic* is also used in cross-references to other parts of the document and to other documents.

Bold text is also used for indicators and touch screen “push-buttons” commands.

Blue text is used for hyperlinking to other sections within this document or to external documents or websites.

Bold italic text is used when display screens are mentioned in text.

`Monospace` text is used for input/output strings to/from the device.

1.7.2 Special Notices

WARNING
A warning indicates the risk of bodily harm or serious damage to the hardware.

CAUTION
A caution indicates the risk of damaging the hardware or adversely impacting the operation of the system.

NOTE
A note contains important information to help you make better use of the system.

1.8 LD900 Notices

The following notices apply to the LD900:

1.8.1 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 electronics 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 WEEE. The symbol shown below is on the product or on its packaging, which indicates that this product must not be disposed of with other waste. Instead, it is the user’s responsibility to dispose of their waste equipment by handing it over to a designated collection point for the recycling of waste electrical and electronic equipment.

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.

1.8.2 FCC

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

LD900 has been tested and found to comply with the radiated and conducted emission limits for a Class B digital device. The Class B limits are designed to provide reasonable protection against harmful interference in a residential installation.

The equipment listed generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Re-orient or relocate the LD900
- Increase the separation between the equipment and the LD900
- Connect the equipment to an outlet on a circuit different from that to which the LD900 is connected
- Consult Veripos for help

CAUTION
To maintain compliance with the limits of a Class B digital device, you must use shielded interface cables.

WARNING
The LD900 has been authorised for use in mobile applications. At least 20 cm (8 inches) of separation between the LD900 and the User must be maintained during normal operation.

WARNING
Changes or modifications to this equipment, not expressly approved by Veripos could void the user's authority to operate this equipment.

1.8.2.1 Wi-Fi

The LD900 contains a Wi-Fi radio with the following approval:

- FCC ID: Z64-WL18SBMOD (USA)

1.8.3 European Union / United Kingdom (UK)

1.8.3.1 Radio Equipment Directive

Veripos declares that the LD900 including its Wi-Fi transceiver is in compliance with:

1. EU Directive 2014/53/EU
2. UK Regulations S.1. 2017/1206

Radio Information:

Description of Service: Wi-Fi (802.11b/g/n)
Operational Frequency: 2412 MHz to 2462 MHz
Modulation: OFDM
Rated Power: 16.38 dBm

The full text of either the UK or EU Declaration of Conformity may be obtained from Veripos upon request.

1.8.3.2 ROHS

The LD900 is in conformity with Directive 2011/65/EU of the European Parliament and of the council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment.

1.8.3.3 Reach

The LD900 is compliant with Regulation (EC) No. 1907/2006 of the European Parliament and the Council of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Chemicals (REACH). The candidate list of Substances of Very High Concern (SVHC) published by the European Chemical Agency

(ECHA) is available at: https://echa.europa.eu-/candidate-list-table.

1.9 Disclaimer

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1.10 Equipment care

This section summarizes safety guidelines when installing the LD900 unit.

1.10.1 Unpacking and inspection

Carefully unpack and inspect the unit. If the equipment appears damaged, then return it using the original packaging. Responsibility for damage will not be accepted if the approved packaging is not used. Ensure all the major items and the ancillary equipment are supplied. If any items are found to be missing, contact the system supplier or Veripos as soon as possible.

1.10.2 Safety warnings

Always observe the following safety precautions:

- **Always** disconnect the LD900 and associated equipment from the power supply when connecting equipment.
- Before replacing a fuse, **disconnect the equipment from the power supply**.
- Always use the power connections supplied with the unit.
- Ensure adequate air circulation to ventilate the unit, especially to the sides, to avoid heat build-up.
- Avoid excessive heat, humidity, dust or vibration.
- Never use the equipment in damp or wet conditions.
- Do not use the equipment where it may be subjected to dripping or splashing liquids.
- Connect only to a power supply with a voltage within the range of 12V to 24V DC.Installation

1.10.3 Installation

During installation ensure the following:

- DC power supply is disconnected. The power connection is easily accessed on the unit rear.
- The unit is secured using the holes in the base plate. Position the unit to ensure there is ample spacing for access to the interface panel and adequate ventilation during normal operation.
- All cables are routed safely to avoid sharp edges, bends and pinches.
- Only the cables specified within this manual are used for interconnection of the equipment.
- Equipment is connected to the ships ground.

1.10.4 Maintenance

Clean the unit using a clean dry cloth only. Do not wet the unit or allow the penetration of water. Do not use solvents to clean the unit.

1.10.5 Servicing

This unit contains no user-serviceable parts. Please refer all repairs to a qualified service agent or Veripos.

1.10.6 Fault diagnosis

Follow the guidance in this document to correctly install the LD900. Where the LD900 does not perform as indicated firstly check all connections before contacting your supplier or support.veripos@hexagon.com for assistance.

2 Hardware overview

This section provides an overview of the LD900 receiver and details the physical characteristics of the system and the different models.

2.1 System overview

The LD900 is a high-precision system built into a rugged enclosure and designed to operate reliably in the most demanding of marine environments. The LD900 is available in three separate models and is upgradable as required to provide any Veripos positioning solutions. Key model-dependent system features include:

- Multi-channel L-band reception supporting all Veripos correction services
- Multi-constellation GNSS system with a quad-frequency capability
- Dual antenna inputs for heading
- Multiple RS232 / RS422 ports
- Dual Ethernet ports
- Front panel display UI
- Integrated data logging
- Optional INS

2.2 Hardware models

The product label on top of the LD900 will indicate the model, with the system available in three models:

Model	Receiver modules
LD900L	L-band
LD900	L-band, GNSS
LD900M	L-band, GNSS & MF

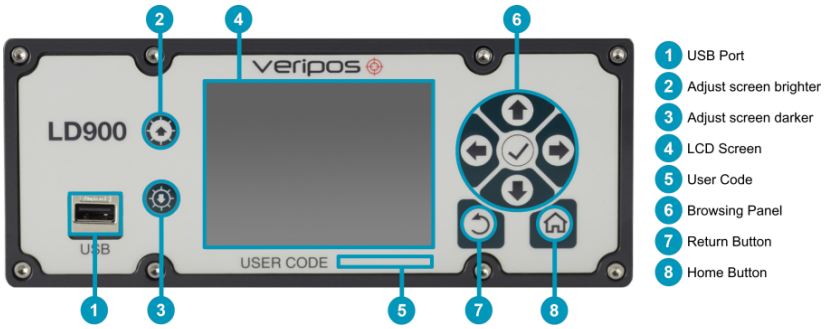
Both the LD900 and LD900M models are capable of GPS, GLONASS, BeiDou and Galileo multi-constellation tracking. The constellations used in the calculated solutions will depend on the use of the appropriate activated Veripos services.

2.3 Interface and connectors

The LD900 features a 3.5” colour MMI with keys to navigate the UI, allowing user configuration and status monitoring.

2.3.1 Front panel interface

The LD900 front panel provides a display UI, controls and USB 2.0 port for system updates and data archiving:



2.3.2 Rear panel connectors

The LD900 rear panel has several RF and data connectors for interfacing with the unit:

Model	Connector	Description
LBAND	TNC	Primary L-band antenna connector
GNSS1	TNC	Primary GNSS connector. Used to generate the receiver position and additionally acts as a Secondary L-band antenna connector.
GNSS2	TNC	Secondary GNSS antenna. Used for secondary positioning and to generate a heading in relation to the GNSS1 antenna.
BEACON	TNC	MF antenna connector
PPS	BNC	1PPS output
COM1, COM2, COM3	DB9	RS-422/RS-232
AUX	DB15	UHF module connector or for use as an additional RS-422/RS-232 port
LAN1	RJ45	Ethernet network 10/100Mbps for interfacing.
LAN2	RJ45	Ethernet network 10/100Mbps for connection to Quantum
PWR	SAL M12 4 Pin	12 to 24 VDC power input

2.3.3 Serial ports

The LD900 has three rear serial ports, COM1, COM2 and COM3, accessible via 9-pin D-Type connectors and a 15-pin D-Type AUX serial port.

Port	RS-232	RS-422	Galvanically isolated	Flow control
COM1	Yes	Yes	Yes	No
COM2	Yes	Yes	Yes	No
COM3	Yes	Yes	Yes	No

Access to COM4, COM5 and COM6 is available when connecting a 3-port adapter cable to the AUX serial port. COM4 is available for data input and output and, alongside COM5 when authorised, can output secondary positioning NMEA positions at 1Hz. COM6 accepts correction inputs, at 38400 baud:

Port	RS-232	RS-422	Galvanically isolated	Flow control
COM4	Yes	Yes	No	No
COM5	Yes	Yes	No	No
COM6	Yes	Yes	No	No

Refer to the Cabling and connectors section for more details.

2.3.4 1PPS output

LD900 and LD900M models can output a 1PPS (one pulse per second) signal, synced to GPS time to external equipment for accurate time synchronisation. The PPS voltage with no load is 8V. The PPS pulse width is configurable (1 to 500ms).

2.3.5 PTP

LD900 and LD900M models support PTP (Precision Time Protocol), enabling synchronization of clocks on PTP-compatible network equipment via LAN1 using GPS time. Upon enabling PTP in the network settings, additional Time Scale (PTP or UTC) and profile selections become available with a number of supported profiles.

2.3.6 Ethernet

The LD900 has two RJ45 sockets that support Ethernet (10Base-T/100Base-TX) for configuration and interfacing with vessel and survey systems. Both Ethernet ports support the IPv4 Internet layer and TCP/IP and UDP protocols.

LAN1 of the LD900 is used for data communications and ships with a factory default IP address of 192.168.2.91. Configure connecting systems to use the same IP subnet. If the LD900 needs to join an existing TCP/IP network, see the required configuration detailed in the section Receiver > Network.

LAN2 of the LD900 is available for connecting to Quantum and ships with a factory default IP address of 192.168.2.92.

2.3.7 Wi-Fi

The LD900 has a wireless access point, disabled by default but available via the front panel for use with potential future developments.

2.3.8 USB port

The USB 2.0 port is used for software and firmware updates and exporting logged data.

2.3.9 Power

The system power input is required to be 12 to 24V when connecting to a DC power source, and 110-240 Volts when using the approved AC/DC power supply as provided by Veripos:

CAUTION
If the voltage supplied is below the minimum specification, the receiver will automatically shut down.

If the voltage supplied exceeds the maximum specification, this may permanently damage the receiver and void the warranty.

The supply must be capable of providing enough current to operate the LD900.

WARNING
Only use limited power source AC/DC adapters supplied by Veripos with the product to ensure safety.

The AC/DC adapter has been tested and approved by Veripos, and the DC supply cable incorporates a 10A fuse to protect the unit.

2.3.10 Grounding

An M4 stud chassis grounding point is available for connection to the ships ground with a minimum gauge 24AWG wire:

3 LD900 installation

This section provides guidance on the installation of the LD900 receiver. In the event of difficulty, contact your supplier or Veripos (support.veripos@hexagon.com).

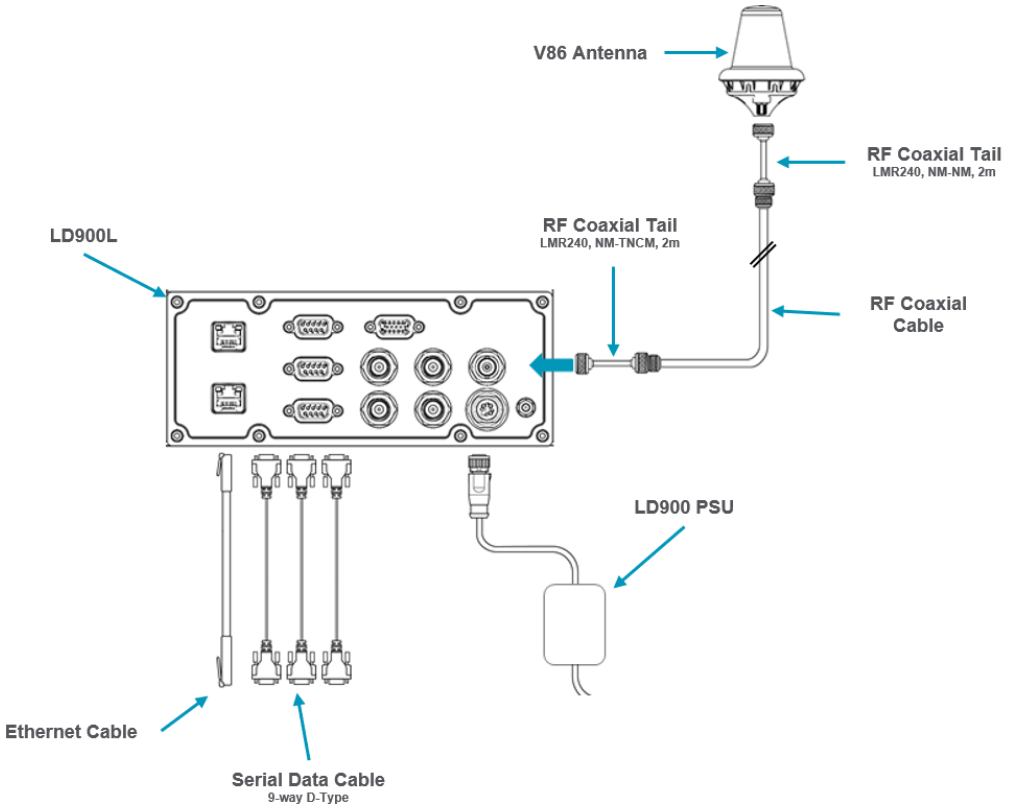
CAUTION
The personnel responsible for installing the LD900 system must be properly trained and competent to install electronic equipment.

WARNING
No user-accessible parts. Disconnect the GNSS antenna(s) prior to servicing the LD900. Only trained personnel are permitted to install/service the LD900 and antennas.

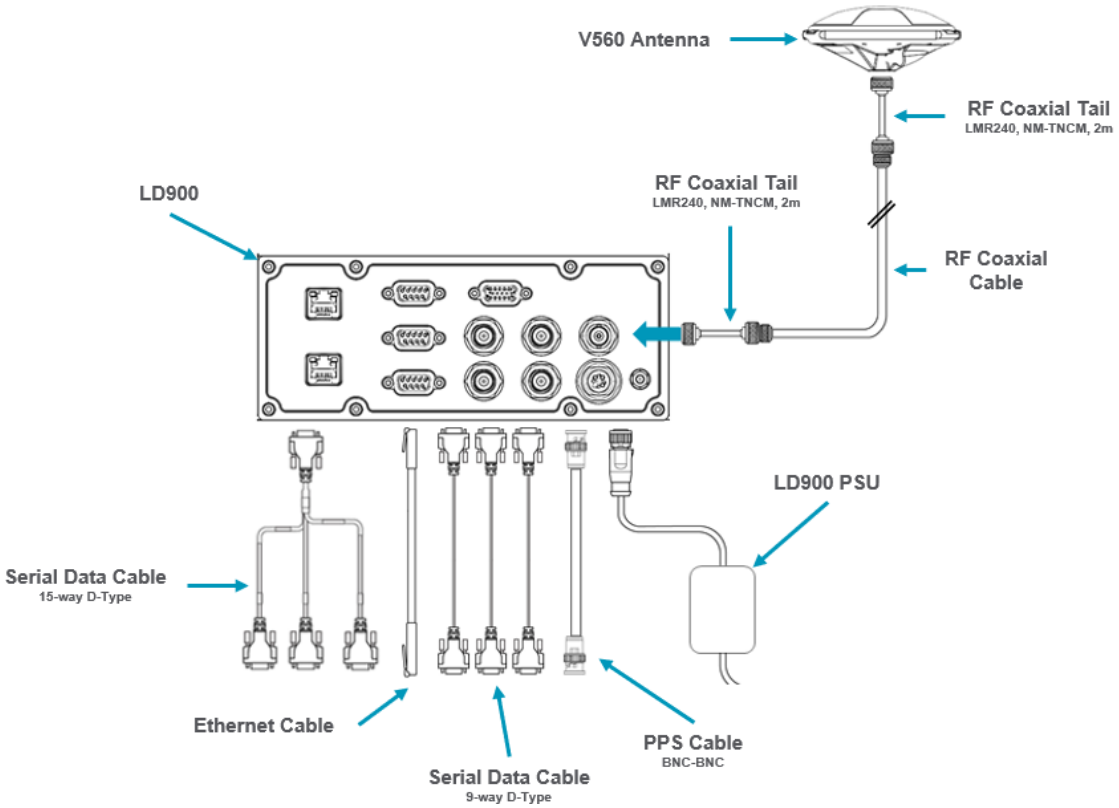
3.1 Schematic examples

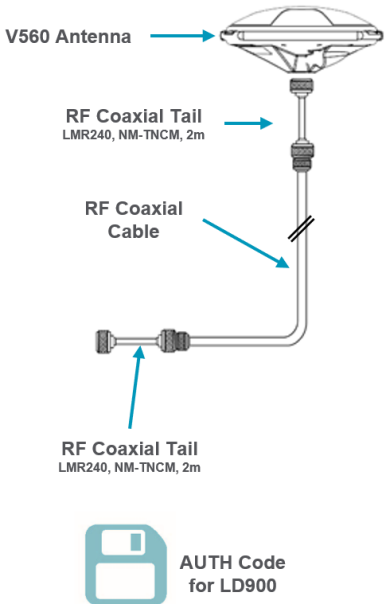
The schematics shown below represent three examples of antenna setup arrangement. Please be aware that other antenna configurations are possible. For long-term installations, always contact Veripos to obtain setup drawings specific to your installation, as these may differ from the examples below:

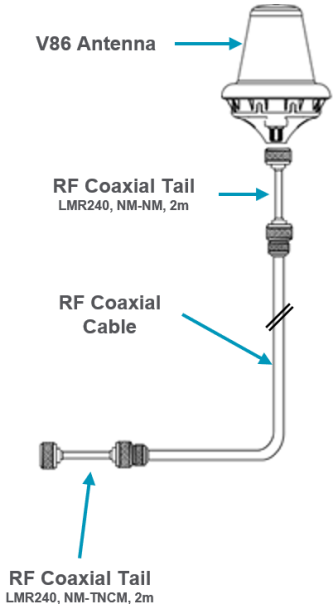
3.1.1 L-band demodulator installation (LD900L model)



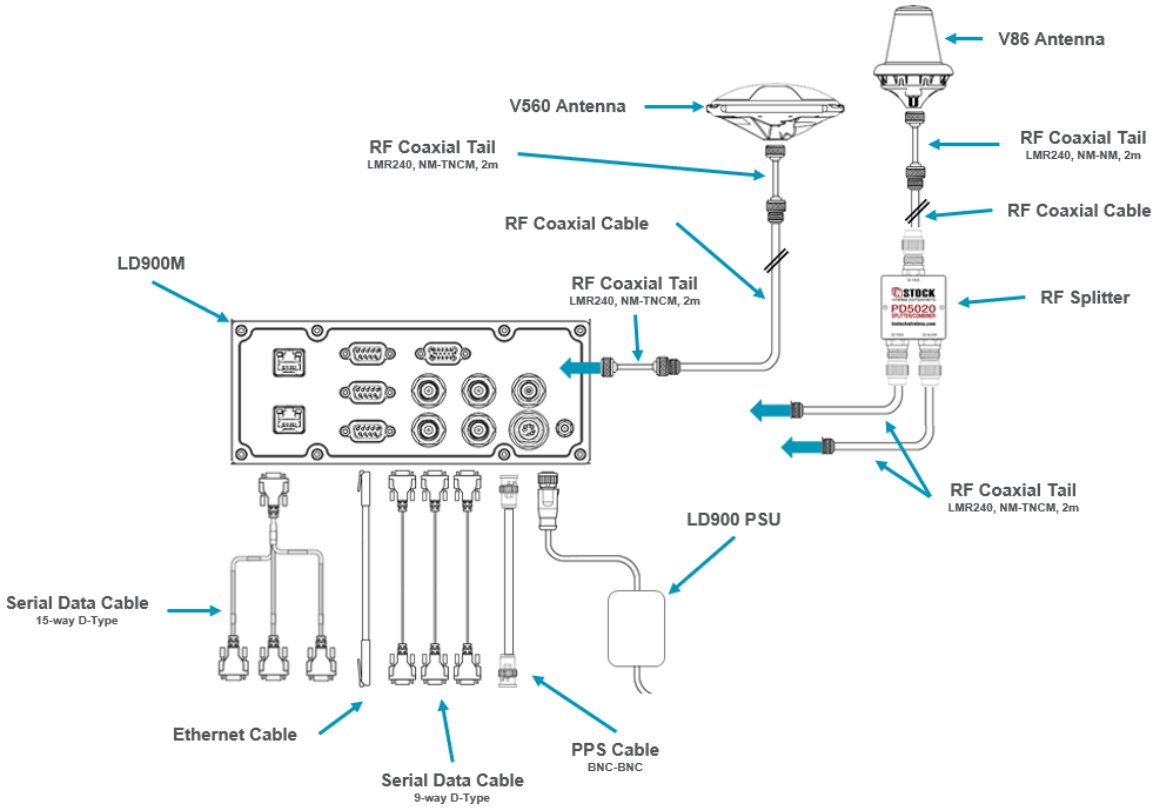
3.1.2 Survey installation (LD900 model)

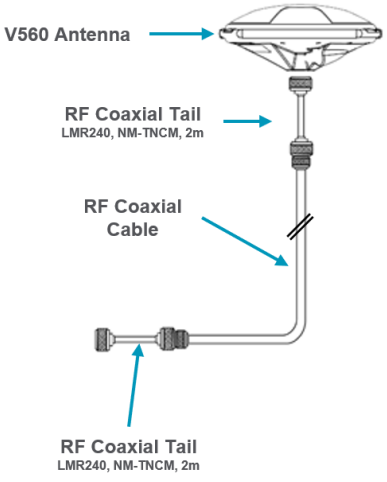






3.1.3 DP installation (LD900M model)





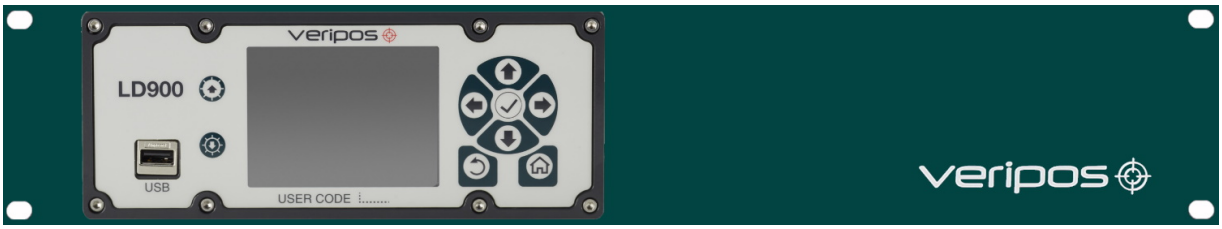
AUTH Code
for LD900

3.2 Rack mount formats

The LD900 can be supplied in one of two rack-mountable formats. The single format integrates a single LD900 with optional extras and easy access to configurable ports, while the dual format provides two LD900s within a single enclosure. Both formats can be shipped with aVeripos PC capable of running the Veripos Quantum software if required.

3.2.1 Single format rack mount

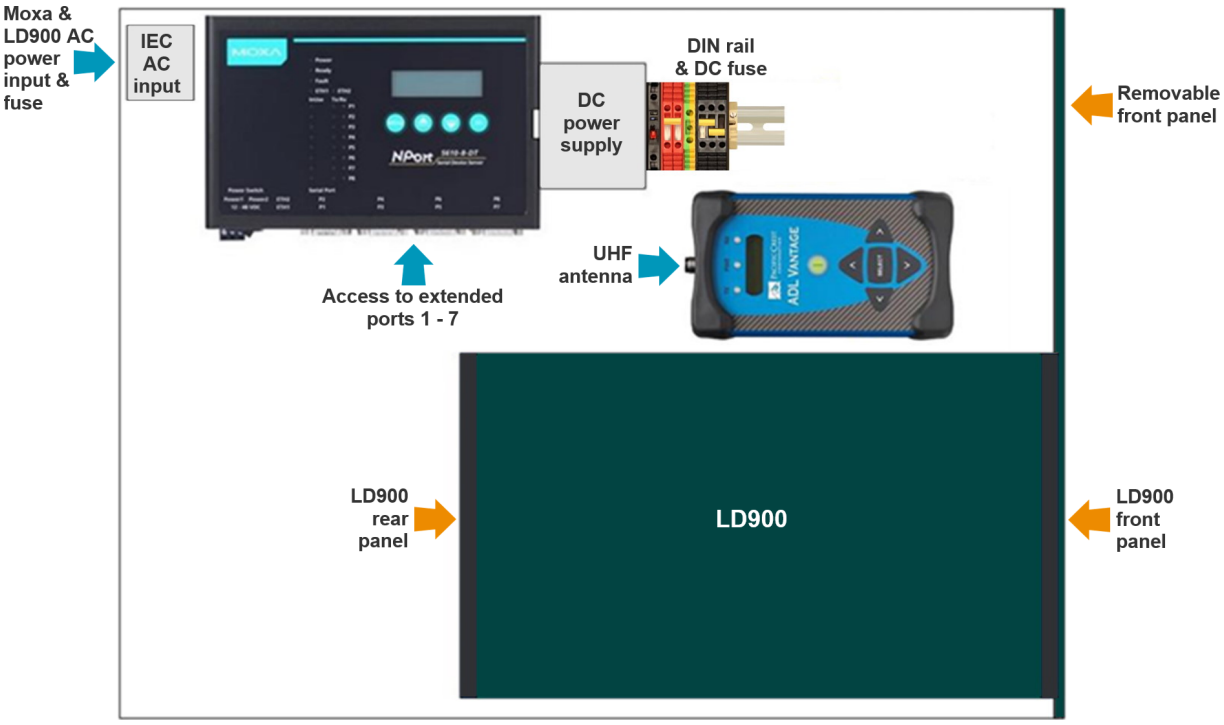
Alongside an LD900 the single format rack mount can also be provided with a Moxa 8 serial port expansion unit and/or UHF receiver as required.



Single format rack mount (front)

The front facia of the single format rack mount (as shown in the above image) can be removed by unscrewing the two front panel hex screws. This will provide access to the UHF module if included.

The diagram below illustrates the internal layout of the main components that are included in the single format rack mount system and details how the user can access the various system connectors:



Single format rack mount (top)

The single format rack mount system has many of the internal interconnections preinstalled, with the remaining connections to be finalised at installation:

Connection	Prewired?
LD900 antenna/s (L-band, GNSS, MF)	No
LD900 1PPS	No
LD900 COM ports (1-3)	No
LD900 LAN ports	Yes
LD900 UHF receiver data	Yes
LD900 DC power	Yes
Moxa DC power	Yes
Moxa LAN ports	Yes
Moxa COM ports	Yes
UHF receiver COM port	Yes
UHF receiver DC power	Yes
UHF antenna	No

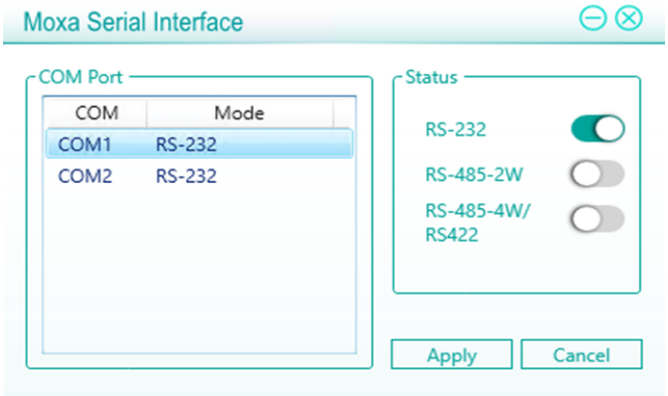
By default, both LD900 LAN ports will be wired directly to Moxa LAN ports with one connection for data transfer and the other for control. This arrangement will need to be modified for installations that incorporate a Quantum PC or need LAN interfacing for other purposes. Please consult Veripos Support for guidance if required.

3.2.2 Moxa PC Rack

By housing a marine-certified PC and LD900 in a compact rack-mounted format, the MOXA PC Rack provides an all-in-one solution for customers looking to maximise space-saving effectiveness within modern bridge environments.

LD900 Moxa PC Rack

Within a minimal footprint, the MOXA PC Rack efficiently hides a Moxa MC3201 PC within the enclosure while allowing rear access to COM ports and embedding power switch and USB port access into the front plate.The Windows PC Moxa Serial Interface program allows users to toggle between RS232, RS422 and RS485 protocols for the Moxa PC ports COM1 and COM2. Quantum visualisation software also provides the ability to toggle protocol and allows for input and output configuration on NMEA ports 1-4.



The Reference information chapter provides further information about the Moxa MC3201 PC used in this solution. For more details on connection and capabilities, please contact your Veripos account manager.

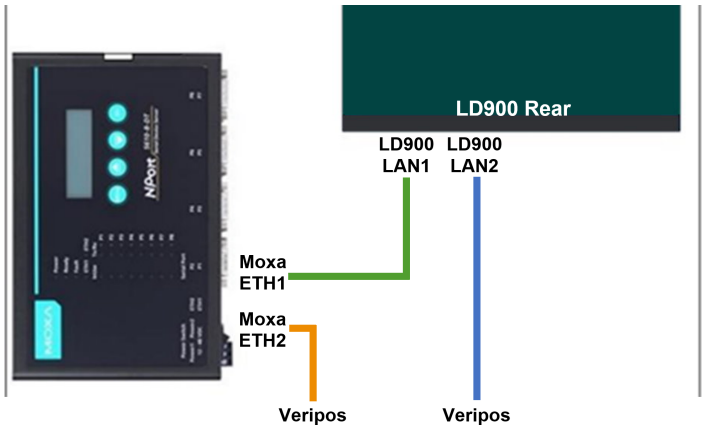
3.2.3 Dual format rack mount

The dual format rack mount securely mounts two LD900 units in an equipment rack with a removable front facia:

3.2.4 LD900 and Veripos PC – Ethernet cabling setup

For setups that are supplied with a Veripos PC, Ethernet cabling should be connected as follows:

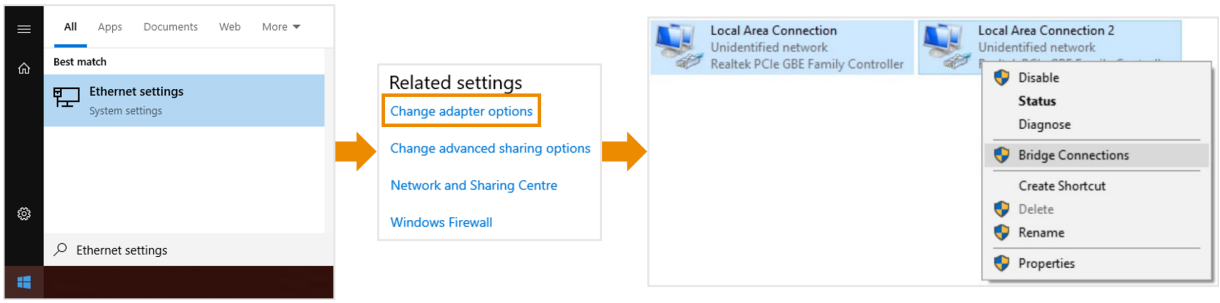
- **Note**: The Veripos PC will normally be setup on the shelf above the LD900.
- **LD900 LAN1** should be connected to **Moxa ETH1**.
- **LD900 LAN2** should be connected to **PC LAN1**.
- **Moxa ETH2** should be connected to **PC LAN2**.



3.2.5 LD900 and Veripos PC – Network bridge setup

Once the Ethernet connections have been established, the PC ports will need to be bridged together.

Within Windows, on the Veripos PC, go to **Start**, type **Ethernet Settings** and press **Enter**. In the window that opens, under Related settings, select **Change adapter options**. Using the left-mouse button highlight both **Local Area Connection** and **Local Area Connection 2**, then right-click and select **Bridge Connections**.



Windows will then report the systems as successfully bridged and a **Network Bridge** icon will appear:

Right click on the Network Bridge icon and ensure that the IP address of the bridge is within the subnet of 192.168.2.x (avoid using IP addresses 192.168.2.91, 192.168.2.92 and 192.168.2.93 which are reserved for the LD900 and Moxa device).

All devices will now be bridged and operational on the same network.

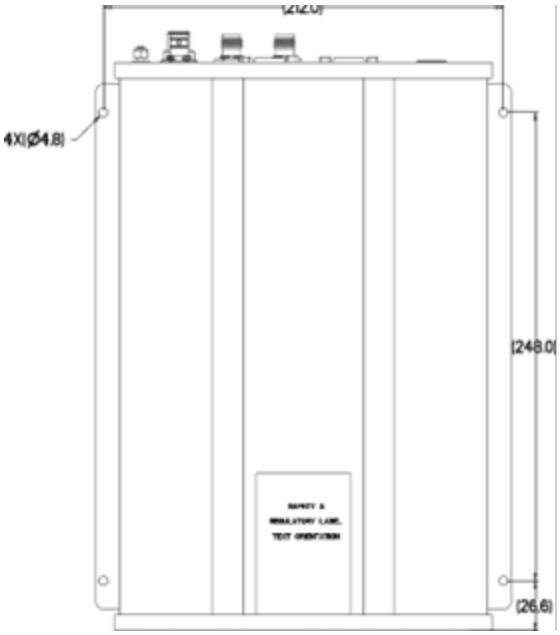
3.2.6 LD900 location guidelines

When choosing installation locations, the following requirements should be taken into consideration:

- Ensure adequate ventilation for free airflow to the main unit. This is especially important when working in hot or humid conditions. See section Ventilation requirements for more details.
- Locate unit in areas free from excessive dust or smoke.
- Avoid locations that experience excessive vibration.
- Avoid exposure to high temperatures.
- Shield the unit from direct sunlight.
- Mount the unit securely to prevent movement.
- Ensure there is easy access to the interface panel.
- Do not mount the receiver in confined spaces.
- Ensure sufficient slack remains in unit cabling to allow easy access to the unit rear.
- Ensure all bends in coaxial cables are maintained above minimum bend radius.
- Use short tails of flexible coaxial cable (e.g. LMR 240). Ensure a sufficient strain relief on the main antenna coaxial to avoid stress being placed on coaxial connectors.

3.2.7 LD900 mounting

Mount the LD900 on a secure, stable surface. The unit can be secured via the four mounting holes, size M5 (imperial size #10) as shown in the figure below. Make sure not to overtighten as this will result in damage to the housing. The torque of the screws should not exceed 15 inch-lb.



Measurements shown in millimetres

3.3 Ventilation requirements

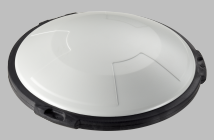
The LD900 needs 15-25mm minimum clearance all-round to allow a flow of air:

3.4 Antenna installation

This section provides general guidance on installation of antennas and cabling. It is important to the on-going performance of your system that a high-quality installation is performed, as this will ensure optimum performance and reliability.

3.4.1 Antennas

The antennas supplied with the LD900 are detailed below, these will vary depending on the LD900 model:

	V560	V86
		
Primary tracking:	GPS, GLONASS, BeiDou & Galileo	L-band
Ancillary tracking:	L-band & MF beacon	MF beacon

3.4.2 LD900 models and coaxial connections

Model name	'LBAND' TNC*	'GNSS1' TNC	'GNSS2' TNC**	'BEACON' TNC
LD900L (L-band)	V86	--	--	--
LD900 (L-band & GNSS)	V86	V560	V560	--
LD900M (L-band, GNSS & IALA)	V86	V560	V560	V86 or V560

**'LBAND' antenna required only for dedicated L-band set-ups.*

***'GNSS2' antenna required for secondary positioning and heading installations*

NOTE

After equipment installation it is recommended that a calibration survey is carried out to compute the heading offset (also referred to a C-O) and the position offset (Primary GNSS antenna). The position offset and heading offset should be entered within the navigation or DP software.

3.4.3 GNSS / L-band antenna installation guidelines

The GNSS antenna receives both multi-constellation and L-band communication satellites (used for Veripos Correction Signals).

This section describes best practice when positioning and installing your GNSS antenna/s.

For more details please refer to Veripos document *Antenna and Coaxial Cable Installation* provided as part of the installation documentation.

Antennas should be located with a clear 360° view of the sky. The best way to ensure this is to mount the antenna at the highest possible location. If the GNSS antenna does not have good satellite visibility, there will be times when system performance is degraded.

Examples of good installations – Antennas placed at top of mast with good spacing

During installation observe the following additional guidelines:

- Offsets to the GNSS antennas must be measured carefully to ensure that no errors are introduced to the DP, Survey or Navigation systems.
- Care must be taken to ensure that antennas are not installed in the direct path of transmissions from vessel radar, Inmarsat systems, VSAT systems or high-power HF (whip/wire antennas).
- If the antennas cannot be installed directly at the top of the vessel mast or structure, it is essential that the mounting point is sufficiently strong for this purpose. The installation must be able to withstand vibration and wind over a period of many years of operation.
- Stainless steel brackets and mounts are recommended to mitigate the effects of saltwater corrosion.
- A mounting pole can be used with a 5/8"x11 UNC threaded end (standard marine mount). The pole can be attached by welding, or by using “U” clamps as above. This method allows the antenna to be mounted without the need for a bracket.
- Ensure that grease (such as copper slip) is applied to the threads when installing the antenna.
- Fit the antenna to the bracket and clamp the bracket to the mounting pole or the mast by using U-clamps. When mounting the antenna on an extension pole, fit the antenna to the pole first for ease of handling at height.
- If the threaded pole is already installed up the mast, use a small length of coaxial cable attached to the N-type connector as a safety lanyard for the antenna.
- Carefully connect the coaxial cable following manufacturers’ guidelines. Form cable below the antenna into a small loop, approximately 150–220 mm (6 to 8 inch) in diameter.
- Attach the loop to the mounting pole under the antenna to provide strain relief from the cable.

3.4.4 Placement for heading antennas

Careful consideration for the placement of the primary and secondary antennas is required to maximise the LD900 GNSS heading accuracy.

3.4.4.1 Antenna separation

The GNSS heading solution accuracy is largely determined by the distance (or baseline) between the primary and secondary antennas. The larger the baseline, the better the heading precision will be.

Under ideal GNSS clear-sky conditions, the accuracy of the GNSS heading solution largely depends on the distance between the primary and secondary antennas. Increasing this baseline improves the heading measurements by facilitating more effective position triangulation, thereby minimizing errors.

The table below shows typical GNSS heading precision values for different baseline lengths. Veripos recommends maintaining a baseline of at least 2m.

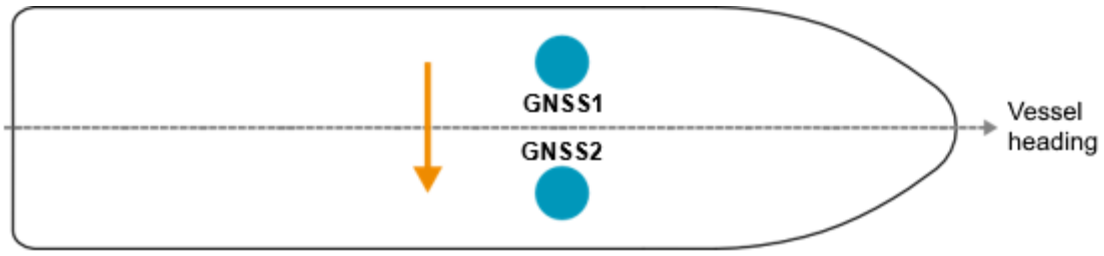
Baseline	GNSS Heading Accuracy (RMS)
2m	0.08°
4m	0.05°
10m	0.02°

3.4.4.2 Antenna orientation and height

The heading direction is computed from **GNSS1** to **GNSS2**.

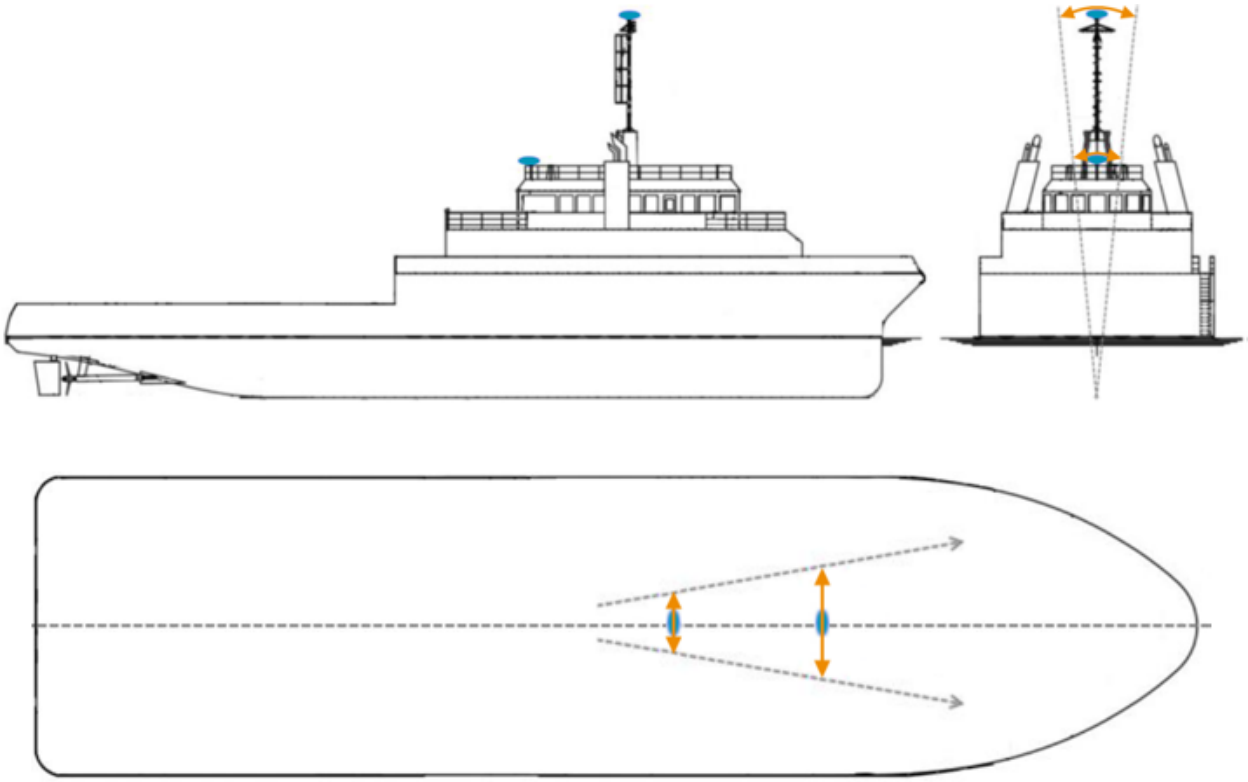
Assuming the antennas are mounted along the vessel centreline, with GNSS2 being the furthest forward antenna, the GNSS heading would closely reflect the vessel heading. In the below example, a small heading alignment correction would need to be applied in the navigation system software.

In the next example, GNSS1 and GNSS2 are installed perpendicular to vessel North with the GNSS1 at the port side and GNSS2 at the starboard side. A larger correction offset (C-O) would be required in the navigation system software to align the GNSS heading to vessel North.



NOTE
The provided examples are simplified for illustration purposes. To achieve optimal heading accuracies a calibration must also be conducted.

GNSS1 and GNSS2 should be installed at similar heights to ensure consistent heading. If this is not done the heading solution will be noisy, due to each antenna being subject to different amounts of vessel motion (such as vessel roll):



The effect of vessel motion when antennas (blue) are mounted at different heights

3.4.5 UHF antenna

If the LD900 is interfaced to a UHF receiver module, a colinear UHF Antenna will need connecting to the UHF receiver. The UHF antenna should be ideally 2 metres away from other antennas. The metal brackets and metal base of the UHF antennae should be installed below the line of sight of GNSS or L-band antennas.

3.5 Coaxial cable installation

Veripos can supply pre-terminated LMR type coaxial cables. The LMR cable type has been found to give the best overall technical and cost-effective performance. When cables are supplied by Veripos they will be supplied with 2m tails to allow for connection from main cable run to the antenna and the receiver.

It is necessary to attenuate the various GNSS and differential signals at different rates depending on the signal type and the quality of the coaxial cable.

The following table shows the maximum recommended cable length for signal types for three types of coaxial cable. It is best practice to use low loss cable, before resorting to inline amplifiers.

	L1 GNSS Only	L1/L2 GNSS	L-band
LMR-400	70 m / 229 ft	52 m / 170 ft	120 m / 393 ft
LDF4-50	130 m / 426 ft	110 m / 360 ft	210 m / 688 ft
LMR600	110 m / 360 ft	90 m / 295 ft	180 m / 590 ft

3.5.1 General cable guidance

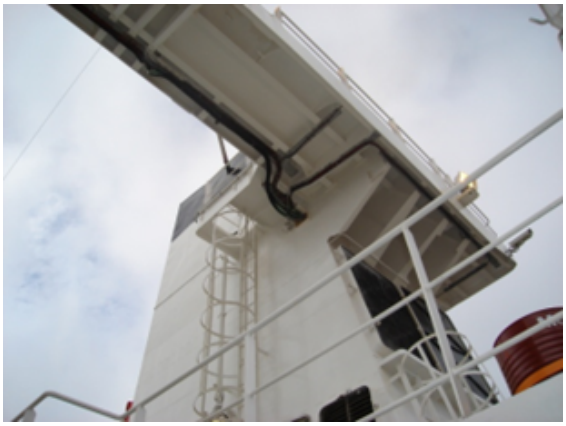
The Veripos recommended cable for the antenna runs is LMR-400. It is highly recommended that LMR-240 (thinner and more flexible) terminated tails are used at both ends of the LMR-400 cable to ease the attachment to antennas and receiver RF connectors.

Terminated tails of LMR-240

When running multiple coaxial cables Veripos recommend labelling to ensure cables are attached to the correct antennas and equipment.

Survey the route of the antenna cabling to ensure:

1. The total length of the cable run does not exceed the supplied cable length for this installation. Contact your supplier or Veripos if this is the case.
2. The cable does not cross or run parallel with any **single phase or three phase mains cable** (110 VAC, 220 VAC or 440 VAC) or any **high-power RF cables** leading to transmitting devices such as Inmarsat and VSAT domes.
3. The cable **avoids the proximity to fluorescent lighting and wiring**.
4. The cable is not placed under tension. A **support wire** is used where the cable run has to cross a free space and does not rely solely on cable ties for support.
5. Sufficient space is available in the selected cable entry through the bulkhead, for the connectors to pass through without damage. If the connector cannot pass through the cable entry it may be necessary to cut the connector off and re-terminate once the cable has been passed through.
6. The cable is **not pinched**.
7. The route is **free from all burrs or sharp edges** that could cut the cable jacket over time and lead to water ingress.
8. All **connectors and couplers are completely sealed** from the environment with overlapping layers of self-amalgamating tape and finished with layers of electrical tape or Scotchkote.
9. **Stress loops** are fitted to prevent excess force on the connectors, in particular on the antenna connectors.
10. The **minimum bend radius** for the cable is not exceeded.

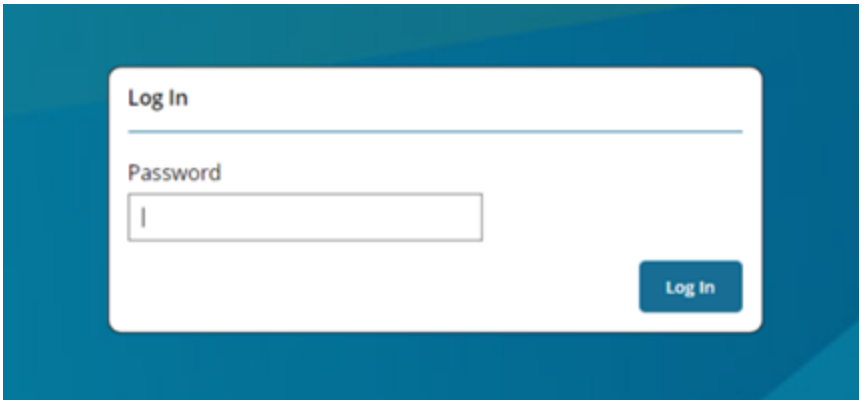


Typical cable installation in a bridge mast area

3.6 LD900 Web User Interface (WebUI)

The inbuilt WebUI of the LD900 provides the ability to authorise additional features to enhance system functionality and perform firmware upgrades.

To access the WebUI, connect a PC to the LD900 LAN2 (directly or via a network), ensuring the PC ethernet adapter is on the same subnet as the LD900 LAN2. Once connected, use a web browser to open the WebUI at the LAN2 IP address. The WebUI will prompt for a password:



Enter the LD900 seven-digit serial number and press the **Log In** button.

3.6.1 Applying Authorisation codes

Authorisation codes may be applied to provide the following:

- **GNSS Heading (Align®)**
  - GNSS heading computation using GNSS1 and GNSS2 antennas
  - NMEA heading serial output (HDT)
- **Secondary Positioning**
  - A independent secondary position using the GNSS2 antenna
  - Secondary position output
- **INS (SPAN®)**
  - A blended GNSS and Inertial positioning solution.
  - Attitude (pitch, roll and heave) output.

> **CAUTION**
> Do not attempt to perform the Authorisation code upgrade while the LD900 system is in operations.

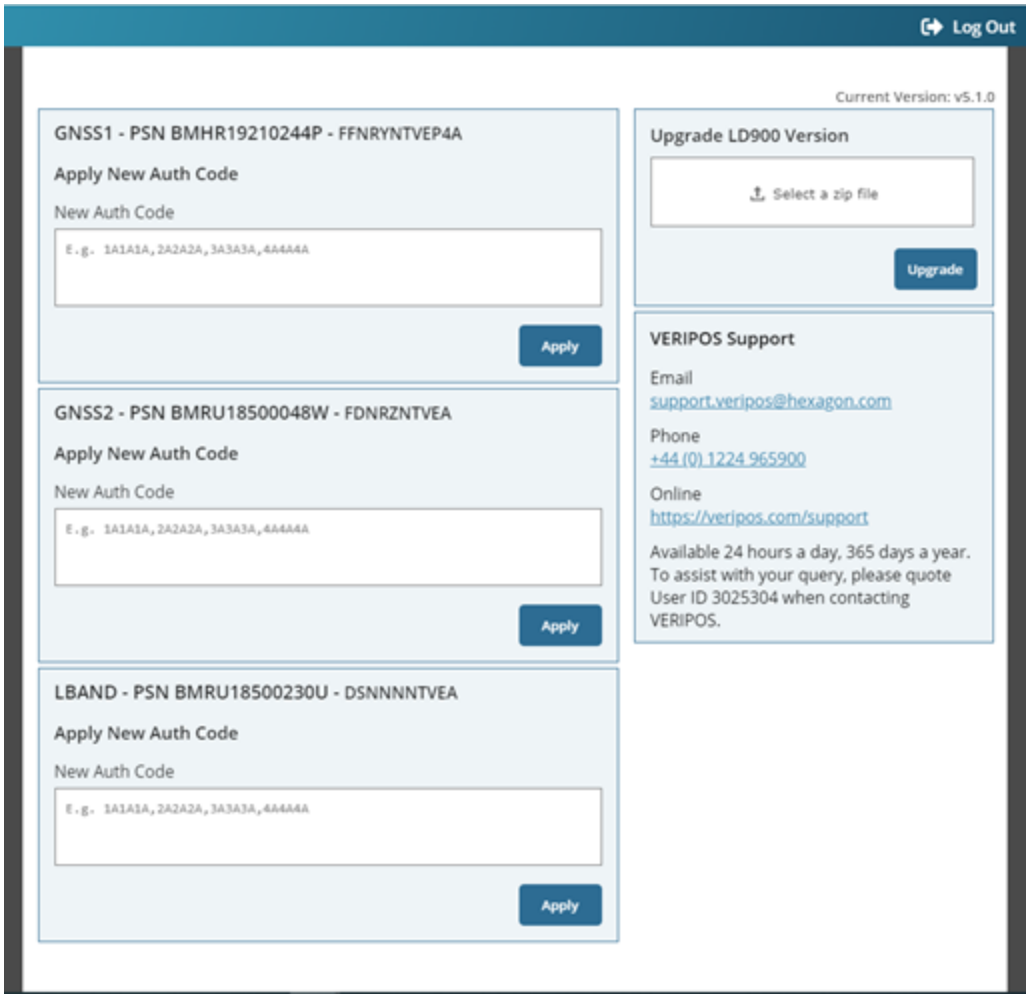
To purchase **Heading, Secondary Positioning** or **INS** functionality, e-mail the serial number of the LD900 system to your Veripos account manager, who will supply a corresponding authorisation code. The following is an example of a Heading authorisation code:

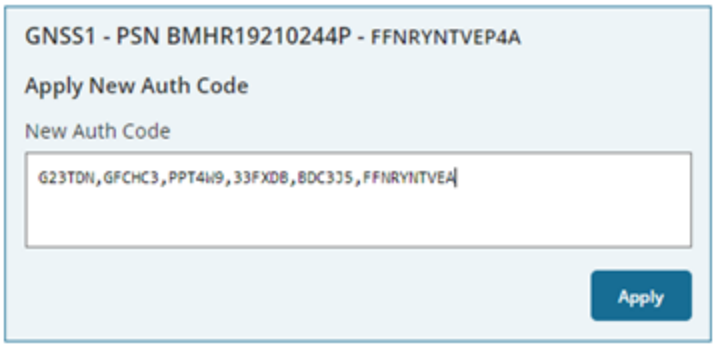
G23TDN,GFCHC3,PPT4W9,33FXDB,BDC3J5,FFNRYNTVEA

The red text is a secure code specific to the quoted LD900 serial number, and the blue text is the upgraded model details.

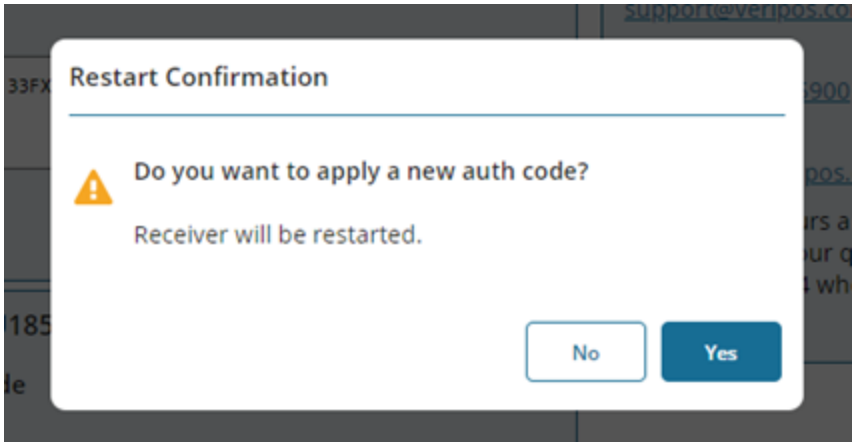
Within the LD900 WebUI, carefully cut and paste the supplied authorisation code into the Apply New Auth Code field to the correct section:

- Apply **Heading** upgrades within the **GNSS1** section.
- Apply **INS** upgrades within the **GNSS1** section.
- Apply **Secondary Positioning** upgrades within the **GNSS2** section.





After pasting the Auth code, press the **Apply** button, and the system will display the following prompt:



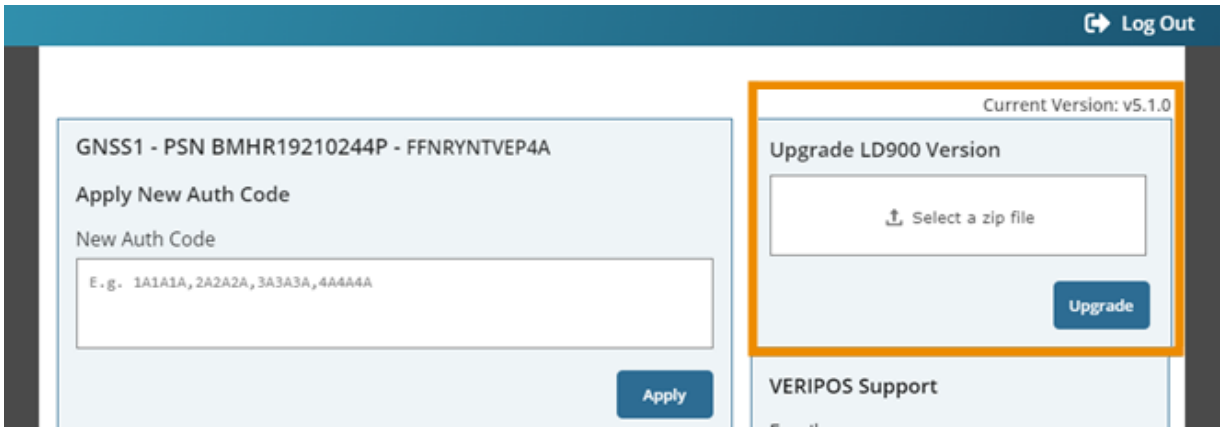
Select **Yes** and allow the LD900 system time to restart. Once the system has restarted, the new functionality can be enabled and configured.

3.6.2 Applying firmware updates

When outside of operations, users can apply firmware updates via the LD900 WebUI (from firmware version 5 onwards), as detailed below, or the front LCD panel as detailed in section Receiver > Update. Before a firmware upgrade, record all system settings - see Appendix section LD900 firmware upgrade - Settings to note.

To upgrade via the WebUI

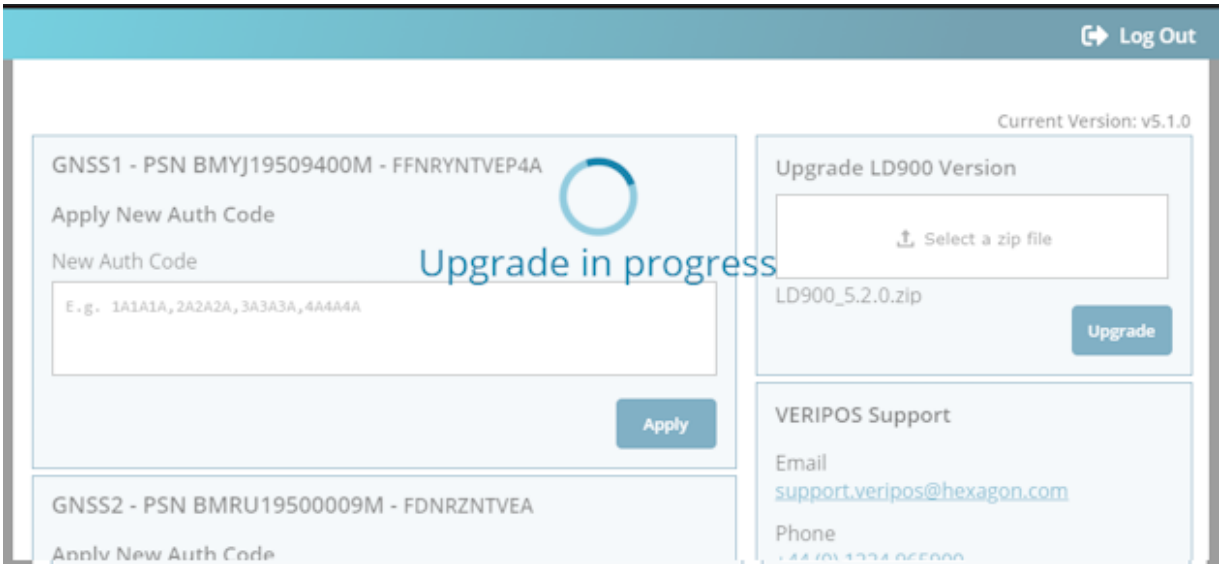
1. Place a copy of the required LD900 upgrade zip file in a known folder (e.g. the desktop).
2. Within the WebUI, click the **Select a zip file** button as highlighted below.
3. Select the LD900 upgrade zip file from the folder and select the **Upgrade** button to initiate the upgrade.



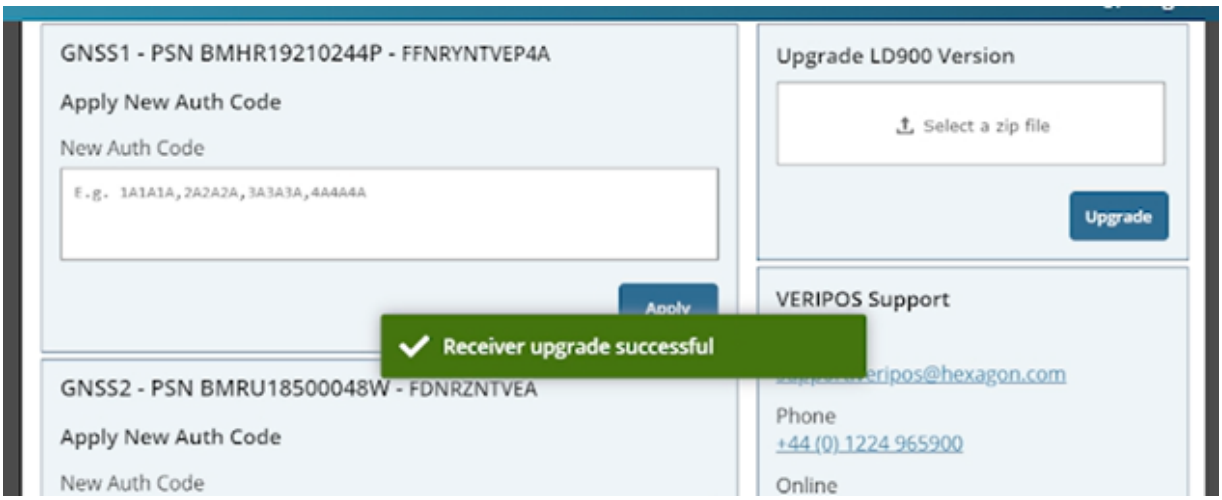
The upgrade will commence once the correct upgrade file is selected and the upgrade button is selected.

CAUTION
Do not refresh the web browser while an upgrade is in progress.

The upgrade may take approximately 10 minutes.



Once the upgrade is complete, the following message is displayed:



The LD900 will restart and will be available for operational use.

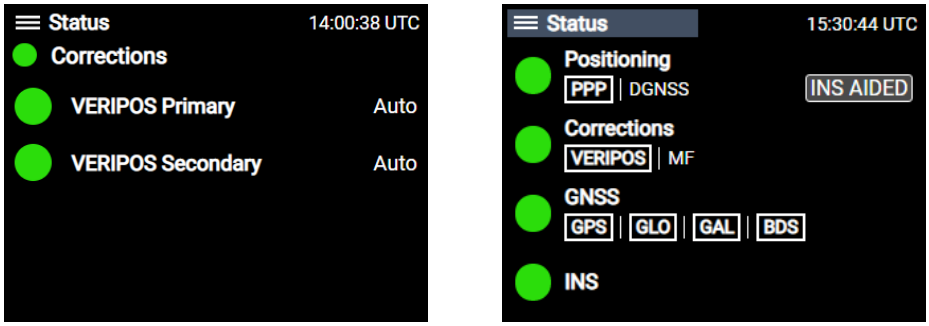
4 Configuration and operations

The LD900 can be configured via the front LCD panel and controls or by using a licensed version of the Veripos Quantum software.

For information on configuration using Quantum, please see the Quantum User Manual.

4.1 Start-up

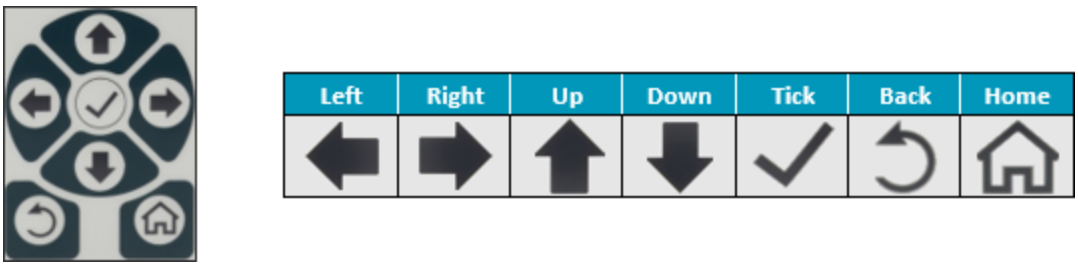
Connect power to the rear of the unit. Once the system has booted, the ***Status*** page will be displayed:



Status page examples, with an LD900L model shown on the left and an LD900M model shown on the right

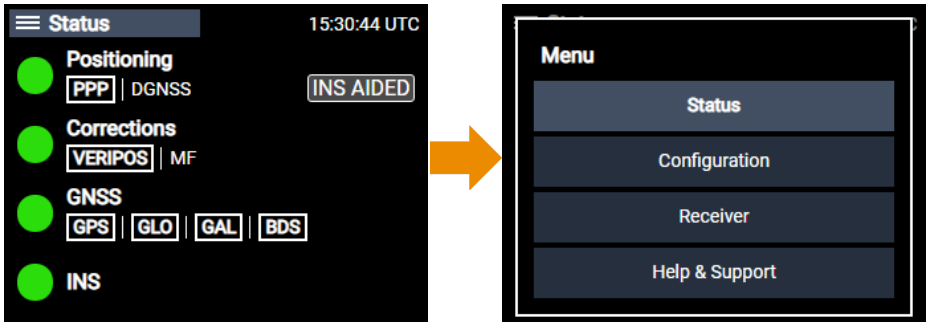
4.2 Front panel interface

Users may navigate the LD900 by using the front panel interface:



4.3 Menu & navigation basics

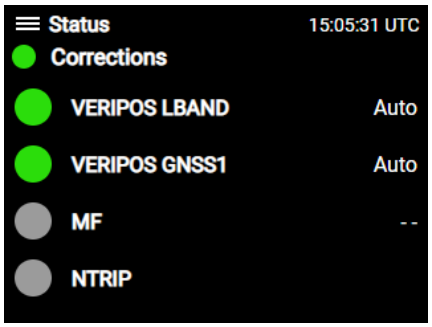
To access the LD900 ***Menu*** page, where **Status**, Configuration, Receiver or **Help & Support** can be selected, press the front panel tick button (using the Up button to move the cursor to **Status** first if necessary):



NOTE
A user can return to the Status page anytime by pressing the **Home** button.

4.4 Status (LD900L model)

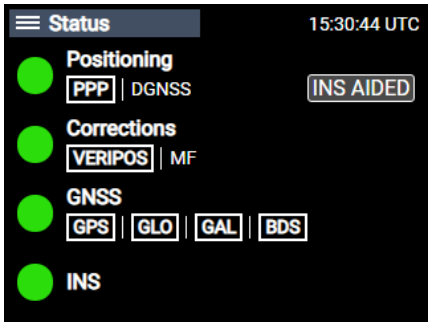
The ***Status*** page of the L-band-only LD900L model will display beam and signal strength information based on user location, with the ***Menu*** page accessible by pressing the front panel tick button:



The use of Traffic light indicators conveys three different beam states (red is <32.5dB/Hz, amber is <36.5dB/Hz & green is >36.5dB/Hz). The LD900L can take two antennas, which will show green when connected and working. If only one antenna is connected, the other will display as red.

4.5 Status (LD900 & LD900M models)

The Status page of LD900 and LD900M models provides a high-level system overview by highlighting the state of four LD900 operational items (Positioning, Corrections, GNSS and Heading (or) INS). Traffic light indicators convey the different possible states for each status item, with the positioning mode in use, corrections modes available for use and the GNSS constellations used in calculations highlighted.



Users may view additional status pages relating to **Positioning**, **Corrections**, **GNSS** and **Heading** (or) **INS** by navigating the front panel buttons and tick.

4.5.1 Status > Positioning overview

4.5.1.1 Positioning indicator states

- = Position corrected
- = Position uncorrected (or) PPP settling
- = No active position

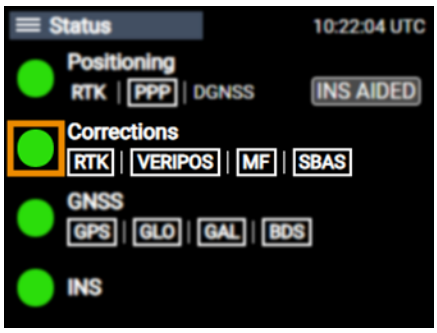
Positioning mode in use will be highlighted (RTK)

PPP = Apex (or) Ultra

DGNSS = Standard, MF or SBAS

Any INS aided position will be highlighted (INS AIDED)

4.5.1.2 Corrections indicator states



- = Sync + Services enabled + SS ≥32.5dB
- = System using MF, SBAS or UHF corrections.
- = No beam sync
- = All corrections disabled

Available correction sources will be highlighted.

MF = LD900 models SBAS = SBAS enabled

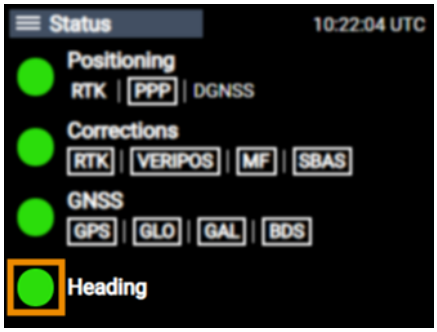
UHF = UHF enabled

4.5.1.3 GNSS indicator states

- = GNSS satellites used in solutions are >5
- = GNSS satellites used in solutions are <5

Constellations used in positioning are highlighted.

4.5.1.4 Heading indicator states



- = Heading computed
- = No heading being computed
- = Heading not configured

Where Heading is not a licensed option or INS is enabled, the heading indicator will not appear.

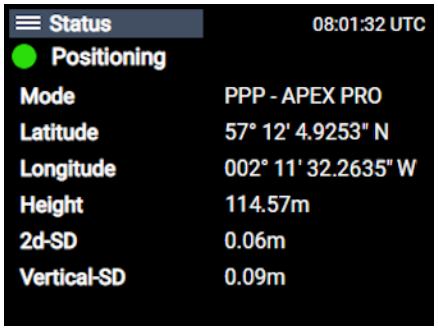
4.5.1.5 INS indicator states

- = INS converged
- = INS settling
- = INS inactive
- = INS not configured

Any INS aided position will be highlighted (INS AIDED)

The INS status is shown only when licensed. Note when INS is authorised the heading will be displayed within the INS page.

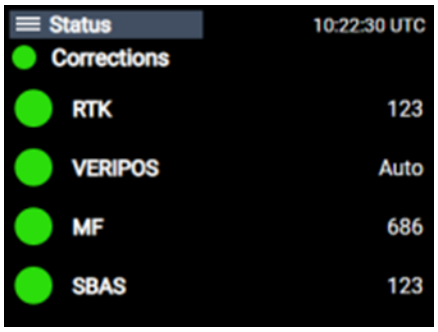
4.5.1.6 Status > Positioning



The ***Positioning*** page displays the following:

- **Mode** - Current positioning mode & service
- **Latitude** - DD° MM' SS.SSSS" (WGS84)
- **Longitude** - DDD° MM' SS.SSSS" (WGS84)
- **Height** - Antenna height (WGS84)
- **2d-SD** - Horizontal standard deviation
- **Vertical-SD** - Vertical standard deviation

4.5.1.7 Status > Corrections



The ***Corrections*** page displays the following:

- **RTK** - Correction latency indicator & station ID

  <30s >30s >60s

- **VERIPOS** - Service & beam status

  = Enabled & sync Enabled & using NTRIP
  = Enabled & no sync = Disabled

- **MF** - Signal status & station ID

  = Locked = Not locked = Off

- **UHF** - Signal status & station ID

  = Locked = Not locked = Off

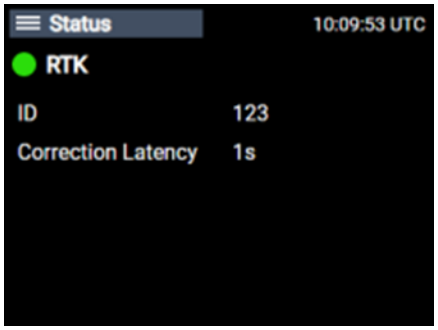
- **SBAS** - Satellite tracking status & satellite ID

  = Locked = Not tracked = Off

Use the up / down arrows to view additional details for systems which have more than four correction sources.

4.5.1.8 Status > Corrections > RTK

The ***RTK*** page displays the station ID and the correction age value.



4.5.1.9 Status > Corrections > VERIPOS

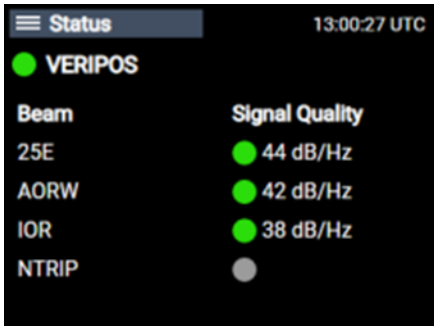
The ***VERIPOS*** page displays the following:

- **Beam** - Tracked L-band beam name
- **Signal Quality** - Signal strength in dB/Hz

>36.5 <36.5 <32.5

NTRIP indicator states are as follows:

= NTRIP available
= NTRIP disconnected
= NTRIP disabled

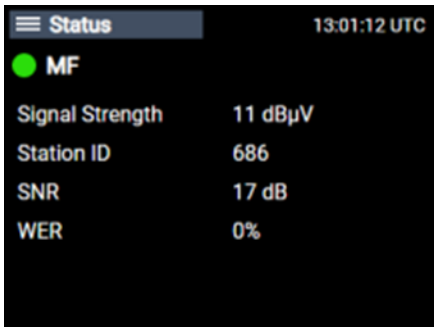


4.5.1.10 Status > Corrections > MF

The ***MF*** page displays the following:

- **Signal Strength** - Signal strength in dBµV
- **Station ID** - ID of signal locked station*
- **SNR** - Signal noise ratio
- **WER** - Word error rate

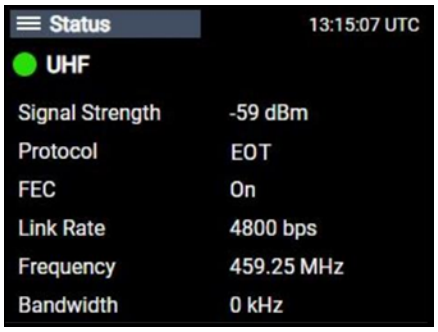
**Station ID will be '--' if insufficient MF signal exists.*



4.5.1.11 Status > Corrections > UHF

The ***UHF*** page displays the following:

- **Signal Strength** - Signal strength in dBm
- **Protocol** - EOT
- **FEC** - Forward Error Correction
- **Link Rate** - Baud (BPS)
- **Frequency** - Signal Frequency (MHz)
- **Bandwidth** - Signal Bandwidth (KHz)

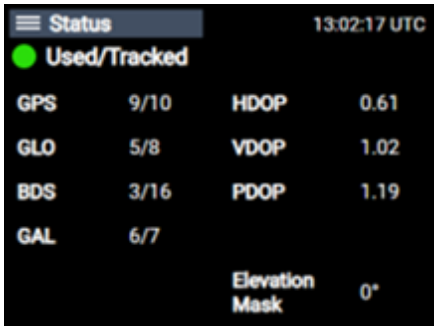


4.5.1.12 Status > Corrections > SBAS

The ***SBAS*** page displays the satellite PRN code and signal strength of the satellite used for corrections.

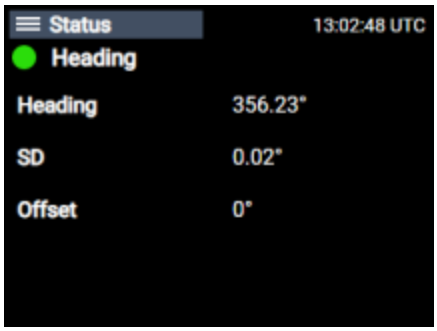
4.5.1.13 Status > Corrections > GNSS

The ***GNSS*** page displays the number of satellites used and tracked for each constellation, the DOP values, and the tracking Elevation Mask.



4.5.1.14 Status > Corrections > Heading

The ***Heading*** page displays the present heading, the current heading standard deviation and the configured heading offset. Note for INS-enabled systems, the computed heading is shown on the ***INS*** page.

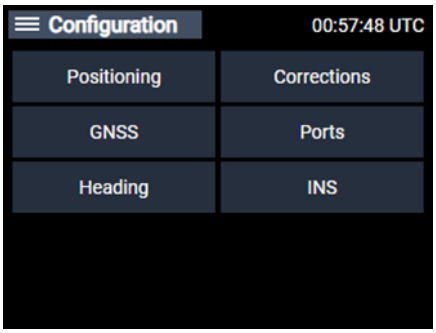


4.5.1.15 Status > Corrections > INS

In INS-enabled systems, the ***INS*** page displays the INS-calculated heading, the GNSS-calculated heading, and the INS-calculated pitch and roll.

4.6 Configuration

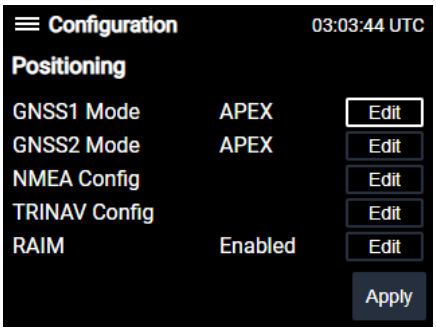
The ***Configuration*** menu page provides control of system settings, with the exact menu options visible depending on your particular LD900 model type. Starting with **Positioning**, this section details the different menu options and the corresponding configuration settings available.



4.6.1 Configuration > Positioning

Within the ***Positioning*** menu page changes can be made to the Primary positioning solution (**GNSS1 Mode**) and, where authorised, Secondary positioning solution (**GNSS2 Mode**)

NMEA Config, **TRINAV Config** and **RAIM** selection by clicking on the corresponding Edit options:



Note the configuration parameters for NMEA Config and RAIM will be applied to both primary and secondary position solutions.

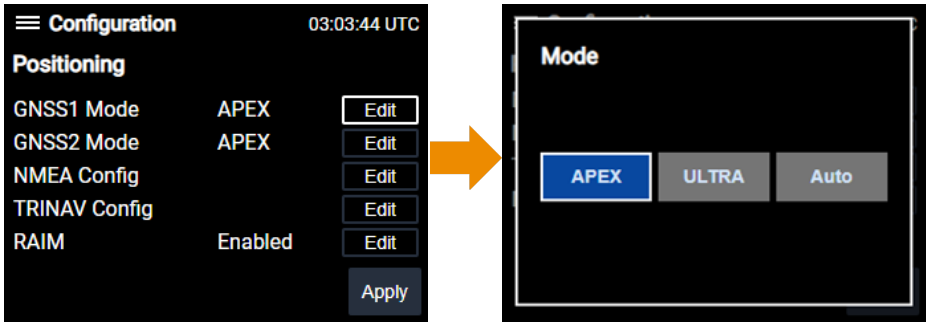
4.6.2 Configuration > Positioning > GNSS1/GNSS2 Mode

Within the ***Positioning*** menu page changing **Mode** will change the type of PPP solution computed by the LD900.

> **NOTE**
> The PPP solution selected in this menu must match the Veripos service(s) enabled on the LD900.

PPP **Mode** can be set to Apex (default), Ultra or Auto. On systems with corrections subscriptions that include both Ultra and Apex, using ‘Positioning Mode: Auto’ will prioritise Apex and only change to Ultra if Apex becomes unavailable.

To set the Mode click on **Edit** and use the arrow keys to select **Apex**, **Ultra** or **Auto** as required, followed by tick. Then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the change.



NOTE

Secondary Positioning via GNSS2 is only available for Authorised LD900 systems.

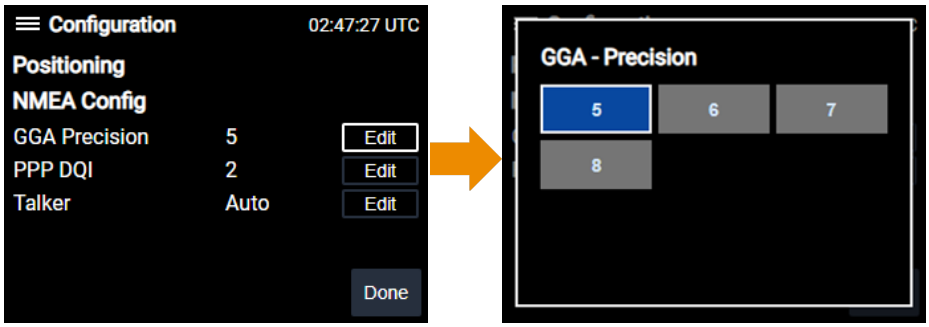
- The activation code applies to both primary and secondary solutions.
- The secondary positioning mode does not support APEX Pro and will default to APEX5 when activated for APEX Pro.
- The secondary positioning solution NMEA position output is limited to 1Hz and COM4 and COM5 only (ICOM ports are unavailable).
- IALA, 3rd Party, and RTK corrections are unavailable for secondary positioning.

4.6.3 Configuration > Positioning > NMEA Config

As part of configuring port outputs, users may also wish to define the **GGA Precision** and **PPP DQI** values of the GGA sentence.

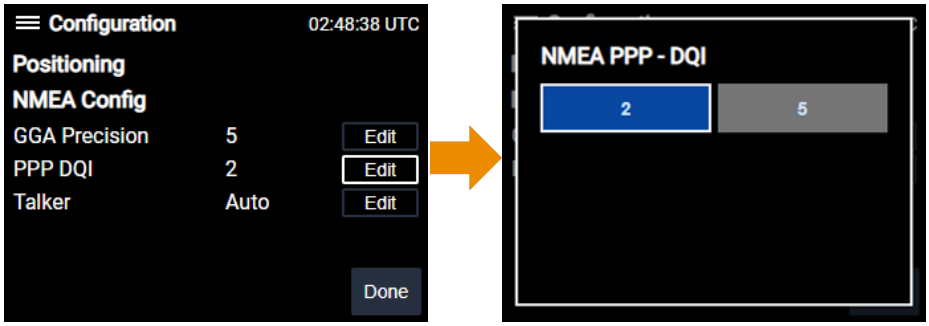
GGA Precision

The **GGA Precision** value is set to **5** by default but can be toggled between **5**, **6**, **7** or **8** as required.



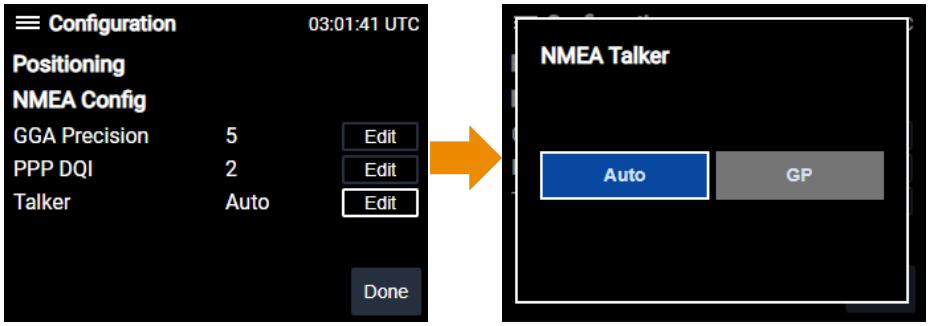
PPP DQI

The **PPP DQI** value is set to **2** by default but can be toggled between **2** and **5** as required.



Talker

The **Talker** is set to **Auto** by default but can be toggled between **Auto** and **GP** as required.



NOTE

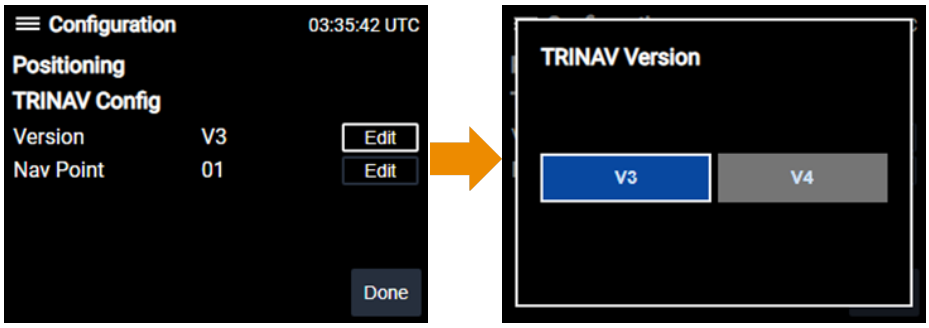
Changing the **NMEA Talker** configuration from AUTO to GP will force all NMEA Talker ID values to become GP.

4.6.4 Configuration > Positioning > TRINAV Config

As part of configuring port outputs, users may also wish to define the **TRINAV Version** and **Nav Point** used.

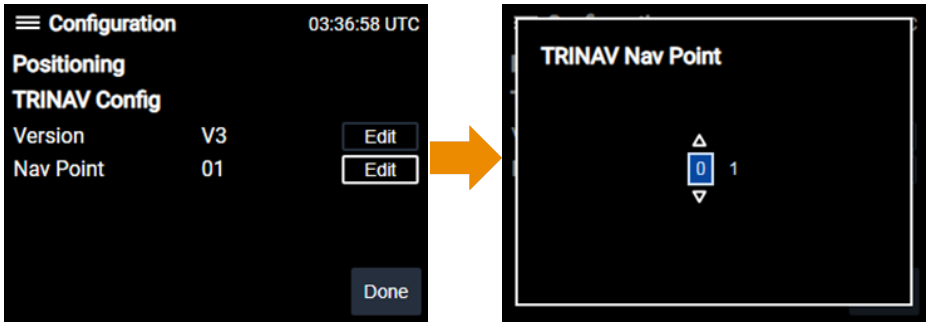
Version

The **Version** is set to **V3** by default but can be toggled to **V4** as required.



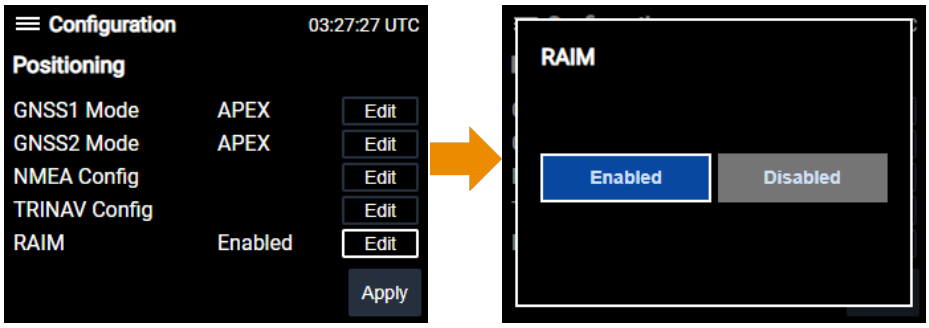
Nav Point

The **Nav Point** is set to **01** by default but can be set to a value between **01** and **99** as required.



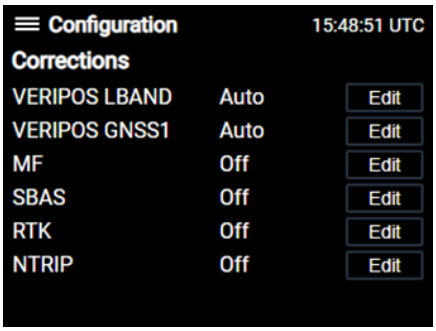
4.6.5 Configuration > Positioning > RAIM

Receiver autonomous integrity monitoring (RAIM) is a technology developed to assess the integrity of GNSS signals used by a GNSS receiver. RAIM uses redundant signals and a statistical function to determine if there are problems with the positioning solution; in simple terms, RAIM acts as an internal self-check. RAIM is enabled by default. Do not disable RAIM unless advised by Customer Support.



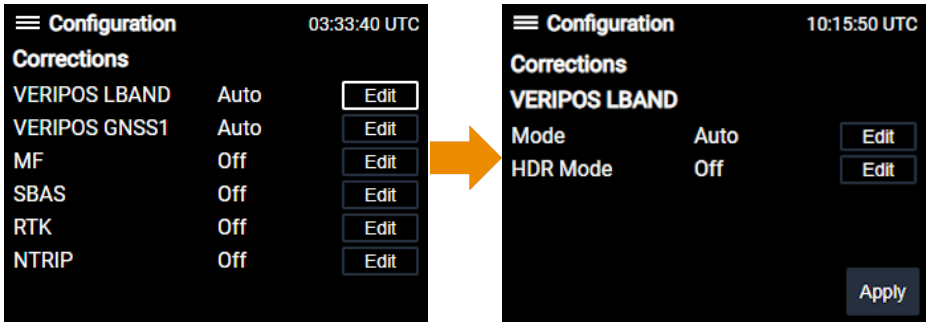
4.6.6 Configuration > Corrections

Within the Corrections menu page, users can make **VERIPOS LBAND**, **VERIPOS GNSS1**, **MF**, **SBAS**, **RTK** and **NTRIP** changes by clicking on the corresponding **Edit** options:

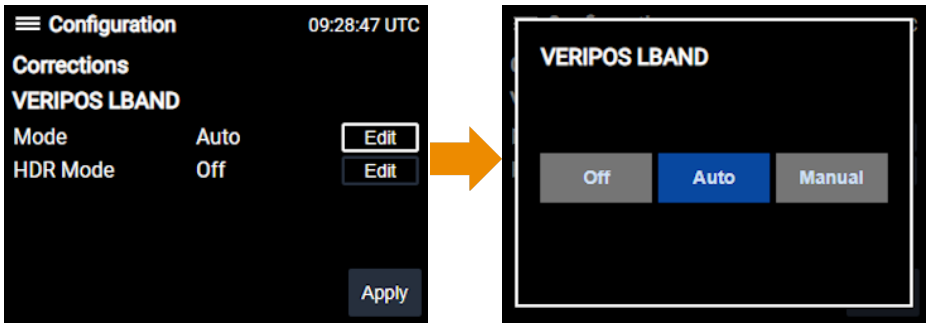


4.6.7 Configuration > Corrections > VERIPOS LBAND/VERIPOS GNSS1

L-band beam tracking is required to receive Veripos correction service data. This section will detail how to establish tracking to use Veripos services. To provide redundancy, the LD900 will accept two L-band antenna sources.



The VERIPOS LBAND source is the rear **LBAND** antenna RF connector. VERIPOS SECONDARY source is the rear **GNSS1** RF antenna connector. When selecting an L-band source, there is an option available to choose a beam Mode and an option to toggle HDR Mode:



Mode

The LD900 receiver supports multi-channel L-band tracking, providing reception of services from up to three satellites broadcasting Veripos corrections simultaneously, reducing the risk of satellite masking or blocking and ensuring continuous reception of Veripos correction services.

Setting the beam Mode to **Off** will simulate the failure of corrections, which is useful in failure mode and effects (FMEA) testing.

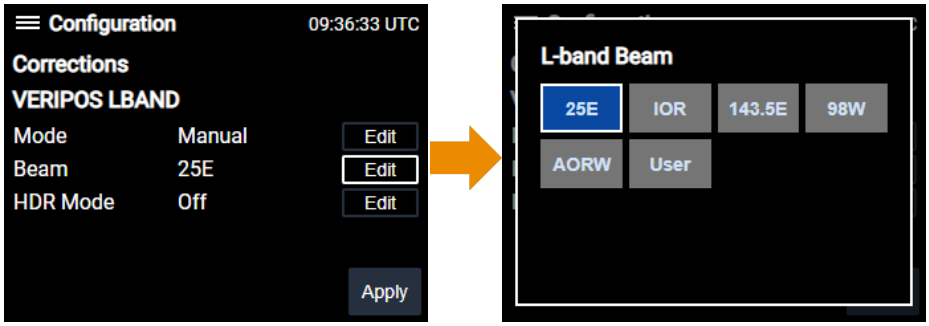
Auto is the recommended L-band selection. It automatically selects the three highest elevated available L-band beams for a location and merges all the correction information within the position calculations.

Auto effectively mitigates the risk of losing signal from a manually assigned L-band signal and losing positional accuracy, such as through signal blockage or during increased ionospheric activity. Should an L-band beam be lost when Auto is selected, the receiver will use the correction data from the other available beams without any loss in positional accuracy.

Veripos have five available beams as detailed below and, in most regions, more than one beam should be available. A global map with a beam overlay is available for reference in the Appendix.

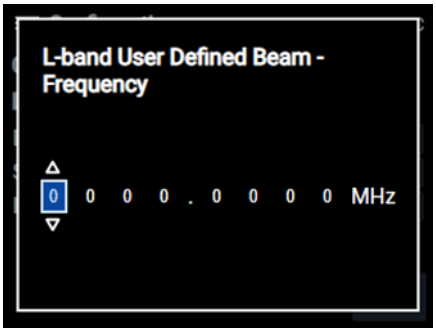
Beam Name	Coverage
98W	North America, Gulf of Mexico, South America
AORW	North America, Gulf of Mexico, South America, North Sea, West Africa
25E	North Sea, Mediterranean Sea, Africa, Persian Gulf, Caspian Sea
IOR	Asia, Australasia, Indian Ocean, East Africa, Persian Gulf, Caspian Sea, East Mediterranean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

Selecting **Manual** will allow the choice of individual beam selection, as well as provide the option to manually enter a **User** L-band beam name and frequency (in MHz) which should only be used under the instruction of Veripos support.



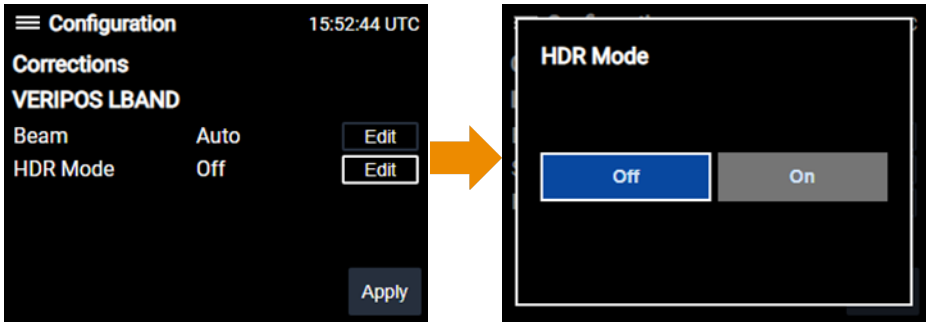
Beam can be set to **25E**, **IOR**, **143.5E**, **98W**, **AORW** (or) **User** by clicking on **Edit** and using the arrow keys to select the required beam choice, followed by tick. Then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the change.

If inputting a user beam, a prompt will appear to input an **L-band User Defined Beam – Frequency**, which can be added by using the arrow keys, followed by tick.



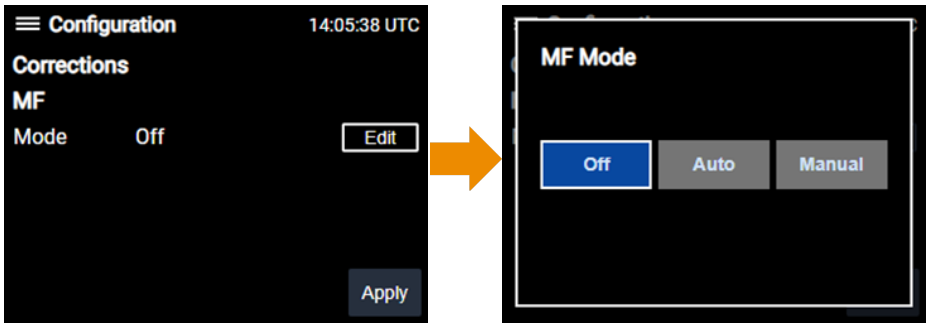
HDR Mode is set to **Off** by default but can be set to **On** to assist with L-band tracking when potential interference sources are present. HDR Mode uses signal processing to dampen potential sources of RF distortion, at the cost of increased CPU usage. It is recommended that if any L-band tracking issues are observed (intermittent, low or no signal) this option is enabled.

To turn **HDR Mode** Off or On select **Edit** and use the arrow keys to select **On** or **Off** as required, followed by tick. Then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the change:

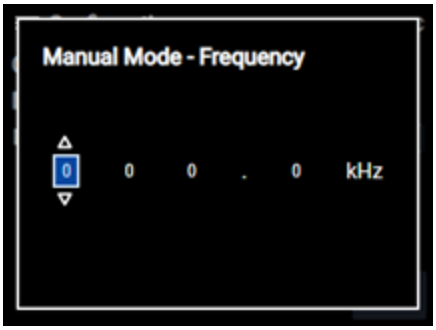


4.6.8 Configuration > Corrections > MF

MF Mode allows the user to select either **Off** (default), **Auto** or **Manual** MF tracking. When set to **Auto** the highest quality signal detected from a local MF beacon station will be tracked. When set to **Manual**, the user will be prompted to enter a frequency and data rate. To configure **MF Mode**, click on **Edit** and using the arrow keys select **Off**, **Auto** or **Manual** as required followed by tick. Then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the change.



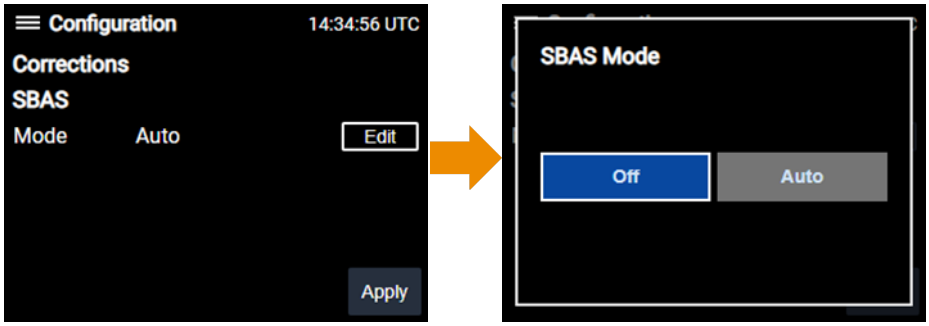
When setting to **Manual**, the user will be prompted to enter a valid station frequency, between 283.5 and 325.0kHz, which can be added by using the arrow keys followed by tick:



4.6.9 Configuration > Corrections > SBAS

Within the ***SBAS*** menu page, it is possible to set the SBAS solution to be available as a backup solution should Veripos corrections fail. This can be set to **Off** (default) or **Auto**.

To configure **SBAS Mode**, click on **Edit** and using the arrow keys select **Off** or **Auto** followed by tick. Then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the change.

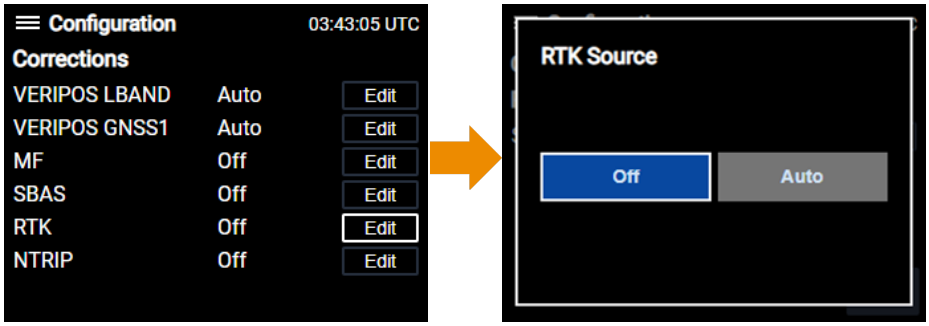


> **NOTE**
> When MF is enabled, the MF solution will be output in the event of a loss of Veripos corrections. An SBAS solution will only be used if both Veripos, and MF solutions are unavailable.

4.6.10 Configuration > Corrections > RTK

The LD900 (primary positioning solution only) is capable of using RTK corrections from a suitable source. **RTK Source** controls if RTK corrections are used by the system, where corrections are available. This can be set to **Off** (default) or AUTO. For the corrections to be accepted by the receiver they must be provided in either RTCM v2, RTCMv3, CMR or NOVATELX format. For RTK solutions the position will be output in the datum of the correction source. To input RTK corrections a port must be configured to receive the corrections.

Press tick to select **Edit** and use the arrow buttons to select **Off** or **AUTO** as required. Then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the required change:



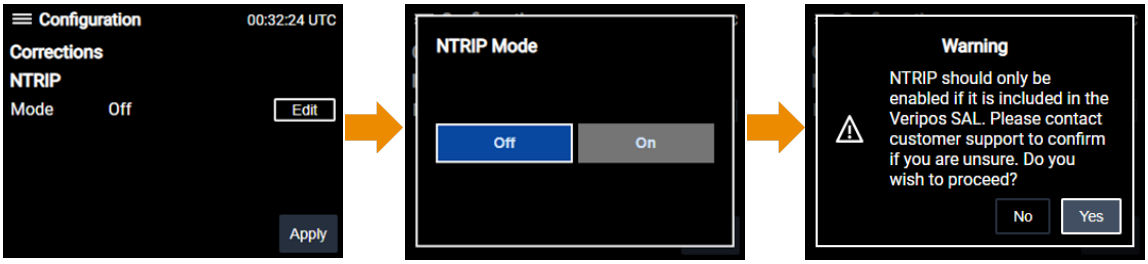
4.6.11 Configuration > Corrections > NTRIP

The LD900 can receive Veripos RTCM corrections via NTRIP on LAN1. An NTRIP service activation from Veripos Support is necessary for use, and the LD900 must also be connected directly to a network with external access to obtain Veripos NTRIP caster data.

> **CAUTION**
> NTRIP should only be enabled if included in the Veripos SAL. Please contact Veripos Support to confirm if you are unsure.

To configure the LD900 to receive VERIPOS corrections via NTRIP, firstly use an internet-connected laptop on the same network as the LD900 and browse to the Veripos NTRIP caster **http://ntrip-veripos.com:2101** to verify that connectivity via port 2101 is available. The browser should reply with four lines of structured binary data. No reply may suggest that port 2101 is blocked, which can be resolved by contacting local IT support. Upon establishing a successful connection, setting **NTRIP Mode** from **Off** (default) to **On** will make the NTRIP source available to the system.

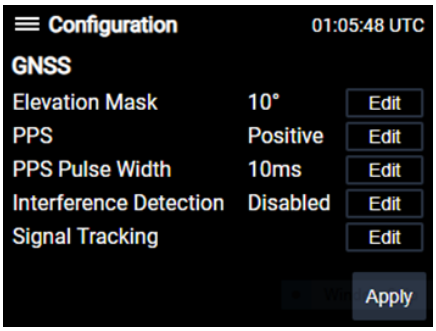
Press tick to select **Edit** and use the arrow buttons to select **Off** or **On** as required. Then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the required change:



To confirm that corrections are received via NTRIP, navigate to **Status > Corrections > VERIPOS**, where the indicator next to NTRIP will appear green if successful.

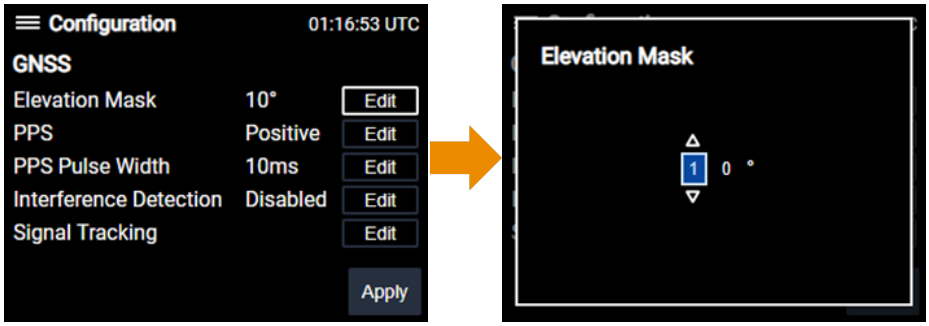
4.6.12 Configuration > GNSS

Within the GNSS menu page, changes can be made to the Elevation Mask, PPS, PPS Pulse Width and Interference Detection by clicking on the corresponding Edit options:



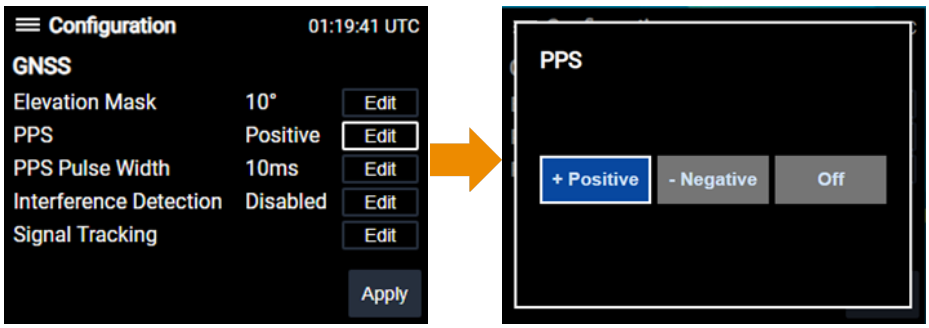
4.6.12.1 Configuration > GNSS > Elevation Mask

The LD900 will not track satellites below the **Elevation Mask** value. Veripos recommends the default mask value of 10 degrees, which prevents GNSS satellites on or below a 10-degree elevation from being tracked. To edit, press tick to select **Edit** and use the arrow buttons to enter a value, then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the change:



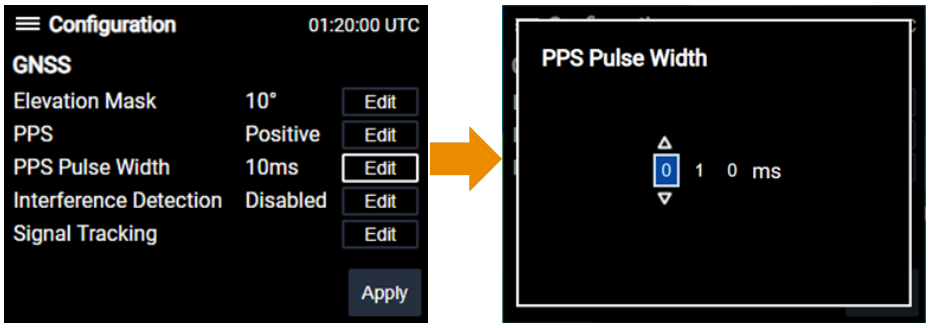
4.6.12.2 Configuration > GNSS > PPS

The PPS pulse is configurable as either positive-going, negative-going pulse or disabled. The PPS pulse has a peak voltage of 8V (unloaded) and a default pulse width of 10 milliseconds. The pulse width is configurable within a range of 1 to 500 milliseconds. To configure PPS polarity, click on Edit and, using the arrow keys, select **Off**, **+ Positive** (default) or **- Negative**, followed by tick. Select **Apply**, right to select **Yes** and tick to apply the change:



4.6.12.3 Configuration > GNSS > PPS Width

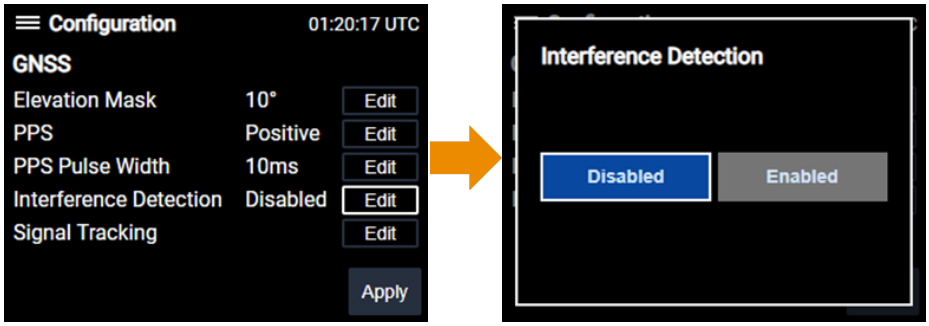
To configure PPS pulse width, click on Edit and using the arrow keys select the desired **PPS Pulse Width** in milliseconds, followed by tick. Select **Apply**, right to select **Yes** and tick to apply the change:



4.6.12.4 Configuration > GNSS > Interference Detection

Interference Detection is set to **Off** by default but can be set **to** On to provide an alert on the Error Code Page if interference sources are detected.

To toggle Interference Detection to Disabled or Enabled select **Edit** and use the arrow keys to select **Disabled** or **Enabled** as required, followed by tick. Then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the change:



4.6.12.5 Configuration > GNSS > Signal Tracking

Signal tracking allows for both the toggling of specific GNSS constellations or specific constellation signals, which is helpful if an identified signal disturbance is present, and the specification of a Time Source.

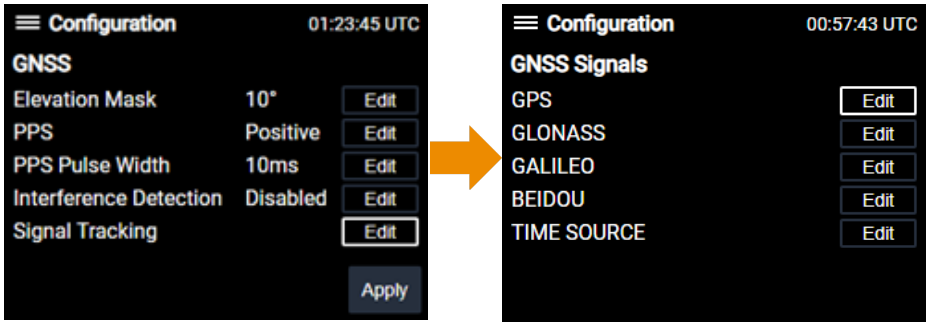
CAUTION
Do not change the default signal tracking unless advised by Veripos Support.

NOTE
Users can not turn off constellations selected as the primary time source.

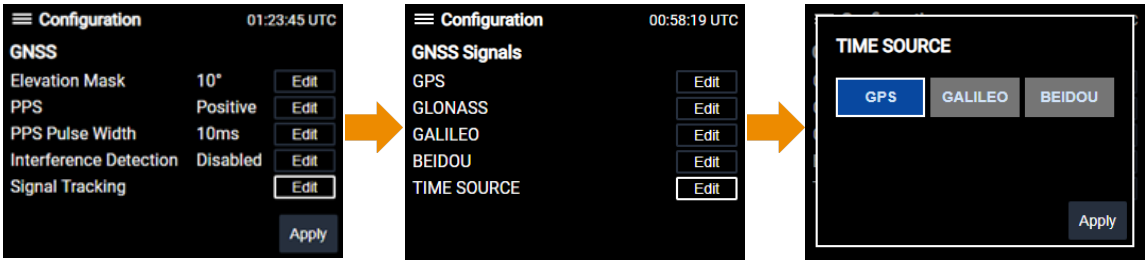
By default, the LD900 selects all constellations and signals. The options available for toggling are as follows:

- GPS – Constellation (or) L5
- GLONASS – Constellation (or) L2, L3
- Galileo – Constellation (or) E5A, E5B, E6
- Beidou – Constellation (or) B2A, B2B, B3

To toggle the usage of a specific constellation or signals within a constellation, use the arrow keys to select Edit on the constellation in question followed by tick:



Time Source allows users to specify whether to use GPS, Galileo or Beidou as the primary timing source:



4.6.13 Configuration > Ports

LD900 data input and output are available via serial or network using TCP or UDP protocols. A Moxa serial port expansion unit can convert network to serial where required, providing eight additional serial ports. Users can make changes within the Ports menu page to the LD900 Serial and Network inputs and outputs by clicking on the corresponding Edit options:

NOTE
Heading requires a Heading license and must be turned on before the HDT NMEA sentence will become available for selection.

INS requires an INS license before the PASHR NMEA, INHDT, INSPVA, HEAVE, and TSS1 sentences are available.

Once licensed for Secondary Positioning, NMEA sentences are available for selection on serial ports 4 and 5.

NOTE
The official NMEA 0183 Standard specifies 4800 as the default baud for most communication. Lower baud, such 2400, should generally be avoided, as the reduced data transmission speed may result in delayed or missed updates, particularly in systems requiring frequent position or heading data.

4.6.13.1 Configuration > Ports > COM (COM 1 to 6)

To select a COM port, use the arrow buttons and tick to select the required **COM#** port. **A COM# Settings** page will then be displayed. With **Baud Rate** highlighted, use tick to **Edit** the baud if needed. LD900 COMs 1-3 supports baud between 1200 and 460800 is set to a default baud of 9600. The LD900 additionally includes the following:

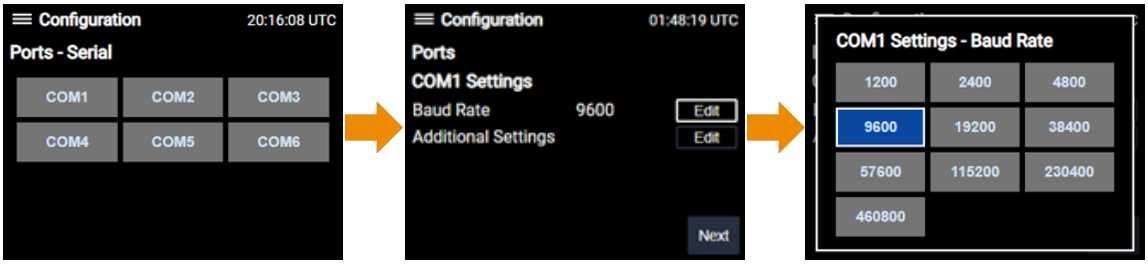
Without the use of a Veripos-supplied 3-port Aux cable on DB15HD connector on COM4 Aux Port:

- COM4, supporting 9600 to 460800 baud.

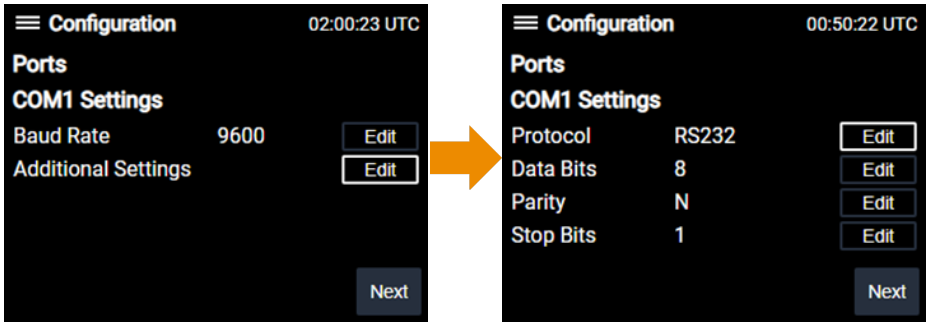
With the use of the 3-port Aux cable on DB15HD connector:

- COM4, supporting 9600 to 460800 baud.
- COM5, supporting 9600 to 460800 baud for the output of secondary positioning.
- COM6, supporting a fixed baud of 38400 for corrections input (RTK, IOLAN, UHF).

Use the Arrow keys followed by tick to select the required baud:



Once returned to the **COM# Settings** page, use the arrow buttons to highlight **Additional Settings** and tick to **Edit**. Use the up and down arrow buttons to navigate through the options and tick to **Edit** as required:

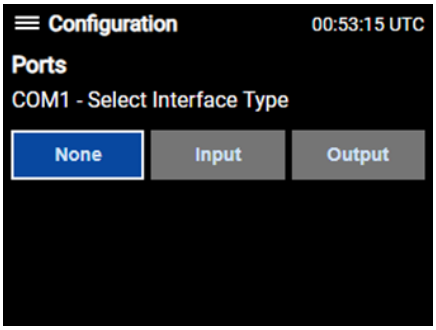


The Additional Settings options are as follows:

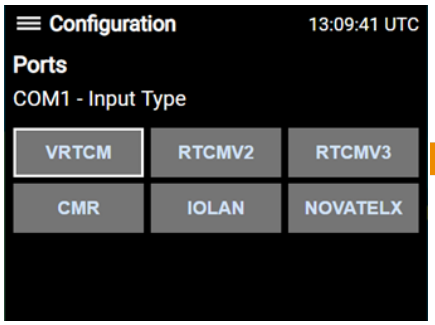
- **Protocol - RS232** (default) / **RS422**
- **Data Bits - 7 / 8** (default)
- **Parity Bits - N** (default) / **E** / **O**
- **Stop Bits - 1** (default) / **2**

Once the desired COM port has been configured, use the arrow buttons and tick to select **Next**.

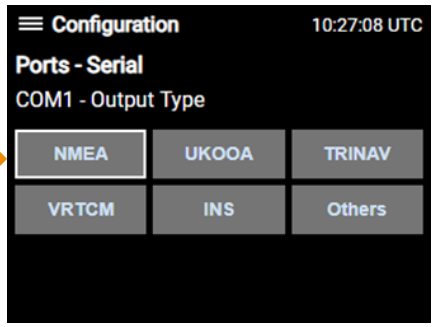
The next page will prompt to "**Select Interface Type**". Using the arrow buttons, select the appropriate response and click tick to confirm. Selecting **None** will cease all inputs and outputs for that particular COM port and return the user to the **Configuration > Ports** page. The selection of **Input** or **Output** will determine which additional configuration settings will be displayed.



Selecting Input provides a choice of **VRTCM** (Veripos format RTCM), **RTCMV2**, **RTCMV3**, **CMR**, **IOLAN** and **NOVATELX**. Selecting **Output** provides a choice of **NMEA**, **UKOOA**, **TRINAV**, **VTRCM** and **Others**, with an additional **INS** option shown if licensed. Use the arrow buttons and tick to choose the appropriate response:



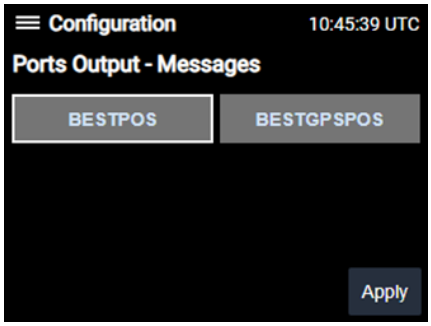
COM 1 – Input Type options



COM 1 – Output Type options

Selecting **Output > INS** provides a choice of **INSPVA** (default), **HEAVE**, **TSS1**, **STDEV**, **SHEAVE** or **DHEAVE**, with a selection of **BESTPOS** or **BESTGPSPOS** available when choosing **Output > Others**.

COM 1 – INS Output options



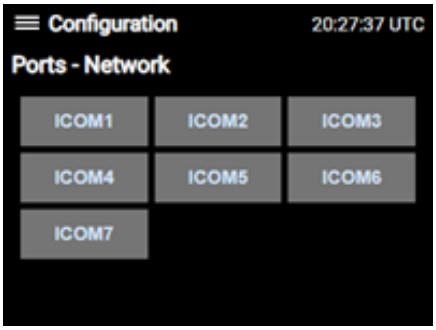
COM 1 – Others Output options

When selecting **Output > NMEA**, a choice of **GGA**, **GLL**, **VTG**, **ZDA**, **GST**, **GSA**, **GSV**, **GRS** and **RMC** will be shown, followed by a request to pick an NMEA output rate of **1** (default), **2**, **5**, **10** or **20**Hz. If heading is licensed and enabled **HDT** will also be shown and additionally if INS is licensed **PASHR** and **INHDT** will be shown. Once configured the user will be returned to the **Configuration > Ports** page.

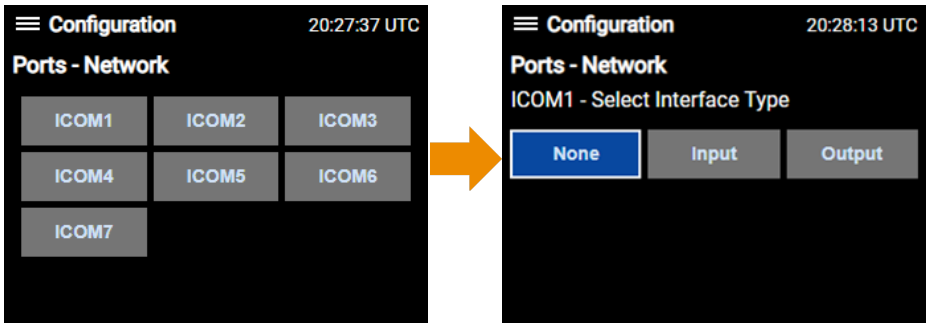
4.6.13.2 Configuration > Ports > ICOM (1 to 7)

An ICOM port can be configured as a TCP/IP client (data input), TCP server (data output) or a UDP (data input or output).

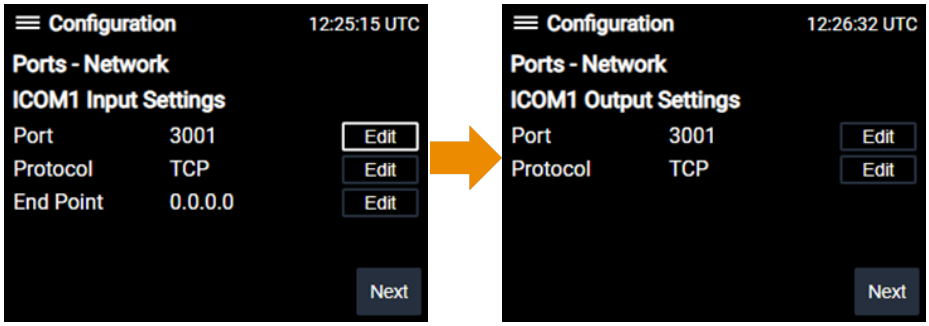
There are seven ICOM ports available. If the single format rack mount system is interfaced the seven ICOM ports will instead be dedicated to the Moxa serial port expansion unit and will be named P1 - P8 (see section Configuration > Ports > P (1 to 8).



Use the arrow buttons to select the required port. The next page will prompt to "**Select Interface Type**". Using the arrow buttons select the appropriate response and click tick to confirm. When selecting **None** all input and outputs for that particular ICOM port will cease and the user will be returned to the **Configuration > Ports** page.

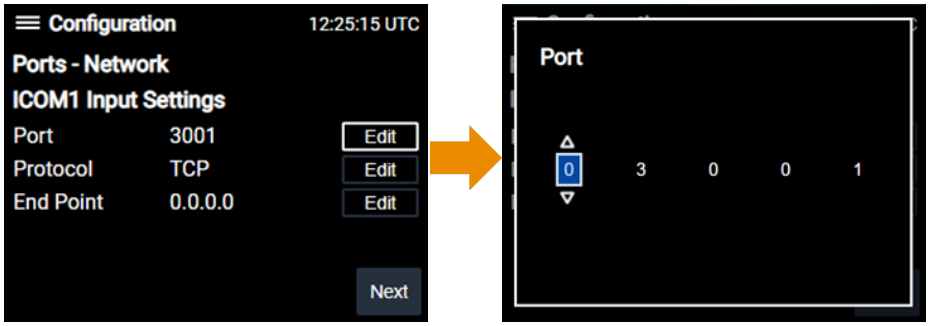


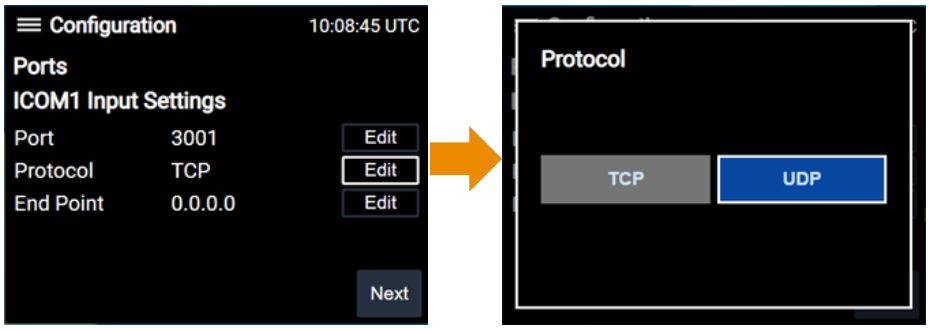
After selecting the Interface Type the next stage is to configure the IP interface details (note there is no **End Point** configuration for data outputs):



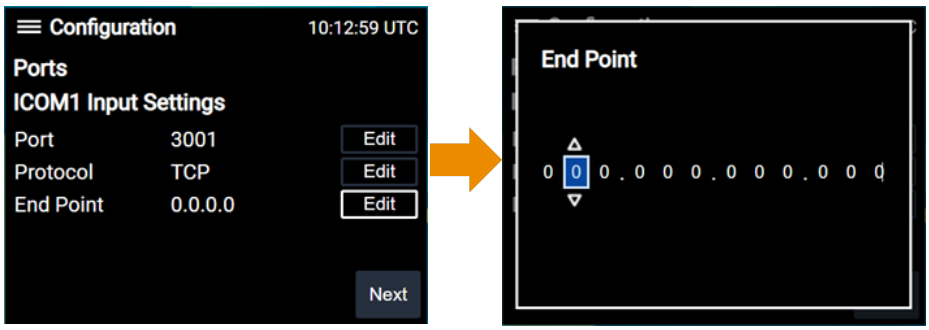
ICOM1 – Input options *ICOM1 – Output options*

Enter the Port number (from 1 to 65535) and select the **Protocol** (TCP or UDP).

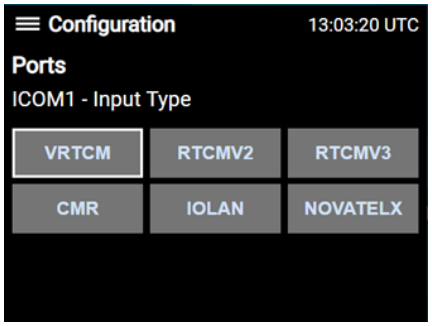




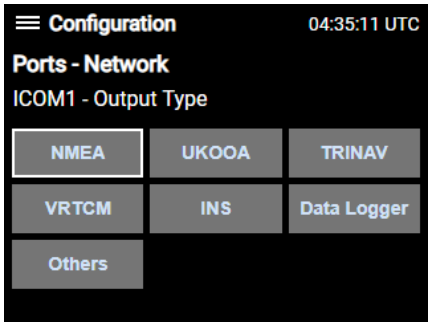
Specify the End Point (note: there is no End Point for TCP outputs):



If selecting **Input**, a choice of **VRTCM** (Veripos format RTCM), **RTCMV2**, **RTCMV3**, **CMR**, **IOLAN** and **NOVATELX** will be shown. If selecting **Output**, a choice of NMEA, UKOOA, TRINAV, VTRCM, Data Logger and Others will be shown, with an additional INS option shown if licensed. Use the arrow buttons and tick to choose the appropriate response:



COM 1 – Input Type options



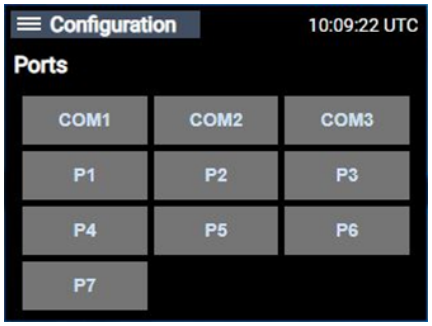
COM 1 – Output Type options

When selecting **Output > NMEA**, a choice of **GGA**, **GLL**, **VTG**, **ZDA**, **GST**, **GSA**, **GSV**, **GRS** and **RMC** will be shown, followed by a request to pick an NMEA output rate of **1** (default), **2**, **5**, **10** or **20**Hz. If heading is licensed and enabled **HDT** will also be shown and additionally if INS is licensed **PASHR** and **INHDT** will be shown.

Once configured the user will be returned to the **Configuration > Ports** page.

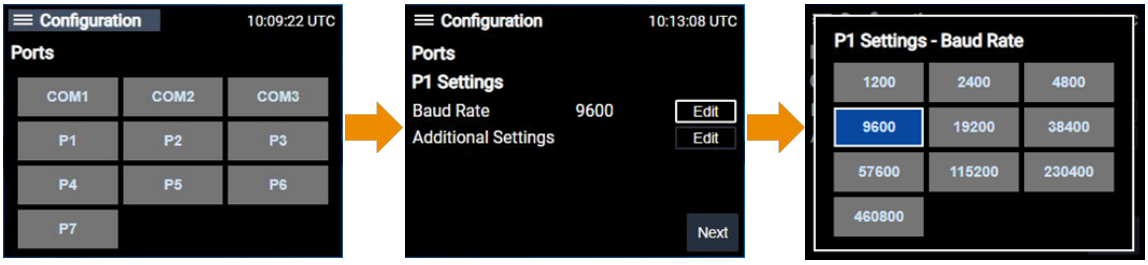
4.6.13.3 Configuration > Ports > P (1 to 8)

If the single format rack mount system is interfaced seven Moxa serial port expansion unit ports will be available, named P1 – P8. Note per the below table the settings of P7 are duplicated to P8:

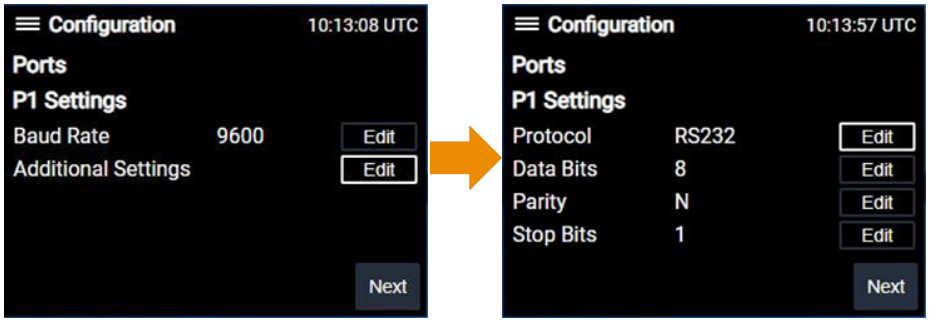


Model	Moxa port
P1	1
P2	2
P3	3
P4	4
P5	5
P6	6
P7	7
P8	8

To select a specific port for input or output, use the arrow buttons and tick to select the required **P#** port. A ***P# Settings*** page will then be displayed. With **Baud Rate** highlighted, use tick to **Edit** the baud if needed. LD900 P1-7 ports are set to a baud of 9600 by default but support a baud between 1200 and 460800. Use the Arrow keys followed by tick to select the required baud.



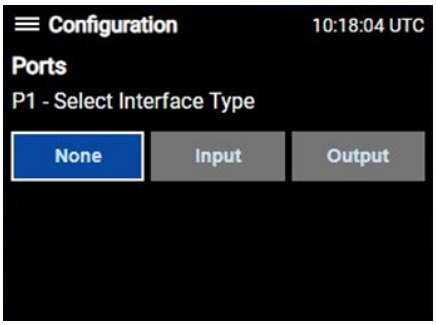
Once returned to ***the P# Settings*** page, use the arrow buttons to highlight **Additional Settings** and tick to **Edit**. Use the up and down arrow buttons to navigate through the options and tick to **Edit** as required:



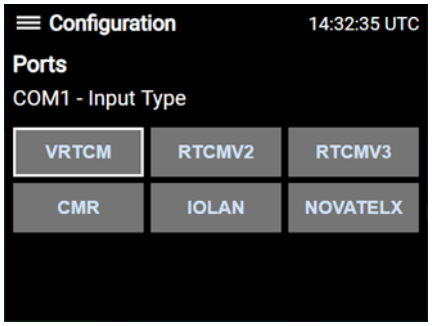
The Additional Settings options are as follows:

- **Protocol - RS232** (default) / **RS422**
- **Data Bits - 7 / 8** (default)
- **Parity Bits - N** (default) / **E** / **O**
- **Stop Bits - 1** (default) / **2**

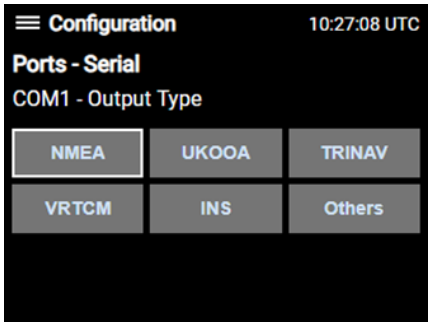
The next page will prompt to "**Select Interface Type**". Using the arrow buttons, select the appropriate response and click tick to confirm. When selecting **None** all input and outputs for that particular COM port will cease and the user will be returned to the **Configuration > Ports** page. If selecting **Input** or **Output** the provided response will determine which additional configuration settings will be displayed.



If selecting **Input**, a choice of **VRTCM** (Veripos format RTCM), **RTCMV2**, **RTCMV3**, **CMR**, **IOLAN** and **NOVATELX** will be shown. If selecting **Output**, a choice of **NMEA**, **UKOOA**, **TRINAV**, **VTRCM** and **Others** will be shown, with an additional **INS** option shown if licensed. Use the arrow buttons and tick to choose the appropriate response:



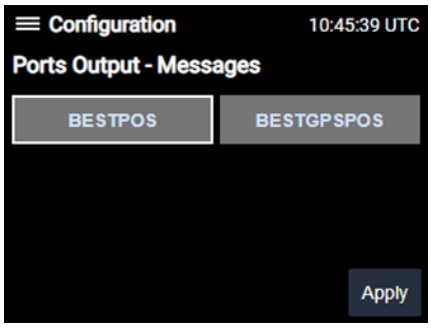
P1 – Input Type options



P1 – Output Type options

If selecting **Output > INS** a choice of **INSPVA** (default), **HEAVE**, **TSS1**, **STDEV**, **SHEAVE** or **DHEAVE** will be shown, alternatively if selecting **Output > Others** a choice of **BESTPOS** or **BESTGPSPOS** will be shown:

P1 – INS Output options



P1 – Others Output options

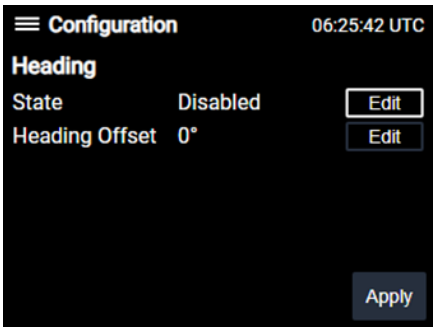
Followed by a request to pick an output rate of **1** (default), **2**, **5**, **10**, **20**, **50** ,**100** or **200** Hz.

When selecting **Output > NMEA**, a choice of **GGA**, **GLL**, **VTG**, **ZDA**, **GST**, **GSA**, **GSV**, **GRS** and **RMC** will be shown, followed by a request to pick an NMEA output rate of **1** (default), **2**, **5**, **10** or **20**Hz. If heading is licensed and enabled **HDT** will also be shown and additionally if INS is licensed **PASHR** and **INHDT** will be shown.

Once configured the user will be returned to the ***Configuration > Ports*** page.

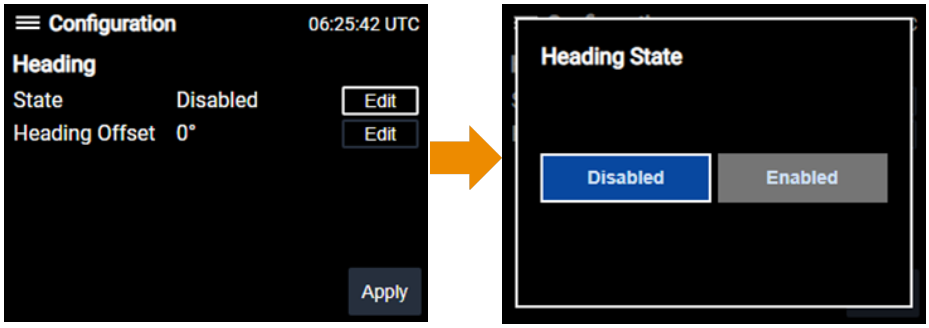
4.6.14 Configuration > Heading

LD900 models (LD900 and LD900M) supplied with heading capability and an enabled heading **State** within the unit will be capable of producing a heading solution. A **Heading Offset** can also be specified:



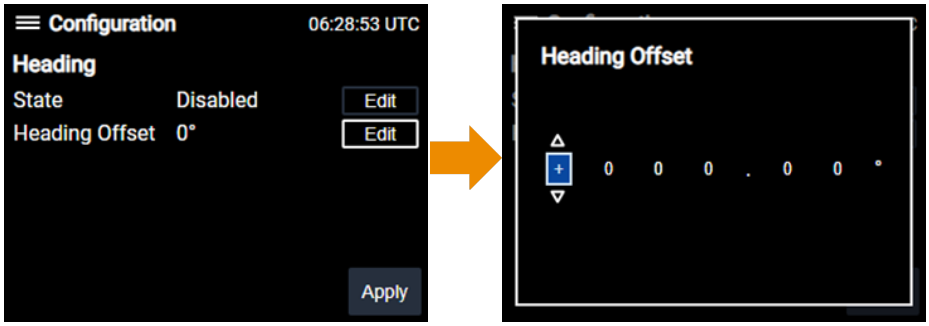
4.6.14.1 Configuration > Heading > State

State controls if heading is computed and available from the system. With **State** selected, use tick to bring up the **Heading State** and using the arrow keys select **Disabled** or **Enabled**, followed by tick. Then use the arrow keys to select **Apply**, right to select **Yes** and tick to apply:



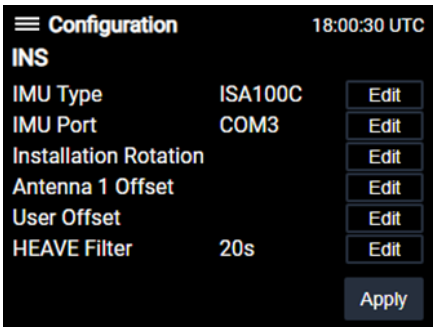
Configuration > Heading > Heading Offset
The heading offset is often referred to as the C-O (computed minus observed). The offset will adjust for any misalignment of the GNSS antenna baseline and the vessel centre line. Entering an accurate heading offset is also an important configuration for INS enabled system. Care should be taken not to apply the heading offset within the LD900 and the interfaced survey software or DP system.

Use the arrow keys to select **Heading Offset**, followed by tick. Then use the arrow buttons and tick to enter a value between -180.00° and 180.00°. Use the arrow keys to select **Apply**, right to select **Yes** and tick to apply the change:



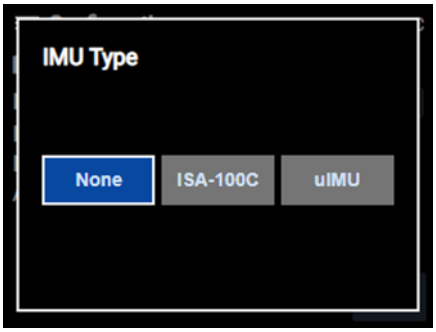
4.6.15 Configuration > INS

LD900 and LD900M models interfaced to an appropriate IMU Type via a specified **IMU** Port will be capable of INS. IMU type, port and system offsets must be correctly entered before the INS solution will start to initialise.



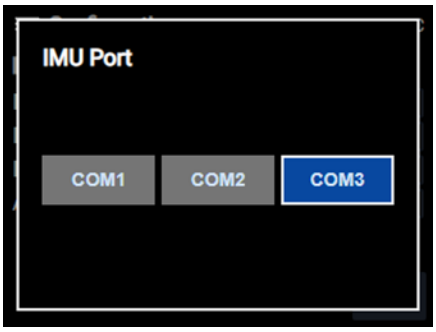
4.6.15.1 Configuration > INS > IMU Type

While **IMU Type** is selected click on **Edit** and using the arrow keys select **None** (default), **ISA-100C** or **uIMU** as required, followed by tick. Then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the change:



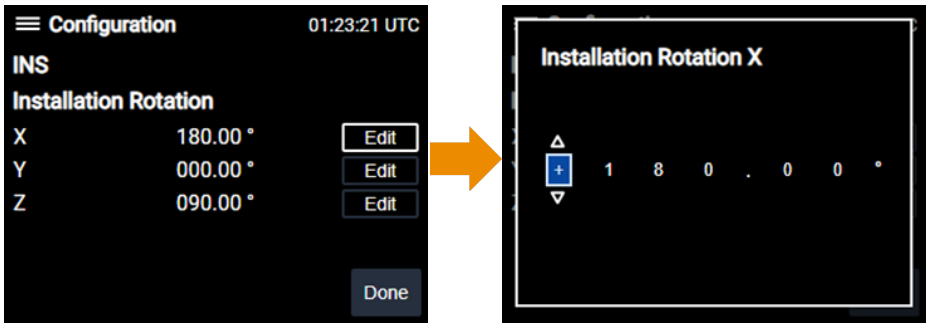
4.6.15.2 Configuration > INS > IMU Port

To configure the IMU Port click on **Edit** and using the arrow keys and tick select **COM1**, **COM2** or **COM3** (default) as required, followed by tick. Then use the arrow keys to select **Apply**, tick to select **Yes** and tick to apply the change:



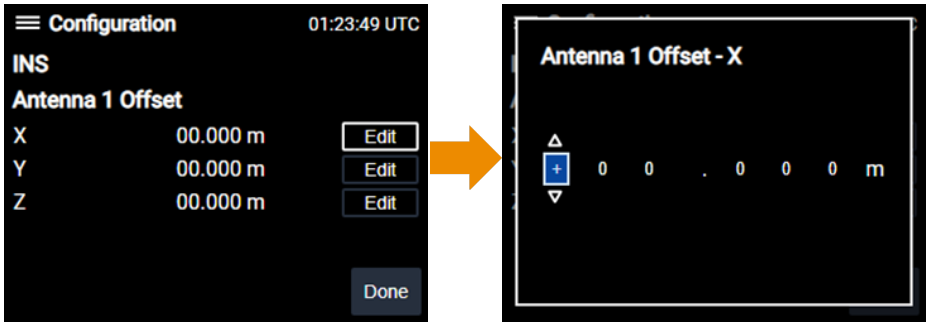
4.6.15.3 Configuration > INS > Installation Rotation

Use the arrow keys to select **Installation Rotation**, followed by tick. Then use the arrow buttons and tick to enter an **X** value within + / - 180.00. Use the arrow keys and tick to select **Done**, then use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the change. Repeat the same process for the **Y** and **Z** offsets.



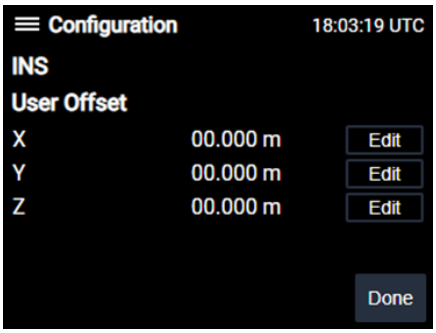
4.6.15.4 Configuration > INS > Antenna 1

Use the arrow keys to select either **Antenna 1 Offset**, followed by tick. Then use the arrow buttons and tick to enter an **X** value within +/- 99.999 meters. Use the arrow and tick keys to select **Done**, then use the arrow and tick keys to select **Apply**, right to select **Yes** and tick to apply the change. Repeat the same process for the **Y** and **Z** offsets:



4.6.15.5 Configuration > INS > User Offset

The optional User Offset is the X, Y, and Z distance in metres **from** the IMU centre of navigation **to** a user-defined point to the Offset location. This user-defined reference point is used for the INS position as output within the INSPVA log. The GNSS position outputs (NMEA GGA or BESTGNSSPOS) always output the position on the GNSS1 antenna ARP.



4.6.15.6 Configuration > INS > Heave Filter

The INS > Heave Filter addresses heave motion (vertical movement of vessel in response to waves or other disturbances).

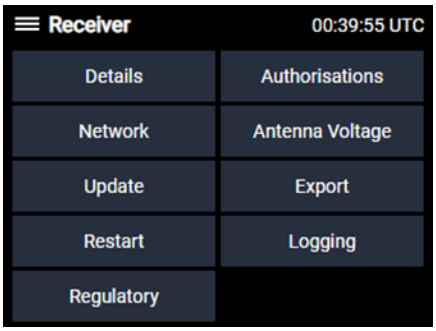
The Heave Filter period is the duration of time which the filter analyses and adjusts for vertical displacement variations of the vessel. A shorter filter period might provide more frequent updates but may be susceptible to noise, while a longer filter period may smooth out the data but could introduce a delay in responding to changes in heave motion.

The time entered in seconds will determine how quickly the INS can adapt to changes in the vertical motion of the platform while maintaining accuracy and stability.

With an understanding of the trade-offs between responsiveness and noise filtering Users may adjust the Heave Filter period based on operational scenario requirements.

4.7 Receiver

The ***Receiver*** menu page provides information and control of the receiver related settings. This section details the different menu options and the corresponding settings available.

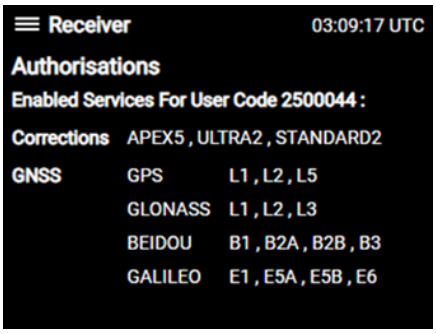


4.7.1 Receiver > Details

The ***Details*** page displays the LD900 User Code and Version:

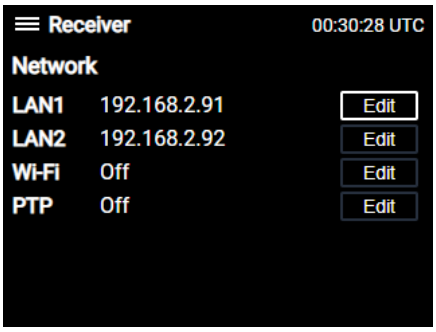
4.7.2 Receiver > Authorisations

The ***Authorisations*** page displays the Veripos correction services presently activated for the receiver and also the GNSS constellations and signals available for use:



4.7.3 Receiver > Network

The stock configuration of the LD900 includes a static IP address of 192.168.2.91 for LAN1 and 192.168.2.92 for LAN2. However, users may change these to different static IP addresses or switch to using DHCP. While the option exists to set the system to operate as a Wi-Fi Access Point (AP), this is for use with potential future developments. The option to configure PTP settings provides the LD900 with the ability to use its GPS time to synchronise the clocks on other PTP compatible network equipment



NOTE
IP addresses, subnet masks and gateways on both the LD900 and connecting devices need to be configured within an appropriate range, between 0.0.0.0 and 255.255.255.255.

If necessary, see FAQ How do I configure my PC to connect to an LD900?

4.7.3.1 Receiver > Network > LAN1 (or) LAN2

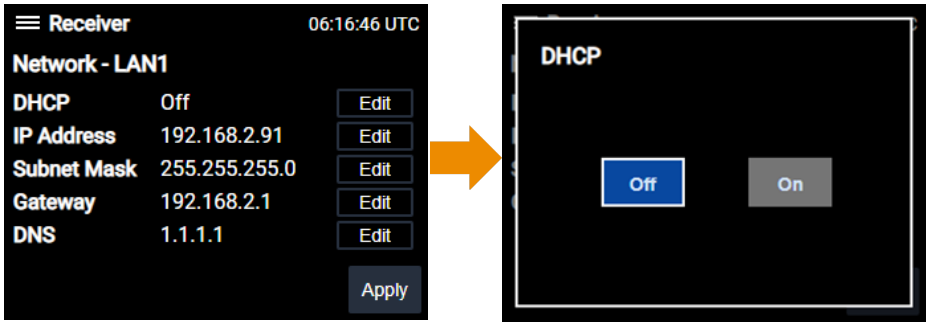
Two LAN ports are available, with LAN1 allowing ICOM data outputs and LAN2 serving as a direct feed to Quantum software.

CAUTION
Avoid setting LAN1 and LAN2 to the same IP address whilst on static, and note that a DNS address is essential for NTRIP via Ethernet to work.

Use the arrow buttons and tick to select **LAN1** (or) **LAN2**, followed by tick. To configure DHCP, click on **Edit**, and using the arrow keys and tick, choose **On** or **Off** as required, followed by tick. Then, use the arrow keys and tick to select **Apply**, right to select **Yes** and tick to apply the change.

When selecting **DHCP**: On, the IP Address, Subnet Mask and Gateway will auto-populate after a short period, and no further configuration will be required. If selecting **DHCP: Off** the IP Address, Subnet Mask and Gateway will require configuring by clicking on the corresponding **Edit** for each and using the arrow buttons and tick to set. A DNS field is also available for LAN1 configuration if required.

Note for LAN2 that when DHCP is Off and changes have been made, an additional field, **Speed**, will be shown on the network page. This field provides **Auto** (default), **10Mbps**, or **100Mbps** speed settings.

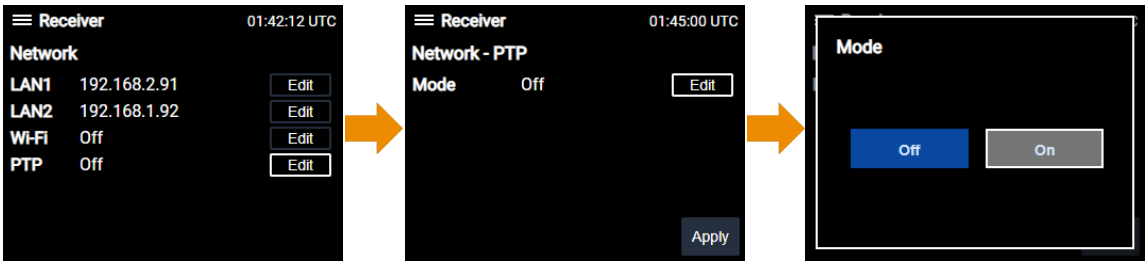


4.7.3.2 Receiver > Network > Wi-Fi

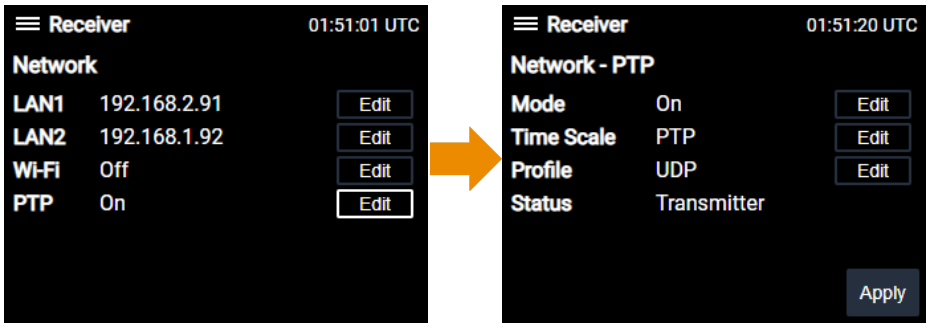
Options to configure Wi-Fi exist however, these are intended for use with potential future developments and should be left **Off**.

4.7.3.3 Receiver > Network > PTP

The option to configure PTP settings provides the LD900 with the ability to use its GPS time to synchronise the clocks on other PTP compatible network equipment via LAN1. To activate this feature, with **PTP** selected, press tick to bring up the **Mode** option. Press tick again, and using the arrow keys, choose **On**, followed by tick. Then use the arrow keys to select **Apply**, right to select **Yes** and then tick:



Once PTP Mode is On, additional PTP configuration options will become available within the sub-menu. **Time Scale** may be toggled between **PTP** format (default) which does not correct for leap seconds or **UTC** format, which adjusts the time to UTC. **Profile** may be set to the default of **UDP** (end to end), **UDP P2P** (peer to peer), **ETH** (end to end), **ETH P2P** (peer to peer) or **ITU - T**.

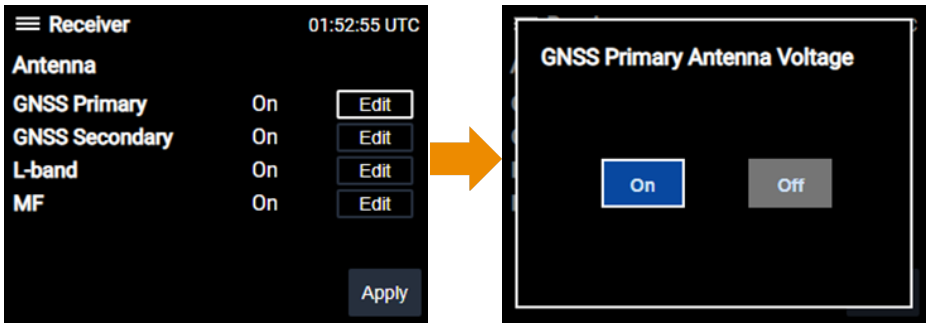


4.7.4 Receiver > Antenna Voltage

The LD900 allows for GNSS Primary, GNSS Secondary, L-band and MF Antenna Voltages to be configured.

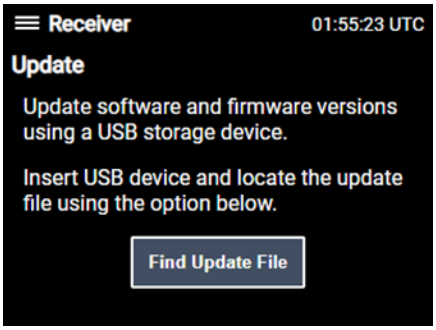
4.7.5 Receiver > Antenna Voltage > (GNSS Pri', GNSS Sec', L-band)

To configure an antenna voltage, click on **Edit** and using the arrow keys select Off, or On (default) as required, followed by tick. Turning Off will result in a loss of tracking, as the power to the antenna will no longer be provided when directly connected to the receiver. Then use the arrow keys to select **Apply**, right to select **Yes** and tick to apply the change:



4.7.6 Receiver > Update

Within the Update menu page, a Find Update File option is available. Users wishing to upgrade the LD900 may place any required firmware version .zip file into the root folder of a virus-free USB drive (FAT32 format only, with at least 512MB free) and then insert the drive into the LD900 front-facing USB port. Before a firmware upgrade record all system settings - see Appendix section LD900 firmware upgrade - Settings to note.

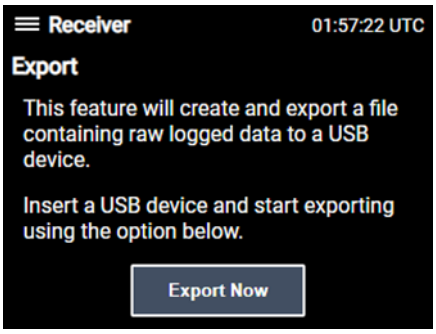


The upgrade may take up to 15 minutes to complete. Once complete navigate to the Receiver > Details menu and confirm the installed version.

4.7.7 Receiver > Export

Within the **Export** page, the **Export Now** option is available. In the event of receiver issues such as loss of solution, this option provides a method for exporting data to USB drive (FAT32 format) for further analysis.

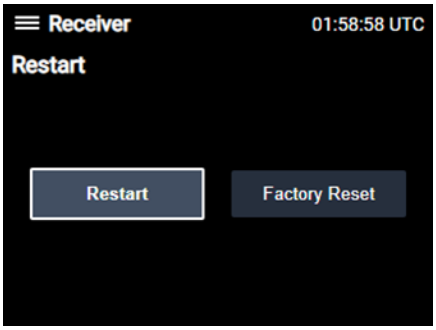
The LD900 will retain the last 72 hours of logs. When exporting data for analysis by Veripos support it is recommended to provide data commencing from three hours prior to an event until one hour after. Data will be exported to a file titled with 'ld900_archive_data', the date in 'dd_mm_yyyy' format and the time in 'hh_mm_ss' format.



4.7.8 Receiver > Restart

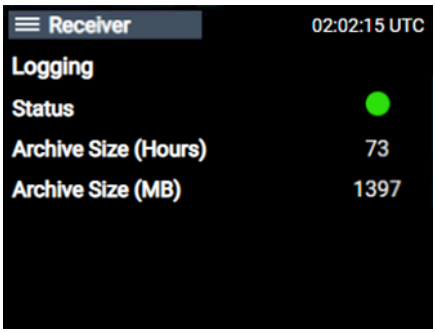
Within the ***Restart*** menu page, the **Restart** option is available. This allows the system to restart while preserving all user-configured settings. A **Factory Reset** option is also available, which should only be carried out under the advice of Veripos Support.

To restart or factory reset the system, use the arrow keys to toggle between Restart and Factory Reset as required and press tick. When selecting Factory Reset a confirmation dialog will be shown. Click Yes, Reset and use tick to confirm.



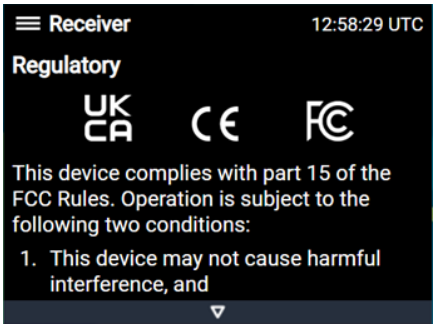
4.7.9 Receiver > Logging

The ***Logging*** page displays the status of internal system logging.



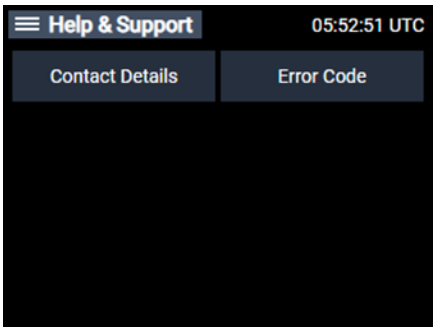
4.7.10 Receiver > Regulatory

The ***Regulatory*** page contains UKCA, CE and FCC compliance information:



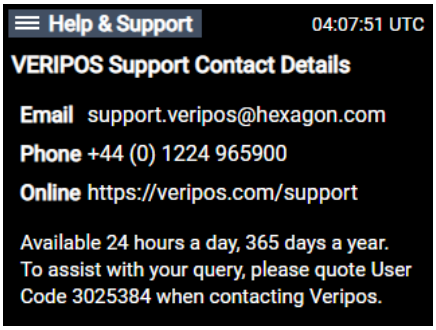
4.8 Help & Support

Should support be needed the ***Help & Support*** menu page provides access to Veripos support contact information and system error codes for use in troubleshooting.



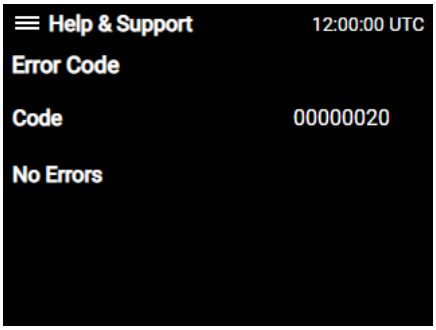
4.8.1 Help & Support > Contact Details

The ***Contact Details*** page provides details for contacting Veripos with support related queries and activation requests:



4.8.2 Help & Support > Error Code

The ***Error Code*** page provides information that might be requested by Veripos support during the course of troubleshooting.



Error Code	Description
00000020	No errors
01000000	Software resource warning
00040000	Almanac invalid / unknown
00008000	Interference detected
00004000	Antenna gain out of range
00001000	Input (COM, USB, ICOM) overun
00000800	Link (USB, ICOM, COM) overrun
00000100	COM port overrun
00000080	CPU overload
00000002	Temperature warning

5 Troubleshooting

The LD900 uses a colour LCD screen and navigation panel to provide status information and help with troubleshooting issues.

> **CAUTION**
> Front and rear panels should not be removed. Please contact your Veripos project manager if maintenance is required.

Most potential problems that might occur when using this system will relate to signal reception problems or configuration errors. This section will assist in resolving the most commonly encountered system issues.

5.1 Hardware issues

Hardware fault finding should be limited to checking that all connectors are secure and checking supply voltage.

Before thorough investigations are undertaken, it is **strongly recommended** to verify coaxial cable connections, cable integrity and correct antenna siting. For further guidance please see:

- Antenna and Coaxial Cable Installation Manual
- GNSS Heading Antenna Installation Guide (where relevant to installation)

5.2 Power issues

Fault description	Possible cause	Solution
Screen blank	Screen brightness setting.	Adjust screen brightness using the buttons on the left-hand side of the LCD display.
	External supply fault or external supply disconnected or switched off.	Check power connection to the unit for physical, fuse and electrical integrity.
	Fault in AC/DC supply.	Disconnect the power supply. Check voltage to and from the supply. The LD900 AC 110/240 should supply 12-24 VDC to the LD900.
	Hardware fault	If the PSU voltage is correct, contact Veripos Support.

5.3 Activation issues

Fault description	Possible cause	Solution
Grey corrections indicator	Unit disabled	Contact Veripos Support with vessel name, SAL number and services required.
Red corrections indicator	No L-band signal	See section L-band signal issues.

5.4 L-band signal issues

Fault description	Possible cause	Solution
Red corrections indicator	Selected L-band beam unavailable in the work location.	Refer to the L-band coverage map to check that selected beam is appropriate for work region, amending if required. Setting L-band to Auto will mitigate against the need to do this. Where L-band signal is derived from the vessel's Inmarsat system check that the LD900 is set to the same satellite, referring to the latest Veripos beam frequency table if necessary.
	Antenna blockage (masking).	Visually check if the path between the antenna and the L-band satellite is blocked. This can be caused by other vessels, rigs, structures or the vessels own superstructure.
	Incorrect L-band source.	Check the LD900 Source antenna selection, which defines which RF connector should be used for connecting the L-band input. Change if necessary.
	L-band antenna voltage turned off.	Check **Receiver > Antenna** to ensure that voltage is switched on for the L-band Source Antenna.
	Interference.	Sources of interference within the vessels control (such as onboard sources of L-band or high-power transmissions) should be identified and eliminated.
	Antenna disconnected or faulty.	Check antenna and cabling for DC power as well as signs of damage.

5.5 GNSS signal issues

Fault description	Possible cause	Solution
Red positioning indicator	Antenna blockage (masking).	Visually check whether the path between the antenna and the GNSS satellites is blocked. This can be caused by other vessels, rigs, structures or the vessels own superstructure.
	Interference	Sources of interference within the vessels control should be identified and eliminated. Investigations should focus on sources of signal transmissions around the same frequency as GNSS, as well as high power transmissions of other frequencies.
	Antenna disconnected or inoperative	Check antenna and cabling for DC power as well as signs of damage.
	GNSS antenna voltage turned off.	Check **Receiver > Antenna** to ensure that voltage is switched on for the **GNSS Primary** (GNSS1) antenna.

5.6 Corrections issues

Fault description	Possible cause	Solution
System has not converged to PPP	System set to wrong PPP corrections service type.	Navigate to **Configuration > Positioning** and verify that the **Positioning Mode** matches a service shown in **Receiver > Authorisations**. If this is not the case toggle the **Positioning Mode** within **Configuration > Positioning** or contact Veripos Support and request the appropriate service.

5.7 GNSS heading issues

Fault description	Possible cause	Solution
No GNSS heading available	No GNSS reception from GNSS1 antenna.	Check the LD900 Status Page to see if valid GNSS signals are being received (GNSS icon should be green). A red GNSS icon and no constellations highlighted indicates a problem with the GNSS1 feed. Check coaxial connection to GNSS1 and inspect antenna and cabling for damage. Confirm that there are no potential sources of interference or physical obstructions around the GNSS1 antenna.
	No GNSS reception from GNSS2 antenna.	Check coaxial connection to GNSS2 and inspect antenna and cabling for damage. Confirm there are no potential sources of interference or physical obstructions around the GNSS2 antenna.
	GNSS Heading not enabled	Navigate to **Configuration > Heading** and confirm that **State** is set to **Enabled**. If not proceed to set to **Enabled**.
	GNSS antenna voltage turned off.	Check **Receiver > Antenna** to ensure that voltage is switched on for the **GNSS Secondary** (GNSS2) antenna.
	Lack of common satellites between antennas.	Ensure adequate spacing has been provided between both antennas while avoiding masking from vessel superstructure.

5.8 INS signal issues

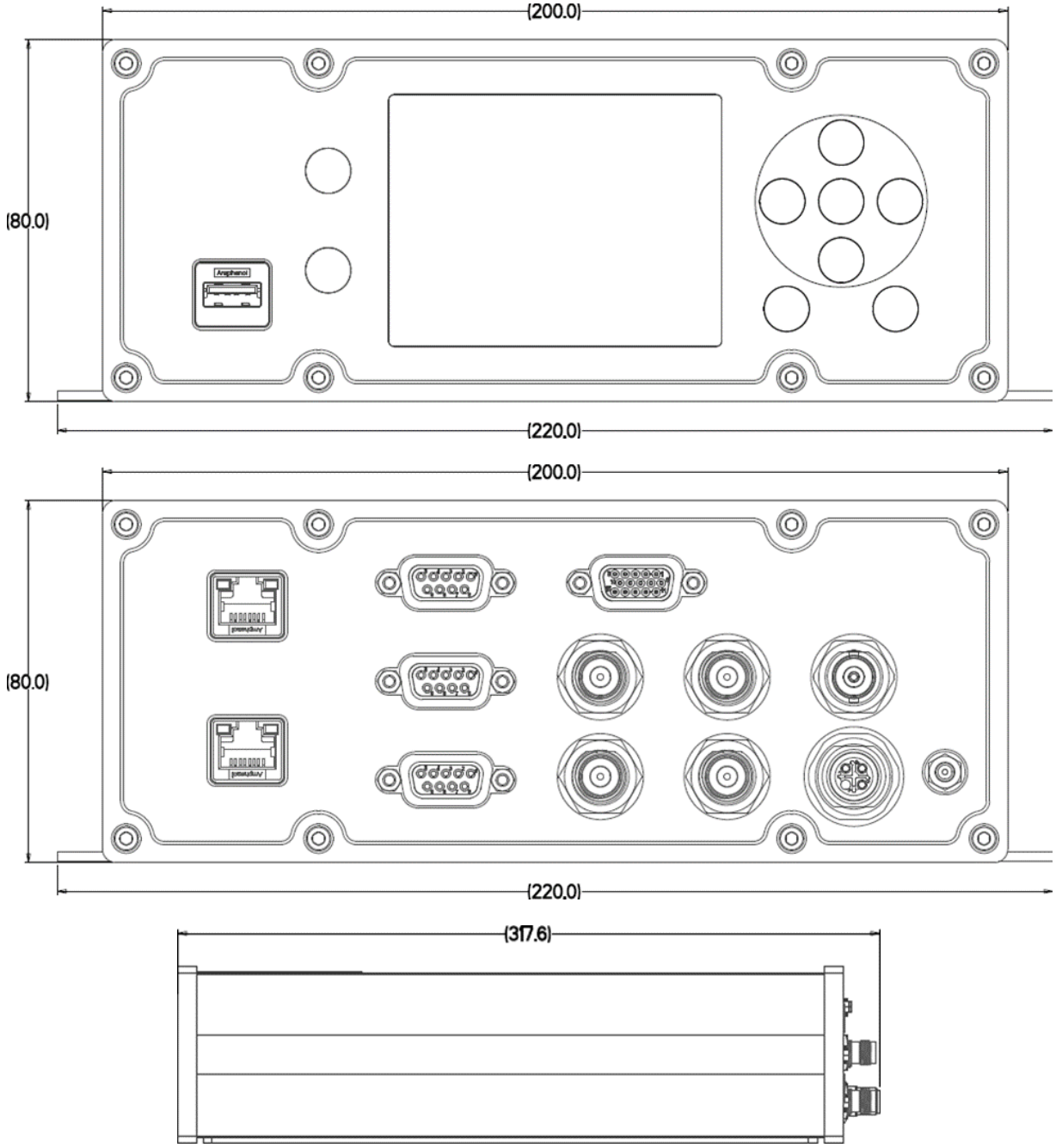
Fault description	Possible cause	Solution
No INS available	No GNSS reception from GNSS1 antenna.	Check the LD900 Status Page to see if valid GNSS signals are being received (GNSS icon should be green). A red GNSS icon and no constellations highlighted indicates a problem with the GNSS1 feed. Check coaxial connection to GNSS1 and inspect antenna and cabling for damage. Confirm that there are no potential sources of interference or physical obstructions around the GNSS1 antenna.
	No GNSS reception from GNSS2 antenna.	Check coaxial connection to GNSS2 and inspect antenna and cabling for damage. Confirm there are no potential sources of interference or physical obstructions around the GNSS2 antenna.
	INS not enabled	Navigate to **Configuration > Heading** and confirm that **State** is set to **Enabled**. If not proceed to set to **Enabled**.
	GNSS antenna voltage turned off.	Check **Receiver > Antenna** to ensure that voltage is switched on for the **GNSS Secondary** (GNSS2) antenna.
	Lack of common satellites between antennas.	Ensure adequate spacing has been provided between both antennas while avoiding masking from vessel superstructure.
	Disconnection to IMU	Check that the IMU is both powered on and connected to the COM port specified within **Configuration > INS**.

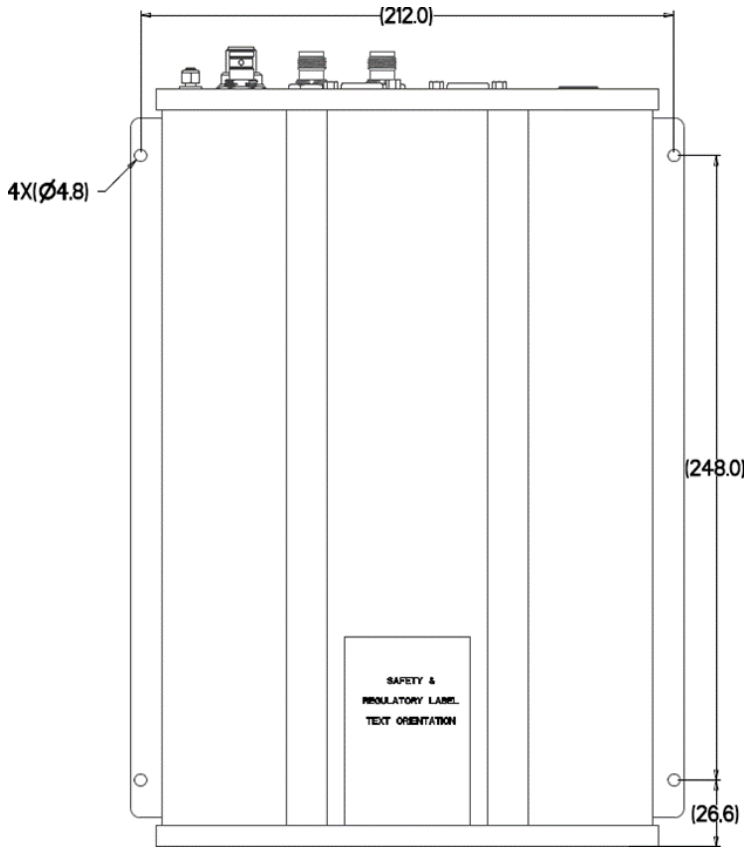
6 Reference information

6.1 Technical specifications

6.1.1 Dimensions

Note: All measurements shown are in millimetres.





6.1.2 Mechanical specifications

Equipment complies with EN/IEC 60945 (Protected Equipment).

6.1.3 Compass safe distance

Standard Compass Distance: 30 cm
Steering Compass Distance: 15 cm

6.1.4 Environmental specifications

Operating temperature range:-15°C to +55°C
Maximum relative humidity: 95% non-condensing

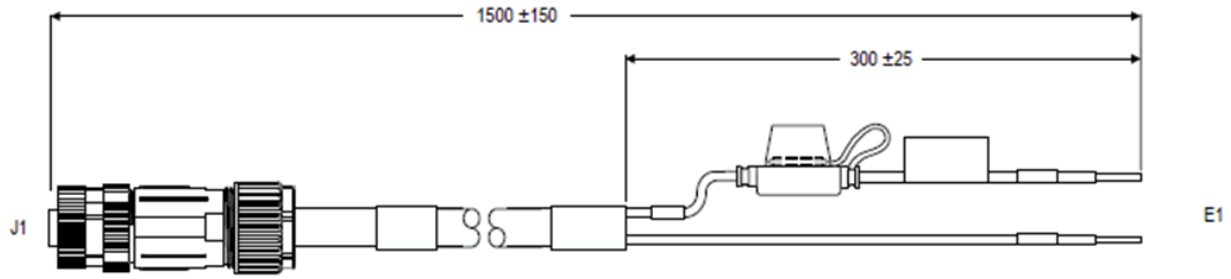
6.1.5 Electrical specifications

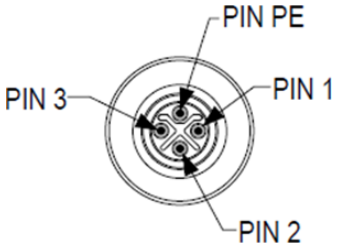
Voltage: +12 to +24 VDC
Power Consumption: 18 Watts maximum

NOTE
These are typical values using serial ports without interference mitigation. These values can change with the number of satellites in view, firmware version, data logging rates and features in use.

6.2 Cabling and connectors

6.2.1 Power cable (DC)

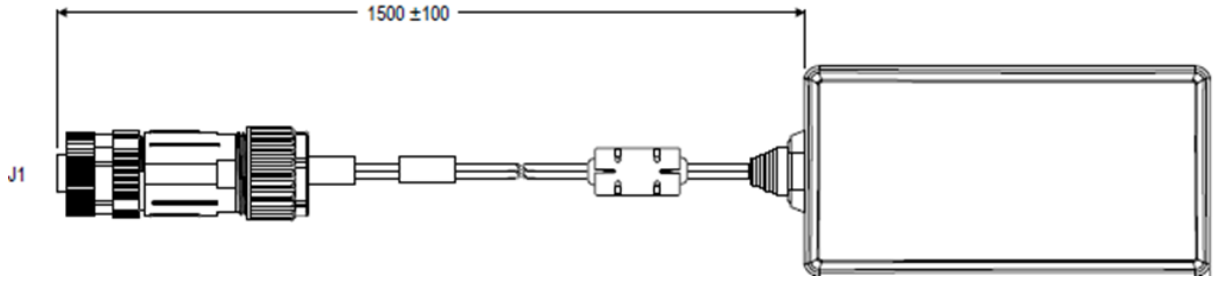


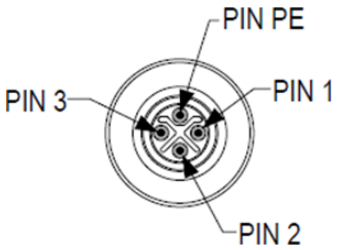


J1 Pins

From	To	
J1	E1	Tag name
1	FLYING LEAD	PWR+
2	NC	
3	FLYING LEAD	PWR-
PE	NC	

6.2.2 Power adapter (AC)

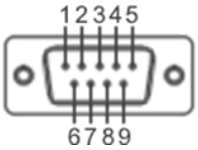




J1 Pins

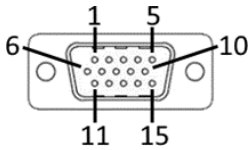
6.2.3 COM 1-3 serial COM ports

Pin	RS232	RS422
1	N/C	
2	TX	TX+
3	RX	RX+
4	N/C	
5	GND	-
6	N/C	
7	-	RX-
8	-	TX-
9	N/C	



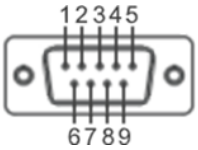
6.2.4 COM 4 serial COM port

Pin	Function	RS232	RS422
1	EVENT_GND	N/A	
2	COM4	RX	RX+
3	COM4		TX-
4	COM5	RX	RX+
5	COM5	RX	RX+
6	EVENT_IN	N/A	
7	COM4		RX-
8	COM4	TX	TX+
9	COM5	TX	TX+
10	COM5		TX-
11	COM6		RX-
12	COM6	RX	RX+
13	GND	GND	N/A
14	COM6		TX-
15	COM6	TX	TX+



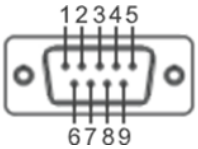
6.2.5 Moxa serial extender

Pin	RS232	RS422
1	DCD	Tx-
2	Rx	Tx+
3	Tx	Rx+
4	DTR	Rx-
5	GND	GND
6	DSR	–
7	RTS	–
8	CTS	–
9	–	–



6.2.6 Moxa PC

Pin	RS232	RS422
1	DCD	TxDA(-)
2	RxD	TxDB(+)
3	TxD	RxDB(+)
4	DTR	RxDA(-)
5	GND	GND
6	DSR	–
7	RTS	–
8	CTS	–



NOTE

NMEA ports are RS422 only and the following format applies:

NMEA TXA = TX-

NMEA TXB = Tx+

NMEA RX A = Rx-

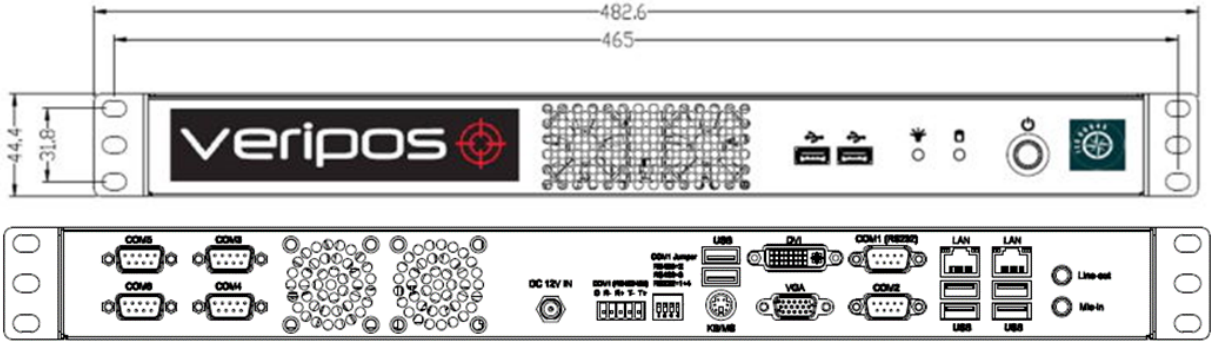
NMEA RXB = Rx+

6.3 Veripos H70 PC

6.3.1 Veripos H70 PC - Dimensions

Note: All measurements shown are in millimetres.

Dimensions W x D x H (mm) 430 x 203 x 44.4 (1U 19" Rackmount)



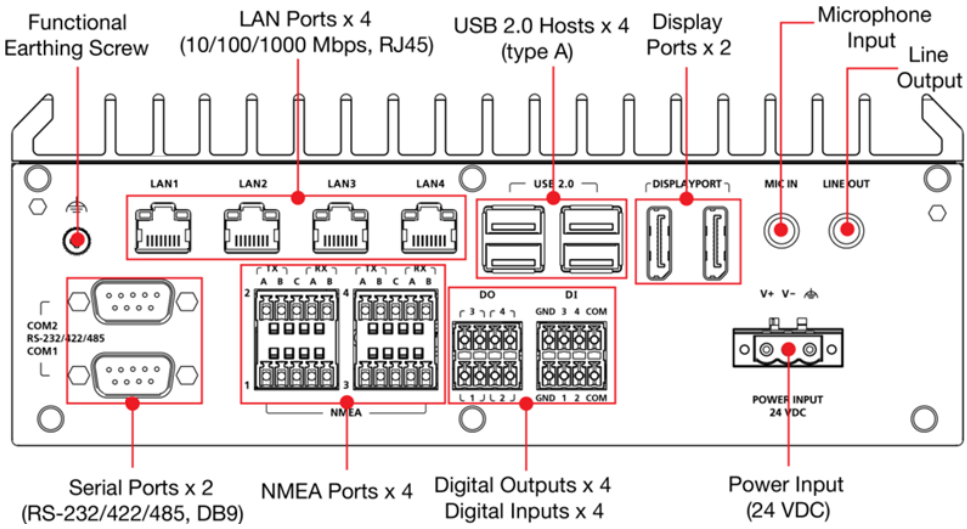
6.3.2 Veripos H70 PC - Technical specifications

- Intel Core i5 processor
- 8GB RAM
- 250GB SSD
- Dual gigabyte Ethernet
- Audio output (3.5 mm jack)
- Intel HD graphics
- VGA and DVI display
- 8 USB ports 2.0 (2 ports front mounted)
- 6 COM ports (1 port RS232 /422, 5 ports RS232)
- PS2 mouse / keyboard support (with PS2 splitter)
- Front power switch
- External AC-DC power module (Input 100 – 240 VAC) 12 Volts @ 8A

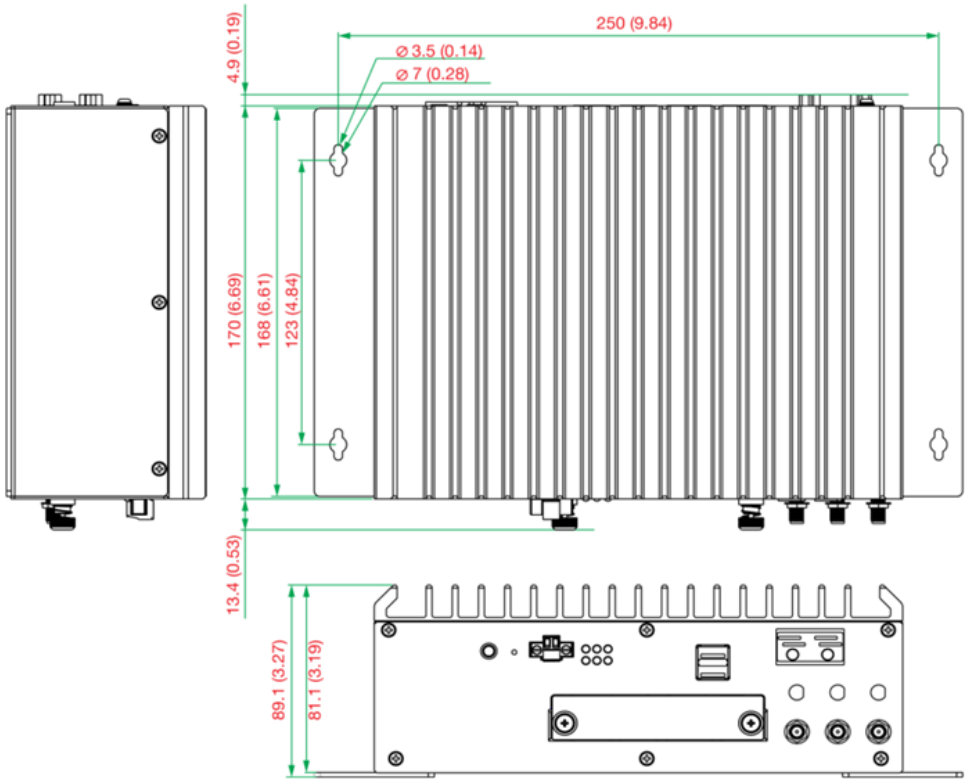
6.3.3 Veripos H70 PC - Environmental specifications

- Operating temperature: 0 °C to 60 °C
- Storage temperature: -20 °C to 80 °C
- Storage humidity: 10% to 90% non-condensing
- Vibration: 17 to 500HZ 1G PTP; Shock: 1G /peak (11m sec)
- Conformance - CE/FCC/ROHS (IEC-60945 Certified)

6.4 Moxa MC3201 PC



6.4.1 Moxa MC3201 PC - Dimensions



6.4.2 Moxa MC3201 PC - Technical specifications

- Intel® Core™ i7-1185G7E processor
- Intel® Iris® Xe Graphics
- 8 GB DDR4
- SODIMM DDR4 2133 slot x 2
- Windows 10 Embedded IoT Ent 2019
- 10/100/1000 Mbps ports LAN x 4
- RS-232/422/485 ports x 2
- M-S Models: DIs x 4
- M-S Models: DOs x 4
- USB 3.0 hosts x 2, type-A connectors
- USB 2.0 hosts x 4, type-A connectors
- DisplayPort x 2 up to 3840 x 2160
- Line in x 1, Line out x 1, 3.5 mm jack
- Reset button Power button

6.4.3 Moxa MC3201 PC - Physical Characteristics

- 220 x 80 x 170 mm (8.66 x 3.15 x 6.69 in)
- 3,000 g (6.61 lb)

6.4.4 Moxa MC3201 PC - Power Parameter

- Input Voltage M-S Models: 24 VDC

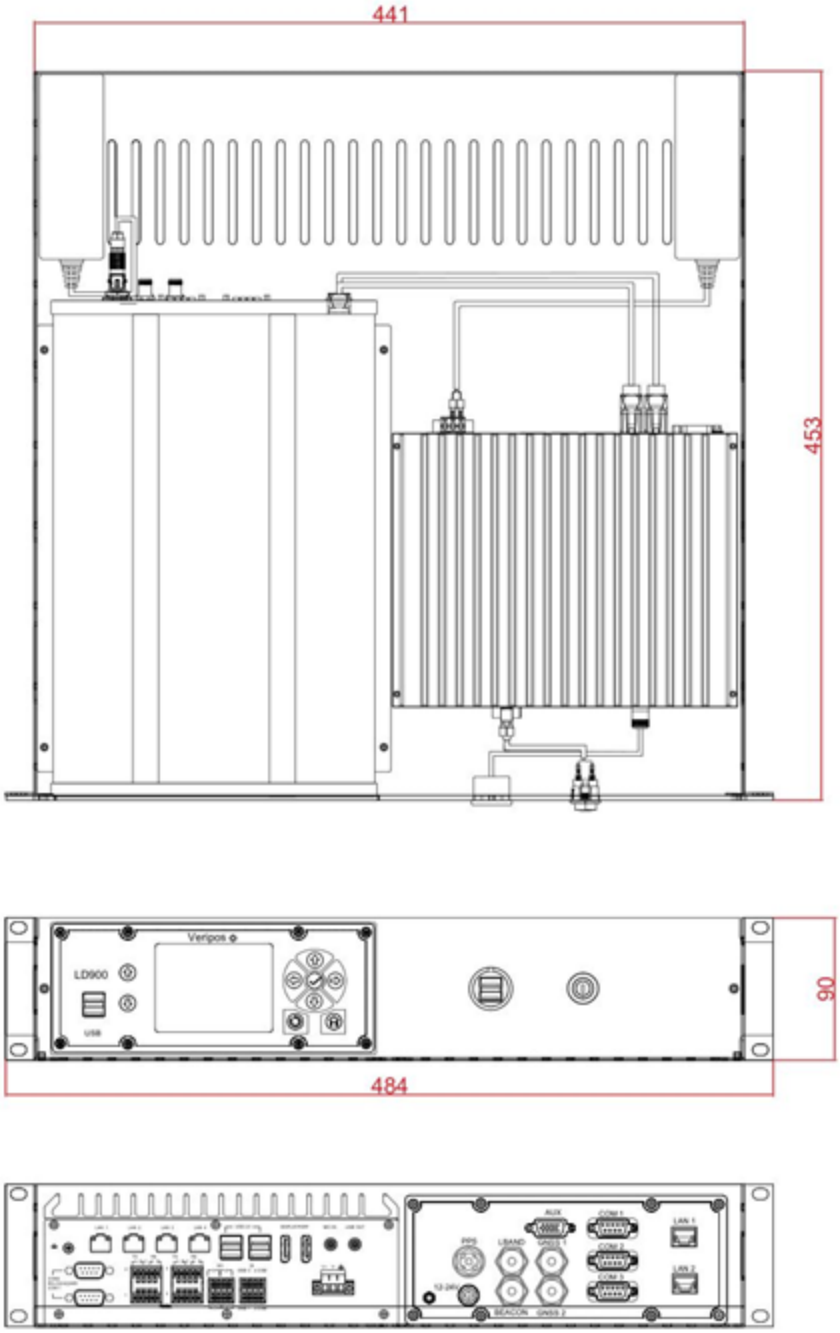
6.4.5 Moxa MC3201 PC - Environmental Limits

- Operating Temperature -20 to 55°C (-4 to 131°F)
- Storage Temperature -30 to 60°C (-22 to 140°F)

6.4.6 Moxa MC3201 PC - Power button

Please note that the power button is an ON button only. To power the unit down, use the Start menu and select Shutdown.

6.5 Moxa PC Rack



6.6 LD900 output sentences

This section outlines the structure of the following message output types:

- GGA
- GST
- ZDA
- GSA
- VTG
- GSV
- GLL
- GRS
- RMC
- HDT
- INHDT
- TRINAV
- Veripos UKOOA
- BESTPOS / BESTGPSPOS
- INSPVA
- HEAVE
- TSS1
- PASHR

6.6.1 NMEA talker IDs

The NMEA talker identifier serves to define the nature of the data being transmitted. The talker is the first two characters after the $ sign within the NMEA sentence. As the LD900 is capable of utilising more than only the GPS constellation, the talker has a set value for each constellation. For sentences where the data relates to multiple constellations the ID '**GN**' will be found.

Not all NMEA sentences will have a variable talker ID (the GGA and ZDA will be fixed with **GP**) however all other NMEA messages will have a variable talker.

Note that the talker ID is determined by the constellation/s in use and cannot be changed to another value.

The table below shows the talker IDs and the represented constellation:

Talker ID	Constellation
GP	GPS
GL	GLONASS
GA	Galileo
BD	BeiDou
GN	Multiple Constellations
IN	Dead reckoning

6.6.2 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 Corrections’.

GGA sentence structure & example

$GPGGA,	hhmmss.ss,	ddmm.mmmmm,	a,	dddmm.mmmmm,	b,	q,	xx,	p.p,	a.b,	>M,	c.d,	M,	x.x,	nnnn	*hh
$GPGGA,	123519.00,	4807.03787,	N,	01131.00547,	E,	1,	15,	0.9,	545.4,	M,	46.9,	M,	14.0,	0281	*47

GGA sentence defined

Field	Content
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 = DGNSS fix, 4 = Fixed RTK, 5 = Float RTK / PPP, 6 = Dead Reckoning), 7 = Manual Input Mode, 8 = Simulation Mode
xx	Number of satellites in use
p.p	HDOP (Horizontal dilution of precision)
a.b	Antenna altitude above/below mean-sea-level
M	Units of antenna altitude, meters
c.d	The relationship between the geoid and the WGS84 ellipsoid
M	Units of meters
x.x	Age of differential GNSS data
nnnn	Differential reference station ID, 0000 to 1023
*hh	Checksum
[CR][LF]	Sentence Terminator

NOTE
The number of decimal places in the GGA message Latitude and Longitude values is configurable, see sections relating to COM or ICOM GGA precision for details. If making changes from five decimal places the sentence will no longer conform with NMEA v3.01.

6.6.3 GST sentence

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

GST sentence structure & example

```
$GNGST, hhmmss.ss, a.aa, b.bb, c.cc, d.dddd,  e.ee, f.ff,   g.gg *hh
$GNGST, 024603.00,  1.47, 0.11, 0.07, 28.3688, 0.10, 0.08, 0.16 *58
```

GST sentence defined

Field	Content
GST	Estimated error in position solution
hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
a.aa	RMS value of the standard deviation of the range inputs to the navigation process. Range inputs include pseudo-ranges and differential DGNSS corrections
b.bb	Standard deviation of semi-major axis of error ellipse (meters)
c.cc	Standard deviation of semi-minor axis of error ellipse (meters)
d.dddd	Orientation of semi-major axis of error ellipse (meters)
e.ee	Standard deviation of latitude error (meters)
f.ff	Standard deviation of longitude error (meters)
g.gg	Standard deviation of altitude error (meters)
*hh	Checksum
[CR][LF]	Sentence terminator

6.6.4 ZDA sentence

The NMEA ZDA sentence provides time and time zone information.

ZDA sentence structure & example

```
$GPZDA, hhmmss.ss, dd, mm, yyyy, null, null *hh
$GPZDA, 201530.00, 04, 07, 2019, ,    ,    *6E
```

ZDA sentence defined

Field	Content
ZDA	Time and Date data
hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
dd	Day, 01 to 31
mm	Month, 01 to 12
yyyy	Year
null	Local zone hours (not available)
null	Local zone minutes (not available)
*hh	Checksum

6.6.5 GSA sentence

The NMEA GSA sentence provides time and time zone information.

GSA sentence structure & example

```
$GNGSA, a, 1, cc, cc, cc, cc, cc, cc, cc, cc, cc, cc, cc, cc, d.d, e.e, f.f  *hh
$GNGSA, a, b, 02, 12, 15, 20, 21, 24, 25, 29, 32, ,  ,  ,  1.7, 0.9, 1.5 *58
```

GSA sentence defined

Field	Content
GSA	GNSS DOP and Active Satellites
a	Mode (M = Manual mode, forced to operate in 2D or 3D mode, A = Automatic mode, allowed to automatically switch 2D/3D)
b	Fix (1 = Not available, 2 = 2D, 3 = 3D)
cc	PRN ID numbers of satellites used in solution a total of 12 fields GPS = 1 to 32 GLONASS = 65 to 96 As shown in the above example, if less than 12 satellites for one constellation are used null values will be output in the string.
d.d	PDOP
e.e	HDOP
f.f	VDOP
hh	Checksum

6.6.6 VTG sentence

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

VTG sentence structure & example

```
$GNVTG, ppp.ppp, T, qqq.qgg, M, rr.rrr,  N, ss.sss, K, U, *hh
$GNVTG, 167.608, T, 167.608, M, 0.006, N, 0.012,  K, D, *3D
```

VTG sentence defined

Field	Content
VTG	Course over ground and ground speed
ppp.ppp	True course over ground
T	Degrees True indicator
qqq.qgg	Magnetic course over ground
M	Degrees Magnetic
rr.rrr	Speed over ground, knots
N	Nautical speed indicatior (N = Knots)
ss.sss	Speed over ground, kilometres/hour
K	Speed indicator (K = km/hr)
U	Positioning mode indicator (A = Autonomous, D = Differential, E = Estimated (Dead reckoning), M = Manual, N = Data not valid)
*hh	Checksum

6.6.7 GSV sentence

The NMEA GSV sentence provides information relating to the number of satellites (SV) in view, satellite ID numbers, elevation, azimuth, and SNR value in one sentence.

GSV sentence structure & example

```
$GPGSV, a, b, cc, dd, ee, fff,   gg, dd, ee, fff,   gg, dd, ee, fff,   gg, dd,  ee, fff,   gg, *hh,
$GPGSV, 4, 1, 13, 02, 10, 043, 41, 05, 05, 103, 38, 10, 04, 238, 42, 12,  13, 030, 44, *7E,
                  (Satellite 1)       (Satellite 2)       (Satellite 3)       (Satellite 4)
```

GSV sentence defined

Field	Content
GSV	GNSS Satellites in view
a	Total number of sentences (1-9)
b	Sentence number (1-9)
cc	Total number of satellites in view, within the talker ID constellation
dd	Satellite ID number GPS = 1 to 32 GLONASS = 65 to 96
ee	Elevation, degrees (90° maximum)
fff	Azimuth, degrees true, 000 to 359
gg	SNR (C/No) 00-99 dB-Hz, null when not tracking
hh	Checksum

NOTE
Fields dd, ee, fff and gg will be repeated a maximum of 4 times per sentence, where all satellite info is already output null values will be output.

6.6.8 GLL sentence

The NMEA GGL sentence provides Latitude and Longitude position data for the present position.

GLL sentence structure & example

```
$GNGLL, ddmm.mmmmmmm, a,  dddmm.mmmmmmm, b,  hhmmss.ss, S, I  *hh
$GNGLL, 5708.7104685,      N, 00217.1169613,      W, 062859.00,  A, D *72
```

GLL sentence defined

Field	Content
GLL	Geographic position - Latitude and Longitude
ddmm.mmmmmmm	Latitude of position
a	Latitude direction (N or S)
dddmm.mmmmmmm	Longitude of position
b	Longitude direction (E or W)
hhmmss.ss	UTC time of position
S	Status (A = data valid ; V = data not valid)
I	Positioning mode indicator (A = Autonomous, D = Differential, E = Estimated (Dead reckoning), M = Manual, N = Data not valid)
*hh	Checksum

6.6.9 GRS sentence

The NMEA GRS sentence provides range residuals for each satellite.

GRS sentence structure & example

```
$GNGRS, hhmmss.ss, a, b.b, b.b, b.b, b.b, b.b, b.b, b.b, b.b, b.b, b.b, b.b, b.b, ,cc ,dd *67
$GNGRS, 142406.00,  1, -1.1, -0.1, 1.7, 1.2, -2.0, -1.3, 1.3, -0.4, -1.2, -0.2, ,    ,    1,  1,  *hh
```

GRS sentence defined

Field	Content
GRS	GNSS range residuals
hhmmss.ss	UTC time of position
a	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)
b.b	Range residuals for satellites used in the navigation solution. Order matches order of PRN numbers in GPGSA.
cc	GNSS System ID (see tables below for further explanation).
dd	Ranging Signal ID (see tables below for further explanation).
*hh	Checksum

	GNSS Constellation: GPS					
GNSS System ID:	1 (GP)					
Signal Channel:	All Signals	L1 C/A	L1 P(Y)	L2 P(Y)	L2C-M	L2C-L
Ranging Signal ID:	**0**	**1**	**2**	**3**	**4**	**5**

	GNSS Constellation: GLONASS				
GNSS System ID:	**2** (GL)				
Signal Channel:	All Signals	L1 C/A	L1 P	L2 C/A	L2 P
Ranging Signal ID:	**0**	**1**	**2**	**3**	**4**

	GNSS Constellation: Galileo					
GNSS System ID:	**3** (GA)					
Signal Channel:	All Signals	E5a	E5b	E5a+b	E6-A	E6-BC
Ranging Signal ID:	**0**	**1**	**2**	**3**	**4**	**5**

	GNSS Constellation: BeiDou								
GNSS System ID:	4 (BD)								
Signal Channel:	All Signals	B1I	B1C	B1A	B2-a	B2-b	B3I	B3Q	B3A
Ranging Signal ID:	0	1	3	4	5	6	8	9	A

	GNSS Constellation: QZSS					
GNSS System ID:	**5** (GQ)					
Signal Channel:	All Signals	L1 C/A	L1C (D)	L1C (P)	L2C-M	L2C-L
Ranging Signal ID:	**0**	**1**	**2**	**3**	**5**	**6**

6.6.10 RMC sentence

The NMEA RMC sentence provides essential GPS PVT (position, velocity, time) data.

RMC sentence structure & example

$GNRMC,	hhmmss.ss,	a,	ddmm.mmmmmmm,	b,	dddmm.mmmmmmm,	c,	dd.ddd,	eee.e,	ddmmyy	f.f,	g,	h	*hh
$GNRMC,	143909,	A,	5107.0020216,	N,	11402.3294835,	W,	0.036,	348.3,	210307,	0.0,	E,	D	*31

RMC sentence defined

Field	Content
RMC	Recommended Minimum Sentence C
hhmmss.ss	UTC time of position
a	Position status (A = Active V = Void)
ddmm.mmmmmmm	Latitude of position
b	Latitude direction (N or S)
dddmm.mmmmmmm	Longitude of position
c	Longitude direction (E or W)
dd.ddd	Speed over the ground, knots
eee.e	Course over ground, degrees True
ddmmyy	Current date
fff.f	Magnetic variation, degrees
g	Magnetic variation direction E/W Easterly variation (E) subtracts from True course. Westerly variation (W) add to True course.
h	Mode indicator (A = Autonomous, D = Differential, E = Estimated (dead reckoning), M = Manual input, N = Data not valid)
*hh	Checksum

6.6.11 HDT sentences

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

HDT sentence structure & example

```
$GNHDT, dd.dddd, T hh
$GNHDT, 75.5664, T *36
```

HDT sentence defined

Field	Content
HDT	Heading (true) message
dd.dddd	Heading in degrees
T	Degrees True
*hh	Checksum

6.6.12 INHDT sentences

The NMEA INHDT sentence provides an NMEA HDT log based on any active INS solution

INHDT sentence structure & example

```
$INHDT,  dd.dddd,   T  hh
$INHDT,  292.5276,  T  *36
```

INHDT sentence defined

Field	Content
INHDT	Heading (true) message
dd.dddd	Heading in degrees
T	Degrees True
*hh	Checksum

6.6.13 TRINAV sentences (V3 & V4)

TRINAV version 3 sentence example

[WGPOS,3,1,OEM7VERI,APEX5,OM7MR0702AN0006,1041,392609.00,0.0,57 12.08207N,002 11.53782W,114.421,0.7,1.2,,0.005948,0.000899,0.004640,0.030111,0.14,3,1,3,16,0,1,8,10,11,14,20,2 2,27,28,32,65,66,67,73,81,82,]

TRINAV version 3 sentence defined

Field	Content	Unit	Notes
Start character	A6	[-]	$WGPOS
Format version	I	[-]	= 3 for this version
Nav. point no.	I	[-]	See comment 1
System name/version	A	[-]	Name + version of DGPS system. See comment 2
GPS week number	I	[-]	GPS week no. since April 6 2019
GPS time of fix	F10.2	[s]	Seconds into GPS week (GPS time).
Age of fix	F4.1	[s]	See comment 3
Latitude	A13	[dm]	dd mm.mmmmmN, space between D and M
Longitude	A14	[dm]	dd mm.mmmmmE, space between D and M
Height	F7.3	[m]	Antenna height above ellipsoid. See comment 4
HDOP	F5.1	[-]	Horizontal dilution of position
VDOP	F5.1	[-]	Vertical dilution of position
Unit variance	F9.3	[m2]	See comment 5
Variance latitude	F10.6	[m2]	See comment 5
Covariance lat/long	F10.6	[m2]	See comment 5
Variance longitude	F10.6	[m2]	See comment 5
Variance height	F10.6	[m2]	See comment 5
External reliability	F7.2	[m]	See comment 6
Fix status	I	[-]	See comment 7
Computation type	I	[-]	See comment 8
Correction type	I	[-]	See comment 9
No. of satellites (n)	I	[-]	No. of satellites used for this fix
No. of ref. stations (r)	I	[-]	No. of ref. stations used for fix. See comment 10
PRN’s of sats. used	I*n	[-]	Satellites used for this fix. Separated by commas
Ref. station idents	I*n	[-]	Ref. stations used for this fix. Separated by commas
End character	A1	[-]	Close string
CRLF	A2		

TRINAV version 3 definitions commentary

1. The "Nav point no." is a unique integer identifying the position. It should be manually entered into the software according to requests from Positioning Engineers. Alternatively, this should start from 1 and be incremented if several positions are output from the same system.
2. The system name should identify the system (or contractor) and software version (e.g. "SEADIFF 2.1" or "MFIX 1.2.3").
3. The "Age of fix" is the time of the first character of the data string being output to WesternGeco's positioning system minus the time of position.
4. WGS84 ellipsoid and datum must be used. The height must be antenna height above the WGS84 ellipsoid.
5. The variance and covariance terms are elements from the variance-covariance matrix of the position fix computation (un-scaled).
6. The external reliability is the maximum positional effect of an undetectable error in an observation. This quantity is related to the power of the test (the probability that the MDE would be detected) and the significance level used.
   1. The values recommended by UKOOA should be used (see UKOOA Guidelines for the use of Differential GPS in offshore surveying, Issue no. 1, Sept. 1994) i.e. a significance level of test 1% and the power of the test 80%.
   2. If values other than those given above are used, this must be explicitly stated by the contractor.
7. TRINAV V3 fix status codes:

Status code	Meaning
0	No or bad fix
1	Altitude aiding (Weighted height used in fix)
2	Altitude hold (2D fix)
3	3D fix
4	3D fix INS aided
5	INS only (dead reckoning)

8. TRINAV V3 computation type codes

Type code	Meaning
0	No corrections
1	Single frequency DGNSS
2	Dual frequency DGNSS
3	PPP (satellite orbit and clock corrections)
4	PPP-AR (ambiguity resolution) using phase bias information.
5	Other

9. TRINAV V3 source codes:

Type code	Meaning
L	L-band only, always followed by 1 (i.e. L1)
M	L-band multi-channel, followed by number of links tracked (e.g. M3)
I	Internet source, always followed by 0 (i.e. I0)
O	Other, always followed by 0 (i.e. O0)

10. "No. of ref. stations" gives the number of reference stations in use for this fix, not the number of stations available. This field must be set to 0 if the fix is not differential.

TRINAV version 4 sentence example

[WGPOS,4,1,OEM7VERI,APEX5,OM7MR0702AN0006,1041,396729.00,0.0,57 12.08195N,002 11.53806W,113.340,0.7,0.9,,0.285460,0.009316,0.156003,0.663714,1.33,3,2,G,R,1,0,0,0,1,M3,IOR,2 5E,AORW,18,2,G01,G03,G08,G10,G11,G14,G17,G18,G22,G28,G32,R02,R03,R09,R11,R17,R18,R19 ,777,706,]

TRINAV version 4 sentence defined

Field	Content	Unit	Notes
Start character	A6	[-]	$WGPOS
Format version	I	[-]	= 4 for this version
Nav. point no.	I	[-]	See comment 2
System	A	[-]	Application name and version, space separated e.g. Quantum 3.0.0.0
Service level	A	[-]	Highest enabled service permitted e.g. APEX Pro
Version	A	[-]	Firmware version as reported by the GNSS card e.g. OEM060700SN0062
GPS week number	I	[-]	GPS week no. since April 6 2019
GPS time of fix	F10.2	[s]	Seconds into GPS week (GPS Time).
Age of fix	F4.1	[s]	This field indicates the age of the solution as reported by the GNSS card, based on the time between receiving measurements and generating output.
Latitude	A13	[dm]	dd mm.mmmmmN, space between D and M
Longitude	A14	[dm]	ddd mm.mmmmmE, space between D and M
Height	F7.3	[m]	Antenna height above ellipsoid. See comment 3
HDOP	F5.1	[-]	Horizontal dilution of position
VDOP	F5.1	[-]	Vertical dilution of position
Unit variance	F9.3	[m2]	See comment 4
Variance latitude	F10.6	[m2]	See comment 4
Covariance lat/long	F10.6	[m2]	See comment 4
Variance longitude	F10.6	[m2]	See comment 4
Variance height	F10.6	[m2]	See comment 4
External reliability	F7.2	[m]	See comment 5
Fix status	I	[-]	See comment 6
Constellations in fix (c)	I	[-]	Number of constellations used in the computation
Identifiers of constellations	A*c	[-]	Constellation character based on RINEX format (G-GPS, R-GLONASS, E-Galileo, C-BeiDou, J-QZSS)
GNSS frequency	I	[-]	Number of GNSS frequencies used in the computation (i.e. single frequency, dual frequency, triple frequency)

Field	Content	Unit	Notes
PPP-AR	I	[-]	Phases biases used or not to perform ambiguity resolution. Value of 1 indicates a PPP-AR solution, 0 it is not.
Atmospheric corrections	I	[-]	Use of external atmospheric corrections in computation Value of 1 shows it has atmospheric correction applied, 0 it hasn't.
GNSS integrity/Authentication message	I	[-]	External information used as an integrity check on GNSS broadcast data. Value of 1 shows it has been used, 0 it hasn't.
Correction type	I	[-]	See comment 7
Correction source(s)	A2	[-]	See comment 8
Names of correction links	A*s	[-]	Link names providing corrections. Separated by commas
No. of SV's (n)	I	[-]	No. of GNSS satellites used for this fix
No. of ref. stations (r)	I	[-]	No. of ref. stations used for fix. Set to 0 for non-differential solutions
PRN's of SV's used	A*n	[-]	GNSS satellites used for this fix in RINEX format (G-GPS, R-GLONASS, E-Galileo, C-BeiDou, J-QZSS). Separated by commas (e.g. G01,R03)
Ref. station ID	I*r	[-]	Reference stations used for this fix. Separated by commas. Field(s) will not appear for non-differential solutions.
End character	A1	[-]	] (Close string)
CRLF	A2		

TRINAV version 4 definitions commentary

1. CSV formatting is provided as a guide and it is possible and expected that greater resolution will be output if required.
2. The "Nav point no." is a unique integer identifying the position. It should be manually entered into the software according to requests from Positioning Engineers. Alternatively, this should start from 1 and be incremented if several positions are output from the same system.
3. WGS84 ellipsoid and datum must be used. Must be antenna height above the WGS84 ellipsoid.
4. The variance and covariance terms are elements from the variance-covariance matrix of the position fix computation (un-scaled).
    1. Unit variance currently unavailable and will be a NULL field for the moment.
5. The external reliability is the maximum positional effect of an undetectable error in an observation. This quantity is related to the power of the test (the probability that the MDE would be detected) and the significance level used.
    1. The values recommended by IMCA/OGP should be used (see IMCA/OGP Guidelines for GNSS positioning in the oil & gas industry Report No. 373-19 or IMCA S015, June 2011) i.e. a Significance level of test 1% and the Power of the test 80%.
    2. If values other than those given above are used, this must be explicitly stated by the contractor.

3. Veripos statistics are implemented as per the IMCA/OGP 'Guidelines for GNSS positioning in the oil & gas industry' Report No. 373-19 or IMCA S015, June 2011, unless otherwise indicated.

6. TRINAV V4 fix status codes:

Status code	Meaning
0	No or bad fix
1	Altitude aiding (weighted height used in fix)
2	Altitude hold (2D fix)
3	3D fix
4	3D fix INS aided
5	INS only (dead reckoning)

1. TRINAV V4 computation type codes:

Type code	Meaning
0	No corrections
1	Single frequency DGNSS
2	Dual frequency DGNSS
3	PPP (satellite orbit and clock corrections)
4	PPP-AR (ambiguity resolution) using phase bias information.
5	Other

2. TRINAV V4 correction source codes:

Type code	Meaning
L	L-band only, always followed by 1 (i.e. L1)
M	L-band multi-channel, followed by number of links tracked (e.g. M3)
I	Internet source, always followed by 0 (i.e. I0)
O	Other, always followed by 0 (i.e. O0)

6.6.14 Veripos UKOOA sentence

The Veripos UKOOA sentence is compliant with **OGP 373-19** and **IMCA S015 (July 2011)**. For further information relating to these standards please visit https://www.iogp.org and https://www.imca-int.com.

Veripos UKOOA sentence structure & example

[240 7300 VERI 1 2067 295238.0 +0.1 +8.0 057 12.08207N 002 11.53776W 63.997 +50.40 1.151 0.564 1.004 7 0.025 0.054 0.14 0.001 0.000 0.000 0.003 0.06 0.05 6.5 P 15{ 20 27 13 30 26 8 21 16 7 10 15 85 77 75 86} 1{ 481}]

Veripos UKOOA sentence defined

Field	Content	Notes
Field	Content	Notes
1	Start Character	Open string
2…5	Length of Message	Number of characters
6…10	Software Version	
11…16	System Name	
17…18	Record Identifier	Shows the calculation used, as different calculations can be labelled: 1, 2, 3 etc
19…23	GPS Week Number	Since Jan 6th 1980
24…32	GPS Time of Fix	Seconds into current GPS Week
33…37	Age of Record	Time (in seconds) of the first character of the data string being output, minus the time of position.
38…43	Latency	Latency in seconds
44…56	Latitude	Latitude displayed with spaces, dd mm.mmmmm’
57	Latitude Hemisphere Indicator	N or S
58…71	Longitude	Longitude displayed with spaces, dddmm.mmmmm’
72	Longitude Hemisphere Indicator	E or W
73…79	Altitude above MSL	Antenna height (in metres) above mean sea level (datum for height calculations)
80…87	Geoid Separation	Separation between mean sea level and the WGS84 reference ellipsoid (in metres), based on a Geoid model as for example EGM96.
88…94	PDOP	
95…101	HDOP	
102…108	VDOP	

Field	Content	Notes
109…110	Fix Status	Single Frequency
0 = None or Bad Fixes	4 = None or Bad Fixes	0 = None or Bad Fixes
1 = Altitude Aiding (weighted height)	5 = Altitude Aiding (weighted height)	1 = Altitude Aiding (weighted height)
2 = Altitude hold (2D Fix)	6 = Altitude hold (2D Fix)	2 = Altitude hold (2D Fix)
3 = 3D Fix	7 = 3D Fix	3 = 3D Fix
111…117	Internal Reliability	Smallest outlier (in metres) that is likely to be detected by the current solution.
118…125	External Reliability	Maximum positional effect (in metres) of an undetectable error in an observation. This quantity is related to the Power of the test (probability that the MDE would be detected) and the Significance level used.
126…130	Unit Variance	The Variance and Covariance terms are elements from the variance-covariance matrix of the position fix computation (un-scaled) in metres².
131…137	Variance Latitude	
138…145	Covariance Lat/Long	
146…152	Variance Longitude	
153…159	Variance Height	
160…165	95% Error Ellipse Semi Major Axis	Shows 95% confidence level of the semi-major axis of the error ellipse in metres.
166…171	95% Error Ellipse Semi Minor Axis	Shows 95% confidence level of the semi-minor axis of the error ellipse in metres.
172…177	Orientation Of Semi Major Axis of Error	Orientation of the semi major axis (degrees from true North)
178…179	F Test	A test applied to the Unit Variance. (P=Pass, F=Fail). A “Fail” may result from large outliers in the measurements.
180…182	No of Satellites used in the Fix (n)	

Field	Content	Notes
Variable	Satellite PRN Numbers of Satellites used in Fix	PRN numbers are space separated
Variable	Number of Reference Stations used for this Fix (00 – 99)	
Variable	Ids of the Reference Stations used in the Fix	Station ID numbers are space separated
	End of Character	Close string
	Carriage Return	
	Line Feed	

6.6.15 BESTPOS / BESTGPSPOS sentences

BESTPOS / BESTGPSPOS sentences contain time and position fix-related data for a GPS system and include basic quality information, limited to ‘Fix Quality’, ‘Number of Satellites in Use’, ‘HDOP’ and ‘Age of Corrections’.

BESTPOS / BESTGPSPOS sentences structure & example

#BESTPOSA,USB1,0,58.5,FINESTEERING,2209,502061.000,02000020,cdba,16809;SOL_COMPUTED,PPP,51.15043706870,-114.03067882331,1097.3462,-17.0001,WGS84,0.0154,0.0139,0.0288,"TSTR",11.000,0.000,43,39,39,38,00,00,7f,37*52483ac5

BESTPOS / BESTGPSPOS sentences defined

Field	Content
1. Log header	BESTPOS header
2. sol stat	Solution status
3. pos type	Position type
4. lat	Latitude (degrees)
5. lon	Longitude (degrees)
6. hgt	Height above mean sea level (metres)
7. undulation	Undulation - the relationship between the geoid and the ellipsoid (m) of the chosen datum
8. datum id#	Datum ID number 61 = WGS84 63 = USER
9. lat σ	Latitude standard deviation (m)
10. lon σ	Longitude standard deviation (m)
11. hgt σ	Height standard deviation (m)
12. stn id	Base station ID
13. diff_age	Differential age in seconds
14. sol_age	Solution age in seconds
15. #SVs	Number of satellites tracked
16. #solnSVs	Number of satellites used in solution
17. #solnL1SVs	Number of satellites with L1/E1/B1 signals used in solution
18. #solnMultiSVs	Number of satellites with multi-frequency signals used in solution
19. Reserved	
20.ext sol stat	Extended solution status
21. Galileo and BeiDou sig mask	Galileo and BeiDou signals used mask
22. GPS and GLONASS sig mask	GPS and GLONASS signals used mask

Field	Content
23. xxxx	32-bit CRC (ASCII and Binary only)
24. [CR][LF]	Sentence terminator (ASCII only)

6.6.16 INSPVA sentence

The INSPVA sentence allows INS position, velocity and attitude, with respect to the SPAN frame, to be collected in one log, instead of using three separate logs.

INSPVA sentence structure & example

#INSPVAA,COM1,0,31.0,FINESTEERING,1264,144088.000,02040000,5615,1541;1264,144088.002284950, 51.116827527,-114.037738908,401.191547167,354.846489850,108.429407241,-10.837482850,1.116219952, -3.476059035,7.372686190,INS_ALIGNMENT_COMPLETE*af719fd9

INSPVA sentence defined

Field	Content	Notes
1	INSPVA Header	Header terminates with a semi colon ';'
2	Week	GNSS week
3	Seconds	Seconds from week start
4	Latitude	Latitude in decimal degrees
5	Longitude	Longitude in decimal degrees
6	Height	Ellipsoidal height in meters
7	North velocity	Velocity in a northerly direction in metres per second (-ve = southerly direction)
8	East velocity	Velocity in an easterly direction in metres per second (-ve = westerly direction)
9	Up velocity	Velocity in an up direction in metres per second
10	Roll	Right-handed rotation from local level around y-axis in degrees
11	Pitch	Right-handed rotation from local level around x-axis in degrees
12	Azimuth	Left-handed rotation around z-axis in degrees clockwise from north This is the inertial azimuth calculated from the IMU gyros and INS filters.
13	Status	INS status. See below INS status table
14	xxxx	32-bit CRC (ASCII, binary and short binary only)
15	[CR][LF]	Sentence terminator

INSPVA sentence – INS status

Status	Notes
INS_INACTIVE	IMU logs are present, but the alignment routine has not started; INS is inactive.
INS_ALIGNING	INS is in alignment mode.
INS_HIGH_VARIANCE	While valid, the INS solution contains outliers. GNSS may be absent or poor.
INS_SOLUTION_GOOD	INS filter is in navigation mode and the INS solution is good.
INS_SOLUTION_FREE	INS filter is in navigation mode and a GNSS solution error is suspected.

Status	Notes
	Inertial filter rejected the GNSS position and is waiting for the solution quality to improve.
INS_ALIGNMENT_ COMPLETE	INS filter is in navigation mode but has not yet determined orientation.
DETERMINING_ ORIENTATION	INS is determining the IMU axis aligned with gravity.
WAITING_INITIALPOS	IMU orientation determined by INS filter. Awaiting initial position estimate.
WAITING_AZIMUTH	Initial position estimated by INS filter. Awaiting initial azimuth.
INITIALIZING_BIASES	INS filter is estimating initial biases during the first 10 seconds of stationary data.
MOTION_DETECT	INS filter has not completely aligned, but has detected motion.
WAITING_ ALIGNMENTORIENTATION	INS filter awaiting alignment based on orientation and roll and pitch estimates.

6.6.17 TSS1 sentence

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

TSS1 sentence structure & example

```
:XX, AAAA T M HHHH Q M RRRR S M PPPP
:00, FFCA   - 0003   F - 0325       0319
```

TSS1 sentence defined

Field	Content
:	TSS1 header
XX	Horizontal acceleration (from 0 to 9.81 m/s2)
AAAA	Vertical acceleration (from -20.48 to +20.48 m/s2)
S	A space delimiter
M	Heave polarity (space if positive, minus if negative)
HHHH	Heave value (from -99.99 to +99.99 m)
Q	Status flag (H if alignment not complete, F if INS active)
M	Roll polarity (space if positive)
RRRR	Roll value (from -99.99 to +99.99 degrees)
S	Space delimiter
M	Pitch polarity
PPPP	Pitch

6.6.18 HEAVE sentence

The HEAVE sentence allows INS position, velocity and attitude, with respect to the SPAN frame, to be collected in one log, instead of using three separate logs.

HEAVE sentence example

#HEAVEA,USB1,0,38.5,FINESTEERING,1630,232064.599,02000000,a759,6696;1630,232064.589885392,0.086825199*93392cb4

HEAVE sentence defined

Field	Notes
HEAVE Header	Heave computed by integrated heave filter. Header is terminated by a semicolon ';'
Week	GNSS week
Seconds into week	Seconds from week start
Heave	Instantaneous heave in meters
xxxx	32-bit CRC (ASCII, Binary and Short Binary only)
[CR][LF]	Sentence Terminator

6.6.19 PASHR sentence

The PASHR sentence uses a UTC time, calculated with default parameters, to output NMEA messages without waiting for a valid almanac. The UTC time status is set to WARNING since it may not be 100% accurate. When a valid almanac is available, the receiver uses the real parameters and sets the UTC time to VALID. The PASHR log contains only INS derived attitude information and is only filled when an inertial solution is available.

PASHR sentence structure & example

```
$PASHR,    hhmmss.ss,  aaa.aa,  T  b.bb,  c.cc,   d.dd,   e.eee,  f.fff,    g.gggg,  h,  i,   *hh
$PASHR,    123816.80,  312.95,  T  -083,  -0.41,  +0.01,  0.234,   0.224,   0.298,   2,  1,  *2B
```

PASHR sentence defined

Field	Content
PASHR	INS attitude
hhmmss.ss	UTC time
aaa.aa	Heading in decimal degrees
T	Degrees true
b	Roll in decimal degrees (±)
c	Pitch in decimal degrees (±)
d	Instantaneous heave in meters (±)
e	Roll standard deviation in decimal degrees
f	Pitch standard deviation in decimal degrees
g	Heading standard deviation in decimal degrees
h	GPS Update Quality indicator (0 = No position, 1 = All non-RTK fixed integer positions, 2 = RTK fixed integer position)
i	INS status indicator (0 = All SPAN pre-alignment INS status, 1 = All SPAN post-alignment INS status)
*hh	Checksum
[CR][LF]	Sentence terminator

7 Contact information

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

7.1 Veripos Support details

Veripos Support website	https://veripos.com/support
Veripos Support telephone	+44 1224 965900
Veripos Support e-mail	support.veripos@hexagon.com

8 Appendix

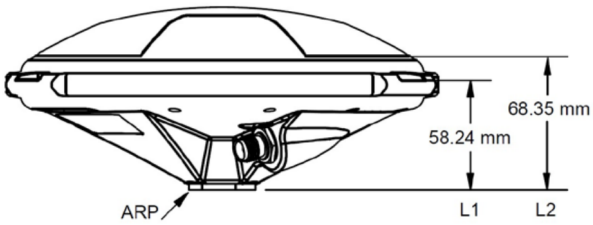
8.1 Summary specification of antennas

8.1.1 Veripos V560 combined GNSS & L-band antenna

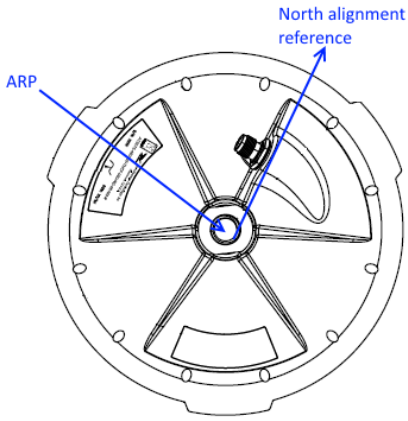
L-band/GPS/GLONASS:	1525-1610 MHz
GPS L2/GLONASS L2:	1160-1252 MHz
(complete with a narrow band filter for interference rejection)	
LNA Gain:	45db
DC Voltage input:	3.0 to 15.0V
RF Input Connector:	TNC female (note cable RF connector – TNC male)
Material:	Weather Proof Polymer Plastic
Mount:	5/8” Tripod Tread Connector
Temperature Range:	-55 to +85°C
Certification:	IEC 60945
Diameter:	7.5" / 19.05cm
Height:	3.17” / 8.05cm
Weight:	1.6lbs / 0.73kg

8.1.2 V560 phase centre offsets

The diagram on the left shows the antenna reference position (ARP) vertical offset from the GNSS L1 and L2 frequencies phase centres, and the diagram on the right shows ARP at the antenna base and the antenna North alignment reference:



V560 phase centre values above ARP



V560 ARP & North alignment reference

The table below details the North, East and Up phase centre values for GNSS L1 and L2 frequencies:

	Relative to Antenna Reference Point (ARP)		
GNSS Frequency	**North (mm)**	**East (mm)**	**Up (mm)**
L1	-0.34	-0.53	58.24
L2	0.11	-0.76	68.35

8.2 Summary specification of cabling

With the system Veripos typically provide pre-terminated cables and tails for use with both L-band and GNSS antennas (see the *Delivery note*). Veripos recommend use of Times Microwave coaxial LMR cable for installation of all antennas.

8.2.1 Times LMR-400 coaxial cable

8.2.1.1 Electrical specifications

Performance property	Units	US	(metric)
Attenuation @1.5GHz:			
30.77m (100ft.)	5.1dB		
100m	16.8dB		
Velocity of propagation	%	85	
Dielectric constant	N/A	1.38	
Time delay	nS/ft (nS/m)	1.20	(3.92)
Impedance		50	
Capacitance	pF/ft (pF/m)	23.9	(78.4)
Inductance	uH/ft (uH/m)	0.060	(0.20)
Shielding effectiveness	dB	>90	
DC resistance			
Inner conductor	/1000 ft (/km)	1.39	(4.6)
Outer conductor	/1000 ft (/km)	1.65	(5.4)
Voltage withstand	VDC	2500	
Jacket spark	Vrms	8000	
Peak power	kW	16	

8.2.1.2 Mechanical specifications

Performance property	Units	US	(metric)
Bend radius, installation	in. (mm)	1.00	(25.4)
Bend radius repeated	in. (mm)	4.0	(101.6)
Bending moment	ft-lb (N-m)	0.5	(0.68)
Weight	lb/ft (kg/m)	0.068	(0.10)
Tensile strength	lb (kg)	160	(72.6)
Flat plate crush	lb/in. (kg/mm)	40	(0.71)

8.2.1.3 Environmental specifications

Performance property	°F	°C
Installation temperature range	-40 to +185	-40 to +85
Storage temperature range	-94 to +185	-70 to +85
Operating temperature range	-40 to +1851	-40 to +85

8.2.2 Times LMR-240 coaxial cable

8.2.2.1 Electrical specifications

Performance property	Units	US	(metric)
Attenuation @1.5GHz:			
30.77m (100ft.)	9.9dB		
100m	32.4dB		
Velocity of propagation	%	84	
Dielectric constant	N/A	1.42	
Time delay	nS/ft (nS/m)	1.21	(3.97)
Impedance		50	
Capacitance	pF/ft (pF/m)	24.2	(79.4)
Inductance	uH/ft (uH/m)	0.060	(0.20)
Shielding effectiveness	dB	>90	
DC resistance			
Inner conductor	/1000 ft (/km)	3.2	(10.5)
Outer conductor	/1000 ft (/km)	3.89	(12.8)
Voltage withstand	VDC	1500	
Jacket spark	Vrms	5000	
Peak power	kW	5.6	

8.2.2.2 Mechanical specifications

Performance property	Units	US	(metric)
Bend radius, installation	in. (mm)	0.75	(19.1)
Bend radius repeated	in. (mm)	2.5	(63.5)
Bending moment	ft-lb (N-m)	0.25	(0.34)
Weight	lb/ft (kg/m)	0.034	(0.05)
Tensile strength	lb (kg)	80	(36.3)
Flat plate crush	lb/in. (kg/mm)	20	(0.36)

8.2.2.3 Environmental specifications

Performance property	°F	°C
Installation temperature range	-40 to +185	-40 to +85
Storage temperature range	-94 to +185	-70 to +85
Operating temperature range	-40 to +185	-40 to +85

8.3 Configuration and settings log

8.3.1 Configuration > Positioning

Configuration* > *Positioning* > GNSS1 Mode > *Edit

Mode:	☐ APEX ☐ ULTRA ☐ Auto

Configuration* > *Positioning* > GNSS2 Mode > *Edit

Mode:	☐ APEX ☐ ULTRA ☐ Auto

Configuration* > *Positioning* > NMEA Config > *Edit

GGA Precision:	☐ 5 ☐ 6 ☐ 7 ☐ 8
PPP DQI:	☐ 2 ☐ 5
Talker:	☐ Auto ☐ GP

Configuration* > *Positioning* > TRINAV Config > *Edit

Version:	☐ V3 ☐ V4
Nav Point:	

Configuration* > *Positioning* > RAIM > *Edit

RAIM:	☐ Enabled ☐ Disabled

8.3.2 Configuration > Corrections

Configuration* > *Corrections* > VERIPOS LBAND > *Edit

L-band Beam: ☐ AUTO ☐ 25E ☐ IOR ☐ 143.5E ☐ 98W ☐ AORW
☐ User: [ ] MHz

HDR Mode: ☐ Off
☐ On

Configuration* > *Corrections* > GNSS1 > *Edit

L-band Beam: ☐ AUTO ☐ 25E ☐ IOR ☐ 143.5E ☐ 98W ☐ AORW
☐ User: [ ] MHz

HDR Mode: ☐ Off
☐ On

Configuration* > *Corrections* > MF > *Edit

MF Mode: ☐ Off
☐ Auto
☐ Manual

Configuration* > *Positioning* > SBAS > *Edit

SBAS Mode: ☐ Off
☐ Auto

Configuration* > *Positioning* > RTK > *Edit

RTK Source: ☐ Off
☐ Auto

Configuration* > *Positioning* > NTRIP > *Edit

NTRIP Mode: ☐ Off
☐ Auto

8.3.3 Configuration > GNSS

Configuration* > *GNSS* > Elevation Mask > *Edit

Elevation Mask:	°

Configuration* > *GNSS* > PPS > *Edit

PPS:	☐ Positive ☐ Negative ☐ Off

Configuration* > *GNSS* > PPS Pulse Width > *Edit

PPS Pulse Width:	ms

Configuration* > *GNSS* > Interference Detection > *Edit

Interference Detection:	☐ Disabled ☐ Enabled

Configuration* > *GNSS* > Signal Tracking > *Edit

	Tick only if Disabled
GPS:	☐ L5
GLONASS :	☐ GLONASS ☐ L2 ☐ L3
GALILEO:	☐ GALILEO ☐ E5A ☐ E5B ☐ E6
BEIDOU:	☐ BEIDOU ☐ B2A ☐ B2B ☐ B3

8.3.4 Configuration > Ports

***Configuration* > *Ports* > Serial > COM1**

Baud Rate:
- ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200
- ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings:

Protocol:
- ☐ RS232
- ☐ RS422

Data Bits:
- ☐ 7
- ☐ 8

Parity:
- ☐ N
- ☐ E
- ☐ O

Stop Bits:
- ☐ 1
- ☐ 2

Interface Type:
- ☐ None
- ☐ Input:
  - ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3
  - ☐ CMR ☐ IOLAN ☐ NOVATELX
- ☐ Output:
  - ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT
  - ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT
- ☐ UKOOA
- ☐ TRINAV
- ☐ VRTCM
- ☐ INS:
  - ☐ INSPVA ☐ HEAVE ☐ TSS1
  - ☐ STDEV ☐ SHEAVE ☐ DHEAVE
- ☐ Others:
  - ☐ BESTPOS
  - ☐ BESTGPSPOS

***Configuration* > *Ports* > Serial > COM2**

Baud Rate:
- ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200
- ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings:

Protocol:
- ☐ RS232
- ☐ RS422

Data Bits:
- ☐ 7
- ☐ 8

Parity:
- ☐ N
- ☐ E
- ☐ O

Stop Bits:
- ☐ 1
- ☐ 2

Interface Type:
- ☐ None
- ☐ Input:
  - ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3
  - ☐ CMR ☐ IOLAN ☐ NOVATELX
- ☐ Output:
  - ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT
  - ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT
- ☐ UKOOA
- ☐ TRINAV
- ☐ VRTCM
- ☐ INS:
  - ☐ INSPVA ☐ HEAVE ☐ TSS1
  - ☐ STDEV ☐ SHEAVE ☐ DHEAVE
- ☐ Others:
  - ☐ BESTPOS
  - ☐ BESTGPSPOS

***Configuration* > *Ports* > Serial > COM3**

Baud Rate:
- ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200
- ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings:

Protocol:
- ☐ RS232
- ☐ RS422

Data Bits:
- ☐ 7
- ☐ 8

Parity:
- ☐ N
- ☐ E
- ☐ O

Stop Bits:
- ☐ 1
- ☐ 2

Interface Type:
- ☐ None
- ☐ Input:
  - ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3
  - ☐ CMR ☐ IOLAN ☐ NOVATELX
- ☐ Output:
  - ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT
  - ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT
- ☐ UKOOA
- ☐ TRINAV
- ☐ VRTCM
- ☐ INS:
  - ☐ INSPVA ☐ HEAVE ☐ TSS1
  - ☐ STDEV ☐ SHEAVE ☐ DHEAVE
- ☐ Others:
  - ☐ BESTPOS
  - ☐ BESTGPSPOS

***Configuration* > *Ports* > Serial > COM4**

Baud Rate: ☐ 1200 ☐ 19200 ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings: Protocol: ☐ RS232 ☐ RS422

Interface Type: ☐ None

☐ Output: ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT ☐ GSA ☐ GSV ☐ GRS ☐ RMC

***Configuration* > *Ports* > Serial > COM5**

Baud Rate: ☐ 1200 ☐ 19200 ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings: Protocol: ☐ RS232 ☐ RS422

Interface Type: ☐ None

☐ Output: ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT ☐ GSA ☐ GSV ☐ GRS ☐ RMC

***Configuration* > *Ports* > Serial > COM6**

Additional Settings: Protocol: ☐ RS232 ☐ RS422

Interface Type: ☐ None

☐ Input: ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3 ☐ CMR ☐ IOLAN ☐ NOVATELX

8.3.5 Configuration > Ports

***Configuration* > *Ports* > P1 (only available if Moxa serial expansion unit in use)**

Baud Rate:
- ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200
- ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings:

Protocol:
- ☐ RS232
- ☐ RS422

Data Bits:
- ☐ 7
- ☐ 8

Parity:
- ☐ N
- ☐ E
- ☐ O

Stop Bits:
- ☐ 1
- ☐ 2

Interface Type:
- ☐ None
- ☐ Input:
  - ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3
  - ☐ CMR ☐ IOLAN ☐ NOVATELX
- ☐ Output:
  - ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT
  - ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT
- ☐ UKOOA
- ☐ TRINAV
- ☐ VRTCM
- ☐ INS:
  - ☐ INSPVA ☐ HEAVE ☐ TSS1
  - ☐ STDEV ☐ SHEAVE ☐ DHEAVE
- ☐ Others:
  - ☐ BESTPOS
  - ☐ BESTGPSPOS

***Configuration* > *Ports* > P2 (only available if Moxa serial expansion unit in use)**

Baud Rate:
- ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200
- ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings:

Protocol:
- ☐ RS232
- ☐ RS422

Data Bits:
- ☐ 7
- ☐ 8

Parity:
- ☐ N
- ☐ E
- ☐ O

Stop Bits:
- ☐ 1
- ☐ 2

Interface Type:
- ☐ None
- ☐ Input:
  - ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3
  - ☐ CMR ☐ IOLAN ☐ NOVATELX
- ☐ Output:
  - ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT
  - ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT
- ☐ UKOOA
- ☐ TRINAV
- ☐ VRTCM
- ☐ INS:
  - ☐ INSPVA ☐ HEAVE ☐ TSS1
  - ☐ STDEV ☐ SHEAVE ☐ DHEAVE
- ☐ Others:
  - ☐ BESTPOS
  - ☐ BESTGPSPOS

***Configuration* > *Ports* > P3 (only available if Moxa serial expansion unit in use)**

Baud Rate:
- ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200
- ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings:

Protocol:
- ☐ RS232
- ☐ RS422

Data Bits:
- ☐ 7
- ☐ 8

Parity:
- ☐ N
- ☐ E
- ☐ O

Stop Bits:
- ☐ 1
- ☐ 2

Interface Type:
- ☐ None
- ☐ Input:
  - ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3
  - ☐ CMR ☐ IOLAN ☐ NOVATELX
- ☐ Output:
  - ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT
  - ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT
- ☐ UKOOA
- ☐ TRINAV
- ☐ VRTCM
- ☐ INS:
  - ☐ INSPVA ☐ HEAVE ☐ TSS1
  - ☐ STDEV ☐ SHEAVE ☐ DHEAVE
- ☐ Others:
  - ☐ BESTPOS
  - ☐ BESTGPSPOS

***Configuration* > *Ports* > P4 (only available if Moxa serial expansion unit in use)**

Baud Rate:
- ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200
- ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings:

Protocol:
- ☐ RS232
- ☐ RS422

Data Bits:
- ☐ 7
- ☐ 8

Parity:
- ☐ N
- ☐ E
- ☐ O

Stop Bits:
- ☐ 1
- ☐ 2

Interface Type:
- ☐ None
- ☐ Input:
  - ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3
  - ☐ CMR ☐ IOLAN ☐ NOVATELX
- ☐ Output:
  - ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT
  - ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT
- ☐ UKOOA
- ☐ TRINAV
- ☐ VRTCM
- ☐ INS:
  - ☐ INSPVA ☐ HEAVE ☐ TSS1
  - ☐ STDEV ☐ SHEAVE ☐ DHEAVE
- ☐ Others:
  - ☐ BESTPOS
  - ☐ BESTGPSPOS

***Configuration* > *Ports* > P5 (only available if Moxa serial expansion unit in use)**

Baud Rate:
- ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200
- ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings:

Protocol:
- ☐ RS232
- ☐ RS422

Data Bits:
- ☐ 7
- ☐ 8

Parity:
- ☐ N
- ☐ E
- ☐ O

Stop Bits:
- ☐ 1
- ☐ 2

Interface Type:
- ☐ None
- ☐ Input:
  - ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3
  - ☐ CMR ☐ IOLAN ☐ NOVATELX
- ☐ Output:
  - ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT
  - ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT
- ☐ UKOOA
- ☐ TRINAV
- ☐ VRTCM
- ☐ INS:
  - ☐ INSPVA ☐ HEAVE ☐ TSS1
  - ☐ STDEV ☐ SHEAVE ☐ DHEAVE
- ☐ Others:
  - ☐ BESTPOS
  - ☐ BESTGPSPOS

***Configuration* > *Ports* > P6 (only available if Moxa serial expansion unit in use)**

Baud Rate:
- ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200
- ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings:

Protocol:
- ☐ RS232
- ☐ RS422

Data Bits:
- ☐ 7
- ☐ 8

Parity:
- ☐ N
- ☐ E
- ☐ O

Stop Bits:
- ☐ 1
- ☐ 2

Interface Type:
- ☐ None
- ☐ Input:
  - ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3
  - ☐ CMR ☐ IOLAN ☐ NOVATELX
- ☐ Output:
  - ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT
  - ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT
- ☐ UKOOA
- ☐ TRINAV
- ☐ VRTCM
- ☐ INS:
  - ☐ INSPVA ☐ HEAVE ☐ TSS1
  - ☐ STDEV ☐ SHEAVE ☐ DHEAVE
- ☐ Others:
  - ☐ BESTPOS
  - ☐ BESTGPSPOS

***Configuration* > *Ports* > P7 (only available if Moxa serial expansion unit in use)**

Baud Rate:
- ☐ 1200 ☐ 2400 ☐ 4800 ☐ 9600 ☐ 19200
- ☐ 38400 ☐ 57600 ☐ 115200 ☐ 230400 ☐ 460800

Additional Settings:

Protocol:
- ☐ RS232
- ☐ RS422

Data Bits:
- ☐ 7
- ☐ 8

Parity:
- ☐ N
- ☐ E
- ☐ O

Stop Bits:
- ☐ 1
- ☐ 2

Interface Type:
- ☐ None
- ☐ Input:
  - ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3
  - ☐ CMR ☐ IOLAN ☐ NOVATELX
- ☐ Output:
  - ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT
  - ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT
- ☐ UKOOA
- ☐ TRINAV
- ☐ VRTCM
- ☐ INS:
  - ☐ INSPVA ☐ HEAVE ☐ TSS1
  - ☐ STDEV ☐ SHEAVE ☐ DHEAVE
- ☐ Others:
  - ☐ BESTPOS
  - ☐ BESTGPSPOS

***Configuration* > *Ports* > Network> ICOM1 (not available if Moxa serial expansion unit in use)**

☐ None

☐ Input:

Port: ☐

Protocol: ☐ UDP ☐ TCP

End Point: ☐

Type: ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3 ☐ CMR ☐ IOLAN ☐ NOVATELX

☐ Output:

Port: ☐

Protocol: ☐ TCP ☐ UDP

Type:

☐ NMEA: ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT

☐ UKOOA

☐ TRINAV

☐ VRTCM

☐ INS

☐ Others: ☐ BESTPOS ☐ BESTGPSPOS

***Configuration* > *Ports* > Network> ICOM2 (not available if Moxa serial expansion unit in use)**

☐ None

☐ Input:

Port: ☐

Protocol: ☐ UDP ☐ TCP

End Point: ☐

Type: ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3 ☐ CMR ☐ IOLAN ☐ NOVATELX

☐ Output:

Port: ☐

Protocol: ☐ TCP ☐ UDP

Type:

☐ NMEA: ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT

☐ UKOOA

☐ TRINAV

☐ VRTCM

☐ INS

☐ Others: ☐ BESTPOS ☐ BESTGPSPOS

***Configuration* > *Ports* > Network> ICOM3 (not available if Moxa serial expansion unit in use)**

☐ None

☐ Input:

Port: ☐

Protocol: ☐ UDP ☐ TCP

End Point: ☐

Type: ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3 ☐ CMR ☐ IOLAN ☐ NOVATELX

☐ Output:

Port: ☐

Protocol: ☐ TCP ☐ UDP

Type:

☐ NMEA: ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT

☐ UKOOA

☐ TRINAV

☐ VRTCM

☐ INS

☐ Others: ☐ BESTPOS ☐ BESTGPSPOS

***Configuration* > *Ports* > Network> ICOM4 (not available if Moxa serial expansion unit in use)**

☐ None

☐ Input:

Port: [ ]

Protocol: ☐ UDP ☐ TCP

End Point: [ ]

Type: ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3 ☐ CMR ☐ IOLAN ☐ NOVATELX

☐ Output:

Port: [ ]

Protocol: ☐ TCP ☐ UDP

Type:

☐ NMEA: ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT

☐ UKOOA

☐ TRINAV

☐ VRTCM

☐ INS

☐ Others: ☐ BESTPOS ☐ BESTGPSPOS

***Configuration* > *Ports* > Network> ICOM5 (not available if Moxa serial expansion unit in use)**

☐ None

☐ Input:

Port: ☐

Protocol: ☐ UDP ☐ TCP

End Point: ☐

Type: ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3 ☐ CMR ☐ IOLAN ☐ NOVATELX

☐ Output:

Port: ☐

Protocol: ☐ TCP ☐ UDP

Type:

☐ NMEA: ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT

☐ UKOOA

☐ TRINAV

☐ VRTCM

☐ INS

☐ Others: ☐ BESTPOS ☐ BESTGPSPOS

***Configuration* > *Ports* > Network> ICOM6 (not available if Moxa serial expansion unit in use)**

☐ None

☐ Input:

Port: [ ]

Protocol: ☐ UDP ☐ TCP

End Point: [ ]

Type: ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3 ☐ CMR ☐ IOLAN ☐ NOVATELX

☐ Output:

Port: [ ]

Protocol: ☐ TCP ☐ UDP

Type:

☐ NMEA: ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT

☐ UKOOA

☐ TRINAV

☐ VRTCM

☐ INS

☐ Others: ☐ BESTPOS ☐ BESTGPSPOS

8.3.6 Configuration > Ports

***Configuration* > *Ports* > Network> ICOM7 (not available if Moxa serial expansion unit in use)**

☐ None

☐ Input:

Port: ☐

Protocol: ☐ UDP ☐ TCP

End Point: ☐

Type: ☐ VRTCM ☐ RTCMV2 ☐ RTCMV3 ☐ CMR ☐ IOLAN ☐ NOVATELX

☐ Output:

Port: ☐

Protocol: ☐ TCP ☐ UDP

Type:

☐ NMEA: ☐ GGA ☐ GLL ☐ VTG ☐ ZDA ☐ GST ☐ HDT ☐ GSA ☐ GSV ☐ GRS ☐ RMC ☐ PASHR ☐ INHDT

☐ UKOOA

☐ TRINAV

☐ VRTCM

☐ INS

☐ Others: ☐ BESTPOS ☐ BESTGPSPOS

8.3.7 Configuration > Heading

Configuration* > *Heading*> State > *Edit

State: ☐ Enabled ☐ Disabled

Configuration* > *Heading*> Heading Offset > *Edit

Heading Offset: ☐ °

8.3.8 Configuration > INS

Configuration* > *INS* > IMU Type > *Edit

IMU Type:
- ☐ None
- ☐ ISA-100C
- ☐ uIMU

Configuration* > *INS* > IMU Port > *Edit

IMU Port:
- ☐ COM1
- ☐ COM2
- ☐ COM3

Configuration* > *INS* > Installation Rotation > *Edit

Installation Rotation:

X:		m
Y:		m
Z:		m

Configuration* > *INS* > Antenna 1 Offset > *Edit

Antenna 1 Offset:

X:		m
Y:		m
Z:		m

Configuration* > *INS* > User Offset > *Edit

User Offset:

X:		m
Y:		m
Z:		m

Configuration* > *INS* > Heave Filter > *Edit

Heave Filter: secs

8.3.9 Receiver > Network

Receiver* > *Network* > LAN1 > *Edit

DHCP:
- ☐ On
- ☐ Off
  - IP Address: [ ]
  - Subnet Mask: [ ]
  - Gateway: [ ]
  - DNS: [ ]

Receiver* > *Network* > LAN2 > *Edit

DHCP:
- ☐ On
- ☐ Off
  - IP Address: [ ]
  - Subnet Mask: [ ]
  - Gateway: [ ]
  - Speed:
    - ☐ Auto
    - ☐ 10
    - ☐ 100

Receiver* > *Network* > PTP > *Edit

Mode:
- ☐ Off
- ☐ On
  - Time Scale:
    - ☐ PTP
    - ☐ NTP
  - Profile:
    - ☐ UDP
    - ☐ UDP P2P
    - ☐ ETH
    - ☐ ETH P2P
    - ☐ ITU - T

8.3.10 Receiver > Antenna Voltage

Receiver > Antenna Voltage* > GNSS Primary *> Edit

GNSS Primary:
- ☐ On
- ☐ Off

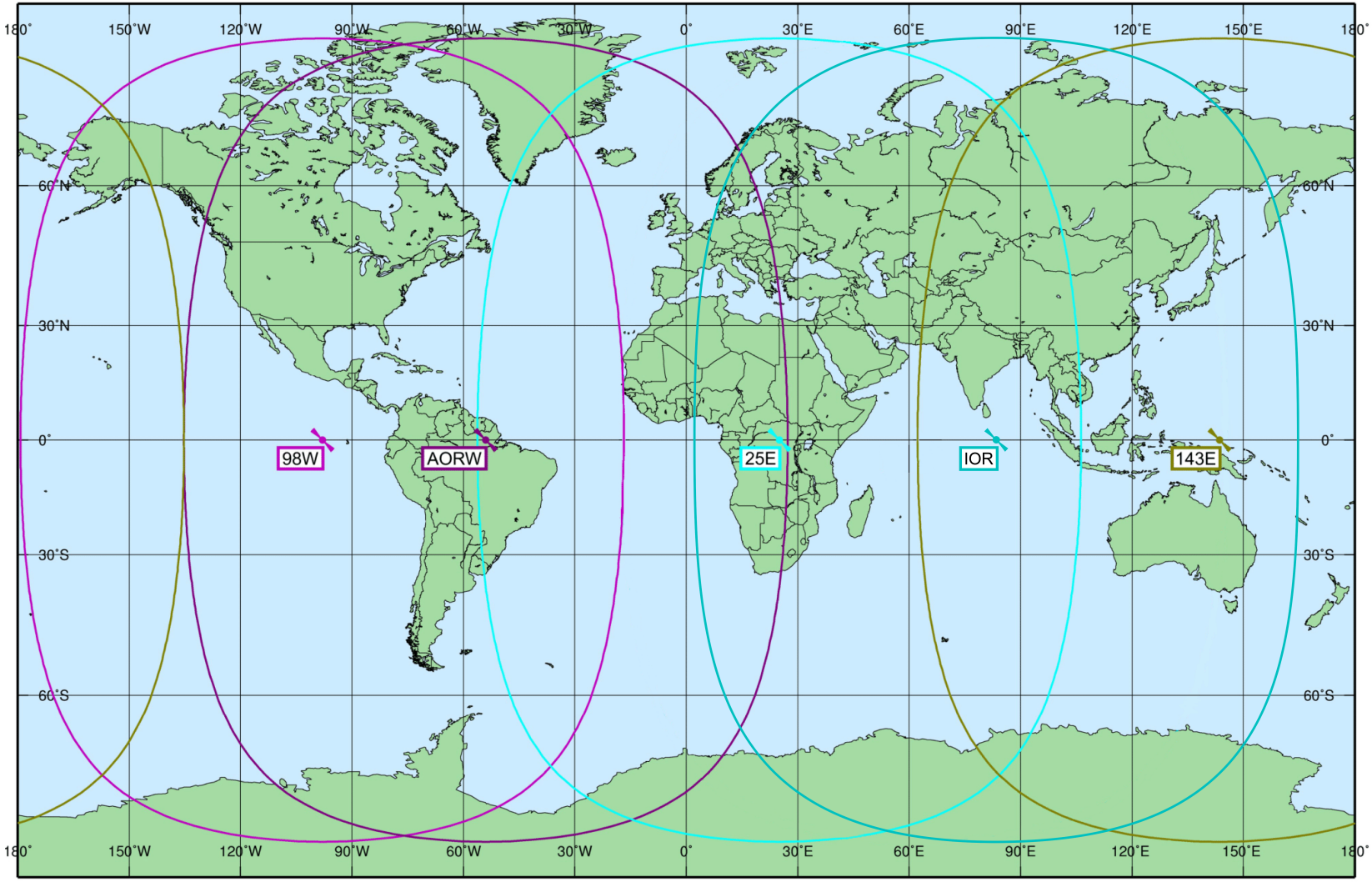
Receiver > Antenna Voltage* > GNSS Secondary *> Edit

GNSS Secondary:
- ☐ On
- ☐ Off

Receiver > Antenna Voltage* > L-band *> Edit

L-band:
- ☐ On
- ☐ Off

Receiver > Antenna Voltage* > GNSS Secondary *> Edit

MF:
- ☐ On
- ☐ Off

8.4 L-band coverage map