Orion User Manual

Version 2.0.2.74

VERIPOS

A2	03.10.2016	Renamed to relate to Orion v2.0.2.74 only	AR	RR	RR	-
A1	25.01.2016	Minor updates for Phase 8 compliance	AR	RR	RR	-
A	03.08.2015	Minor changes following review	AR	RR	RR	-
1	23.07.2015	For review	AR		-	-
REVISION	DATE	DESCRIPTION	ORIGINATOR	CHECKED	APPROVED	CLIENT APPR

Procedure Title:

Orion User Manual (Version 2.0.2.74)

	File Ref: AB-V-MA-00594

CONTENTS

1.1 INTRODUCTION

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

The VERIPOS receiver may optionally be equipped with on-board visualisation software called Orion which is optimised for DP operations. It can also be used with VERIPOS Integrated Mobile Units connected to the Orion software running on a PC and connected (using a LAN). This manual contains the information required to operate the Orion software when running on-board an LD6 IMU.

Orion is quality and position monitoring software that has been designed specifically for DP operators and navigation users who need to quickly and continuously assess the quality of their positioning. It shows key positioning parameters as well as overall solution status.

The display has a fixed format. The information displayed includes:

- Position and Correction Status information
- UTC Time
- Horizontal Error
- Latency
- Satellite Polar Plot
- PDOP and HDOP
- Night Mode access
- Constellation status
- Solution status
- Vessel heading
- Course
- Speed
- Track

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

Related documents:

LD6 Operations manual.

1.2 SOFTWARE PLATFORMS

Orion software can be used on Veripos LD6 Integrated Mobile Unit with a touch panel display or a PC Running Windows XP or Windows 7 and attached to a VERIPOS receiver (IMU).

This manual covers the use of Orion when running on-board LD6 (on software version 8.2.0.3 & below) only. For details on Orion on a PC or on higher LD6 software versins, please refer to Orion manual (AB-V-MA-00553).

1.3 SOFTWARE ACTIVATION

Orion must first be ENABLED in the receiver. Orion is an additional VERIPOS service. When contacting the Helpdesk for an enable code please specify that a DP service is required in addition to your GNSS augmentation service. (e.g. DP and Ultra Service.)

See the receiver Operations manual for details on enabling VERIPOS services with your receiver.

The VERIPOS Helpdesk contact details are available in *Appendix I.*

1.4 ORION ON VERIPOS LD6

The Orion software is typically provided pre – loaded on an LD6 and may use a touch screen display for viewing the Orion software suite.

Where Orion is required, first check you have a build of software on the LD6 which includes Orion.

The LD6 can be used in conjunction with a touchscreen monitor, using a VGA and USB (A) connection.

Note: When installing the monitor a USB mouse is required for screen calibration.

Attach the monitors VGA and a USB ports to the LD6 and power up.

Go to ***Home screen/ Actions/ Apps***. A "Launch Orion" button is shown when Orion software is installed on the LD6.

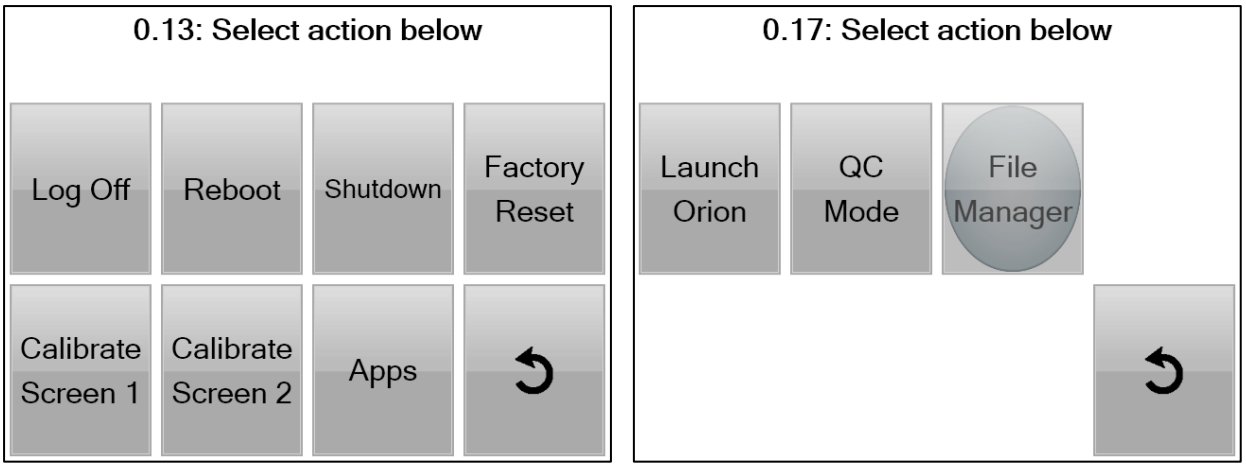
The VERIPOS Helpdesk can provide further information on a LD6 software build required for use with Orion.

Before using the software ensure the LD6 is enabled for a DP code and working with VERIPOS corrections. The LD6 Operations Quick Guide and Manual provide more information.

1.4.1 Launching Orion On-board LD6

Steps:

1. Power down and disconnect LD6 from the power supply.
2. Connect the touch screen provided to the VGA port and a USB A cable to a free USB port on the rear of the LD6.
3. Power up the LD6 and touch screen. Allow a few minutes for the LD6 to start.
4. Attach a USB mouse for use during screen configuration.
5. To Calibrate Screen 1 *(LD6 screen* - on the LD6 front panel, use the mouse to navigate to ***Home/ Actions*** and then ***Calibrate Screen 1****.* Follow the on-screen directions to touch the buttons with your finger to calibrate the LD6 screen (Screen 1).
6. Touch ***Calibrate Screen 2*** and wait until the display appears on the external touch screen monitor. Follow the on screen instructions and touch the four points as they appear on screen in turn to calibrate.
7. When the external screen calibration is completed, on the LD6 screen, touch through menu structure ***Actions/ Apps/ Launch Orion***.

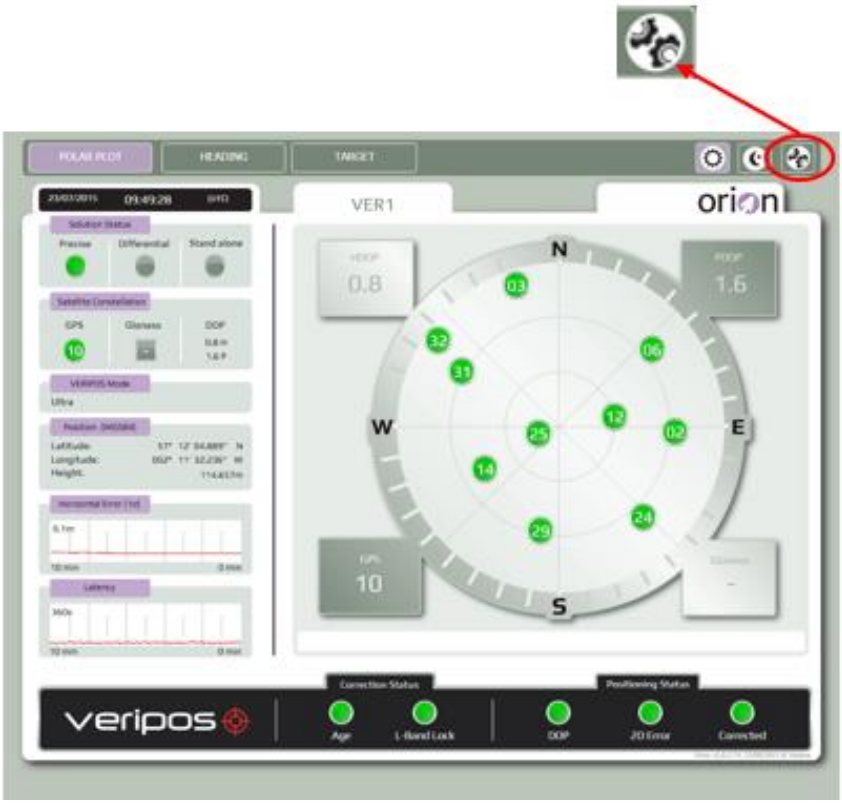


LD6 launch screen for Orion

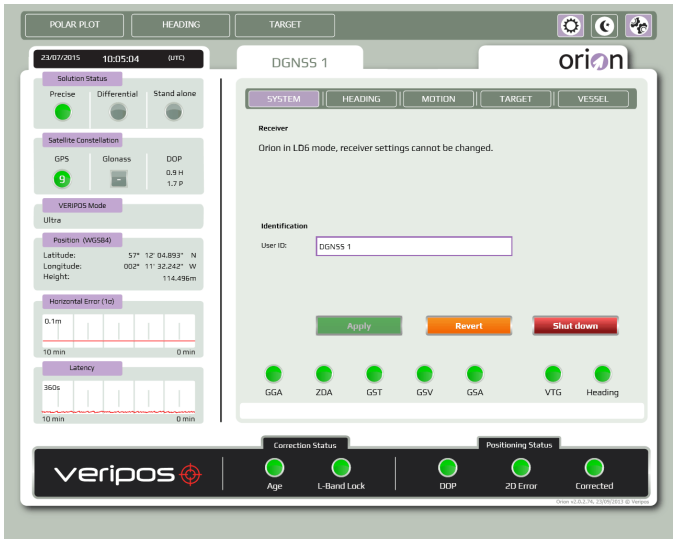
8. Wait until the Orion application launches and appears on the external screen, then touch the LD6 backup button to return to the LD6 *Home* screen.

1.5 ORION CONFIGURATION MENUS

The Orion software can be configured via the configuration icon shown below:



1.5.1 Configuration - System Tab



When running the Orion software on board an LD6, the required NMEA messages will be available automatically without the need for user configuration.

All NMEA message icons should be green to show that all required messages are being received by the Orion software:

The ***Heading*** icon will only be green if a gyro input has been manually configured. See section 1.5.2 for further details regarding configuration of heading data input.

In the ***Identification*** field, a ***User ID*** can be entered. The User ID entered here will be displayed above within the tab shown below. This is useful when more than one Orion system is running.

Once changes have been made, confirm by pressing ***Apply***.

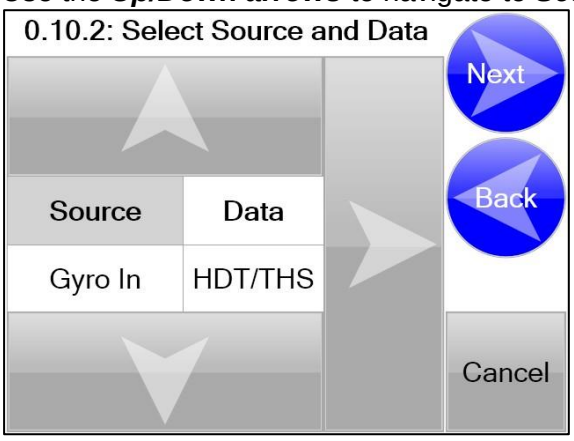
To restore settings back to previous configuration press ***Revert***.

1.5.2 Configuration - Heading Input

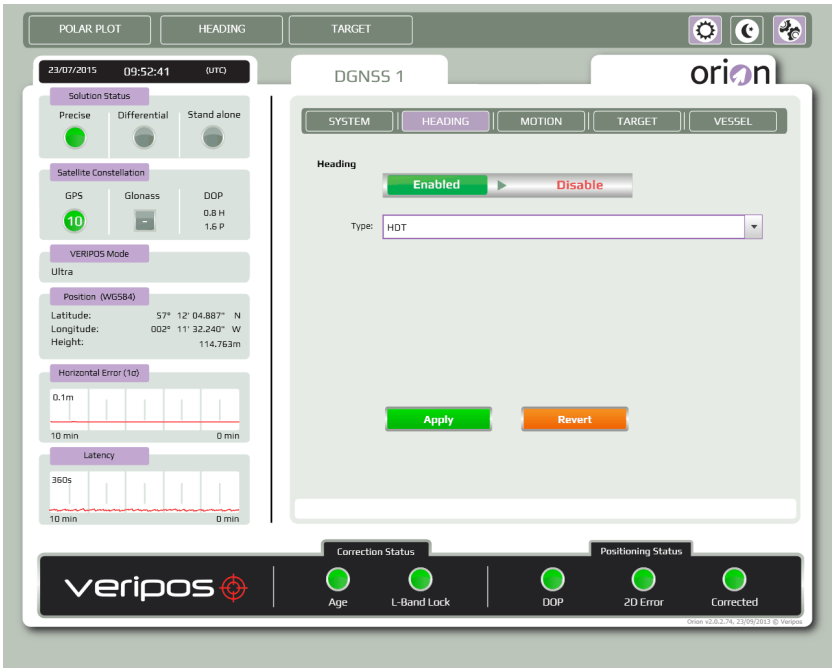
Orion can display the vessel's heading providing valid heading data is interfaced to the LD6.

If a HDT or THS string is available to input for DP Orion, the following steps will be required to configure Orion for the use of the heading tab:

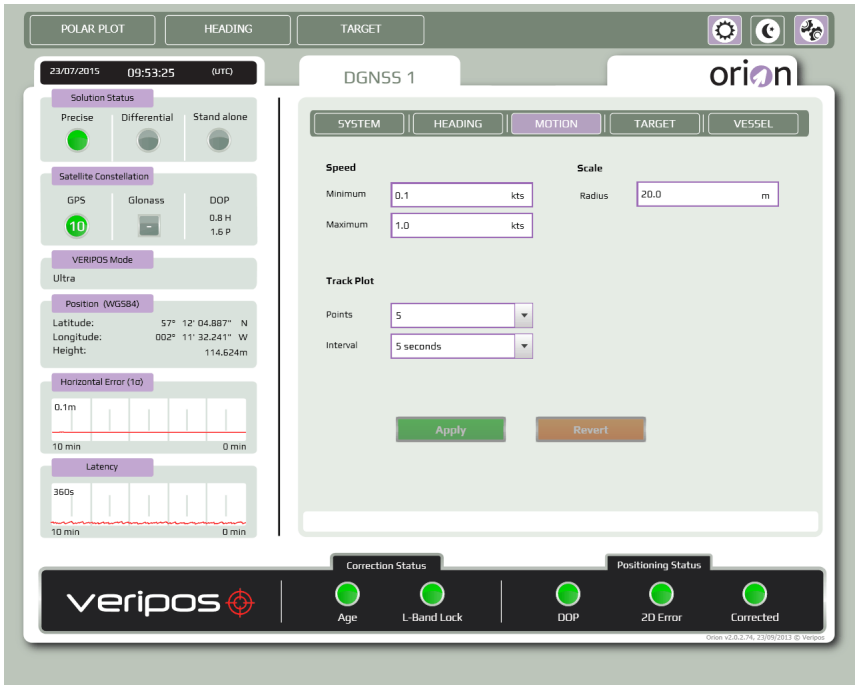
1. Select an available Com port on the LD6 to input the Heading string.
2. From LD6 Home page, go to ***settings/ IO*** and use the ***Up/Down arrows*** to select the matching com port and press ***Next***
3. Use the ***Up/Down arrows*** to navigate to *Source*-***Gyro In*** and press ***Next***



4. Set up Com port settings to match the output of heading string i.e. format, baud rate, data bits, parity etc.
5. In Orion go to the ***Configuration*** and ***Heading*** tab.
6. Press ***Enable***.
7. Select which type of message (either ***HDT*** or ***THS*****)** from the drop down menu
8. Press ***Apply*** to confirm set up



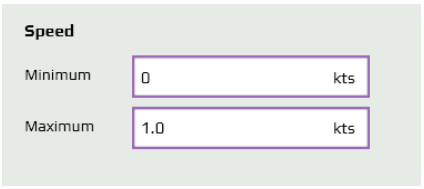
1.5.3 Configuration - Motion



In this tab you are able to configure the view for the Heading tab.

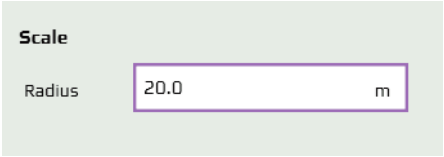
Once changes have been made user will have to confirm by pressing ***Apply***.

1.5.3.1 Speed



This option is for the course arrow in the heading view. The arrow will increase and decrease to a varied size depending on speed. The options are minimum and maximum; a minimum can be set between 0 and 0.3. If the speed drops below the minimum speed set the arrow will disappear. The maximum speed can be set up to 20 knots. Once the vessel reaches the maximum speed set in the software the arrow will remain at its largest touch the edge of the circle.

1.5.3.2 Scale

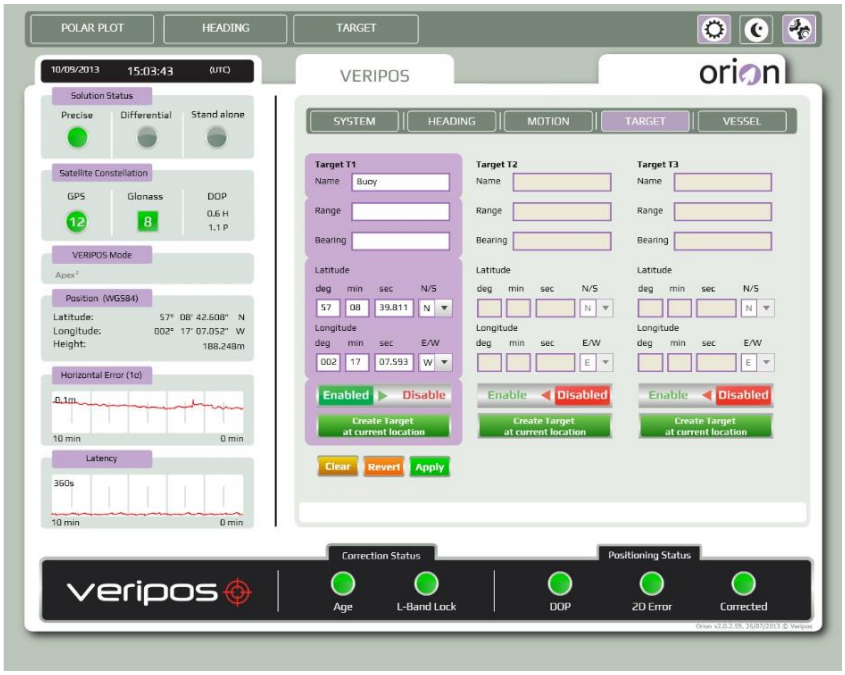


The scale option allows the user to change the scale of the circle. The measure is from the centre of the circle to the edge of the circle.

1.5.3.3 Track Plot

The Track Plot will allow for a bubble to be printed on the screen at different intervals as the vessel moves allowing the user to view the movement of the vessel. There are 2 options to configure, Points and Interval. Points is the option for how many bubbles are displayed on screen, and is able to be set from 0 to 15 from the drop down menu and is in incremented values of 5, if Zero is selected there will be no bubble trail displayed. Interval is how often a bubble will be plotted on the screen, this is selected from the drop down menu and is selectable from values of 5 varying between 5 and 30 seconds.

1.5.4 Configuration - Targets



The Target sub tab allows for input of up to three targets T1 – T3.
Only ONE target may be used at a time.

To enter a target, click in the Name box of a free target entry column and enter a suitable name e.g. Buoy.

Either enter a range and bearing, click on "*Create Target at current location*" or type in the Latitude and Longitude (WGS84) for the target in *Degrees/Mins/Secs*.

Once all information is entered, click on ***Apply***.

Repeat above for other targets.

To activate a target, select ***Enable*** then ***Apply*** for that target.

1.5.5 Configuration - Vessel

The Vessel sub – tab allows input of dimensions as an approximation for the vessel.

Use the ***Antenna Offset*** field to enter (in metres) to the required decimal point accuracy, the GNSS antenna offset as measured form the Central Reference Point (CRP) of the vessel.

Use the ***Vessel*** field to enter the length and width of the vessel.

NOTE: The antenna offset entered has no effect on the position output from the LD6 – the LD6 will <u>ALWAYS</u> output the antenna position.

2. OVERVIEW OF ORION

With the receiver connected the Orion software will run when launched.

The home screen will be shown;

Orion Main screen

The main screen elements are:

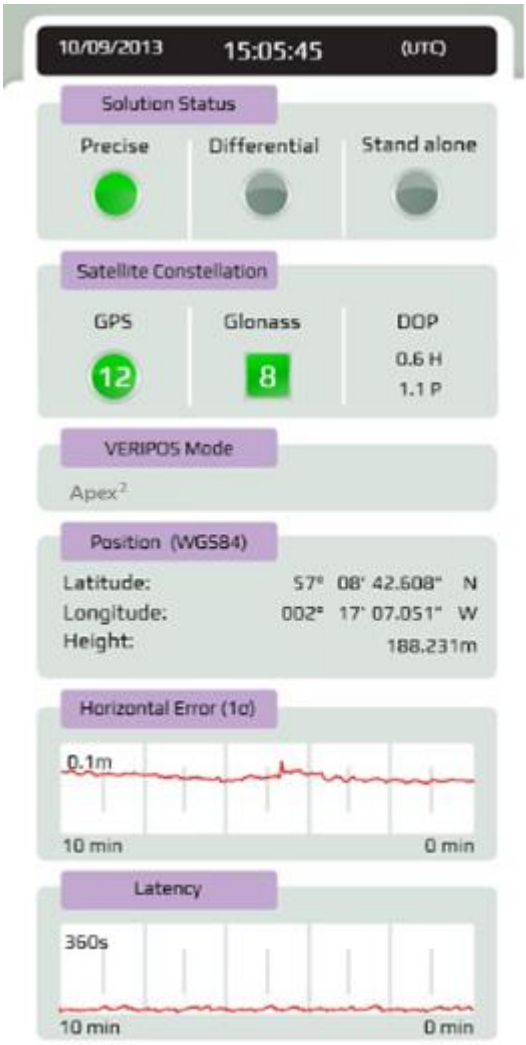
- **Tabs Bar**
- **Main Display Screen**
- **Information Panel**
- **System Status Dashboard**
- **Message Bar**

2.1 TABS BAR

The top tabs bar gives access to switching of the main display between:

- Display Polar Plot of satellites tracked and used by the receiver
- Heading gives a view of the ships heading along with the course and track if enabled
- View a Target display relative to Vessel
- Switch between Day and Night mode screen display formats
- Switch to a Configuration screen (on a PC: set up the NMEA data source) set the heading input and Track and Course arrow settings.

2.2 INFORMATION PANEL



The side bar displays the Information Panel & provides key data:

2.2.1 Date & Time

When receiving an NMEA data stream the software displays UTC time.

When no NMEA data is present the PC system clock time is displayed and the display turns from White numbers to red.

2.2.2 Solution Status

Status information is shown for the correction solution currently being output from the receiver.

In normal use a single, green illuminated button indicates the solution being output with the colour indicating status:

Green button = Solution applied
Grey button = Not being applied

Example: for output of a ***Precise*** point position output

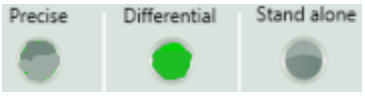
Amber button = Shown only against the ***Stand alone*** (uncorrected) position when this is being output

Example: for output of ***Stand-alone****:*

Where the solution = ***Differential***, the -

- Precise radio button = Grey
- Differential radio button = Green
- Stand Alone radio button = Grey

Example:



2.2.3 Satellite Constellation

Indicates the number of satellites for each constellation (**GPS / GLONASS**) in use.

Green when being used

Grey when not used (e.g. calculation not using satellite or constellation)

A dash in the box indicates the information is not available.

2.2.4 DOP (HDOP &PDOP)

The boxes on the main display screen show the respective current values for these two Dilution of Precision parameters.

2.2.5 Veripos Mode

This region displays in words the current solution status which is determined by the Veripos corrections being applied (when present).

Ref. info below:

Solution	Determining Factors
Apex[2] (GPS + GLO)	ID 0281
Apex (GPS)	ID 81
Ultra[2] (GPS + GLO)	ID 0268
Ultra (GPS)	ID 68
Standard (GPS)	None of the ID's above, DQI=2, GSA only has GPS SV's
Standard[2] (GPS + GLO)	None of the ID's above, DQI=2, GSA has GPS+GLO SV's
Uncorrected	DQI = 1
No Solution	DQI = 0 or empty GGA strings

2.2.6 Position (WGS84)

This region displays the Latitude, Longitude (and Height above the Geoid) being output from the Receiver.

Latitude and Longitude are displayed in DD:MM:SS.XXX (to 3 decimal places decimal) in the WGS84 model.

Ellipsoidal Height is displayed in metres to 3 decimal places.

2.2.7 Horizontal Error (1ð)

The horizontal error is displayed in metres to 1 decimal place and represented at a continuous red line trace.

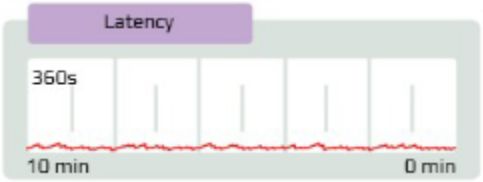
The graph scale is fixed when in operation and will change for different solution status for Precise, Differential and Stand Alone.

The time series display shows 1SD or 95% value for the semi-major axis of the position solutions.

Time period of the display is 10 minutes and populates the view once the software is started.

2.2.8 Latency

This is a 10 minute historical graph of the “age of differential data” values from the GGA string.



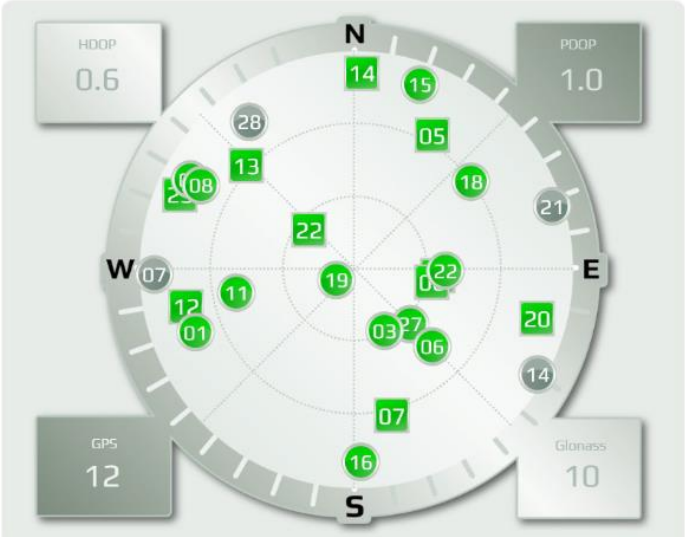
When present Latency is shown in seconds and represented at a continuous red line trace.

The graph scale is fixed when in operation and will change for different solution status for Precise, Differential and Stand Alone.

2.3 MAIN DISPLAY SCREEN

Currently there are 3 options to be displayed in the main display screen, selected from the tabs bar of Polar Plot, Heading and Target.

2.3.1 Polar Plot



The Main screen displays the Polar Plot for satellites above the GNSS antenna mask.

Satellites in use will be displayed	Green
Satellites tracked but not in use will be displayed	Grey

Circles	represent GPS satellites.
Squares	represent GLONASS satellites.

Satellites being used within the solution calculation are identified as being present within the GSA string. Satellites being tracked but not used within the solution calculation are identified as being present within the GSV string but not in GSA string.

2.3.1.1 PDOP

The current PDOP value for the solution being output

2.3.1.2 HDOP

The current HDOP value for the solution being output

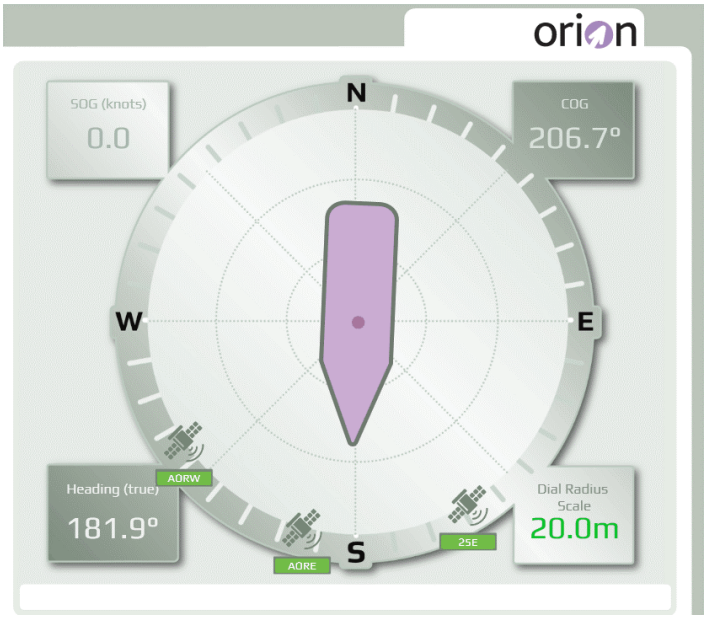
2.3.1.3 GPS

The number of GPS satellites being used to derive the position

2.3.1.4 GLONASS

The number of GLONASS satellites being used to derive the position

2.3.2 Heading tab



The main screen displays the vessel in relation to the heading and will rotate along with heading input.

A ”bubble trail”, when enabled, will be displayed to show direction of travel.

2.3.2.1 SOG (knots)

This is the speed of the vessel input from the VTG NMEA message.

2.3.2.2 COG

This is the course of the vessel input from the VTG NMEA message.

2.3.2.3 Heading (true)

This is the heading input if option is enabled. This can be input via a **HDT** or **THS** NMEA message.

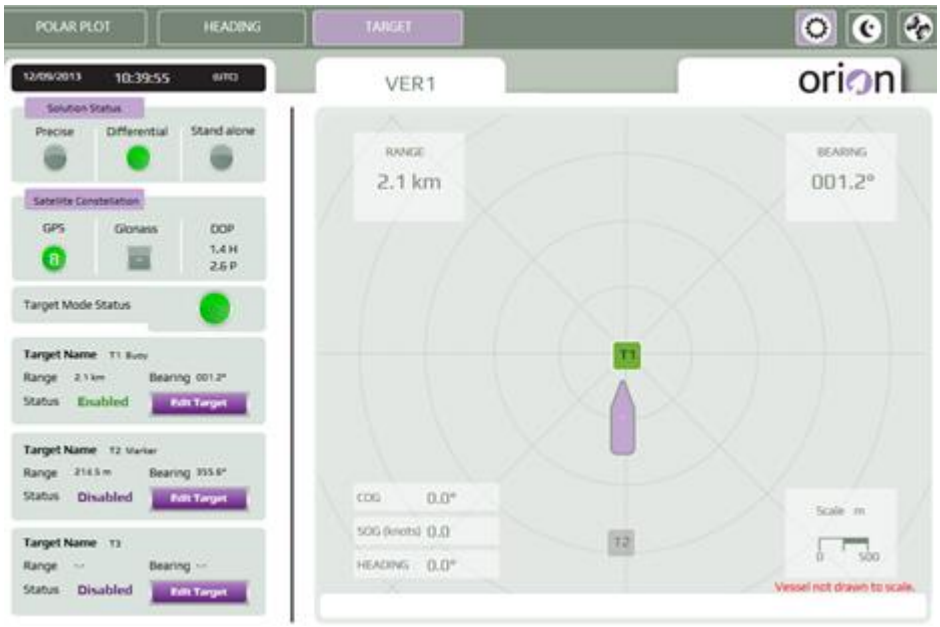
2.3.2.4 Dial Radius Scale

Displays the scale from the centre of the circle to the edge of the circle can be edited in the configuration tab.

2.3.2.5 Beam Icons

Icons of Veripos beam satellites will be displayed at their bearing on the outer of the circle. This will assist when selecting available beams on the IMU.

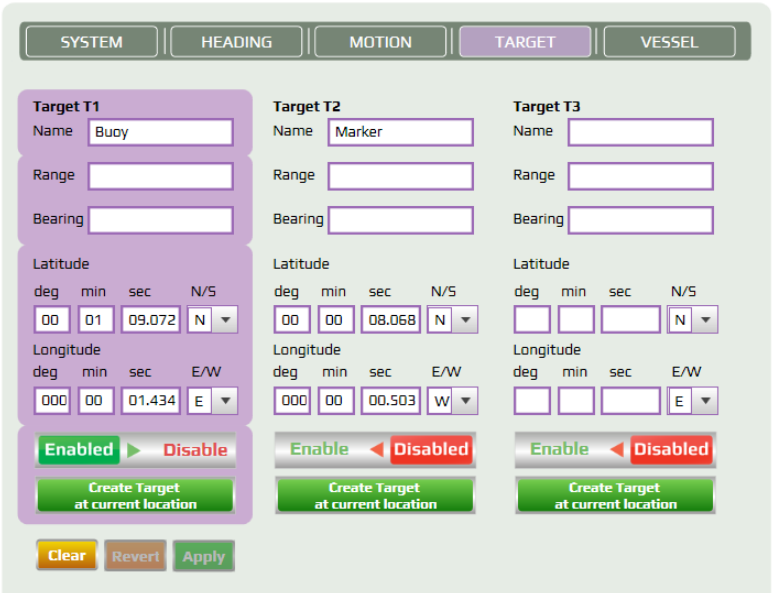
2.3.3 Target



The Target screen displays an aerial view of the vessel relative to the selected target, together with relevant information on the bearing and range, COG, Speed (in knots) and Heading against scaled range rings. Note that the Vessel outline is not shown to scale.

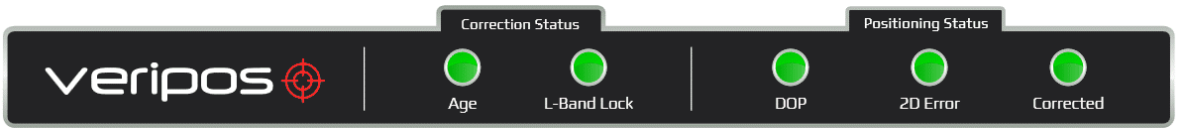
2.3.3.1 Change target / parameters

To add / amend / delete a target go to the configuration  /Target page:



Click on the Target to Add/ change and enter the required information. Then ***Apply*** to confirm.
To use this target, click on ***Enable*** then ***Apply***. Only one target may be active at a time.

2.4 SYSTEM STATUS DASHBOARD



The foot of the screen displays a dashboard of five buttons to give an overall summary of the system status.
It is recommended to ensure that all NMEA messages are turned on at the IMU prior to starting the Orion software.

When first started the status buttons may be Grey, they change when data is received.

Green indicates working within pre-set parameters.
Amber indicates alert to operator.
Red indicates an alarm condition to operator.

2.4.1 Correction Status

2.4.1.1 Age

When data is received the age status button parameters (in seconds) are:

Precise

- Status Button goes Red when age is >=360
- Status Button goes Amber when age is >100 and <360
- Status Button goes Green when age is <=100

Differential

- Status Button goes Red when age is >=120
- Status Button goes Amber when age is >60 and <120
- Status Button goes Green when age is <=60

Stand Alone

- Status Button is Red when Solution Status = Stand Alone

2.4.1.2 L-Band Lock

When the L-Band module has lock to a VERIPOS beam the button will be green.
If there is no lock to a beam or not available, the button is Red.

2.4.2 Positioning Status

2.4.2.1 DOP

On start up the DOP Status Button will be Grey.

This will change when data is received.

When data is received the DOP Status Button will behave as follows:

Red	Excessive DOP
Amber	High DOP
Green	Good DOP
Grey	Never received

	PDOP value
• Status Button goes Red when PDOP	>=6
• Status Button goes Amber when PDOP	>4 and <6
• Status Button goes Green when PDOP	<=4

2.4.2.2 2D Error

On first start-up, the 2D Error Status button will be Grey until positional NMEA data is received.

This will change when data is received.

When data is received the 2D Status Button will behave as follows:

Red	Excessive
Amber	High
Green	Good
Grey	Never received

Precise

- Traffic light goes Red when 2D Error >=0.5 m
- Traffic light goes Amber 2D Error >0.3 m and <0.5m
- Traffic light goes Green when 2D Error <=0.3m

Differential

- Traffic light goes Red when 2D Error >=1.5 m
- Traffic light goes Amber 2D Error >1 m and <1.5m
- Traffic light goes Green when 2D Error <=1m

Stand Alone

- Traffic light goes Red when 2D Error >=1.5 m
- Traffic light goes Amber 2D Error >1 m and <1.5m
- Traffic light goes Green when 2D Error <=1m

2.4.2.3 Corrected

When started, the Corrected status button will be Grey.

This will change when data is received.

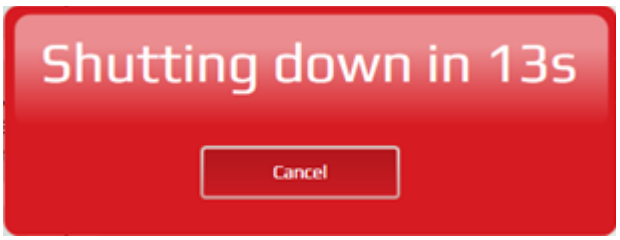
If data is received the Corrected status button will behave as follows:

Red	Uncorrected Solution
Green	Corrected Solution
Grey	Never received

Traffic light goes Red when DQI	= 1 or 0
Traffic light goes Green when DQI	>1

2.5 SHUT DOWN

To shut down the Orion software, navigate to the ***CONFIGURATION***  / ***System*** tab. Select ***Shut Down***. A timer appears confirming your selection before closing Orion.



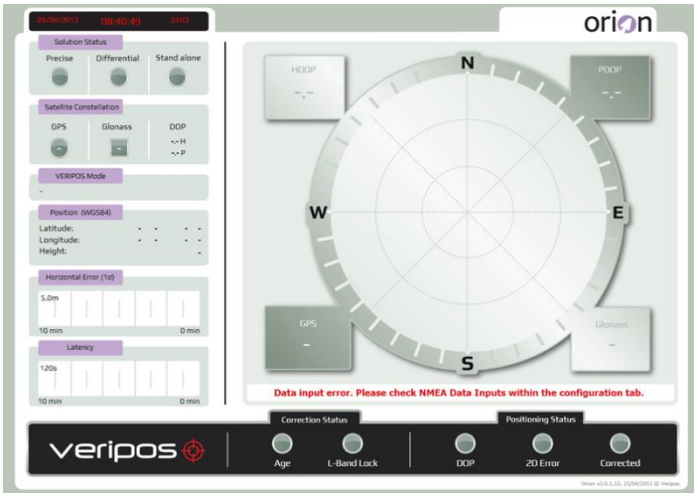
Select ***Cancel*** to stop shut down of Orion

3. TROUBLESHOOTING

Use this section to assist any problems encountered when using Orion.
Note that the illustrations shown are representative and for later releases the messages and screens displayed may differ slightly. However, the remedies recommended apply.

PROBLEM:

No data or Polar Plot satellites are displayed: A message appears in the Messages Bar.



"Data Input error. Please check NMEA data inputs within the Configuration tab."

SOLUTION:

Go to the Configuration page which will display further information on the problem, where available.

Three types of problem may be displayed;

1. ***Client socket unable to connect. Please check connection.***

- The configuration information entered may be incorrect.
- Cable or connection may be faulty.

2. **No data. Please check connection.**

- An interruption, breakage or error in the connection to the receiver has occurred.
- If using a LAN connection the socket is connected but no data is received. Check the receiver configuration.

3. **No valid GNSS data. Please check GNSS configuration.**

   Position Calculation stopped in receiver and null strings are being output.

Check the configuration on Orion, all connections and settings on the receiver in line with the units troubleshooting guidance where required.

PROBLEM:

I shut down my LD6. When re-started, the Orion touch screen does not display Orion.

SOLUTION:

Each time the LD6 is started, Orion should launch automatically if it was running when the LD6 was shut down..

If Orion does not launch automatically, from LD6 Home screen, touch *Actions/Launch Orion* and wait 10 seconds or so for the application to launch.

PROBLEM:

The screen appears darkened.

SOLUTION:

Night mode has been selected; monitor brightness / contrast has been modified.

Adjust monitor controls or select the Day Mode from the Tabs Bar.

PROBLEM:

The display freezes and the remainder of the screen does not update.

SOLUTION:

This indicates a total positioning failure caused a by a loss of GNSS input.
Refer to the receiver Operations manual for troubleshooting procedures.

PROBLEM:

Using Orion with an LD6, the unit displays 16 satellites: however the data streams indicate there are more than 16 satellites available / in use to calculate the position.

SOLUTION:

On an LD6 a maximum of 16 satellites will display.
This is a known issue with the output from RTMFVC on an LD6.

APPENDIX I.

CONTACT INFORMATION

VERIPOS CONTACT INFORMATION

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

VERIPOS Helpdesk Telephone: +44 (0) 1224 965900

VERIPOS Helpdesk E-mail: helpdesk@veripos.com

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

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

UK VERIPOS office address:

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

For other VERIPOS office locations visit www.veripos.com.

APPENDIX II.

ABBREVIATIONS

ABBREVIATIONS

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

APPENDIX III.

VERIPOS REFERENCE STATIONS

VERIPOS reference stations.

The latest VERIPOS Station listing can be found on the VERIPOS Online Support System via the following URL: http://help.veripos.com in FAQ's.

VERPOS Ultra, Ultra² APEX and APEX² ID's

Satellite	ULTRA ID	ULTRA²IDs	APEX ID	APEX²IDs	Status
98W	68	68 + 75	81	81+ 82	Operational
AORW	68	68 + 75	81	81+ 82	Operational
25E	68	68 + 75	81	81+ 82	Operational
AORE	68	68 + 75	81	81+ 82	Operational
IOR	68	68 + 75	81	81+ 82	Operational
143.5E	68	68 + 75	81	81+ 82	Operational
POR	68	68 + 75	81	81+ 82	Operational

Updated 11 April 2013

MF / IALA BEACONS:

A listing of IALA MF stations is available from: http://site.ialathree.org/
(Select "IALA Lists of Radionavigation Services")

APPENDIX IV.

QUALITY STANDARDS

QUALITY STANDARDS

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

1. UKOOA
2. NMEA-0183

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

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

References

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

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

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

UKOOA STANDARD

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

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

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

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

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

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

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

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

It recommends the following Test Statistics:

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

It recommends also the following Quality Measures:

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

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

NMEA-0183 STANDARD

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

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

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

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

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

At 4800 baud 480 characters per second can be sent. As an NMEA sentence can be as long as 82 characters this can be limited to less than six different sentences. The actual

limit is determined by the specific sentences used and it is easy to overrun the capabilities for rapid sentence response.

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

APPENDIX V.

NMEA SENTENCES

NMEA SENTENCES

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

- GGA
- GST
- VTG
- ZDA
- GSV
- GSA

NMEA GGA Sentence

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

Structure and Example: -

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

GGA sentence defined: -

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

Verify-QC supports 4 variations of the NMEA GGA. These variations are: -

- GGA (Default) number of SV's can exceed 12 and sentence length can exceed 82 characters. Increased precision (7 decimals for Lat & Lon)
- GGA-DP fully NMEA-0183 compatible string. Number of SV's is limited to 12 and the sentence length is restricted to 82 characters

- GGA-Alstom — number of SV's is limited to 12 and the sentence length can exceed 82 characters. The latency value equals the actual latency divided by 12 for DGNSS solutions and divided by 36 for the Ultra solution
- GGA-PPP — number of SV's can exceed 12 and sentence length can exceed 82 characters. The DGPS QI parameter offers the full range from 0-9. It will show 5 for an Ultra solution and 2 for a DGPS solution. Increased precision (7 decimals for Lat & Lon)

NMEA GST Sentence

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

Structure and Example:

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

GST sentence defined:

GST = GNSS Pseudo-range Error Statistics

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

NMEA VTG Sentence

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

Structure and Example:

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

VTG sentence defined:

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

Verify QC supports 2 variations of the NMEA VTG sentence. These variations are:

- VTG (Default) conforms to NMEA v3.0 standard and includes the mode indicator
- VTG (Old) conforms to previous NMEA standards and does not include the mode indicator

NMEA ZDA Sentence

The NMEA ZDA sentence provides time and time zone information.

Structure and Example:

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

ZDA sentence defined:

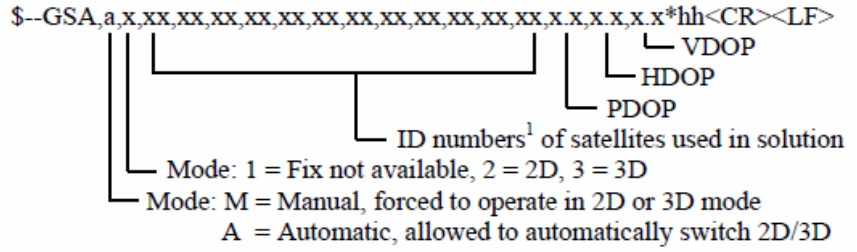
ZDA = Time & Date	
hhmmss.ss	UTC time in hours, minutes, seconds of the GPS position
dd,mm,yyy	Day,Month,Year (UTC)
xx	local zone hours (00 to +/-13 hrs)
yy	local zone minutes (00 to 59)
*hh<CR><LF>	checksum, carriage return and line feed

NMEA GSA Sentence

GSA sentence defined:

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

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



Notes:

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

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

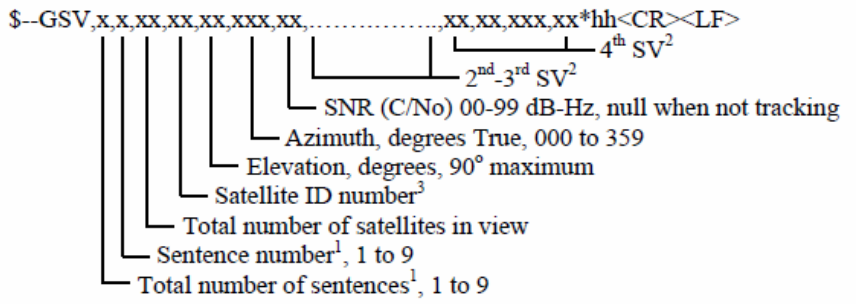
NMEA GSV Sentence

GSV sentence defined:

GNSS Satellites In View

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

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



Notes:

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

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

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

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

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