# Verify QC for LD6

## User Manual

VERIPOS

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**Verify QC For LD6 User Manual**

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# CONTENTS

## 1.INTRODUCTION

This manual covers:

- configuration
- Views
- operational procedures

VERIPOS Verify QC software on board the VERIPOS LD6 IMU.

The Verify QC suite of processing software provides real-time position with quality control information for the professional positioning user. It contains full calculation configuration flexibility with performance monitoring.

The Verify QC functionality is scalable in concept. It is expandable with many specific features enabled through a USB software key (dongle) providing user flexibility and simplicity of operation. The software provides a window into the complete position derivation process by capturing both GNSS observation and received augmentation data. Multiple calculation permutations can be configured providing complete visibility of all parameters with associated quality control.
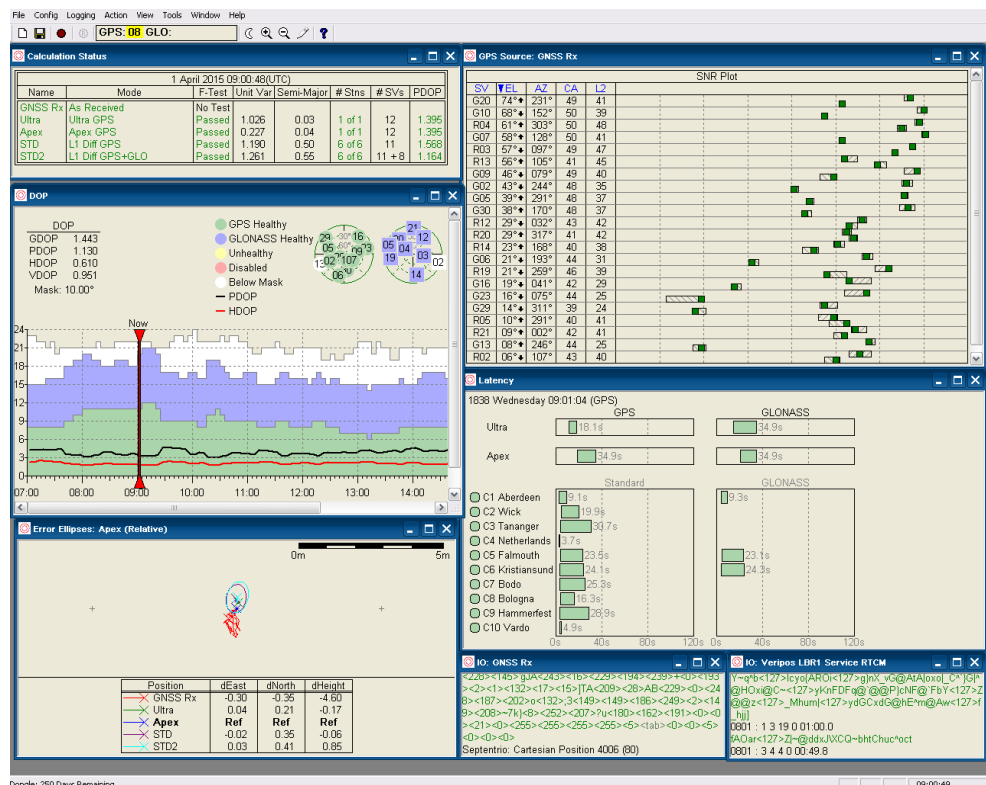


**Verify QC Example Screen**

Verify QC can receive and output data using serial, TCP/IP communications and data files. It operates in real-time whilst retaining full functionality in post-processing mode.

The Verify QC software is dongle protected. An enabled dongle will need to be attached when running Verify QC before the software can be used. Verify QC will not run without an enabled dongle being attached.

Principal features of Verify QC are:

- Intuitive use - simple to operate and use
- User configurable
- Supports a range of GNSS receivers
- Supports all VERIPOS data broadcast services
- Accepts corrections from 3rd party non-VERIPOS sources e.g. IALA
- Capable of multi-reference station and single station GPS-only, GLONASS-only and GPS/GLONASS calculations
- Capable of use of high accuracy Precise Point Positioning (PPP) calculations
- Capable of real-time tidal calculations
- Provides statistical analysis and QC information
- Compliant with UKOOA recommendations
- High number of position calculations
- Raw and computed data can be logged for analysis and replay
- Output of position solutions and associated QC information
- Supports TCP/IP communication

## 1.1 DIFFERENCES WHEN USING VERIFY QC ON THE LD6

The following lists the key differences in use when running Verify QC on the LD6:

1. Existing LD6 must be fitted / upgraded to **2Gb RAM**.
2. No *Advanced Views* are available.
3. In Verify QC the GNSS Receiver and RTCM input configuration options are preconfigured for the Client Sockets used within the LD6.
4. A maximum of *eight on-screen windows* *(views)* are available. The menu will grey out once eight screens are open.
5. COM port mapping (in *Tools*) is *not available*.
6. There is no facility to import a new map configuration file.
7. The Verify QC manual is **not** viewable as a pdf on-screen.
8. Verify QC configurations from a PC are **not** compatible.
9. RS232/422 *ports 9 – 14* are dedicated to Verify QC use. The port default baud rate for these ports is 9600 bps (all are user configurable)
10. There are 6 pre – assigned server socket ports when using the LAN connection – 19201 to 19206.
11. Archive of Verify QC data facility has been removed. Refer to LD6 Operations manual for archiving procedure which, when in QC mode archives all the relevant troubleshooting data files.
12. On LD6 variants (software build v50 and below), when in QC mode the LD6 internal calculations are not available to be applied (all calculations are carried out within QC).
13. On LD6-N variants (software build v100 and above), when in QC mode the LD6 PPP calculations are available to use. LD6 differential calculations are degraded while in QC mode therefore should not be used.
14. Switching between LD6 DP and QC modes – the QC mode configuration files will be retained. The assigned output ports will be retained.

15      LD6 Factory Reset – deletes all QC mode data and will revert the system to LD6 mode.

For further information visit the VERIPOS Online Support System (VOSS) web site
http://help.veripos.com

## 1.2 ABBREVIATIONS

| | |
|---|---|
| Apex | VERIPOS PPP GNSS Service |
| BER | Bit Error Rate |
| CoG | Course over Ground |
| CRP | Central Reference Point |
| COM | Communication Port (Serial Port) |
| CSL | Concept Systems Limited |
| DGPS | Differential GPS |
| DOP | Dilution of Precision |
| DP | Dynamic Positioning |
| GDOP | Geometry Dilution of Precision |
| GLONASS | Globalnaya Navigatsionnaya Sputnikovaya Sistema (Russian GNSS System) |
| GNSS | Global Navigation Satellite System |
| GPS | Global Positioning System |
| HDOP | Horizontal Dilution of Precision |
| Hz | Hertz |
| IALA | International Association of Lighthouse Authorities |
| ID | Identifier/ Identification |
| IMU | Integrated Mobile Unit (i.e. LD6, LD5 LD2 etc.) |
| ITRF | International Terrestrial Reference Frame |
| LAN | Local Area Network |
| L-Band | Method of transmitting correction data to mobile users |
| MF | Medium Frequency |
| MMI | Man Machine Interface (used to control LD6) |
| MSL | Mean Sea Level |
| MSS | Mean Sea Surface |
| NMEA | National Marine Electronics Association |
| PDF | Portable Document Format |
| PDOP | Positional Dilution of Precision |
| PPP | Precise Point Positioning |
| PPS | Pulse Per Second |
| PRN | Pseudo Random Noise |
| RAM | Random Access Memory |
| RINEX | Receiver Independent Exchange Format |
| RMS | Root Mean Squared |
| RTCM | Radio Telecommunication Commission Maritime |
| SAL | Service Agreement License |
| SD | Standard Deviation |
| SNF | Signal Notification Form |
| SNR | Signal to Noise Ratio |
| Spotbeam | High power L-Band signal |
| Standard / Std | VERIPOS Single Frequency DGPS system |
| SV | Space Vehicle |
| TCP-IP | Transmission Control Protocol - Internet Protocol |
| UHF | Ultra High Frequency |
| UKOOA | United Kingdom Offshore Operators Association |
| Ultra | VERIPOS PPP GNSS Service |
| USB | Universal Serial Bus |
| UTC | Coordinated Universal Time |
| VDOP | Vertical Dilution of Precision |
| VGA | Video Graphics Array |

| VOSS | Veripos Online Support System (http://help.veripos.com) |
| --- | --- |
| WEEE | Waste Electrical and Electronic Equipment |
| WER | Word Error Rate |

## 2.STARTING VERIFY QC

When using Verify QC on an LD6 the software is pre-installed as part of the LD6 software package.

### 2.1  DONGLE DRIVER

Verify QC when run on the LD6 has a driver pre – installed. The LD6 requires a dongle with permissions supplied by VERIPOS.  VERIPOS recommend one of the rear USB ports is used.

### 2.2  RUN VERIFY QC ON THE LD6

When using Verify QC on an LD6 the software is preinstalled.
Ensure you have an <u>activated USB dongle</u> attached to the LD6 before starting Verify QC.

The following section provides details on how to start to use Verify QC on the LD6.

**IMPORTANT:** *<u>Before</u> turning on the LD6:*

- Attach a VGA monitor, USB keyboard & mouse and a valid Verify QC Dongle to the LD6.

Equipment used when using Verpos LD6 running Verify QC
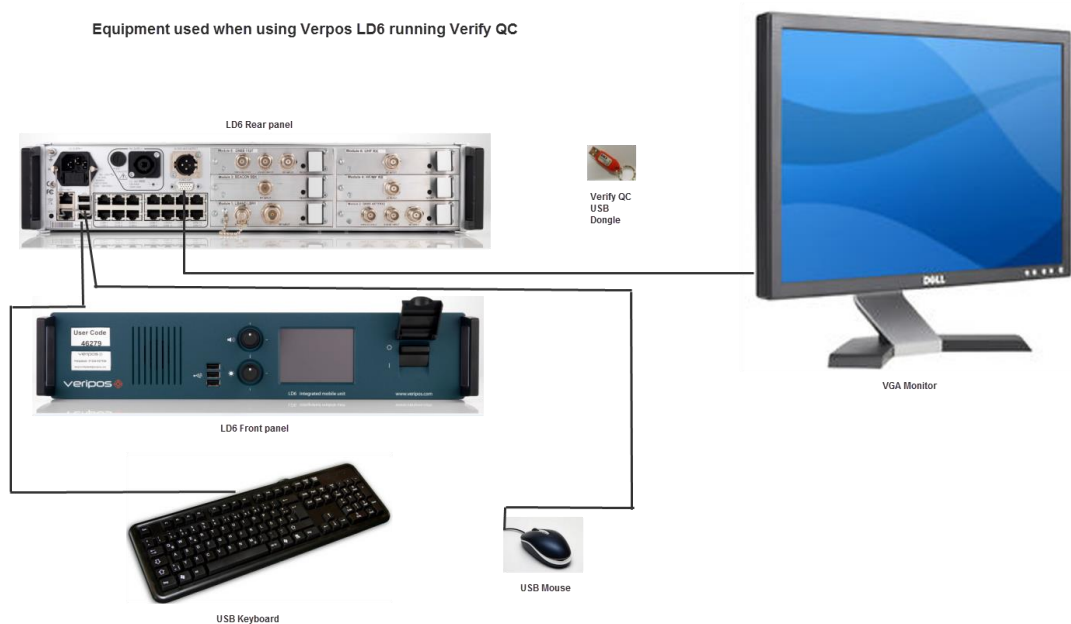


- Ensure all antenna connections, etc. are correctly attached to the LD6.
  If you need help refer to the *LD6 Operations Manual* and
  *LD6 Quick Guide* (available from VOSS at http://help.veripos.com ).

Power up the LD6 and allow the unit time to acquire signals, etc.

If necessary enable the LD6 for the Veripos service(s) you require to use in conjunction with Verify QC.

Start Verify QC on the LD6

Confirm that the firmware version running on your LD6 supports Verify QC.

Go to **Actions** and using the mouse, click on icons to calibrate the screens attached to the LD6. Follow instructions on-screen.
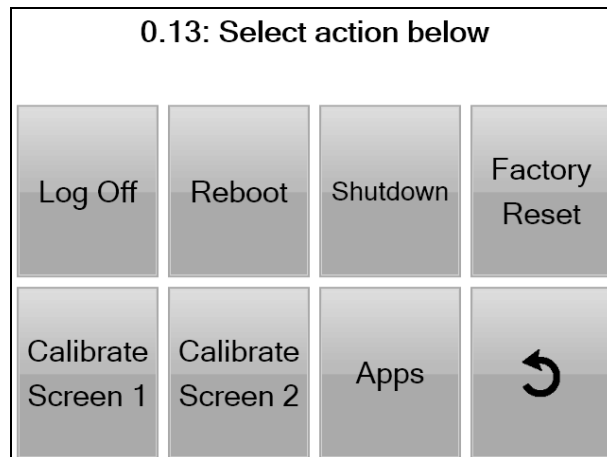


Check the LD6 correction signal status (From the home screen go to **LBand/Status**) and if necessary, request from Veripos Helpdesk that the appropriate Veripos correction service(s) for your work are enabled.
If corrections are not available to Verify QC running on the LD6, the quality and accuracy of position output is restricted.

Go to **Actions/Apps/QC Mode** and select **Yes** to launch Verify QC.
Allow the LD6 to launch Verify QC.

You can now start to use Verify QC with the monitor screen using the mouse and keyboard.

### 3.FUNCTIONAL OVERVIEW

To custom configure Verify QC the user can work from left to right along the menu bar to complete the Verify QC software configuration.

### 3.1 MENU STRUCTURE

Menu icons along the top menu bar contain all the necessary dropdown menus to configure, operate and adjust Verify QC for optimum operation.
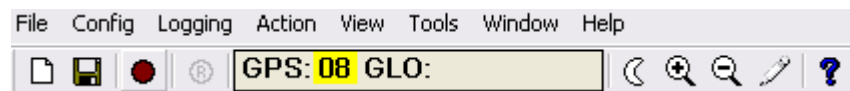


**Verify QC Main Menu Structure**

Functions are shown in icons on the task bar below the menu bar. These help you to;

- o Create a New Configuration
- o Save your Configuration
- o Start logging data
- o Start RINEX logging (operates when enabled)
- o Disable GPS / GLONASS satellites
- o Switch to night-time mode / day-time mode
- o Increase font size
- o Decrease font size
- o Add notes to the configuration change log
- o About Verify QC dialogue showing software version number

### 3.2 DONGLE DEPENDANT FUNCTIONS

An enabled dongle is required to operate Verify QC.
By default the dongle will support VERIPOS Standard calculations and associated functions. A dongle can be enabled for additional software features.

Access to more advanced software functions is controlled by your dongle. To confirm the functions enabled on your dongle its status can be viewed under *Help/Dongle/View…* and in your selections under *Tools/Advanced Options.*

This manual describes all the Verify QC functions and views. Where functions described in this manual are optional and additional this is stated.

The **dongle dependent Verify QC software** functions are listed below:

o   Ultra:            introduces the Ultra calculation and associated functions. Ultra is a PPP (Precise Point Positioning) calculation offering decimetre level accuracies

o   Apex:            introduces the Apex calculation and associated functions. Apex is a PPP (Precise Point Positioning) calculation offering decimetre level accuracies

o   GLONASS:      introduces a combined GPS+GLONASS calculation and associated functionality. Note: The combined GPS+GLONASS calculations are only available when a Topcon, Septentrio AsteRx or NovAtel receiver is selected ***LD6 receiver pre configured***

o   CSL Output:    introduces an additional interface for output of P2/94 records to the Concept Systems Limited (CSL) ViGPS process in various CSL navigation products

o   Tides:            introduces a Tide calculation and associated functions. This function requires the Apex or Ultra service to be enabled on your dongle. The Tide calculation estimates the real-time tide at the users location based on the high accuracy Apex or Ultra positions

o   PPP Ref:         introduces a virtual base station RTCM Output based on the current PPP position, which is used as a virtual reference station location. This function allows highly stable and accurate DGPS corrections to be calculated and then be output to external DGPS systems or a telemetry link

o   Axiom:           For use with the VERIPOS 4D positioning software suite


You can check the dongle enable status in *Help/Dongle/View…*

If a function you require is absent contact the VERIPOS helpdesk for information, assistance and to order a dongle upgrade.

## 3.3  USER SELECTABLE FUNCTIONS

You can customise the appearance of Verify QC. A number of advanced software options can be disabled to simplify the appearance of the software.

The dialogue to do this is accessed via *Tools/Advanced Options.*
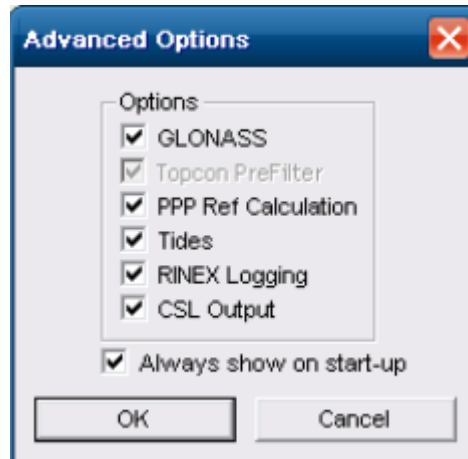


**Advanced Options dialogue**

The Advanced Options dialogue also appears on initial start-up of the software.

Enabling / disabling options will affect which configuration dialogues and associated views are accessible through the Verify QC menu structure.

By default all options enabled on the Verify QC dongle will appear enabled in a new configuration.

Options will be presented depending on the features available from the selected GNSS card.

Options selected or deselected are stored when you save the configuration file and will be in place when you reopen the configuration file.

This manual covers all Verify QC functions and views. If any are absent, please first check the dongle enable status, under *Help/Dongle/View…* and your selections under *Tools/Advanced Options.*

## 4. FILE MENU

The File commands "*File/LD6 Default*, *File/Save* and *File/Save As…* " allow the user to create a new configuration file and save it or open configuration files for editing.

*Notes: The Verify QC configuration file should be saved and a backup copy created and stored in a safe area. If a configuration is running and LD6 Default is selected, a warning appears to save or cancel the existing configuration. Creating a new configuration will close the existing configuration.*
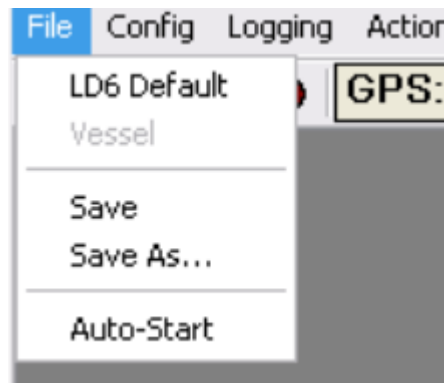


**File Menu Structure**

### 4.1  LD6 DEFAULT

This menu option closes the current configuration and opens a default configuration. This configuration will have the data inputs for installed modules preconfigured. The user is required to configure all other applicable options within the software.

### 4.2  VESSEL

A vessel configuration can be saved at commissioning stage with options preconfigured such as External RTCM or data outputs.

The V*essel* configuration file cannot be overwritten by the user, if the option is selected the user will be prompted with a Save As dialogue to save the file under a different name.

For information regarding the setup and use of the *Vessel* option, please contact the VERIPOS Helpdesk.

### 4.3  AUTO START

Selecting Auto-Start ensures the last saved configuration file will re-open automatically when Verify QC is started.

If you do not require to use the last saved configuration when Verify QC starts you can close this configuration, create a new configuration file or open a previously saved file.

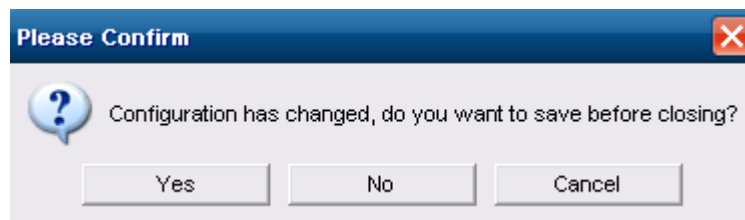### 4.4  PREVIOUS VERIFY QC CONFIGURATION FILES

Verify QC configurations that have previously been saved on the LD6 can be loaded from the file menu. This is done by selecting the configuration file name under the Auto-Start option in the file menu.

Previous configuration files will be displayed in the *File* menu, underneath *Auto-Start*:
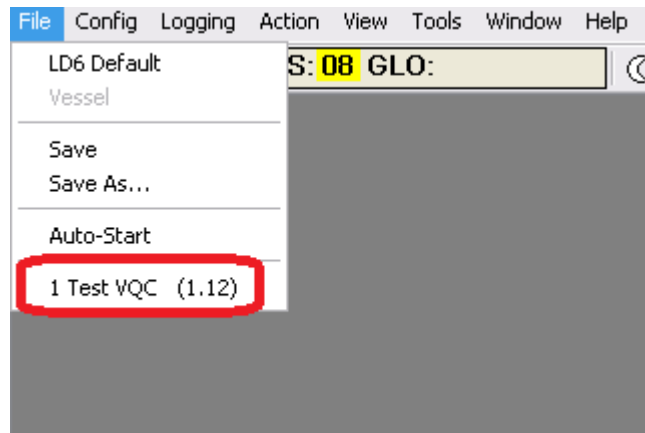


**Available saved VQC Configs**

Click on the desired configuration.  A prompt to save the current configuration will appear:



**Save Current Configuration Prompt**

## 4.5  COPYING VERIFY QC CONFIGURATION FILES FROM USB MEMORY STICK

To copy a Verify QC configuration onto the LD6 the config files need to be stored in a folder with the same name as the config in the following directory on the memory stick:

***LD6ImportExport\VQC\Config\…***
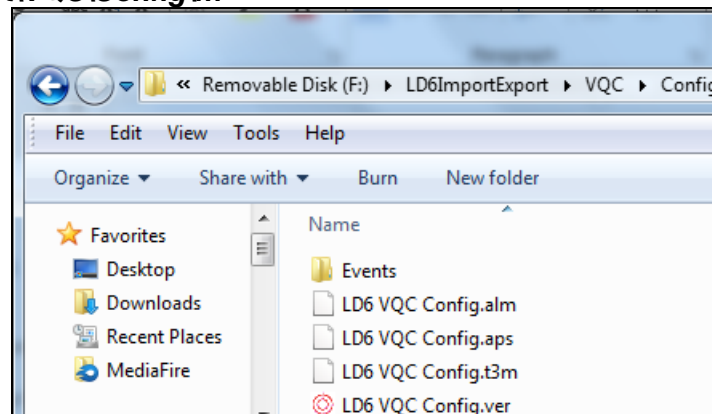


The above is the default directory if the VQC configuration files were backed up as described in the *LD6 Operations Manual.*

Note. Verify QC configuration loaded onto the LD6 should have been created on the same Verify QC version. These being copied from an LD6 or provided by a VERIPOS technician. Once the config files have been stored in the correct folder structure insert the USB memory stick into the LD6 when in QC mode and from the File drop down menu select the correct QC config from the following option:

*Open From F:\LD6ImportExport\VQC\Config...*
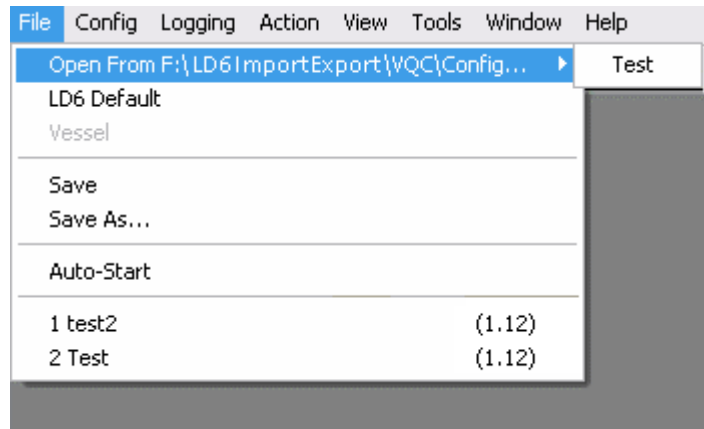


This action will copy the config files onto the LD6 storage drive and open the config.

## 5.CONFIGURATION

This section contains information specific to the use of QC when loaded on an LD6 Integrated Mobile Unit (IMU).

The QC version provides full functions for use with all Veripos services and algorithms, to output high accuracy positioning information.

The LD6 requires that a valid Verify QC Dongle is installed on a USB port before launching in to QC mode on the LD6. **DO NOT** remove the dongle during QC mode operation.
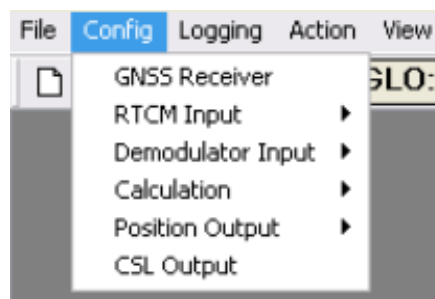


**Config Menu Structure**

The Config (configuration) menu is used to set up all parameters within Verify QC.

Time and care must be taken to ensure all parameters are entered or selected correctly during the configuration process. Failure to do so may affect the performance of Verify QC operation.

The configuration menu is structured such that the software is configured in a logical order.

The primary steps with QC on the LD6 are:

1. Automatic configuration of the GNSS receiver input
2. Configure RTCM inputs for Beams, stations and external RTCM inputs to be applied
3. Automatic configuration of the Demodulator Input
4. Set / check elevation mask and Geoid Model
5. Configure DGNSS calculations
6. Select backups to Apex, Apex$^2$ and/or Ultra / Ultra$^2$ calculations
7. Configure advanced calculations, for example Tides and PPP Ref
8. Configure Position Outputs – server socket, datagram & serial port
9. Configure other outputs as for example CSL Output

## 5.1  CONFIGURE GNSS RECEIVER

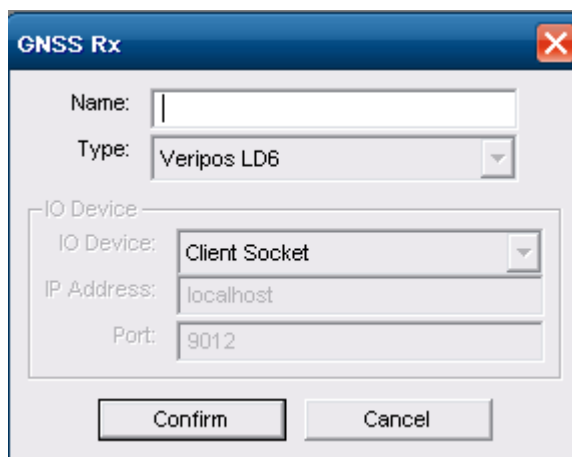When using the GNSS Receiver check the following points:

- the antennas is installed with the best possible view of the open sky, avoiding any masking or possibility of interference
- cable runs must be short to avoid any effect on the L2 signal to Noise Ratio values or degradation of VERIPOS correction services performance

*Note: Offsets are not required during setup of the GNSS receiver as the positions generated by Verify QC are referenced to the phase centre of the GNSS antenna.*

### 5.1.1  Configuring the GNSS Receiver

The LD6 with QC is pre-configured to work with the unit's built-in GNSS receiver.

Select "*Config/GNSS Rx*" and enter the information described in the following sections.



**GNSS Receiver**

### 5.1.1.1 GNSS Name

When no entry is made against "*Name"* for a GNSS receiver the default name of 'GNSS Rx' is inserted automatically.

Where more than one Verify QC system is installed on a vessel, it is good working practice to give the receivers unique and more descriptive names such as "Port/Fwd", "Starboard/Aft" or "Primary" and "Secondary".

This makes it easier to distinguish between the systems and aids troubleshooting.

To check that communications are established:

1. open the IO view from the main menu (View/IO)
2. check the GNSS data is correct:
    a. successfully decoded data appears as green text within the IO view
    b. scrolling text is shown in red where data cannot be decoded
    c. no text appears is no data is received
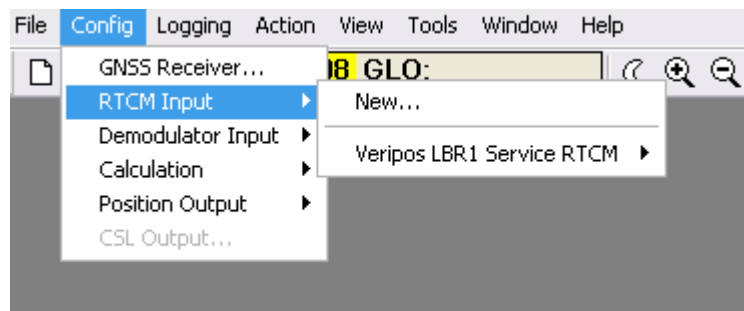
## 5.2  CONFIGURE RTCM INPUT

### 5.2.1  Configure RTCM Input

#### 5.2.1.1  Preconfigured RTCM Inputs

RTCM Inputs are created automatically for installed RTCM Modules within the LD6 (i.e. LBR1 RTCMa, MF and UHF).
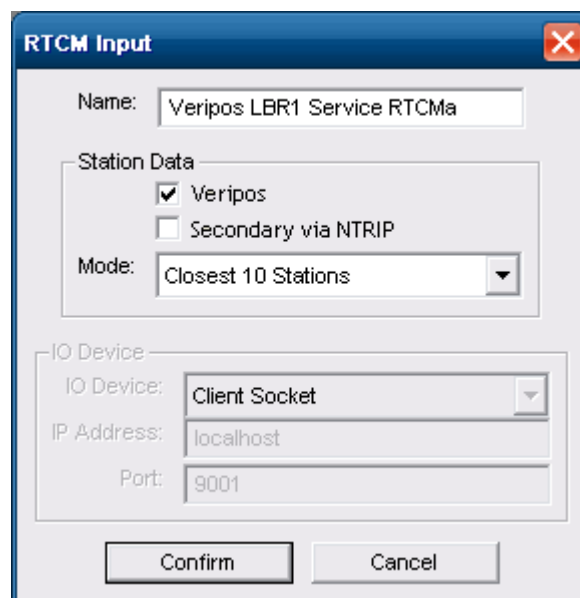
Certain options such as *Device IO* are preconfigured for these inputs and cannot be changed by the user. The user is required to configure options such as Mode, Beam, and Stations if applicable.

To configure these RTCM inputs click "*Config/RTCM Input/RTCM Name/Edit*"



**RTCM Input**

This will open the following dialogue:



**RTCM Input dialogue**
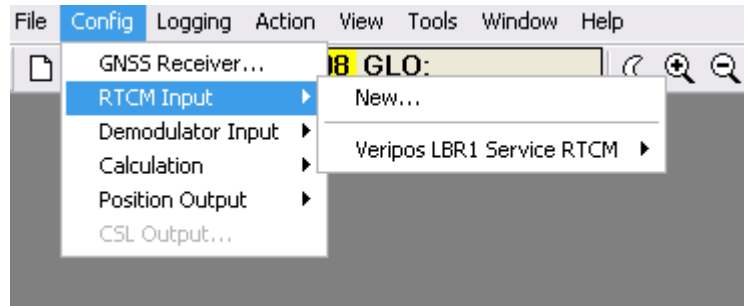
## 5.2.1.2 External RTCM Inputs

Additional (external) RTCM inputs can be interfaced to Verify QC and configured via Serial Port, Client Socket and Datagram.
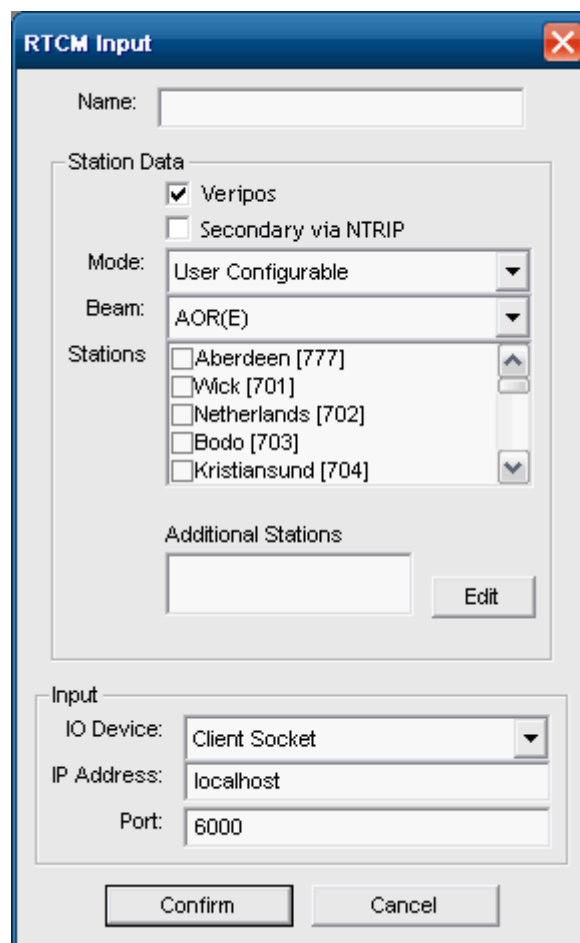
Serial Port, Client Socket and Datagram connection details are detailed in the Appendix.

To add an RTCM input click "*Config/RTCM Input/New…*"



**RTCM Input**

This will open the following dialogue:



**RTCM Input dialogue**

### 5.2.1.3  RTCM Name

If using more than one RTCM Data link it is good working practice to allocate a more descriptive *Name* to each link. This allows each link to be easily identified by the operator.

The use of a descriptive naming convention will assist in distinguishing the RTCM source when operating Verify QC.

If no name is entered for an RTCM input, name will default to the VERIPOS beam name or 'Closest 10 Stations' if Closest 10 Stations mode is selected.

### 5.2.1.4  Station Data

VERIPOS recommend users tick the *VERIPOS* station data type box. This allows the user to select from the predefined lists of reference stations that are available on each VERIPOS downlink beam and ensures that the Ultra and Apex corrections will be decoded and available. All are pre – configured for use.

Where RTCM from an external source is required, it can be input using a serial port.
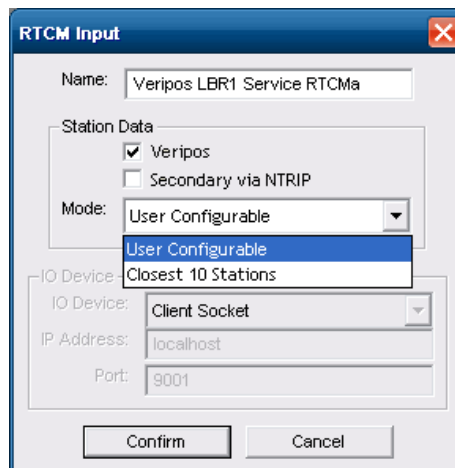
The *Secondary via NTRIP* must be ticked if the RTCM is being received via NTRIP. When the *Secondary via NTRIP* box is ticked, if the RTCM being received via L-Band antenna were to drop out Verify QC switches to use NTRIP RTCM corrections.

### 5.2.1.5  Mode

Verify QC can automatically detect the 'Closest 10 Stations' received on the RTCM input for decoding. The beam and station then do not need to be selected and so are removed from the dialogue.

VERIPOS recommends that when selecting 'Closest 10 Stations' all available stations are enabled on the demodulator (LD6) RTCM output port.

Alternatively if "Mode" is set to 'User Configurable' the user can manually select a preferred list of stations from the 'Stations' list for decode by Verify QC.



**RTCM Mode selection**
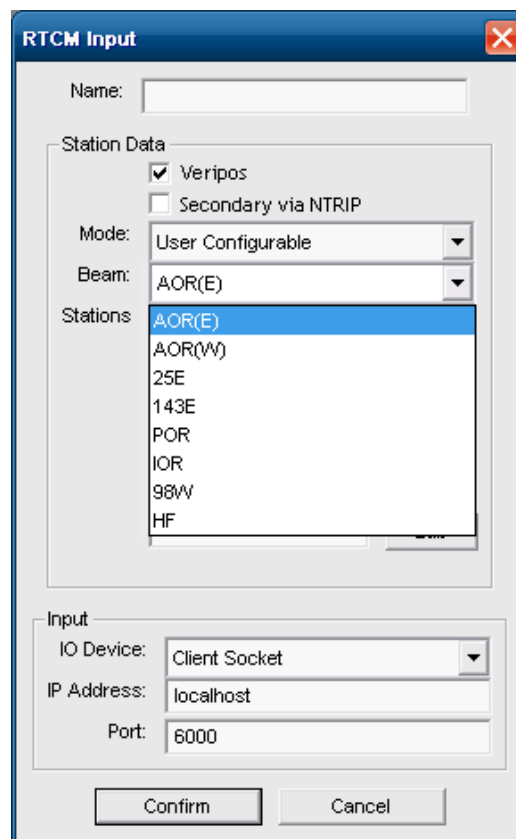
### 5.2.1.6  RTCM Beam

Once RTCM Input has been named, use the drop down menu to identify the *Beam* supplying the RTCM message.

Selecting the correct beam is important as each one has a predefined list of VERIPOS stations.

*Note: The beam selection in the receiver and Verify QC need to be paired, i.e. selecting a Beam in Verify QC only determines which stations are displayed in the station list; it does not control which Beam is selected in the VERIPOS IMU.*

*The IMU must also be configured to use this same Beam – see relevant VERIPOS IMU manual.*



**RTCM Beam**

### 5.2.1.7  RTCM Stations

If the user has selected 'User Configurable', next select the actual *Stations* to be decoded by Verify QC.

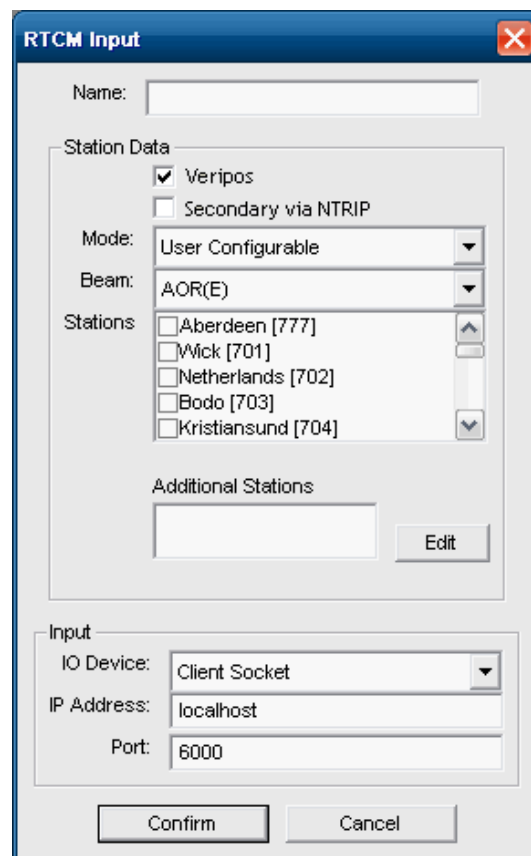*Note: Use VeriChart planning software available from [help.veripos.com](help.veripos.com) to determine the stations appropriate for the work area. Verify QC will NOT use any selected stations that are 2500km or more from the users' location in the DGNSS calculations.*

The reference station selection in the VERIPOS IMU and in Verify QC need to be matched such that all stations required for calculations in Verify QC are also enabled on the corresponding RTCM output port of the IMU.



**RTCM Stations**

### 5.2.1.8  Additional Stations

Previously undefined VERIPOS stations can be added to the station list of a VERIPOS beam. You will need to add these when VERIPOS announces a new station available on that beam.

Users can add a station by selecting 'Edit' under Additional Stations. The Additional Stations dialogue will open and new stations can be defined, edited or deleted:

**Additional Stations dialogue**

Added stations will be included in the Stations list for selection.
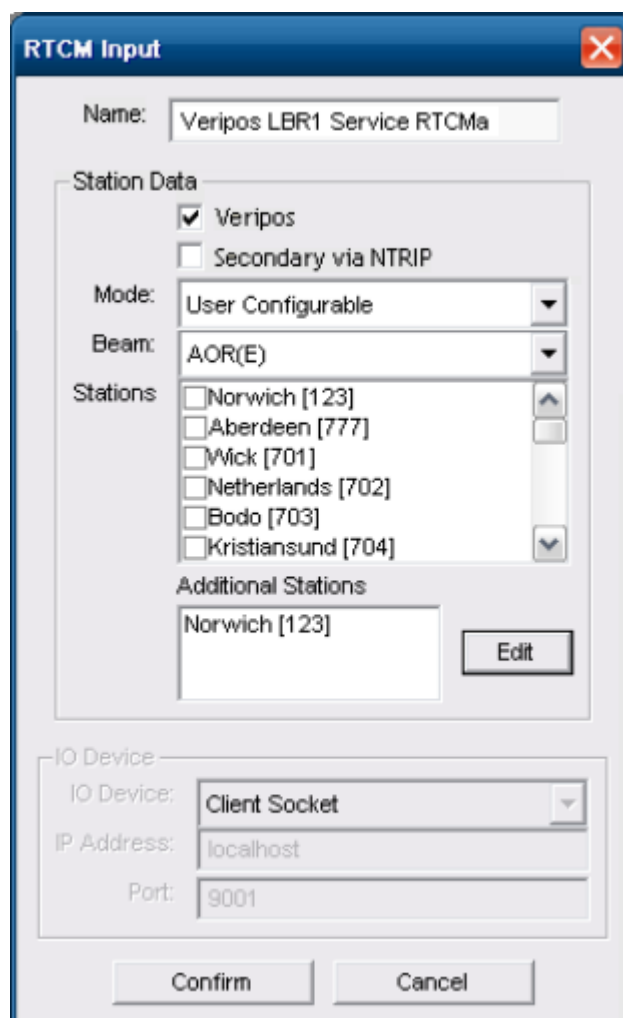


**Additional Stations**

When adding <u>new</u> stations:

- Ensure the new station was indeed added to the selected beam
- The demodulator configuration must be update separately to enable stations on its RTCM output port. See the Veripos IMU manual

### 5.2.1.9  IO Device

IO Device is configured automatically for installed RTCM Sources (i.e. RTCMa, MF and UHF).

Additional (external) RTCM inputs can be interfaced and configured via Serial Port, Client Socket and Datagram.

Serial Port, Client Socket and Datagram connection details are detailed in the Appendix.
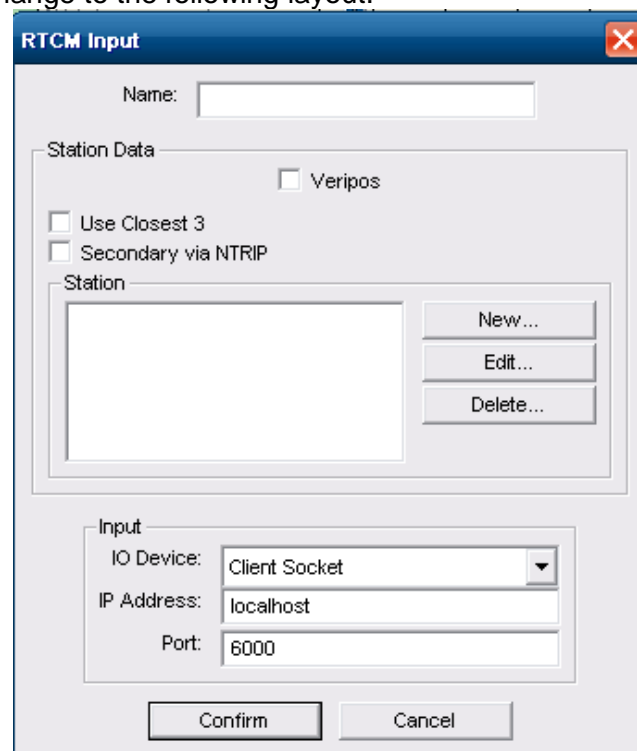
### 5.2.1.10  Use of Non-VERIPOS RTCM stations

Verify QC is capable of using non-VERIPOS corrections. These corrections should comply with the RTCM SC104 V2 format.

Stations need to be coordinated in the ITRF reference frame to ensure compatibility with the VERIPOS reference station network.

*Note: VERIPOS cannot guarantee the performance of position calculations that include correction data from 3$^{rd}$ party non-VERIPOS RTCM stations.*

When interfacing a non-VERIPOS RTCM source, uncheck the VERIPOS box. The RTCM Input dialogue will change to the following layout:



**Non-VERIPOS RTCM Stations**

Click on "**New**".

A New Station dialogue helps you to define non-VERIPOS stations.



**New Station**

Enter the station *Name* and *RTCM ID*. The RTCM ID is obtained from the reference station provider.

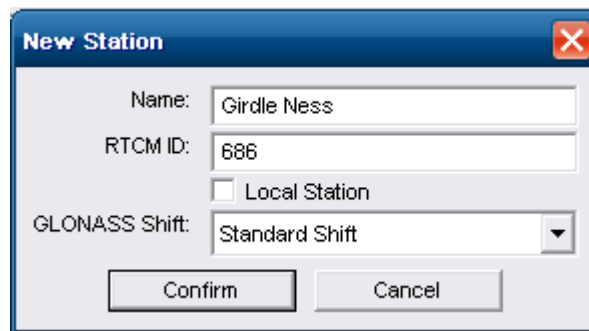If the RTCM ID is unknown it can be read from the RTCM message header in the Verify QC IO view after the Device IO settings have been entered.

Select "*View/IO*" then right click and change the input source to RTCM.

The RTCM ID is stamped at the start of the decoded RTCM header information in each message.

In the example below, RTCM messages with ID 0505 and 0506 are being input.
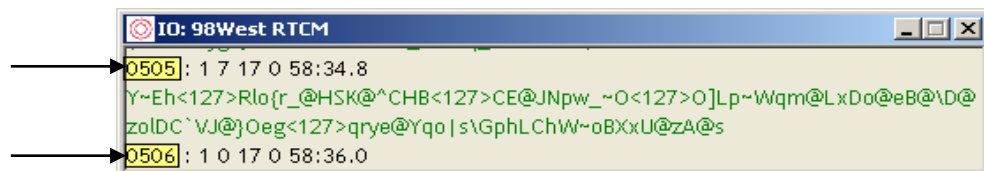


**View IO View**

Verify QC requires the RTCM Type 3 (and when using GLONASS stations, the RTCM Type 32) to determine the reference station location.  Where not present the station data will be rejected by Verify QC.

In order to use reference stations that do not provide Type 3 and/or Type 32 message, but are at a short range, the user needs to tick the box 'Local Station'. Verify QC will then assume that this station is at the users' location, not apply any differential tropospheric and ionospheric models, and subsequently use this correction data.

The GPS-to-GLONASS datum shift used by the reference station receiver is normally detected automatically from the Type 3 and Type 32 messages. Users of non-VERIPOS stations need to select the datum shift between the GPS and GLONASS reference frames for the non-VERIPOS stations.

Options available are:

- Standard shift (Topcon/Javad default)
- RTCM shift (RTCM v2.3)
- NovAtel shift (NovAtel default)
- Zero Shift

These shifts have the following predefined Helmert parameters:

| Shift | dX (m) | dY (m) | dZ (m) | rX (rad) | rY (rad) | rZ (rad) | Scale |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Standard | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | -1.00e-6 | 1.0 |
| RTCM | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | -1.66e-6 | 1.0 |
| NovAtel | 0.0 | 2.5 | 0.0 | 0.0 | 0.0 | -1.90e-6 | 1.0 |
| Zero | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |

If the RTCM decoding of non-VERIPOS stations is to be automatic then the option 'Use Closest 3 'should be selected. The manual station configuration area is then made unavailable in the dialogue. Verify QC will then automatically select the closest 3 stations based on their coordinates in the RTCM Type 3 messages and label them with identifiers N1, N2 and N3. These stations will appear in the 'Config/Calculation/New GNSS Calc…' dialogues with name 'N1 {*RTCM Input Name [ID]*}' etc, as for example in the dialogue below:
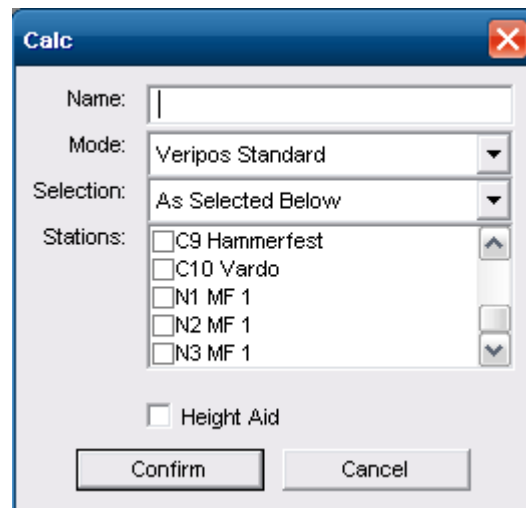


**Closest Non-VERIPOS Station Names**

*Note: stations that do not broadcast RTCM Type 3 message will not be detected by the automatic 'Use Closest 3' process and therefore cannot be used in Verify QC position calculations.*

### 5.2.1.11  IO Device

The *IO Device* section supports RTCM inputs via Serial Port, Client Socket and Datagram.

Serial Port, Client Socket and Datagram connection details are detailed in the Appendix.

Guideline settings for RTCM data: -
- Baud Rate :  9600
- Data Bits:    8
- Parity:        None
- Stop Bits:    1

Users should consult the manual for the demodulator used to provide the RTCM input to Verify QC to confirm the settings.

## 5.2.2  Editing Existing RTCM Inputs

The *Config/RTCM* menu lists all configured RTCM inputs.
Input can be selected separately for editing, deletion or change of order as required.

### 5.3  DEMODULATOR INPUT

The demodulator input is the Demodulator Status message from the L-Band Demodulators in VERIPOS LD6.

This option is preconfigured when running Verify QC on board the LD6
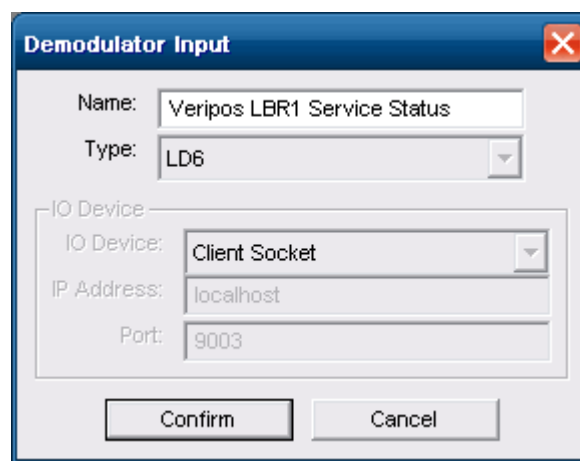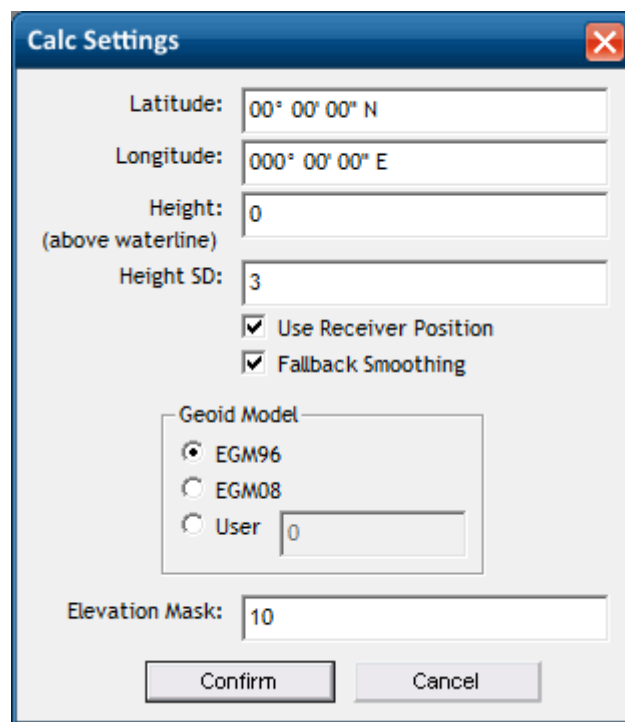


**Demodulator Status**

5.4  CALCULATION

There are no *software* limitations to the amount of calculations that can be configured in Verify QC. Limits are defined by the user hardware, particularly the availability of processor and memory resources.

### 5.4.1  Settings

Click **"***Config/Calculation/Calc Settings***"** to bring up the Calc Settings dialogue box.



**Calc Settings**

It is optional (but not essential) to enter a trial point into Verify QC to start the positioning process.  Entering the current approximate position as a trial point will speed up the calculation process.

Alternatively *Receiver Position* can be used and the trial point will be based on the uncorrected position as output by the GNSS receiver.

It is necessary to enter the user's location when referencing the calculated positions to the Trial Point in the Track Plot and Time Series windows.  This is of help when comparing a static point to the computed positions within Verify QC.

### 5.4.1.1 Height

This measurement is the height of the GNSS antenna phase centre above the waterline of the vessel.

The height information is used for Geoid Tides and height aided DGNSS calculations.

The antenna height is used in Tides to reduce the antenna location to the waterline before calculating the GeoidTide values only. Hence changes to this parameter will have an immediate effect on the estimated GeoidTide values but will not influence the estimation of the MSSTide values.

Height aiding can be used to add an extra observation to the position calculation in order to provide additional cover for periods when the GPS constellation is weak or insufficient to calculate a position.

*Height* and *Height SD* values are used when Height Aiding is selected during calculation setup.

If the *Height SD* value is reduced, the weighting of *Height* value will increase.
(See relevant sections in this manual.)

The *Height SD* value entered should represent the total uncertainty of:
- the accuracy of the GPS antenna height measurement
- the expected fluctuations in antenna height due to vessel movements caused by swell
- changes in draft and tides
- the accuracy of the Geoid model

*Note: Height Aiding does not fix the height.*

*Note: height aiding should not be used in land locked waterways (the Geoid and Mean Sea Levels do not coincide). Height aiding is not applied to the Apex and Ultra calculations.*

### 5.4.1.2 Fallback Smoothing

The Fallback Smoothing option is enabled by default.  When enabled, this smooth's the transition between the Apex/Ultra solutions and their fallback /backup solutions. This is accomplished by breaking down the distance between solutions and transitioning from the previous solution to the active solution in smaller increments over time, the solution position doesn't immediately jump.

When the Fallback Smoothing option is unchecked, the transition will not be smoothed, therefore will immediately switch between the previous and active solutions as soon as they become active and a position jump will be observed between calculations.

The Fallback Smoothing option is primarily for use with the VERIPOS AXIOM application, where Fallback Smoothing should be disabled.

### 5.4.1.3  Geoid Model

Users can select the EGM96, EGM08 Geoid/Spheroid Separation Model or an externally derived separation value, by selecting the *User* radio button.  By default the system uses EGM96.

A User defined separation value should be maintained as the user moves around the area.

*Note: The User option should only be used when the exact Geoid/ellipsoid separation from an alternative source or model is known.*

### 5.4.1.4  Elevation Mask

The user elevation mask sets the minimum elevation at which a satellite will be used in the position calculations. By default the elevation mask is set to $10^0$.

The VERIPOS reference stations are all configured to provide corrections above a $7^0$ elevation mask.

Changing the elevation mask in Verify QC can affect which reference stations are used for corrections, as the following logic is applied:

| | |
|---|---|
| User elevation mask ≥ $10^0$ | correction elevation mask = $10^0$ |
| User elevation mask < $10^0$ and ≥ $5^0$ | correction elevation mask = user elevation mask |
| User elevation mask < $5^0$ | correction elevation mask = $5^0$ |
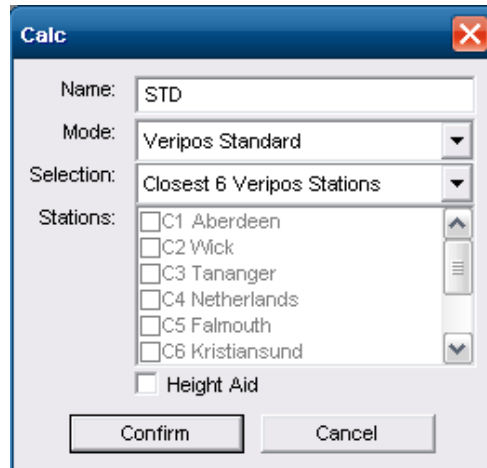
A higher mask setting may be useful where satellites at slightly higher elevations are suffering poor signal to noise ratios or intermittent masking.

*Note: setting the elevation mask does not change the GNSS receiver configuration. Verify QC manages the elevation mask setting of the GNSS receiver, which is automatically set to $0^0$.*

*Note: the VERIPOS Apex and Ultra calculations use a fixed elevation mask of $7^0$.*

### 5.4.2  New DGNSS Calc

Click "*Config/DGNSS Calculation/New DGNSS Calc…*" to configure a new calculation.



**DGNSS Calculation dialogue**

5.4.2.1  DGNSS Calc Name
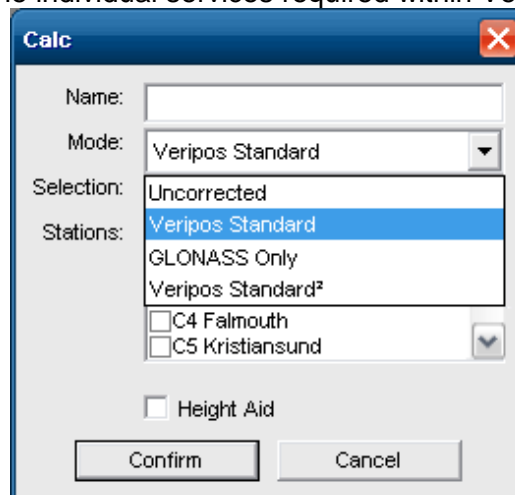
Allocate a name to the calculations in the Name box.  Use a descriptive name to make it easy to identify the individual calculations when viewed in the Calculation Status window ("*View/Calculation/Calculation Status*").

If left blank Verify QC will assign a name automatically based on the number of reference stations selected. e.g. when 5 stations are selected the software will assign the name "Network of 5". When one station is selected the name of that station will be assigned as the name of the calculation.

### 5.4.2.2 DGNSS Calc Mode

Choose the desired calculation *Mode* (Uncorrected, VERIPOS Standard, VERIPOS Standard² or GLONASS Only). Please note that the VERIPOS demodulator will have to be enabled accordingly for the individual services required within Verify QC.
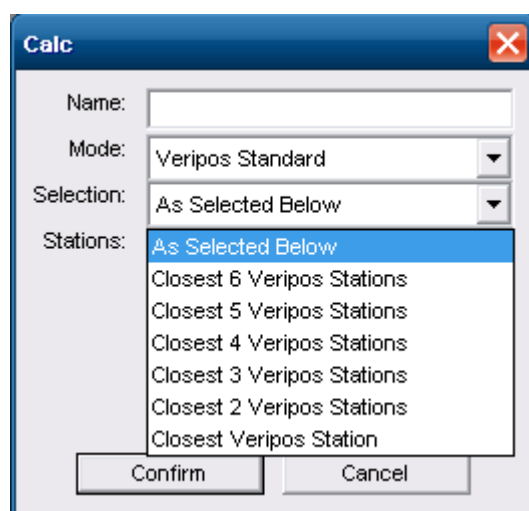


**DGNSS Calculation Mode Selection**

### 5.4.2.3 DGNSS Calc Selection

When **'***Selection'* is set to '*As Selected Below'*, the user can manually select a preferred list of stations from the **'***Stations***'** list for use within the calculation. This list is derived from the stations that were defined under 'Config/RTCM Input...'

Alternatively, a 'Closest Station' calculation can be created. Verify QC can automatically select the closest between 1 and 6 stations within a 1500km range for use within a calculation. Choosing one of these settings means manual selection of stations is no longer presented as an option.



**DGNSS Calculation Selection**

The following logic is applied for the station selection for 'Closest Stations' calculations:
1. Only stations within 1500km range are selected
2. Only VERIPOS stations are selected – non-VERIPOS stations are excluded
3. A 'Standard' calculation only selects stations with RTCM Type 1 messages
4. A 'GLONASS Only ' calculation only selects stations with RTCM Type 31 messages
5. A 'Standard²' calculation first selects stations which provide both RTCM Type 1 and RTCM Type 31 messages. The remaining station slots are then filled with stations that only provide RTCM Type 1 messages

### 5.4.2.4 DGNSS Calc Stations

Where 'As Selected Below' is selected users can select the Stations to be use in the calculations.
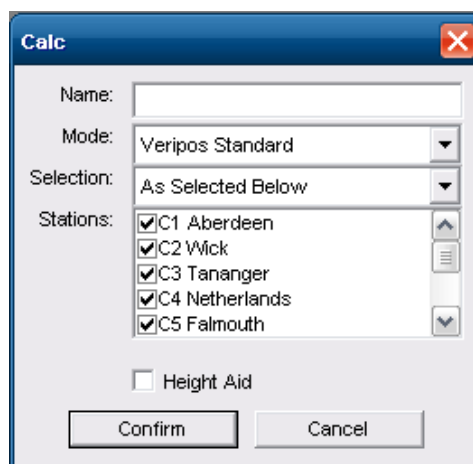
All reference stations that were defined on each of the RTCM inputs will be available in the *Stations* box in the calculation dialogue box.

Select the required reference stations by ticking that box in the list. If more than one station is to be selected highlight the range of stations to be used and select a tick box. This will tick all of your highlighted stations.
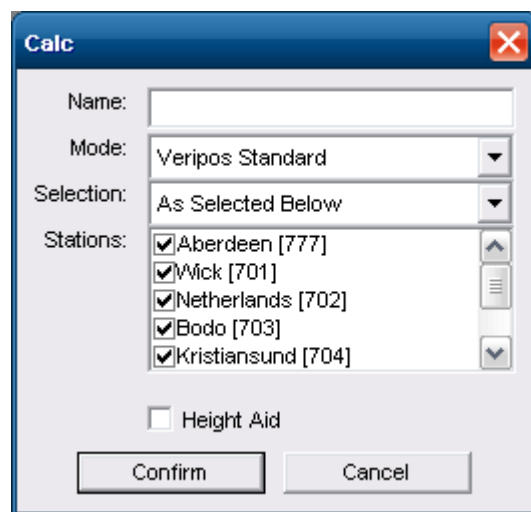


**DGNSS Calculation Stations**

The stations will appear differently if you selected 'Closest 10 Stations' under the RTCM Input. Then the closest VERIPOS stations all have a prefix Cn in front of their name:
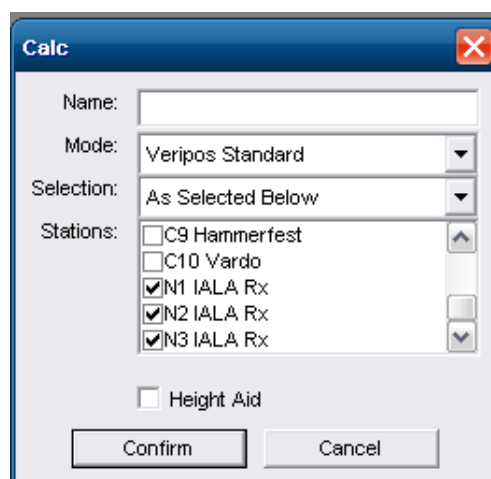
**DGNSS Calculation Stations – using Closest RTCM Input Stations**

Selecting C1 and C3 means that the 1st and the 3rd closest stations will be used in the calculation - independent of their station name or station ID. This means that the data for the closest 4th station will automatically take the place of the closest 3rd station in case the latter is no longer received.

Similarly, closest non-VERIPOS stations all have a prefix Nn in front of their names:



**DGNSS Calculation Stations – using Closest non-VERIPOS RTCM Input Stations**

Using these closest RTCM Input feature allows the user vessel to roam a larger (or even a Global) area without the need to closely monitor or update the station selection.

Checking the *Height Aid* tick box adds an observation based on the height entered in the Calc Settings dialogue.

*Note: Enabling height aiding allows the Standard, GLONASS Only and Standard² calculations to work with as little as 3 GNSS satellites. This can be beneficial in environments with significant masking or in geographic areas of higher ionospheric disturbance where scintillation can effectively reduce the amount of satellites in view, or when working in areas that are subject to masking of satellites.*

### 5.4.3  Ultra

*This menu option is available only with an Ultra enabled dongle.*

VERIPOS Ultra service is based on the Precise Point Positioning (PPP) technique. Using this technique the GNSS orbit and clock errors in the GNSS systems are corrected and remaining system errors are estimated or mitigated to a high degree of accuracy giving a position solution with a decimetre level accuracy.

The Ultra calculation is automatically made available when the dongle is enabled for Ultra.

The **Ultra calculation** is possible where the conditions exist as follows:

1. The Verify QC dongle is enabled for Ultra.
2. GPS receiver has dual channels and is receiving both frequencies.
3. The VERIPOS demodulator is enabled for the Ultra Service.
4. The Ultra "station" ID is enabled on the demodulator output port.
5. The "Veripos" check box is ticked in the Station Data dialog box.

The **Ultra GPS and GLONASS (Ultra$^2$)** calculation requires the following additions:

1. The Verify QC dongle is enabled for Ultra and Glonass.
2. GNSS receiver is enabled for GPS and GLONASS, has dual channels and is receiving both frequencies.
3. The VERIPOS demodulator is enabled for the Ultra$^2$ Service.
4. The Ultra "GPS station" ID AND "GLONASS station" ID are enabled on the demodulator output port.

The "*Config/Calculation/Ultra*" option allows users to select the PPP Mode and up to 4 backup solutions for when the Ultra solution is not available.

The backup solutions can be selected from Apex or the user defined Standard, Standard+ or Standard GLONASS calculations (see 'New DGNSS Calc' section in this manual).

The PPP Mode dictates which constellation is used in the Ultra calculation. This will be GPS Only or GPS and Glonass. The PPP Mode is available if Ultra and Glonass options are enabled on the dongle and Glonass is ticked in Advanced Options. If Glonass is not enabled on the dongle or ticked in Advanced Options the Ultra calculation will be GPS Only.
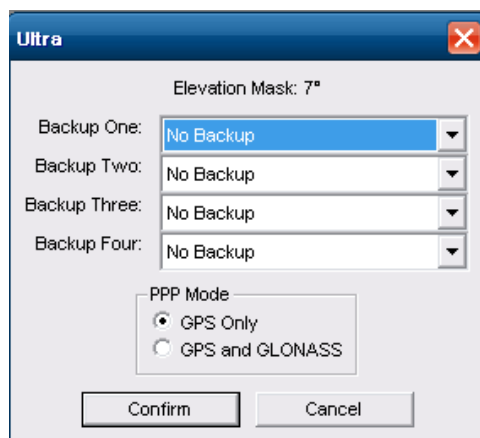


**Ultra dialogue**

The logic of the backup process is as follows:

1. *An Ultra solution will be output if the calculation is in 'Ultra' mode and has a minimum of 5 satellites reported in the 'Calculation Status' view*
2. *Alternatively, the 'Backup One' solution will be output provided its mode is 'Differential' or 'Reduced Differential'*
3. *Alternatively, the 'Backup Two' solution or the 'Backup Three' solution or the 'Backup Four' solution will be output provided its mode is 'Differential' or 'Reduced Differential'*
4. *Alternatively, an uncorrected solution will be output*

Steps 2 and 3 are omitted from the process if no backup solutions have been selected.

A smoothing process is used during switches between the different stages of the backup process allowing Verify QC to seamlessly fall back without steps or interrupting in the Ultra position output. The smoothing process removes the initial difference between the previous and current calculation stage over a 100sec time period.


### 5.4.4  Apex

*This menu option is available only with an Apex enabled dongle.*

VERIPOS Apex service is based on the Precise Point Positioning (PPP) technique. Using this technique the GNSS orbit and clock errors in the GNSS systems are corrected and remaining system errors are estimated or mitigated to a high degree of accuracy giving a position solution with a decimetre level accuracy.

The Apex calculation is automatically made available when the dongle is enabled for Apex.

The **Apex calculation** is possible where the conditions exist as follows:

1. The Verify QC dongle is enabled for Apex.
2. GPS receiver has dual channels and is receiving both frequencies.
3. The VERIPOS demodulator is enabled for the Apex Service.
4. The Apex "station" ID is enabled on the demodulator output port.
5. The "Veripos" check box is ticked in the Station Data dialog box.


The **Apex GPS and GLONASS (Apex$^2$)** calculation requires the following additions:

5. The Verify QC dongle is enabled for Apex and Glonass.
6. GNSS receiver is enabled for GPS and GLONASS, has dual channels and is receiving both frequencies.
7. The VERIPOS demodulator is enabled for the Apex$^2$ Service.
8. The Apex "GPS station" ID AND "GLONASS station" ID are enabled on the demodulator output port.

The "*Config/Calculation/Apex*" option allows users to select the PPP Mode and up to 4 backup solutions for when the Apex solution is not available.

The backup solutions can be selected from Ultra or the user defined Standard, Standard+ or Standard GLONASS calculations (see 'New DGNSS Calc' section in this manual).

The PPP Mode dictates which constellation is used in the Apex calculation. This will be GPS Only or GPS and Glonass. The PPP Mode is available if Apex and Glonass options are enabled on the dongle and Glonass is ticked in Advanced Options. If Glonass is not enabled on the dongle or ticked in Advanced Options the Apex calculation will be GPS Only.
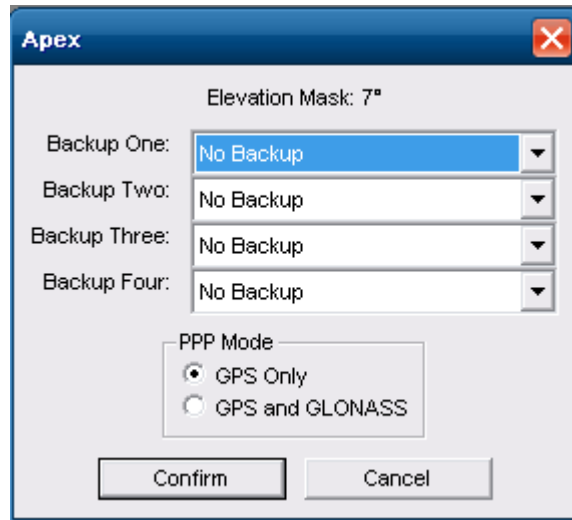


**Apex dialogue**

The logic of the backup process is as follows:

1. An Apex solution will be output if the calculation is in 'Apex' mode and has a minimum of 5 satellites reported in the 'Calculation Status' view
2. Alternatively, the 'Backup One' solution will be output provided its mode is 'Differential' or 'Reduced Differential'
3. *Alternatively, the 'Backup Two' solution or the 'Backup Three' solution or the 'Backup Four' solution will be output provided its mode is 'Differential' or 'Reduced Differential'*
4. Alternatively, an uncorrected solution will be output

**N.B.** Steps 2 and 3 are omitted from the process if no backup solutions have been selected.

A smoothing process is used during switches between the different stages of the backup process allowing Verify QC to seamlessly fall back without steps or interrupting in the Apex position output. The smoothing process removes the initial difference between the previous and current calculation stage over a 100sec time period.
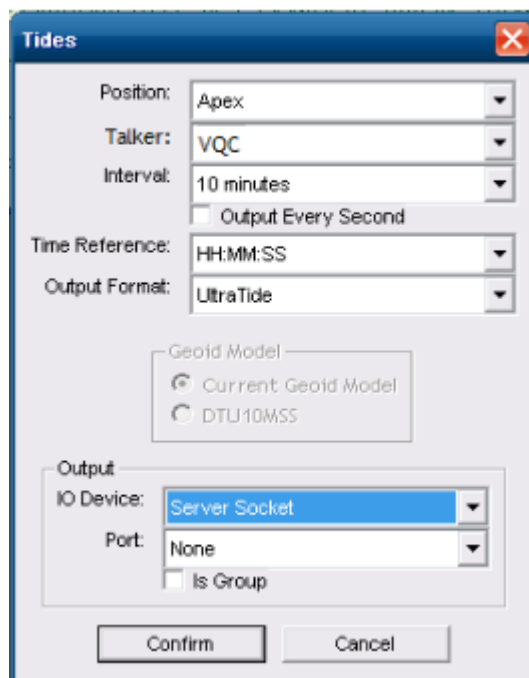
### 5.4.5 MSS Tides

*Tides calculation is available only with dongles specifically enabled for Tides and Apex and/or Ultra. If the dongle is not Tides enabled, the MSS Tides menu option will NOT be shown in the Config menu.*

Tides calculation creates Tides estimates relative to two different vertical references:
- Geoid Tide, relative to the Geoid model selected in the Calculations settings dialogue. It is an instantaneous tide estimate, generated soon after the Tides calculation is initialised
- Ultra Tide. This is calculated relative to Mean Sea Surface.
  The Ultra Tide calculation requires 39 hours of historic height information to be available before a tide estimate can be generated

Select "*Config/Calculation/MSS Tides*" to configure the Tides calculation.



**Tides dialogue**

#### 5.4.5.1 Tides Directory

The Tides files are stored within the Config/ *Config Name*/ Tides directory

#### 5.4.5.2 Tides Position

The position input is defined here. Users can choose from Apex and Ultra, depending on which features have been enabled on the dongle.

### 5.4.5.3  Talker

Choose the Talker between VQC and Standard.
If Standard is selected then the talker ID in the tide output files (TideInfo.txt & Doodson.txt) will be **'$UltraTide'** or **'ApexTide'**, depending on which solution is used for the tides calculation.

When VQC is selected the talker ID will be **'VQCnnnTide'**, where *nnn* represents the Verify QC version number.  For example if Verify QC v1.13 is used, it will have a talker ID of **'VQC113Tide'.**

### 5.4.5.4  Geoid Model

Verify QC supports the use of a Mean Sea Surface (MSS) model, relative to which the user can estimate tides. The Mean Sea Surface is the displacement of the sea surface relative to a mathematical model of the earth. It closely follows the Geoid (approximated by EGM models), though with additional Mean Dynamic Topography deviations due to currents etc. The Geoid Model has 3 options available and can be selected from *"Config/Calculation/Settings…"*.  For further information regarding geoid models within Verify-QC see section 4.4.1.3.

Currently the DTU10MSS model is unavailable for use with Verify-QC.  As a result the DTU10MSS will remain unavailable for selection within the Tides configuration.

### 5.4.5.5  Tides Interval

*Interval* is the period over which the height information is averaged to remove the impact of heave. A 10 minute averaging interval is recommended for the Tides calculation.

### 5.4.5.6  Output every second

When this box is checked the interval of the real time output of tides message is 1 second. The message is repeated for the period set in the Tides Interval and is updated with the new values after the interval has passed.

The Tides logged files (Tides Info and Sprint) are unaffected by this check box, they are updated after the interval period.

### 5.4.5.7  Time Reference

The Time reference is the time stamp format used in the UltraTides (TidesInfo) message.
- HH:MM:SS:    This time format is Hour,  Minutes, Seconds in UTC
- GPS:            This time format is seconds starting at 00:00:00 6th Jan 1980

### 5.4.5.8  Output Format

MSS Tides can output the Tides information via Serial Port, Server Socket or Datagram in addition to the Tides information being logged to file

The Output Format selects the format of data that will be output on the selected IO Device. The output format can be set to UltraTide or SPRINT. Details of these formats can be found in *Appendix G*.

The UltraTide output will not include values for Doodson, Ultra Tide and Draft for the first 39hrs of use. Verify QC will re-calculate all Tide values and update the existing *TideInfo.txt* file once it has enough data to populate the Doodson filter. Any separate records made using real-time output will not benefit from this feature.

### 5.4.5.9  IO Device

The *IO Device* section supports Real time Tides output via Serial Port, Server Socket, and Datagram.

### 5.4.5.10  Tides Antenna Height

The *Antenna Height* entry has been moved to "*Config/Calculation/Settings*" in Verify QC Version 1.10. Details can be found in section 4.3.1 of this document

## 5.4.6  PPP Ref Calculation

The PPP Ref calculation (Config/Calculation/PPP Ref/Calculation) uses the current position of the Apex or Ultra calculation as a 'virtual reference station' location, for which real-time DGPS corrections in RTCM format are calculated. This calculation is specific to VERIPOS. This function allows highly stable and accurate DGPS corrections to be calculated and then be output to external DGPS systems or a telemetry link.

### 5.4.6.1  PPP Ref Name

PPP Ref Name (is used to allocate a name to the PPP Ref calculation)
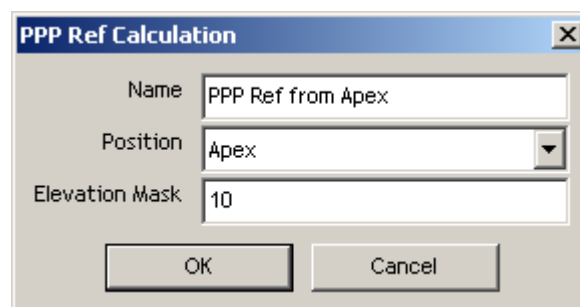


**PPP Ref calculation dialogue**

### 5.4.6.2 PPP Ref Position
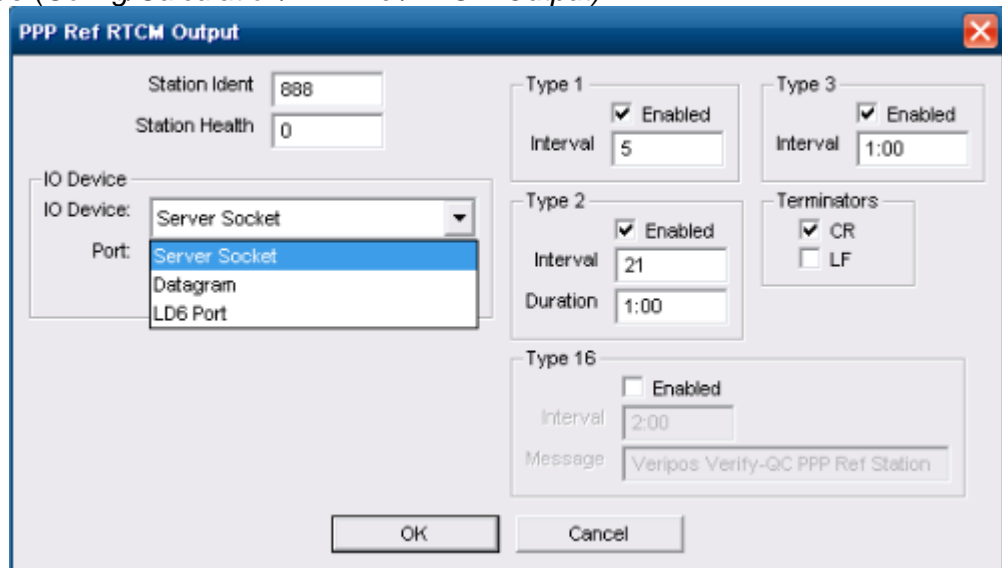
This allows the PPP solution to be used as the reference position for the PPP ref process to be selected. Users can select, depending on their availability, from Ultra or Apex.

### 5.4.6.3 PPP Ref Elevation Mask

This sets the user elevation mask for PPP Ref calculation.

### 5.4.6.4 PPP Ref RTCM Output

The actual RTCM output parameters and IO Device settings are configured in a second dialogue (*Config/Calculation/PPP Ref/RTCM Output)*.



**PPP Ref RTCM Output dialogue**

### 5.4.6.5 PPP Ref Station Ident

Use this to set the RTCM Station ID of the PPP Ref corrections (between 0-1023).

### 5.4.6.6 PPP Ref Station Health

Use this to set the RTCM Station Health of the PPP Ref corrections (between 0-7
As defined in RTCM v2.3, where 0 is healthy and 7 is unhealthy.

### 5.4.6.7 PPP Ref IO Device

The *IO Device* section supports RTCM output via Serial Port, Server Socket and Datagram. Details are in the Appendix.

### 5.4.6.8  PPP Ref RTCM Settings

The PPP Ref calculation can output the RTCM messages required for a single-frequency DGPS calculation, i.e. Type 1, Type 2 and Type 3 messages.
PPP Ref also supports Type 16 messages to keep DGPS systems up to date on the source of the DGPS corrections.
Each of these messages can be enabled and their output intervals set.

The output interval of Type 1 and Type 2 messages is defined in seconds.
The output interval of Type 3 and Type 16 messages is set in minutes.

### 5.4.6.9  PPP Ref Terminators

By default a carriage return (CR) is added to each RTCM message. The CR can be removed. An additional option exists to add a Line Feed (LF) to each RTCM message.

## 5.5  POSITION OUTPUT

There are no *software* limitations in the Verify QC to the number of outputs that can be configured.

### 5.5.1  New

Click "*Config/Position Output/New…*"

This will open the following dialogue:



**Output Name**

#### 5.5.1.1  Position Name

A *Name* can be given to the output. Use a name that indicates which calculation is being output and the external system connected.

#### 5.5.1.2  Position

Select the *Position* calculation to be used. The pull down menu displays the list of all user configured calculations.
Apex and Ultra will be included where these are enabled on the dongle.

### 5.5.1.3 Position Message

Select the *Message* type to output from:
- NMEA
- WesternGeco TRINAV
- WesternGeco TRINAV V3
- VERIPOS UKOOA Output
- VERIPOS UKOOA2 Output
- GPLCT
- Veripos Applications - (Axiom)

The NMEA message type allows users to select one or more NMEA sentences.
Of these the GGA (DP), GLL, GST, ZDA, GNS, VTG (Default), GSV and GSA all conform to the NMEA v3.0 standard.

Further options exist for the GGA and VTG sentences. Options 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 (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 and Apex solutions
- 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 or Apex solution and 2 for a differential Standard, Standard+ or Standard GLONASS solution. Increased precision (7 decimals for Lat & Lon)
- GGA (DP) - fully NMEA-0183 v3.0 compatible string. Number of SV's is limited to 12 and the sentence length is restricted to 82 characters
- VTG (Default) - conforms to NMEA v3.0 standard
- VTG (Old) - conforms to NMEA v2.3 standard

The Axiom String is a proprietary string for use with VERIPOS INS Module (Axiom).

Detailed descriptions of Verify QC position output messages are contained in Appendices.

### 5.5.1.4  IO Device

The *IO Device* section supports position output via Serial Port, Server Socket and Datagram.

Serial Ports are restricted to Com 9 to 14.  Server Sockets and Datagrams are restricted to ports 19201 to 19206.

If using Serial Ports the following options must be configured on the LD6 IMU front panel:
- Baud Rate
- Data Bits
- Parity
- Stop Bits
- Protocol (RS232 or RS422)

See Appendix for details.

### 5.6  CSL OUTPUT

*Note: this menu option is available only with a "CSL Output" enabled dongle.*

The CSL Raw Output option allows users to output a series of records to the Concept Systems Limited (CSL) ViGPS* process (built into CSL navigation products).

This process can accept satellite data over an Ethernet or serial connection and convert it to CSL format.

*For further information contact CSL www.csl.co.uk . CSL are a subsidiary of ION.
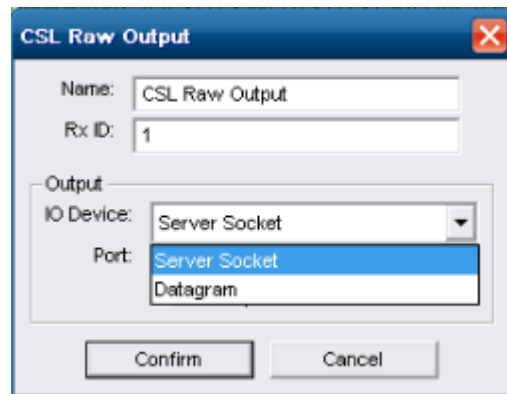


**CSL Raw Output**

Allocate a name to the output. If no name is entered it will default to 'CSL Raw Output'.

The *Rx ID* output must be enabled for it to become active. It is in the range of 0-99 and is used by the receiving application to identify the source of the CSL Raw messages.

The *IO Device* section supports CSL Raw output via Server Socket and Datagram.

See the Appendix for details.

## 6.LOGGING

Verify QC can log all raw GNSS data and raw RTCM data to files in the proprietary Verify QC logging format.
Verify QC can also log the GPS data in RINEX (Receiver INdependent EXchange) format.

*Note: When Verify QC is running on an LD6 the logging paths are all pre-set to the Config folder. As a result there is no need to browse for a file location. To remove data from an LD6 unit use the File Manager application preinstalled on the LD6 (See section 11).*
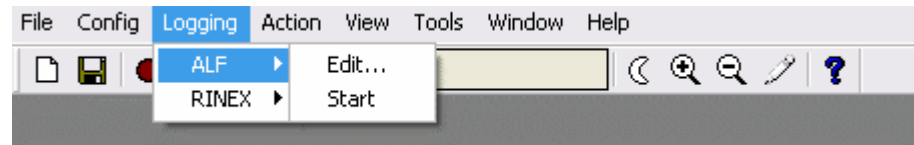


**Logging menu structure**

### 6.1  ALF

Verify QC can be configured to log all GNSS data and RTCM data to files in the proprietary Verify QC logging format. The data can be archived and replayed at a later time to provide the same information as seen real time, enabling additional offline analysis to be undertaken.

### 6.1.1  Edit

*"Logging/ALF/Edit…"* allows the user to set the desired file size prior to starting the logging process.

ALF file location is preconfigured to the "Config/ *Config Name*/ Data" folder
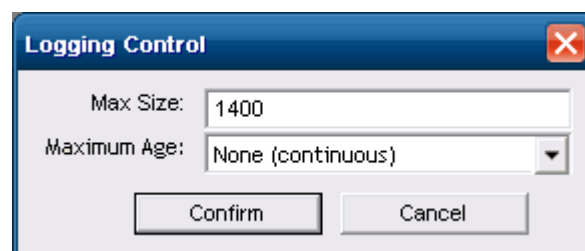


**Logging Control**

Enter the logging file "*Max Size"*. Default is 1400kB.

Files are logged for fault finding may be emailed and the recommended file size is 1400kB. When logging data for review and archive purposes the recommended file size is 2000-5000kB. The maximum allowable file size is 10,000kB.

Once a file reaches the set maximum file size, Verify QC will open a new, additional file automatically and assign a unique name using date and time of file creation.

Within the 'Maximum Age' field, Verify QC offers options to clear old log files at intervals of:
- None (continuous) – **Default**
- Daily (24 hour)
- Weekly (7 day)
- Monthly (31 day) N.B. a **31 day month** will be used irrespective of the calendar, to allow for overlap and data recovery.

### 6.1.2  Start

Click on the red 'record' button in the tool bar to start logging.

Alternatively *"Logging/ALF/Start"* starts data logging and confirms the logging control settings.



**Logging Start Button**

A name for the logging session and useful information can be added. This will show when selecting a log for replay. VERIPOS recommend adding information on the hardware and software configuration and operating environment.  This aids analysis of the replay and provides an opportunity to describe any specific areas for review.
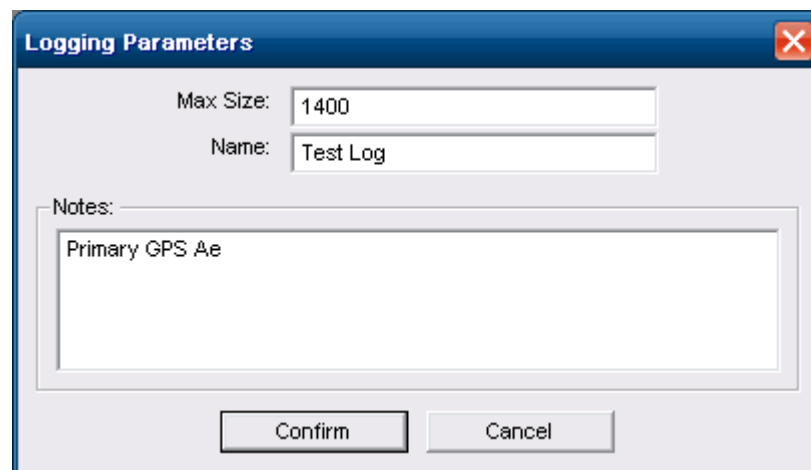


**Logging Parameters**

Information you enter is stored in the Logging Schedule (**.ars** file) in the same directory as the Verify QC logging files. *Name* field is used as the filename.

Once *Path* and *Notes* fields have been completed click "**OK"** to start the log.
When logging commences Verify QC menu options and the toolbar will update to include "Pause" and "Stop" buttons.
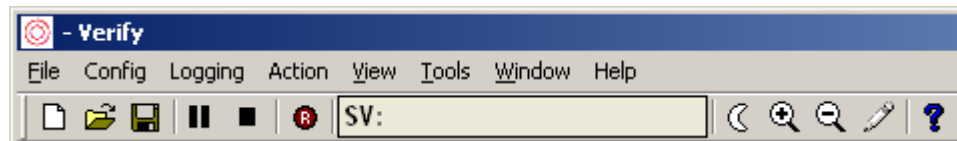
**- Pause**     **- Stop**

**Logging Button**

## 6.2  RINEX

Verify QC software supports RINEX v2.10 standard and can log GPS data files in the RINEX format. Logging intervals of 1, 15 and 30 seconds are available.



**RINEX Logging menu**

RINEX logging must be ticked in *Tools/Advanced Options* before RINEX logging can be used.

Use "*Logging/RINEX/Edit…*" to bring up the RINEX Logger dialogue box.

The RINEX Logger dialogue appears:
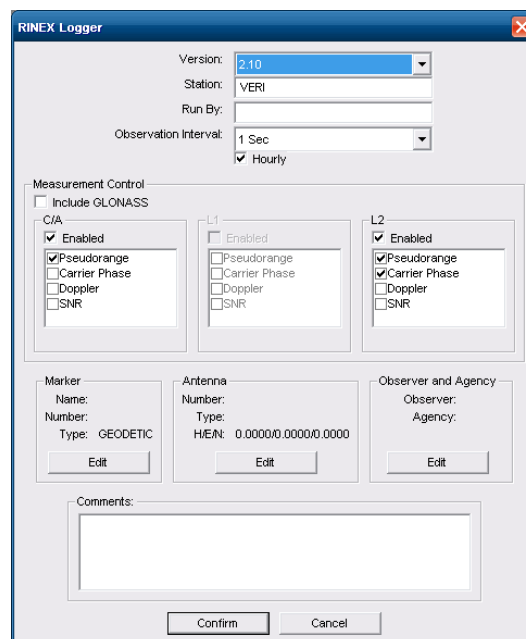


**RINEX Logging**

### 6.2.1.1 RINEX – Version

RINEX files that comply with the v2.10 standard can be logged.

### 6.2.1.2 RINEX Station

This is for entering a four character *Station* identifier, which will be used as the first 4 characters of the RINEX log files.

### 6.2.1.3 RINEX Run By

The operators' name may be entered.

### 6.2.1.4 RINEX Observation Interval

The files are automatically split at midnight if an interval is not selected.

The drop down menu allows users to select RINEX *Logging Interval* of 1, 15 or 30 seconds. RINEX data at a one second interval will amount to approximately 100Mb per day.

A one second interval is recommended or even required for dynamic users.
15 and 30 second intervals are more suited to static users.

*Hourly* creates a new file every hour.

### 6.2.1.5 Measurement Control

The three *Measurement Control* dialogue boxes C/A, L1 and L2 are used to select the GNSS observation types to be recorded in RINEX files.

*Note: which observation types are available is GNSS receiver dependant. Observations not available from the receiver will be greyed out.*

If the receiver only outputs C/A measurements - L1 and L2 dialogue boxes will be greyed out. Similarly, if receiver outputs C/A and L2 measurements but not L1, the L1 dialogue box will be greyed out.

The *Marker*, *Antenna*, *Observer* and *Comments* inputs allow configuration of the header within the RINEX file. It is recommended these are as complete as possible to aid post-processing and identification.

Click '**Confirm'** to complete the RINEX logging configuration.

Following this the 'Record', 'Play' and 'Pause' control buttons are visible in Tool Bar.

*Note: users are required to manually start RINEX logging after setting the following parameters for measurement control.*

Manually start RINEX logging by selecting the *"***Start RINEX Logging***"* control button on the toolbar or "*Logging/RINEX/Start* ".

## 7. ACTION

The Action drop down menu allows for commands to be sent to the processes as shown in the screen below:
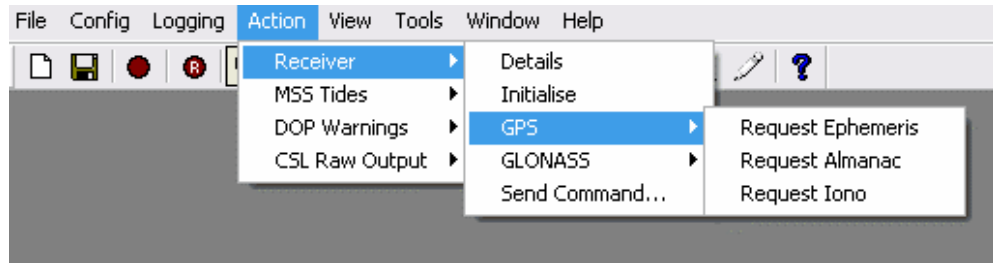


**Action Menu**

## 7.1 RECEIVER

*Note: GLONASS entries in the menu are only available if the dongle has been enabled for GLONASS.*
*Establish and Set receiver Baud Rate entries are only available when a GNSS receiver has been connected using a serial port and set to communicate at matching baud rates.*

### 7.1.1 Details

*"Action/Receiver/Details"* displays details of connected receiver hardware and software. Details vary on the receiver type used. Typically they include the receiver serial number and firmware version.
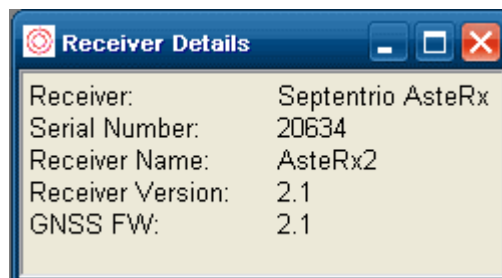


**Receiver Details View**

The view will populate only when Verify QC is connected to a receiver.
This example is for a Septentrio receiver.

### 7.1.2  Initialise

"*Action/Receiver/Initialise*" sends commands to configure the receiver for use with Verify QC.

*Note: this does not set or change the communication parameters. Interface the GPS receiver to Verify QC using "Config/GNSS Rx" prior to using this command.*

Users are not required to initialise the receiver once the software is operational.

Required when setting up a new system or when Verify QC stops receiving data from the GNSS Receiver.

#### 7.1.2.1  GPS/GLONASS Request Ephemeris

The command requests the latest GPS or GLONASS ephemeris data from the receiver.

These settings can be accessed via *"Action/Receiver/GPS/Request Ephemeris"* and "*Action/Receiver/GLONASS/Request Ephemeris"*.

Verify QC will actively request the ephemeris during normal software operation as required. Users are not required to request the ephemeris once the software is operational.

#### 7.1.2.2  Request Almanac

 *"Action/Receiver/GPS/Request Almanac"* and "*Action/Receiver/GLONASS/Request Almanac"* - requests the latest GPS or GLONASS almanac data from the receiver.

Verify QC actively requests the almanac. Not required once the software is operational.

#### 7.1.2.3  Request Iono

 "*Action/Receiver/GPS/Request Iono"* requests the latest GPS ionospheric model information from the receiver.

Verify QC actively requests the ionospheric model information. Not required once the software is operational.

### 7.1.3  Send Command

"*Action/Receiver/Send Command"* allows specific commands to be sent to the receiver. These must conform to the receivers' proprietary command structure.
Refer to manufacturer's documentation for details.
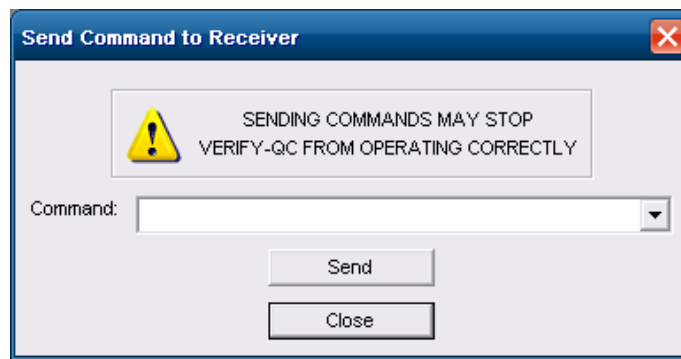
**Send Message**

*Note: take care when sending additional commands to the receiver.*
*These may interfere with normal operation of Verify QC.*

## 7.2  MSS TIDES

*Note: the Tides function is a dongle control advanced functionality in the Verify QC software.*

It can be used with VERIPOS Apex and Ultra services. The Tides function allows a vessel to determine local tidal height.

### 7.2.1  Reset

It is possible to reset the Tide calculation process manually when the work area changes or essential input information is known to have changed such as the antenna height above the waterline. Previously logged data is deleted and the Tides logging process starts afresh.

The Geoid Tide calculation gives an instantaneous tides estimate whereas the Ultra Tide calculation requires an initialisation period of 39 hours.
When the process is reset Ultra Tide estimates are not available for the first 39 hours after reset.
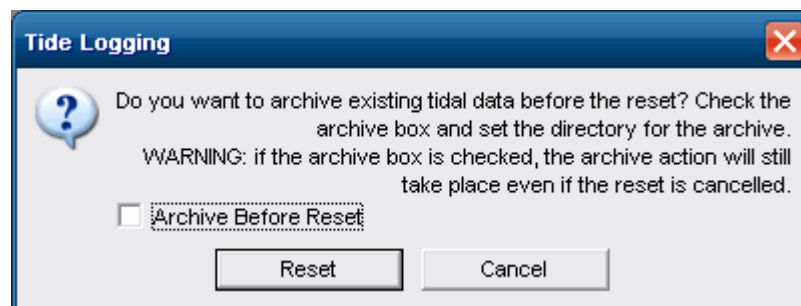


**Tides Dialogue Box**

An option to archive logged Tide information is presented before resetting.
Select an archive location where the two log files will be stored using "**Browse…"**

### 7.2.2 Archive

Logged Tide information can be archived whilst the Tide calculation is active.
Archiving the tide log files will not automatically reset the process.
The Archive function will copy the Tides logging files to a designated directory.

Files may be split using the drop – down box between daily, weekly or monthly.
*Note that* the Monthly option covers a **31 day** period.

To delete an existing Tides logging file, select the '*Delete files after archiving'* tick box.

***Please be aware that deleting files after archive will reset the tides calculation therefore do not delete the tides files if you require the tides calculation to continue.***

To Archive Tides data from the LD6 for Post Processing, click "*Action/MSS Tides/Archive…"*

The following window will appear:
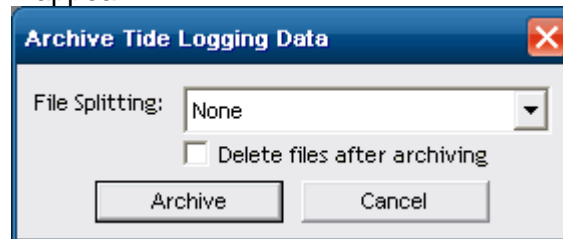


**Tides Archive**

Select *Archive* button

The data can be copied the following folder on the LD6:

Archive/ *DateandTimestamp*/ Tides

The file naming conventions for logged archived data will vary dependant on the file splitting option which is selected:

- None – TideInfo.txt
- Daily – TideInfo_YYMMDD.txt
- Weekly – TideInfo_GPSWWWW.txt (WWWW is the GPS week number)
- Monthly – TideInfo_YYMM.txt

**Note: Sprint.txt and Doodson.txt file naming conventions will follow the same pattern as above. For weekly files, Sunday is defined as the first day of the week.**

This can be copied to a USB drive using the LD6 File Manager application (see Section 11).

## 7.3 POP UP DOP WARNINGS

DOP Warnings inform the users about future periods of bad geometry or low satellite count. They appear at the centre screen with an audible alarm.

Advance DOP warnings alert the user about the weakness of the available GNSS constellation in the work area. More detailed information is available from the DOP View when the icon button is selected.

The DOP Warnings appear if the number of SV's is <6 and if PDOP is >10 during the next 12 hours.

The DOP view shows the elevation mask setting.

It may be possible to increase the number of satellites and improve the DOP by reducing this elevation mask under *Config/Calculation/Settings*.

This dialogue permits DOP warnings to be disabled.

Restore DOP warnings in *Action/DOP Warnings/Display Current DOP Warnings*.
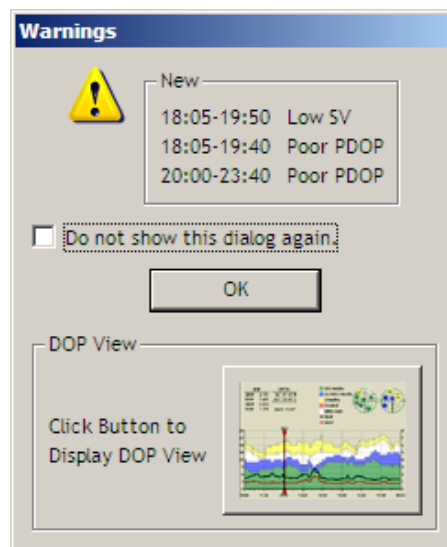


**Example DOP Warning Pop-up**

The above example shows two periods of poor DOP and one period of low satellite numbers forecast over the coming 12 hour period.

Verify QC's program menu is locked-out when the warning pop-up box is open.

The pop-up will disappear when the warning is acknowledged. Access to Verify QC's program menu is restored.

Additional DOP warnings for the next 12 hours are shown in the 'Info Bar' at the bottom left of the Verify QC main program window. These are independent of the DOP warning enable/disable status.

### 7.3.1 Disable

The DOP warning feature can be disabled by ticking the 'Do not show this dialogue again' box or select "*Action/DOP Warnings/Disable*".

The DOP warning status can be reversed by selecting "*Action/DOP Warnings/Enable*".

### 7.3.2 Display Current DOP warning

To recall the most recent warnings select "*Action/DOP Warnings/Display Current DOP Warnings.*"

7.4 CSL RAW OUTPUT

It is possible to force the instant output of Ephemeris, Ionospheric and UTC CSL Raw records on the configured CSL Raw Output IO device.

*Note: This function applies where the dongle is enabled for CSL output and Verify QC is providing an output to a Concept Systems Limited navigation system.*

These actions are available under *Action/CSL Raw Output/*

## 8. VIEW

The View menu contains all views available to the user for monitoring the data input, data quality, positioning and QC status of Verify QC.
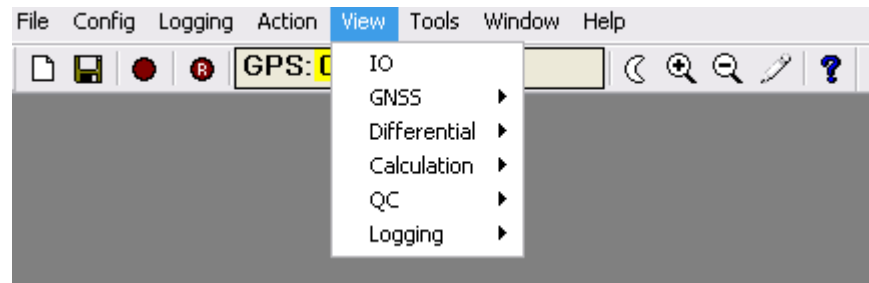


**View menu structure**

When Verify QC has been configured for use* the user can select the required display screen information.
Recommend only windows required for the current operation are opened.

Verify QC does not require windows open on the screen to function correctly.

*Note: The range of options available in the View menu is dependent on the dongle enable status or the settings under "Tools/Advanced Options."*

### 8.1 IO

Select "View/IO" to display scrolling IO data. This terminal window allows the user to view the data input and output on a specified port. Correct decoding of the input data is printed in green with the decoded data header printed in black. If input data is NOT decoded correctly or is corrupted it will be printed in red or not at all. Output data is printed in blue.
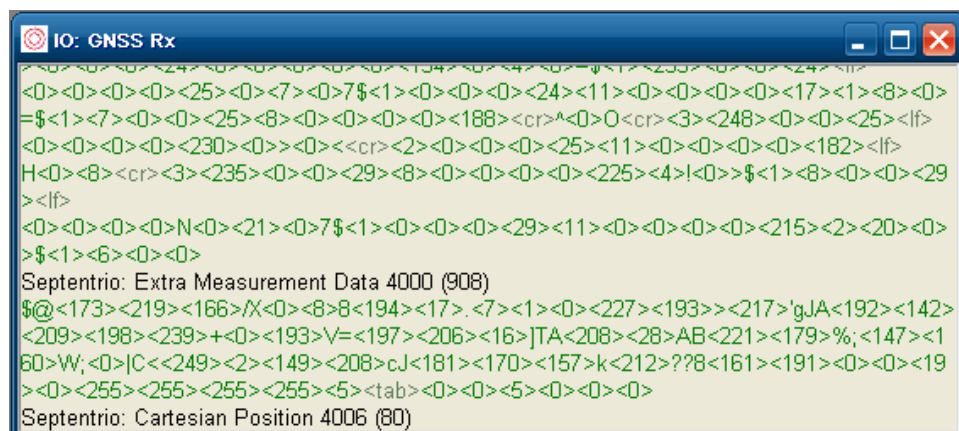


**IO View**

Right clicking in the IO view allows the user to change the data source. All defined inputs to, or outputs from Verify QC can be monitored.
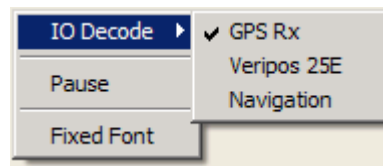
**View IO Options**

Pause and Fixed Font options are available to aid data interpretation.

## 8.2 GNSS

The *GNSS* menu section contains views relating to the GNSS receiver and satellites.
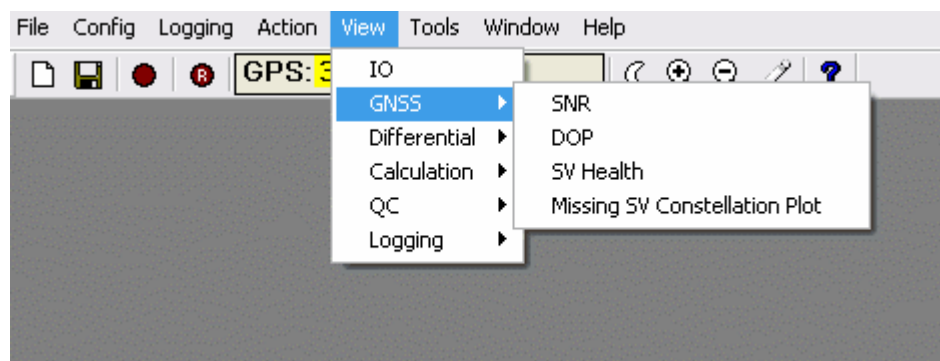


**View GNSS Menu**

### 8.2.1 SNR

SNR displays the Signal to Noise Ratios, measured in dbHz for each GPS/GLONASS satellite in view.
The following characteristics are displayed by the various GPS receiver types: -

- A stronger signal is displayed when the signal indicator moves to the right side of the window
- The width of the signal indicator summarises the recent variation in signal strength
- A large hatched area indicates unstable tracking
- When the signal strength becomes critical the colour of the signal indicator changes to yellow and then red Parameters are set in the system.
- Satellites at higher elevations have higher signal strengths and are less prone to noise. All signals are normal in the figure below
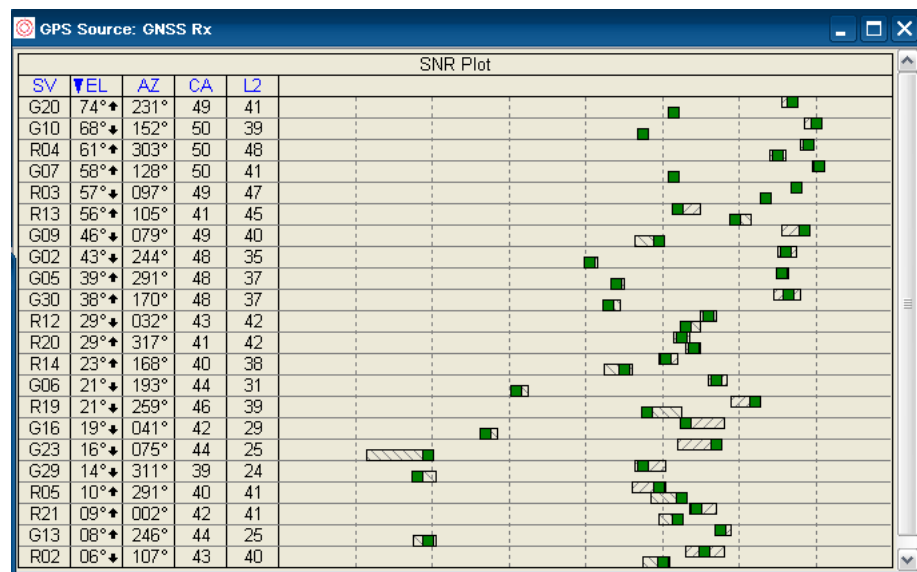
**SNR Measurements View**

GPS satellites are identified by their PRN number and are preceded by a 'G'. GLONASS satellites by their slot number and are preceded by a 'R'. The slot number for GLONASS refers to the transmit frequency slot for each satellite. GPS uses a pseudo random code number (PRN) to identify satellites.

Clicking SV, AZ, EL L1 or L2 changes the vertical order in which the window displays the data.

Right clicking will do the same using a menu. This allows selection of the 'GPS Source'. (Feature only available when a second GNSS receiver input is configured for the Heading Calculation).
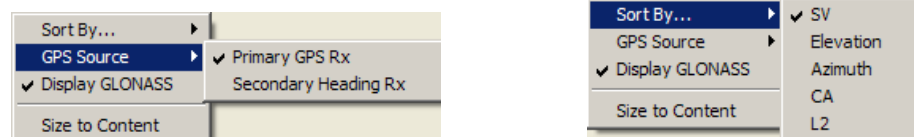


**SNR View Options**

SNR View:

| | |
|---|---|
| SV | Space Vehicle. For GPS satellites this is the Pseudo Random Noise code, a unique identifier for each satellite. GLONASS satellites use the slot number as unique identifier for each satellite. (Indicates the unique slot in the GLONASS constellation) |
| EL | Elevation. The elevation angle measured in degrees that the satellite resides above the horizon at the user location |
| AZ | Azimuth. This is a horizontal angle measured in degrees from the north direction to the direction of the satellite. This is relative to the user's location. |
| CA & L2 | This is the SNR value, measured in dBHz, of the carrier at frequencies L1 and L2 respectively L2 frequency is only available when using a dual frequency receiver with a dual frequency antenna. |

### 8.2.2  DOP

The DOP view displays data available from the GPS/GLONASS Almanac providing a 6, 12 or 24hour window used when planning. The range of information includes satellite status and location as well as the number of useable satellites above the elevation mask at the users' location.
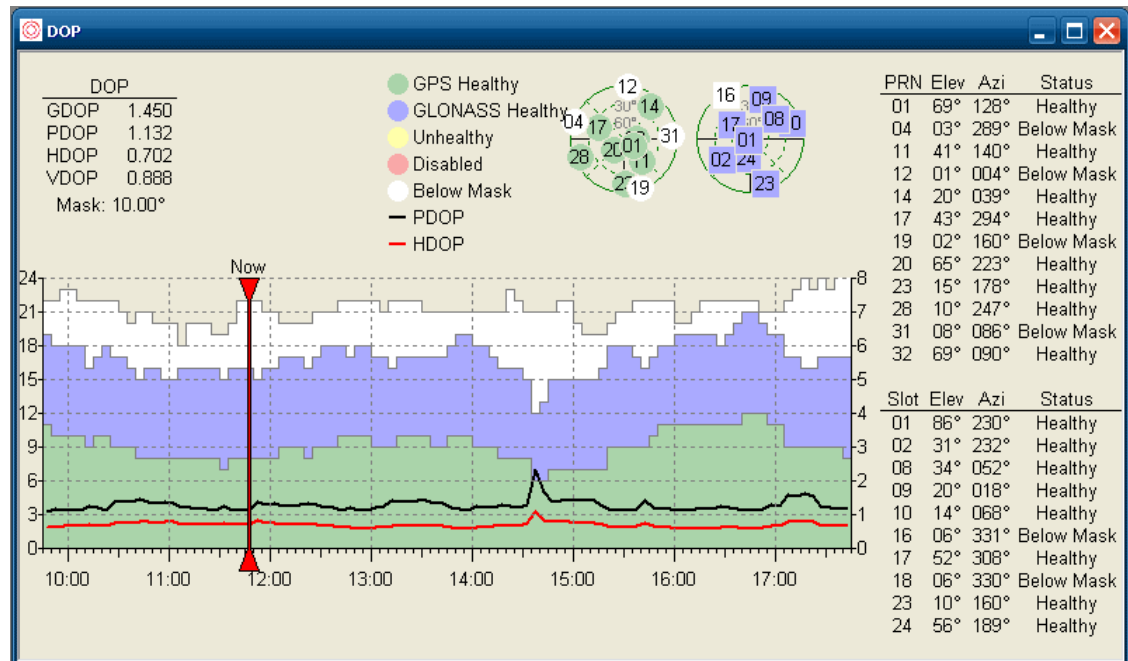


**DOP View**

Keyboard space bar is used to animate the display illustrating satellite geometry changes over time. Holding down space bar causes the vertical bar to move along the time axis until the space bar is pressed again.

All associated information on the view is updated.

Use left or right arrow keys to adjust the display at 5 minute intervals. The 'time' bar can be dragged with the mouse to any required location.

DOP View Key

| Line Colour | Detail |
|---|---|
| Black | Predicted PDOP |
| Red | Predicted HDOP |
| Green and Blue | Healthy GPS and GLONASS satellites above the elevation mask |
| White | Satellites below the mask |
| Yellow | Unhealthy satellites (unavailable for positioning) |
| Red | Disabled |

The animation can also be started by right clicking on the DOP view and selecting 'Start Animation'.

By default the DOP view predicts the Next 6 Hours.

Time windows of the DOP view can be increased to the Next 12 Hours, to display a Full Day. Set the Display Mode using right click in the DOP view.
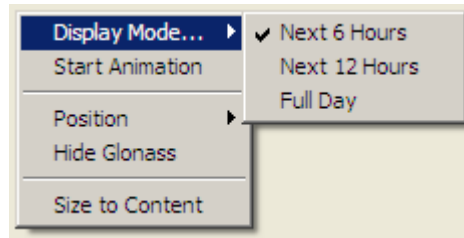


**DOP View Display Mode**

Right click can also be used to hide GLONASS constellation details.

### 8.2.3  Almanac

This is an Advanced View. See Appendices for detailed description.

### 8.2.4  SV Health

"View/SV Health" displays the current health status of all the GPS and/or GLONASS satellites in view.

| SV | Enabled | Ephemeris | Almanac | SV | Enabled | Ephemeris | Almanac | Slot | Enabled | Ephemeris | Almanac | Slot | Enabled | Ephemeris | Almanac |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01 | Enabled | | 0 Healthy | 17 | Enabled | | 0 Healthy | 01 | Enabled | | 1 Healthy | 13 | Enabled | 0 Healthy | 1 Healthy |
| 02 | Enabled | 0 Healthy | 0 Healthy | 18 | Enabled | 0 Healthy | 0 Healthy | 02 | Enabled | 0 Healthy | 1 Healthy | 14 | Enabled | 0 Healthy | 1 Healthy |
| 03 | Enabled | 0 Healthy | 0 Healthy | 19 | Enabled | 0 Healthy | 0 Healthy | 03 | Enabled | 0 Healthy | 1 Healthy | 15 | Enabled | 0 Healthy | 1 Healthy |
| 04 | Enabled | | 0 Healthy | 20 | Enabled | 0 Healthy | 0 Healthy | 04 | Enabled | 0 Healthy | 1 Healthy | 16 | Enabled | 0 Healthy | 1 Healthy |
| 05 | Enabled | 0 Healthy | 0 Healthy | 21 | Enabled | 0 Healthy | 0 Healthy | 05 | Enabled | 0 Healthy | 1 Healthy | 17 | Enabled | | 1 Healthy |
| 06 | Enabled | 0 Healthy | 0 Healthy | 22 | Enabled | | 0 Healthy | 06 | Enabled | 0 Healthy | 1 Healthy | 18 | Enabled | 0 Healthy | 1 Healthy |
| 07 | Enabled | 0 Healthy | 0 Healthy | 23 | Enabled | 0 Healthy | 0 Healthy | 07 | Enabled | | 1 Healthy | 19 | Enabled | 0 Healthy | 1 Healthy |
| 08 | Enabled | 63 Unhealthy | | 24 | Enabled | 0 Healthy | 0 Healthy | 08 | Enabled | 0 Healthy | 1 Healthy | 20 | Enabled | 0 Healthy | 1 Healthy |
| 09 | Enabled | 0 Healthy | 0 Healthy | 25 | Enabled | | 0 Healthy | 09 | Enabled | | 1 Healthy | 21 | Enabled | 0 Healthy | 1 Healthy |
| 10 | Enabled | 0 Healthy | 0 Healthy | 26 | | | | 10 | Enabled | 0 Healthy | 1 Healthy | 22 | Enabled | 0 Healthy | 1 Healthy |
| 11 | Enabled | | 0 Healthy | 27 | Enabled | 0 Healthy | 0 Healthy | 11 | Enabled | 0 Healthy | 1 Healthy | 23 | Enabled | | 1 Healthy |
| 12 | Enabled | | 0 Healthy | 28 | Enabled | 0 Healthy | 0 Healthy | 12 | Enabled | 0 Healthy | 1 Healthy | 24 | Enabled | | 1 Healthy |
| 13 | Enabled | 0 Healthy | 0 Healthy | 29 | Enabled | 0 Healthy | 0 Healthy | | | | | | | | |
| 14 | Enabled | | 0 Healthy | 30 | Enabled | 0 Healthy | 0 Healthy | | | | | | | | |
| 15 | Enabled | 0 Healthy | 0 Healthy | 31 | Enabled | | 0 Healthy | | | | | | | | |
| 16 | Enabled | 0 Healthy | 0 Healthy | 32 | Enabled | | 0 Healthy | | | | | | | | |

**SV Health View**

GPS SV Health

| SV | Identifies the GPS satellite PRN number |
|---|---|
| Enabled | Satellites enabled or disabled by the user in the current Verify QC software configuration |
| Ephemeris | Shows the satellite health status based on ephemeris data. This is the primary source of satellite health status. The information is available only for satellites tracked at the user location. The number indicates the health flag as per the GPS ICD. |
| Almanac | Shows satellite health status based on the ephemeris data. This is the secondary source of satellite health status. Information is available for all satellites in the constellation. The number indicates the health flag per GPS ICD. |

GLONASS SV Health

| Slot | Identifies the GLONASS satellite slot number |
|---|---|
| Enabled | Satellites enabled or disabled by the user in the current Verify QC software configuration |
| Ephemeris | Gives satellite health status based on ephemeris data. This is the primary source of satellite health status. The information is available only for satellites tracked at the user location. The number indicates the health flag as per the GLONASS ICD. |
| Almanac | As for GPS satellites |

The individual GPS and GLONASS sections can be displayed or hidden by ticking the system name.
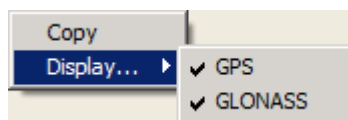


**SV Health View Options**

Unhealthy satellites transmit a warning flag uploaded by satellite ground control during maintenance operations.  Verify QC uses this flag to temporarily prevent the data from these satellites from being used in position calculations.

Disabled satellites have been manually flagged by the user for exclusion from the position calculations. This option covers a scenario in which a satellite goes "rogue" and transmits bad data without being flagged unhealthy.

GPS/GLONASS satellites - users can disable satellites in the matrix on the Verify QC menu bar at the top of the screen.
Unhealthy satellites are already shown in yellow. Individual satellites can be disabled and removed from all calculations by clicking on the satellite number. This number will be in red to indicate its disabled status.

Click on the satellite number to Toggle between enable/disable.
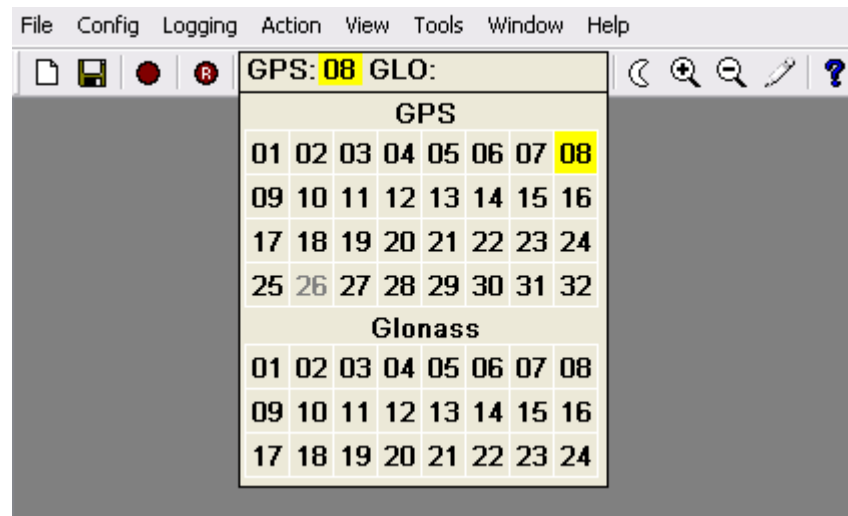


**SV Disable/Enable**

*Note: Use this facility with caution. The status of any disabled satellite should be frequently reviewed. Leaving healthy satellites in a disabled condition can seriously reduce positioning accuracy and stability.*

### 8.2.5  Missing SV Constellation Plot

The missing SV Constellation Plot indicates satellite observations missing for one or more epochs. Verify QC uses the GPS and GLONASS almanac to determine the satellites above the user's elevation mask and their visible position. If a GPS or GLONASS observation is not received a dot with the GPS PRN/GLONASS slot number is indicated on the colour constellation plot.

Colour provides additional information on the missing observation type as indicated by the on-screen legend.

Possible causes of missing satellites are: -

- masking
- intermittent tracking due to external interference
- intermittent tracking due to low signal levels
- unhealthy satellites

Observations for unhealthy satellites will be missing continuously. These create a yellow arc on the plot.

When unhealthy satellites are not reported as being unhealthy by the receiver they will appear as a red arc on the plot.
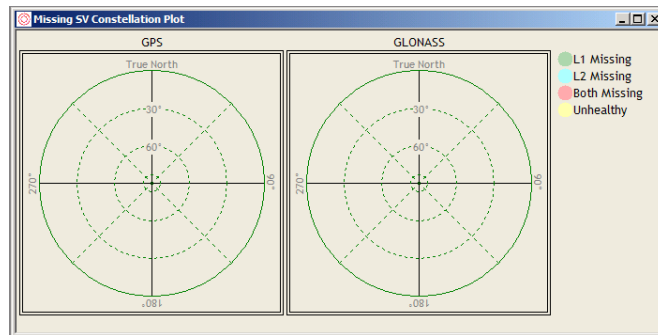
**Missing SV Constellation Plot View**
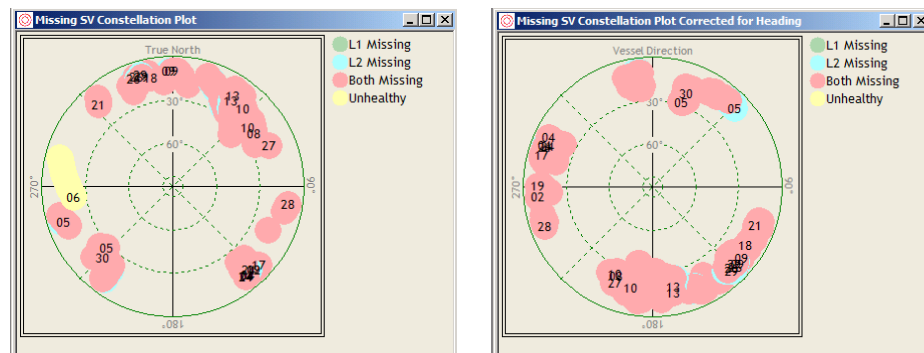


**Missing SV Plot – Poor Tracking/Corrected for Heading**

View options are selected by right clicking on the view.
GLONASS can be hidden.
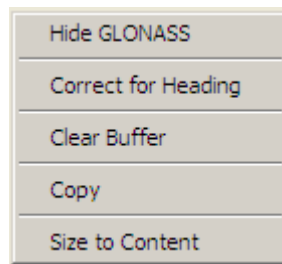


**Missing SV Constellation Plot View Options**

By default the missing satellites are plotted with azimuths relative to the *True North* direction. These can be corrected for heading such that the constellation plot becomes 'fixed' to the vessel and relative to the *Vessel Direction*.

This allows vessel specific masking areas to be identified by the user.

Calculated heading is less accurate when the vessel has a very low velocity.
The correction for vessel heading takes place only when the vessel velocity **exceeds 3km/hr**.
Switching the view to "Correct for Heading" may reduce the number of points on the constellation plot.

The plot will display missing satellite data for the last 24 hours.
Clear the buffer by right clicking on the view and select this option.

## 8.3  DIFFERENTIAL

The Differential menu contains all views relating to correction data.
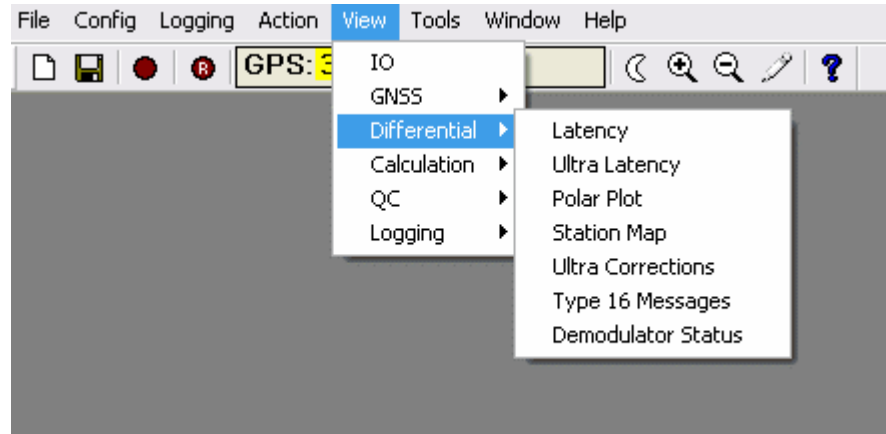


**View Differential Menu**

### 8.3.1  Latency

The "View/Differential/Latency" view displays information about the age of the correction data for all stations and services with RTCM inputs.
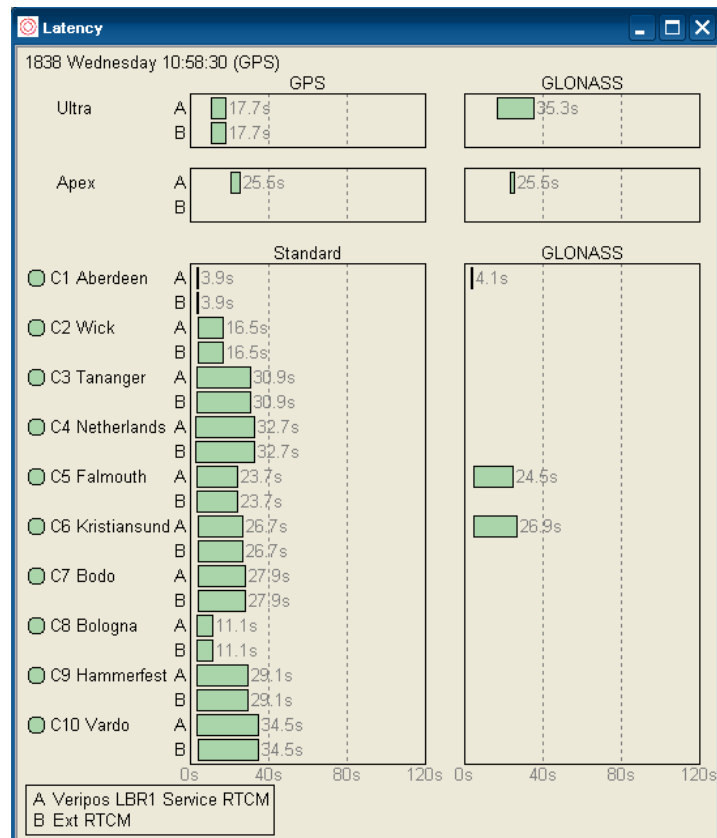


**Latency View**

The view contains separate columns for the various differential services provided by VERIPOS.

The VERIPOS Ultra and VERIPOS Apex messages contain orbit & clock correction data for the GPS and GLONASS satellites.

VERIPOS 'Standard' messages contain correction data for the L1 GPS ranges at the reference stations.

VERIPOS 'GLONASS' messages contain correction data for the L1 GLONASS ranges at the reference station

The green circle next to the reference station name indicates the receipt of the reference station location information. This circle is red if this information has not yet been received (viewed at start-up). Verify QC will not use differential corrections from a reference station until its location is known. The station locations are saved to file so that Verify QC does not wait to reacquire them every time the configuration is restarted.

The left-hand edge of the bar shows how old the current correction was when first received by Verify QC. Since the messages are time stamped when generated by the reference station, Verify QC is able to determine their age.

The right-hand side of the bar advances across the display until a new correction is received. Values next to the bar show the current age (latency) of the current correction message.

A threshold of 120 sec applies for Type 1 and Type 31 messages. When this threshold is exceeded data is rejected and the calculation mode changes to uncorrected as shown in the Calculation Status view.

A threshold of 600 seconds applies to for Type 15 messages and when this is exceeded the calculation mode of Standard+ calculations become uncorrected.

A threshold of 360 seconds applies to the Ultra and Apex correction messages and when this is exceeded the calculation mode Ultra and Apex become uncorrected.

The latency bar moves from left to right as the latency increases.

A traffic light colour scheme applies to the latency bars: -

| Colour | Latency (%) |
|---|---|
| Green | less than 50% of the threshold |
| Yellow | latency exceeds 50% of the threshold |
| Red | latency exceeds 75% of the threshold |

The view can be customised to hide the Standard Plus and/or GLONASS columns or to hide the key. The *Time Period* can also be changed - this will not affect the latency thresholds for each of the correction message types. The *Key* helps to identify each RTCM input.
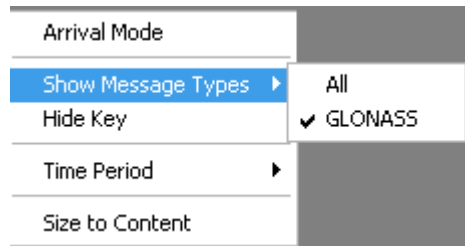
**Latency View Options**

The Latency View can operate in a Standard or Arrival Mode. Users can set the mode by right click on the screen.

In *Arrival Mode* the Latency view only shows the age of the corrections when they arrive.

In *Standard Mode*, the columns show the correction latency as bars.

Clicking on blue reference station names will open a Differential Data view for the station.

Clicking on the blue Ultra name opens the VERIPOS Ultra Corrections view. Similarly, the VERIPOS Apex Corrections view can be opened by clicking on the blue Apex name.

### 8.3.2 Polar Plot

Polar Plot displays information regarding the GPS and GLONASS satellite constellations at the users' location and at the reference stations.
This view shows which satellites are in the sky and the status of these satellites.

Information is based on the reference station location and received GNSS almanac and live GNSS measurement information. The polar plot will be empty if this information is absent.
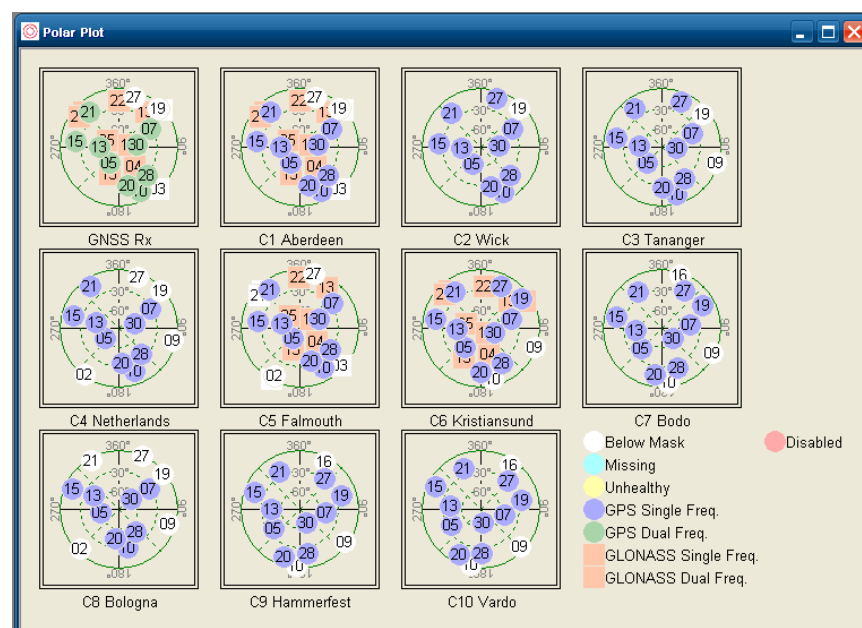


**Polar Plot View**

The polar plot is used to indicate the status of the corrections and the local observations. The legend at the right hand side of the chart gives an interpretation for each colour used.

Details for GLONASS constellation can be hidden - right click on the view and select 'Hide GLONASS'.

### 8.3.3 Station Map

"View/Differential/Station Map" opens a map of the user work area. The map is scaled automatically to fit the users' location and the location of all reference stations selected in RTCM inputs and from which station location information has been received.
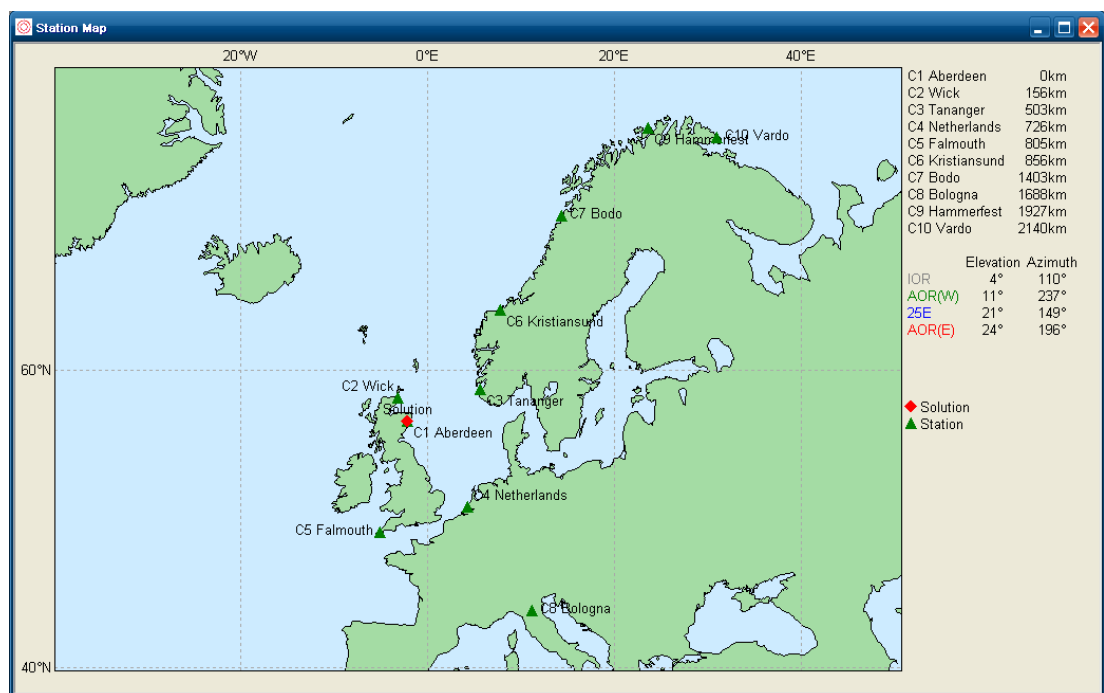


**Station Map View**

Options are available using right click.
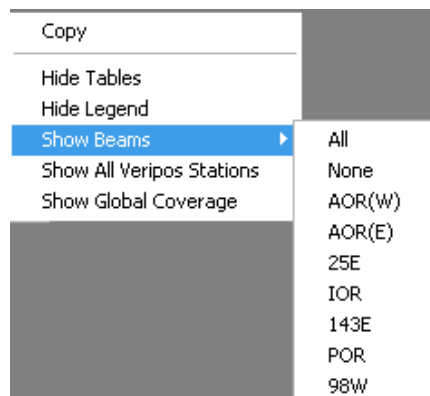


**Station Map View Options**

The map can be copied as an image and the tables and legend can be hidden.

By default the map will zoom in to the user location and the stations for which corrections have been received.

The map can be changed to show the VERIPOS coverage, displaying all stations in the global VERIPOS network.

It can also be adjusted to show the 5º, 15º and 30º elevations of all satellite delivery links.
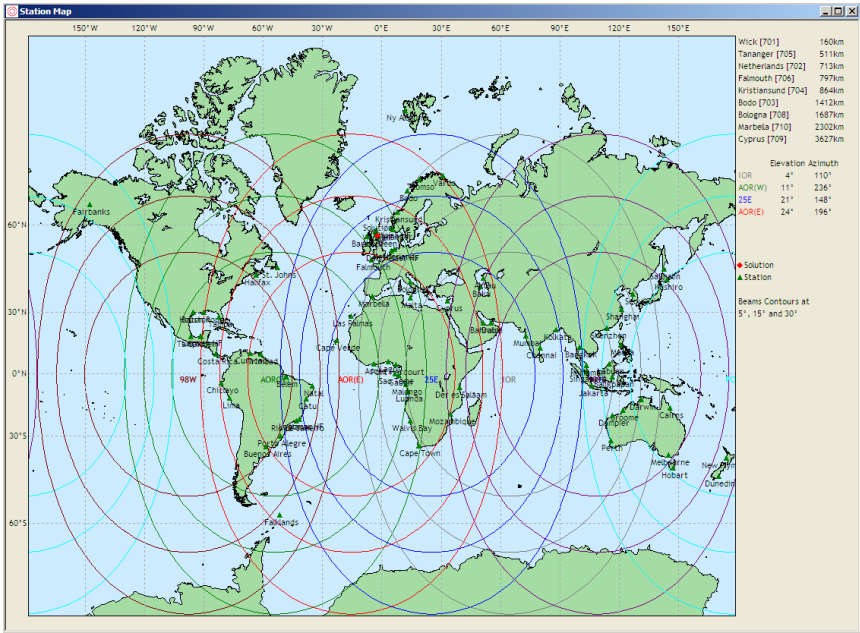


**Station Map View – Global Coverage**

Use the mouse to draw a box on the map and zoom to that area. Use zoom out / zoom in icon to move back to the previous map.

### 8.3.4 Type 16 Messages

*View/Differential/Type 16 Messages* opens a view showing details for received Type 16 messages.
Reference stations may issue additional station information or status updates by sending a Type 16 message containing ASCII information up to 90 characters long.

The Type 16 messages view lists for one (or more) stations the time of the last received message, the number of times the same message has been received, the station name and the message.



**Type 16 Messages View**

### 8.3.5 Demodulator Status

This view presents a table with decoded information from the last 5 demodulator status messages and a time series view, with the Signal Strength values for the last 24 hours.

The sample rate for the Signal Status is 60 seconds.
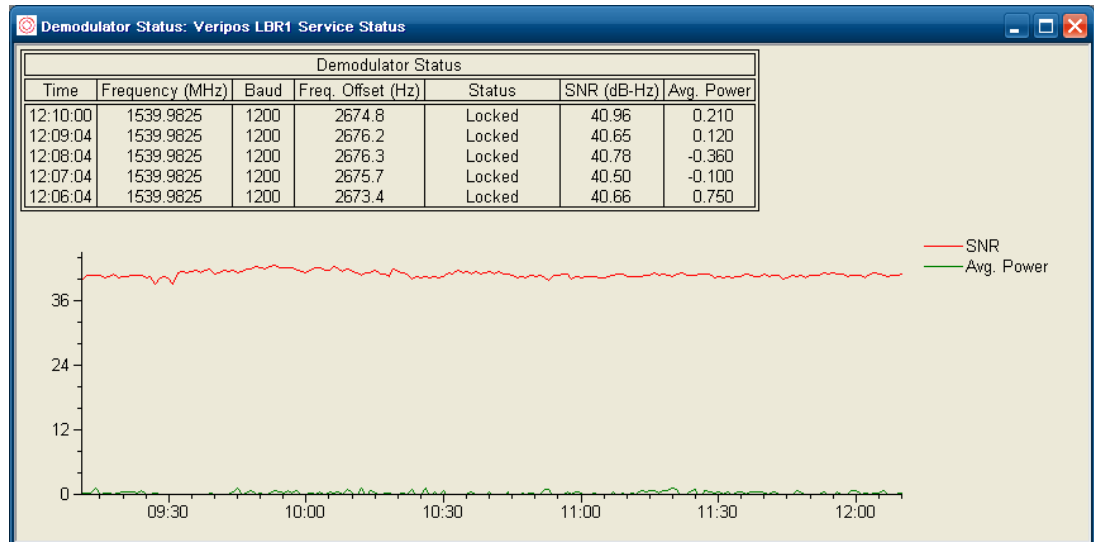


**Demodulator Status View**

Demodulator Status Table

| Time | time of the demodulator status message |
|---|---|
| Frequency (MHz) | Frequency of L-Band (Inmarsat) satellite currently in-use. |
| Baud | Transmission rate of L-Band (Inmarsat) satellite currently in-use. |
| Freq. Offset (Hz) | Tuning frequency offset for the demodulator |
| Status | Shows the current L-Band lock status.  Should read 'Locked' under normal conditions. |
| SNR (dB-Hz) | Signal to Noise Ratio.  Indicates strength of signal lock to selected L-Band (Inmarsat) satellite. |
| Avg. Power | Power at the output of the variable gain amplifier, normalized to the optimal power at that point and expressed in dB-Hz. |
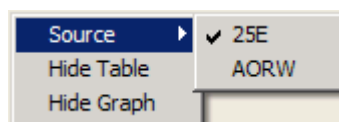


**Demodulator Status View Options**

Right clicking on the view menu allows the user to view the demodulator status information of another demodulator source or simplify by hiding the table or the graph.

## 8.4 CALCULATION

The *Calculation* menu contains all the views relating to the calculations
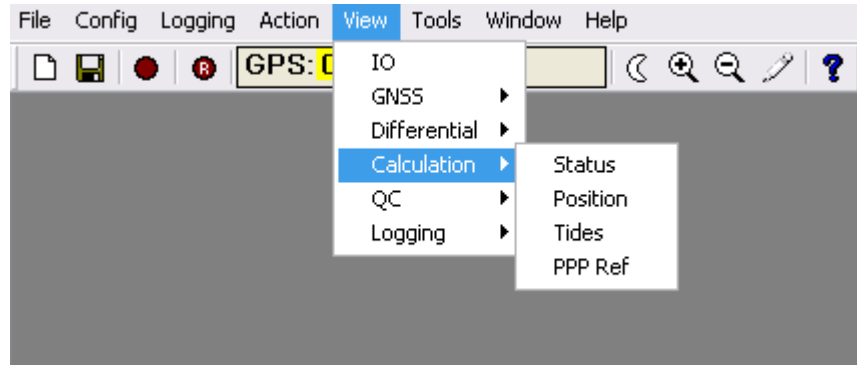


**View Differential Menu Structure**

### 8.4.1 Calculation Status

The Calculation Status view displays the current status of the configured calculations to give an indication of the quality of these calculations. All calculations setup in the Configure Calculations page are listed.

Ultra and Apex calculations will only be shown if the dongle has been enabled for these services.



| Name | Mode | F-Test | Unit Var | Semi-Major | # Stns | # SVs | PDOP |
|---|---|---|---|---|---|---|---|
| GNSS Rx | As Received | No Test | | | | | |
| Ultra | Ultra GPS | Passed | 0.732 | 0.04 | 1 of 1 | 9 | 1.592 |
| Apex | Apex GPS | Passed | 0.322 | 0.04 | 1 of 1 | 9 | 1.592 |
| STD | L1 Diff GPS | Passed | 0.607 | 0.51 | 6 of 6 | 8 | 1.755 |
| STD2 | L1 Diff GPS+GLO | Passed | 1.435 | 0.45 | 6 of 6 | 8 + 7 | 1.309 |
| Network of 5 | L1 Diff GPS | Passed | 0.705 | 0.55 | 5 of 5 | 8 | 1.755 |
| Stand Alone | Uncorrected | Passed | 0.817 | 2.26 | 0 of 0 | 8 | 1.755 |

*1 April 2015 12:31:30(UTC)*

**Calculation Status View**

The top of the table shows the current date and time in UTC.

*Note*: Clicking the **left** mouse button on a calculation <u>name</u> will open up a Position view containing more detailed calculation status information, with toggle between *advanced* and *simple* views.

Calculation Status Data

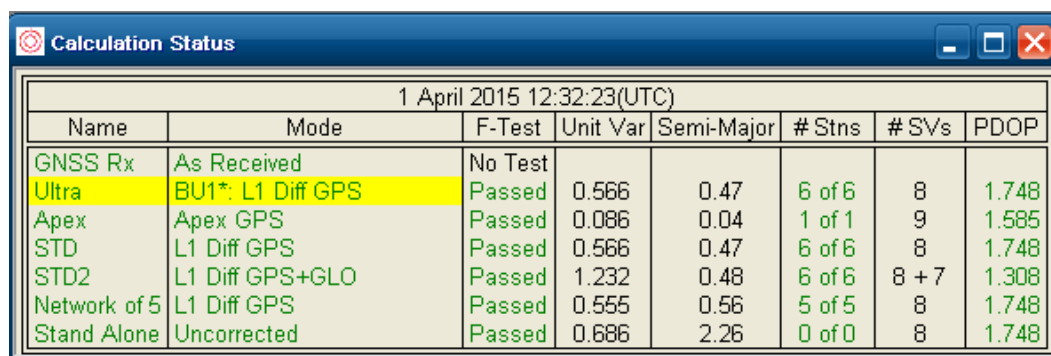| Name | Name allocated to the calculation by the user |
|---|---|
| Mode | Current mode of the calculation. This is the prime indicator of the current calculation status. Possible modes are: -<br>▪ As Received – indicates the position as generated by the external GPS receiver<br>▪ No Position<br>▪ No Solution<br>▪ Uncorrected – no differential correction has been applied<br>▪ L1 – Solution using single frequency measurements<br>▪ L1/ L2 – Solution using Dual frequency measurements<br>▪ Diff – differential corrections have been applied for all stations<br>▪ Reduced– differential corrections have been applied for some stations<br>▪ GPS – Solution using GPS Constellation only<br>▪ GPS+GLO – Solution using GPS and GLONASS Constellations<br>▪ Uncorrected (Settling) – Ultra initialisation fixes<br>▪ Ultra DGPS (Settling) – initial Ultra orbit & clock corrected fixes<br>▪ Ultra (Settling) – Ultra converging<br>▪ Ultra – Ultra converged<br>▪ Apex DGPS (Settling) – initial Apex orbit & clock corrected fixes<br>▪ Apex (Settling) – Apex converging<br>▪ Apex – Apex converged<br>▪ BU 1: 'Backup One calculation mode'<br>▪ BU 2: 'Backup Two calculation mode'<br>▪ Reduced Diff - data from some stations is not received<br>→ BU1 or BU2 indicate the Ultra or Apex calculation is currently unavailable and that the Backup One or Backup Two calculation is being output. The * indicates that backup smoothing is active. The backup smoothing is used in the transition from Ultra or Apex to BU1 or BU 1 to BU 2 and vice versa to ensure a seamless transition avoiding a step in the position. |
| F-Test | An indication of the overall fit of the observations to the statistical model. The F-Test does not detect the source of any errors but gives an indication as to the pass or failure status of the test. |
| Unit Var. | The ratio between actual and modelled errors. Values range around 1. Spikes in the unit variance indicates outliers and erroneous pseudo-range measurements. |
| Semi Major | 95% semi-major axis of the error ellipse shown in the Track Plot view |
| # Stns | Number of reference stations for which corrections are being used in the calculation |
| # SVs | Number of satellites used in the calculation. Combined GPS and GLONASS calculations follows the syntax 'x + y' with x being the number of GPS satellites and y being the number of GLONASS satellites |
| PDOP | Positional Dilution of Precision indicates the strength of the geometry for determining a 3D position estimate and a basic accuracy indicator |

If Verify QC detects a problem in a position calculation the name of the calculation in the Calculation Status view changes colour. A yellow background indicates a warning about possible position quality degradation whilst red text indicates a calculation failure.

Other possible causes of the name field changing to yellow will be the loss of a reference station or a high DOP value, as shown below.
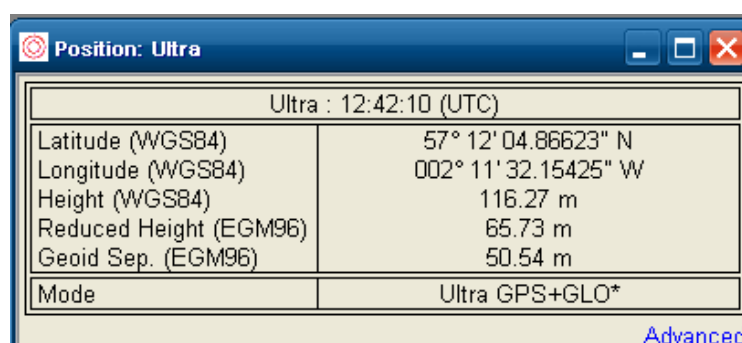


**Calculation Status Warning**

### 8.4.2  Position

*View/Calculation/Position* first opens the 'Simple' version of the position view. This displays the calculation name, the time (UTC) and the geographical coordinates.
No statistical parameters are shown.

Height is the height above the Geoid model, selected by the user in *Config/Calculation/Settings* either EGM96, EGM08 or a user defined Geoid separation.



**Simple Position View**

Advanced (bottom right) opens the view showing calculation statistics.

**Advanced Position View**

Right clicking in this window allows editing of the position calculation or copying contents to clipboard for use in another word application.
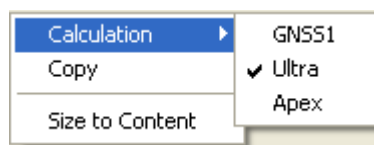


**Position View Options**

The Advanced Position View includes several sections including:

- Positions Table
- General Statistics Table
- Notes Table
- Error Ellipse View
- Constellation View

Position Table

The Position table displays the calculation name, the time (UTC) and the geographical coordinates. These include the height above the WGS84 reference ellipsoid. Using the Geoid model selected by the user in *Config/Calculation/Settings* (EGM96, EGM08 or a user defined Geoid separation) this ellipsoidal height is also split into a Geoid separation and height above this Geoid. The reference for each coordinate and height value is indicated between brackets.

The right hand column gives standard deviation of the individual coordinate components. The bottom row displays current calculation mode.

**Position View – Position Table**

Position Table

When the Tides function (dongle dependent) is enabled, the Position Table for Apex or Ultra will include three extra rows,

Additionally, the user will enter height of the antenna above the waterline and the calculated MSSTide and Geoid Tide values, which are displayed.



**Position View – Position Table**

General Statistic Table

The General Statistics Table provides the main statistical parameters associated with the calculated position.



**Position View – General Statistics Table**

This table displays the following information: -

| Confidence | reliability of the position indicating that 99% of the positions are contained within the error ellipse |
|---|---|
| Power | measures the tests ability to reject the null hypothesis when it is actually false |
| F-Test | indication of the overall fit of the observations to the statistical model. The F-Test does not detect the source of any errors; it will give only an indication as to the pass or failure of the test. |
| Deg. Of Freedom | number of additional observations compared to the unknown quantities that are being solved for. When the number of observations equals the number of unknowns there is no redundant information in the position calculation |
| Unit Var. | the ratio between the actual and modelled errors. The expected value of unit variance is 1. Occasional small values are of no concern; however large values can indicate a bias in the data. Spikes in the unit variance indicate outliers and erroneous pseudo-range measurements |
| RMS | Root Mean Square is a statistical measure of the scatter of computed positions around a "Best Fit" position solution. This is shown in meters |
| Semi-Major | Semi-Major axis of the error ellipse produced by the calculation |
| Semi-Minor | Semi-Minor axis of the error ellipse produced by the calculation |
| Angle | direction of the Semi-major axis from the centre of the error ellipse |
| DOP | Dilution of Precision is a measure of the strength of the satellite geometry at the receiver. The DOP value can be used as a multiplier to the standard deviation of the GPS measurements to derive an estimated standard deviation of the position |
| PDOP | Positional DOP is a 3 dimensional measure of the accuracy composed of Horizontal DOP and Vertical DOP |
| HDOP | Horizontal DOP is a two dimensional measure of the accuracy of the horizontal position |
| VDOP | Vertical DOP is an indicator of the strength of the calculation in the height component |
| SOG | Speed over the Ground |
| CMG | Course Made Good |

The bottom row of the General Statistic Table lists the PRN number of the GPS satellites used in the calculation. Slot numbers (*) of the GLONASS satellites is displayed.

Notes Table

The Notes Table lists statistical parameters.

| | Notes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| PRN | Station | SD | Resid | ResidSD | mde | wStat | wTest | East | North | Up |
| G11 | Ultra | 0.021 | -0.017 | 0.001 | 0.079 | -0.903 | Passed | -0.004 | 0.000 | -0.025 |
| G14 | Ultra | 0.028 | 0.007 | 0.001 | 0.110 | 0.267 | Passed | -0.018 | 0.011 | 0.012 |
| G17 | Ultra | 0.031 | 0.023 | 0.001 | 0.118 | 0.828 | Passed | 0.011 | 0.013 | 0.005 |
| G19 | Ultra | 0.030 | -0.002 | 0.001 | 0.123 | -0.077 | Passed | -0.013 | -0.026 | 0.049 |
| G20 | Ultra | 0.026 | -0.010 | 0.001 | 0.099 | -0.402 | Passed | 0.010 | -0.014 | 0.012 |
| G28 | Ultra | 0.029 | 0.007 | 0.001 | 0.111 | 0.277 | Passed | 0.015 | -0.002 | 0.010 |
| G32 | Ultra | 0.021 | 0.016 | 0.001 | 0.079 | 0.859 | Passed | 0.001 | 0.000 | -0.030 |
| R04 | Ultra | 0.071 | 0.015 | 0.005 | 0.250 | 0.213 | Passed | -0.007 | 0.004 | 0.016 |
| R05 | Ultra | 0.044 | 0.026 | 0.002 | 0.155 | 0.610 | Passed | -0.004 | 0.009 | -0.015 |
| R06 | Ultra | 0.046 | 0.012 | 0.002 | 0.159 | 0.264 | Passed | 0.002 | -0.005 | -0.004 |
| R12 | Ultra | 0.072 | -0.018 | 0.005 | 0.252 | -0.257 | Passed | 0.004 | 0.002 | 0.013 |
| R13 | Ultra | 0.065 | -0.023 | 0.005 | 0.230 | -0.365 | Passed | 0.000 | 0.008 | 0.005 |
| R14 | Ultra | 0.071 | -0.052 | 0.005 | 0.251 | -0.772 | Passed | -0.007 | 0.004 | 0.017 |
| R20 | Ultra | 0.050 | 0.015 | 0.003 | 0.173 | 0.319 | Passed | -0.006 | -0.007 | 0.007 |
| R21 | Ultra | 0.040 | -0.034 | 0.002 | 0.145 | -0.879 | Passed | 0.005 | 0.008 | -0.026 |
| R22 | Ultra | 0.059 | -0.048 | 0.004 | 0.205 | -0.840 | Passed | 0.005 | 0.007 | -0.002 |

**Position View – Notes table**

This table displays the following information: -

| Notes | displays general information such as a reference station being out of range, missing data or data being rejected |
|---|---|
| PRN | a unique identification PRN or slot number for each GPS and GLONASS satellite respectively. |
| Station | reference station name |
| SD | standard deviation of the corrected pseudo-range |
| Resid | residual of the corrected pseudo-range in the position computation |
| ResisSD | standard deviation of the residual |
| mde | Marginally Detectable Error is the smallest error identified by the w-test with a probability of 80% |
| wStat | figure used in the w-test |
| wTest | w-test is used to prove the null hypotheses by testing against a series of alternative hypothesis. These are formulated to describe any possible error pattern, or combination of error patterns. If the error turns out to be statistically significant for any of the alternative hypotheses the null hypotheses will be rejected in favour of the particular alternative, if no alternative then the null hypothesis will be accepted. If this w-test matched the proposed error patterns with the error patterns found in the observation, and if no match is found, the null hypothesis is accepted |
| East | component of external reliability on the measurement, i.e. the effect an error the size of the mde would have on the East component of the position |
| North | a component of external reliability on the measurement, i.e. the effect an error the size of the mde would have on the North component of the position |
| Up | component of external reliability on the measurement, i.e. the effect an error the size of the mde would have on the North component of the position |

Error Ellipse and Constellation View

The error ellipse and its scale are displayed with the constellation of the GPS and GLONASS satellites. GPS satellites are white circles. GLONASS satellites are white squares.
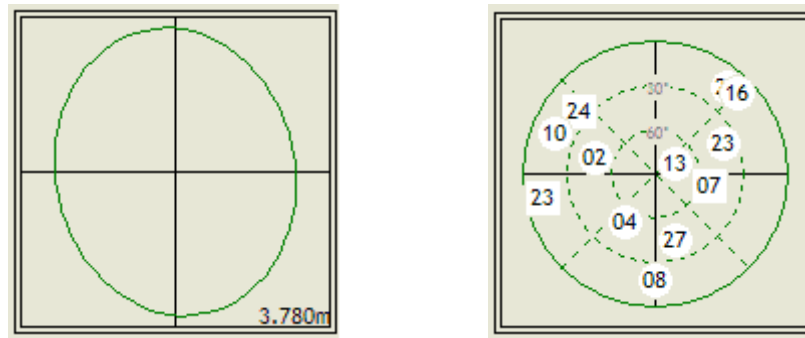
**Position View – Error Ellipse and Constellation View**

### 8.4.3 Tides

*View/Calculation/Tides* opens the Tides table and a time series view. The view options are accessible via right click.
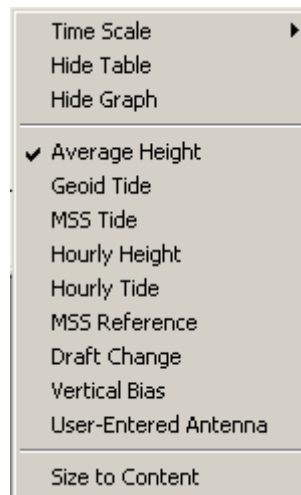


**Tides View Menu Options**

The user can choose from nine time series:

| Antenna Height: | A time series plotting the minimum, maximum and mean height of the GPS antenna relative to the user selected Geoid model. Points are added at the user selected interval |
|---|---|
| Geoid Tide: | A time series, plotting the minimum, maximum and mean height of the vessel waterline relative to the user selected Geoid model. Points are added at the user selected interval |
| MSS Tide* | Time series plotting the minimum, maximum and mean height of the vessel waterline relative to the Tide filter estimate of Mean Sea Surface. Values displayed are called the Ultra Tide. Points are added at the user selected interval. |
| Hourly Height | Time series plotting the minimum, maximum and mean height of the GPS antenna relative to the user selected Geoid model. Points are added at an hourly interval |
| Hourly Tide* | Time series plotting the minimum, maximum and mean height of the vessel waterline relative to the Tide filter estimate of Mean Sea Surface. Values displayed are called Ultra Tide. Points are |

| | |
|---|---|
| | added at an hourly interval. |
| MSS Reference* | Time series plotting the Tide filter estimate of Mean Sea Surface. Points are added hourly. |
| Draft Change | Time series plotting the change in Draft. This is calculated as the current Doodson value minus the Doodson value for the first record. |
| Vertical Bias | Time series plotting the vertical bias detected between Ultra Tide and Geoid Tide. |
| User-Entered Antenna | Time series plotting the User entered height of the antenna above the waterline. As entered in **"*Config/Calculation/Settings*"** |

*\* Estimate is only available after 39 hours of continuous operation*

The first five time series contain three separate lines for the minimum (red), mean (blue) and maximum (green) height or tide values.
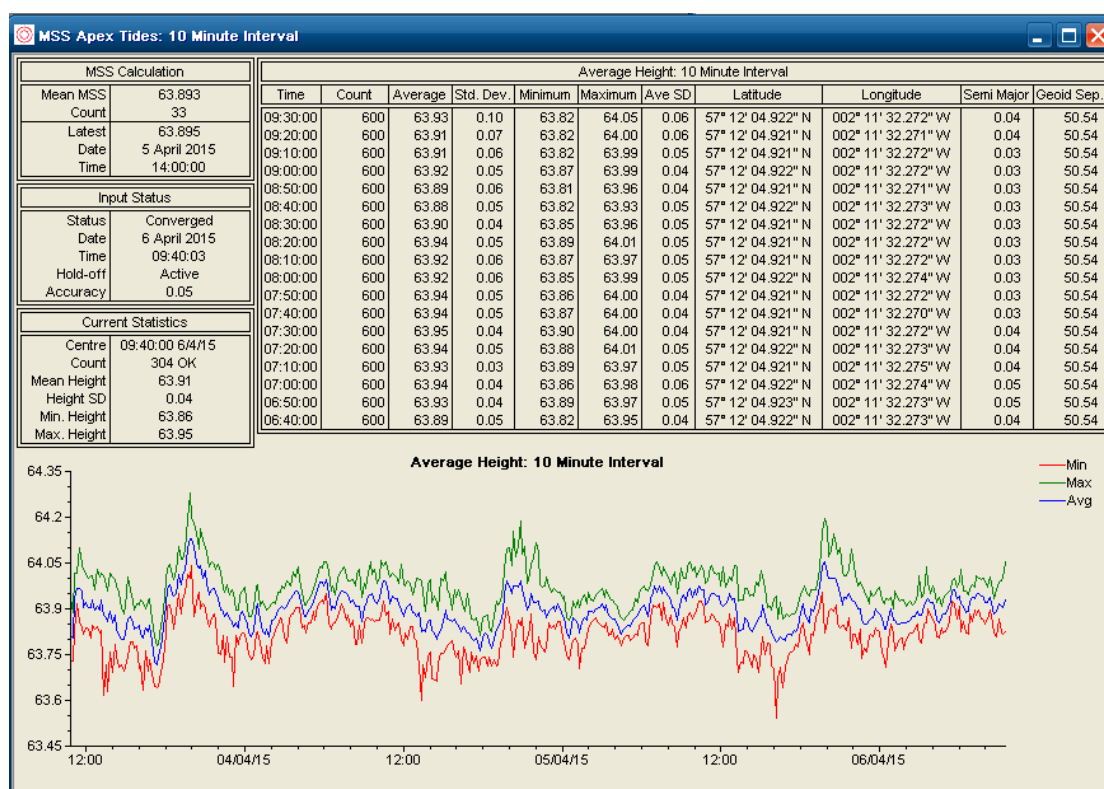


**Tides View – Table and Time Series**

The Tides View includes several sections including the Tidal Height table, the MSS Calculation table, the Input Status Table, the Current Status table and the time series graph.

Tidal Height table

| Time | Time for which information is valid |
|---|---|
| Count | Number of height samples used for deriving listed results |
| Average | Height average |
| Std. Dev. | Standard deviation of height values included in average |
| Minimum | Minimum of height values included in average |
| Maximum | Maximum of height values included in average |
| Ave SD | Average of the standard deviation of height values included in average |
| Latitude | Latitude at given time |
| Longitude | Longitude at given time |
| Semi Major | Average of semi major of height values included in average |
| Geoid Sep. | Separation between the Geoid and the WGS84 reference ellipsoid |

MSS Calculation table

| MSS | Tide filter overall estimate of MSS |
|---|---|
| Count | Sequence number of local hourly estimate of MSS |
| Latest | Most recent Tide filter local estimate of MSS |
| Date | Date for which information is valid |
| Time | Time for which information is valid |

| MSS Calculation | |
|---|---|
| Mean MSS | 5.613 |
| Count | 34 |
| Latest | 5.445 |
| Date | 4 March 2007 |
| Time | 16:00:00 |

**Tides View – MSS Calculation Table**

Input Status table

| Status | Status of height input into Tide filter. Can show 'No Position', 'Converging', 'Converged' |
|---|---|
| Date | Date for which information is valid |
| Time | Time for which information is valid |
| Hold-off | Can show 'Active' or time until hold-off period expires |
| Accuracy | Shows reported standard deviation of the current height input If the standard deviation exceeds the threshold it also shows the threshold |

**Input Status**

| | |
|---|---|
| Status | Converged |
| Date | 5 March 2007 |
| Time | 11:23:37 |
| Hold-off | 19:34 |
| Accuracy | 0.24 > 0.2 |

**Tides View – Input Status Table**

Current Statistics table

| Centre | Shows time and date for the current averaging period |
|---|---|
| Count | The number of accepted height input values during the current averaging period, followed by 'OK' (if count exceeds the minimum 50% required to generate a valid result) |
| Mean Height | Average height during the current averaging period |
| Height SD | Standard deviation of the the heights during the current averaging period |
| Min Height | Minimum height during the current averaging period |
| Max Height | Maximum height during the current averaging period |

**Current Statistics**

| | |
|---|---|
| Centre | 11:30:00 22/9/06 |
| Count | 339 OK |
| Mean Height | 29.61 |
| Height SD | 0.11 |
| Min. Height | 29.48 |
| Max. Height | 29.71 |

**Tides View – Current Statistics Table**

### 8.4.4  PPP Ref

The PPP Ref calculation uses the current position of the selected Apex or Ultra calculation as a virtual reference station location.

This allows highly stable and accurate DGPS corrections to be calculated, which can be output to external DGPS systems or a telemetry link.

*Note: the PPP Ref calculation will only generate an RTCM output whilst the selected Apex or Ultra calculation has an converged status, i.e. respectively reports 'Apex' or 'Ultra' in the Calculation Status View*

The full status of the PPP Ref calculation can be monitored using *View/Calculation/PPP Ref ….*

The view displays the status of the PPP position calculation (used as a virtual reference station location). Initially, following the start of the PPP calculation, only the PPP position

and its calculation status (Mode) are shown in the PPP Ref view. Once the PPP calculation is converged, i.e. reports 'Apex' or 'Ultra', the status of RTCM DGPS corrections that are currently being output is also displayed.

Once the calculation Mode, depending on the selected PPP solution, reaches an 'Ultra' or 'Apex' status, the view expands to include the DGPS corrections for the satellites above the elevation mask set in the PPP Ref calculation configuration dialogue.



**PPP Ref View – Position Status and Correction Data Table expanded view**

PPP Ref Differential Data

| | |
|---|---|
| PRN | Pseudo Random Noise code. A unique identification number for each GPS satellite. E.g. PRN 13 refers to the satellite that transmits the 13th weekly portion of the P code |
| Elev | Elevation. The elevation angle measured in degrees that the satellite resides above the horizon at the reference station location |
| Azi | Azimuth. This is a horizontal angle measured in degrees from the north direction to the direction of the satellite. This is relative to the reference station location |
| Iono | The delay in meters caused by the Ionosphere to the GPS signal from the particular satellite. An ionospheric delay value derived from the Klobuchar model in the Almanac |
| Tropo | The delay in meters caused by the troposphere to the GPS signal from that satellite at the reference station. Value is derived using the Hopfield model. |
| SF | This is the scale factor as a code which could be either 0 or 1:<br>• 0 = scale factor for pseudo range correction is better than 0.02 meter and for range rate correction is 0.002 meter/second<br>• 1 = scale factor for pseudo range correction is better than 0.32 meter and for range rate correction is 0.032 meter/second |
| PRC | PRC is the Pseudo Range Correction as observed on the L1 pseudo-range at the reference station |
| Rate | This is the rate of change, in meters, of the pseudo-range corrections |

| UDRE | User Differential Range Error. An estimate of the performance of the satellites pseudo-range as measured at the reference station in meters. This number is provided as part of the RTCM Type 1 messages in the form of a binary code 0 to 3:<br>0: ≤ 1 meter at 1 sigma<br>1: > 1 meter and ≤ 4 meter at 1 sigma<br>2: > 4 meter and ≤ 8 meter at 1 sigma<br>3: > 8 meter at 1 sigma |
|---|---|
| IODE | Data Ephemeris identifies the set of ephemeris parameters. Gives the user a means of detecting change |

The PPP Ref position table displays the GPS week, day and time and the geographical WGS84 coordinates for the Apex or Ultra solution.

The table also includes the height above the Geoid model selected by the user in *Config/Calculation/Settings* and the separation value from this Geoid model.

The column to the right shows the standard deviation of the individual coordinate components.

The rows underneath show the latency of the last received Apex / Ultra corrections, the Unit variance, Semi-Major and PDOP of the calculated PPP Position and its calculation mode.

## 8.5 QC

"View/QC" accesses views displaying the position status and quality information.
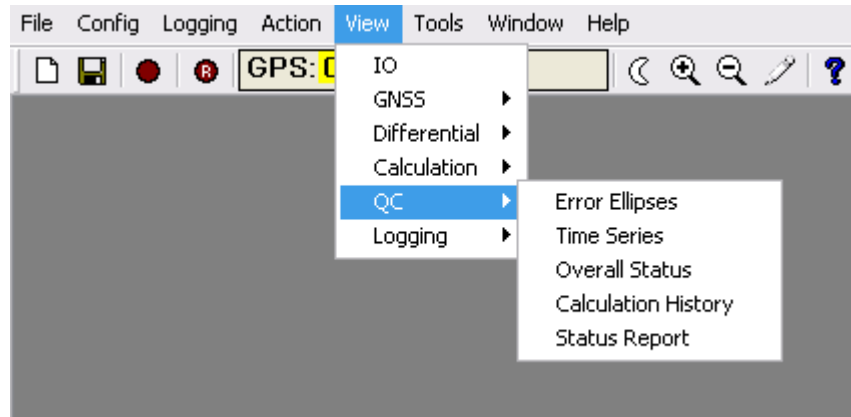


**View QC Menu**

### 8.5.1 Error Ellipses

Error Ellipses displays position error ellipses over the entire calculation setup.

Each ellipse is colour coded for ease of identification and a key displays the solution deviation compared to the selected reference solution.



| Position | dEast | dNorth | dHeight |
|---|---|---|---|
| GNSS Rx | 0.56 | -0.46 | 1.07 |
| Ultra | 0.01 | -0.09 | 0.16 |
| **Apex** | **Ref** | **Ref** | **Ref** |
| STD | 0.93 | -0.04 | -0.11 |
| STD2 | 0.25 | 0.59 | 1.56 |
| PPP REF | 1.55 | -0.03 | -1.67 |
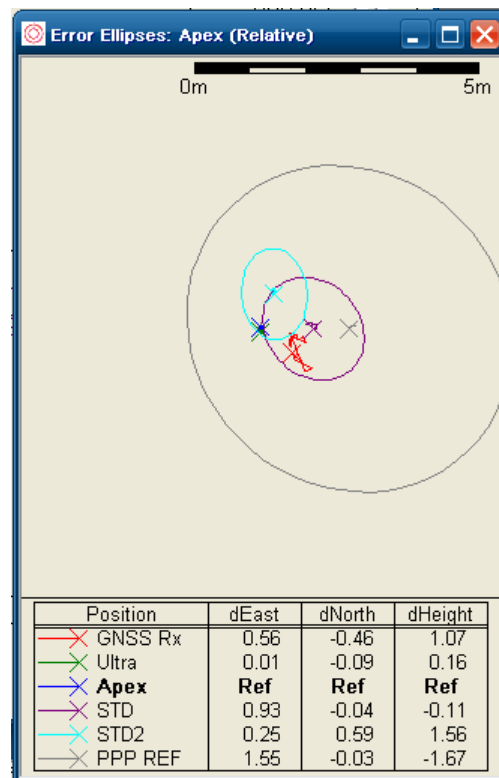
**Error Ellipses View**

The error ellipses view can be altered using the scroll wheel of the mouse.

Highlight the error ellipse for a specific calculation by clicking on the calculation name in the *Position* box.

Right clicking in the window allows the user to change parameters:
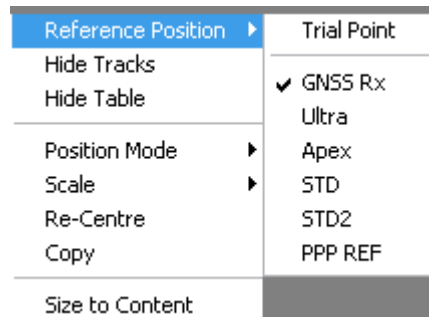


**Error Ellipses View – Reference Position**

The "*Reference Position…"* can be set to any of the position calculations or the Trial Point (*Config/Calculation/Settings)* if the system is stationary. The selected solution is shown in the index in bold print.

"*Hide Tracks*" allows the user to remove the track plots for all the calculations in the Error Ellipse display

"*Hide Table*" allows the user to hide the key completely.
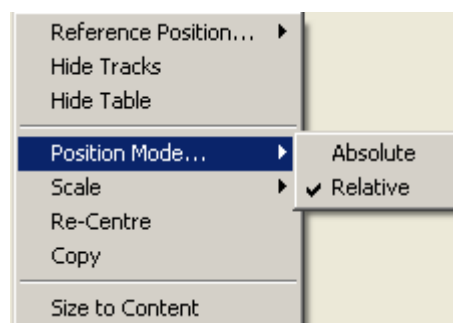


**Error Ellipses View – Position Mode**

The "*Position Mode…*" can be set to Relative or Absolute:

- Relative - Displays the position calculations relative to the Reference Position. This can be fixed (i.e. Trial Point) or moving (i.e. a Position Calculation). The chosen Reference Position remains in the <u>centre</u> of the screen with the other positions shown relative to it.
- Absolute - Displays all Position Calculations in their actual positions. In a moving environment, none of the positions will be centred and will all move around the screen. For a known reference position the differences are shown for each position.
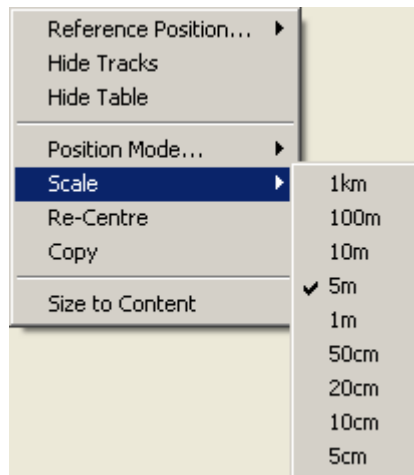
**Error Ellipses View – Scale**

"*Scale*" can be changed and the plot *Re-Centred* to the current position. The Track Plot can be copied to the PC's clipboard as a bitmap image for pasting into applications.

### 8.5.2  Time Series

The time series plot is used to monitor the performance of positions calculated over a known period of time. Users can select one of five predefined views from the tabs at the top of the display:

- Position
- Difference
- UKOOA
- Statistics
- Scatter

8.5.2.1  Position

The default Position view shows Delta East, Delta North & Delta Height of the calculated positions (relative to the reference position selected by the user).

Right mouse click on the view to select the reference position.
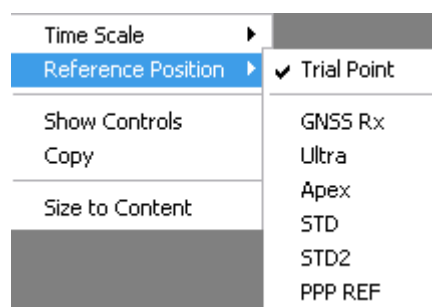


**Time Series View – Reference Position**
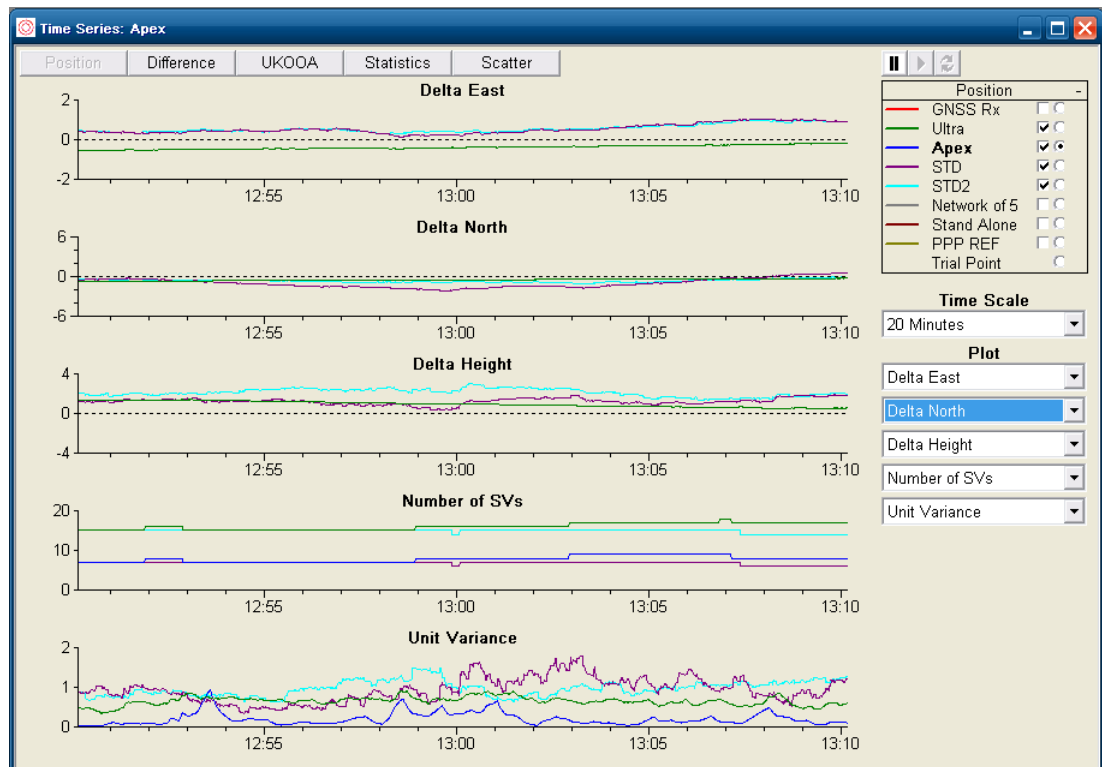
**Time Series View**

### 8.5.2.2 Difference

The Difference View show the differences in position between each consecutive position fix.  This is an indication of positioning stability.

View shows the 1st differences for each calculated position including Number of SV's and the Unit Variance.

### 8.5.2.3 UKOOA

The UKOOA View shows the primary statistical parameter present within the UKOOA output. The view includes the Semi-major axis, Unit Variance, Internal Reliability, 2D External Reliability and RMS.

### 8.5.2.4 Statistics

Shows range of general Statistics, namely HDOP, PDOP, RMS, Number of SV's, Number of Stations and Latency.

### 8.5.2.5  Scatter

The Scatter View shows a 2D North-East scatter plot of the positions.
This view has the following appearance: -
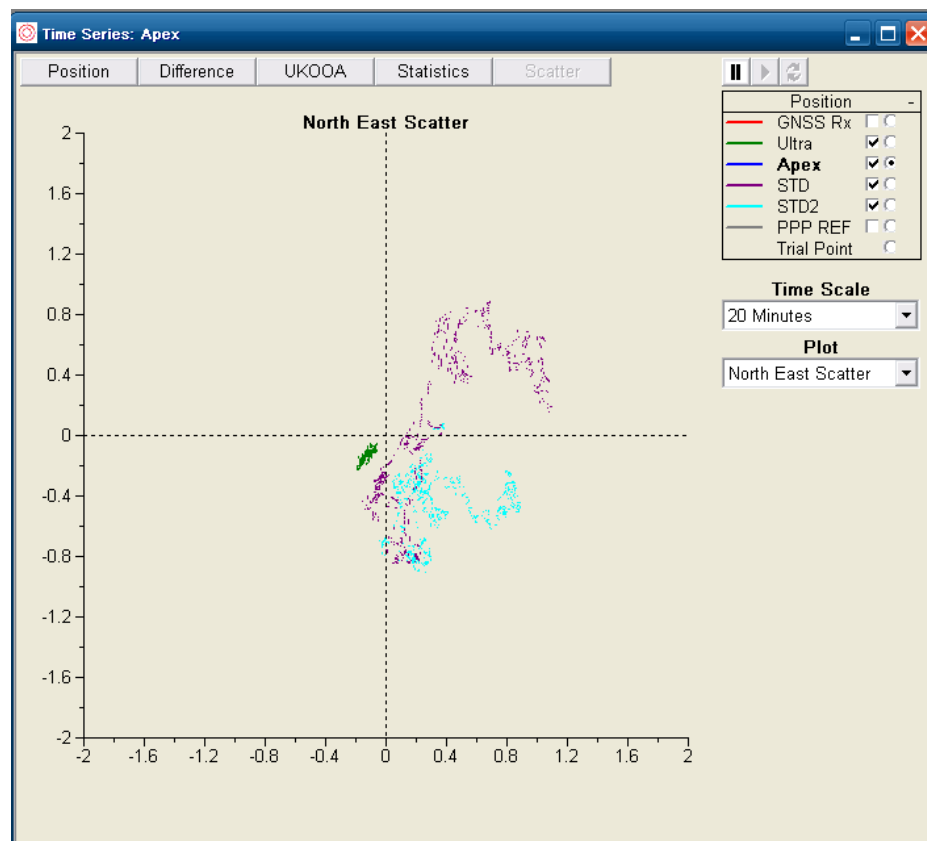


**Time Series View – Scatter Plot**

In addition to selecting the five predefined views, users can customise each view with the *Time Scale* and *Plot* pull down menus to the right of the screen.

Right click on the view and select *"Show Controls/Hide Controls"*.

A graph for a calculation can be highlighted by clicking on the calculation name in the *Position* selection box.

The *Position* selection box can be hidden or shown. Use the + icon to expand the display. When the box is open the user can select the calculations required for plotting (select the square boxes) and selecting the calculation, or Trial point - to be used as the reference position (tick the round box).

Moving the pointer over a particular time series or scatter plot changes the cursor to a zoom magnifying icon and a box can be dragged over a selected area - right mouse button - to start the area to be reviewed. This pauses the view, adds a magnified graph of the selected area at the bottom of the screen and a small, full graph at the top of the screen:
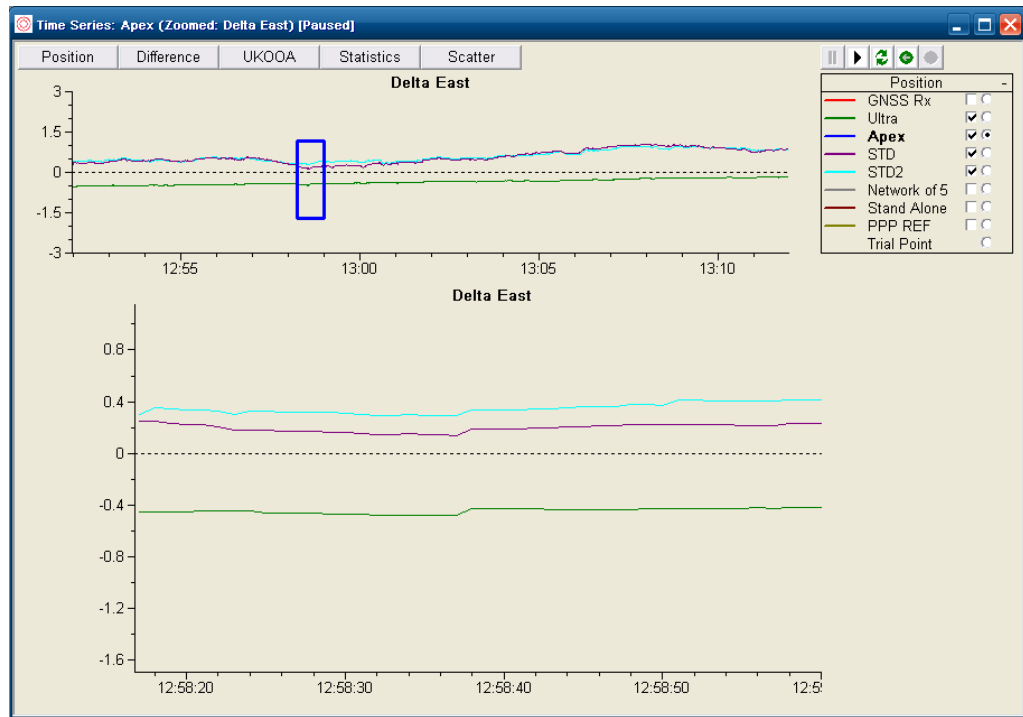
**Time Series View – Zoom**

Zoom in as many times as required. Icon functions:

| Icon | Function |
|---|---|
| ⏸ | Pauses the live update view to review a previous period |
| ▶ | Play option puts the user into real time mode and jumps to current time |
| ↻ | Refresh the screen |
| ◀ | Back button for stepping between previous zoomed areas |
| ▶ | Forward button for stepping between successive zoomed areas |

The right mouse button in the window of both the time series and scatter plot accesses menu to change the *Time Scale*:
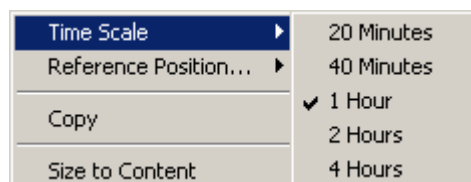


**Time Series View Options**

Change the Y-scale of the vertical axis by moving the mouse pointer to the vertical axis and double clicking.

Select Automatic or customise:
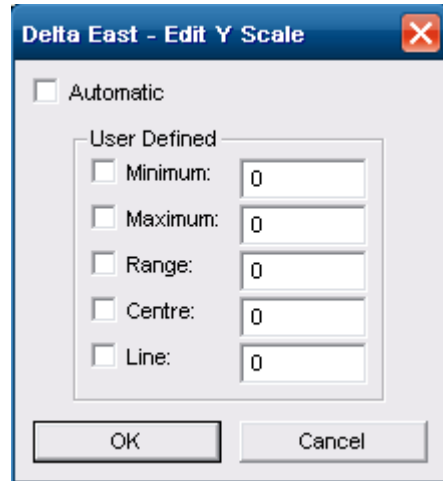


**Time Series View – Y-Scale**

The Time Series view can be copied to the PC's clipboard as a bitmap image for pasting into MS Paint or MS Word.

### 8.5.3 Overall Status

"View/Overall Status" opens a detailed summary view of the GPS/GLONASS and RTCM data input status, the calculation status and the data output status and provides a general picture of the Verify QC operational status.
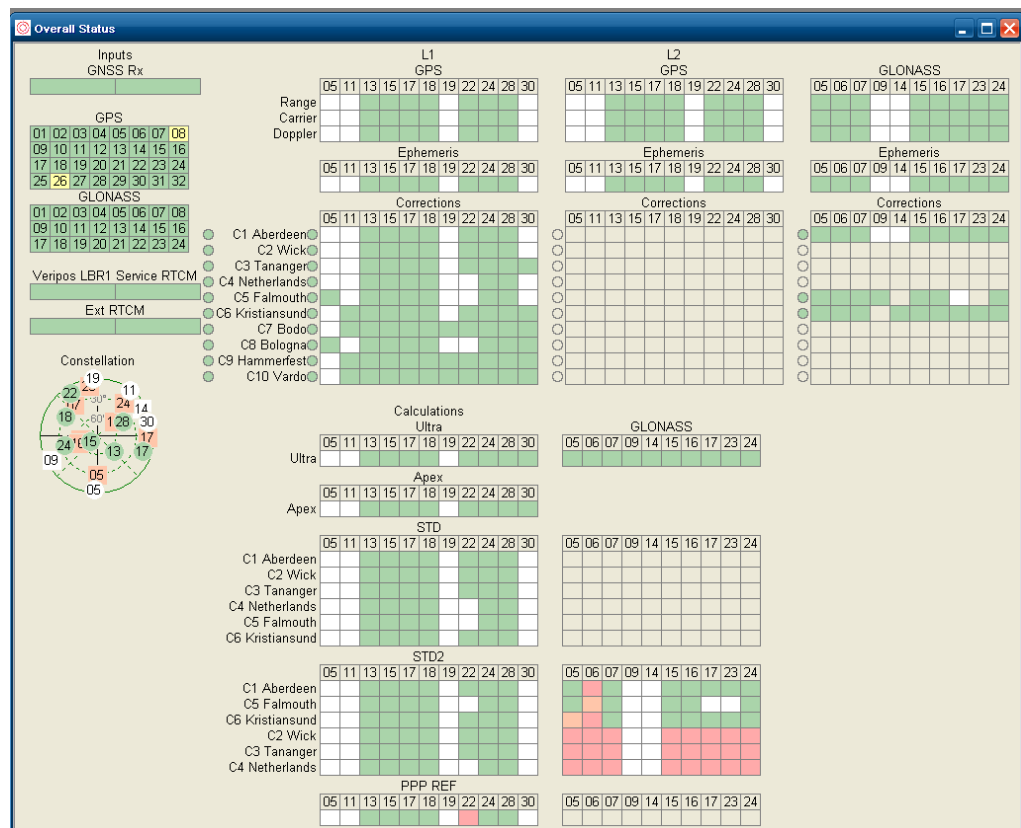


**Overall Status View**

The overall status view has three zones. The area to the left indicates the status of the inputs, the centre area indicates the status of the received GPS/GLONASS and RTCM data and the area to the right indicates the status of the outputs. Each area is described in more detail as follows:

Inputs area

| | |
|---|---|
| Receiver | indicates if the receiver data is being received and decoded. When both halves are green the receiver data is receiving and decoding successfully. Red indicates a failure. |
| GPS / GLONASS | indicates whether almanac information is available for each satellite (green). Unhealthy satellites are shown in yellow and disabled satellites are shown in red. |
| 'RTCM Link x' | indicates that the RTCM data for each RTCM input is being received and decoded. If both halves are green then the RTCM data is received and decoded successfully. Red indicates a failure. |
| Constellation | shows the location of GPS (green circle) and GLONASS (orange square) satellites and their status (white = below elevation mask, yellow = unhealthy, red = disabled). |

L1/L2 area

| GPS / GLONASS | indicates whether the pseudo-range, carrier and Doppler observations for satellites above the horizon have been received (green). Satellites below the elevation mask at the user end are shown in white. |
|---|---|
| Ephemeris | indicates if GPS and GLONASS ephemeris data for satellites above the horizon have been received. Satellites below the elevation mask at the user end are shown in white. |
| Corrections | indicates whether GPS L1 (Type 1), GPS L2 (Type 15) and GLONASS L1 (Type 31) corrections have been received (green) for the listed satellites at each reference station. Missing corrections are shown in red and satellites 'just above the elevation mask' at the reference station without corrections are shown in orange. Satellites below the elevation mask at the reference station are shown in white. The circle before the station name indicates whether a Type 3 with the station position has been received (green = yes, red = no). The circle after the station name indicates whether the correction data is within the latency thresholds (green < 60sec, orange < 90 sec, and red > 90sec). |
| Calculations | indicates which satellites are included in the position calculation (green). Satellites not included in the calculation (due to missing GPS/GLONASS observations or their corrections, or due to w-test rejection) are shown in red, as are disabled satellites. Satellites below the elevation mask at the user end are shown in white. |

Outputs area

| 'Output x' | indicates the output status of each position output. Green indicates a data message output recently and the number indicates the length of message. |
|---|---|

The appearance of the view can be changed by selecting the relevant options after right clicking on the view.



**Overall Status View Options**

Mouse clicking on each coloured box will open the relevant view with additional information. Clicking on the receiver input, RTCM input and position output boxes will open the IO View. Clicking on the corrections area will open the Differential Data view for that particular station. Clicking on the calculation area will open the Position view for that particular calculation.

It is also possible to open the Almanac, GPS & GLONASS Ephemeris, GPS & GLONASS Measurements, Latency and Station Map by clicking on the relevant areas.

### 8.5.4 Calculation History

The calculation history displays a history of the main events against a time scale. The top bar provides a general overview of event happenings and the time period. The black box acts as a viewfinder and can be moved along the time axis. Depending on the overall time scale an area of 5, 30 or 60 minutes is magnified in the bottom bar. The left-hand column describes the event whilst the right-hand column shows the time-span.
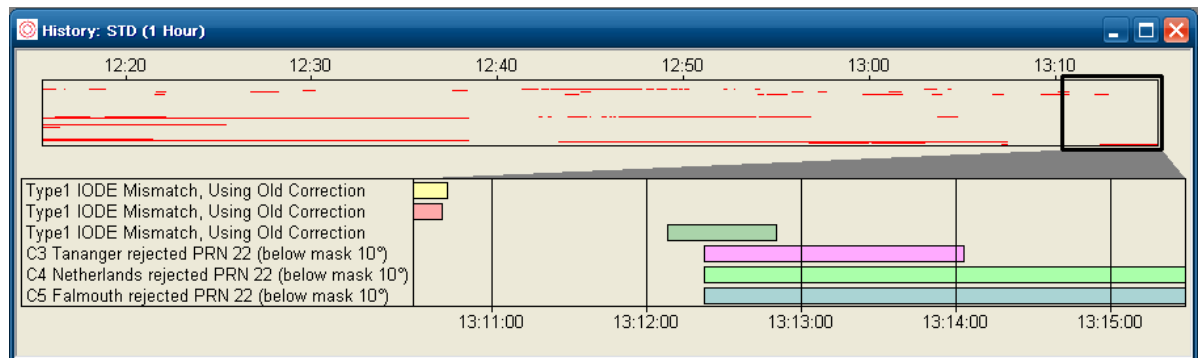


**Calculation History View**

The time period can be changed by using the mouse to right click in the screen. Time period options are 1, 6, 12 and 24 hours. The user can select also the calculation for the calculation history to be displayed: -



**Calculation History View Options**

### 8.5.5 Status Report

The Status Report view provides 3 views to monitor the availability of GNSS measurements and correction data.

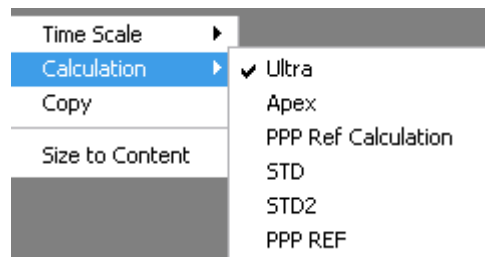The primary view is the GNSS Availability View. The view is split into an availability bar indicating the availability of GPS and GLONASS measurement sets against the present day's 24-hour time scale and an availability table indicating the availability of GPS and GLONASS measurements against 5º elevation brackets.
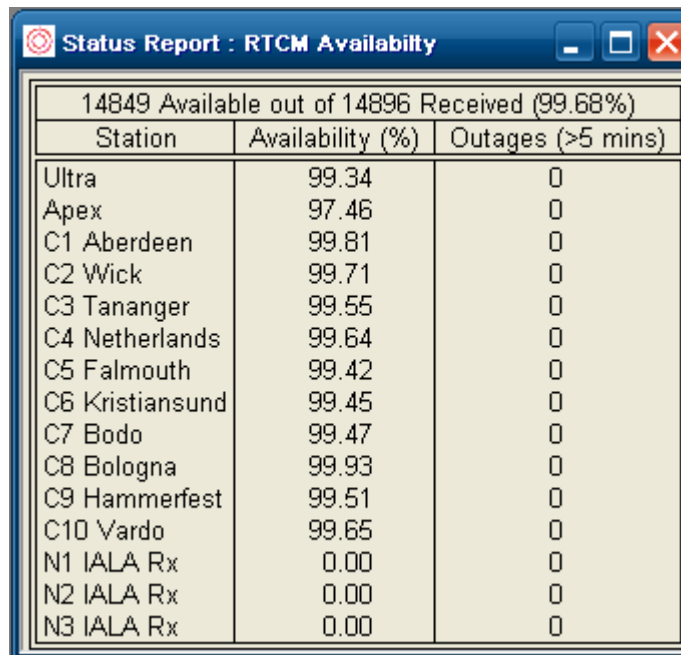
The availability bar appears continuous with a green colour for all measurement sets. A missing measurement set will appear as a black vertical line to indicate a break in the GPS and/or GLONASS data input. A missing measurement set may be caused by a break in the data connection to the receiver, corruption of the data stream or total loss of data due to interference.

The availability table will, for each 5⁰ elevation bracket, indicate what percentage of expected CA, L1 and L2 observations were received in Verify QC. Percentage values less than 100% may for example be caused by (low elevation) antenna masking or intermittent tracking due to interference.



**Status Report View – GNSS Availability**

*Note: which observation types are monitored depends on the GNSS receiver type. The Septentrio AsteRx2 receiver, for example, does not output L1 observations and the column therefore will appear blank when using that GNSS receiver type.*

The view options dialogue, accessible via a right mouse click on the view, allows GLONASS information to be hidden and the contents of the Status Report View to be changed to show GNSS Health History information or RTCM Availability information.



**Status Report View Options**

The GNSS Health History View shows the PRN or Slot Number of GPS and GLONASS satellites, and the time period they were unhealthy, against the present day's 24-hour time scale.

**Status Report View – GNSS Health History**

The RTCM Availability View shows the RTCM message availability of Ultra, Apex and individual DGPS reference stations since the start of the present day. The number of station outages exceeding 5 minutes is listed in a separate column.



14849 Available out of 14896 Received (99.68%)

| Station | Availability (%) | Outages (>5 mins) |
| --- | --- | --- |
| Ultra | 99.34 | 0 |
| Apex | 97.46 | 0 |
| C1 Aberdeen | 99.81 | 0 |
| C2 Wick | 99.71 | 0 |
| C3 Tananger | 99.55 | 0 |
| C4 Netherlands | 99.64 | 0 |
| C5 Falmouth | 99.42 | 0 |
| C6 Kristiansund | 99.45 | 0 |
| C7 Bodo | 99.47 | 0 |
| C8 Bologna | 99.93 | 0 |
| C9 Hammerfest | 99.51 | 0 |
| C10 Vardo | 99.65 | 0 |
| N1 IALA Rx | 0.00 | 0 |
| N2 IALA Rx | 0.00 | 0 |
| N3 IALA Rx | 0.00 | 0 |

**Status Report View – RTCM Availability**

## 8.6 LOGGING

The Logging menu contains all views available to the user for monitoring the logging status.
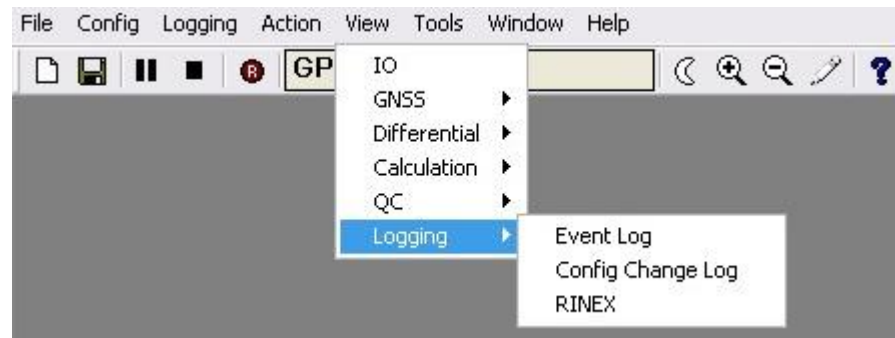


**View Menu - Logging**

The Logging functionality contains logging of all GNSS & RTCM input data (ALF) and logging of GPS data in the Receiver Independent Exchange format (RINEX).

Verify QC will create also event logs and a record of all configuration changes.

### 8.6.1 Event Log

"*View/Logging/Event Log*" will display the Verify QC event for the last 4 hours.

The event information is split over four columns with the heading Time, Mode, Event and Source respectively.
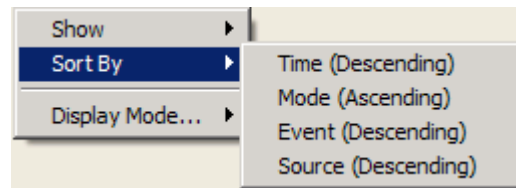


**Event Log View**

The *Time* column displays date and time information. The *Mode* column indicates if the event is for the users' information or if it constitutes a warning. Warnings are displayed when critical data inputs time out. The *Event* column provides a description of the event. The *Source* column gives an indication of which process detected the event.

The event log can be sorted by any of the columns. Clicking on the column name changes the sort order for each column. Alternatively the sorting parameters can be set by right clicking on the view menu and selecting options under '**Sort by**'.



**Event Log View – Sort By Options**

Individual columns can be hidden by right clicking on the view and selecting options under '*Show'*.

The Display Mode of the event log can be changed. The live mode can be paused or set to display a past event log file.
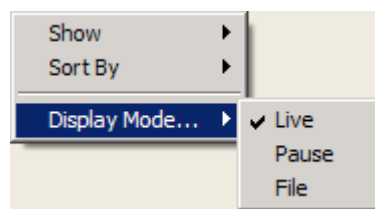


**Event Log View – Display Mode Options**

The user can view the events of previous days by right clicking on the view menu and selecting "*Display Mode…/File."* The full list of event files associated with the current configuration are shown and are available for selection.
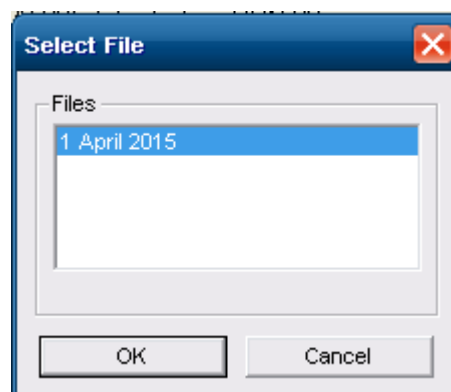


**Event Log View – Select File**

Whilst the event log is in 'File' mode it is possible to browse through the event files using the '*Next'* and '*Prev'* commands or to select the file for a specific date via the '*Select'* sub-menu.
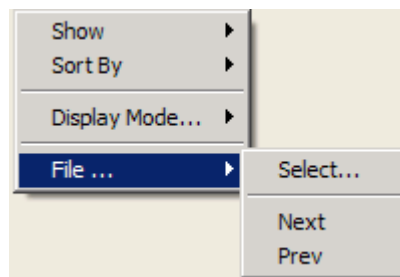


**Event Log View – File Mode**

The view options outlined above are available also by right clicking on the header bar of the view.

### 8.6.2 Config Change Log

All configuration changes are stored in an XML file with the same name and kept in the same location as the configuration file. This log of configuration changes is displayed also in Verify QC in the Config Change log View.

The view contains a record of the date and time of the change, a title and a description of the change. Further details of the change can be displayed by clicking on the '**+**' symbol at the start of the specific change entry. Similarly, the details can be collapsed.



**Config Change Log View**

In addition to the software storing all configuration changes automatically, the user can add notes to the log (XML file). The 'Add Notes to Config Change Log' dialogue will open following a right mouse click on the view and selecting '**Add to Log**'.



**Config Change Log Add Notes Dialogue**

### 8.6.3  RINEX

"View/Logging/RINEX" opens the RINEX logging status view and displays the Measurements, Header and Stats chosen from the option menu at the top of the view.

See RINEX standards for further details about the displayed RINEX data records.



**RINEX View - Measurements**

**RINEX View - Header**

The RINEX '**Stats**' view shows the current logging path and the size of the current data file.



**RINEX View - Stats**

## 9.TOOLS

The Tools menu offers a small selection of amenities to enhance Verify QC operations.
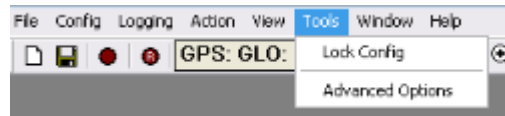


**Tools Menu Structure**

### 9.1  LOCK CONFIG

The configuration file in use can be secured by means of a password. Using "*Lock Config*" allows file protection by the entry of a password (at least 6 characters long). It is recommended that all Users are advised of this password for access to the configuration once it has been locked.

Locking the configuration file will disable access to configuration menus. However, users can still change the window display, and make any other cosmetic changes.
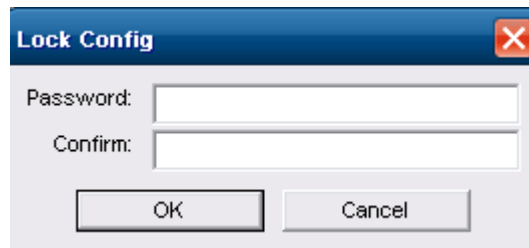


**Lock Config**

## 9.2  ADVANCED OPTIONS

The user can disable certain advanced views or software options using "*Tools/Advanced Options*".
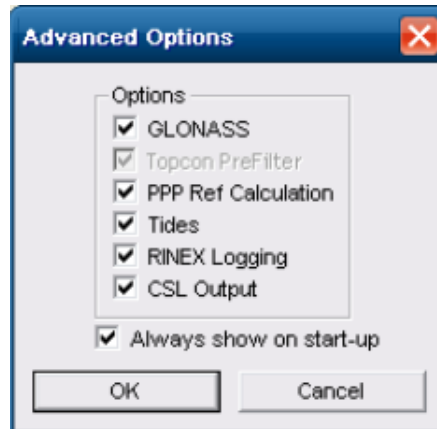


**Advanced Options dialogue**

The Advanced Options dialogue also appears on start-up of the software.

Enabling / disabling views or options affects the functionality and views accessible through the Verify QC menu structure.

The Advanced Views appear deselected by default. If views are enabled their enable status is stored in the configuration file such that the same view will be available when the user re-opens the configuration file.

The Options currently supported by the dongle are all selected by default in a new configuration. Several additional options can be selected. Options not supported by the dongle are greyed out. For options selected or deselected the selection status is stored in the configuration file such that the option is set correctly when the configuration file is re-opened.

The manual covers all option dependent functionality and views by describing the full menu structure.

If certain functionality or views are absent the user is advised to check the dongle enable status under "*Help/Dongle/View…*" and the selections under "*Tools/Advanced Options*."

## 10.WINDOWS

In the "Windows" menu all open Verify QC views can be selected or displayed in Tile or Cascade format.

## 11.HELP

The Help menu contains utilities for reprogramming dongles and gives access to the revision history, the User Manual and the software About details.

### 11.1 DONGLE

#### 11.1.1 View

"*Help/Dongle/View*" allows the user to see the current status of the Verify QC Dongle.
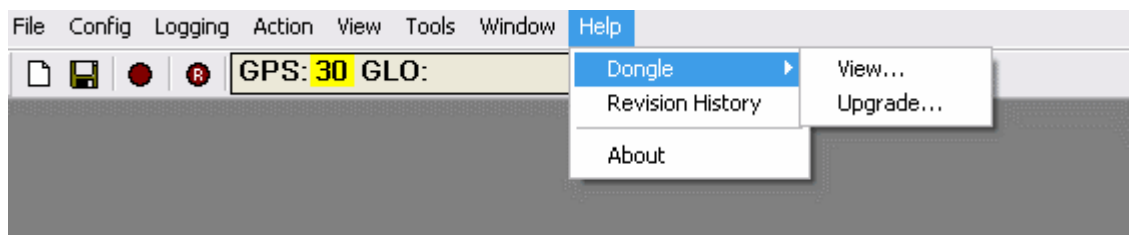


**Help Dongle Menu**

The Dongle view displays the amount of time left on the dongle activation and the software features enabled for the dongle. It also shows the most recent dongle upgrade Confirmation Code, which has to be supplied to the VERIPOS Helpdesk after the dongle has been upgraded with new features.

Verify QC will remind the user by means of a pop-up warning box when the dongle has less than 7 days remaining and is about to expire. The number of dongle days remaining is also displayed on the 'Information Bar' at the bottom left of the Verify QC screen.
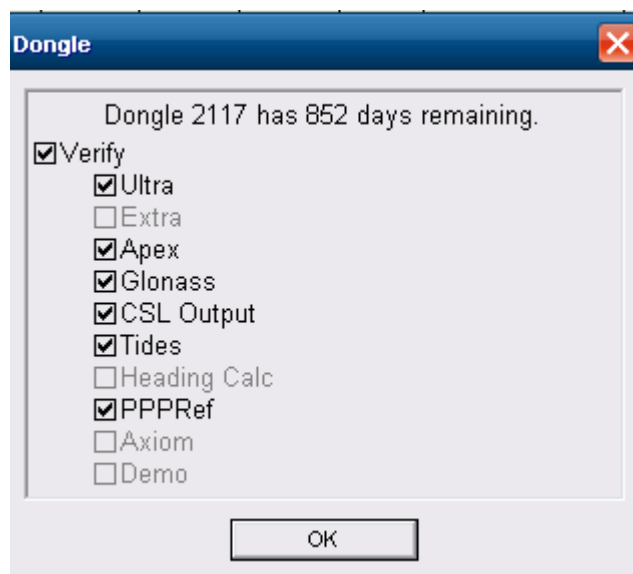


**Dongle View**

### 11.1.2 Dongle Upgrade

"*Help/Dongle/Upgrade*" allows the user to save the current dongle code to a USB memory stick. This code is needed to request a dongle upgrade or extend the dongle duration with the VERIPOS Helpdesk.
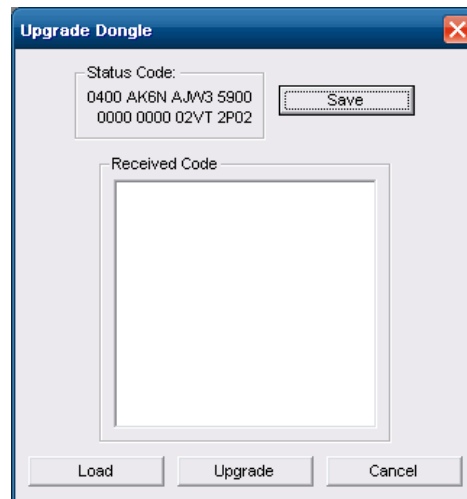


**Verify QC Dongle Status Code**

The '**Save**' button will create an ASCII file on the USB memory stick with the name status.dsf. This file can be sent by the user to the VERIPOS Helpdesk as an email attachment.

VERIPOS help desk details:  helpdesk@veripos.com

Once the VERIPOS Helpdesk returns an upgrade code the code will be required to be saved in a file named "upgrade.dsf", save file onto USB memory stick and insert into LD6. Go to "*Help/Dongle/Upgrade…",* press Load and the upgrade code will appear in the text box in the middle of the window.  Press Upgrade and the code will be applied to the dongle and a confirmation code will be returned by the software.   Users are required to send this confirmation code to the VERIPOS Helpdesk to record a successful upgrade. Failure to do so may result in dongles not accepting future updates.

When the codes have been entered the user can check if the upgrade has been applied as requested by selecting "*Dongle/View*" to bring up the following view which will now contain the latest confirmation code.

## 11.2  REVISION HISTORY

Provides a summary of the revisions of the previous Verify QC software versions.

## 11.3  USER MANUAL

The user Manual does not open on an LD6 unit. The user should view the manual on a PC. Or paper copy.

## 11.4  ABOUT

This opens the following dialogue box containing the necessary support contact information together with the Verify QC Software Version and the version of the Algorithms. The software version may be requested if the user requires support to assist in resolving any technical issues.
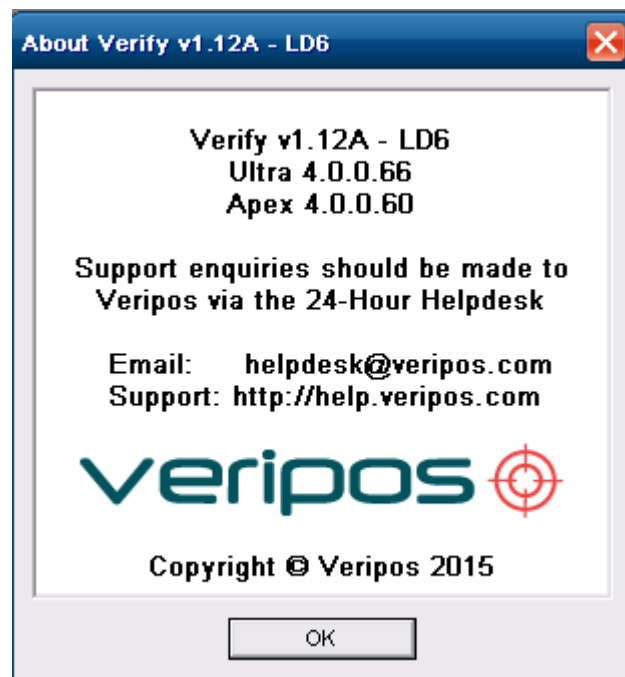


**Verify QC About View (Example)**

## 12.LD6 FILE MANAGER

The LD6 when used in QC mode provides a facility to manage files.
It is recommended to launch file manager by inserting a clean (virus scanned) memory stick in to a free USB port and selecting Run File Manager.



**USB Splash Screen**
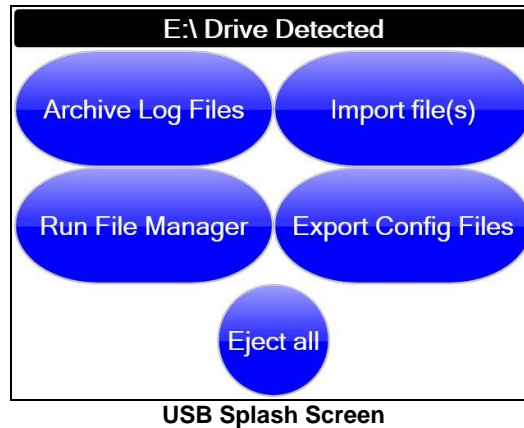
Alternatively to launch file manager;

From the LD6 home page, go to *Actions/Apps* and select *File Manager*.



**Launch Page**
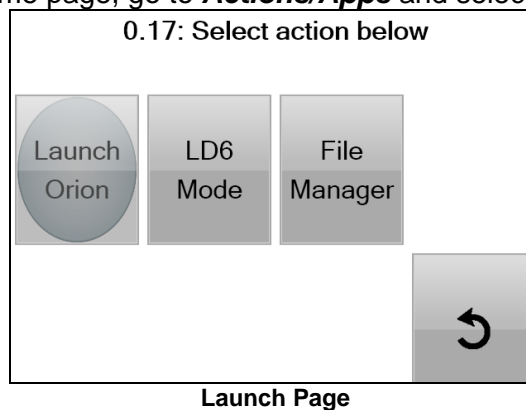
A Config window will be presented on Screen 2.
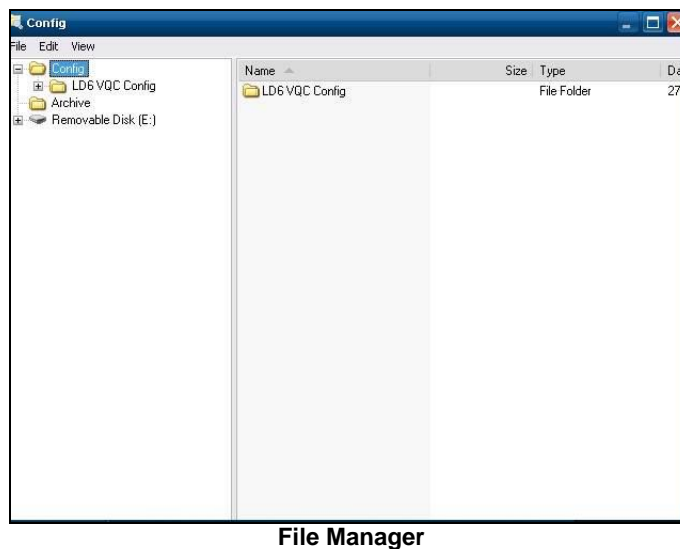


**File Manager**

In File Manager use the Keyboard and mouse for:

- Viewing and Transfer of Verify QC configurations
- Logged ALF data retrieval
- Logged Tides data retrieval

## 12.1 VIEW AND TRANSFER OF QC CONFIGURATIONS

Navigate to the QC configuration folders, copy and paste to desired location on the memory stick.
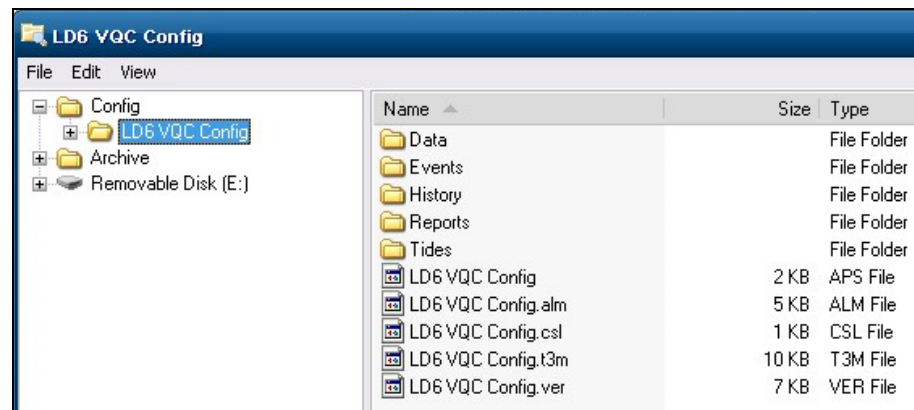


It is recommended to use the default directory **LD6ImportExport\VQC\Config\...** on the USB memory stick so that a QC configuration file can be opened via the **File** menu within Verify QC.
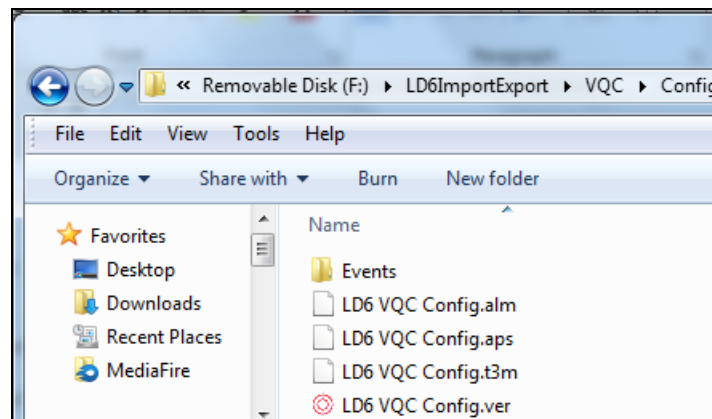


Refer to section 4.5 for information regarding the USB default directory and restoring QC configuration files from USB.

When running Verify QC on an LD6, there is an **Export Config Files** option available within the LD6 MMI which backs up the QC configuration files in addition to LD6 configuration files.  For further information regarding this feature, please refer to the *LD6 Operations Manual*.

## 12.2  LOGGED DATA RETRIEVAL

Verify QC data files that can be archived using File Manager are:
- Configuration
- Tides
- ALF
- RINEX

To archive data from the LD6 for QC, insert a USB stick in to the LD6 (If not already inserted to launch file manager).

Use the file manager on-screen to locate the data, then copy and paste files to the memory stick.

### 12.2.1  Tides Data retrieval

To remove Tides data from the LD6 for Post Processing, firstly Archive the Tides data within QC.

Click "*Action/MSS Tides/Archive…*"
The following window will appear:
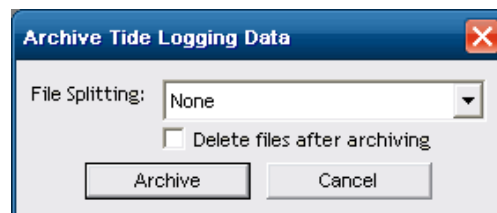


**Archive**

It is possible to split the Tides files during archive for ease of processing.  Select the desired file splitting option.  File splitting options are:

- None        Files will not be split
- Daily        Files will be split daily
- Weekly      Files will be split weekly
- Monthly    Files will be split monthly

If the *Delete files after archiving* option is ticked, the original tides files will be deleted.

**Note:  Deleting the tides files will reset the tides calculation.  Do NOT delete the tides files if you wish to continue to use the Tides calculation.**

Select *Archive* button

The data can be found in the following folder on the LD6 using the File Manager application:

Archive/ *DateandTimestamp (YYYY-MM-DDTHH-MM-SS)*/ Tides
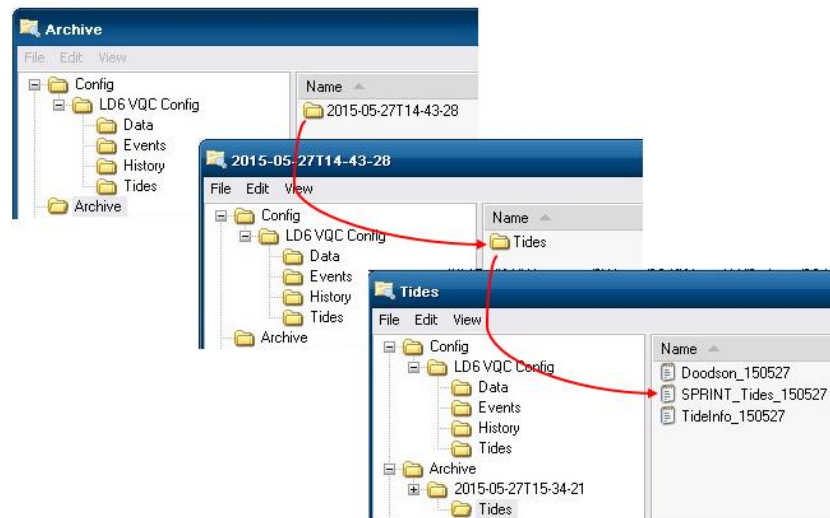
This can be copied to a USB drive.

## 12.3 REMOVAL OF USB MEMORY STICK

To remove the USB memory stick use the *Eject All* button on the LD6 that appears when any USB memory stick is inserted into the LD6.  This will safely dismount USB sticks.



**USB Splash Screen**
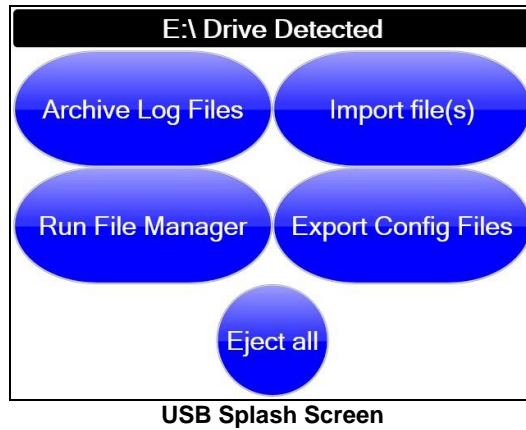
## 12.4 ARCHIVE DATA

In the event of any receiver issues, such as loss of solution, it is possible to archive the raw GNSS and RTCM data in a VERIPOS proprietary format. These files can then be sent to VERIPOS for analysis in order to determine the cause of any issues.

Note that in Verify QC on the LD6 there is no option to Archive data within Verify QC, only on the LD6 itself.

In the event of any receiver issues, such as loss of solution, it is possible to archive the raw GNSS and RTCM data in a VERIPOS proprietary format. These files can then be sent to VERIPOS for analysis in order to determine the cause of any issues.

When an LD6 is in *QC Mode*, it retains the last 3 days (72 hours) of logged data.

To archive LD6 data, insert a USB memory stick into an available LD6 USB socket. The screen below will appear:
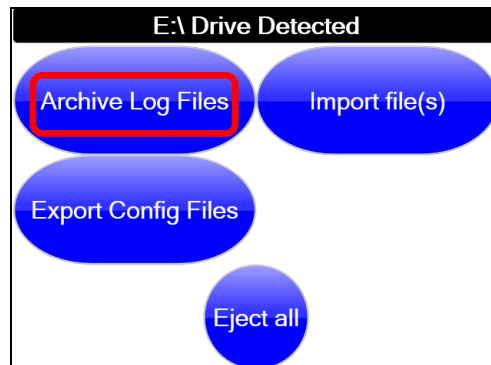


Select **Archive Log Files** to commence archiving the raw logged data to the USB memory stick.

The screen will now show that the data is currently being archived and an option to cancel the operation will be available if required:



---
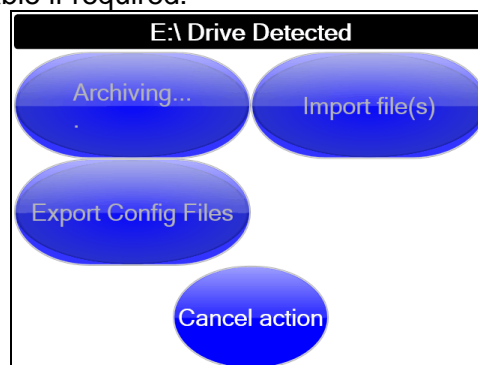
ℹ️ **NOTE** ───────────────

*Always* perform a virus scan on the USB memory stick before inserting into the LD6. The data archive may take several minutes and is complete when the **Eject all** icon becomes available.
Before removing the USB memory stick from the LD6, ensure that **Eject all** is pressed. This will then allow the USB memory stick to be safely removed.

## 13. INDEX OF APPENDICES

A      DEVICE IO DESCRIPTIONS
      A.1    SERIAL PORTS
      A.2    CLIENT SOCKET
      A.3    SERVER SOCKET
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B      QUALITY STANDARDS
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D      TIDES LOGGING FILE FORMATS

# APPENDICES

## A    DEVICE IO DESCRIPTIONS

This appendix outlines the steps required to configure the interfacing within Verify QC and the LD6 MMI when Verify QC is running on an LD6 unit.

The Verify QC software supports a number of communication types for data input and output as described below: -
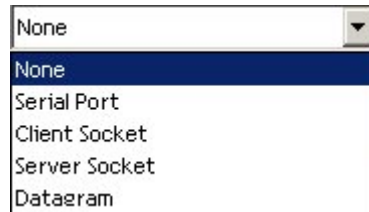


**IO Device Communication Types**

All communication types available within the software are displayed in the drop down "**IO Device**" menu. The list has been customised such that only input communication types are available in input dialogues and vice versa.

Each communication method is described in the following sections.

### A.1    SERIAL PORTS

Serial ports are the physical connections to the hardware. The settings depend on the device being used or the data being output. To access the serial port configurations options, select Serial Port connection type from the IO Device menu.

When running Verify QC on board the LD6 the serial port configuration is completed in 2 steps.

1. Configure the Baud Rate, Data Bits, Parity, Stop Bits and Protocol on the LD6 front panel MMI.
2. Configure the IO Device in Verify QC to the designated Serial Port (Com 9 to14)
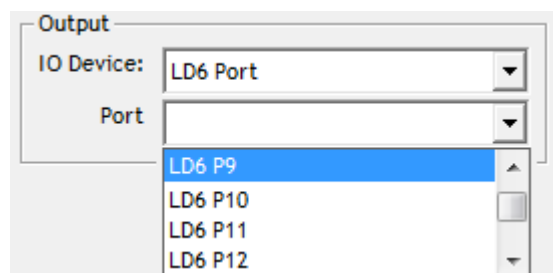


**Serial Port Options**

## LD6 configuration

When the LD6 is running in Verify QC Mode Com Ports 9 to 14 are assigned to be used for Verify QC.

The user must set the desired Baud Rate, Data Bits, Parity, Stop Bits and Protocol prior to configuring the input or output IO Device in Verify QC.

To do this press the **Settings** then **IO** button on the LD6 front panel and scroll to desired com port in the list (Com 9 to 14)
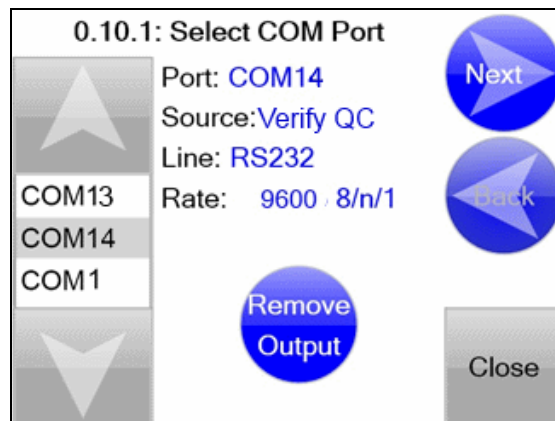


**LD6 Serial Ports – Reserved for VQC use**

Click **Next** to display the Select Device page. This should be set to Verify QC and should not be changed by the user.
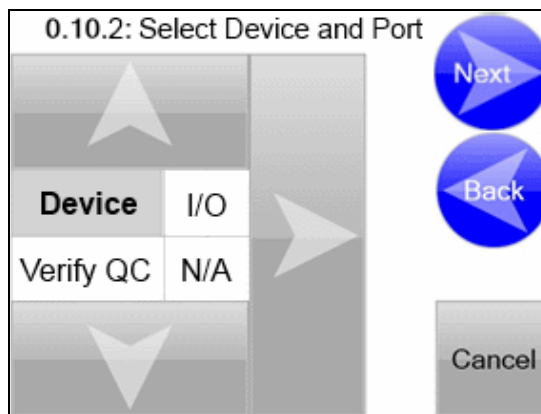


**LD6 Serial Ports – Reserved for VQC use**

Click *Next* then select the Protocol from RS232 or RS422
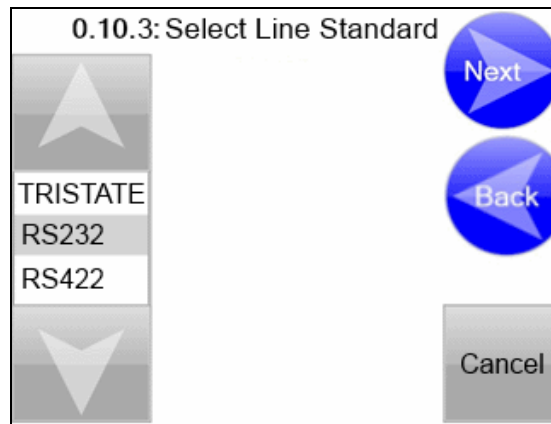


**LD6 COM Port Settings – Data Protocol Selection**

Click *Next*, select the Baud, Data, Parity and Stop Bits and then select *Finish*.
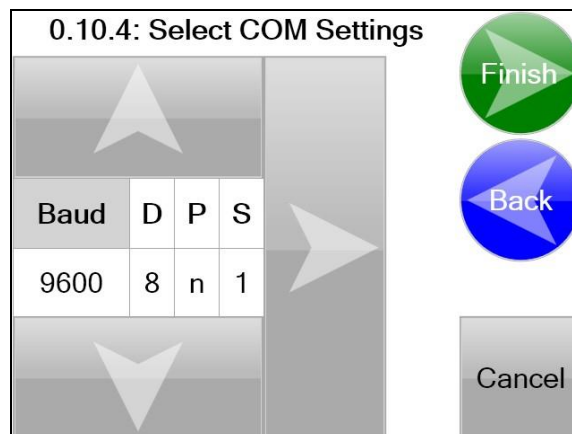


**LD6 COM Port Parity Settings – Data Protocol Selection**

A window will appear to confirm the correct settings, if the settings are correct click *Yes*.

**Verify QC Configuration**

In Verify QC IO Device section the user should set the Type to **LD6 Port**
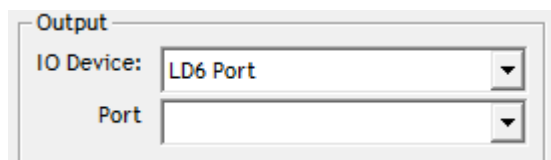


**VQC Output – LD6 Port**

In the Port list there are predefined ports 9 to 14

**VQC LD6 COM Ports**
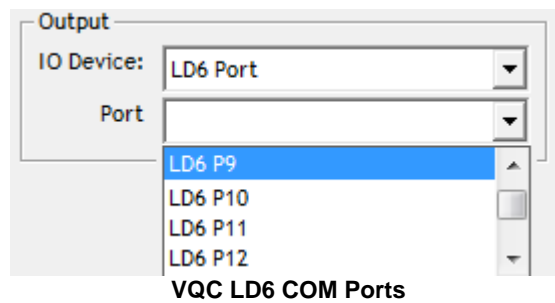
The user should then select the desired Port



**VQC LD6 COM Port**
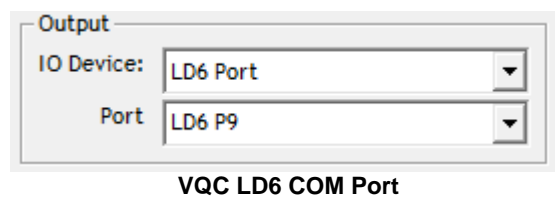
A Com port already in use by Verify QC or another application on the PC will be greyed out in the *Port* pull down menu.

The *Baud* rate must match the settings of the device connected to Verify, or the setting required for the output string. *Data Bits*, *Parity* and *Stop Bits* can be changed if the interfaced device does not use the 8 NONE 1 protocol.

A.2     CLIENT SOCKET

RTCM and Demodulator Status data can be received from other applications on the network using Client Sockets with the TCP/IP protocol.
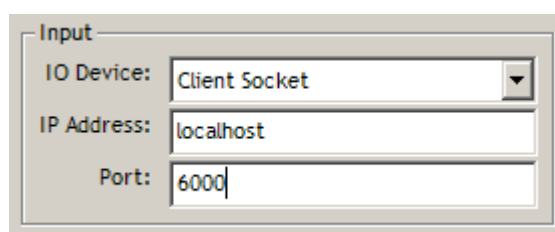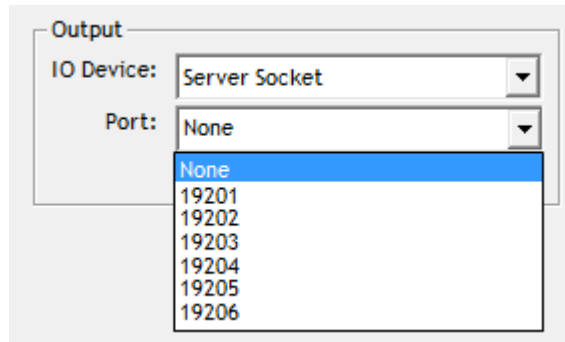


**Client Socket Options**

The Client Socket dialogue allows users to enter the *IP Address* of the device serving out the data and the *Port* on which the TCP/IP data is present. If the data is coming from the same computer as Verify QC the IP address should be left as "localhost". Ports range is between 0 – 65535.

A.3     SERVER SOCKET
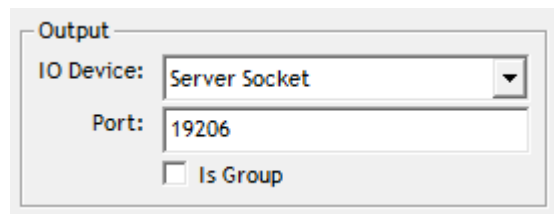
Position output data can be sent to other applications on the network using Server Sockets with the TCP/IP protocol.

The Server Socket ports available in Verify QC, when running on an LD6, are restricted to ports 19201 to 19206



**Server Socket Options**

Select IO Device **Server Socket** and then select desired **Port**
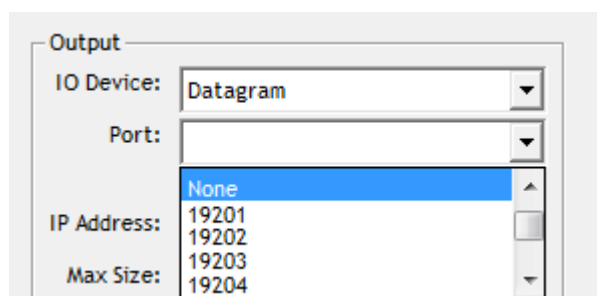


**Server Socket Configured**

The Server Socket dialogue allows users to enter the *Port* on which the TCP/IP data will be present.

A.4      DATAGRAM

The Datagram connection type in Verify QC uses the User Datagram Protocol (UDP). UDP is an alternative to TCP. It does not manage a connection for purposes of flow control. Instead packets of data are issued to the intranet/internet in either broadcast mode, where any networked computer on the LAN can receive them, or in the address mode where the data packets have headers specifying the addressees of the intended recipient. There is no guarantee with this protocol that the messages will arrive in the order they were sent.

The Datagram ports available in Verify QC, when running on an LD6, are restricted to ports 19201 to 19206
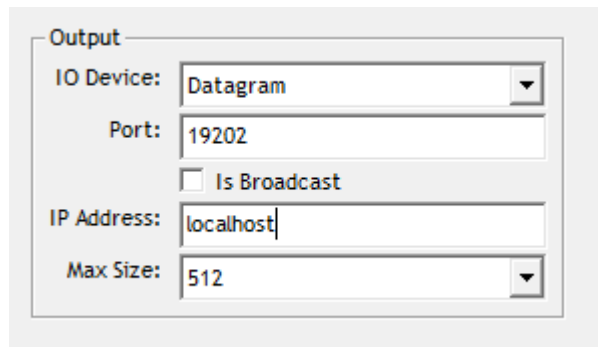


**Datagram Options**

As with Server and Clients Sockets the user is required to enter a *Port* number. The Datagram communication type can be used to send or receive data. To broadcast data, tick the 'Is Broadcast' box. To receive data, leave this box unchecked.

The *IP Address* configuration defaults to 'local host' with a Max Size of 512, limiting the packet size to 512kb. These two parameters are user selectable.

Select IO Device **Datagram, Port, IP Address** and **Max Size**



**Datagram Configured**

## B    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

### B.1    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:*
  - o *Precision:      a-posteriori error ellipse*
  - o *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.

## B.2 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](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.

## C   VERIFY QC OUTPUTS

Verify QC can output the following NMEA sentences (see [2]):

- GGA (Default)
- GGA (PPP)
- GGA (DP)
- GGA (Alstom)
- GLL
- GST
- ZDA
- GNS
- VTG (Default)
- VTG (Old)
- GSA
- GSV

In addition Verify QC can output the following advanced positioning and QC output sentences:

- WesternGeco TRINAV (see [4])
- WesternGeco TRINAV V3 (see [5])
- VERIPOS UKOOA Output (see [6])
- VERIPOS UKOOA 2 Output (see [7])
- GPLCT
- Veripos Applications – Axiom

References

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

[4]     GPS and RTCM Formats, Schlumberger, 2002

[5]     Third Party Equipment GPS Interface Format, WesternGeco, 23 February 2009

[6]     Document AB-R-MD-01673. Data Format Definition, UKOOA Format, 03 October 2005

[7]     Document AB-V-MD-00511. Data Format Definition, UKOOA 2 Format, 30 June 2006

## C.1    NMEA SENTENCES

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

- GGA
- GLL
- GST
- ZDA
- GNS
- VTG
- GSA
- GSV

### 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.mmmmmmm,a,dddmm.mmmmmmm,b,Q,s,p.p,h.h,M,g.g,M,x.x,nnnn*c<CR><LF>
$GPGGA,150207.00,5708.7100972,N,00217.1170486,W,2,10,0.9,137.44,M,50.72,M,6.4,0704*57

GGA sentence defined: -

| GGA | Global Positioning System Fix Data |
|---|---|
| hhmmss.ss | UTC of position |
| ddmm.mmmmmmm | latitude of position |
| a | N or S, latitude hemisphere |
| dddmm.mmmmmmm | longitude of position |
| b | E or W, longitude hemisphere |
| Q | 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) |
| s | number of satellites in use |
| p.p | horizontal dilution of precision |
| h.h | antenna altitude above mean-sea-level |
| M | units of antenna altitude, meters |
| g.g | Geoidal height |
| M | units of geoidal height, meters |
| x.x | age of differential GPS data |
| nnnn | Differential reference station ID, 0000 to 1023 |
| *c<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

- o 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 or Apex solution
- o 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 Apex or Ultra solution and 2 for a DGPS solution. Increased precision (7 decimals for Lat & Lon)

## NMEA GLL Sentence

The NMEA GGL sentence provides 2D position data.

Structure and Example:

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

GLL sentence defined:

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

## NMEA 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.aa,b.bb,c.cc,ddd.dd,e.ee,f.ff,g.gg*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.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) |
| ddd.dd | Orientation of semi-major axis of error ellipse (degrees) |
| 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<CR><LF> | checksum, carriage return and line feed |

### NMEA ZDA Sentence

The NMEA ZDA sentence provides time and time zone information.

Structure and Example:

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

ZDA sentence defined:

|   |   |
|---|---|
| ZDA = Time & Date | |
| hhmmss.ss | UTC time in hours, minutes, seconds of the GPS position |
| dd,mm,yyyy | 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 GNS Sentence

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

Structure and Example:

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

GNS sentence defined:

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

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

### NMEA GSA Sentence

The NMEA GSA sentence contains the GNSS DOP and satellites used in the solution. If only GPS SVs are used in the calculation the talker ID will be GP. If only Glonass SVs are used in the calculation the Talker ID will be GL. If the GPS and Glonass SVs are used in a combined solution the talker ID will be GN and multiple GSA sentences are produced.

Structure and Example:

```
$--GSA,a,n,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,pp.p,hh.h,vv.v*c<CR><LF>
$GNGSA,A,3,02,04,05,07,08,10,13,16,23,29,,,1.1,0.6,0.9*21
$GNGSA,A,3,68,69,70,78,79,80,85,86,,,,,1.1,0.6,0.9*2F
GSA sentence defined: -
      GSA = GNSS DOP and Active Satellites
      a           Mode M = Manual, forced to operate in 2D or 3D mode A = Automatic,
                  allowed to automatically switch 2D/3D
      n           Mode: 1 = Fix not available, 2 = 2D, 3 = 3D
      xx (x12)    ID numbers of satellites used in solution, up to the first 12 ID's
      pp.p        PDOP
      hh.h        HDOP
      v.vv        VDOP
      *c<CR><LF>  checksum, carriage return and line feed
```

## NMEA GSV Sentence

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.
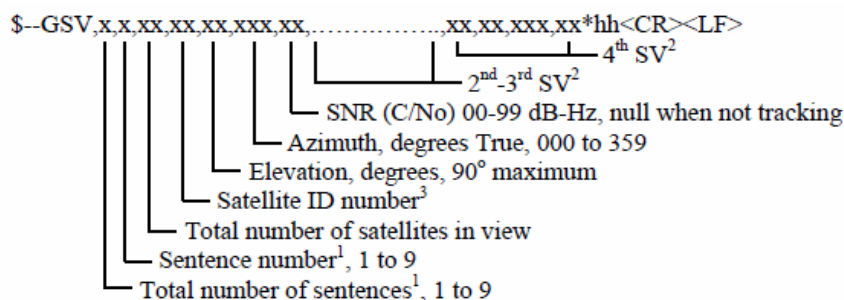


Notes:

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.

## ADVANCED POSITIONING AND QC SENTENCES

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

- o WesternGeco TRINAV
- o WesternGeco TRINAV v3
- o VERIPOS UKOOA Output
- o VERIPOS UKOOA 2 Output
- o GPLCT
- o Veripos Applications – Axiom

In order to provide the necessary outputs, VERIPOS have designed two proprietary formats containing information relative to position information and statistical measure as recommended by UKOOA. The VERIPOS UKOOA and VERIPOS UKOOA 2 outputs are in line with the recommendations used within the UKOOA standard.

The primary objective of the formats is to provide an output containing all the main proprietary advanced positioning and QC information used by the majority of navigation systems and DP systems within industry.

The formats allow the transfer of enough information to produce statistical testing when required and contain the positioning and QC information required by navigational systems. The VERIPOS formats contain also extra information unique to the VERIPOS system.

The format is variable in length as it includes the number of satellites and the PRN numbers of the satellites used in the calculation. Additionally, the number of reference stations used and their ID's are included. As these fields change, length of the message changes also. To assist with integration to the other systems, the variable fields are included at the end of the message and the length of the message is included at the start.

### WesternGeco TRINAV Sentence

Example:

[0102 1 Verify108 501 486140.0 2.0 23 56.73661N 096 17.34229W -4.2  0.8  1.6  1.28  0.06  0.00  0.06  0.48   0.3 3 10  3  2 10 12 15 18 21 24 26 29 30501502503]

WesternGeco TRINAV sentence defined:

| Content | Format | Field | Unit | Comments |
|---|---|---|---|---|
| Start Character | A1 | 1……1 | - | = [ (Open string) |
| Record Identifier | I2 | 2…....3 | - | = 01 |
| Format Version | I2 | 4……5 | - | = 02 for this version |
| Nav. Point No. | I2 | 6……7 | - | See comment 1 |
| System Name/Version | A10 | 8……17 | - | See comment 2 |
| GPS Week Number | I4 | 18…..21 | - | GPS Week no. since 21/08/99 |
| GPS Time of Fix | F9.1 | 18…..30 | sec | Seconds into GPS week (GPS Time). |
| Age of Fix | F4.1 | 31…..34 | sec | See comment 3 |
| Latitude | A13 | 35…..47 | dm | ^dd^mm.mmmmmN  (^=space) |
| Longitude | A14 | 48…..61 | dm | ^dd^mm.mmmmmE   (^=space) |
| Height | F5.1 | 62…..66 | m | Antenna height above WGS84 ellipsoid. See comment 4 |
| HDOP | F5.1 | 67…..71 | - | |
| VDOP | F5.1 | 72…..76 | - | |
| Unit Variance | F6.3 | 77…..82 | - | |
| Variance Latitude | F6.3 | 83…..88 | m² | See comment 5 |
| Covariance Lat/Long | F6.3 | 89…..94 | m² | See comment 5 |
| Variance Long. | F6.3 | 95…..100 | m² | See comment 5 |
| Variance Height | F6.3 | 101…106 | m² | See comment 5 |
| External Reliability | F6.1 | 107…112 | m | See comment 6 |
| Fix Status | I2 | 113…114 | - | See comment 7 |
| No. of Satellites (n) | I3 | 115…117 | - | No. of satellites used for this fix |
| No. of Ref. Stations (r) | I3 | 118…120 | - | No. of ref. stations used for this fix. See Comment 8 |
| PRN's of sats. used | I3*n | Variable | - | Satellites used for this fix |
| Idents of ref. stations | I3*r | Variable | - | Reference stations used for this fix |
| End Character | A1 | | - | Close string |
| CRLF | A2 | | | |

Comments:

1. The "Nav point no." is a unique integer identifying the position. It should be input manually to the software according to requests from Navigations System operators. Alternatively it 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
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 (probability that the MDE would be detected) and the Significance level used.
   a. 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%
   b. If values other than those given above are used, this must be explicitly stated by the contractor
   c. If no statistical testing takes place in the software, or the value is not computed, the external reliability must be set to -1
7. Fix status codes:

| Single Frequency | |
|---|---|
| **Status Code** | **Meaning** |
| 0 | No or Bad Fixes |
| 1 | Altitude Aiding (Weighted Height used in Fix) |
| 2 | Altitude hold (2D Fix) |
| 3 | 3D Fix |
| **Dual Frequency** (4 is added to the above values when positioning is set-up for dual frequency calculations) | |
| **Status Code** | **Meaning** |
| 4 | No or Bad Fix |
| 5 | Altitude Aiding (Weighted Height used in Fix) |
| 6 | Altitude hold (2D Fix) |
| 7 | 3D Fix |

8. "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. If numerical data is missing or can not be computed, the value must be set to -1.

Field Formats:

Ax      Alphanumeric text
Ix       Integer Field
Fx.y    Floating point field

Where:
      x      gives the total length including the decimal point and decimals
      y      the number of decimals

If a sign (+ or -) is included in the field, the sign must be immediately adjacent to the number it relates to with no spaces in between i.e. -3.12

Alphanumeric text fields must be left justified, and numeric fields must be right justified.

The field sizes are selected with a space between each field. This aids manual readability and protects against overflow.

## WesternGeco TRINAV V3 Sentence

The WesternGeco Third Party Equipment GPS Interface Format V3 was introduced on 23 February 2009. It describe a standard GPS interface format applying to all installations of Third Party GPS equipment interfaced to WesternGeco Marine Positioning Systems.

Example:

$WGPOS,3,1,Verify1.08,501,486140.00,2.0,23 56.73661N,96 17.34229W,-4.197,0.8,1.6,1.279,0.055265,0.002591,0.062898,0.482222,0.35,3,0,1,10,3,2,10,12,15,18,21,24,26,29,30,501,502,503,]

WesternGeco TRINAV V3 sentence defined:

| Content | Format | Unit | Comments |
|---|---|---|---|
| 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 August 21 1999 |
| 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 | [-] | |
| VDOP | F5.1 | [-] | |
| 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 | | |

Comments:

1. The "Nav point no." is a unique integer identifying the position. It should be manually input to 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 (probability that the MDE would be detected) and the Significance level used.
   a. 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%
   b. If values other than those given above are used, this must be explicitly stated by the contractor
7. 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 |

8. Computation Type Codes

| Type Code | Meaning |
|---|---|
| 0 | Single Frequency |
| 1 | Dual Frequency |
| 2 | GLONASS Augmented |
| 3 | Other |

9. Correction Type Codes

| Type Code | Meaning |
|---|---|
| 0 | No Corrections |
| 1 | Single Frequency pseudo range diff corrections |
| 2 | Dual Frequency pseudo range diff corrections |
| 3 | Satellite Orbit Corrections |
| 4 | Other |

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

## VERIPOS UKOOA Sentence

Example:

[ 239 1.06Verify 1 1392 491778.0 +0.4  +5.4 57 07.719007N 002 04.750811W 25.781
+50.28  1.389  0.775  1.152 3 19.258   0.781 0.13  1.398  +0.125  0.656  1.635  1.75  0.81
004.3 P 10{01 02 05 06 07 16 21 23 25 30} 4{0777 0701 0702 0705}]


VERIPOS UKOOA sentence defined:

| Content | Format | Field | Unit | Comments |
|---|---|---|---|---|
| Start Character | A1 | 1 | - | Open string |
| Length of Message | I4 | 2….5 | - | Number of characters |
| Software Version | A5 | 6….10 | - | |
| System Name | A6 | 11….16 | - | |
| Record Identifier | I2 | 17…18 | - | See comment 1 |
| GPS Week Number | I5 | 19…23 | - | Since Jan 6th 1980 |
| GPS Time of Fix | F9.1 | 24…32 | sec | Seconds into current GPS Week |
| Age of Record | F5.1 | 33…37 | sec | See comment 2 |
| Latency | F6.1 | 38…43 | sec | |
| Latitude | F13.6 | 44…56 | dm | ^dd^mm.mmmmm  (^=space) |
| Latitude Hemisphere Indicator (N or S) | A1 | 57 | - | N or S |
| Longitude | F13.6 | 58…71 | dm | ^dd^mm.mmmmm  (^=space) |
| Longitude Hemisphere Indicator (E or W) | A1 | 72 | - | E or W |
| Altitude above MSL | F7.3 | 73…79 | m | Antenna height above mean sea level. See comment 3 |
| Geoid Separation | F8.2 | 80…87 | m | See comment 4 |
| PDOP | F7.3 | 88…94 | - | |
| HDOP | F7.3 | 95…101 | - | |
| VDOP | F7.3 | 102…108 | - | |
| Fix Status | I2 | 109…110 | - | See comment 5 |
| Internal Reliability | F7.3 | 111…117 | m | See comment 6 |
| External Reliability (m) | F8.3 | 118…125 | m | See comment 7 |
| Unit Variance | F5.2 | 126…130 | m² | See comment 8 |
| Variance Latitude | F7.3 | 131…137 | m² | See comment 8 |
| Covariance Lat/Long | F8.3 | 138…145 | m² | See comment 8 |
| Variance Longitude | F7.3 | 146…152 | m² | See comment 8 |
| Variance Height | F7.3 | 153…159 | m² | See comment 8 |
| 95% Error Ellipse Semi Major Axis | F6.2 | 160…165 | m | See comment 9 |
| 95% Error Ellipse Semi Minor Axis | F6.2 | 166…171 | m | See comment 9 |
| Orientation Of Semi Major Axis of Error | F6.1 | 172…177 | º | See comment 10 |
| F Test (P=Pass, F=Fail) | A2 | 178…179 | - | See comment 11 |

| No of Satellites used in the Fix (n) | I3 | 180…182 | - | |
|---|---|---|---|---|
| Satellite PRN Numbers of Satellites used in Fix | {I3*(n-1)+I2} | Variable | - | PRN numbers have format I2 and are space separated |
| Number of Reference Stations used for this Fix (00 – 99) | I2 | Variable | - | |
| Ids of the Reference Stations used in the Fix | {I5*(n-1)+I4} | Variable | - | Station ID numbers have format I4 and are space separated |
| End of Character | A1 | | - | Close string |
| Carriage Return | ¬ | | - | |
| Line Feed | ^ | | - | |

Field Formats:

Ax      Alphanumeric text
Ix      Integer Field
Fx.y    Floating point field

Where:
        x       gives the total length including the decimal point and decimals
        y       the number of decimals

If a sign (+ or -) is included in the field, the sign must be immediately adjacent to the number it relates to with no spaces in between i.e. -3.12

Alphanumeric text fields must be left justified, and numeric fields must be right justified.

The field sizes are selected with a space between each field. This aids manual readability and protects against overflow.

Comments:

1. Record Identifier — shows the calculation used, as different calculations can be labelled: 1, 2, 3 etc
2. Age of Record — time of the first character of the data string being output, minus the time of position
3. Altitude Above MSL — the datum for height calculations
4. Geoid Separation — separation between mean sea level and the WGS84 reference ellipsoid, based on a Geoid model as for example EGM96
5. Fix Status Codes:

<table>
<tr><td colspan="2" align="center"><strong>Single Frequency</strong></td></tr>
<tr><td><strong>Status Code</strong></td><td><strong>Meaning</strong></td></tr>
<tr><td>0</td><td>No or Bad Fixes</td></tr>
<tr><td>1</td><td>Altitude Aiding (Weighted Height used in Fix)</td></tr>
<tr><td>2</td><td>Altitude hold (2D Fix)</td></tr>
<tr><td>3</td><td>3D Fix</td></tr>
<tr><td colspan="2" align="center"><strong>Dual Frequency</strong><br>(4 is added to the above values when positioning is set-up for dual frequency calculations)</td></tr>
<tr><td><strong>Status Code</strong></td><td><strong>Meaning</strong></td></tr>
<tr><td>4</td><td>No or Bad Fix</td></tr>
<tr><td>5</td><td>Altitude Aiding (Weighted Height used in Fix)</td></tr>
<tr><td>6</td><td>Altitude hold (2D Fix)</td></tr>
<tr><td>7</td><td>3D Fix</td></tr>
</table>

6. Internal Reliability — smallest outlier that is likely to be detected by the current solution
7. External Reliability — maximum positional effect 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.
8. (Co)-variance — The Variance and Covariance terms are elements from the variance-covariance matrix of the position fix computation (un-scaled)
9. 95% Error Ellipse — Shows 95% confidence level of the semi-major and semi-minor axis of the error ellipse
10. Orientation — Orientation of the semi major axis (degrees from true North)
11. F Test — A test applied to the Unit Variance. A "Fail" may result from large outliers in the measurements.

## VERIPOS UKOOA 2 Sentence

Example:

[ P0  1741590150906006W570743144N0020445062E0256M
3010007175008005021001P010022006060906071013162123253000364777770170270500
0000000000000A6

VERIPOS UKOOA 2 sentence defined:

| Content | Format | Field | Unit | Comments |
|---|---|---|---|---|
| Start Character | A1 | 1 | - | Open String |
| Length of Message | binary | 2 | - | Dependent - SVs |
| Message Type Identifier | A1 | 3 | - | P |
| Message Version Identifier | I1 | 4 | - | 0 |
| Message Dependent Byte | A1 | 5 | - | |
| Message Dependent Byte | A1 | 6 | - | |
| UTC Time of Fix | I7 | 7…13 | HHMMSSs | |
| Date of Fix | I6 | 14…19 | DDMMYY | |
| Age of Data | I3 | 20…22 | SSs | See comment 1 |
| Datum Indicator | A1 | 23 | - | See comment 2 |
| Latitude | I9 | 24…32 | DDMMSSsss | |
| Latitude Hemisphere | A1 | 33 | - | N or S |
| Longitude | I10 | 34…43 | DDDMMSSsss | |
| Longitude Hemisphere | A1 | 44 | - | E or W |
| Height | I4 | 45…48 | HHHh | See comment 3 |
| Height Reference Indicator | A1 | 49 | - | See comment 4 |
| Mode | A1 | 50 | - | See comment 5 |
| 95% / 68% Error Ellipse Semi-major Axis | I3 | 51…53 | MMm | See comment 6 |
| 95% / 68% Error Ellipse Semi-minor Axis | I3 | 54…56 | MMm | See comment 6 |
| 95% / 68% Error Ellipse Max Direction | I3 | 57…59 | DDD | See comment 7 |
| 95% / 68% Latitude s d / Precision Value | I3 | 60…62 | MMm | See comment 8 |
| 95% / 68% Longitude s d / Precision Value | I3 | 63…65 | MMm | See comment 8 |
| 95% / 68% Height s d / Precision Value | I3 | 66…68 | MMm | See comment 8 |
| Unit Variance | I2 | 69…71 | MMm | |
| F Test (P=Pass, F=Fail) | A1 | 72 | - | See comment 9 |
| HDOP | I3 | 73…75 | NNn | |
| PDOP | I3 | 76…78 | NNn | |
| External Reliability | I3 | 79…81 | m | See comment 10 |
| LOP with External Reliability | I2 | 82…83 | MMm | See comment 11 |
| Number of SV's used at the Mobile (*N*) | I2 | 84…85 | NN | |
| Satellite PRN Numbers | {I2*n} | Variable | NN*n | |

| W-Test Rejected LOP | I2 | | NN | See comment 12 |
|---|---|---|---|---|
| Total Number of SV's used in Solution | I2 | | NN | Approximately = *N x V* for multi-reference solution |
| Number of Reference Stations Used (*V*) | I1 | | N | 0-9, 9 = 9 or more |
| The Codes of the Reference Station used. | {I3*n} | Variable | NNN*n | See comment 13 |
| Optional Additional Data Before Checksum | I0 or {I1*n} | Variable | | |
| Checksum | CS | | | |
| Carriage Return | ¬ | | | |
| Line Feed | ^ | | | |

Comments:

1. Age of Data — the time of the first character of the data string being output, minus the time of position
2. Datum Indicator — this indicates which Datum is being used by the calculation. (W=WGS 84, Z=Other Datum, ?=Datum Not Known)
3. Height — height ranges from -999.9 to 9999.9
4. Height Ref Indicator — this shows which vertical datum is being used to calculate height in the calculation. (S=Spheroidal Height, M=Height above MSL i.e. Orthometric)
5. Mode — positioning mode used to derive height value. (H=Height Aided, 3=3D Solution, ?=Unknown)
6. Error Ellipse — shows 95% confidence level (or 68% confidence level, if the 'Output SD's at 1 sigma' box is ticked) of the semi-major axis and semi-minor axis
7. Direction — orientation of the semi major axis from centre to largest error detection (degrees from true North)
8. 95% / 68% SD — shows 95% precision value (or 68% precision value, if the 'Output SD's at 1 sigma' box is ticked) of the latitude, longitude and height coordinates
9. F Test — a test applied to the Unit Variance. A "Fail" may result from large outliers in the measurements.
10. External Reliability — 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 (probability that the MDE would be detected) and the Significance level used. It is considered to be a more useful concept than internal reliability, hence its recommended use by UKOOA as the most suitable measure of Reliability. External reliability is measured in metres
11. LOP — LOP (Line of Position) indicates the PRN of the last satellite in the list with the External Reliability value. (SV PRN '01' – '99', 'HT' if Altitude, '00' = OK)
12. w-test Rejected LOP — w-test Rejected LOP gives the PRN of the last satellite in the list that fails the W-Test (SV PRN '01' – '99', 'HT' if Altitude, '00' = OK)
13. Reference Station ID — this lists the station ID's of stations being used in the calculation. If a multi ref is being calculated, this field can be padded with zeros to a fixed length if required by checking the box in the UKOOA 2 output setup window.

### GPLCT Sentence

The GPLCT Sentence is particularly intended for use with the Ultra and Apex services as it includes a Float RTK GPS Quality Indicator.

| String name | | | |
|---|---|---|---|
| GPLCT | | | |
| **General Description** | | | |
| This string is comma delimited but with fixed length fields. A checksum is included for extra robustness. The string is 87 characters, including the "*" character and the checksum. | | | |
| **Sample** | | | |
| $GPLCT,2006365,170002.00,2859.836227,N,09304.171413,W,5, -025.13, 090.00,05.55,02.01*64 | | | |
| **Pos** | **Field Name** | **Format or Units** | **Comment** |
| 0 | Identifier | N/A | $GPLCT – fixed string that identifies the string |
| 1 | Date | yyyyjjj | Identifies year and Julian day. |
| 2 | Time | hhmmss.ss | Time |
| 3 | Latitude | ddmm.mmmmmm | Degrees and decimal minutes, 6 digits on the decimal minutes |
| 4 | Latitude Hemisphere | c | N or S |
| 5 | Longitude | dddmm.mmmmmm | Degrees and decimal minutes, 6 digits on the decimal minutes |
| 6 | Longitude Hemisphere | c | E or W |
| 7 | GPS Quality indicator | n | 0 = fix not valid<br>1 = Uncorrected GPS fix<br>2 = DGPS fix<br>5 = Ultra or Apex fix |
| 8 | Antenna Height | ±mmm.mm | Relative to ellipsoid, meters;<br>Range: -999.99 to +999.99 |
| 9 | Course | ddd.dd | Vessel course over ground, degrees from North |
| 10 | Velocity | ss.ss | Vessel speed over ground, knots;<br>Range: 0.00 to +999.99 |
| 11 | PDOP | pp.pp | PDOP |
| | * | | Fixed end delimiter |
| | | | Checksum |
| | | | <CR><LF> |

## Veripos Applications - Axiom

The Axiom (INS) message is a proprietary message containing the variables required for the VERIPOS INS Module.

| String name |
|---|
| Axiom (INS) |
| **General Description** |
| This string is comma delimited but with fixed length fields. A checksum is included for extra robustness. The string is 87 characters, including the "*" character and the checksum. |
| **Sample** |
| $--INS,hhmmss.ss,ddmm.mmmmmmm,a,dddmm.mmmmmmm,b,D,P,hh.h,pp.p,vv.v,h.hh, g.gg,l.ll,cc.c,ss.s,r.rr,t.tt,u.uu,w.ww,x.xx,y.yy,z.zz,nnnn,gp,xx (x gp),gl,xx (x gl) *c<CR><LF> $GPINS,120102.00,5708.7102489,N,00217.1179453,W,1,1,0.6,1.1,0.9,137.57,50.72,27.20,190.8 53,0.007,0.04,0.04,0.03,124.22,0.04,0.04,0.04,0081,10,02,04,05,07,10,16,20,23,29,30,9,04,05,06 ,13,14,15,20,21,22*5A |

| Pos | Field Name | Format or Units | Comment |
|---|---|---|---|
|  | Identifier | $--INS | $--INS – fixed field that identifies the string |
| 0 | Time | hhmmss.ss | UTC of position |
| 1 | Latitude | ddmm.mmmmmmm | Latitude of position |
| 2 | Latitude Hemisphere | a | N or S, latitude hemisphere |
| 3 | Longitude | dddmm.mmmmmmm | Longitude of position |
| 4 | Longitude Hemisphere | b | E or W, longitude hemisphere |
| 5 | Differential indicator | D | Differential indicator (0 = false, 1 = true) |
| 6 | Precise indicator | P | Precise indicator (0 = false, 1 = true) |
| 7 | HDOP | hh.h | HDOP (max 99.9) |
| 8 | PDOP | pp.p | PDOP (max 99.9) |
| 9 | VDOP | vv.v | VDOP (max 99.9) |
| 10 | Height | h.hh | Antenna altitude above mean-sea-level |
| 11 | Geoid Height | g.gg | Geoidal height |
| 12 | Age of correction | l.ll | Age of differential GPS data |
| 13 | Course over ground | cc.c |  |
| 14 | Speed over ground | ss.s |  |
| 15 | RMS | r.rr | RMS value of the standard deviation of the range inputs to the navigation process. Range inputs include pseudo-ranges and differential DGNSS corrections |
| 16 | Semi-major SD | t.tt | Standard deviation of semi-major axis (meters) |

| 17 | Semi-minor SD | u.uu | Standard deviation of semi-minor axis (meters) |
|----|---------------|------|------------------------------------------------|
| 18 | Semi-major Axis orientation | w.ww | Orientation of semi-major axis of error ellipse (degrees) |
| 19 | Lat SD | x.xx | Standard deviation of latitude error (meters) |
| 20 | Lon SD | y.yy | Standard deviation of longitude error (meters) |
| 21 | Altitude SD | z.zz | Standard deviation of altitude error (meters) |
| 22 | Reference Station ID | nnnn | Differential reference station composite ID, 0000 to 1023 |
| 23 | No. of GPS Svs | gp | Number of GPS satellites in use |
| 24 | GPS IDs | xx (x gp) | ID numbers of GPS satellites used in solution |
| 25 | No. of Glonass Svs | gl | Number of GLONASS satellites in use |
| 26 | Glonass IDs | xx (x gl) | ID numbers of GLONASS satellites used in solution |
| 27 | | *c | Checksum |
| 28 | | <CR><LF> | |

## D  TIDES LOGGING FILE FORMATS

The Tides functionality will create three files in ASCII format:
- *Tideinfo.txt*
- *Doodson.txt*
- *SPRINT_Tides.txt*

The structure of each of these files is outlined in the tables below.

| Filename |
|---|
| Tideinfo.txt |

**General Description**

The TideInfo.txt file contains current system height and tide information at the Averaging Period as configured by the Verify QC user.

This file contains comma delimited strings with variable length fields. Null fields indicate that no information is currently available; they should not be interpreted as 'zero'. A checksum is included for extra robustness.

Negative tide is low tide and positive tide is high tide respectively.

**Sample**

$UltraTide,20070228,21:40:00,28,600,600,5236.2830,N,00143.5184,E,5.74,0.08,0.07,5.66,5.82,5.45,0.29,0.02,5.72,44.84,0.00,0.27,EGM96*2B

| Field Number | Field Name | Format or Units | Description & Comments |
|---|---|---|---|
| 0 | TalkerID | - | Standard ($UltraTide or $ApexTide position used dependant) or VQC ($VQCnnnTide with nnn being the version of Verify-QC used) |
| 1 | Date | yyyymmdd | Identifies year, month and day for which all information in the string is valid. |
| 2 | Time (UTC or GPS) | hhmmss.ss or SSSSSSSSS | Identifies time in UTC or GPS for which all information in the string is valid. |
| 3 | Sequence Number | numerical | Sequential number incrementing by 1 for every extra string. Maximum is 99999999 after which an automatic reset back to 1 takes place. |
| 4 | Averaging Period | numerical | User selected period over which VERIPOS Apex or Ultra heights are averaged in seconds. Minimum is 60, maximum is 3600. |
| 5 | Sample Count | numerical | Number of VERIPOS Apex or Ultra height samples that were included to derive the antenna height average. Minimum is 50% of 'Averaging Period', maximum is 'Averaging Period' |
| 6 | Latitude | ddmm.mmmm (degrees, minutes and decimal minutes) | Location where height and tide information is valid. |

| 7 | Latitude Hemisphere | c | N or S |
|---|---|---|---|
| 8 | Longitude | dddmm.mmmm<br><br>(degrees, minutes and decimal minutes) | Location where height and tide information is valid. |
| 9 | Longitude Hemisphere | c | E or W |
| 10 | Mean Height | hh.hh (metres) | Mean of the VERIPOS Apex or Ultra heights during the 'Averaging Period' |
| 11 | Mean of Height SD | hh.hh (metres) | Mean of the Height SD's associated with the VERIPOS Apex or Ultra heights during the 'Averaging Period'. This is an indication of the quality of the VERIPOS Apex or Ultra heights |
| 12 | SD of Heights | hh.hh (metres) | Standard deviation of the VERIPOS Apex or Ultra heights during the 'Averaging Period'. This is an indication if the variation of the height due to vessel motion and position quality. |
| 13 | Minimum of Heights | hh.hh (metres) | Minimum of the VERIPOS Apex or Ultra heights during the 'Averaging Period' |
| 14 | Maximum of Heights | hh.hh (metres) | Maximum of the VERIPOS Apex or Ultra heights during the 'Averaging Period' |
| 15 | Doodson | hh.hh (metres) | Estimated tide-less antenna height above Mean Sea Surface from the Doodson filter. First available after 39 hours. |
| 16 | Ultra Tide | hh.hh (metres) | Local tide based on the Mean Sea Surface derived from the Doodson filter. First available after 39 hours. |
| 17 | Geoid Tide | hh.hh (metres) | Local tide relative to user selected Geoid (see field 22). Available instantaneously after user configured 'hold-off' time |
| 18 | Antenna Height | hh.hh (metres) | User entered height of the antenna above the waterline. |
| 19 | Geoid Separation | hh.hh (metres) | Local offset between the user selected Geoid and the WGS84 reference ellipsoid. |
| 20 | Draft | hh.hh (metres) | The draft. Calculated as the current Doodson value minus the Doodson value for the first record. |
| 21 | Vertical Bias | hh.hh (metres) | The vertical bias detected between Ultra Tide and Geoid Tide. Calculated as Antenna Height minus Doodson plus Draft. |
| 22 | Geoid Model | - | EGM96, EGM08 or USER, depending on user selection |

| | * | c | Fixed end delimiter |
|---|---|---|---|
| A4 | | cc | Checksum |

| Filename |
|---|
| Doodson.txt |

| General Description |
|---|
| The Doodson.txt file contains current system height and tide information at hourly intervals. |
| The information in this file is consistent with the information contained in the file TideInfo.txt but information has been condensed to a fixed averaging period of one hour. |
| This file contains comma delimited strings with variable length fields. Null fields indicate that no information is currently available; they should not be interpreted as 'zero'. A checksum is included for extra robustness. |
| Negative tide is low tide and positive tide is high tide respectively. |

| Sample |
|---|
| $UltraTide,20070301,23:00:00,31,3600,3599,5236.2829,N,00143.5183,E,5.90,0.09,0.11,5.74,6.06,5.45,0.45,0.18,5.72,44.84,0.00,0.27,EGM96*22 |

| Field Number | Field Name | Format or Units | Description & Comments |
|---|---|---|---|
| 0 | TalkerID | - | Standard ($UltraTide or $ApexTide position used dependant) or VQC ($VQCnnnTide with nnn being the version of Verify-QC used) |
| 1 | Date | yyyymmdd | Identifies year, month and day for which all information in the string is valid. |
| 2 | Time | hhmmss.ss | Identifies time in UTC for which all information in the string is valid. |
| 3 | Sequence Number | numerical | Sequential number incrementing by 1 for every extra string. Maximum is 99999999 after which an automatic reset back to 1 takes place. |
| 4 | Averaging Period | numerical | Fixed period (3600 seconds) over which the VERIPOS Apex or Ultra heights are averaged in seconds. |
| 5 | Sample Count | numerical | Number of VERIPOS Apex or Ultra height samples that were included to derive the antenna height average. Minimum is 50% of 'Averaging Period', maximum is 'Averaging Period' |
| 6 | Latitude | ddmm.mmmm (degrees, minutes and decimal minutes) | Location where height and tide information is valid. |
| 7 | Latitude Hemisphere | c | N or S |
| 8 | Longitude | dddmm.mmmm (degrees, minutes and decimal minutes) | Location where height and tide information is valid. |
| 9 | Longitude Hemisphere | c | E or W |

| 10 | Mean Height | hh.hh (metres) | Mean of the VERIPOS Apex or Ultra heights during the 'Averaging Period' |
|---|---|---|---|
| 11 | Mean of Height SD | hh.hh (metres) | Mean of the Height SD's associated with the VERIPOS Apex or Ultra heights during the 'Averaging Period'. This is an indication of the quality of the VERIPOS Apex or Ultra heights |
| 12 | SD of Heights | hh.hh (metres) | Standard deviation of the VERIPOS Apex or Ultra heights during the 'Averaging Period'. This is an indication if the variation of the height due to vessel motion and position quality. |
| 13 | Minimum of Heights | hh.hh (metres) | Minimum of the VERIPOS Apex or Ultra heights during the 'Averaging Period' |
| 14 | Maximum of Heights | hh.hh (metres) | Maximum of the VERIPOS Apex or Ultra heights during the 'Averaging Period' |
| 15 | Doodson | hh.hh (metres) | Estimated tide-less antenna height above Mean Sea Surface from the Doodson filter. First available after 39 hours. |
| 16 | Ultra Tide | hh.hh (metres) | Local tide based on the Mean Sea Surface derived from the Doodson filter. First available after 39 hours. |
| 17 | Geoid Tide | hh.hh (metres) | Local tide relative to user selected Geoid (see field 22). Available instantaneously after user configured 'hold-off' time |
| 18 | Antenna Height | hh.hh (metres) | User entered height of the antenna above the waterline. |
| 19 | Geoid Separation | hh.hh (metres) | Local offset between the user selected Geoid and the WGS84 reference ellipsoid. |
| 20 | Draft | hh.hh (metres) | The draft. Calculated as the current Doodson value minus the Doodson value for the first record. |
| 21 | Vertical Bias | hh.hh (metres) | The vertical bias detected between Ultra Tide and Geoid Tide. Calculated as Antenna Height minus Doodson plus Draft. |
| 22 | Geoid Model | - | EGM96, EGM08 or USER, depending on user selection |
| | * | c | Fixed end delimiter |
| | | cc | Checksum |

| Filename |
|---|
| SPRINT_Tides.txt |

| General Description |
|---|
| The SPRINT_Tides.txt file contains the current UltraTide with the opposite sign compared to the Ultra Tide contained in the TideInfo.txt and Doodson.txt files.<br><br>This file contains comma delimited strings with variable length fields. Null fields indicate that no information is currently available; they should not be interpreted as 'zero'. A checksum is included for extra robustness.<br><br>Negative tide is high tide and positive tide is low tide respectively. |

| Sample |
|---|
| 12,20,22,09,2006,-0.88 |

| Field Number | Field Name | Format or Units | Description & Comments |
|---|---|---|---|
| 0 | Hours | HH | Hours in the day (UTC). Time for which all information in the string is valid. |
| 1 | Minutes | MM | Minutes in the day (UTC). Time for which all information in the string is valid. |
| 2 | Day | DD | Day in the month. |
| 3 | Month | MM | Month in the year. |
| 4 | Year | YYYY | Year. |
| 5 | UltraTide | hh.hh (metres) | Local UltraTide based on the Mean Sea Surface derived from the Doodson filter. First available after 39 hours. Set as 99999.99 when no UltraTide value is available. |
|  | * | c | Fixed end delimiter (real time output only) |
|  |  | cc | Checksum (real time output only) |