WinFrog Device Group:	GPS
Device Name/Model:	NOVATEL TELEMETRY
Device Manufacturer:	NOVATEL INC. 1120 - 68th Avenue N.E. Calgary, Alberta, Canada, T2E 8S5 Tel: U.S. & Canada: 1-800-NovAtel Fax: (403) 295-4501 E-mail: gps@NovAtel.ca
Device Data String(s) Output to WinFrog:	Pseudorange Data
WINFROG DATA STRING(S) Output to Device:	Polling Command. Remotes interrogated sequentially by ID. Almanac and Ephemeris requested after several good RNGA records (to set # of SV's).
WinFrog .raw Data Record Type(s):	303,PR-NOVATELE1

DEVICE DESCRIPTION:
The NovAtel TELEMETRY device is a single unit that combines a GPS receiver with a UHF transmitter. This device is typically installed on an unmanned vehicle (such as a tail buoy) or a vehicle for which a dedicated WinFrog system is not required, such as an anchor tug. The NovAtel TELEMETRY device receives and in turn transmits GPS pseudorange information to a master WinFrog system. WinFrog receives the transmitted pseudoranges, then combines them with ephemeris and (optionally) RTCM pseudorange corrections to calculate the remote antenna position.

The NovAtel TELEMETRY device is similar to the Fugro Pelagos' GPS POD device with the exception of the GPS receiver used. (GPS Pods use the Ashtech Sensor II GPS card).

DEVICE CONFIGURATION INSTRUCTIONS:
Baud Rate: 9600
Data Bits: 8
Stop Bits: 1
Parity: none

WINFROG I/O DEVICES > CONFIG OPTIONS:
The NovAtel TELEMETRY device is added to WinFrog from the GPS device category. This device must be configured at this level. Highlight the NOVATELE1 device then right-click and select the Configure Device option. The Configure Remote GPS Pods window will appear as seen below.

Enable Pods:
Each NovAtel Telemetry device to be tracked requires unique Remote and Code numbers. The Remote and Code values are added as follows: click the *Add* button, enter the corresponding Code in the Code entry window, and then click on the line associated with the associated Remote in the Enabled Pods entry window. The Code of the associated Remote will change to the code number specified. The Remote numbers are automatically incremented for each remote unit added. The Remote unit's Code value is designated when the telemetry unit is programmed. The above steps must be performed for each NovAtel Telemetry device added, with unique Codes entered for each Remote. Note that Code 0 cannot be assigned to a Remote. This code value is reserved for the master unit.

Remotes can be deleted by highlighting the desired remote and clicking the Delete button.

Update Interval:
An update interval must be assigned in the Update Interval Box. The update value to be entered depends on the number of remotes included in the network. A value of 4.5 seconds is suggested as a starting point.

WINFROG VEHICLE > CONFIGURE VEHICLE DEVICES > EDIT OPTIONS:
Adding the NovAtel TELEMETRY device to WinFrog creates the GPS, NOVATEL, PSEUDORANGE data item. This Pseudorange data item must be added to the appropriate (remote) vehicle's device list, then edited to suit that particular installation/ application.

Note: This vehicle's device list must also include an Ephemeris device. Another GPS receiver interfaced to the WinFrog computer must provide this information. If the remote's GPS position is to be differentially corrected (i.e. DGPS), you must also add the RTCM device to this remote vehicle's device list.

The PSEUDORANGE data item must be edited once it is added to a vehicle's device list. Highlight the data item in the vehicle's device list and click the Edit button. The Pseudorange Calculation dialog box appears as seen below, allowing you to define, among other things, antenna offsets and DGPS mode.
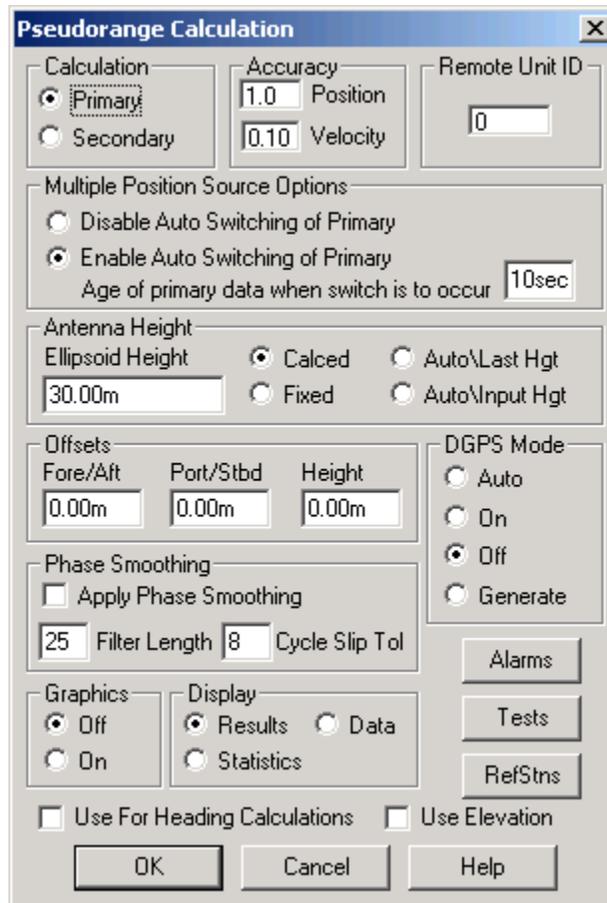
Calculation:
Set the Calculation selection to Primary or Secondary. Devices set to Primary calculation are used to provide a vessel position. Note that more than one Primary positioning device can be added to a vehicle's device list; data from these devices will be combined in a weighted mean solution. (See the paragraph on Accuracy below for more on the weighting of Primary calculation device data).

If the Calculation type is set to Secondary, WinFrog will simply monitor the device's data. WinFrog will not use the data from a secondary device in the final solution of the vehicle's position.

If auto switching is enabled (see below) a secondary may automatically become a primary should all the primaries fail.

Accuracy:
The Accuracy value entered provides WinFrog with the expected accuracy of the position from this device. This value is used in the weighting of this device compared

to other positioning devices that may be added to the vehicle's device list. The smaller the value entered, the more accurate it is considered to be, and hence the more weight that will be applied to the device's data. The Accuracy parameter can be changed from the suggested values, although changes should be made with caution, as they will affect the final filtered position of the vehicle.

The Velocity value is used in positional filtering. The lower the value entered, the more smoothing that is applied.

Remote Unit ID:
The Remote Station ID parameter is set to zero (0) unless the GPS device is interfaced to WinFrog via a telemetry device.

Multiple Position Source Options:
This group box allows you to enable automatic switching of a secondary to primary should the data from all POSITION and PSEUDORANGE data items set to primary timeout. The **Age** entered is the length of time that the secondary will wait in the absence of data from all primaries, before taking over as primary. This age is only entered for the secondary.

For example, if the POSITION or PSEUDORANGE data items associated with two GPS receivers were set to primary and the POSITION or PSEUDORANGE data item of a third GPS receiver was set to secondary, both primary GPS receivers must time out before the secondary will become the primary. Upon the recovery of either of the original primary data items, the original primary will be reset to primary and the original secondary will be reset to secondary.

Note for the auto switching feature to work, there must be at least one primary and one secondary enabled. For example, given two data items, one set to primary with the auto switching disabled and the other set to secondary with the auto switching enabled, if the primary fails the secondary is not set to primary and the vehicle positioning stops until the primary data item recovers.

Disable Auto Switching of Primary:
If this data item is not to be involved in the auto switching process, check this box. As stated above, this data item is then not involved in the auto switching process in any way.

Enable Auto Switching of Primary:
If this data item is to be involved in the auto switching process, either as a primary or a secondary, check this box. If set to secondary, enter the Age of data the primary data items must reach before this secondary is switched to act as the primary.

In order for this option to be effective you must have at least one primary and one secondary. If there are multiple secondary data items that are enabled for switching, the first one to receive data will become primary.

Note: This option is not enabled unless WinFrog determines that there is more than one POSITION and/or PSEUDORANGE data item associated with the respective vehicle. The exception to this is the case of a WinFrog with the Remote module operating as a Controlled Remote being configured remotely from the Controller. In this case, the option is always enabled even though it may not be applicable. The operator must be aware of what is available on the Remote and configure the data item accordingly.

Note: This option is not available in the WinFrog Remote package.

Antenna Height:
Set the Antenna Height using the radio buttons and the (input) Ellipsoid Height field. Settings are as follows:

Calculated – Select this option to force WinFrog to calculate the GPS antenna Height, as well as its Latitude and Longitude. In this mode, WinFrog requires a minimum of four satellites to be visible.

Fixed – Select this option to fix the GPS antenna ellipsoid height to the value entered in the **Ellipsoid Height** field. In this mode, WinFrog is able to calculate valid positions using a minimum of three satellites.

Auto\Last Height – If this mode is selected, WinFrog will calculate a 3D position if four or more satellites are available. If only three satellites are visible, or if the VDOP of the solution exceeds the value set in the Alarms dialog box, the height is fixed to that of the last valid position. In this mode WinFrog is able to calculate valid positions using a minimum of three satellites.

Auto\Input Height – If this mode is selected, WinFrog will calculate a valid 3D position if four or more satellites are available. If only three satellites are available, or if the VDOP of the solution exceeds the value set in the Alarms dialog box, the height is fixed to the value entered in the **Ellipsoid Height** field. In this mode, WinFrog is able to calculate valid positions using a minimum of three satellites.

Note**:** The Antenna height entered in the **Pseudorange Calculation** dialog box refers to the WGS 84 Ellipsoid.

Offsets:
Offsets are entered to relate the GPS antenna position to the vessel's Common Reference Point (CRP). Offsets are entered as measured from the CRP (of the vehicle) to the device (antenna) location. Offsets Fore and Starboard are entered as positive values, offsets measured Port and Aft are entered as negative values. Rule of thumb suggests the CRP "Z" reference should be at the water line.

DGPS Mode:
Select the desired mode of DGPS operation

There are four different DGPS modes: Auto, On, Off and Generate.

Auto: WinFrog will automatically use differential corrections in its position calculations, when available. If no corrections are available, WinFrog will compute a single point (autonomous) position solution.

On: WinFrog will always attempt to use differential corrections. If no corrections are available, no position will be computed.

Off: WinFrog will not use differential corrections in its position computations, even if they are available. Instead it will always compute a single point GPS solution.

Generate: WinFrog will generate differential corrections based on a fixed reference position. This option is used for Base Stations only.

Phase Smoothing:
Phase smoothing utilizes the GPS receiver's observations of the GPS satellite's carrier signals. Because the GPS L1 frequency has a wavelength of only 19 cm., measurements made using this signal will provide higher accuracy than measurements made on the C/A code message modulated onto the L1 signal. Note, however, that since the carrier phase position is derived from the C/A code position, it does not offer an improvement in precision.

If the Phase Smoothing feature is enabled, WinFrog will use the C/A Code derived (DGPS corrected) position to derive the number of L1 wavelengths to each of the observed satellites. Over the length of time entered into the **Filter Length** field (value in seconds), WinFrog will switch the GPS calculated position from the C/A code position to the derived Carrier Phase position.

WinFrog will continue to use the carrier phase data to provide positioning until the **Cycle Slip Tolerance** is exceeded. A Cycle Slip is the loss of lock on a satellite's signal. This loss of lock forces WinFrog to re-establish the number of wavelengths from the antenna to the satellite. If the number of cycle slips exceeds the Cycle Slip Tolerance, WinFrog will resort back to the C/A code position and re-calculate the number of wavelengths to all received satellites.

Graphics:
Select the On radio button to display a labeled square in the Graphics and Bird's Eye displays depicting the raw (unfiltered) location of the GPS antenna. This provides a means of comparing raw and filtered positions between different sources.

Display:
The selection made here determines which type of information will be displayed in WinFrog's Calculations window (when the GPS Pseudorange device is turned on for display in that window). Select from the three provided options:

Results – The Calculations window will show the results of the GPS Calculations, including the Multi-Ref position and all individual solutions.

Data - The Calculations window will show the results of the GPS Calculations, including the Multi-Ref position and data related to each individual carrier phase solution (when Phase Smoothing is enabled).

Statistics - The Calculations window will show the results of the GPS Calculations, including the Multi-Ref position and statistical data related to each individual solution.

Use For Heading Calculations:
Select this checkbox if the device is to be used in conjunction with another GPS device for determination of heading of the vessel. In most cases, only high accuracy receivers should be used for heading calculations as WinFrog simply inverses the individual sensors' raw positions to derive the bearing between them.

Use Elevation:
Setting the Elevation option to "On" will result in the elevation determined by GPS to be used as the elevation of the vessel's CRP referencing the GPS (WGS84) Ellipsoid. The height of the antenna above (below) the CRP must be entered. Do not enable this option unless you are utilizing high accuracy (centimeter level) RTK type GPS positioning.

Alarms:
Click this button to view and enable various GPS alarms, as described below.
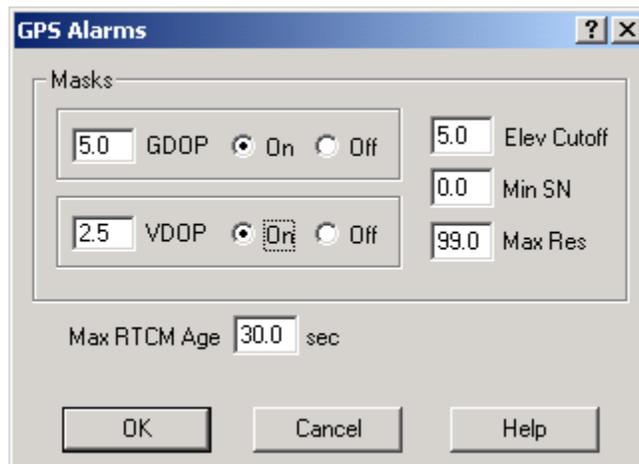
GDOP – Geometric Dilution of Precision. GDOP is a numerical value that serves as a measure of the effect of the satellite constellation's geometry on the derived positional accuracy. In other words, the GPS receiver's measurement accuracy is multiplied by the GDOP value to derive the overall positional accuracy of the GPS receiver (including the three positional dimensions and clock offset). If the GDOP mask is set to On and the calculated GDOP exceeds the entered value, WinFrog will not compute a position solution using pseudoranges. If the

Calculations window is enabled, an alarm will sound to indicate that the GDOP has been exceeded.

VDOP – Vertical Dilution of Precision. This parameter is also calculated from satellite geometry and gives an indication of the expected accuracy of the vertical component of the GPS position solution. If the VDOP mask is set to On and the calculated VDOP exceeds the entered value, WinFrog will automatically initiate 2D or fixed height mode using either the last valid calculated height or the height entered in the Antenna Height **Ellipsoid Height** field. If the Calculations window is enabled, an alarm will sound to indicate that the VDOP has been exceeded.

Elev. Cutoff – (Elevation Angle Cutoff). WinFrog will not use measurements from any satellites with elevation angles below the angular value input in the Elevation Angle Cutoff field. Any satellites not used in the pseudorange position calculations are indicated in the Calculations window by a change of color.

Min SN – Minimum Signal to Noise. This field is used to set the minimum signal to noise ratio for the pseudorange calculations. If a satellite's signal to noise ratio falls below the entered value, the satellite will not be used in position computation by WinFrog. Satellites not used in the position computation due to low signal to noise values are indicated in the Calculations window by a change of color.

Max Res – Maximum Measurement Residual. WinFrog will not use any satellite measurement with a residual greater than the Maximum Measurement Residual in its pseudorange position computations. Satellites not used in the position computation due to measurement residuals are indicated in the Calculations window by a change of color.

Max RTCM Age – Maximum RTCM Differential Correction Age. This parameter sets the maximum latency of real time differential corrections for pseudoranges. If the maximum latency is exceeded, WinFrog will not apply the corrections from that RTCM source. To indicate this condition, the **STAT** light in the Position portion of the Calculations window will turn yellow. Click on the **ACK** button to acknowledge this alarm.

Tests:
Click this button to open the **GPS Solution Statistical Testing** dialog box, as seen below.
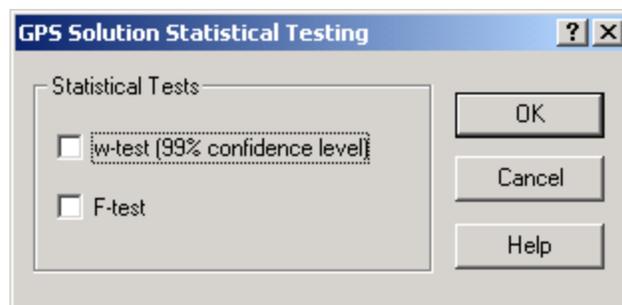
This dialog box provides you with the ability to enable or disable statistical w test and F tests. By default, both of the w-test and the F-test are turned off.

w-Test:
The w-test entails normalizing the residuals of a GPS pseudorange solution and testing these against a 99% confidence limit for outliers. This limit is 2.576. If outliers are found, they are removed and the solution is re-executed excluding that satellite data pertaining to the outlier. If more than one satellite is found to produce a residual outlier, only that satellite with the largest normalized residual is eliminated. This continues until no outliers are present *or* until the exclusion of any more data would result in insufficient data for a solution (four satellites for 3D and three for 2D). Since the normalized residuals tend towards being equal with reduced redundancy (as the number of satellites used in the solution approaches the minimum required), it is unlikely that WinFrog will ever have to stop the exclusion of data due to insufficient satellites. Nonetheless, WinFrog still checks for this condition.

Caution should be exercised when using this option. If the vessel is too far away from the selected reference stations and/or there are few satellites in common with the vessel and the reference station(s) the w-test option may eliminate data to the point where the solution approaches the minimum required.

F-Test:
The F-test is a check of the unit variance of the GPS pseudorange solution. This confirms the validity of the model used for the solution and the weighting of the observations used. Note that it is only a confirmation check, no data or solution results are thrown out based on the results of the test.

The unit variance is the sum of the weighted, squared residuals, divided by the degrees of freedom (number of redundant measurements) in the solution. The F-Test should result in unity. If the unit variance is consistently different from unity, it indicates that there may be a problem with the stochastic model used, or an unmodeled bias in the data.

RefStns:
Click the RefStns button in the Pseudorange Calculation dialog box to open the Select DGPS Reference Stations dialog box, as seen below.

The Select DGPS Reference Stations dialog box allows you to define which reference stations will be used by WinFrog in its Multi-Ref solution. You can either configure WinFrog to simply use all received stations (to a maximum of 5), or you can control the use of corrections, as deemed proper.

To use all received DGPS corrections, select the **Use all Available Stations** checkbox. When this checkbox is selected, all available RTCM corrections are utilized in the solution, each with the same Relative Standard Deviation.

The individual station method is preferable as it allows you to remove or de-weight solutions that may not agree with the weighted mean solution. If this method is used, you should add the RTCM data item to the vehicle's device list once for each solution, then edit that solution entering the proper code and coordinates. For example, if there are five Reference stations to be used in the Multi-Ref solution, add the **RTCM,RTCM1,DGPS-COR's** data item to the vehicle's device list five times.

From the Configure Vehicle-Devices dialog box, highlight and edit each RTCM data item to indicate a unique Code.

Now, back in the **Select DGPS Reference Station** dialog box, ensure that the Use all Available Stations checkbox is not selected. Now the individual reference station ID's must be entered, along with station usage and relative standard deviation values, as detailed below:

Select DGPS Reference Stations:
Selection of individual stations is as follows:

ID – The Reference Station identification code. See SkyFix documentation for a listing of all SkyFix reference station ID Codes. Coast Guard Beacon corrections also contain unique codes for each station.

In the above example, SkyFix stations 535, 545 and 570 are used with assigned relative standard deviations along with Coast Guard station 336. Coast Guard Station 334 is monitored and is therefore not utilized in the position solution.

Off – Corrections from the selected Reference Station will not be used in the Multi-Ref position solution. This individual solution and will appear in red text in WinFrog's Calculations window and not update.

Use – Reference Station is used in the Multi-Ref position solution, and will appear in the Calculations window in black text. This individual solution will appear in red text if no solution (refer to DGPS Mode) can be calculated from the data.

Monitor – Reference Station is simply monitored by WinFrog, and is not used in the Multi-Ref position. This solution will appear in yellow text in WinFrog's Calculations window.

Rel. Std. Dev – This value defines the relative standard deviation of this solution as compared to the other solutions used in the Multi-Ref position. Equal Rel. Std. Dev. values indicate that all individual solutions will be equally weighted in the Multi-Ref solution. Entering a higher Rel. Std. Dev value will de-weight an individual solution compared to the others in the Multi-Ref solution.

CONFIGURE CALCULATIONS WINDOW

A Calculations window can be configured in WinFrog, allowing you to monitor the status of the Mulit-Ref solution and make appropriate adjustments. To open the Calculations window select **View > Calculations** from the main menu. In the Calculations window, select the appropriate vehicle from the dropdown list and click the Setup button.

In the Setup Calculation Views dialog box, select the **Position** and **Data Item Text** checkboxes. Next, highlight the **Pseudorange data item**, click the **On** button and exit with OK. Refer to Chapter 14, GPS Calculations Displays section of the WinFrog User's Guide for more detailed descriptions of the various options and displays available with the Calculations window.

CONFIGURATION DETAILS:

The NovAtel GPS card must be programmed to output the required Pseudorange information. For GPS card configuration details, refer to the NovAtel manual.

Radio Configuration:

Teledesign brand radio transmitters are typically used by Fugro Pelagos, although other types such as Magnavox can be used. For a network system to work correctly, the radios should be of the same type.

To configure a Teledesign 9600 radio you must set the code as well as the transmit and receive frequencies. The code is controlled by dipswitches found on the radio. To set the radio to code 1, set switch 8 to the "on" position and all other switches to "off". To set code 2, switch 7 and 8 "on", all others "off". To set code 3, set switch 6 on, and switch 7 and 8 "off".

The radio's transmit and receive frequencies are set by sending specific program messages to the radio. Before you begin programming, you must set the radio to program mode by switching the small switch found on the top of the radio. Programming a TSI 9600 radio modem is best accomplished by using the HyperTerminal program. HyperTerminal is found on all WINNT systems under the Start> Programs> Accessories menu. Type in a name for your radio programming session, which you will probably want to save, and press enter. Select the correct communications port (according to the one that you are currently interfaced to) with the appropriate settings, as follows:

- Baud rate: 9600 in bits per sec
- Data Bits: 8
- Stop Bits: 1
- Parity: none
- Flow control: none

Click OK.
Click File.
Click Properties.
Click Settings.
Click ASCII set up.
Turn on Echo typed characters locally.
Click OK.
Click OK.
On your keyboard, set caps lock.

The programming control string is: +TSC01R*XXX.XXXX*T*XXX.XXXX*
(where *X*= the frequency expressed in MHz).

The frequency can be anything between 450.0000 and 470.0000 MHz.

Be sure you include the decimal point, type all four decimal places, set "caps lock" on. If and when you have sent a successful program command, when you type in the last digit, the radio will flash three times. Note that all radios in the network must have the same transmit and receive frequencies.

Note: The radio modem does not recognize backspace, delete, spacebar, lower case characters, or any other keyboard functions, so be certain you type everything exactly as listed above. After a successful program, switch the Program/Operate switch back to the operate position.