WinFrog Device Group:	PLOW
Device Name/Model:	Towed Vehicle
Device Data String(s) Output to WinFrog:	None
WinFrog Data String(s) Output to Device:	None
WinFrog .raw Data Record Type(s):	PLOWDATA 490 record HEADING 410 or 409 No data is recorded for the ROV REF VEH data type. The original positioning device will record this data.

DEVICE DESCRIPTION:

This device is used calculate the position of a plow or other ROV vehicle using just cable count and depth or cable count, depth and tension. There are two methods to choose from 1) Pythagorean, which is strictly geometric and 2) Static catenary. In either case the tow wire must be under tension, this device will not work if the vehicle is self-propelled.

This driver is strictly for positioning; it does not obtain plow type data (e.g. burial depth) from a serial port. This device gets its cable count, tension and depth data from other devices.

Other plow devices can also calculate the vehicle position using these same dialogs but with some minor differences. Please refer to the specific driver when using it to position the vehicle.

Positioning using this device can be combined with other positioning methods if the Kalman filter is selected for use. For example, USBL may be combined with this driver; both must be set as prime.

Initial positioning of Vehicle

To reposition the towed vehicle manually, copy or enter the coordinates on the Configure Vehicle Devices dialog, confirm that the Update checkbox is checked and click OK.
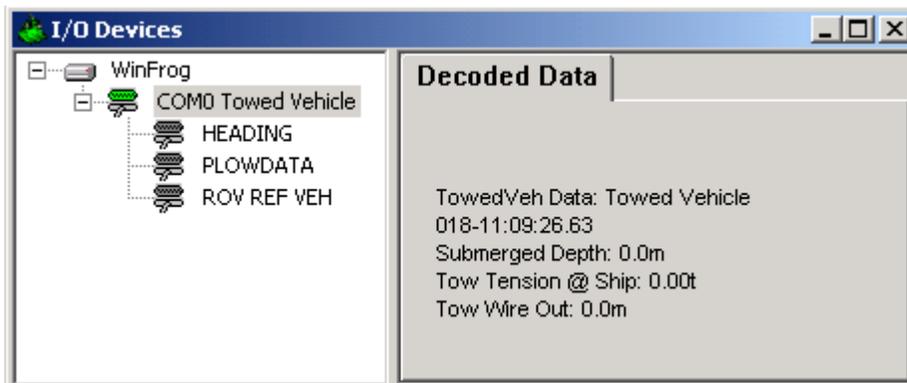
DEVICE CONFIGURATION INSTRUCTIONS

WINFROG I/O DEVICES > EDIT I/O:
A dialog appears in which to change the name of the device if desired.

WINFROG I/O DEVICES > CONFIGURE DEVICE:
The Towed Vehicle device is added to WinFrog from the PLOW device group. Adding this device creates three data items: HEADING, PLOWDATA and ROV REF VEH.

The Towed Vehicle device must be configured at the I/O Devices level. In the I/O Devices window, highlight the Towed Vehicle device, then right-click and select Configure Device. The Configure Towed Vehicle window will appear, as seen below.
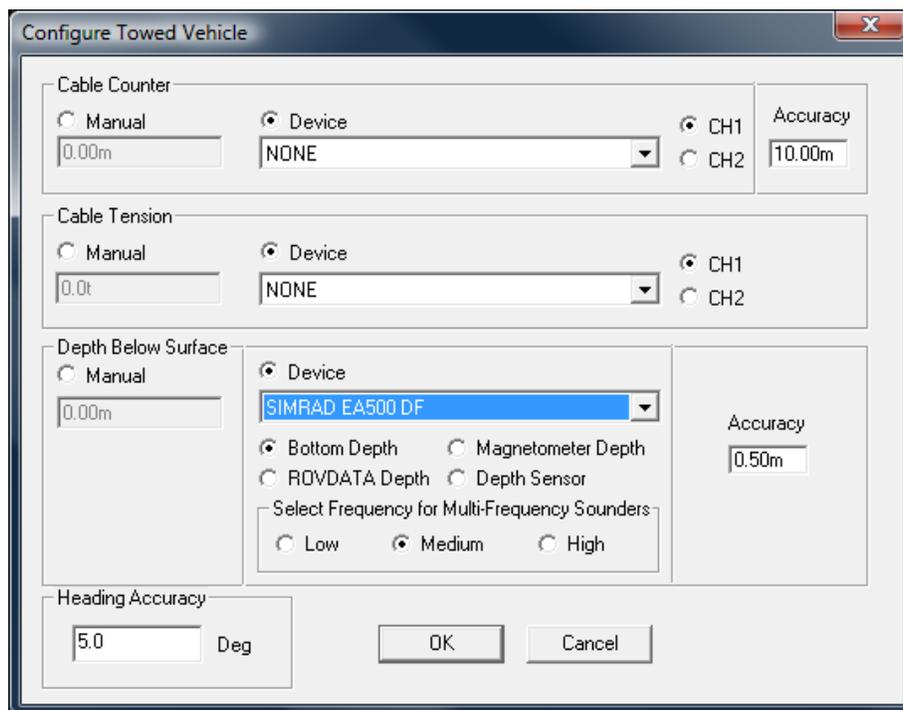
This dialog allows you to specify where this data is to come from in order to calculate the position of the towed vehicle. Each value may be entered manually or may be obtained from a device you select from the drop down list box. If manual entry is selected, the buttons specifying channel (e.g. CH1) or the others (e.g. Bottom depth) have no effect. Enter the manual values in the units shown. (Units are set in the Configure Units dialog accessed from the main menu.)

If only the Pythagorean solution is to be used to fix the towed vehicle position, then only a cable count and depth are required. Otherwise all three values or a source for all three values are required.

Data from a device

Cable Counter
Listed in the dropdown box are all the devices that have a COUNTER data type. Select the desired counter device from the drop down list. Select the channel where the desired count is located. Many counters output several counts. WinFrog stores a tow winch count in channel 2 (CH2) and a telephone count in channel 1 (CH1). **Be sure to check that the correct value is displayed in the I/O device window/Decoded Data tab. The value can also be found in the Calculations window.** See below for more details about configuring a Calculations window.

Enter the accuracy of the cable count source. This is used in determining the relative accuracy of the towed vehicle relative to the reference vehicle.

Cable Tension
Listed in the drop down box are all the devices that have a COUNTER data type. The tension is required if the catenary solution is to be used. The cable weight is also required; see the Configuring the PLOWDATA data item, Layback tab section below.

Select the desired tension device from the dropdown list. Select the channel where the desired tension is located. Many counters output several tensions. WinFrog stores a tow winch tension in channel 2 (CH2) and a telephone cable tension in channel 1 (CH1). **Be sure to check that the correct value is displayed in the I/O device window. The value can also be found in the Calculations window.** See below for more details about configuring a Calculations window.

Depth Below Surface
The depth is required for the position calculation of the towed device. Its source may be selected here and assigned to the towed vehicle. Selection of a depth source here may be overridden by the setting in the **Use ROV Depth** group box described in the Layback tab, see below. Listed in the drop down box are all the devices that have the ROVDATA, MAGNETOMETER, ELEVATION or BOTTOMDEPTH data types.

If the depth required for the position calculation is already assigned to the vehicle:
If the vehicle depth is already being assigned to the towed vehicle and this is the depth desired for use in the position calculation, then select **Device** and **None** for the name of the device; the four radio buttons have no effect. On the Layback tab (see below) in the ROV Depth group box select **Use CRP depth from Vehicle**.

If the depth required for position calculation is to be taken from a specific device:
Select the desired depth type from one of the radio buttons. This will cause WinFrog to list the eligible devices in the drop down list box. Then select the desired device from the list box.

> **Note**:
> 1) The ROVDATA DEPTH is the depth of the ROV.
> 2) The BOTTOM DEPTH, if from an ROV, is the sum of the ROVDATA DEPTH plus the altitude of the ROV plus the offsets. If this device is a multi-frequency sounder, select the frequency to use for the depth.
> 3) Not all ROV devices have ROVDATA, BOTTOM DEPTH or MAGNETOMETER data types.
> 4) Not all magnetometers can provide the depth.
> 5) A depth taken directly from a device will not have any offset or correction applied that was entered in that **device's data item configuration** dialog. Thus to apply any offset or correction, enter it in the Layback tab.

Be sure to check that the correct value is displayed in the I/O device window except if the depth is to come from the vehicle itself. In which case check that the depth is correct in the Calculations window.

Enter the accuracy of the depth source. This is used in determining the relative accuracy of the towed vehicle relative to the reference vehicle.

Heading Accuracy
Enter the accuracy of the heading that will be used in the application of the Towed Vehicle device data. This is used in determining the relative accuracy of the towed vehicle relative to the reference vehicle.

Configure Calculations Window:
To display the Calculations window, select View > Calculations from the main menu. Select the appropriate vehicle from the dropdown list box and click the Setup button. The Setup Calculation Views dialog box opens. Select **Data Item Text** and turn the data item **ROV, Towed Vehicle, PLOWDATA** on by highlighting it and clicking the **ON** button as seen below.
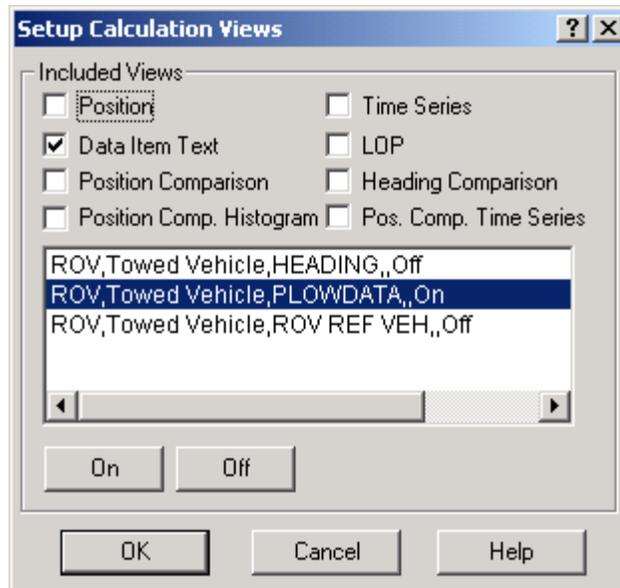
Exiting with OK will display the Calculations window as seen below.
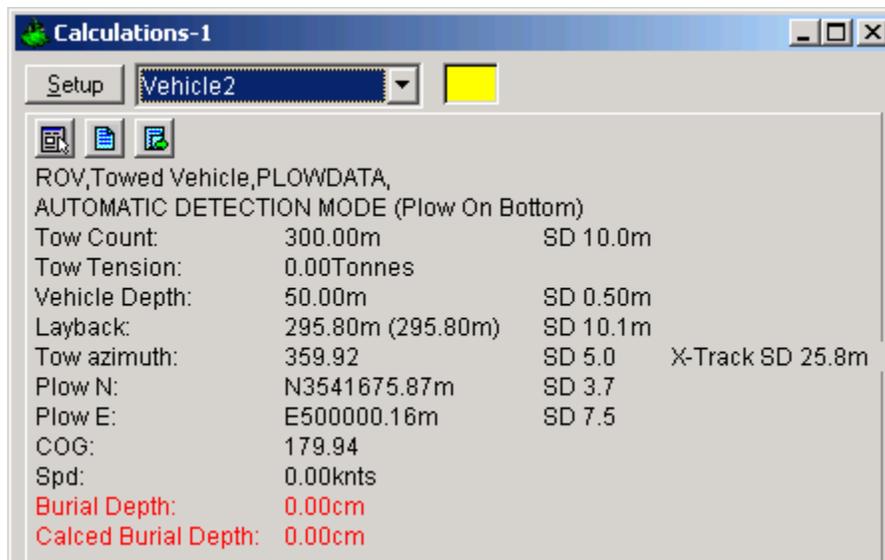
From this window you can monitor the input data as well as the layback calculation. This calculation window also provides a shortcut to the Configure Plow dialog box by clicking the 🖼 button. The use of the Configure Plow dialog is discussed in more detail below. The Tow Count, Vehicle Depth, and Tow Azimuth SD values are the values entered by the operator in the device configuration. The layback and X-Track (across track) values are relative.

WINFROG VEHICLE TEXT WINDOW > CONFIGURE VEHICLE DEVICES > DEVICE > EDIT OPTIONS:

Configuring the ROV REF VEH data item:
The Towed Vehicle ROV REF VEH data item is added to the tow vehicle (ship) and must be edited once it is added to the vehicle's device list. Highlight the ROV, Towed Vehicle, ROV REF VEH data item in the vehicle's device list, then click the Edit button. The Configure ROV Reference dialog box appears as seen below.
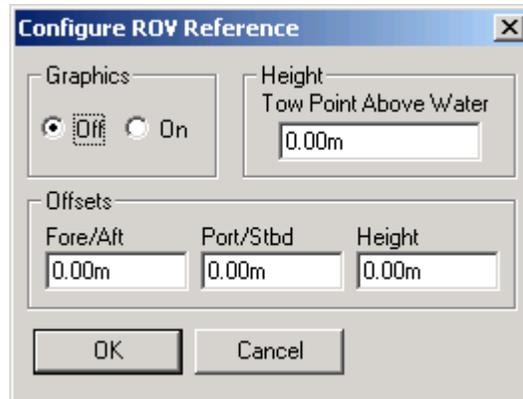
Graphics:

On displays a small square at the offset point in the Graphics window.

Height:

Tow Point Above Water is the distance between the water and the last point the cable touches the vessel. This is also assumed to be where the cable count is measured.

Offsets:

Fore/Aft from the common reference point (CRP) to the point where the cable count is measured. This is also assumed to be the point where the cable leaves the vessel.
**Port/Stbd** from the common reference point (CRP) to the point where the cable count is measured. This is also assumed to be the point where the cable leaves the vessel.
Height is not used.

Configuring the PLOWDATA data item:

The Towed Vehicle PLOWDATA data item is added to the towed vehicle (plow) and must be edited once it is added to the vehicle's device list. Highlight the ROV, Towed Vehicle, PLOWDATA data item in the vehicle's device list, then select the Edit button. The Configure Plow dialog box appears as seen below.

Positioning Mode Tab
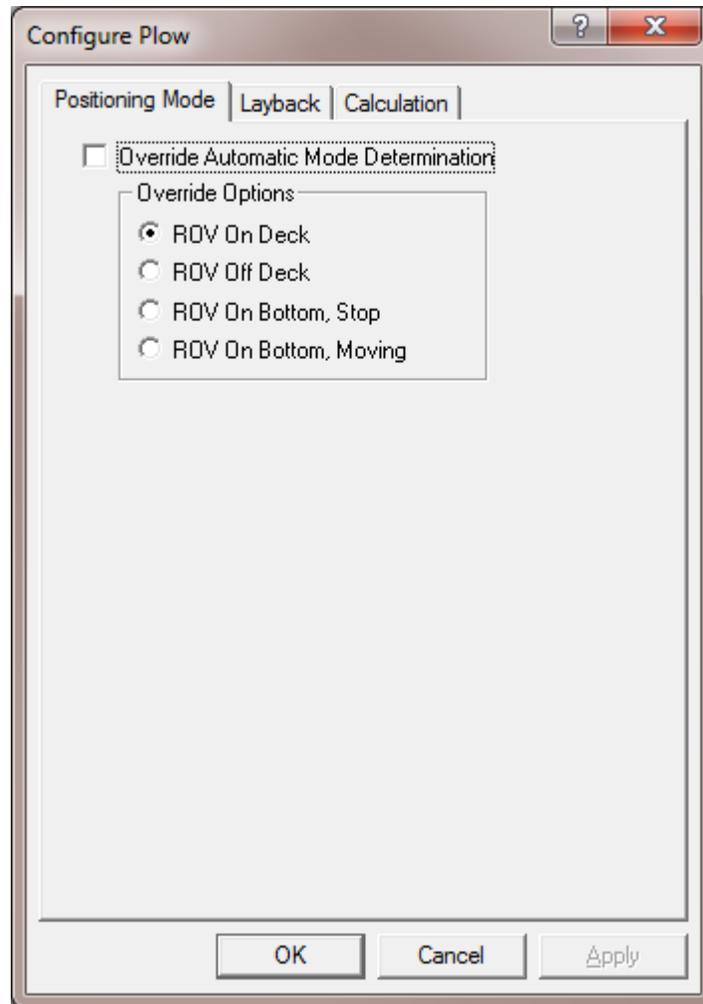
Override Automatic Mode Determination:

This checkbox determines whether WinFrog automatically determines the towed vehicle location and mode or whether the operator determines it.

When in automatic mode WinFrog uses the following criteria to determine the mode of the towed vehicle.

ROV On Bottom, Moving is assumed if the speed is greater than .2 knots or the Use ROV Speed setting is off and the layback is calculated at more than 1 meter.

ROV Off deck is assumed if the speed is greater than .2 and the layback is calculated at less than 1 meter and the altitude is greater than 4 meters.
ROV On deck is assumed if the speed is 0 and the layback calculated is less than the sum of the depth offset entered on the Calculations tab and the Tow point above water entered on the ROV REF VEH dialog.
ROV On Bottom, Stopped is assumed if none of the others are true.

Override Options:

ROV On deck places the towed vehicle on the tow vessel 5 meters forward of the offset point entered in the ROV REF VEH dialog (see above).
ROV Off deck places the towed vehicle on the tow vessel at the tow point, which is the offset point entered in the ROV REF VEH dialog (see above).
ROV On Bottom, Stop leaves the vehicle where it was when this option was selected and makes no further calculations as to its position.
ROV On Bottom, Moving calculates the towed vehicle's position using the data available and updates all displays with this data.

Layback Tab

Layback Calculation Method

Pythagorean uses the depth and cable count to form a right triangle. The layback is then calculated and applied to the tow vehicle's offset position along with an azimuth based upon the previous towed vehicle's raw position. WinFrog will use this position to calculate an azimuth but use the calculated layback for the distance between the towed vehicle and the tow vehicle.

The right triangle is formed thus: the hypotenuse is the cable count and the vertical value is the sum of the depth, Tow Point Above Water and the z offset found on the Calculations tab below.

Catenary requires the weight of the cable in Newtons/meter, (1lbs/ft = 14.63nt/m). This calculation uses the cable count, depth of the towed vehicle and the tow tension to calculate the layback using a static catenary model. The angle used is the same as described above.

ROV Depth

Use PLOWDATA depth for calculations and assign to vehicle causes two actions:
1) The depth obtained from this device, either manually entered or from the selected device, will be added to the Height offset entered here and assigned to this vehicle.
2) The value used to calculate the layback is the above value plus the depth offset entered on the Calculations tab plus the value *Tow Point above the Water*, entered in the ROV REF VEH configuration dialog (attached to the tow vehicle).

This allows a different value to be assigned for the towed vehicle's depth than the cable length used to calculate its layback.

Use CRP depth from Vehicle causes the depth for the layback calculation to be obtained from the vehicle. Essentially, this means the depth must be assigned by another device. This overrides the selection of a device or manual entry of depth. The value used to determine the layback is then the vehicle's assigned depth plus the depth offset entered on the Calculations tab plus the value *Tow Point above the Water*, entered in the ROV REF VEH configuration dialog (attached to the tow vehicle).

Use ROV Speed

Yes causes the speed of the device to be obtained from this device. Since the Towed Vehicle device has no source for the ROV speed this value will always be zero. Consequently, always use no.
No causes the speed to be calculated from the positional information and time. It will be assigned to the vehicle.

Use ROV Tow Angle

This option does not apply to the Towed Vehicle device, only to the SeaplowVIII.

Trench Depth

Offset: If the Trench depth checkbox is checked on the Calculation tab below, then this value, 0.0 or otherwise, will be assigned as this vehicle's trench depth. Generally the Towed Vehicle device cannot determine trench depth, therefore this edit box is ignored and the Trench Depth checkbox on the next tab is set unchecked.

Layback Direction Source

Path Follow (Recommended) This is the recommended selection. It uses its own previous position and the tow vehicle location to determine the direction to the new position.

Tow Vessel CMG This selection uses the tow vehicle's course made good (plus 180 degrees) to determine the direction to the new position. As the course made good changes the towed vehicle will swing back and forth.

Tow Vessel Heading This selection uses the tow vehicle's heading (plus 180 degrees) to determine the direction to the new position. As the vessel's heading changes the towed vehicle will swing back and forth. This is usually more pronounced than the Tow Vessel CMG selection.

Calculation Tab

Calculation

Primary: the layback described above will be used to calculate this vehicle's position, advance and speed which will be assigned to it.
Secondary: this device will not determine this vehicle's position.

Accuracy

This data type cannot be utilized with the Kalman Filter and thus in this case, this value is not used.

Graphics

On causes a box to be drawn in the Graphics and Bird's Eye windows, at the offset position below.
Off means that no box will be drawn.

Offsets

The **Fore/Aft** and **Port/Stbd** offset point is the reference point for the layback distance. Essentially the lay back distance is the distance between this point and the offset point of the tow vehicle described in **ROV, Towed Vehicle, ROV REF VEH** section above. This can also be viewed as the beginning or 0 point of the tow cable. This offset point is from the towed vehicle's CRP.

Depth
If the Pythagorean or catenary solution is selected, this value is added to the vehicle depth along with the *Tow Point Above Water* (entered on the ROV REF VEH configuration dialog) value to compute the layback.

Real-Time Navigation Updates

Since the Towed Vehicle device does not read any of these values, all of these checkboxes should be unchecked. If left checked, 0 will be assigned to that value overwriting data from another device. If the trench depth was unavailable from another source and you wanted this value recorded, you could manually enter it as the offset on the previous tab (Layback) then leave the Trench Depth checkbox selected.

Real-Time Calculations

Calculate Toe Position only applies to the Smart Cutter plow device.

Configuring the HEADING data item:

The **Towed Vehicle Heading data item** must also be edited once it is added to a vehicle's device list. Highlight the **ROV, Towed Vehicle, HEADING** data item in the vehicle's device list, then click the **Edit** button. The **Configure Gyro** dialog box appears as seen below. As mentioned above, this driver is strictly for positioning, i.e. it does not obtain heading data from a serial port. Instead this data would have to come from another device.
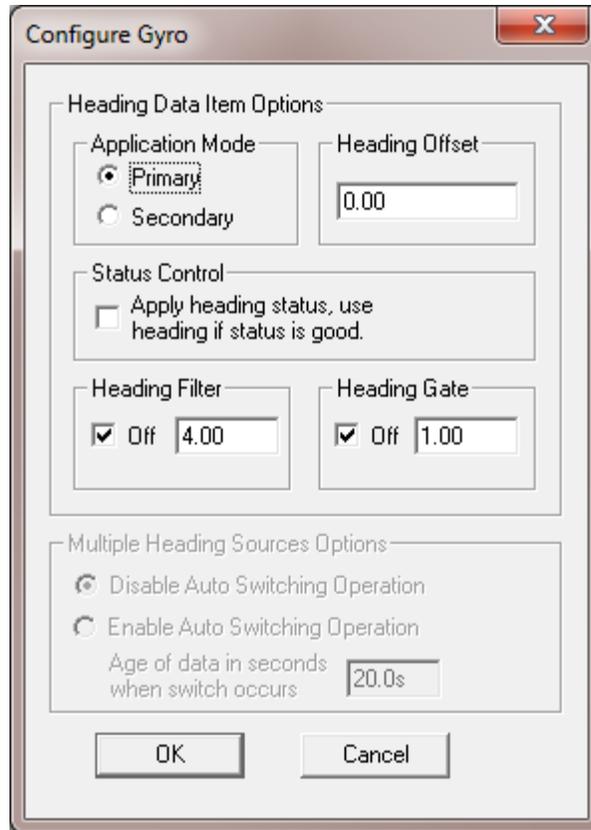
Heading Data Item Options

Application Mode(Primary/Secondary):

Set the type of calculation to Primary or Secondary by selecting the appropriate radio button. Devices set to Primary are used to provide the vehicle heading information. Devices set to Secondary are simply monitored, and are not used in the vehicle's calculations.

Note that WinFrog supports automatic switching from a designated Primary to a Secondary in the event that data from the Primary fails (see Multiple Heading Sources Options).

Heading Offset:

A correction value (as determined from a gyro calibration) can be input in the Heading Offset box. This value is added to the heading value from the device to provide a corrected heading for the vehicle. Note that positive or negative values can be entered.

Status Control

If the respective device is providing data status (valid or not valid) for the HEADING data, selecting this option will result in WinFrog monitoring the data status and if it is set to not valid, the data will not be used.

If this option is not selected, the data is used regardless of the data status.

Heading Filter/Heading Gate:

The Heading Filter is used to "smooth" heading values used by the vehicle. The value entered in the Heading Filter indicates the number of headings that will be used to predict the next heading value. The larger the value entered, the "heavier" the filter will be – i.e. the slower the vehicle's heading will respond to changes.

The Heading Gate defines a tolerance value to limit the use of anomalies in gyro readings. If the next observed gyro value received falls outside the specified range of predicted values (i.e. plus or minus the entered value), the value will not be used.

Multiple Heading Sources Options:

WinFrog supports automatic switching from a designated Primary source to an alternate Secondary source in the event that the Primary fails. The first Secondary source to receive data after the Primary has failed becomes the alternate Primary providing the heading for the vehicle. When the designated Primary is detected as active again, the alternate Primary source reverts to Secondary and the designated Primary provides the heading data to the vehicle.

If an alternate Secondary fails and there are additional Secondary sources, it in turn is detected by the first of the remaining operational Secondary sources to receive data after the failure, at which time this Secondary becomes the alternate Primary.

Note that this option is only available if more than one HEADING source is associated with the respective vehicle. Changes made to the Auto Switching options for any one of the HEADING data items are automatically assigned to the others upon exiting this dialog with OK. If the Auto Switching option is enabled and the respective HEADING source has been set to Primary, all others are automatically set to Secondary. The exception to this is when configuring a WinFrog Controlled Remote (WinFrog with a Remote module) from a Controller. In this case, changes made to one HEADING source are not automatically made to other HEADING sources. The operator must explicitly make them for each HEADING source.

This option is not available in the WinFrog Remote package.

Disable/Enable Auto Switching Operation:

Select the mode you wish to operate WinFrog.

Age of data in seconds when switch occurs:

Enter the age of data that is permitted before the source is considered to have failed.