WinFrog Device Group:	**USBL**
Device Name/Model:	**SONARDYNE**
Device Manufacturer:	**Sonardyne International Ltd.** Ocean House, Blackbushe Business Park Yateley, Hampshire GU46 6GD, UK Tel: +44 (0)1252 872288 Fax: +44 (0)1252 876100 Email: sales@sonardyne.co.uk
Device Data String(s) Output to WinFrog:	WinFrog will decode either the HPR 309 telegram (binary) or the CSV Surveyor's output, Transponder type (ASCII). The latter type begins with 6,1,…
WinFrog Data String(s) Output to Device:	Nil
WinFrog .raw Data Record Type(s):	Transceiver(USBL HYDROPHONE): Type 312, Type 316 for CSV format Beacon (BEACON): Type 309, Type 315 for CSV format Heading (HEADING): Type 408, 409 or 410. Attitude (ATTUTUDE): Type 413

DEVICE DESCRIPTION:

The SONARDYNE Ultra Short Baseline (USBL) Acoustic Positioning System can be utilized on its own or in conjunction with Sonardyne's Long Baseline (LBL) System. For this documentation, details are provided for use of the system in USBL mode only.

The USBL positioning method, also referred to as Super short Baseline (SSBL), involves measuring the range and bearing from a vessel-based transceiver to a subsea transponder, usually referred to as a beacon. The beacon may be mounted on a mobile target, (e.g. ROV), on a fixed target on the bottom (e.g. template), on a cable either on the bottom or in the water column or on any underwater object. This is called tracking mode and WinFrog requires the position of the transceiver in order to position the tracked beacon. This is usually done by having a GPS receiver on the vehicle to which the transceiver is attached. A second mode is positioning where the ship is positioned from a beacon. This requires knowledge of the beacon location (coordinates). But these may be arbitrarily assigned if only relative positions are required. A gyro is required in both modes.

The Sonardyne USBL system works in the medium frequency range (19-36kHz) with an operating range of 1-4000 metres. The accuracy of the system, as rated by the manufacturer, is 0.2% of slant range.

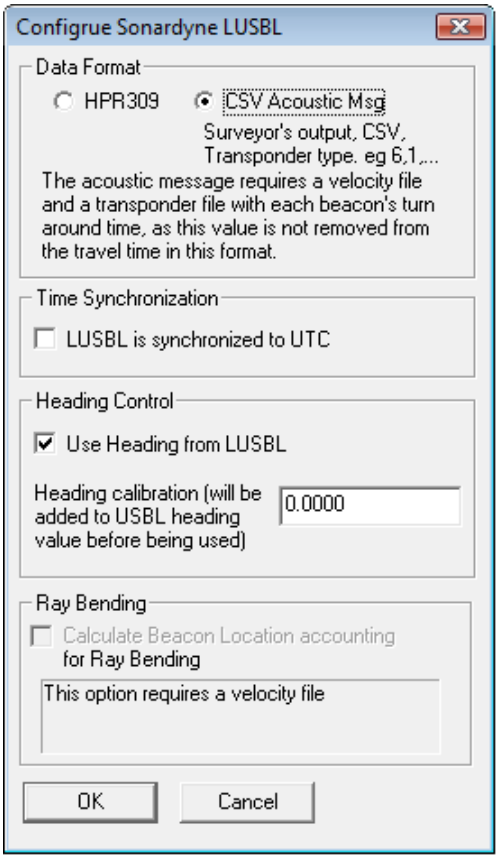
The system can be used for the following applications:

- DP Reference
- ROV Tracking
- Diver Tracking
- Towed Vehicle Tracking
- Sub sea Structure Positioning.

DEVICE CONFIGURATION INSTRUCTIONS:
Baud Rate: 4800
Data Bits: 7
Stop Bits: 2
Parity: ODD

The Sonardyne USBL system uses standard RS-232C serial communication protocol to output data to external devices.

WINFROG I/O DEVICES > CONFIG OPTIONS:
The Sonardyne USBL system is added to WinFrog from the USBL device category. Adding the Sonardyne USBL creates four different data items: Hydrophone, Beacon, Attitude and Heading. The following configuration is available from the I/O Devices Window.



Data Format

Select whichever format the Sonardyne has been set up to output. The HPR 309 telegram is binary and cannot be viewed in HyperTerminal, but one can usually determine if data is being transmitted. The second format is the CSV format or ASCII format. Required is the Surveyor's Acoustic telegram type "Transponder". The telegram begins with the codes 6,1, followed by many other parameters. Since this telegram is ASCII coded it can be view with HyperTerminal. This telegram contains raw data, observed two-way travel time and direction cosines to the beacon. Thus you must have a velocity file and a transponder file containing the beacons code. The velocity file is required to convert the travel time to distance and the transponder file is required to provide the turn around time for the beacon.

Newer Sonardyne systems can output other equipment manufacturer's formats. To use one of these formats select the appropriate device driver.

Time Synchronization

Only used for the CSV format telegram. WinFrog must be synchronized to the one pulse per second (1PPS) from a GPS receiver. The Sonardyne must also be synchronized. Then the beacon observation time found in the telegram will be used as the time for the observation.

Heading Control

Use Heading from LUSBL

This device can be configured to pass the decoded heading data through to the vehicle for use when processing the XYZ data to derive a beacon position (check the *Use Heading from LUSBL* check box). The benefit of this is that the heading is for the specific epoch that the data is valid for and thus is a more correct value to use than the vehicle heading at the time of the telegram reception. (This heading data is also then passed to the calibration file as the vehicle heading at the calibration data epoch).

NOTE: The default setting for the Heading Control is to use the heading from the LUSBL. If no gyro data is being input directly to the device, this may cause inaccurate positioning and must be unchecked.

NOTE: This is independent of the use of the heading data as a HEADING data item and is applicable only for the calculation of beacon positions and being logged to the USBL calibration file.

Heading calibration

The calibration value for the heading source input to the LUSBL system and ultimately output to WinFrog can also be entered. This calibration value is added to the heading data decoded from the LUSBL message. The corrected heading is logged to the respective raw records. In addition, if the HEADING data item is utilized, the heading value passed to the vehicle is the corrected heading.

Ray Bending
This option will be available if the CSV format is selected and there is a working velocity file. Selecting this option causes WinFrog to correct the position of the beacon due to ray bending using the velocity profile. The constant gradient method is used to determine the correction. The methodology used is described by Christian de Moustier, Lecture Notes 16, Sound Refraction in the Water Column in Clarke, de Moustier, Mayer, and Wells, Lecture Notes for Multibeam Training Course, No 26, 2001. Scripps Institute of Oceanography, pp. 2 – 4. See the Calculations window for the BEACON data item to see the amount of the correction.

WINFROG VEHICLE TEXT WINDOW> CONFIGURE VEHICLE DEVICES > DEVICE > EDIT OPTIONS:
As mentioned above, adding the Sonardyne device to WinFrog creates four separate data items: the **USBL,SONARDYNE,USBL HYDROPHONE,** the **USBL,SONARDYNE,BEACON,** the **USBL SONARDYNE,ATTITUDE** and the **USBL,SONARDYNE,HEADING.**

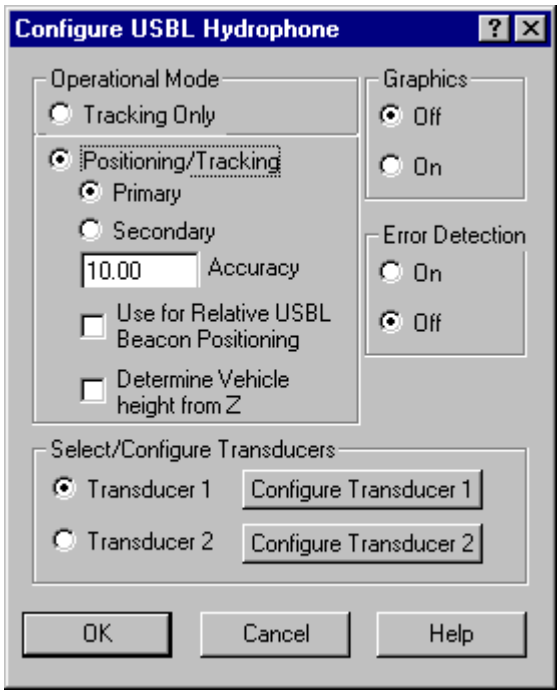
For remote vehicle tracking mode, the Hydrophone data item must be added to the device list of the vehicle to which the hydrophone has been physically attached (i.e. the main ship). The Beacon data item must be added to the vehicle to which the beacon has been physically attached (i.e. the ROV or towed vehicle).

USBL systems can also be used for positioning of the main vessel. In this type of operation the USBL Beacon must be physically attached to some fixed point on the seabed or subsurface structure. In this type of operation the Hydrophone position (i.e. vehicle position) is derived from measurements made to the fixed beacon. For this type of positioning, you must define a working Xponder File (*.XPT) in WinFrog, and enter the fixed position of the Beacon into that file. The Hydrophone must be added to the ship's device list and configured for positioning as opposed to tracking mode. See chapter 5 of the WinFrog User's Guide for more information on setting up *.XPT files.

The Attitude data item can be added to the surface vessel's device list. WinFrog applies corrections to the horizontal device and tracking offsets, as calculated by applying received Pitch and Roll data to the entered height values.

The Heading data item is available when the ship's gyro has been interfaced to the USBL system to provide real time dNorth and dEast values instead of dX and dY data. This data item can be added to the surface vehicle's device list as required. This single data item saves having to interface the ship's gyro device to the USBL system and directly to WinFrog.

1. Configuration of the USBL Hydrophone data item
Once the Sonardyne Hydrophone has been added to the appropriate vehicle's device list it must be edited to suit the application. In the vehicle's devices list, highlight the USBL,SONARDYNE,USBL HYDROPHONE then click the Edit button. The Configure USBL Hydrophone dialog box appears as seen below.



Operational Mode:
As mentioned above, USBL systems can be used for tracking of remote vehicles or for positioning of the main vehicle to which the hydrophone is attached. Select **Tracking Only** if relative tracking of a structure/vessel is desired.

Select **Positioning/Tracking** and **Primary** if you want to position the Master Vessel relative to a stationary (fixed) beacon. The beacon must be located on a stationary (fixed) object, as defined in a working XPONDER (.XPT) file. Select the **Secondary** radio button if this is not the primary positioning source (i.e. if this is a comparison position). If you are setting up for a USBL Calibration, the Hydrophone must be specified as a Secondary Positioning/Tracking device. See chapter 20 of the WinFrog User's Guide for more information on USBL Calibrations.

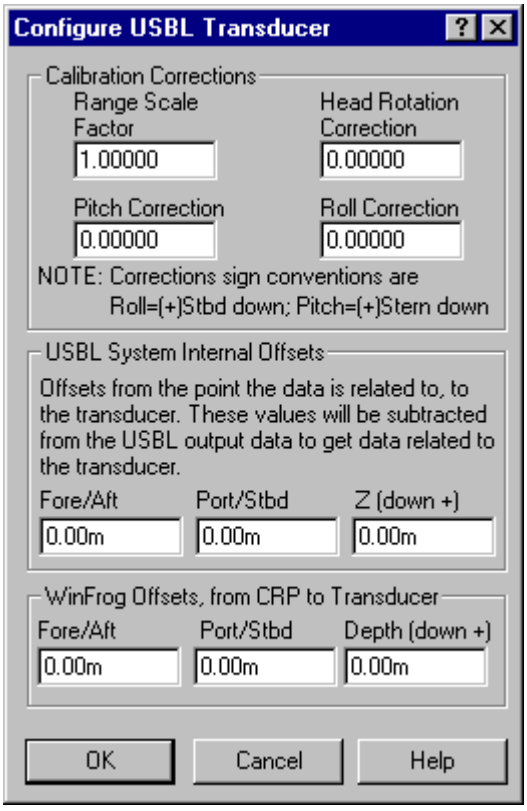
If **Positioning/Tracking** is selected, you can also specify **Use for Relative USBL Beacon Positioning**. This feature controls the use of the USBL positioning of the hydrophone from a fixed beacon for application to relative USBL Beacon positioning. In this mode, the difference between the hydrophone position as determined directly from observation to fixed beacon is compared to the hydrophone position determined from other positioning sources (e.g. DGPS). This difference is then applied to the position determined for any tracked beacon. The concept is that any inherent errors due to local conditions, both environmental and mechanical, are cancelled out. This is independent of the Primary/Secondary setting.

Determine Vehicle height from Z
Select this checkbox if the USBL system is to be used to determine the height of the vehicle. This is independent of the Primary/Secondary setting.

Graphics:
Select On to have WinFrog display the device name and a square at the location of the hydrophone within the Graphics and Bird's Eye windows.

Error Detection:
Select On to have WinFrog reject a telegram if an error code is detected. All data is still recorded in the Raw file.

Select/Configure Transducers:
Some USBL systems can be configured with two hydrophones. Before configuring a transducer ensure that it is the correct one, and that the values entered refer to that device. Click Configure Transducer 1 or Configure Transducer 2 as required. The Configure USBL Transducer dialog box appears as seen below.



Calibration Corrections:
WinFrog allows you to enter **Range, Scale**, **Heading**, **Pitch** and **Roll** correction values to correct raw USBL measurements. Note that the Heading, Pitch and Roll values are entered in degrees and decimal degrees. These values can be determined by using WinFrog's USBL calibration utility. See Chapter 20 of the WinFrog User's Guide for detailed information on calibration of USBL systems.

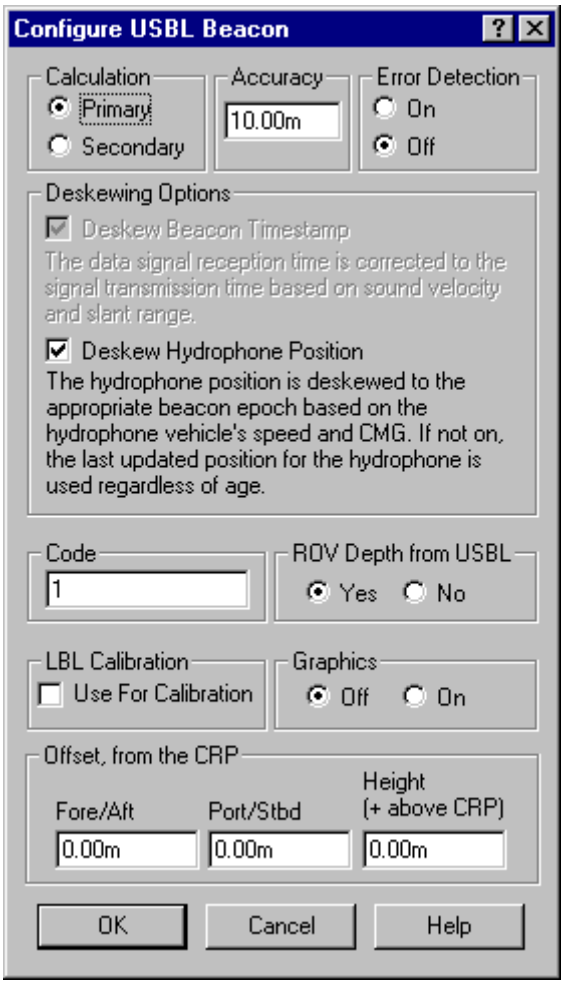
USBL System Internal Offsets:
This section of the Configure USBL Transducer dialog box is for the entry of X,Y and Z offsets that will be applied to the raw observations received from the SONARDYNE console.

The upper fields are used to remove any offsets that have been entered into the SONARDYNE console. This may come into use specifically when USBL systems are used for vessel positioning, where the ship's DP system needs positional information to relate to the vessel's center of gravity as opposed to just at the USBL hydrophone. WinFrog, however, requires all XYZ offsets to relate to the USBL hydrophone. These upper fields are then used to enter the same offsets as are entered in the SONARDYNE Console, nullifying the offsets in the SONARDYNE. Ensure that the signs are correct; the values here will be subtracted from the observed ship relative beacon position relative to some point on the vessel and the expected result will be relative to the hydrophone head.

The lower fields, **WinFrog Offsets, from CRP to Transducer**, are similar to all other positional device offsets entered in WinFrog. These offsets must be entered to relate the hydrophone's position to the vessel's Common Reference Point (CRP). All offsets are entered with signage referring to the distance *from* the CRP *to* the hydrophone.

2. Configuration of the USBL Beacon data item

As mentioned above, for subsurface vehicle tracking, the USBL beacon must be added to the appropriate vehicle's device list. Once added to the device list, it must be edited to suit the application. Editing the **USBL, SONARDYNE, Beacon** device brings up the Configure USBL Beacon dialog box, as seen below.



Calculation
Set Calculation to **Primary** if the beacon is to be used for positioning the vehicle to which it is attached. Multiple beacons can be added to the same vehicle's device list, each configured as Primary. WinFrog will calculate a weighted mean position using the Accuracy value entered.

Accuracy
This value is used by WinFrog to weight the use of different positioning devices in solving a single vehicle's position. The lower the accuracy value entered, the more accurate it is deemed to be, and hence the more weight that will be applied to it in comparison to the other devices.

Error Detection:
Setting Error Detection to 'On' instructs WinFrog to identify error codes received in the USBL data string and disable the use of bad data. USBL systems include various error codes in the data string when the beacon is not within the optimum "cone of operation" or other operational parameters have been exceeded.

Deskewing Options

Deskew Beacon Timestamp

This option is for future development.

Deskew Hydrophone Position

When positioning the beacon, WinFrog uses the last calculated position for the associated USBL Hydrophone to determine the tracked beacon's position. Depending on the vehicle's Kalman filter and Dead Reckoning settings, the position of the hydrophone may be up to 1 second old.

It is recommended that this deskewing option be enabled to remove positional inaccuracies associated with this latency.

Code:

Enter a value matching the code of the beacon attached to the vehicle.

ROV Depth from USBL:

If **Yes** is selected, the ROV's depth will be set to the calculated USBL beacon depth.

LBL Calibration:

Select the **Use for Calibration** checkbox if the vehicle to which the beacon is attached is to be used in an LBL Calibration. This would be the case if the LBL hydrophone is in a fish, the beacon would be used to position the fish and its LBL hydrophone for an LBL calibration.

Graphics:

Select **On** to have WinFrog plot a square and label to represent the beacon location in the Graphics and Bird's Eye displays.

Offsets:

This portion of the dialog box is used to enter Offsets that relate the beacon's location to the vehicle's Common Reference Point (CRP). These values are set similar to values that would be applied to any device offset within WinFrog, with values entered as measured from the CRP to the device. A heading device must also be added to the vehicle's device list to ensure the correct application of the offsets.

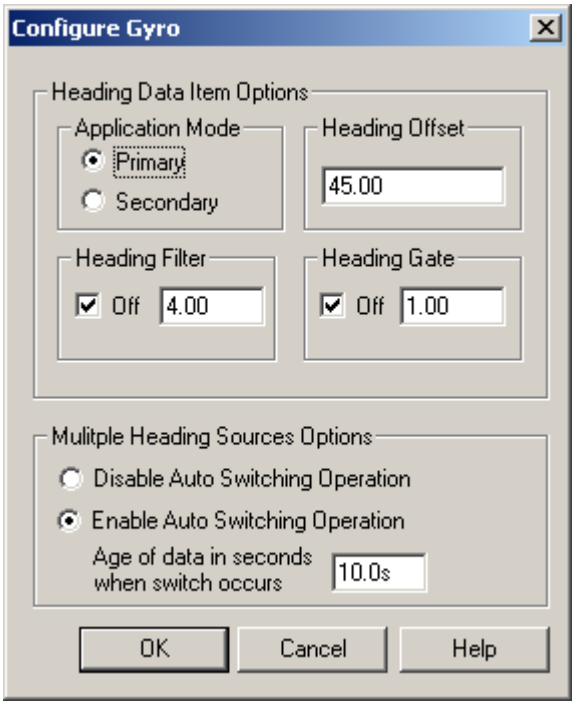
3. Configuration of Heading data item

As mentioned above, the Sonardyne USBL system can be configured to accept real time heading data from an interfaced gyro device. This heading data can in turn be output to and used by WinFrog as a HEADING data item.

Note: The update rate of this device does not adequately support the use of this data item as a vehicle's HEADING data item for anything other than a secondary heading source for comparison only.

Note: The heading value passed to the vehicle is the corrected heading based on the calibration value entered in the device configuration. Therefore, it is most likely that a Heading Offset value will not be required here.

To add the heading data to a vehicle's calculations, simply add the **USBL,SONARDYNE,HEADING** data item to the vehicle's device list.Once this data item has been added to a vehicle's device list, it must be edited to suit the application. Highlight the **USBL,SONARDYNE, HEADING** data item and click the Edit button. The Configure Gyro dialog box appears as seen below.



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 case 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.

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 1 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.

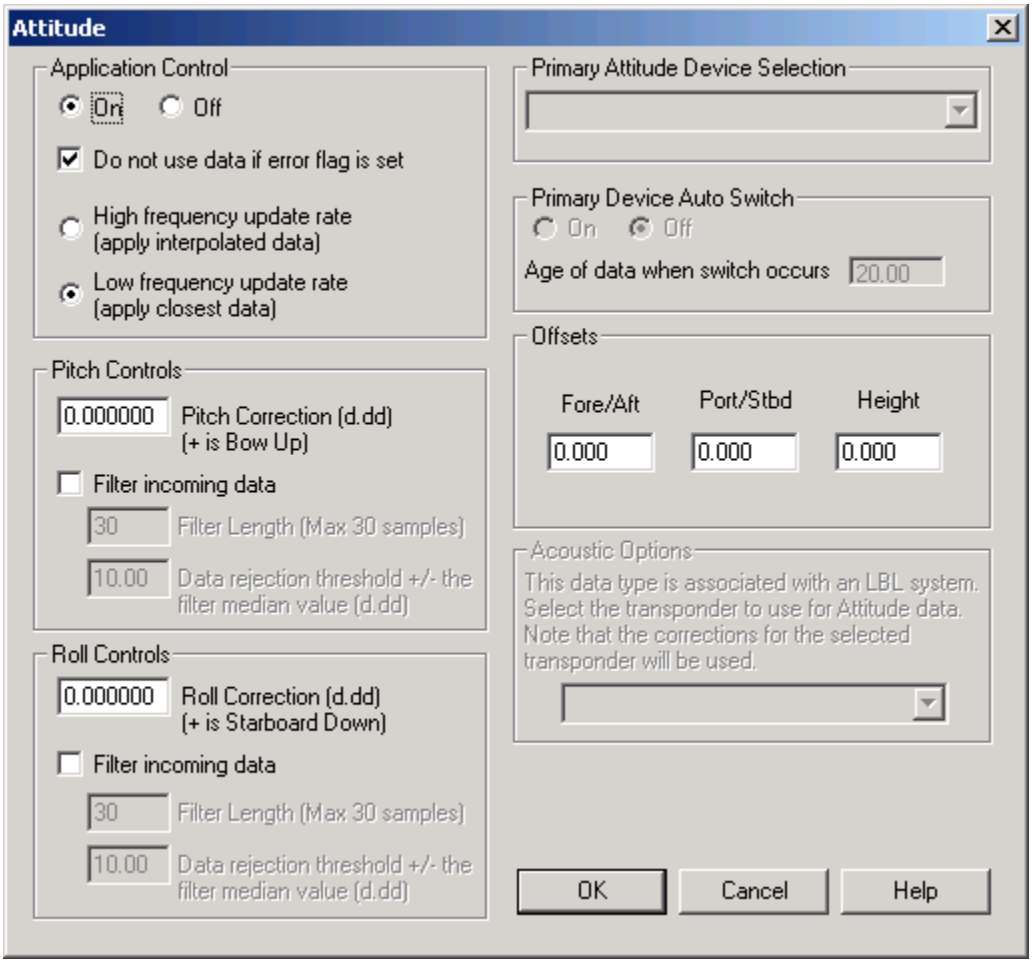
This option is not available in the WinFrog Remote package.

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.

4. Configuration of the Attitude data item

As mentioned above, the Sonardyne USBL system is capable of including “real time” pitch and roll data in its output data string. This information can be added to a vehicle’s calculations by adding the **USBL,SONARDYNE,ATTITUDE** data item to the appropriate vehicle’s device list. Once this data item has been added to a vehicle’s device list, it must be edited to suit the application. Highlight the USBL,SONARDYNE, ATTITUDE data item and click the Edit button. The Attitude dialog box appears as seen below.



Attitude

By default, the sensor mode is off, meaning that data from the device will not be used in the vehicle’s calculations. To turn the sensor on, and begin using the inclination corrections in the position output, click the ‘On’ radio button.

Error flag testing

The error flag check box is applicable to those devices that output a code indicating the data is either good or bad. If checked and the device supports such a code in its telegram, WinFrog will look at the code and if the data is indicated as bad, WinFrog will not use the data.

Sensor Update Frequency Rate
If the associated attitude sensor has a high frequency update rate (e.g. 10Hz and higher) it is appropriate to extract attitude data for application by either interpolating or extrapolating for a given epoch. In this case, the *High frequency update* option should be selected. Some attitude sensors have slow update rates, in particular those installed in acoustic transponders that require interrogation. For these sensors interpolation/extrapolation can produce a bad value as there is insufficient information to determine the correct shape of the curve (aliasing). Thus the most current attitude needs to be used. In this case, select the *Low Frequency update* option. This option applies to the use of the attitude data by the following data items:

- POSITION
- ELEVATION
- ALTITUDE
- XPONDER
- LBL TRANSCEIVER
- PROFILE

Pitch and Roll
There are two control groups, one for each of pitch and roll. Correction values can be added in this section of the window. The correction values (entered in units of degrees-decimal degrees) are added to the raw pitch and roll values received from the device before the data is applied to the vehicle's calculations. Ensure that entered values adhere to the sign convention used by WinFrog. You can verify that the corrections are entered properly by viewing the pitch and roll values in the I/O Device window and the Vehicle Text window.

Filtering
Additionally you may filter the incoming values to remove extraneous noise or spikes – check boxes are provided to switch this feature on or off. A filter length (up to 30 samples) and a threshold value (applied to the median of the samples in the filter to obtain lower and upper bounds) can be entered. Any pitch or roll values outside of the bounds are rejected and not used in the vehicle calculations, but will be recorded in the RAW files. If either one of pitch or roll is rejected, both values are ignored, although you may set up the filtering parameters for them separately. The status of the filters, including the current valid range for each of pitch and roll, and the percentage of values rejected, can be viewed in the calculations window, selecting the appropriate ATTITUDE data item.

> ***Important:***
> Do not enable filtering unless there is a high enough data rate (say 10hz) to correctly determine the shape of the curve. Essentially, if the low frequency update rate is selected above, do not enable filtering.

Primary Attitude Device Selection
If more than one attitude device is present, you may select one of them to be primary and the others to be secondary and allow WinFrog to automatically switch

between them should the primary system stop sending data or has bad data. There must be at least two attitude data items added to the vehicle to use this feature. (Note: The attitude and offset data displayed in this dialog is for the attitude device corresponding to the data item that is being edited. Selecting a Primary Attitude Device from the drop down list does not affect these values for any attitude device in the list. Every attitude device needs to be set up for its own corrections and offsets.)

Primary Device Auto Switch
Select the On radio button to turn on this feature. Then enter the time out time in the edit box. If WinFrog does not receive data from the primary attitude device, or if it receives bad data for this length of time, it will switch to the next secondary that is enabled and has good data.

Auto Switch Feature Usage
To use this feature first turn the sensor on as described in the Attitude section above. Next, select the attitude device that you wish to be primary from the drop down list box. Then turn the primary device auto switch on and enter the time out time. Then edit all the other attitude data items and enable them in the Attitude group box. Note that the same selected primary will be displayed for all attitude data items; similarly, the automatic feature will be turned on and the time out time will be the same. However, you must individually enable each attitude device in the Attitude group box.

Offsets
These are not applicable in this case.

Acoustic Options
This applies to long base line acoustic transponders that have inclinometers. See chapter 17 for more information.

CONFIGURATION DETAILS:
Please refer to the (most current) Sonardyne USBL operator's manual for complete information on the configuration of the device.