| | |
|---|---|
| **WinFrog Device Group:** | **USBL** |
| **Device Name/Model:** | **MBARI NMEA** |
| **Device Manufacturer:** | MBARI<br>7700 Sandholdt Road<br>Moss Landing, California 95039-9644<br>Phone: 831-775-1700<br>Fax: 831-775-1620<br>**Email: conn@mbari.org** |
| **Device Data String(s) Output to WinFrog:** | $GPDBS, $SDDBS, $GPHDT, $GPHDG, GPGLL, $GPGGA, $PROV as well as USBL data |
| **WinFrog Data String(s) Output to Device:** | N/A |
| **WinFrog Data Item(s) and their RAW record:** | POSITION 303<br>HEADING 910<br>ROV DATA 496<br>USBL DATA 309 |

**DEVICE DESCRIPTION:**
This device was designed for the Monterey Bay Aquarium Research Institute (MBARI). With this device MBARI can incorporate various sensors including position, heading, ROV and USBL into WinFrog for data logging purposes.

## *DEVICE CONFIGURATION INSTRUCTIONS*

**WINFROG I/O DEVICES > EDIT I/O:**
Serial
Configurable Parameters

**WINFROG I/O DEVICES > CONFIGURE DEVICE:**
No configuration is required at the I/O Device window level.

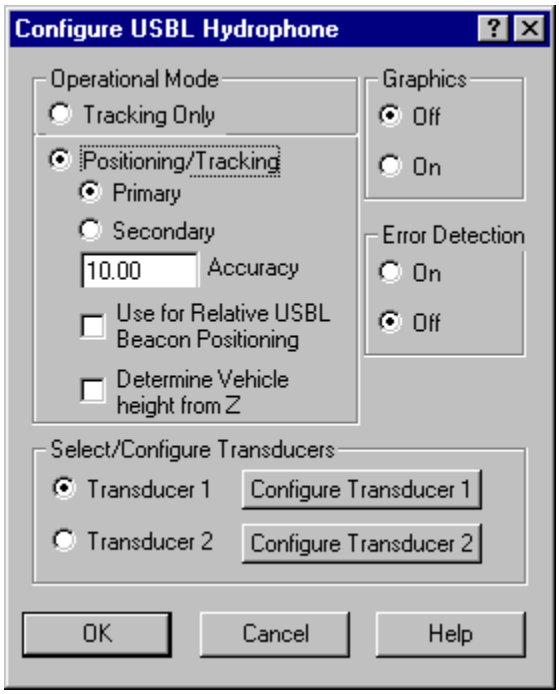
**WINFROG VEHICLE > CONFIGURE VEHICLE DEVICES > DEVICE DATA ITEM > EDIT:**
Adding the MBARI NMEA device creates five data items: USBL HYDROPHONE, BEACON, HEADING, POSITION and ROVDATA. Once the data items have been added to the vehicle, they must be edited to suit the application.

**Data item: USBL, MBARI NMEA, USBL HYDROPHONE**

For remote vehicle tracking, the USBL MBARI NMEA 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. 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 coordinates 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.

**Configuration of the USBL Hydrophone**

Once the MBARI NMEA 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, MBARI NMEA, USBL HYDROPHONE** data item 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 subsurface 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 fixed at a stationary (fixed) location, 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), or if you are setting up for a USBL Calibration. Note as well that if you are setting up for a USBL Calibration, the Hydrophone should also be specified as a Secondary positioning device. See chapter 20 of the WinFrog User's Guide for more information on USBL Calibrations.

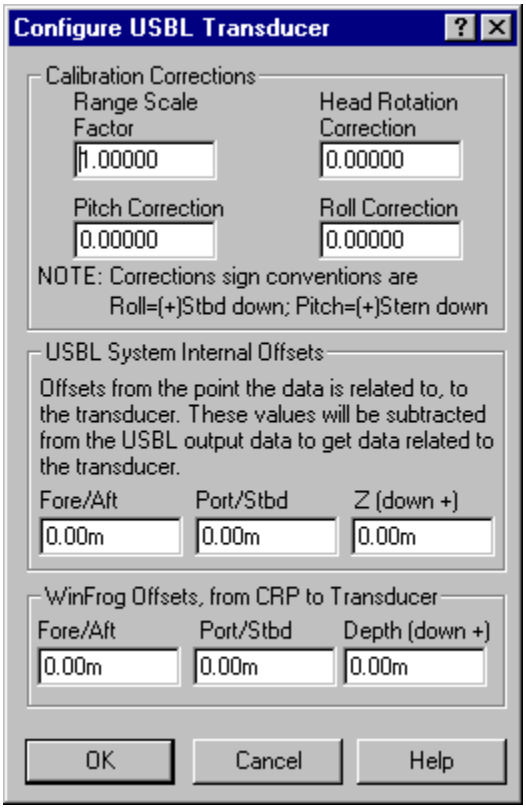
If Positioning/Tracking is selected, you can also specify **Use for Relative USBL Beacon Positioning**. This feature controls the use of the USBL positioning of the hydrophone from a fixed beacon for application to relative USBL Beacon positioning. In this mode, the difference between the hydrophone 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 analyze the error codes included in the MBARI NMEA's output data strings and to have WinFrog include error detection codes in the Raw Files for post project QC analysis. If an error code is recognized, WinFrog will not utilize that particular data string in its calculations of the beacon position.

**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 MBARI console.

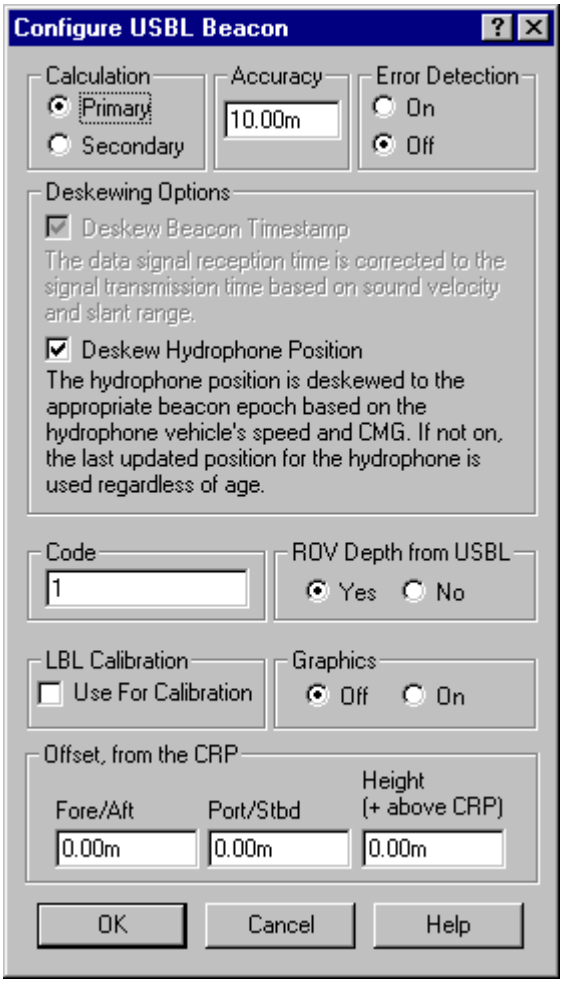
The upper fields are used to remove any offsets that have been entered into the MBARI console. This may come into use particularly when USBL systems are used for vessel positioning, where the ship's DP system needs positional information to relate to the vessel's center of gravity as opposed to just 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 MBARI console, nullifying the offsets in the MBARI unit. As these values are subtracted from the received data, ensure that values are entered using the same sign as internal MBARI unit offsets.

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.

### Data item: USBL, MBARI NMEA, BEACON

As mentioned above, for subsurface vehicle positioning, the USBL beacon must be added to the appropriate subsurface vehicle's device list. Once added to the device list, it must be edited to suit the application. Editing the **USBL, MBARI NMEA, Beacon** data item 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 as the basis for the relative weighting.

Setting the calculation to Secondary will result in the Beacon's position being monitored but not used in the vehicle's position calculation. Note that in case of Primary data item failure, WinFrog will not automatically use the data item(s) designated as Secondary. You must change the calculation to Primary in order for the data item to be used in position calculations.

**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 beacon is to be used in an LBL Calibration.

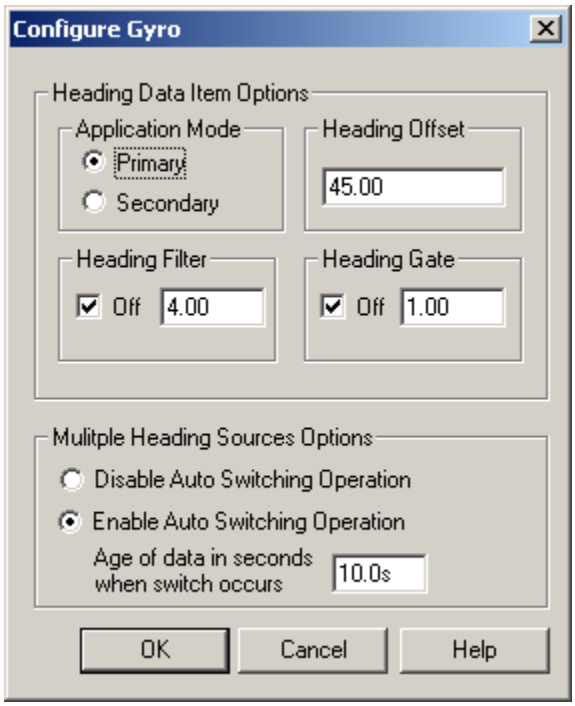
**Graphics:**
Select On to have WinFrog plot a square and label to represent the beacon location in the Graphics and Bird's Eye displays.

**Offsets:**
This portion of the dialog box is used to enter Offsets that relate the beacon's location to the subsurface 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 (i.e. gyro) device must also be added to the vehicle's device list to ensure that the offsets are applied in the correct direction.

**Data item: USBL, MBARI NMEA, HEADING**

The Heading data item must also be edited once it is added to a vehicle's device list. Highlight the **USBL, MBARI NMEA, HEADING** data item in the vehicle's device list, then 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:**

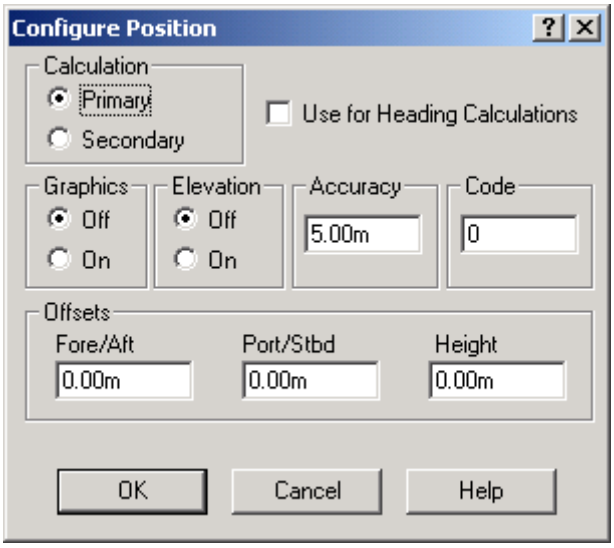
Select the mode you wish to operate WinFrog.

**Age of data in seconds when switch occurs:**

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

**Data item: USBL, MBARI NMEA, POSITION**

The Position data item must be edited once it is added to a vehicle's device list. Highlight the **USBL, MBARI NMEA, POSITION** data item in the vehicle's device list, then click the Edit button. The Configure Position dialog box appears as seen below.




**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 position data from the device in the final solution of the vehicles' position.

Note: In the case of Primary device failure, WinFrog will not automatically use the Secondary devices for the vessel's position computation. Instead, the vehicle's positioning will go to dead reckoning (if dead reckoning is turned on). You must manually change a Secondary device to Primary in order for the data to be utilized.

**Use For Heading Calculations:**
Select this checkbox if the device is to be used in conjunction with another GPS device for determination of the heading of the vessel. The vessel's heading will be derived by the inverse of the GPS antenna coordinates.

**Graphics:**
If On is selected, a labeled square will show the raw (offset but unfiltered) location of the GPS antenna in the Graphics and Bird's Eye windows. This provides a means of comparing raw device and filtered vehicle positions.

**Elevation:**
Setting the Elevation option to On will result in the elevation determined by GPS to be used as the elevation of the vessel referencing the GPS (WGS84) Ellipsoid. The sounder data recorded in WinFrog's .RAW data files will not be affected.
This option is meant only for those applications where there is no fixed vertical reference (i.e. mean sea level), such as on a river. For acceptable results, this option requires the use of high accuracy "RTK" GPS data.

**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.

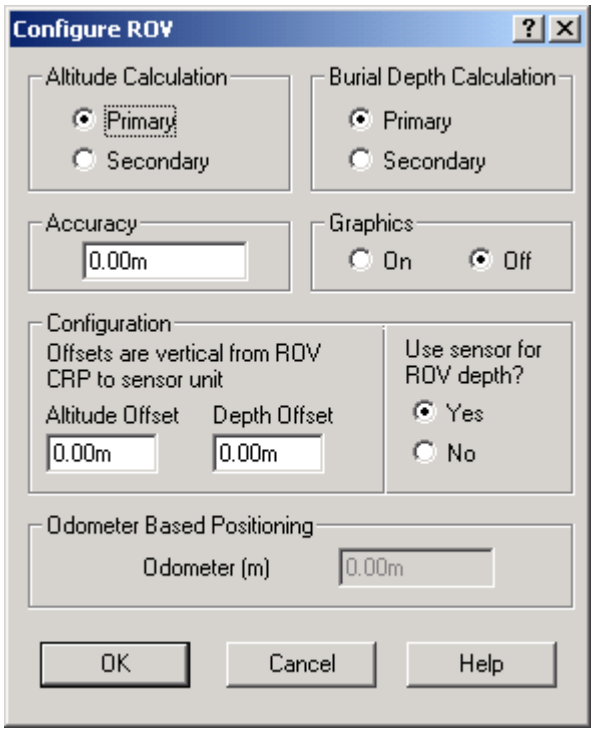
The Accuracy parameter can be changed from the suggested values; changes should be made with caution, however, as they will affect the final filtered position of the vehicle.

**Code:**
This field is used when the GPS data is being received by a remote GPS receiver connected via telemetry link. If this is the case, set the Code to coincide with the code parameters associated with the GPS unit being used. For all other applications, the Code entry must be set to 0.

**Offsets:**
Offsets are required to associate the GPS antenna position with the vessel's Common Reference Point (CRP). The offsets are applied *from* CRP (of the vehicle) *to* the GPS antenna location.
Forward Offsets are entered as positive values.
Aft Offsets are entered as negative values.
Starboard Offsets are entered as positive values.
Port Offsets are entered as negative values.
Height Offsets are positive upwards. (It is suggested that the vessel's Height origin should be at the water line.

**Data item: USBL, MBARI NMEA, ROVDATA**

The ROVDATA data item must be edited once it is added to a vehicle's device list. Highlight the **USBL, MBARI NMEA, ROVDATA** data item in the vehicle's device list, then click the Edit button. The Configure ROV dialog box appears as seen below.




**Altitude Calculation:**
**Primary** will result in this vehicle's altitude being determined from the observed altitude value found in the string from this device minus the altitude offset also found on this dialog. This value can be displayed in the vehicle text window as ROV Alt.

**Secondary** will result in no calculation or assignment of the vehicle's altitude from this device. The raw data is still always recorded.

**Burial Depth Calculation:**
**Primary** will result in the burial depth (if applicable) being determined from the observed burial depth value found in the string from this device minus the Depth Offset also found on this dialog.

**Secondary** will result in no calculation or assignment of the burial depth from this device. The raw data is still always recorded.

**Accuracy:**
A realistic accuracy of the positioning system utilized should be entered. Changing of the default value should be performed with caution, as this will affect the kalman-filtered position of the vehicle.

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

**Configuration:**
Vertical offsets of the altitude and depth sensors, relative to the CRP, can be entered here. The Altitude Offset is the vertical distance (positive up) from the ROV's CRP to the acoustic beacon tracking the seafloor. The Depth Offset would be the vertical distance (positive down) from the ROV's CRP to the sensor that provides depth information of the ROV. The water column depth would be the sum of the depth reading, the two offsets, and the altitude value.

**ROV depth:**
The real-time depth of the ROV can be determined from the depth (pressure) sensor, if one is installed on the ROV.

**Odometer Based Positioning:**
Not used by this device.

## TELGRAM SPECIFICATION:

$GPDBS, $SDDBS (same format for both of these headers)
$GPHDT, $GPHDG (same format for both of these headers)
$GPGLL
$GPGGA

USBL data is decoded from the following message:

| Field | Description |
|---|---|
| 0 | $PROV |
| 1 | beacon code |
| 2 | x distance from the USBL reference point to the beacon |
| 3 | y distance from the USBL reference point to the beacon |
| 4 | z distance from the USBL reference point to the beacon |
| 5 | measurement units ('m' or 'f') |