WinFrog Device Group:	**Speed Log**
Device Name/Model:	**NMEA Speed Log**
Device Manufacturer:	**National Marine Electronics Association** PO Box 3435 New Bern NC 28564-3435, USA Tel: (252) 638-2626 Fax:(252) -638-4885 E-mail: nmea@coastalnet.com
Device Data String(s) Output to WinFrog:	name, time, vForeAft, vPortStbd, vUpDown, vForeAftRaw, vPortStbdRaw, vWForeAft, vWPortStbd, vWUpDown, status
WinFrog Data String(s) Output to Device:	N/A
WinFrog .raw Data Record Type(s):	Type: 402

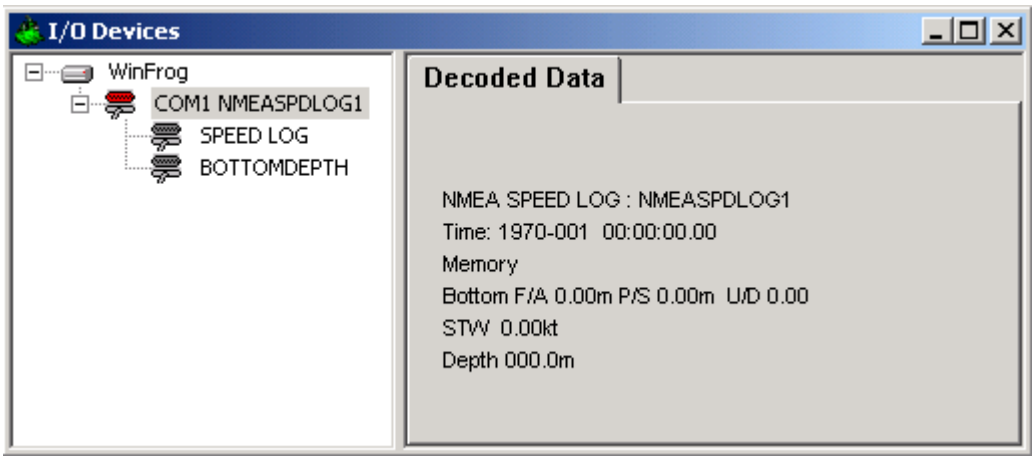
DEVICE DESCRIPTION:
The NMEA 0183 Standard for Interfacing Marine Electronics Devices is a voluntary industry standard, first released in March of 1983. The NMEA 0183 Standard defines electrical signal requirements, data transmission protocol, timing and specific sentence formats for a serial data bus.

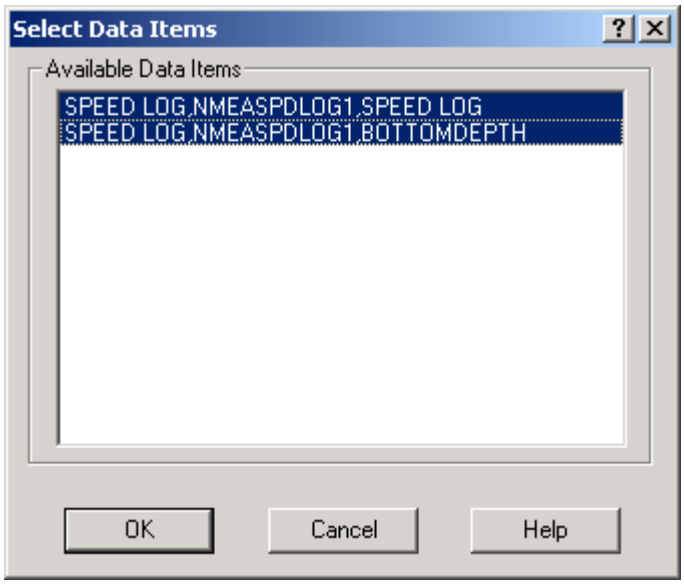
The Standard has been updated from time to time and the latest release is March 1998, Version 2.30.

DEVICE CONFIGURATION INSTRUCTIONS:
Baud Rate: Configurable
Stop Bits: Configurable
Parity: Configurable

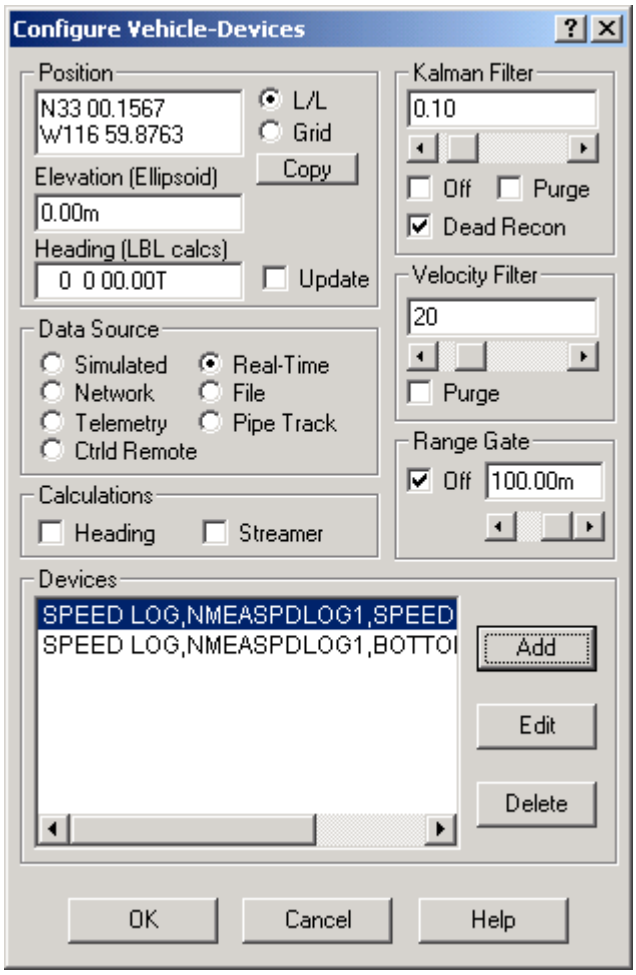
WINFROG I/O DEVICES > CONFIG OPTIONS:
The NMEA Speed Log is added to WinFrog from the SPEED LOG device types. There is no configuration required or available from the Device Window.

WINFROG VEHICLE TEXT WINDOW > CONFIGURE VEHICLE DEVICES > DEVICE > EDIT OPTIONS:
Upon adding NMEA SPEEDLOG to the vehicle, two data items can be selected: Speed Log and Bottom Depth. Once added to the vehicle each item must be edited.





WinFrog is able to utilize the data from Doppler speed logs in the position Kalman Filter to enhance results, specifically for positioning an ROV with USBL. It is critical that the device is set-up correctly, and monitored, in order to ensure correct application of the data. It is also important to note that only the *Speed over Ground* data is used in the Kalman Filter. The Kalman Filter is under the position edit for each vehicle (the Configure Vehicle Devices dialog box).



The application and monitoring of the Doppler speed log is detailed in the following sections. **It is important to note that the values and limits stated here for any of the configurations discussed are guidelines. The operator must evaluate the actual performance and make adjustments accordingly.**

1. Background on Filtering and Gyro Input

General Kalman Filtering:

The Kalman Filtering performed by WinFrog allows the direct input (to the filter) of position and velocity data. The application of this data within the filter is a balance between:

- The accuracy attributed to each individual data type, and,
- The Kalman Filter setting itself.

The former is the accuracy entered by the operator for each data item when configuring its use as attached to a vehicle. The latter is the Kalman Filter setting controlled with the slider bar in the Configure Vehicle Devices dialog box.

It is important to realize that the correct application of the Kalman Filter requires careful consideration of the actual accuracy of each data item, and, the relative accuracy between data items utilized. If the accuracy relationship is unbalanced, the Kalman Filter will be biased towards the data item with the overly optimistic accuracy setting.

The Kalman Filter setting itself controls how reactive to new data the filter will be. The default setting of 0.1 is applicable for many situations. The impact that the new data has in the filter is also affected by the accuracy setting for that data item. Note that the lower the value, the more smoothing that is applied.

If the Kalman Filter is set to OFF, the Velocity Filter kicks in. The Velocity Filter is a 'central tendency' filter, which seeks the median of the input values. The Velocity Filter does not affect position (i.e. the position of the vehicle will be the resultant of the raw data from the positioning sensors). The velocity filter will 'smooth' the velocity only. This is good for use when minor changes in velocity need to be monitored (e.g. Cable Lay Vessels and Vessel Tows where estimated time of arrival is important).

Gyro Requirements:
A Doppler speed log unit provides WinFrog with fore/aft and port/starboard (and in some cases, up/down) velocities. For use in the Kalman Filter, these are converted to Northing and Easting velocity vectors. Therefore, it is necessary to have a reasonably accurate and calibrated vehicle heading source to enable the transformation of the velocities from a vehicle based X/Y reference frame to an absolute North/East reference. The heading data used is that which is configured for the vehicle, including any offsets applied in the associated HEADING data item configuration.

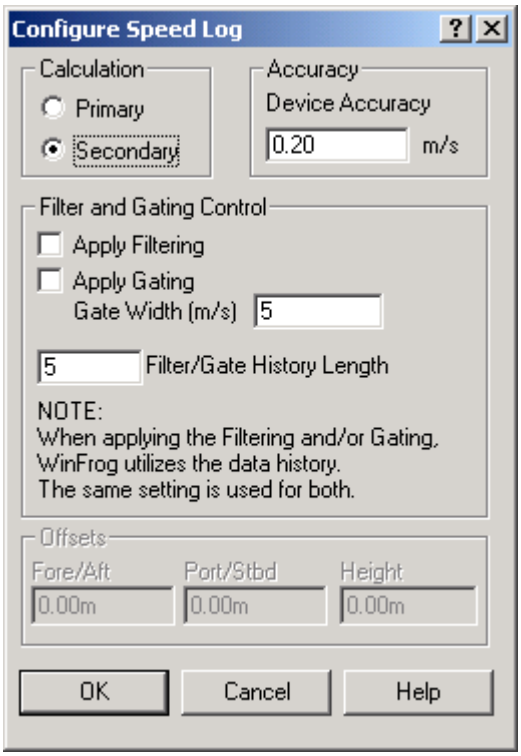
At present, the vertical velocities are not utilized within WinFrog.

2. Speed Log Window Configuration

Configuration of the SPEED LOG data item brings up the Configure Speed Log dialog box.

Calculation:
Set to Primary if you wish the Doppler data to be used to assist the position of the vehicle.

Accuracy:
Accuracy of the Doppler speed logs in m/s. The default is 0.2. Change this only with caution and knowledge of the results.



Apply Filtering:
Controls the filtering of the raw Doppler data prior to its' use in the Kalman Filter. If selected, a central tendency filter is applied to the data using the number of samples defined in the *Filter/Gate History Length*, the result of which is used for input to the Kalman Filter.

Apply Gating:
Controls the gating of the raw data prior to its use in the Kalman Filter. If selected, the new data is tested against the data history based upon the number of samples defined in the *Filter/Gate History Length*. If it exceeds the gate limits, the data is rejected.

Gate Width:
Defines the gating limits in m/s, the value must be determined by monitoring the data.

Filter/Gate History Length:
Defines the number of samples (minimum 3, maximum 30) to be used for both the central tendency filtering and the gating. This setting must reflect the application, environment and the Doppler performance. It depends upon balancing the need to smooth the data and the required responsiveness to real changes in the data. The longer the filter, the smoother the result, however the result will be less responsive to the actual dynamics of the vehicle. The shorter the filter, the less smooth the results, and the more responsive to the actual dynamics of the vehicle.

Offsets:
Not applicable for this operation.

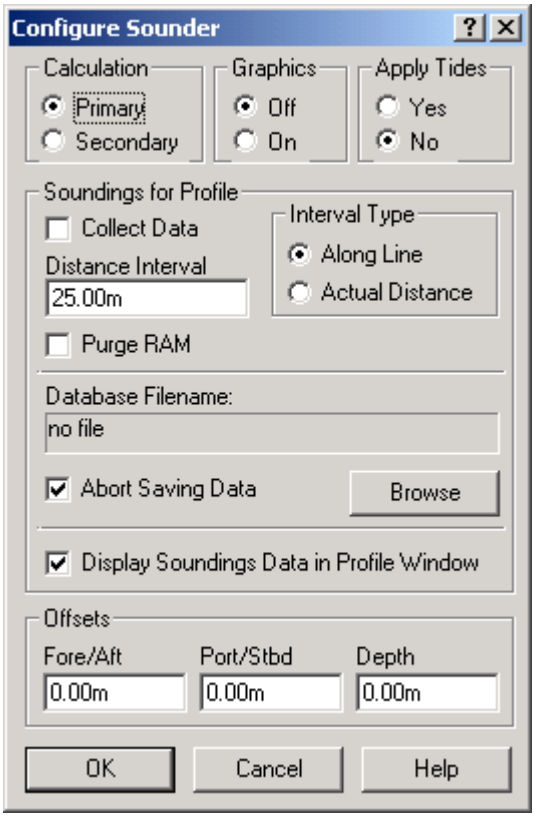
It should be noted that if the *Apply Filtering* option is selected, but not the *Apply Gating* option, a default gating value of 10m/s is used for the purpose of utilizing the filtering function.

3. Sounder Window Configuration

Configuration of the BOTTOM DEPTH data item brings up the Configure Sounder dialog box. Configuration for this item is the standard Primary (used) / Secondary (not used), the Graphics Off/On, Applied Tides Yes/No.

Soundings for Profile:
The option exists to collect data at different Intervals (either 'Along Line' or 'Actual Distance'), and the interval can be specified. If the Collect Data Box is turned on, the soundings are collected for the Profile Window. The Data can also be saved to file for later processing.

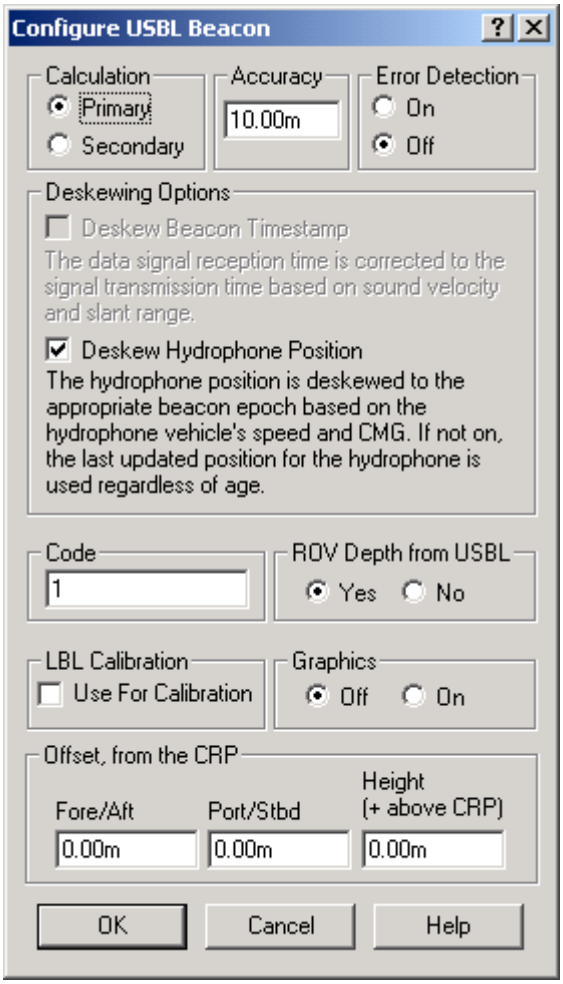
Note: If the Applied Tides radio button is turned on, a Tide Device must be added to the WinFrog system and the specific Vehicle.



CONFIGURATION DETAILS:
Under this section we will attempt to provide further information of the devices that may benefit from the Speed Log input.

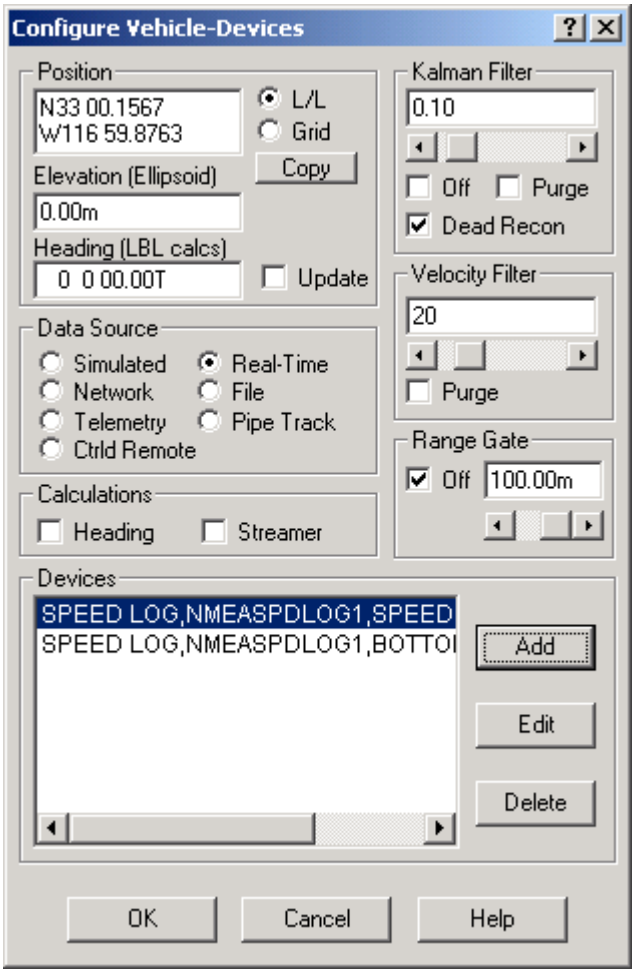
The correct use of the SPEED LOG data item is dependent upon the correct use of associated data items and the configuration of the associated vehicle Position Calculations. In a typical situation, the Doppler speed log is mounted on an ROV being positioned with USBL, so this is the setup that will be examined here.

USBL BEACON Data Item Configuration:
The ROV will be positioned using a USBL BEACON data item.



The *Accuracy* is the critical setting. This is generally between 7-15m, depending upon the performance of the USBL system. The lower the value, the greater the influence of the USBL data in the Kalman Filter. The higher the value, the less the influence of the USBL data in the Kalman Filter.

Vehicle Calculations Configuration - Kalman Filter:
The Configure Vehicle Devices dialog box enables the operator to configure the Kalman Filter and the Position Gating.



In order to utilize the SPEED LOG data in the determination of the vehicle position, the Kalman Filter must be on, i.e. not checked *Off*.

The responsiveness of the filter to new data is controlled with the untitled numerical entry in the *Kalman Filter* panel. This value can be entered directly in this box, or controlled with the slider. The smaller the number, the less responsive to new data the filter is. Again, the default is 0.10 and this is appropriate for the majority of applications. In noisy environments on a vehicle with a low dynamics, this can be reduced. Similarily, with good data on a vehicle with high dynamics, this can be increased. However, changes to this value should be made and monitored carefully to ensure that an inappropriate filter is not used. In general, this value will not be less than 0.05, or greater than 0.4. For ROV operations, a range of 0.10 to 0.30 is reasonable.

Vehicle Calculations Configuration: Range Gate:
The *Range Gate* setting is used not just for gating ranges, but position data also. It is an invaluable tool when positioning with USBL. This should be set to a value in keeping with the performance of the USBL system. The default of 100m is much too large to be of any use with the USBL. A value of 20m is a reasonable initial setting to use.

Resetting of the Vehicle's Position:
Based upon the monitoring of the aforementioned *ghost vehicles*, the operator will be able to determine if the actual ROV position has been overly and incorrectly biased by either the doppler or the USBL to the point where it requires correction. This can be accomplished in several ways.

Purging the Kalman Filter:
From the *Configure Vehicle Devices* dialog box, select the *Purge* checkbox in the Kalman Filter panel and exit this dialog with *OK*. This will reset the Kalman Filter and purge the *history*. The positioning will start afresh with the input of new data of any type currently configured to *Primary* for that vehicle.

Update the Vehicle Position:
Enter or copy a new initial position in the *Configure Vehicle Devices* dialog box and select the *Update* checkbox. This will force the vehicle to this position and the Kalman Filter will take over.

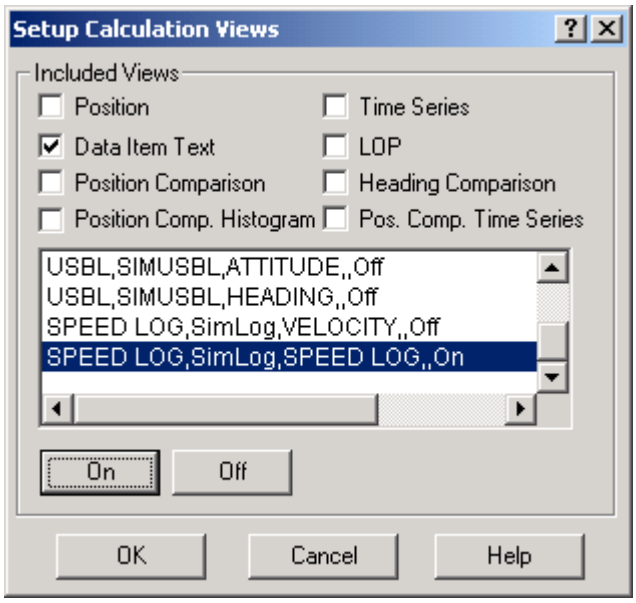
Disabling a Data Source:
Either the SPEED LOG or USBL BEACON data item can be removed from the solution by setting them to *Secondary*. The affect of the data will remain for a short period due to the fact that the Kalman Filter uses history to predict the future.

Monitoring the Application of the Speed Log:
The monitoring of the speed log device falls into 3 categories:

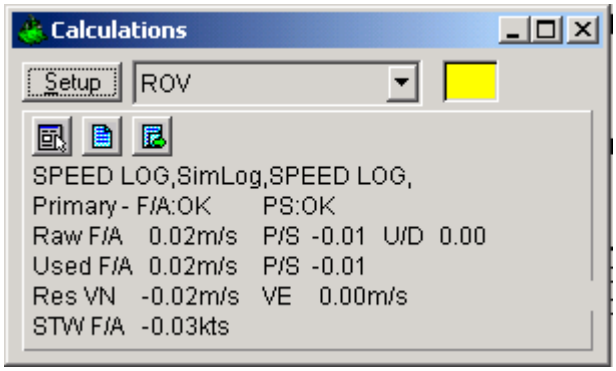
1. Input of data.
2. Filtering and gating of the speed log data, prior to use in the Kalman Filter.
3. Affect of the speed log data on the position.

Monitoring Device Input:
WinFrog does not provide alarms when a device stops updating. Therefore, the device input should be checked at the Device Window regularly. The time of data displayed for every device will indicate if data is being received.

Monitoring the Filtering and Gating of the SPEED LOG Data Item
To monitor the actual use of the speed log data as attached to the vehicle, a Calculation Window should be opened. In this window, select the appropriate vehicle from the dropdown list. Then using the *Config* button to the left of the vehicle dropdown list, access the Setup Calculation Views dialog box.



Check the *Data Item Text* box, highlight the SPEED LOG item and then click the *On* button. Exit with *OK*. The speed log data can then be monitored in this Calculation Window.



The information provided in this window is as follows:

- Data type and device name
- Calculation setting (Primary/Secondary) and the status of the F/A and P/S velocity data. The status can be *OK*, *Gate* or *Bad*. *OK* indicates that the data is valid and used. *Gate* indicates that the data has been gated and is not used. *Bad* indicates that the data as received from the speed log was either invalid, or not an *Over Ground Speed*.
- The raw F/A, P/S and Up/Down Over Ground velocities in m/s.
- The F/A and P/S velocities used in the Kalman Filter. If the speed log data filtering is turned on, these will be the results of the filter. If not, these will be the raw data repeated.
- The Northing and Easting velocity vector residuals in m/s. The residuals are the Kalman Filter results minus the used data.
- The *Speed Through Water*, if the device also provides (or only provides) this value.

This window provides the operator with the means to observe the results of the gating and filtering. If excessive gating occurs, or the filtered data does not reasonably represent the raw data, changes to the SPEED LOG data item configuration are therefore required.

It should also be noted that a time series plot of the *used* fore/aft velocity (and *Speed Through Water* if available) can be displayed by checking the *Time Series* box in the Setup Calculation Views dialog box.

Monitoring the Impact of the SPEED LOG Data Item:
The monitoring of the impact of the SPEED LOG data item on the positioning of the vehicle requires the setting up of *ghost* vehicles.

To monitor the performance of the SPEED LOG data only, add a vehicle to WinFrog, add the appropriate HEADING and SPEED LOG data items. Make sure to configure the vehicle's positioning parameters (i.e. Kalman Filter and Range Gating) and the data items, exactly as configured on the actual ROV Vehicle. When running with only a SPEED LOG data item as a source of positioning data, the vehicle must be given a starting positioning. Do this by copying the current ROV vehicle's position into the appropriate edit box in the *Configure Vehicle Devices* dialog box and select the *Update* checkbox. Though the vehicle's position will always appear as yellow in the Vehicle Window, it will position based upon the doppler speed log data.

To monitor the performance of the USBL BEACON data only, add a vehicle to WinFrog, add the appropriate HEADING and USBL BEACON data items. Make sure to configure the vehicle's positioning parameters (i.e. Kalman Filter and Range Gating) and the data items exactly as configured on the actual ROV Vehicle.

To minimize the distraction of the *ghost vehicles* on actual navigation and tracking, the operator may wish to do the following: from the *Vehicle Presentation* configuration option for the ghost vehicles, turn *Vehicle Window Data to* ***off*** to prevent the display of the vehicle data in the Vehicle window(s). The operator may also wish to limit the vehicle shape to a simple cross in a different colour to make graphical comparison easier.

The difference in positioning between these vehicles and the actual vehicle will illustrate the affect the use of the SPEED LOG data is having in the Kalman Filter.

Resetting of the Vehicle's Position:
Based upon the monitoring of the aforementioned *ghost vehicles*, the operator will be able to determine if the actual ROV position has been overly and incorrectly biased by either the doppler or the USBL (to the point where it requires corrective actions). This can be accomplished in the following ways:

Purging the Kalman Filter
From the *Configure Vehicle Devices* dialog box, select the *Purge* checkbox in the Kalman Filter panel and exit this dialog with *OK*. This will reset the Kalman Filter

and purge the *history*. The positioning will start afresh with the input of new data of any type currently configured to *Primary* for that vehicle.

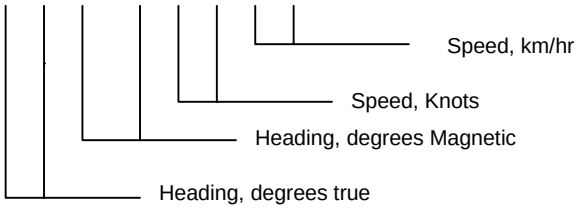
Update the Vehicle Position
Enter or copy a new initial position in the *Configure Vehicle Devices* dialog box and select the *Update* checkbox. This will force the vehicle to this position and the Kalman Filter will take over.

Disabling a Data Source
Either the SPEED LOG or USBL BEACON data item can be removed from the solution by setting them to *Secondary*. The affect of the data will remain for a short period due to the fact that the Kalman Filter uses history to predict the future.

RAW DATA LOGGING:
The record is a Type 402 and record will have the name, time, vForeAft, vPortStbd, vUpDown, vForeAftRaw, vPortStbdRaw, vWForeAft, vWPortStbd, vWUpDown, and status.
The NMEA 0183 string is a Water Speed and Heading (VHW) or Dual Ground/Water Speed (*VBW).

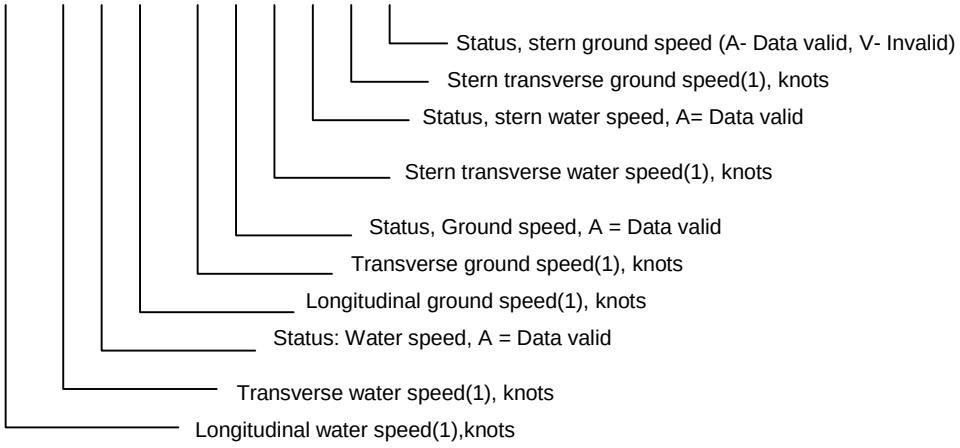
VHW – Water Speed and Heading:
The compass heading to which to which the vessel points and the speed of the vessel relative to the water.

$--VHW,x.x,T,x.x,M,x.x,Nx.x,K*hh<CR><LF>



***VBW – Dual Ground/Water:**
Water reference and ground speed data.

$--VBW,x.x,x.x,A,x.x,x.x,A,x.x,A,x.x,A*hh<CR><LF>



1) Transverse speed: "-" = port, Longitudinal speed: "-" =astern
* Designated by IEC for use with IMO maritime electronic devices as required by IMO in the SOLAS convention (1974 as amended).