

# PILOT™

Precision Underwater Acoustic Positioning System

*Operator's Manual*



Version 4.1

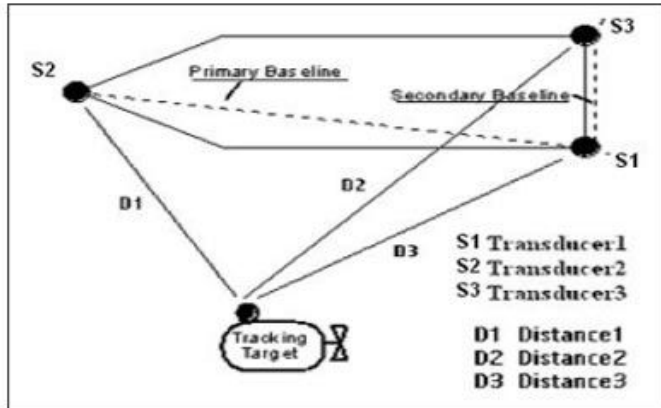
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# PILOT Quick Reference Card



## Quick Operation Walk-Through

1. Install CD provided "DiveBase"
2. Connect Junction Box to PC via RS-232
3. Insure the proper COM port is selected in DiveBase
4. Connect Sonar Transducers to Junction Box
5. Deploy Sonar Transducers: S1, S2, and S3 as shown
6. Lower the Sonar Transducers 2m below the keel
7. Run DiveBase, select *Action->Reg & Cal Base Stat*
8. Enter transducer locations by selecting through radio button and clicking on location, or enter manually.
9. Go to *Item->Filter Settings*, enter the visibility (sets position trace width) and other items as needed.
10. STM should emit a short flash once per second
11. In DiveBase, go to *Action->Start Real-Time Tracking*
12. Transducer in water, go to *Action->Noise Test*
13. Set slider slightly above the noise level, press *End*
14. Adjust the display in *View*, if needed
15. For image annotation, connect USB frame grabber & select *Action->Image Annotation*
16. To record annotations, press space bar



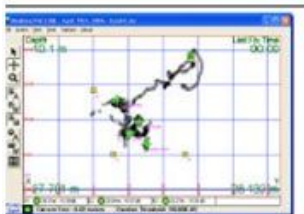
TLT-3 on a ROV

### MAKE SURE YOU HAVE...

1. PC with DiveBase software
2. Tape measure
3. STM-1 or STM-10
4. Sonar Transducers (3)
5. Transponder mounted to target
6. Sonar T'ducer Cables (3)
7. Operator's Manual & Technical Reference Manual



Transponder on ROV



DiveBase PILOT



DiveBase SeaFloor

PILOT COMPONENT	FUNCTION
Surface Station Box (STM-1 or STM-10)	Serves as the junction between Sonar Transducers and the PC.

<p>Sonar Transducers</p> <p>(In the figure at the top: S1, S2, and S3)</p>	<p>Send interrogates to the Transponder and receive pings from it.</p> <p>With the data they calculate depth, time of arrival, and location.</p>
<p>Mobile Station Transponder (TLT-1, VLT-1 or DS-3)</p>	<p>Attached to target, replies with pings as it receives interrogates.</p>
<p>DiveBase Software</p>	<p>Collects all data and plots the position of the target on a grid.</p>



## 1. Introduction

PILOT™ is a Short Baseline acoustic tracking system. Its principal function is to track a ROV or other underwater vehicle. PILOT™ uses high frequency (34 kHz - 42 kHz) sound to track the ROV. While light and most radio waves are quickly absorbed in water, sound actually propagates not only significantly faster but also much further in water than it does in air. For this reason, sound is used in many underwater applications. Common examples include depth sounders, imaging sonars and fish finders.

### Principal Components Of The Pilot™ System

- The **Surface Station** is the centerpiece of the PILOT system. Three cabled sonar transducers (antennae for sound) are connected to the surface station and lowered over the side of the boat. The transducers form a triangle, which is used to locate the ROV. A Windows XP computer serves as the data display and entry unit. The Windows computer runs DiveBase, the surface station software. The ROV range, direction and depth appear on the screen of DiveBase
- The surface station, and STM-1 or STM-10 will track any underwater vehicle that is equipped with a **ROV Transponder**. Several transponders are currently available. The miniature TLT transponders are designed for tracking small ROV to depths of 330 meters (1000 feet). The larger and more sophisticated VLT-1 transponder will track ROV to

depths of 1000 meters (3000 feet). It is suitable for mid-size ROV. The surface station is connected to a Microsoft Windows PC running the DiveBase software.

Figure 1.1 shows how PILOT works. The surface station is on the boat. The three cabled sonar transducers (acoustic antennas) are lowered over the side. The ROV transponder is mounted on the underwater vehicle.

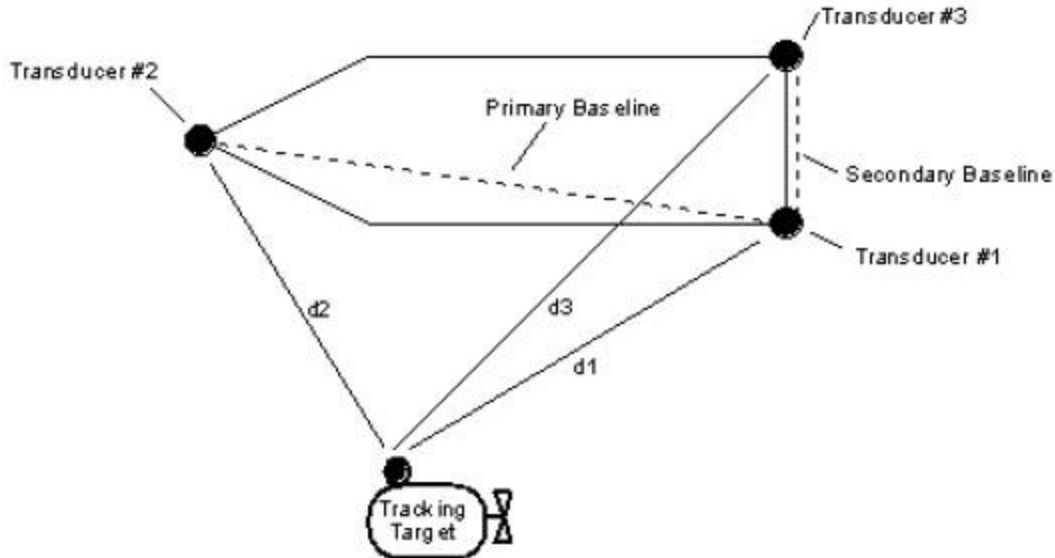


Figure 1.1: Target Position Determined By 'Short Baseline' Method

To find the ROV position, the surface station will transmit an interrogate signal (two pings) through transducer #1. This signal travels through the water and eventually reaches the ROV mounted transponder, which replies with a message that includes its current depth. The reply travels back to all three surface station transducers. The surface station now measures the time elapsed between the transmission of the interrogate and the reception of the ROV reply at transducers #1, #2 and #3. Because the speed of sound in water is fairly well known, these signal run times are easily converted into distances ( $d_1$ ,  $d_2$ ,  $d_3$ ). Finally, a little trigonometry yields the position of the ROV.

This method of tracking is commonly known as short baseline tracking. The word 'baseline' refers to the imaginary lines that connect the sonar transducers at the surface. The baseline is the reference for navigation. It is helpful to remember a few characteristics of short baseline tracking.

#### **Characteristics PILOT 'Short Baseline' Tracking**

- PILOT shows the position of the target (ROV) relative to the position of the boat or more specifically relative to the location of the three surface station sonar transducers. If the boat rotates, the target will appear to move in a circle around the tracking screen.
- PILOT measures the distance of the target with a repeatability of about 0.15 meters, independent of how far the transducers are spaced apart.

- The accuracy of the direction of the target depends on how far the three surface station sonar transducers are spaced apart. If they are 3 meters apart, the accuracy is about +/- 5 degrees. If they are 30 meters apart, direction accuracy is about +/- 0.5 degrees

For best accuracy, concentrate target operations broadside to the longer of the two baselines that are formed by surface transducers #1 and #2, and #1 and #3 respectively.

### **PILOT Performance Characteristics and Limitations**

Short baseline tracking is very convenient. Once the system is set-up, just 'flip the power switch' to start tracking. The PILOT™ Short Baseline (SBL) technology also lets you choose the accuracy of tracking by spacing the surface station transducers further apart. When operating from a larger vessel or the shore, you can often obtain survey (sub-meter) accuracy. In addition, tracking is available with PILOT even if the target is some distance away but just a fraction of a meter below the surface.

Yet, despite these capabilities and our customer's use of PILOT for precision tasks such as surveying pipelines or serving as a 'gold standard' against which other navigation systems are compared against, the SBL technology does have limits:

The further you move away from the location of your surface station transducers, the further the tracking accuracy (expressed in meters) will decline. In addition, if you are using GPS and heading sensor integration in order to operate in a geo-referenced (lat/lon or UTM) frame of work, the error inherent in those sensors will add to the overall positioning error.

Therefore, requirements that call for consistent sub-meter accuracy over a large area of the sea floor remain the domain of long baseline (LBL) systems such as Desert Star's AquaMap system. Due to our system modularity, your PILOT system is readily upgradeable for precision LBL AquaMap™ work. Check on our web site or call for details.

### **Geo Referenced Tracking Operations**

The main part of this manual describes the basic system operation, which yields target positions relative to the location of your surface transducers or vessel. Refer to the Appendix for a description of georeferenced operations and other advanced functions such as chart integration, image annotations and real-time data export to surveyor's software such as Hypack™.

## **2. List of Operational Tasks**

The five sections of the installation and operation process contain the following steps. **Installing**

1. Charge the batteries if necessary
2. Install software
3. Mount the mobile station

4. Conduct initial noise test to determine system noise

### **Preparing**

1. Charge the batteries

### **Deploying**

1. Deploy surface transducers
2. Enter baseline positions in software
3. Check and enter visibility
4. Activate and deploy the mobile station
5. Conduct a noise test to determine ambient (underwater) noise

### **Operation**

1. Start operation
2. Adjust the display
3. Record annotations
4. Retrieve the system

### **Reporting**

1. Replay the survey record
2. Save images of the survey record
3. Create the report document
4. Make the survey record portable

## **Pilot™ System Components**

The specific components included with the Pilot™ system will vary depending upon your configuration.

Typical components include:

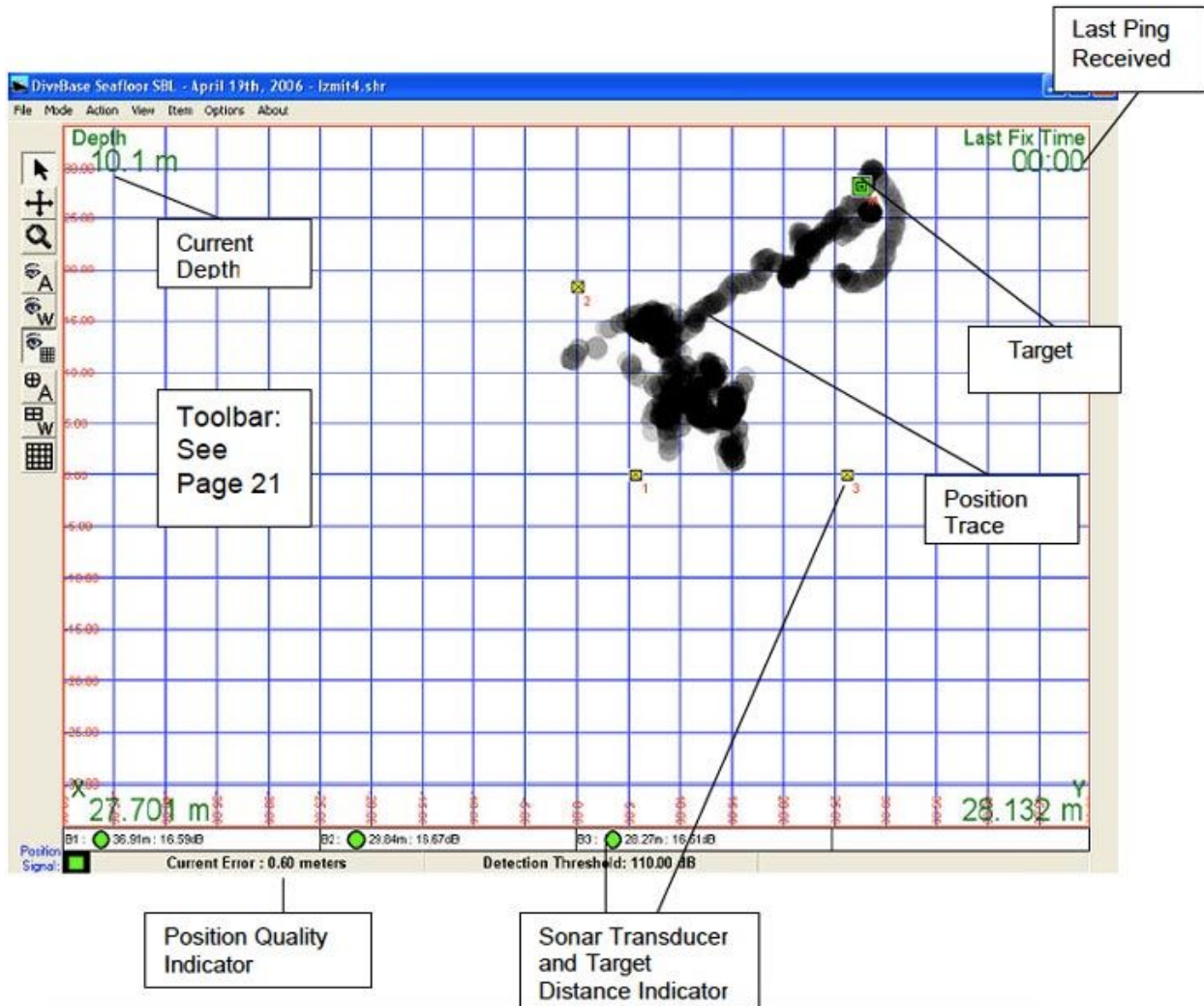
1. 1 Mobile Station (A TLT, VLT, or DS mobile station)
2. An STM surface station
3. Three surface station sonar transducers on 15m or 30m cables
4. Software: DiveBase and Chart Registration
5. This manual and the hardware manuals (for all stations)

Not Included (you must provide):

1. A computer running Windows XP with a minimum of 256MB of RAM.

2. Additional mounting hardware

## The DiveBase Display



## 3. Installing the System

These tasks should be done when you first receive the Pilot™ system. The first operation should be at an inactive test vessel in a quiet location – allow a day to install and learn how to use it.

### Installation Tasks

1. Charge the batteries
2. Prepare the stations
3. Install software
4. Mount the Mobile station

5. Connect the surface station to a PC and connect the surface station sonar transducer cables
6. Test the noise levels

## Charge Station Batteries

The STM-10, and VLT series transponders are equipped with rechargeable batteries. The TL series transponders use replaceable alkaline batteries. The STM-1 is not equipped with a battery.

Plug each station into the wall with the provided charging units, and turn them on (they will not charge **unless they are on**). The red LED light on the end of each station equipped with batteries should settle into a blink pattern of one second on and one second off. When it is done charging the pattern will change to one second on and three seconds off.

If the batteries were completely dead they should require about 3.5 hours to finish charging (7 hours for STM-10). If any other LED blink patterns occur please see the hardware manual (for the VLT-1) for the table of blink patterns that will tell you what it means.

Always try to charge the batteries a day or two before a mission. The nickel cadmium batteries in the baseline stations slowly discharge themselves over a period of 6 months, even if they're not being used. The batteries provide about 20 hours of continuous use with standard power.

## Prepare the Hardware

The stations should be operational after you have charged them. These are the tasks to complete before they're ready to put in the water.

1. **Check blink patterns:** Check that each station turns on and settles into the appropriate blink pattern of a single short blink once per second. If any other blink pattern occurs please see the blink pattern table below and/or the hardware manual for the RBS-1 transponder to troubleshoot it.
2. **Check dummy plugs:** Check to make sure that a dummy plug is plugged into each exposed waterproof connector on the stations. VLT series transponders require a dummy plug if the external connector is not being used during in water operations.
3. **Mount the mobile station on the ROV, diver or other target.**

Blink Pattern	Station Status
One short blink per second	Ready to go, standby



Triple blink once per second	Hardware error
Double-blink	Station received a valid interrogate (mobile station) or reply (surface station)
One sec on, 1 sec off	Charge
One sec on, 3 sec off	Charge done
Rapid blink	Low battery
No blink	Station off or battery dead

Table 3.1: Blink Pattern Meanings

## Installing the Software

The software should install itself when you insert the CD into the computer, if it doesn't do this you can click on the **setup.exe** file in the CD directory to initiate the auto-install program.

## Mounting the Mobile Station



Figure 3.2: Pony bottle bracket mount

The station must be placed properly. Keep the transducer away from ROV thrusters or other sources of noise. Ideally the transducer should be “**free and clear**”, i.e. the near space around it should not have anything in it that will obstruct or reflect the sound waves used by the system.

**For a diver:** A VLT or TLT can be mounted on the SCUBA tank using a pony bottle bracket. If the diver uses a DS-1, it can just be attached to his BC.

**For an ROV:** hose clamps can be used to mount a VLT or TLT, or possibly Velcro to mount a DS-1.

## Connect the Surface Station



Figure 3.3: Velcro mounted DS-1

Connect the STM to an available PC RS-232 port. If you are using a computer without a legacy RS-232 port, a USB adapter will be required.

Insure that the proper COM port has been selected in the DiveBase™ application. The COM port can be changed through the **Options/Mobile Station Com Ports** option on the menu bar.

Connect the three cabled surface station sonar transducers to the STM-1 or STM-10 surface station.

## Test the System Noise Levels

Shipboard hardware, ROV and most other systems emit noise and must be tested to be sure the noise is within acceptable levels for system operation.

1. Place the ROV in the water, start tracking and invoke the noise test feature. (see chapter 4 for details on how to operate the noise test).
2. Maneuver the ROV next to one of the surface station transducers (or even clip surface station transducer #1 to the ROV for this initial test)
3. Monitor noise levels as ROV thrusters and other loads are activated.
4. Make sure the noise never exceeds the maximum permissible amount of 120 dB. If it does, selectively switch all the ROV loads off until the noise level drops. Try moving the mounting position of the mobile station away from the noise generating device. If that does not work, contact Desert Star or the ROV manufacturer for advice.

## 4. Setting Up the System

**Overview:** This section explains how to mount the surface station transducers in their correct places, tell the DiveBase software where they are (relative to the ship or dock). Following deployment of the surface station transducers, activate and deploy the mobile station and check for any interfering background noise.

### Deployment Tasks

1. Deploy the surface station sonar transducers over the side of the ship, dock or dam
2. Enter surface station sonar transducer positions relative to each other in the DiveBase software
3. Check and enter underwater visibility to define the width of the position 'painting trace'
4. Activate and deploy the mobile station
5. Conduct a noise test

### Good Transducer Mounting Is Key To Optimizing Performance

The sonar transducers are the antennas of your surface station. It is important that the transducers are mounted stable, clear of noise sources, and with sufficient distance from each other. The quality of transducer mounting will directly affect the accuracy and range of PILOT. We strongly urge you to read, and understand, the information in this section.

The PILOT surface station connects to three sonar transducers. The transducer connectors are labeled Sonar #1, Sonar #2 and Sonar #3 on the surface station. The transducers serve as the reference for navigation. While there are many ways to mount the sonar transducers, we recommend that you standardize on the general configuration shown below. Using always the same relative layout minimizes the chance of confusion. Figure 7.1 gives a birds eye view of the distribution of three sonar transducers on a vessel.

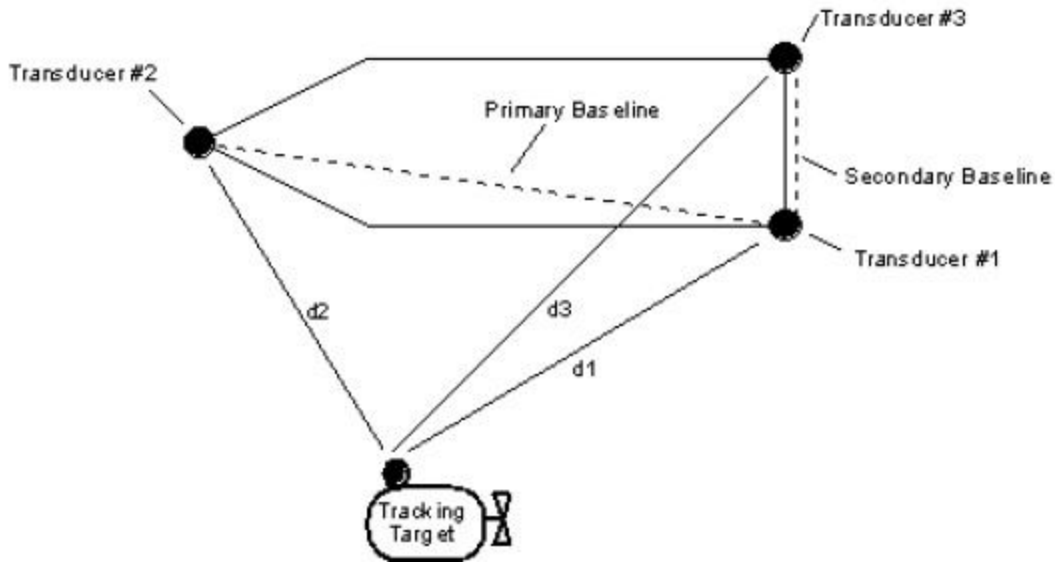


Figure 5.1: Vessel Mounting Of Three Baseline Transducers

Transducer #1 is mounted at the stern port side, #2 is located forward and #3 sits at the stern, starboard side. Transducers #1 and #2 should have the greater separation and form the main baseline. For standardization purposes, transducer #3 should always be to the right of the imaginary line starting at transducer #1 and extending towards transducer #2. The angle between the Transducer #1-#2 and Transducer #1-#3 baseline will ideally be close to 90 degrees. It should never approach either zero degrees or 180 degrees. If the three transducers are employed in something approximating a straight line, PILOT will not be able to determine if the ROV is located to the left or the right of that line. The length of the baselines relates directly to the accuracy of the ROV direction provided by PILOT. If the baseline is 3 meters long, the direction reading will be accurate to about +/- 5 degrees. If the transducer spacing is 30 meters, the direction accuracy will be about +/- 0.5 degrees. On most ship operations, the #1-#2 baseline will be longer than the #1-#3 baseline. In such cases, tracking accuracy will be better broadside to the #1-#2 baseline (broadside to the surface vessel). The accuracy of the ROV distance and depth reading is independent of the surface station transducer separation distance. Distance accuracy is very precise, typically about +/- 0.15 meters. The depth accuracy depends on the sensitivity of the depth sensor in the ROV transponder. It is about +/- 1% of the maximum depth rating of the ROV transponder, which is indicated on the transponder label.



**Figure 5.2: A Sonar Transducer Is Lowered Over The Side Of The Surface Vessel**

The most common method of mounting the surface station sonar transducers is shown in figure 7.2. The cabled transducer is attached to a load carrying (strain relief) line and weighted down with a lead weight of about 5 kg (10 pounds). The line is attached to the top U-bolt of the transducer cage, the weight to the bottom U-bolt. The transducer is then lowered over the side of the vessel. This mounting method is fast and does not require any special engineering. The weighted transducer is kept in the proper 'cable up / transducer head down' orientation by the weight. The approach lends itself to anchored operations as well as live boat operations as long as the weight and line strength is dimensioned properly to keep the transducer down even at the highest conceivable vessel speed. Of course, caution must be taken to prevent the transducer from getting caught up in the ship's propeller.

### **Surface Station Transducer Mounting Techniques**

- Weigh the transducer down with a lead weight of about 5 kg (10 lb) attached to the transducer head side U-bolt of the transducer cage. Attach a load bearing line to the cable side of the transducer cage. Lower the weighted transducer over the side of the vessel and secure. Stay clear of the vessel propeller, water intakes or outlets and other obstacles

- Mount the transducers on poles secured to the side of your vessel. Adjust the pole length to mount the transducers at the desired depth. The transducers should at least clear the keel of the vessel.
- Mount the transducers hard against the hull of your vessel. This is a very clean mounting technique that does not require disassembly when the vessel is in motion. Consider however that the hull will shield any sonar signals. Mount the transducers on the hull such as to obtain a good 'sonar view' of the environment
- If you are operating from a small vessel such as an inflatable, your baseline may be too short to be useful. In this case, mount one transducer on the boat and the second transducer on a buoy anchored some distance away. You can run the transducer cable through the water. If necessary, attach small floatation devices to the transducer feed cable.

In general, the surface station transducers should be lowered at least 2 meters into the water, always below the keel, and with sufficient weight or other stabilizing methods to keep them from swinging about in the surge. Some more detailed considerations are listed here.

### **Surface Station Transducer Mounting Considerations**

- Many objects reflect sonar energy, especially if they contain air such as a ships hull, air tank or even kelp. A 'shadow' is thus created behind the body. A transducer located in that shadow may not pick up sonar energy. It is important to ensure that transducers are placed such that no path blockage will occur. The system can tolerate temporary shadowing, but a permanent blockage will result in loss of navigation and communication capabilities.
- There are many natural and man-made noise sources under water. All stations in a network must be able to 'hear' the other stations. This implies that the signal of the other stations must be 'louder' than the background noise. Thus, it is important to keep sonar transducers away from any interfering noise sources. Most problematic is high frequency noise such as is generated by a boats propeller churning in the water, gas or fluids 'hissing' through a pipe, the banging of tools or loose power equipment etc. The system can tolerate momentary, sporadic noise. It will also tolerate low frequency noise, such as the hum of an engine or a generator. However a persistent high frequency noise source will raise a 'curtain' that PILOT may not be able to penetrate.
- Also consider the stability of your mounting technique. The baseline transducers are the reference for all measurements. Consequently, a shifting baseline will result in skewed position fixes.
- Practical limitations may not allow you to obtain an ideal setting for transducer mounting. However you should attempt to minimize the interfering factors.

## **5. Registering the Transducer Locations and the Noise Test**

Baseline	X	Y	Depth
B1	5.66	0.00	2.00
B2	0.00	18.20	2.00
B3	26.26	0.00	2.00

Baseline Calibration	X	Y	Depth
B1			
B2			
B3			
B4			

Translation: 5.660m, 0.000m  
Rotation: 342.725 deg

Adjust Translation/Bearing  
X: 5.660, Y: 0.000, Bearing (deg): 342.725

Reset To Raw, Transform Baselines

Use raw calibration data  
Use Survey Depths  
Use All Survey Data

Water Properties  
Speed Of Sound: m/s, Temperature(C)  
Correction Factor, Salinity(ppt)

Calibration Instructions:  
Calibration Only Available During Real-Time LBL Tracking

Instructions:  
(All Units In Meters)  
Mouse Selection:  
1. Select Baseline To Set Using Radio Buttons Above.  
2. Use Mouse To Select Location.  
-OR-  
Hand Enter Each Baseline Station Location.

OK, Cancel, Apply

The positions of the surface station transducers are entered into DiveBase using the Register and Calibrate screen.

**Note:** The DiveBase software currently only works in meters so any measurements in feet must first be converted to meters. To convert feet to meters multiply the number of feet by 0.3048. Quick Conversion: 10 feet = 3 meters (approximately). To convert meters back to feet (if you ever need to) multiply the number of meters by 3.2808.

1. Start the DiveBase program.
2. Select **Register and Calibrate Baseline Stations** from the **Action** menu.
3. The window that pops up has places to enter all of the numbers, in meters. These numbers can be entered using the mouse to click on their location in the top view or entered manually.

## Check and Enter Visibility



Figure 6.2: Entering Visibility

PILOT™ is capable of ‘painting’ an ROV position trace, the width of which can correspond to the visibility. In cases where the surface station is static, or PILOT™ is operated in geo-referenced mode, this ‘painting of the sea floor’ is a powerful means to ensure complete survey coverage of a site. The trace will even get darker (thicker paint), as the ROV runs repeatedly over one spot or lingers! To take account of the **visibility** in the water at the time of the inspection, simply enter it into the software. The visibility number determines the width of the trace. For example, if you specify one meter visibility, then the trace will be 2 meters wide (one meter to the left, one meter to the right). Good visibility (or an acoustic imaging system) will allow you to ‘paint’ a wider swath. Choose **Filter Settings** from the **Item** menu and enter the approximate visibility in the appropriate box.

## Activate and Deploy the Mobile Station

1. Activate the mobile station. Make sure you get the ‘ready’ blink pattern (one second on and three seconds off).
2. Select **Start Real-Time Tracking** from the **Action** menu.
3. Wait for the timer to start advancing in the upper right corner of the screen. This means that DiveBase is recording position data. If communication to the mobile station is not available, an error message will appear after about ten seconds. Check all connections and power state and try again.
4. Deploy the mobile station.
5. Check that the mobile station appears as a green square on the screen in the correct place, relative to the map of the ship.

## Perform a Noise Test





Figure 9.3: The noise test display

Common sources of underwater noise include passing boats, snapping shrimp and other biological noise, intensive rain or the sound of nearby breaking surface. By default, PILOT will simply adjust its sensitivity 'to deal' with whatever noise might be present. However, you can also conduct a noise test to find what noise is there, and then set the surface station detection threshold manually (the mobile station will always auto-adjust, as there is no link to control it manually during an operation).

While you can do without a noise test, doing one and then setting the detection threshold is a prudent step just to be aware of the noise on the site, and estimate the impact in terms of tracking range reduction that it might have on your operations today.

But, be aware! Once you set the detection threshold, you have overridden the system's auto adjust and it will maintain your setting until you switch the system off and on again. So, if noise levels should rise (and they DO frequently grow and then recede again underwater), you must adjust the threshold again. Noise test and threshold adjust is a very simple procedure. Here is how it's done:

1. Insure that the surface transducers are the water and select Noise Test from the Action menu.
2. Press the Start Test button.

3. Just watch the noise for 30 seconds or so, then grab the slider and set it so it is above at least most of the noise. The occasional noise spike (every ten seconds or less) breaking the threshold is OK.
4. Now hit end test and you are done!
5. Repeat the procedure every once in a while, so you become familiar with the local noise patterns. In particular, do it when you have lost track even though the target is nearby.

## 6. Operation

**Overview:** This section explains how to perform the tracking operations with Pilot™

### Survey Tasks

1. Start tracking
2. Adjust the display
3. Record annotations
4. Retrieve the system

### Start Tracking

Select **Action/Start Real-Time** tracking from the menu bar. The system will now communicate with the station attached to the selected COM port and initiate tracking operations. If there is a communication error a message box will appear.

### System Status Indicators

During real-time surveying and replay mode, system status is reported by the System Status Indicators (bottom of the main screen). The System Status Indicator group is made up of a Position Signal Indicator and four baseline station Range Indicators, one for each station. The baseline station Range Indicators have two possible states, red or green. Successful operation is indicated by a green circle and reported range (in meters), unsuccessful operation with a red circle and zero reported range. Using the Range Indicators it is possible to know if there are any problems with the baseline stations themselves.


The Position Signal Indicator has **three** possible states, green, orange and red. Green indicates a good calculated position fix, orange indicates a bad calculated position fix and red indicates no position fix with possible loss of communications. During replay mode only the green and orange signals are reported. See **Appendix 4: Troubleshooting** if problems occur.


### Adjust the Display

**Turning on and off graticules, annotations, waypoints**

Each of these layers can be toggled on and off in the View menu or by using the control bar buttons.

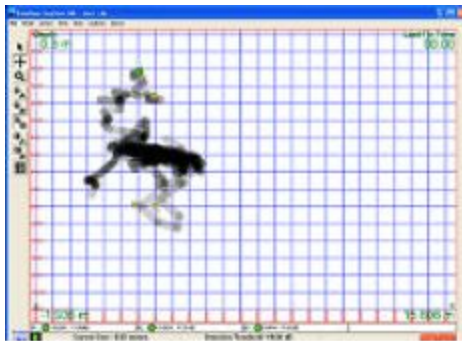
## Panning and Zooming

The vertical toolbar on the left side of the display has buttons for selecting panning and zooming tools. The panning tool (or Translate Tool)  can be used to click and drag the active view of the ship or you can use the arrow keys for panning.

The zoom tool  allows three types of zooming control. Left click to zoom in, right click to zoom out, and click-and-drag a box around any desired area to zoom with precise control. You can also use the hotkeys: O for zooming out and I for zooming in.

## Other display controls

The other buttons in the toolbar can be identified by placing the mouse pointer over them, callouts will indicate their functions. They are also pictured and labeled with their functions in the Display section of the Introduction as well as in Appendix 3: Toolbar Buttons.



## Record Annotations

To enter an annotation into the survey record choose **Add Annotation** from the Item menu, or hit the space bar, and fill in the appropriate information when the Annotation Window pops up. For quick annotations use the “spacebar”. Another method of entering an annotation is to right click, with the mouse, on the image where you would like to place the annotation and enter your text.

Annotations are automatically saved by DiveBase in a text file with the extension “txt”. This will create an annotation file with the same name as the “.shr” file but with ANN added to the name. Example: spruance.shr will have a spruanceANN.txt for annotations.

## Appendix A: Troubleshooting

## Noise Problems

Acoustic or electric noise in the tracking environment will interfere with the signals used by the system. There are many sources of noise, including biological (snapping shrimp, etc...), ship engines, ROV motors, diver's regulators, AC power lines, low quality inverters, etc... The best way to locate controllable noise is to use the noise test feature in the tracking software to monitor noise levels as you turn on and off the possible sources of noise.

ROV noise	
Problem	Reason/Solution
Acoustic noise	Move transducer away from thrusters or hydraulics
Electrical noise  (May be radio interference through the air/water or electrical interference through noise on power supply lines)	Test for power line noise by removing both the ROV transponder and the surface station PC from AC power. Test for radio interference by shutting off all ROV systems. Use battery power, a good generator or a true sine wave inverter if power line noise is a problem. Move the ROV transponder away from the ROV to locate radio interference, then mount in a location where radio interference is minimized.

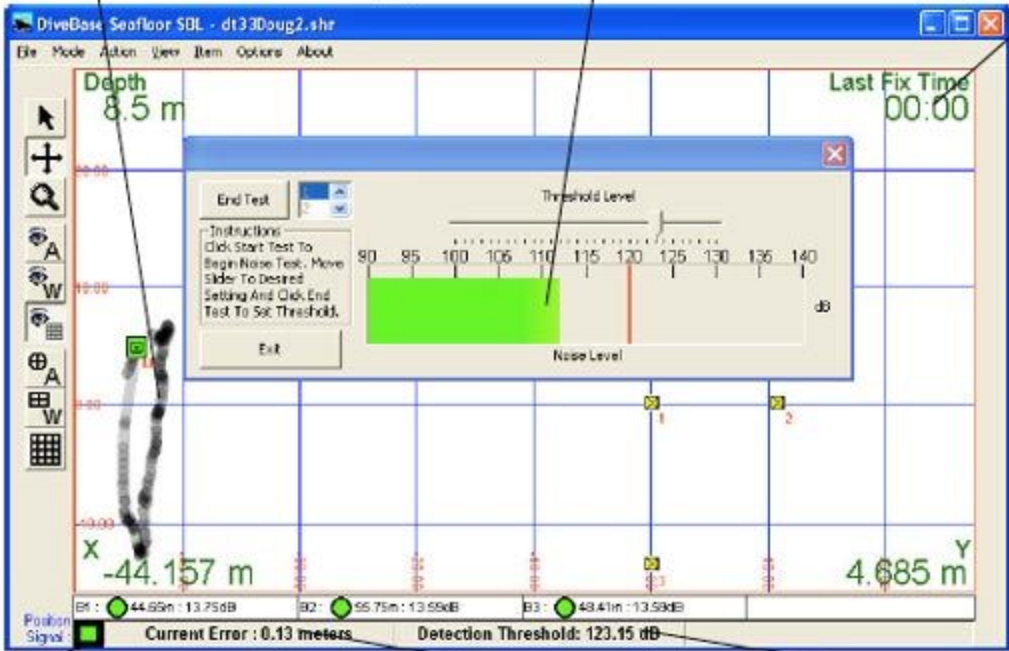
System Status Indicators	
Problem	Reason/Solution
Trace Suddenly Stops	<ul style="list-style-type: none"><li>• Check "last position fix" time in the top right corner of the software. If this is more than 10-15 seconds there is a communication problem.</li></ul>
(After you been tracking successfully)	<ul style="list-style-type: none"><li>• The transponder may be in a shadowed location or too far out of range.</li><li>• The battery on the transponder may have died.</li></ul>

<b>Position Indicator</b>	
Constantly Large Errors	<ul style="list-style-type: none"> <li>• A persistently large error indicates that the baseline survey is incorrect.</li> </ul>
	<ul style="list-style-type: none"> <li>• If the number turns red, the system is not showing positions because the error exceeds the 'maximum error' defined in the filter settings.</li> </ul>
Constantly Displays Red	<ul style="list-style-type: none"> <li>• Communications problem. Cable has been disconnected on mobile station. Check cable connection to mobile station.</li> </ul>
(Real-Time Only)	<ul style="list-style-type: none"> <li>• Power loss. Mobile station has lost power. Check power connection (external power) or battery charge.</li> </ul>
	<ul style="list-style-type: none"> <li>• Transducer is out of range or in a shadowed area.</li> </ul>
	<ul style="list-style-type: none"> <li>• Transducer's battery is dead.</li> </ul>

**Position Trace:** The trace is painted only if the position fixes meet the quality standards defined in the position filter settings. If you see frequent gaps in the trace, then check your filter settings the other indicators on the screen to determine the cause.

**Noise Test & Detection Threshold Slider:** Use this test to evaluate vehicle and environmental noise. More noise means less system range, so make changes to reduce any noise under your control and test again. Use the slider to set the detection threshold above the prevalent noise to avoid noise induced errors.

Check the time since last position fix to make sure your data is up to date.



Green is OK, but a red light indicates that station is out of range, shielded from view or not operating. Are the lights almost consistently green? If not, reduce baseline station spacing and/or avoid obstructions to obtain better system reliability.

For good position quality, the error should be below 1 meter or even 0.5m. A persistently large error indicates that the baseline survey is incorrect, while changing errors indicate unstable baseline station mounting or obstructions in the water. If the number turns red, the system is not showing positions because the error exceeds the 'maximum error' you defined in the filter settings (quality control).

Signal strength above detection threshold: If you see only a few dB, you are near the limit of range. Check the numbers just after baseline station deployment to verify your array is not too large for conditions. Monitor them during ops to get an early warning of an approaching out-of-range condition. CAUTION: A persistently weak signal from one baseline station or sonar transducer may indicate the baseline station transmitter or surface station sonar transducer is not working properly. Replace it.

### Appendix B: Hot Keys (Keyboard Shortcuts)

Menu Command	Hot Key(s)	Function (if it's not self-explanatory)
<u>File</u>		
Load Record File	Ctrl+L	Loads a record

Load Annotations	Ctrl+A	Loads an annotation file
Load Waypoints	Ctrl+W	Loads a way point file
Save Screen Image		Saves currently selected screen image
Save Annotations		Saves the current annotation file
Save Waypoints		Saves the current way point file
Clear Data / Screen	Ctrl+C	Clear all stored data from screen
Close	Ctrl+Q	Closes Application
<b><u>Action</u></b>		
Start Real-Time Tracking	T	Starts tracking of the mobile station, a new record.
Register And Calibrate Baseline Stations Dialog	C	Launches baseline registration and calibration dialog
End Real-Time Tracking	E	Ends tracking of the mobile station, closes record
Replay A Record	R	
Generate Survey Report Image	Ctrl+S	Saves full DiveBase image currently selected loaded
Noise Test	N	Launch Noise Test Dialog
<b><u>View</u></b>		
Graticule	G	Toggles graticules (grid) on and off

Annotations	A	Toggles Annotations on and off
Status Info		Toggles Status Info on and off
Waypoints	W	Toggles Waypoints on and off
Replay Control		Displays Replay Control Bar
<b><u>Item</u></b>		
Graticule Settings	Ctrl+G	Allows changing of graticule (grid) settings
Filter Settings	Ctrl+F	Allows adjustment of <b>Visibility</b> and other settings
Add Annotation		When in Tracking Mode, hit the SPACE BAR
Remove Annotation	Delete Key	If An Annotation is selected Delete Key with remove it.
Remove All Annotations		
Add Way Point		When in Tracking Mode, hit the X key
Remove Way Point	Delete Key	If A Waypoint is selected Delete Key with remove it.
Remove All Way Points		

<b>Keystrokes (Listed by Functional Group)</b>	<b>Function</b>
<b><u>Deployment</u></b>	












"T"	START REALTIME TRACKING
"C"	Launch Baseline Register/Calibration Dialog
CTRL+F	Launch Filter Dialog (where you enter Visibility)
"N"	Launch Noise Test Dialog (only active during realtime tracking)
Up Arrow	Pan Up
Down Arrow	Pan Down
Right Arrow	Pan right
Left arrow	Pan left
"I"	ZOOM IN
"O"	ZOOM OUT
SPACE BAR	Add annotation at mobile station location, allows free text entering
F5	Add Quick Annotation ("1")
F6	Add Quick Annotation ("2")
F7	Add Quick Annotation ("3")

F8	Add Quick Annotation ("4")
DELETE KEY	DELETE Selected Annotation or WayPoint
"E"	END TRACKING
<b><u>Reporting</u></b>	
"R"	Replay Record
CTRL+R	Generate full report image (saves all items displayed)
Ctrl+C	CLEAR SCREEN
CTRL+A	LOAD ANNOTATIONS from file
CTRL+W	LOAD WAYPOINTS from file
CTRL+L	LOAD a RECORD
<b><u>Others</u></b>	
CTRL+ATL+Q	CLOSE/Quit APPLICATION
CTRL+G	Launch GRATICULE SETTINGS dialog
"G"	VIEW/Hide GRATICULE
"A"	VIEW/Hide ANNOTATIONS
"W"	VIEW/Hide WAYPOINTS

## Appendix C: Toolbar Buttons

Button	Name	Description
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	Pointer	Allows selection of annotations and waypoints.
	Translation/Panning Tool	Allows fine control over positioning of ship plan in display. Click and drag to move image.
	Zoom Tool	Allows fine control over zooming, click and drag a box to zoom to that box. Right click = zoom in, left click = zoom out.
		Shows annotations.
		Shows Waypoints
		Shows Graticule layer
		Inserts Annotation
		Inserts Waypoint
	Graticule Setting Adjustment	Calls up Graticule Setting Dialog window for adjusting the values of the graticule.

## Appendix D: Additional Capabilities in DiveBase SeaFloor

The main portion of this manual describes PILOT operation with the entry-level DiveBase PILOT software. The PILOT system can however also be used with the more sophisticated DiveBase Seafloor software, which provides additional capabilities to support underwater survey operations.



DiveBase PILOT (left) and DiveBase Seafloor screen with additional capabilities (right)

The picture shows the substantial additional capabilities of the DiveBase Seafloor version. PILOT is a basic tracking software that shows the target location only relative to the surface station transducers. On the other hand, SeaFloor does that and a lot more. In this software you can reference your trace to a “real” map as well as take image annotations. These are just the immediately noticeable differences. In this scenario there could have been multiple targets in the water, we could have integrated GPS to provide geo-referenced precision tracking anywhere (such as for pipeline surveys), and tracking data can be exported in real-time to other systems or software such as Hypack.

The table lists the additional features available with the DiveBase Seafloor software:

Seafloor Features	Their Use in Seafloor
Picture Annotation	This allows you to snap a picture with an on-board camera leaving, on screen, an annotation where the picture was captured. This later can be used to know exactly where something is in relation to a live map (BMP image).
Chart Overlay	This allows you to overlay a BMP image file. The main goal with this feature is that it gives the ability to place a real world map in the background so that you will know in relation to the actual place, where your transponder is.

Geo-Referenced Operation	DiveBase Seafloor can operate in the georeferenced UTM coordinate system, to provide results that are compatible with industry standard survey methods. The UTM coordinate system precisely specifies the location of any spot on the surface of the earth.
GPS Integration (only used in PILOT SBL mode)	By connecting a GPS receiver and a heading sensor to the surface station PC, DiveBase can determine the geo-referenced (UTM) position of your target. This capability is only used in short baseline (PILOT) mode. See the PILOT manual for details. You are now capable of using GPS to coordinate the location of your stations during the chart overlay and the chart/map registration. During Chart Registration you take two reference points from a “real world” map.
Position Data Export	This allows you to export the data to another charting system such as Hypak or another computer using a dedicated serial (com) port.
Multi-Target Tracking	With the provided DiveBase Level 2 software (FREE OF CHARGE) you are also capable of tracking up to 10 target at the same time. Therefore you can, generally, get a job completed quicker and cover more area while doing so. Refer to the DiveBase Level 2 manual for details.

**Text and Picture Annotations**

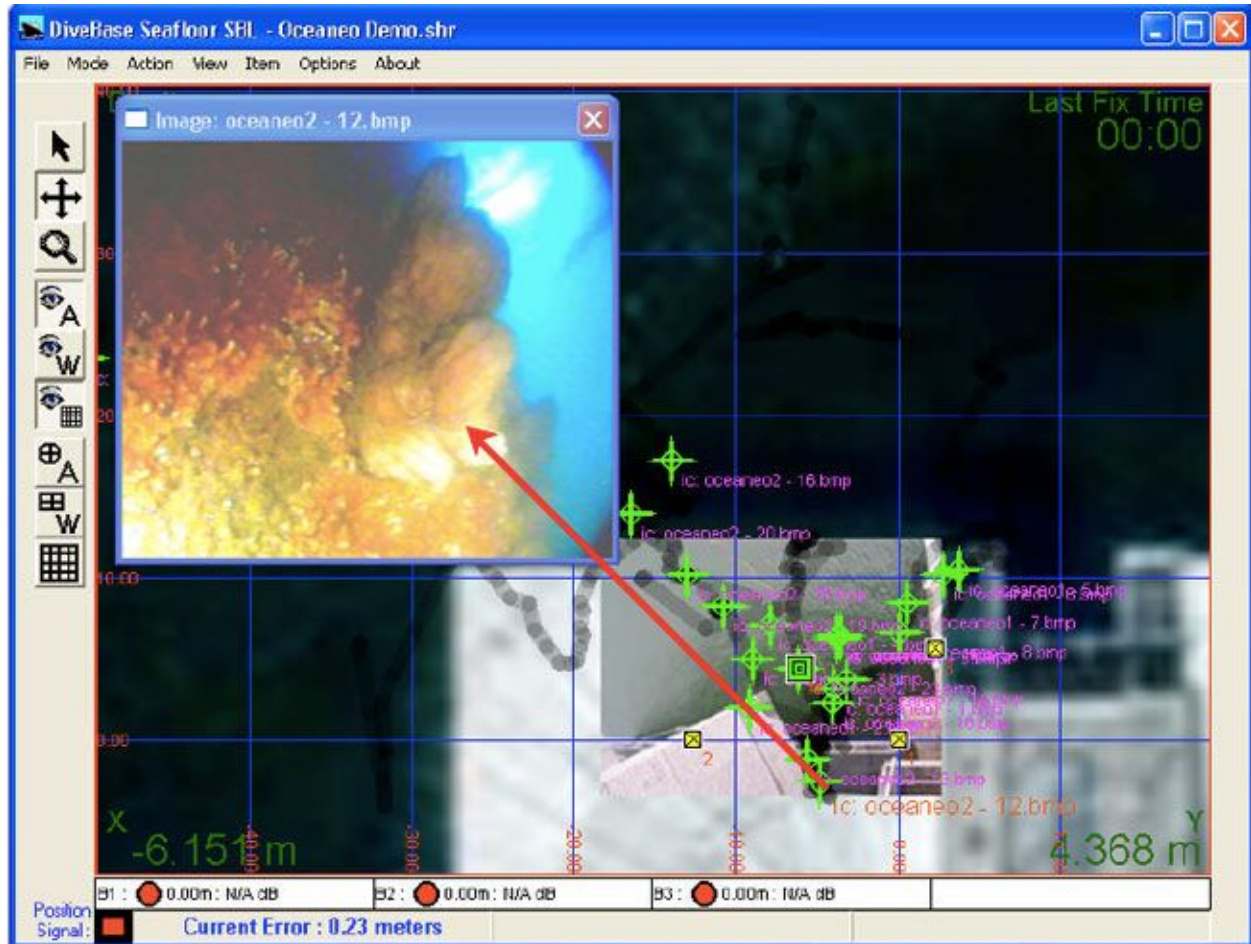


Image annotations associate observations with location, time and depth

Text and picture annotations are used to associate underwater observations with the location, time and depth of the observation. The observation may be a textual description only, or an image with a textual description. The STM-3 and STM-4 surface stations accept image data from any video source, most typically a ROV camera. Each annotation is marked by a green cross hair and an identifier name on the tracking screen. When you click on a location in replay mode, the associated text and image appears in a pop-up window. Overall, annotations are a powerful means of documenting and mapping underwater observations.

### Preparations for annotation

To enable image capture, select **Action** → **Image Capture**. A pop-up video window will now appear, showing the live imagery that is received through the STM-3 or STM-4 video input. The most current image is used for any annotations. For text-only annotations, do not enable the image capture feature.

## Entering an annotation

To enter an annotation at the current location of the target, just hit the space bar or choose **Item** → **Add Annotation** and fill in the appropriate information when the Annotation Window pops up.

Another method of entering an annotation is to right click, with the mouse, on the image where you would like to place the annotation and enter your text.

## Viewing annotations

View annotations by left-clicking on the green cross-hair. DiveBase automatically saves text annotations in a file with the extension “txt”. This will create an annotation file with the same name as the “.shr” file but with ANN added to the name. Example: spruance.shr will have a spruanceANN.txt for annotations. Image annotations are saved as .jpg image files.

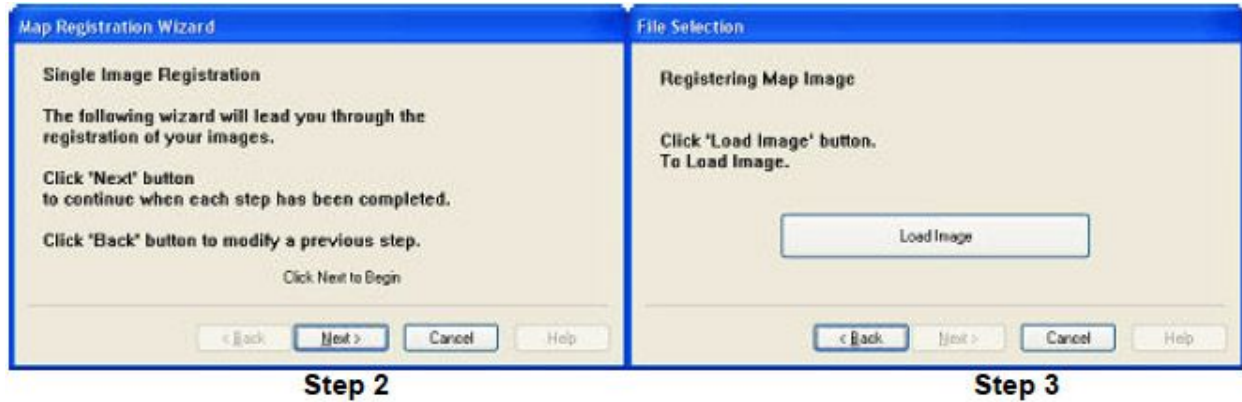
## **Chart Overlay and Chart Registration**

DiveBase Seafloor lets you navigate or track a target against the background of a chart. This could be a nautical chart, but also a sidescan sonar plot or perhaps an engineering map showing pipelines owned by an oil company. In either case, you start with a .BMP image. The chart registration process defines the scale of the image, as well as its location on the surface of the earth as expressed in UTM coordinates (see below).

These are two different subjects that relate to each other. Chart Overlay is just having the function to have a mapped area in DiveBase SeaFloor. Chart Registration is software that comes with DiveBase SeaFloor allowing you to register the chart (map image) to later use in SeaFloor.

Here are the steps to follow when using the Chart Registration software. First pull up and run the software, which you can find in the same location as DiveBase SeaFloor. **Step 1: Select *File—Start Single Image Wizard*** and a window will pop up walking you through the process of registering an image (**Step 2 & 3**). A key note that you will want to remember while using this wizard is that it uses UTM coordinates, not latitude/longitude. The Universal Transversal Mercator (UTM) system divides the world into UTM grid squares and then specifies the location of any point within that grid as an offset in meters north (northing) and east (easting) of the southwest corner of the grid square. UTM is commonly used by surveyors, and virtually all GPS receivers can be configured to operate in UTM. Latitudes and longitudes can be converted to UTM using free web calculators, if UTM coordinates are not directly available.

To register an image for use as a chart, you will be asked for two points to reference. So you will need the coordinates of two separate points. The better precision that you can achieve with these points, the better the overall accuracy will be. For example, if you use a hand-held GPS device to find the location of the two reference points, but the GPS has an error of 10 Meters then your overall error will be worse. You do not want your reference points to be on the same x or y axis.



In these Screen dumps it shows each step except the **File command**. In steps 4-7 the corresponding screens have been combined. In **Step 4 and 5** each has it's own "Point Selection" screen and once you select for Point 1 it will flow into a second screen for Point 2. As well, in **Step 6 and 7** after you hit "Save Registration" it will pop up with the "Chart Registration yes/no box" before you can proceed. Once clicked "No" Chart Registration will be dismissed automatically.

Then you go into DiveBase SeaFloor and select **File—Load Map File**, point yourself to the correct folder and load the map file you have just created. After the "map" file has been selected it will show up as a Chart Overlay.

**Rotating an image for north alignment prior to registration**

There are a few other key notes to take into factor when registering an image. If it is north and south aligned then you will register it as such, but if it is not you have a few options. On of your options is to first rotate the picture using a photo editing software, or you can just reference any point north and



any point east. If you chose the second of the two your task can be made out much easier. For example, if you were working on a dock in a harbor you can make one end “north” and another “east” so that when the image is overlaid in SeaFloor the dock forms a right angle. By doing so, this gives the user a simple way of explaining to someone in the water where he is or needs to be.

### **GPS Integration**

In DiveBase SeaFloor we use the GPS integration and a heading sensor to get geo coordinates rather than just baseline relative positions. That just means that you have the ability to reference your trace to “Real World” coordinates rather than just your baseline survey; therefore, SeaFloor can be used in any application that the goal is to reference an area to an actual map of the area itself. By defining the area with the Chart Registration you can further understand the overall value of GPS Integration because you can see its effects. Remove the map and your reference is only to the baseline survey, but add the map and your reference changes to a “Real World” survey.

### **Position Data Export**

You have the utility available to export the position data into another charting software. There are four different methods available, but the most common one is serial output. This is by far the most commonly used, and is the standard method for connecting to another piece of software, such as Hypack or Winfrog. When doing so you must select a com port and baud rate from the Options Menu on the main menu bar. The output format used depends upon what you are doing with it. The other thing you have to do is select an output format, we currently support 6 formats.