

# RangeNav™

*Transportable Acoustic Tracking Range*



**Operator's Manual**

**Revision 1**

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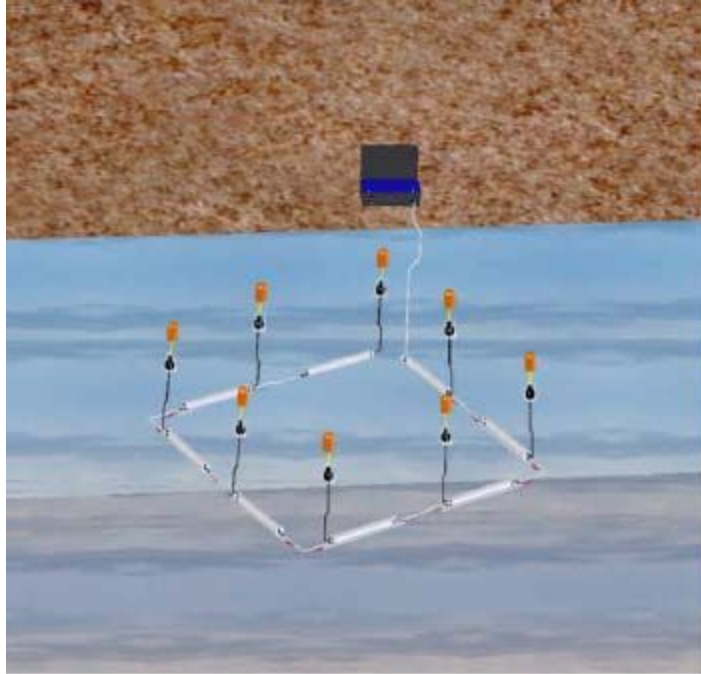
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# 1. Introduction

RangeNav™ is a transportable acoustic tracking range. It is designed to track pinger equipped targets for applications including underwater vehicle performance evaluations and monitoring of underwater assets in naval exercises. Characteristics include:

- A compact, transportable design suitable for quick deployment and recovery at any desired test site.
- Specifically optimized for littoral waters, and capable of operating at depth ranges from 1m to 300m.
- Designed for coverage up to 20 nautical miles x 20 nautical miles.
- Automated acoustic self-survey determines relative station locations within minutes.
- Simultaneous tracking of up to eight targets in three dimensions with horizontal accuracy of approx. 1 meter and vertical accuracy of approx. 0.3 meters. Position quality indicator provides estimated accuracy of each fix.
- Standard position update rate of once per second for all targets.
- Compatible with Desert Star depth-encoded pingers and US Navy standard DPSK pingers.
- Broadband, DSP based design operating from 2 kHz to 80 kHz.
- Simple surface equipment consisting of a junction/power box and a MS Windows notebook computer or desktop.
- Client -server architecture supports tracking data viewing in remote locations via the Internet or LAN.
- Uncomplicated and rugged hardware that enables use of locally available labor and vessels of opportunity.
- A relatively low-cost design permits use in 'risky' locations where equipment loss is a possibility.



**RangeNav™ Systems consist of a number of interconnected listening stations linked to a surface junction/power box and PC.**

RangeNav™ systems are configured from the principal components listed in this chapter. In general, the information in this operator's manual is sufficient for most tasks. Additional detailed information about the components is available in these RangeNav™ Manuals:

#### **RangeNav™ Technical and Software Reference Manuals**

1. The DiveBase RangeNav™ Software Reference Manual describes the surface station software.
2. The TLP-100-101-102 Technical Reference Manual describes the standard pingers.
3. The TLP-103 Technical Reference Manual describes a micro pinger for small targets.
4. The RBS-100-101 Technical Reference Manual describes the listening stations.
5. The STM-100 Technical Reference Manual describes the surface station junction box.
6. The RPD275-550-1100 Technical Reference Manual describes the array data and power cable.

#### **RBS-100 Listening Stations**



At the core of a RangeNav™ system are a set of model RBS-100 broadband listening stations. The stations are linked in a daisy-chain fashion, with up to 100 stations per chain and a maximum supported chain length of 20 nautical miles if stations are spaced in 1km intervals. An anticipated expansion will allow the use of multiple chains, so that a coverage of up to 20nm x 20nm can be achieved.

These 'intelligent' listening stations receive acoustic signals from the pingers through a broadband hydrophone and transmit transducer assembly that is attached to the station via a short (1.5m) cable. Signals are processed in the station using filter and telemetry decoding parameters provided per remote command by the surface station. Instation acoustic signal processing greatly reduces the data volume to a brief ping descriptor, which is transmitted via a RS -485 copper-based data link to the surface.

In addition to their broadband acoustic receive capability, the listening stations are also equipped with an acoustic transmitter and transducer, operating at 16kHz – 24kHz. The acoustic transmit capability is used primarily for array selfsurvey, providing a speedy and very accurate means to determine station locations relative to each other.

In order to determine precise depth of their location, each station is equipped with a 0.1% of full scale accuracy pressure sensor. The pressure sensor rating is 500 PSIA, supporting the station's 300m depth rating. Each station reports its depth to the survey as a part of the array self-survey process.

The listening station are powered by 50/60Hz AC power from the surface junction box, and can be configured to operate at either 880 VAC or 440 VAC nominal. The higher voltage supports maximum

chain length, but the lower voltage is a safer solution for applications or in areas where human interaction with the system is common. Each station relays both power and conditions and relays data down (and up) the chain.

In addition to its main DSP processor, the listening stations include a micro-controller which is exercising supervisory function. These include a data and power bypass that is activated if the DSP chip is not responsive. The mechanism allows the remainder of a chain to keep operating even if the DSP circuitry in one station is defective.

### **RBS-101 Recording Stations**

The model RBS-101 recording station are identical to the RBS-100 listening stations, except that a CF FLASH memory card is integrated and raw acoustic data recording firmware is provided. Due to its copper/RS -485 data interface, umbilical communication bandwidth is limited and not suitable for continuous raw acoustic data transmission by all stations in a chain. (Doing so is not normally necessary, because each station processes the acoustic data and needs to send only short ping descriptor packages).

Yet, the RBS-101 station helps when there is a need to obtain occasional samples of raw acoustic data, such as to evaluate background noise or measure the noise signature of a target. The surface station can instruct any listening station to record the raw data. The data is stored in the FLASH memory, and can be retrieved by the surface station on a bandwidth available basis. FLASH card capacity is 1 GB standard 8 GB optional. The 1 GB standard capacity is sufficient for approx. 30 minutes of raw data recording at the standard sample rate of 250 kHz.

### **Data and Power Cable**



The RBS-100 listening station and RBS-101 recording stations are linked to each other and the surface junction box through the data and power cable. Cable sections of 250m, 500m and 1000m are available. Each section is terminated with wet-mateable (diver serviceable) underwater connectors and a 'chinese finger' strain relief system.

The cables include a cut and abrasion resistant clear polyurethane jacket that supports inspection, a Kevlar braid strength member and water swelling tape to slow cable flooding in case of a cut. The maximum working load is 500lb and the breaking strength is 1500lb. The cable is negative buoyant.

A 250m spool weighs approx. 85lb. The six-conductor cable includes an AC power pair, plus two twisted data pairs supporting two RS-485 data channels.

#### **STM-100 Junction and Power Box**





Each chain is terminated at the surface to a model STM-100 junction and power box. The principal functions of the STM-100 are power generation and handling and data relay between the underwater array and the surface station PC.

The STM-100 connects to 50/60Hz AC power and is factory configured for either 110VAC or 220VAC operation. It converts the power to either 440VAC or 880VAC before feeding it into the array.

A power monitoring operates in conjunction with reports from the listening stations, and provides continuous reports about the voltage at each station and the current flowing through each conductor of the power pair. The power monitoring helps determine the max. available chain length (before voltage gets too low), and detect any faults such as leakage currents, defective station electronics or short circuits. For safety purposes, the STM - 100 also cuts power to the array if either a sudden current spike or a ground fault (current mismatch) is detected.

The STM-100 also includes an input for a GPS time signal. In conjunction with a similar input available on the depth coded pingers, the time signal allows direct pinger-to-listening station

distance measurements (as opposed to the normal distance differences obtained with unsynchronized pingers). This mode is sometimes used to improve the array GPS surveys accuracy and reliability. It yields station coordinates for each listening station individually, and completely independent of the other listening stations.

### **Surface Station PC and Software**



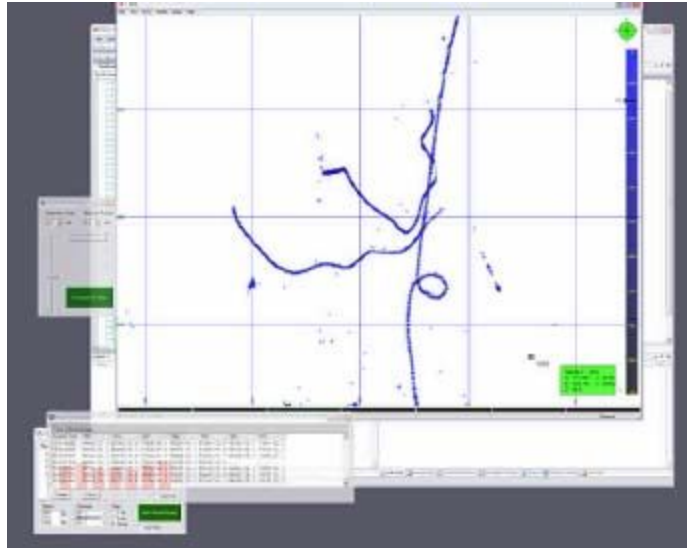
The surface station PC connects to the STM-100 junction box via a RS-485 converter that plugs into a USB port on the PC. The converter and cable are supplied as standard accessories. A powerful Windows XP notebook PC is sufficient to service a maximum length chain, because the computing intensive raw acoustic data processing has already been performed by each listening station.

The PC runs the RangeNav™ software, which computes and displays target tracks, resolves array self and GPS surveys and monitors the array health status.

Due to the small size and minimal power demands of the surface station, it is quite practical to operate a RangeNav™ system from a trailer or control van using line power or a generator.

### **TLP-100, TLP-101, TLP-102 and TLP-103 Depth Encoded Pingers**





The RangeNav™ system is designed to track pinger equipped targets. These may be standard U.S. Navy DPSK pingers, or Desert Star's depth encoded pingers. Four pinger types are currently available:

1. The **TLP-100** low-frequency pinger operates at 8-16 kHz with a transmit power of 192 dB. It includes a precision 500 PSIA depth sensor, with an accuracy of 0.5 PSI. The TLP- 100 yields the greatest range and therefore supports maximum station spacing. It is also the largest design. The TLP-100 is intended primarily for tracking submarines and large UUV.
2. The **TLP-101** is similar to the TLP-100, except that the frequency range is 16-24 kHz. This mid-frequency pinger is suitable for smaller vehicles as well as divers.
3. The **TLP-102** high-frequency pinger operates at 34kHz-42kHz, and is otherwise identical to the TLP-101 including a housing of the same size. The higher frequency produces somewhat less range and thus requires denser station spacing, probably not to exceed 500m. In multi-target tracking, using this pinger along with models for the two other frequency bands provides better ping frequency separation for more robust tracking.
4. The **TLP-103** micro-pinger also operates at 34kHz-42kHz, but comes in a much smaller package. It is suitable for micro UUV, divers and other small targets. Transmit power is limited to 177 dB, and as such listening station spacing should not exceed 250m. Its 500 PSIA depth sensor has an accuracy of 5 PSI.



## 2. RangeNav™ Software, Firmware and Driver Installations

### SEALEVEL P/N 2104 RS485-USB Converter

1. This converter is used for communication between the surface station PC and the STM-100 junction box. Prior to first use, open the black housing of the converter using a small flat-head screwdriver for gently prying. Set switches 1-7 to the ON position and switch 8 to the OFF position. This setting configures the converter for twowire RS-485 operation.
2. Now connect the converter to a USB port of the surface station PC. The PC will detect the new device and start the hardware installation wizard. Insert the SEALEVEL CD ROM and follow the instructions of the wizard.

### RangeNav™ Surface Station Software Installation

1. Insert the RangeNav™ CD ROM
2. The CD should auto-launch. Follow the wizard instructions. If the CD does not auto launch, then use Windows Explorer to click on the Setup icon.

3. Start the RangeNav™ software.
4. Configure the software for communication with the STM -100 junction box by selecting the COM port that the SEALEVEL converter has been assigned to. Do this by selecting Setup→Data Connections from the main menu. The figure below shows proper configuration through a SEALEVEL device on COM4. The standard baud rate is 115200 baud.

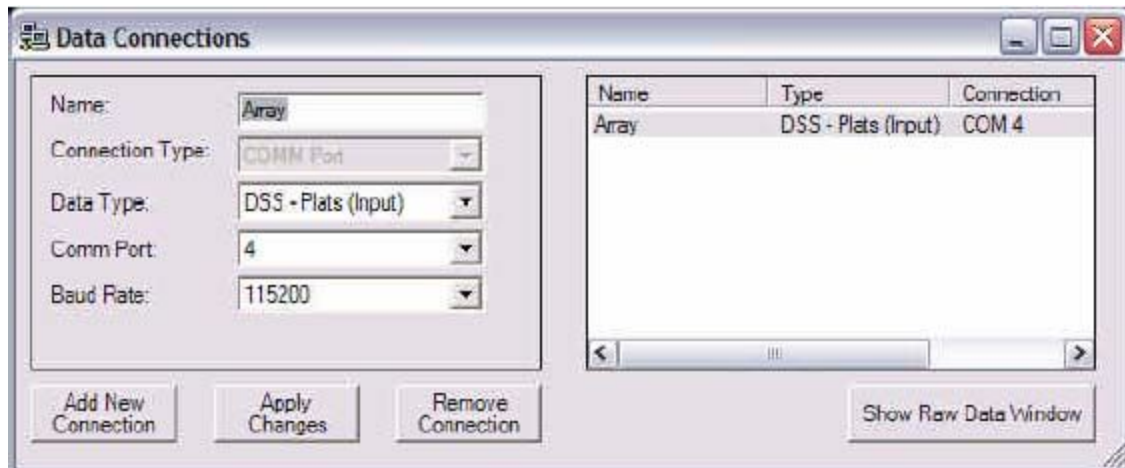


Figure 1: Configuring the connection between the PC and the STM-100 Junction Box

### Updating the RangeNav™ Array Firmware

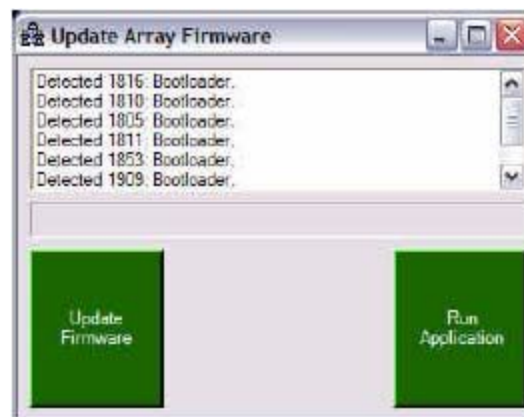


Figure 2: Firmware Update

The firmware on the RBS-100 listening stations, RBS-101 recording stations and STM-100 junction box is updated on occasion. New firmware can be downloaded to the entire array while deployed, or it can be downloaded to individual stations or a set of stations at the maintenance depot. Downloading new firmware to a deployed array is an acceptable practice to test newly developed

capabilities. However, you should always have a production approved version of the firmware at hand, to revert to in case a bug should become apparent.

To update firmware, connect the array as you would for operation (PC to STM-100 to a number of RBS-100 or RBS-101 stations). Then, power up the array. (If you use automatic power-up, make sure the Start Application on Power Up check box is not selected). Next, select Setup→Update Array Firmware. Click the Update Firmware button and select the new firmware file in the browser. The firmware has a .VC extension. The window will show progress information. Once download is completed, click the Run Application button to launch the updated firmware.

### **3. Systems Wiring and the Array Power Up / Down Procedure**

#### **System Wiring**

Wire a RangeNav™ system for operation as follows:

1. Link the surface station PC to the STM-100. A USB port on the PC connects to the PC port of the STM-100 using the supplied SEALEVEL RS -485 converter and STM-100 data cable.
2. Connect the STM-100 to 50/60 Hz AC power (110VAC or 220VAC only as indicated on the STM-100 panel) using the supplied marine power cord.
3. Connect a hydrophone / transmit transducer assembly to each RS -100 listening or RBS-101 recording station. The transducer assembly connects via a 1.5m 4-conductor cable.
4. Use an umbilical cable section (275m, 550m or 1100m spool depending on desired listening station spacing) to link the STM -100 junction box to the first RBS-100 listening station or RBS-101 recording station. The cable section links the ARRAY connector of the STM -100 to the 'upstream' connector of the listening/recording station. (The connector polarity arrangement assures correct connection).
5. Connect the 'downstream' umbilical connector of the first listening station to the 'upstream' connector of the second listening station using another umbilical cable section. Continue in this fashion to the end of the chain.
6. Terminate the downstream connector of the last listening station or cable section with a dummy plug to prevent a water short circuit of live wires.
7. Optionally, connect the one-second time signal output (TTL signal) of a GPS receiver to the GPS input on the STM-100. The GPS time signal can be used to synchronize the listening station array to GPS triggered pingers for improved absolute (earth coordinate) array surveys.

#### **System Power-Up Procedure**

The RangeNav™ system uses power relaying. 440VAC or 880VAC power is injected by the STM-100 junction box into the 'upstream' end of the array. The power reaches the first listening station, which relays the power on command to the second listening station and so on until the entire array is energized. Power relaying allows operation of an only partially energized array, such as to operate an array upstream of a cable cut (short circuit avoidance), to allow service at a point of failure, or when only a partial array is needed for a tracking task.

The RangeNav™ system also monitors the current flowing through each of the two power conductors, and the voltage seen across the conductors in real-time. The electrical current data is useful as an early warning sign of impending failure such as due to a bad connector, cable cut or deteriorating transformer. It is also used by the RangeNav™ safety system to automatically cut power if a ground fault (current imbalance) or a current spike has been detected. The safety system minimizes the risk of both electrocution and equipment damage.

The power up sequence for the array can be executed automatically, or listening stations can be powered up or down individually using the manual power procedure.

### Automatic Power-Up

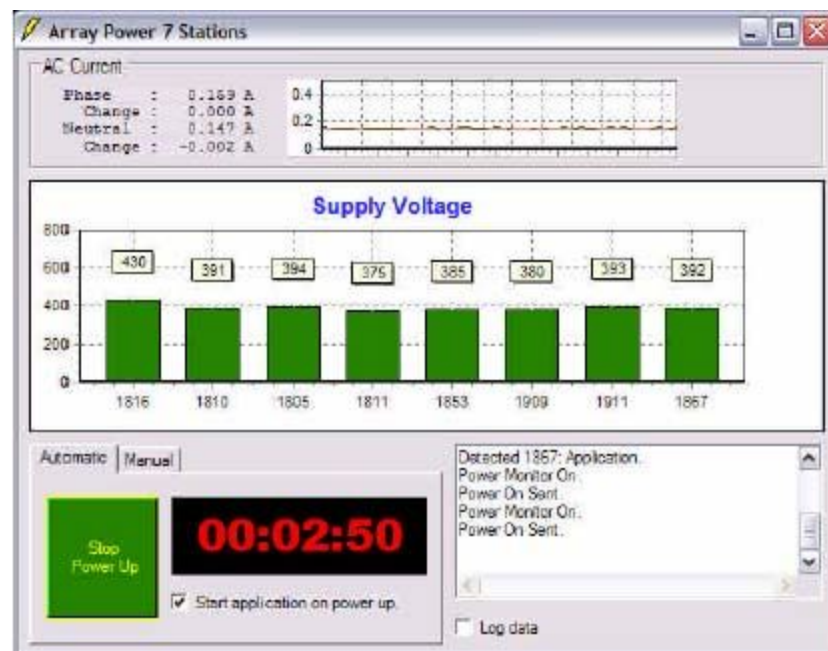


Figure 3: Array Power Window, Automatic Tab

Use this procedure to execute a standard power-up of the entire array.

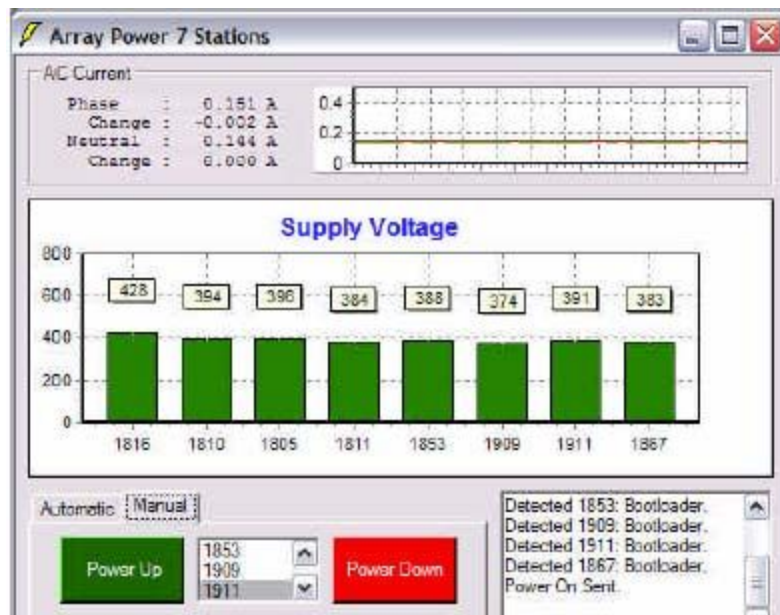
1. Select **Array→Power**
2. Select the **Automatic** tab.

3. Leave the **Start application on power up** tab checked if you wish to initiate tracking immediately following the power-up. Un-check the box if you are powering up the array in order to update firmware or perform other maintenance functions.
4. Hit the Start Power Up button.

Automatic power-up now starts, one station at a time. As each station is powered up and communicates, its serial number appears and a bar indicates the AC voltage seen by that station. You will also see the AC current rise with each energized station. Familiarize yourself with the typical 'look' of the voltage curve and the incremental current increase. This will help you spot problems down the road. Each station power-up and initialization typically takes 10-20 seconds. If the surface station does not see communication from another listening station within 30 seconds of energizing the next cable section, it assumes the entire array is powered up. The array power-up completion pop-up window then appears. You are now ready for tracking operations.

### Manual Power-Up

Use this procedure to manually power-up (or down) one station at a time. Manual power-up provides more operator control and is available for various diagnostic and maintenance purposes.



1. Select **Array→Power**
2. Select the **Manual** tab
3. To power up the next station, hit the **Power-Up** button.
4. To send a power up or down command to a specific station (i.e. power up/down the next station downstream from that station), select its serial number in the list and hit the **Power Up** or the **Power Down** button.
5. To verify umbilical communication with all stations and re-establish their serial numbers, hit the **Enumerate** button. This is useful to determine if a station's main processor may



have failed and has been bypassed by the station's supervisory processor. In that case, its serial number will no longer appear but stations further downstream may still be available.

6. To start or stop power monitoring, hit the Start **Power Monitor** / **Stop Power Monitor** button. In general, it is recommend to keep power monitoring active at all times. An exception might be to conserve umbilical communication bandwidth for tracking functions in a large array.
7. To start the tracking application following manual power-up, click the **Start Application** button. Once started, you cannot exit an application. Instead, it will be necessary to power-down and the power-up the array if you wish to perform functions such as firmware update.
8. Click the **Log data** check-mark if you wish to record all power data. Use this capability to create a power log for diagnostic or Desert Star technical support purposes.

### **Array Power-Off**

To quickly power-down the entire array, flip the STM-100 power switch to the **OFF** position. You can also go to the manual power screen, select the first station (this is actually the STM-100) and send it a **Power Down** command. Use a similar procedure if you wish to power-down a portion of the array.

### **Detecting and Dealing with Power Faults and Array Size Limitations**

RangeNav™ operators should make it a habit to monitor the power characteristics of the array. This will allow you to notice early warning signs of faults such as leakage currents due to a bad cable or connector, or a bad listening station before such a problem causes an automatic array shut-down. Further, the 'voltage curve' formed by the sequence of listening stations indicates when you are approaching the maximum available length of the array due to excessive voltage loss. The following list provides some advice on these matters.

- The low-voltage limit for arrays configured for 440VAC operation is 240VAC. Array voltage will drop in each cable section due to cable losses. When the last station sees 240VAC, you have reached the limits of operation and the array cannot be extended any further. The low-voltage limit for arrays configured for 880VAC operation is 480VAC.
- Each additional listening station will increase current in the array by about 15mA – 30mA. If you see an incremental current above 30mA, the downstream end listening station may be defective. If the incremental current is below 15mA, then the station is probably not seeing power such as because you are at the end of the array (no further stations) or because there is a broken power conductor.
- A cable by itself without a further station will in fact consume power. That is due to the capacitive and inductive characteristics of the cable in conjunction with its ohmic resistance. If you daisy-chain two or more cables without a station, you will see a higher incremental current for that extended cable section.
- The incremental current curve may not be completely even, because energy is stored in the cable system's capacitive and inductive characteristics and some currents may circulate locally.

- There are signs that a given listening station may in fact see a slightly higher voltage than its upstream neighbor. This may be due to localized energy storage in the cable.

## 4. Defining The Array Operating Frequencies and Signal Monitoring

RangeNav™ is a programmable broadband system, with frequency coverage from 600Hz to 80 kHz. Prior to operation, you must define the operating frequency channels, both for the array and the pingers. The single-target version of RangeNav uses three channels:

- Channel 1 is the self-survey frequency. This should always be 16 kHz.
- Channel 2 is the synchronization frequency of the depth coded pinger. It is pinger model specific.
- Channel 3 is the depth telemetry ping of the depth coded pinger. The frequency is pinger model specific.

Operating frequencies and filter characteristics are defined by FIR filter files, which have a .fir extension. Table 1 lists currently available filter files.

Filter Name	Center Frequency	Bandwidth (@ -3dB)	# of coefficients	Use for
16000Hz.fir	16 kHz	800Hz	398	Ch. 1 self survey
8492Hz.fir	8.4925 kHz	800Hz	398	Ch. 2 for TLP -100
10498Hz.fir	10.498 kHz	800Hz	398	Ch. 3 for TLP -100
16528Hz.fir	16.5289 kHz	800Hz	398	Ch. 2 for TLP -101
18518Hz.fir	18.5185 kHz	800Hz	398	Ch. 3 for TLP -101
34482Hz.fir	34.4828 kHz	800Hz	398	Ch. 2 for TLP -102/103
36363Hz.fir	36.3636 kHz	800Hz	398	Ch. 3 for TLP -102/103

## Notes:

1. The filter bandwidth defines the frequency range passed by the filter. A larger bandwidth accepts a higher maximum target speed (allowance for Doppler effect) and yields better ping time detection accuracy. It also passes more noise and therefore reduces the maximum detection range.
2. In order to achieve desired filter characteristics, a certain number of filter coefficients is needed. In general, sharper filters (less bandwidth and/or better stopband rejection) also require more coefficients. However, a filter with more coefficients will increase the time-uncertainty of ping detection, resulting in reduced tracking accuracy. The processing power requirement also relates to the number of coefficients.

Table 1: FIR Filter Files

## Programming the Channel Frequencies of the Array

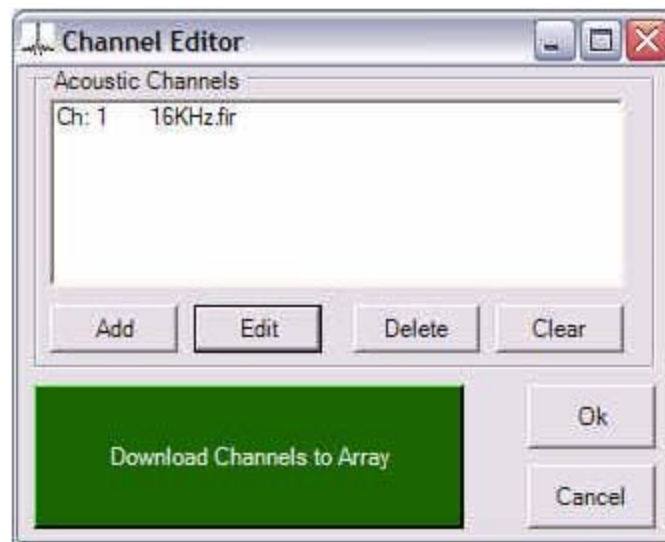


Figure 5: Defining Operating Channels

1. Select **Array**→**Channel Editor**
2. To add a new channel (you must have three channels defined for single-target tracking), hit the Add button
3. Select the .fir filter file for the first/next channel in the browser, using table 1 for guidance. The next free channel number will be automatically assigned.
4. To change a channel definition, select the channel in the list and hit the Edit button.

5. To delete a channel, select the channel in the list and hit the Delete button. The remaining channel numbers will be re-assigned.
6. Once your channel definition list is complete, hit the Download Channels to Array button to download all channels to all energized listening stations.

### **Programming the Channel Frequencies of the Pinger**

1. Connect the pinger to the COM port of the MCU-5 charging/configuration station.
2. Connect the USB port of the MCU-5 station to a USB port of your PC using a standard USB master/slave cable.
3. Start the HyperTerm utility on the PC, select the assigned COM port and select 4800 baud
4. Follow the prompts or pick up the technical reference manual to see how to configure the pinger.

## **5. Deploying and Recovering the RangeNav™ System**

All RangeNav deployment techniques require assembling the chain of cable sections and listening stations. Depending on the deployment technique, this may be done prior to boat departure or while the deployment is in progress. The assembly process is as follows:

1. Connect each listening station to its stainless steel strong-back and lead weights, making sure it is well centered. Use two stainless-steel hose clamps to secure the station. Loop the hose clamp around the station and strong back, and through the two slots of the 5 lb lead weight. Place a 1/8" thick neoprene rubber pad between the station and the strong back at each hose clamp. ***Important: The rubber pad is needed both to avoid longterm bending of the Delrin station housing and as part of the shock absorption system. Do not omit it.*** Tighten the hose clamps only moderately (approx. 12 inch-pound). The station should be snug, but still be able to slip somewhat if dropped on deck onto the end of the strong back. This is part of the shock absorption system.
2. Connect the hydrophone/transducer assembly to each station using the supplied cable. Make sure to secure the locking sleeve on both ends of the cable all the way to assure a positive connection. **IMPORTANT: Secure the cable ends to the strong back using cable ties. This is necessary to prevent repeated flexing at the connector, which has been shown to cause long-term failure of the data conductors due to stress.**
3. Connect the supplied or an alternate flotation device to the transducer assembly. The supplied float is 6" diameter, provides about 3.8 lb of flotation and has a maximum working depth of 400m. Use larger floats if there are substantial water currents in the area. Keep in mind that more weight may be needed as well.

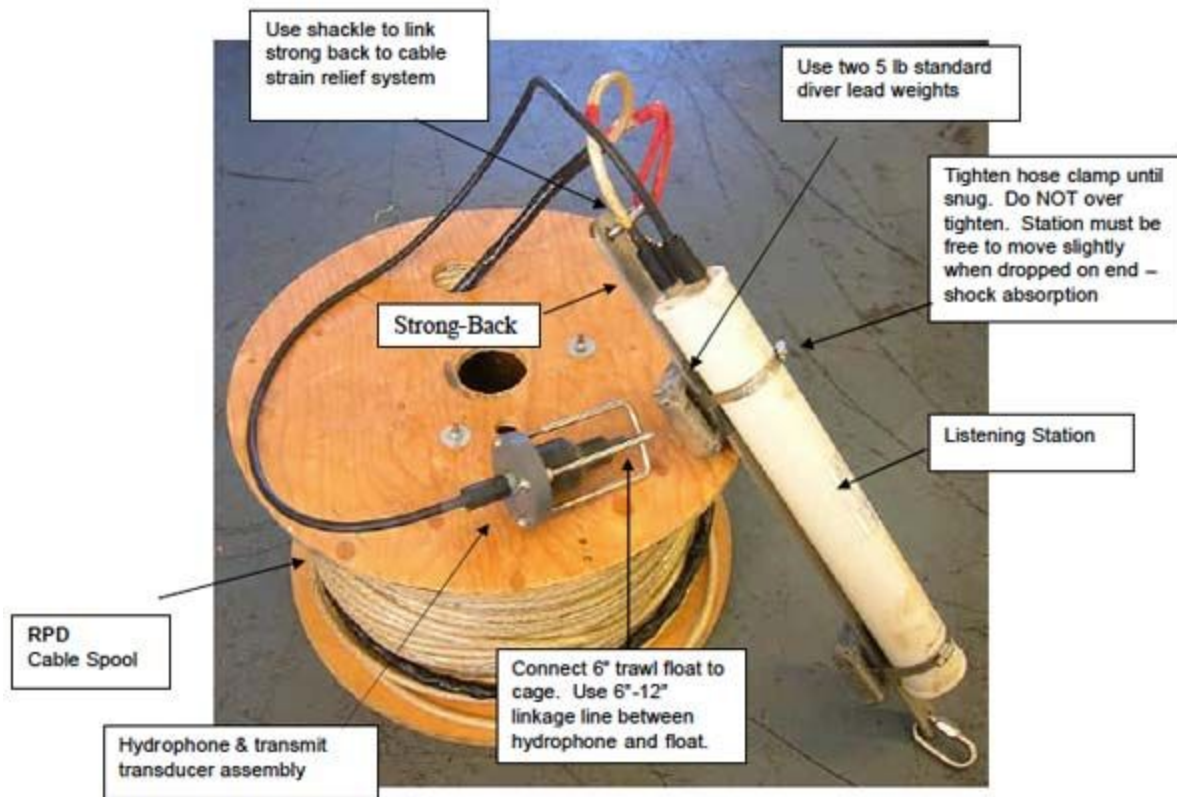


Figure 6A: Rigging the Listening Stations for Deployment



Figure 6B: Listening Station Rigged with Strong-Back & Weights

The RangeNav™ array consists principally of listening stations interconnected by cable sections. There are several deployment techniques, each with its own set of advantages and disadvantages. Recovery is generally the reverse of the deployment process.

#### Array assembly while deploying

Cable sections and listening stations may be stored unassembled on deck and/or in the hold. Each cable section is on a spool. For deployment, a cable section is mounted on an un-powered rack and cable is spooled out over the stern of the boat. As a spool is almost paid out, the boat slows and stops. The crew connects the next listening station and mounts the next spool. The process continues to the end of the array. To aid recovery, the empty spools are mounted on a winch.

This method requires least cable handling equipment and can therefore be done from very small boats. It has excellent electrical safety, because the crew is not handling energized cables. However, the approach is very labor intensive and it may be difficult to keep the boat steady at the ends of sections as listening stations must be connected and spools swapped out. There is also no array monitoring during deployment, and thus faults will not be uncovered until deployment is complete.

### **Deploying multiple pre-assembled sections from a figure-8 rack**

A number of cable sections and listening stations are interconnected on shore and the cable is figure-8 mounted across two posts. The upstream end of the array is connected to the STM-100 and the entire array is energized and tested prior to deployment. During deployment, the array remains energized for continuous monitoring. The cable is deployed over the stern of the boat, and listening stations are lowered into the water as the end of each section is reached. If the rack cannot hold all sections, then the downstream end of the last cable section is terminated with a dummy plug, equipped with a flotation device and left floating in the water. A new set of sections is assembled, loaded and tested. It is connected to the array, and the process continues.

This technique supports array testing prior to deployment and monitoring during deployment. Problems are therefore quickly noted and corrected. Cable handling equipment requirements are minimal, and support use of a small boat. There is no need for the boat to stop at the end of each cable section, allowing for a more precise deployment. However, the figure- process is labor intensive and care must be exercised because the crew is handling energized equipment.

### **Mounting multiple sections on a large, powered winch**

A number of cable sections and listening stations are pre-assembled and mounted on a large winch. The winch is equipped with holders for the listening stations. The winch is also equipped with a slip ring, so that the array can be energized and monitored. The cable and listening stations are deployed over the stern of the boat, and the winch power is used during recovery.

This process requires least labor during deployment and recovery. It supports array testing prior to deployment, and monitoring during recovery. However, it also requires a large winch and a larger boat to handle the equipment. Care must be exercised because the crew is handling energized equipment.

## **6. Conducting an Array Self-Survey**



The acoustic self-survey measures the distance of the listening stations relative to each other. This information in turn is used to compute the coordinates of the stations, expressed as meters 'north' (northing) and meters 'east' (easting) of a point of origin. You will need to pick three 'anchor stations' as a starting point for the system's listening station position computations. You do not need to know the exact location of those three stations, but they should be located in a triangle configuration as opposed to a line and must be within range of each other. This will give the best results.

Anchor station #1 will become the origin of the coordinate system (N=0;E=0). The line between anchor station #1 and anchor station #2 forms the easting axis, and therefore the location of anchor station #2 will always be a Northing of zero and an Easting equivalent to that station's distance from anchor station #1.

Follow this procedure (see screen dump below):

1. Select the **Acquire Data** tab in the array survey window.
2. Enter a reasonable **Cycle Count** such as 5 or 10 tries. A greater number of cycles (distance measurement attempts per station pair) results in better data quality due to averaging, but also takes more time: one second per cycle per station.
3. Enter a sonar **Transducer Depth Offset**. RangeNav measures all depths relative to a vacuum reference ( 0 PSIA). This allows the system to compensate for changing atmospheric pressures be it due to weather systems or because you are operating in a high altitude lake. The depth offset also allows you to compensate for the length of the listening station sonar transducer cable (normally 1.2m) In order to obtain the correct depth of the sonar transducer, enter the atmospheric pressure expressed in meters of sea water PLUS the length of the sonar transducer cable. For oceanic work not during a hurricane or extreme low pressure system, the atmospheric pressure will be around 10m, resulting in an entry of about 11.2m (10m + 1.2m).
4. Click the **Depth Survey** button to obtain the listening station depth from their sensors.
5. Clicking the button **Entire Array** starts the acoustic self survey. Survey progress, including the current cycle count is reported in the white status window in the lower right. The range numbers in the matrix fill in as each range is obtained, and the **Valid** entry for a station turns green once sufficient survey data for that station is available. You can stop the survey at any time by button press, or select a station row and then press **Single Station** if you wish to obtain self survey data for that specific station.
6. When the acoustic self survey is complete (and all or most station's **Valid** field has turned green), proceed to the **Calculate Positions** tab. Select three anchor stations (see explanation in the introduction above), and then click **Calculate Positions**. The software will now compute the relative position of all the stations, and display them as Northing and Easting coordinates. The residual error for the overall survey is displayed in the status window, and the error for the position of each station in the **Survey Data** display row of that station. The residual error is roughly equivalent to the position uncertainty of a station (or the average for all stations). A smaller number means a better result. You can change the anchor station selection and click **Calculate Positions** again to see if a better / more certain result might be obtained.

The below table explains how to explain the screen shot.

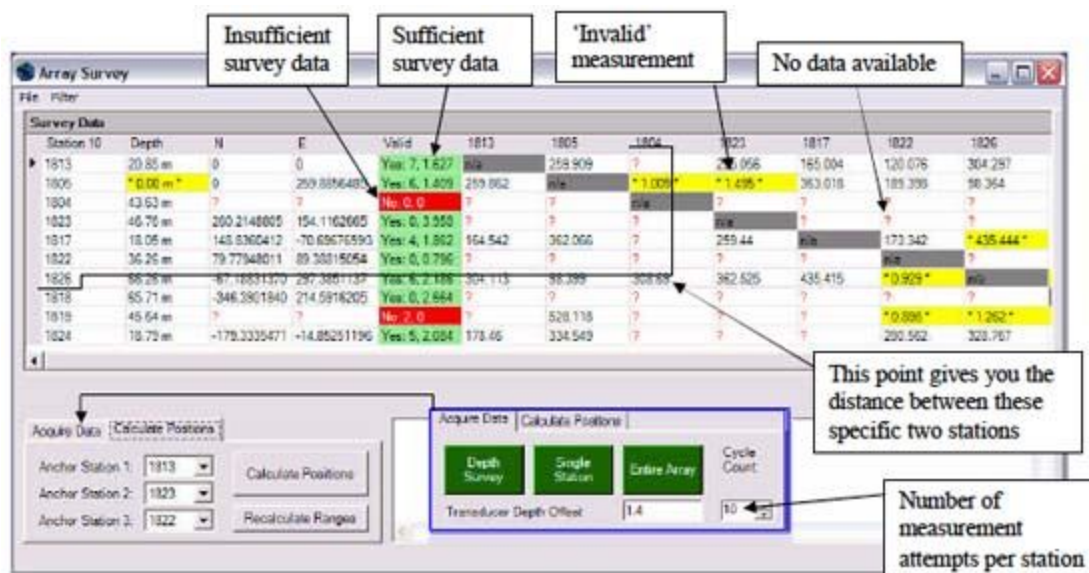


Figure 7: Array Self-Survey Screen

Survey Display Data Field	Interpretation
Station # (example Station 10)	The number of stations in the array is displayed in the upper left corner
Depth	The depth of the station, as measured by its pressure sensor
N	The Northing location of the station
E	The Easting location of the station
Valid	<p>Yes/No— Sufficient survey data to calculate the station position is available</p> <p>1st Number—Number of other listening stations that heard the ping from this stn</p>

	2nd Number—Residual position error (position uncertainty) for that station
Explanation of Colored Areas	<p>Red Question Mark—Means no data</p> <p>Yellow Block— Data available, but considered unreliable and not used</p> <p>Green Block—A valid position for this station is available</p> <p>Red Block—Sufficient data for a position computation is not available</p>
Calculate Positions tab	Use to calculate station positions following a acoustic self survey
Acquire Data tab	<p>Depth Survey—Press to obtain the depth of all listening stations</p> <p>Single Station—Acoustic self survey for that station only</p> <p>Entire Array—Acoustic self survey for the entire array</p> <p>Transducer Depth Offset—Compensation for atmospheric pressure and sonar transducer cable length</p> <p>Cycle count—Desired number of range survey cycles</p>

Figure 8: Self Survey Screen Data & Controls

## 7. Tracking Operations



Figure 9: Tracking Display

### Tracking Display Information & Control Summary

1. The **Current Target Position** is a small rectangle with the target ID code. The single-target version of RangeNav uses the ID code M1 (mobile station #1).
2. The **Position Trace** provides a history of target positions. Each position fix is one small cross. Many individual fixes in random locations, such as on the map above, indicate that the position filter settings are not stringent enough and should be changed by selecting **Mobile** → **Position Estimation Filter** → **Settings**. If the screen gets to cluttered, select **Mobile** → **Clear Track**.
3. The **Variable Grid Scale** should be set to provide convenient scaling, such as for example 10m or 100m per grid line. Select **View** → **Settings**. The view menu is also used to select the tracking display Pan, Zoom and Rotate functions. Select one of these functions, point the cursor at the screen, left click and drag. If in Zoom mode, use left click to zoom in and the '-' key to zoom out. There is also a convenient Measure function. Select it, point, left click and drag to obtain distance and direction between two points.
4. The **Target Depth Display** uses a slider to display the report of a depth encoded pinger.
5. **Numerical Target Information** is available in the green display in the lower right corner. Here you find the target information expressed as **N**orthing and **E**asting, the **D**epth, and the time since last position fix in minutes and seconds (**A**). The **E**rror value in the lower right relates to the estimated accuracy of a fix, with a larger number corresponding to a

greater error. This number currently is in arbitrary units, but our goal is to provide an error estimation in meters in the future.

6. The **Listening Station Locations** are small squares with the listening station serial number. Color indicates the status of that station. Red means the station has not reported a signal from the pinger, and green means that this station is seeing and reporting the pinger signal. As a pinger moves through the array, you can expect to see it surrounded by a 'cloud' of green stations that track its progress. A station symbol may also be blue. That means the station is powered up, but is still sitting in the boot loader and is NOT yet running the application. You will see this when doing a power-up sequence without commanding the stations to run the application (for example in preparation for a firmware update).
7. The **Listening Station Status Lights** provide the status of all listening stations at a glance. The lights are not labeled, but the sequence corresponds to the physical listening station chain. If there are too many stations for one line of lights, then the software displays multiple lines. Read row by row from upper left to lower right. The color encoded status information is the same as for the listening station location displays. The listening station lights use the same colors as the listening station location symbols (see above). Blue means the station is in the boot loader (powered up, but not running the boot loader), red means the station is not seeing a pinger signal, and green means the station is seeing and reporting pinger signal information. In addition, the status lights use shades of red and green. A bright red or green will appear each time a report from that listening station has been received. The color will then darken over a number of seconds until it is black. A healthy station will report once per second, so its color will stay bright with slight pulsing noticeable. If properly synchronized to each other, all stations will also report at approximately the same time. So, a well working system will display a consistent and synchronous 'heart beat' of all stations, with each station either being red or green depending on if it is in the transmission range of the pinger.

RangeNav has two principal modes. **Replay mode** is available to review tracking data and is discussed in the next chapter. Real -Time mode is used for tracking and array survey alike. Real-time mode is active whenever Replay mode is NOT selected, i.e. it is the default mode. When in replay mode, you can switch to real-time mode by selecting **File→Switch to Realtime Mode**. Assuming you have already powered up the listening stations, conducted an array survey and defined the channels used for ping pinger detection, you will be ready for tracking. The display will now be similar as seen above.

The following is a recommended sequence used to initiate tracking information following a successful system power-up and listening station survey. Most steps and the sequence is not mandatory, so your method may vary.

1. Conduct a noise test: **Array→Signal Envelope** Select the Bar Chart display. Choose all the stations by highlighting them, then chose Channel 2, and finally choose 5 Hz...hit Start. Watch the noise peaks on the chart, expressed in dB.
2. Now set the receiver detection thresholds of all stations to be above the noise peaks that you noticed in the first step. Do this by going to **Array→Acoustic Receiver Settings**.

Here, you must also set the post ping-receipt **Blackout Period** to be somewhat less than the expected ping interval. This blackout period helps the system to discriminate against echoes. The recommendation is 100ms less than the nominal ping interval, for example 900ms for a 1 second ping interval (if you are too close to the ping interval, such as perhaps 990ms for a 1 second interval, then the system may persistently home in on one specific echo).

3. To rule out any outside noise distractions that might register, go to: **Mobile→Position Estimation Filter→Settings**. These Range Filter options determine the treatment of pinger signal reports from individual listening stations (i.e. raw ranges):
  1. **Maximum Range:** The maximum accepted distance from a listening station. Use to eliminate impossible or undesirable large and probably unreliable measurements.
  2. **Minimum Signal Strength:** Signal reports below this strength are considered unreliable and will be rejected.
  3. **Maximum Jitter:** If two successive reports from a listening station indicate an apparent distance change more than this amount, then the report is considered unreliable and will not be used.
  4. **These Position Filter options determine the treatment of target positions computed from multiple pinger signal reports.**
  5. **Averaging Period:** Averaging is used to reduce the impact of random range measurement variations (noise) on the position computations, and thus provide a more accurate depiction of the actual position trace. This is a running average over the specified number of seconds. The appropriate averaging period for a slow target such as a diver may be ten seconds. A rapidly moving and turning target such as a torpedo will require a shorter averaging period to reduce position lag.
  6. **Maximum Error:** This is the maximum estimated position uncertainty that will be accepted. Position fixes with a greater uncertainty will be rejected.
4. Select the tracking file name by using **File → New Track Record**. The **Automatic File Name** option assigns the tracking file a name consisting of the start time and date. Use the Custom File Name option to assign a more descriptive name. In either case, the tracking data will be a .TRK file stored in the **RangeNav/Records/Track** folder. The .TRK files are text files that contain all acquired raw tracking information in a text format. They are used to replay a track (see discussion in next chapter), and are available to export the tracking data into other software such as Excel for analysis. See the RangeNav Software Technical Reference Manual for details.
5. Some of the data windows allow you to log the data as well as viewing it. All logs are in text format. The data logs are useful to diagnose system performance, such as for example reviewing electrical logs to monitor cable, connector and electronics health. The available logs are:
  1. **Array →Power Control:** Array current draw and voltage reported by each listening station.
  2. **Array →Signal Envelope:** Acoustic signal seen on a specific channel. Useful to monitor background noise or 'see' the pinger signal.



3. **Array** → **Time of Arrival**: Ping time of arrival reports from all listening stations. Can be used to recompute target positions.
6. Activate the target pinger and start tracking. Move around the display using these functions. They are also described in the box above.
  1. CTRL-Z: Zoom, zoom a rectangle (zoom in +, zoom out -)
  2. CTRL-M: Measure, circle from-to
  3. CTRL-P: Pan, hand. Center on mobile by clicking on mobile box. Center on listening station by clicking on its status field.
  4. CTRL-R: Rotate, pie chart from center

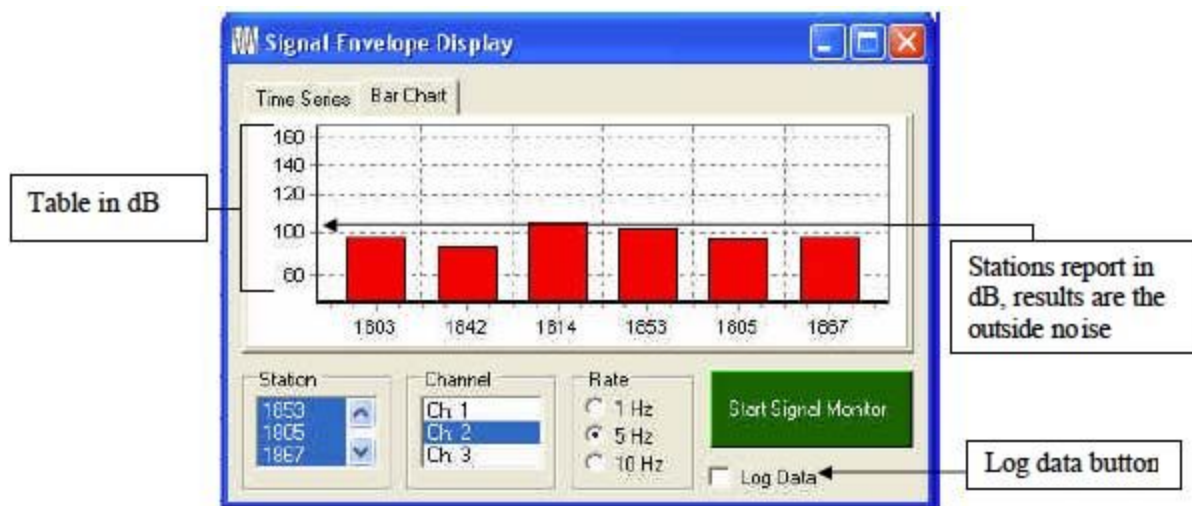


Figure 10a: Step 1—Noise Test

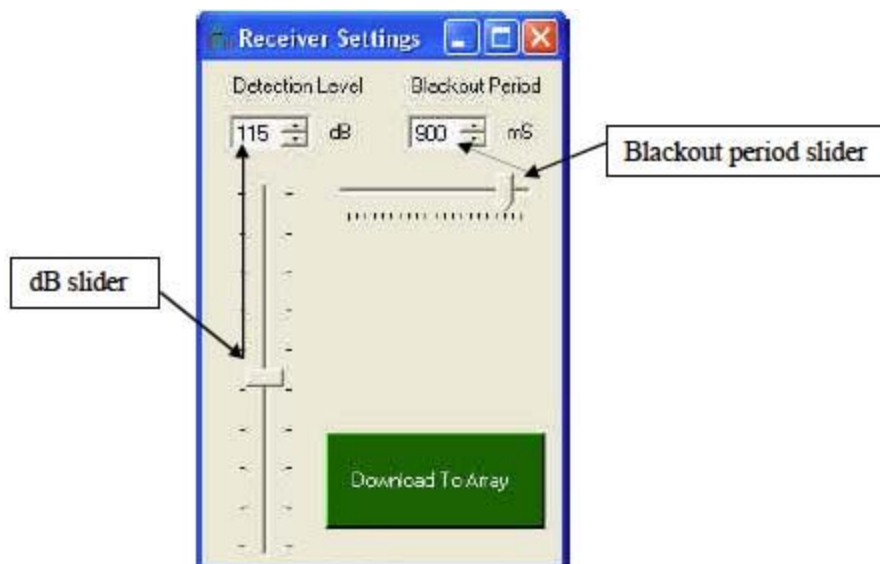


Figure 10b: Step 2—Threshold Level



Figure 10c: Step 3—Position Estimation Filter Settings

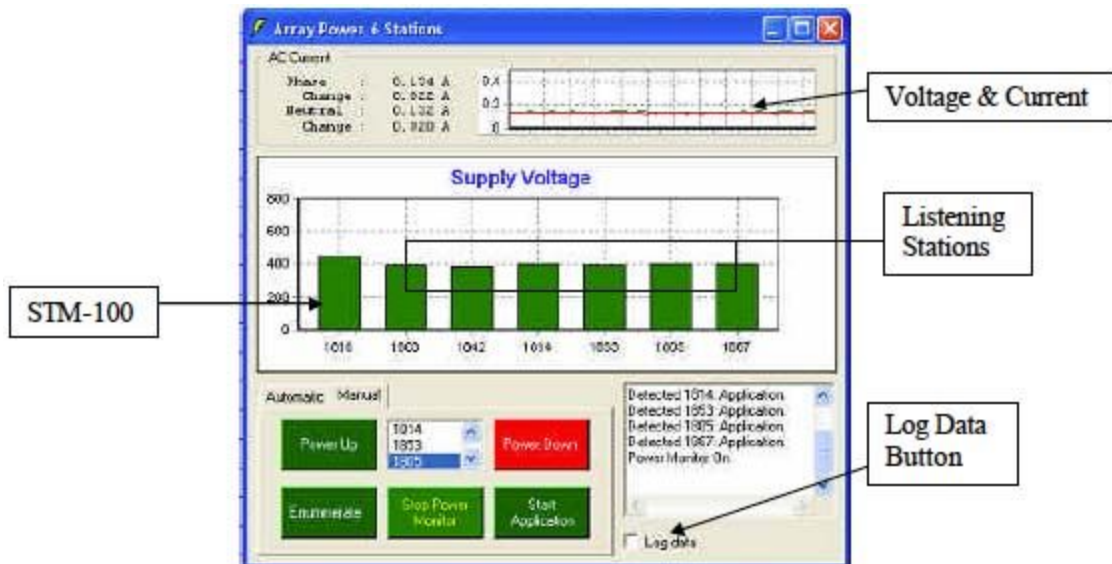


Figure 10d: Step 5—Power Control window with Log data button



Figure 10e: Step 5 —Time Of Arrival window with Log data button

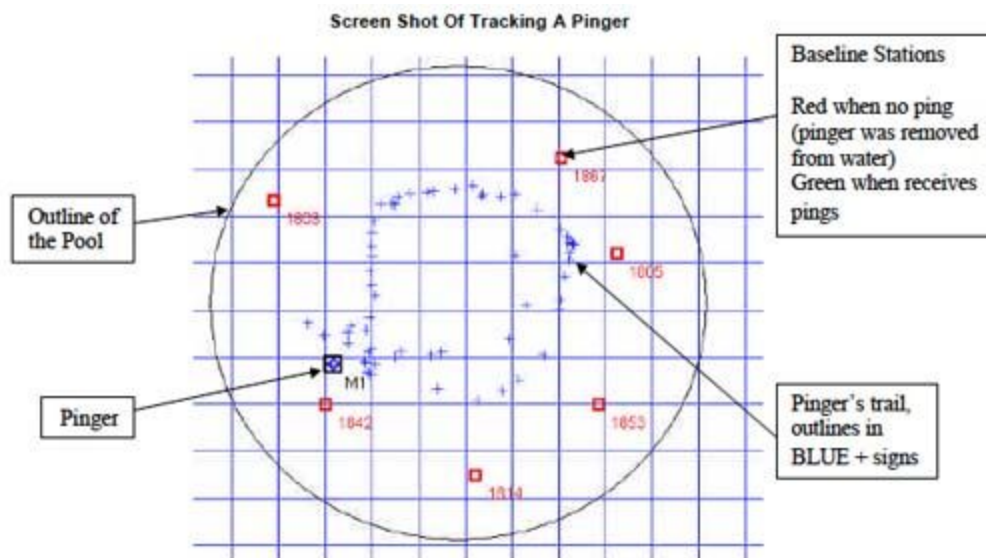


Figure 11: Tracking a pinger in a pool

In this exercise the transducers were the only component in the water (other than pinger). I used a TLP-102 and walked it around in a circle from inside the pool leaving it in the middle as I walked. Over the course of a minute I made a complete circle and turned the pinger off. If you were watching this in real-time then you would see the Baseline Stations glowing green as they received the pings.

## 8. Replaying Tracking Records and the RangeNav™ Data Files

Tracking records can be replayed in **Replay Mode**. Tracking data is also available in text files. These files can be imported into other software for further analysis of your tracking data.

To play back a track record, simply go to **File→Replay Track Record** and then find the corresponding track that you want to replay (figure 12). This will then bring up some controls (see figure 13). All tracking data is recorded in raw format, i.e. signal arrival times, signal strength etc. Prior to playing the record, you must define your filter settings in **Mobile → Position Estimation Filter**. Then, select **File→Reprocess Data**.

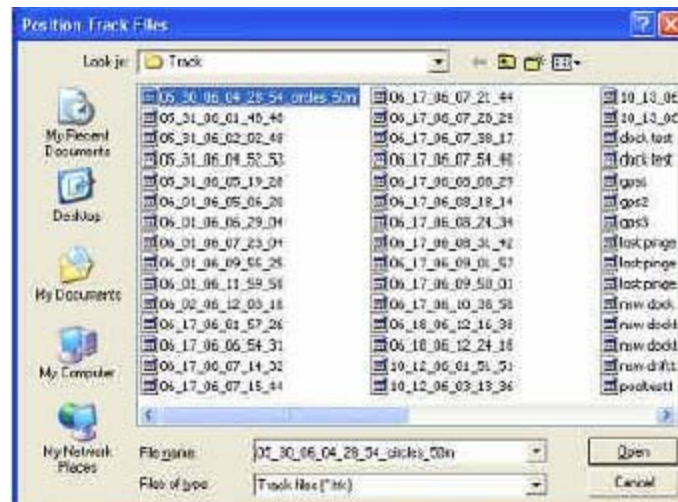


Figure 12: Selecting A Track To Replay

From here you can play the current track as well as pause it, stop it, fast forward or rewind it, and skip to any point in the track. Refer to the controls listed in figure 13.

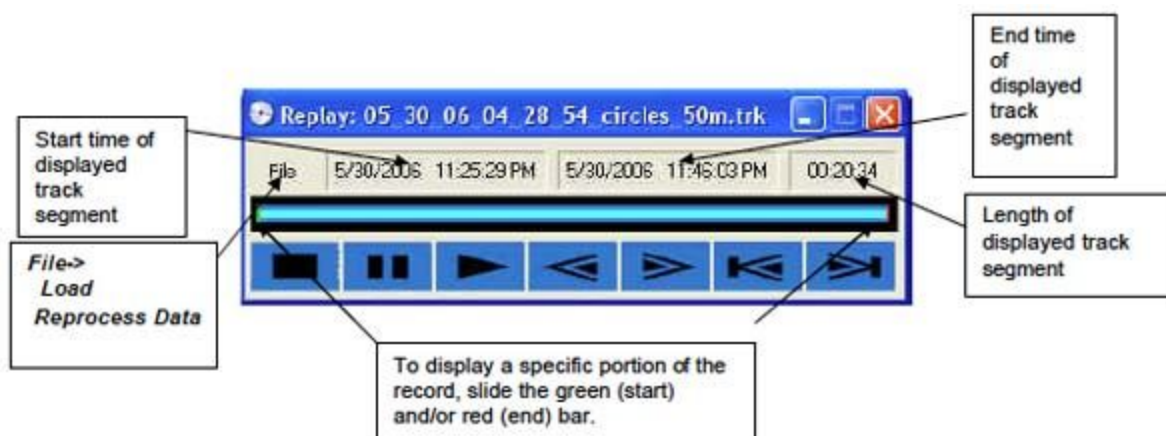




Figure 13: Controls During Track Replay

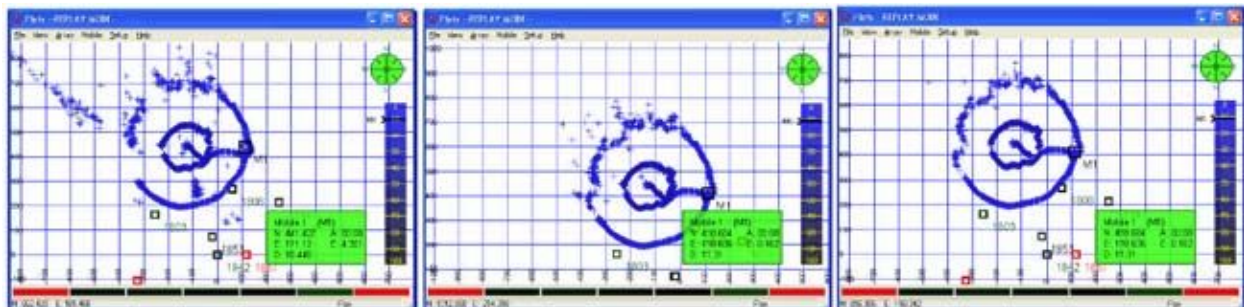


Figure 14: A recording played with no (left), limited (center) and strong (right) filter settings

RangeNav™ stores the full tracking record in a text file with a **.trk** extension. In addition, select data such as times of arrival can also be stored in log files, which are text files with a **.log** extension. These files are available for analysis of your tracking data using your own software tools. Figure 15 shows a portion of a **.trk**file as it appears in Notepad. Refer to the RangeNav™ software manual for a full description of these files.

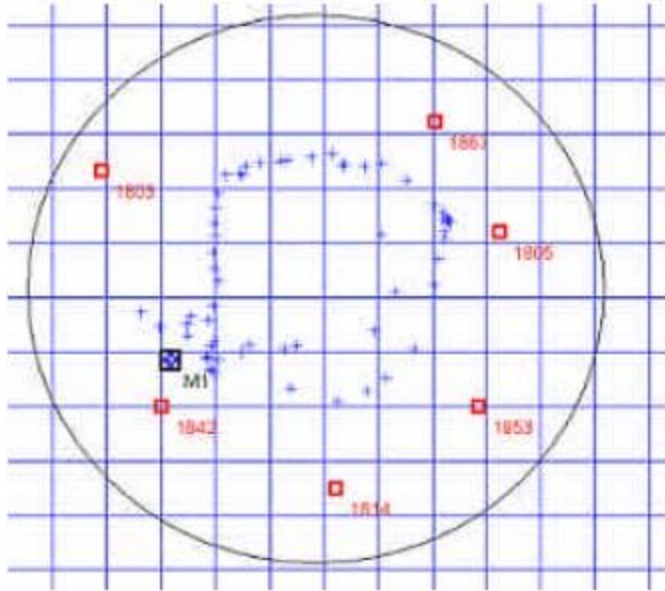




# DiveBase™

**RangeNav**

*Windows Application Software* **Reference Manual**



**1st Edition**

**November 2006**

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# 1. Introduction

The RangeNav system including the surface station software was designed to be very user friendly. The essential software functions and their use are described in the RangeNav™ operator's manual. The operator's manual in conjunction with some experimentation suffices to understand the most significant software capabilities and their use. This manual serves as a supplemental reference. It describes the function of all software functions, sorted by their menu locations. Scan over it to learn all the capabilities of the software, or use it to understand the capabilities and use of a specific software function.

## 2. The Main Menu

This section describes RangeNav™'s main menus at the top of the main window (File, Array, etc). It will give you the function of each menu drop-down list.

### 2.1. File Menu

Use this menu to call up a record file for replay, start, stop and delete records etc.

Option	Function
Replay Track Record	Replay a recorded track for study. Select the desired track record (.trk file) in the file browser
Switch to Realtime Mode	Changes back to real-time tracking mode from replay mode
Load Array Survey Data	

alternative to conducting a new array survey if you know that your listening stations have not moved (i.e. they are well anchored) since that survey. Using the same survey data for all tracking operations provides better repeatability and consistency of the track records. |

Delete Logs	Calls up a file browser that lets you delete log files that are no longer needed. Specify the files to be deleted in the browser window.
Delete Raw Records	Calls up a file browser that lets you delete raw record files (.dat files) that are no longer needed. These files contain the actual 'raw' communications received from the listening station array. Their use is primarily for bug



	documentation purposes. Specify the files to be deleted in the browser window.
?Save Raw Records	Click on this option to start or stop saving the raw tracking data. Desert Star may ask you for some raw records if you are reporting a bug.
File Record Paths	Allows you to designate what folder (other than the default) you want tracking files to be saved in
New Track Record →	Start saving a new track record (.trk file). You can select either automatic or custom name assignment. Automatic names consist of the file start time and date. Use a custom name instead to describe the operation shown by this file.
Pause Track Recording	Allows you to pause but not end track recording, such as when nothing of interest is happening.
Exit	Closes the software

Table 1: File Drop-Down Menu

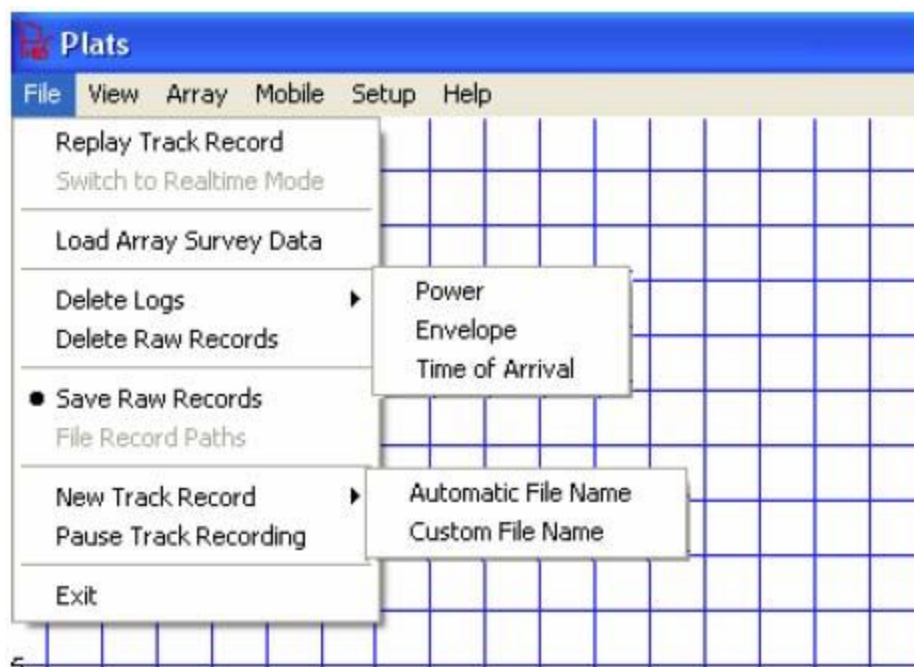


Figure 1: File Drop-Down Screen Shot

## 2.2. View Menu

View menu functions adjust the tracking display. In most cases, your menu selection will activate a cursor function such as pan or zoom. These functions are identified by the ? symbol in the table. Several functions are also available through keyboard commands, which are listed in the table. You need only to hold the “control” button and press the stated letter.

Option	Function
?Pan Ctrl+P	Select to pan the display in any desired direction. Left click and drag the display with the cursor as needed.
?Zoom Ctrl+Z	Select to zoom the display in/out. Use left click or '+' to zoom in. Use '-' to zoom out. The '-' and '+' keyboard commands can be used at all times, even when the zoom function is not selected on the menu.
?Rotate Ctrl+R	Rotates the display including the grid lines in directions needed. Left click and hold, move mouse clockwise or counterclockwise. A pie chart appears during rotate to illustrate the operation.
?Measure Ctrl+M	Measure distances between any two points. Left click on the start point, then hold and drag to the end point. A circle chart with numerical distance and direction (degrees) will appear.
Reset Rotation	Resets the display rotation to the default (zero degrees)
Settings	This allows you to view and set the exact screen settings numerically. Everything changed in here are viewing options: grid size, color, screen background and text color, and various others
Show Replay Controls	Brings up the replay controls (play, stop, rewind, etc) This is in case you accidentally or on purpose dismissed the controls in replay mode.

Table 2: View Drop-Down Menu

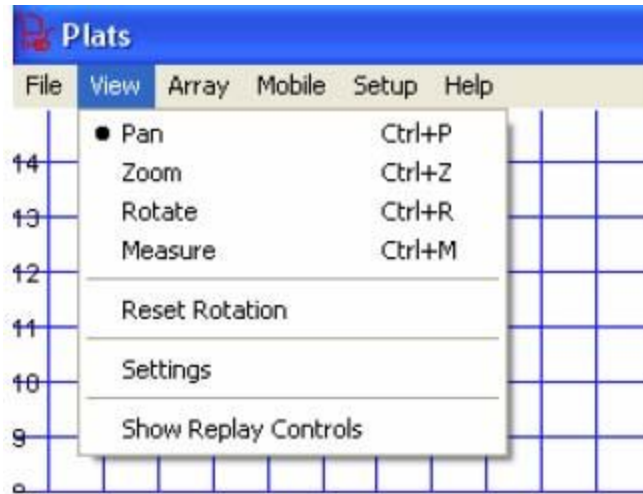


Figure 2: View Drop-Down Screen Shot

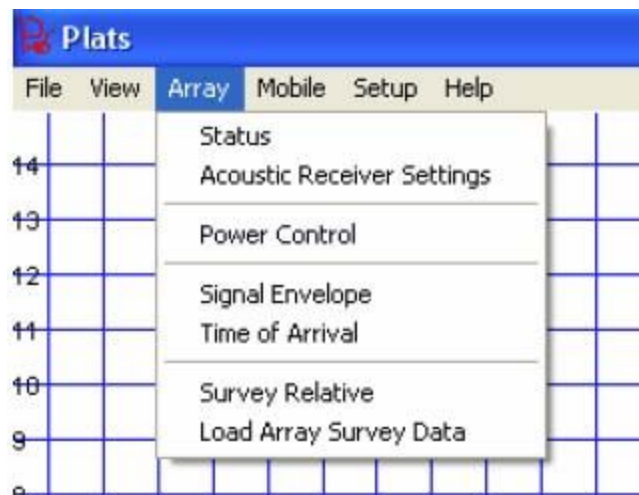
## 2.3. Array Menu

The Array menu options are related to the group of listening stations, i.e. the array. Here is where you power up the array, initiate a listening station position survey, and perform various other tasks defined in the table below.

Option	Function
Status	No function yet; for future use
Acoustic Receiver Settings	Adjust the detection threshold and post ping reception blackout period of all pingers. These options are for fine tuning the detection of pingers, and their use is explained in the Operator's Manual.
Power Control	Calls up the array electric power control and monitoring window. The power control and monitoring functions and techniques are explained in the Operator's Manual.
Signal Envelope	Calls up the acoustic signal envelope display window. This window is used for example to conduct an ambient noise test or to watch the pinger signals. Practical use is explained in the Operator's Manual.

Time of Arrival	Displays the ping time of arrival window, which provides numerical information regarding the detection of pings. This window is sometimes useful to monitor array performance. For example, a valid signal from a pinger that transmits once per second should show up at the same position (microseconds) within each 1 sec interval. If detection times are random, the station is picking up noise and the detection threshold should be raised.
Survey Relative	This calls up the listening station array survey window. A listening station position survey must be conducted before tracking operations can proceed. The Operator's Manual explains how this is done. Refer to the following subchapter for a description of the menu options available in the array survey window.
Load Array Survey Data	Loads previous array survey data. When you know the listening stations have NOT moved locations, use this option for best data consistency. This function is identical to one of the same name in the file menu.

**Table 3: Array Drop-Down Options/Functions**



**Figure 3: Array Drop-Down Screen Shot**

### 2.3.1. Survey Window Menu

The survey window is called up by selecting Array→Survey from the main menu. It's function is to initiate and execute a position survey of the listening stations in preparation for tracking. The survey process is described in the RangeNav™ Operator's manual.

The following tables describe the pull-down menus of the Array Survey window.

<u><b>File Menu</b></u>	
<b>Option</b>	<b>Function</b>
Load Survey	Load a saved survey (see next option) for use in tracking. Use this option to use 'your best' survey result for all tracking operations if you know that the location of the listening stations has not changed. Calls up a file browser.
Save Survey	Save the current survey results. Use to have the survey available for later tracking operations. Calls up a file browser.
Clear Survey	Clears the current survey result so that you can initiate a fresh survey. If you don't do this, then any data that has previously been collected will be maintained and influences the average of all measurements that constitute a survey.
Clear Array	Clears the array definition, i.e. the system will 'forget' which stations are in the array. You can do this to clear the screen of old and confusing data, perhaps left-over from a previous tracking operation.

<u><b>Filter Menu</b></u>	
<b>Option</b>	<b>Function</b>
Settings	Call's up a window to define the filter settings used in the computation of listening station locations from the inter-station distance measurement results of the survey:
	<ul style="list-style-type: none"><li>• <b>Minimum Range:</b> Inter-station distance measurements less than this amount will be ignored. Set this parameter to the minimum plausible station distance to reject false measurements that may occur due to acoustic noise in the environment. Set this value to 5m or more.</li></ul>

	<ul style="list-style-type: none"> <li>• <b>Maximum Range:</b> Same as above, but rejects measurements that are too large to be plausible or reliable enough for use. Use a setting of around 2-4 times your nominal station spacing.</li> </ul>
	<ul style="list-style-type: none"> <li>• <b>Minimum Avg Signal Strength:</b> Rejects distance measurements between stations with a signal strength less than this dB number. Weak signals also may be unreliable, and thus should not be considered in the survey. We recommend a setting of 110 dB, or different if supported by your tests.</li> </ul>
	<ul style="list-style-type: none"> <li>• <b>Maxim Stdev:</b> If the set of distance measurements between a given station pair exceeds this standard deviation, then the measurement will not be used in the position computations. High standard deviations indicate that a measurement is unreliable, perhaps because the direct acoustic path between the stations is obscured and only sporadic reflected signals are received. Use a setting of not more than 5m, less to follow more stringent quality controls.</li> </ul>
	<ul style="list-style-type: none"> <li>• <b>Minimum Number of Range Measurements:</b> If less than this number of measurements are available for a station pair, then the data will not be used. Use to ensure sufficient averaging. Minimum recommended setting is three measurements.</li> </ul>

<u>Adjustments Menu</u>	
Option	Function
Transform	Used to transform the location of the array on the northing/easting grid, such as to convert from the array relative results of an acoustic survey to UTM coordinates. This pops up a window that provides you with two tabs and a few options.
	<ul style="list-style-type: none"> <li>• <b>Translate Tab:</b> Shifts the entire array by the specified distance along the North-South and East-West axis. Hit Apply after defining your translate, Clear to revert to the original setting, or Center followed by Apply to center an array around 0;0.</li> </ul>
	<ul style="list-style-type: none"> <li>• <b>Rotate Tab:</b> Rotate the array by the specified angle. Enter the number and hit Apply, or hit Clear to return to the original setting.</li> </ul>

Guess Unknown Depth	Hit this button to allow the system to ‘guess’ the depth of stations that did not report a depth sensor measurement, such as due to a defective depth sensor. The guessed depth will be the average depth of the stations before and after the one with a missing depth. If several stations in a row have a missing depth, a similar linear interpolation applies.
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<u>View Menu</u>	
Option	Function
Toggle Range Circles	Toggles the range circles that provide a visual illustration of the software’s matching of a listening station to the intersections of the circles that describe the results of the range measurements to other stations. In theory, all range circles should intersect at the location of the station, but in practice measurement errors mean that the circles intersect in an area. A smaller intersect area indicates higher quality range measurements. To operate, select the listening station for which you want to see the circles in the array survey window, and toggle the range circles on.

## 2.4. Mobile Menu

The Mobile menu is pleasantly brief. The only options are clearing the position track in order to ‘clean’ your screen, and the choice of pinger Position Estimation Filter settings.

Option	Function
Position Estimation Filter →	Settings→change different settings to filter out pings that show up in random/far-out locations. Position filtering is important to obtain a clean track. Refer to the Operator’s Manual for details.
Clear Track	Clears the track that the pinger has made so far

**Table 4: Mobile Drop-Down Menu**

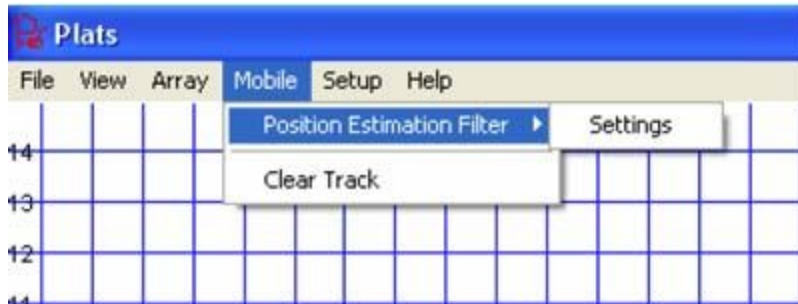


Figure 4: Mobile Drop-Down Screen Shot

## 2.5. Setup Menu

The Setup menu is used to update the listening station firmware, set Acoustic Channel Definitions for pinger detection, and do other tasks. These functions are essential to tracking operations and as such are described in the Operator's Manual. Here is a list of all options.

Option	Function
Input/Output Connections	Specify the COM port through which the STM - 100 connects to the array, a COM port to be used to export tracking data to other systems in real-time, and COM ports to import and export other sensory information or data types related to the tracking operations.
Acoustic Channel Definitions	The acoustic channels must be defined to match the pinger transmit parameters in order to track a pinger.
Sound Speed	Provides three means to estimate the sound speed: A constant speed, a constant temperature and salinity which is used to compute a depth dependent speed of sound, and input of a CTD (conductivity and temperature vs. depth) profile used to estimate sound speed at any depth.
Update Firmware	Update new firmware or re-install old firmware to the listening stations and the STM -100 junction box.

Table 5: Setup Drop-Down Menu



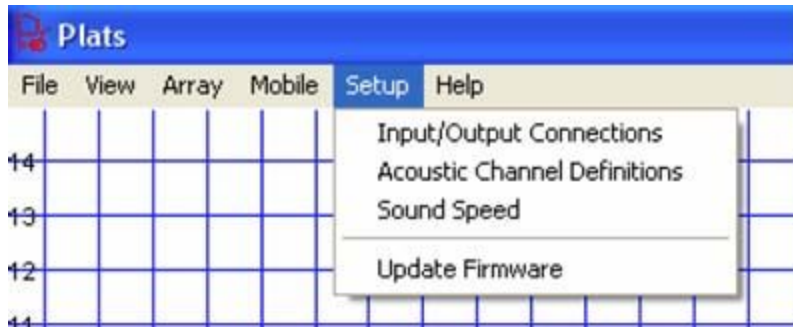


Figure 5: Setup Drop-Down Screen Shot

### 3. File Formats

RangeNav™ stores the full tracking record in a text file with a **.trk** extension. In addition, select data such as times of arrival can also be stored in log files, which are text files with a **.log** extension. These files are available for analysis of your tracking data using your own software tools. Figure 6 shows a portion of a **.trk** file as it appears in Notepad.

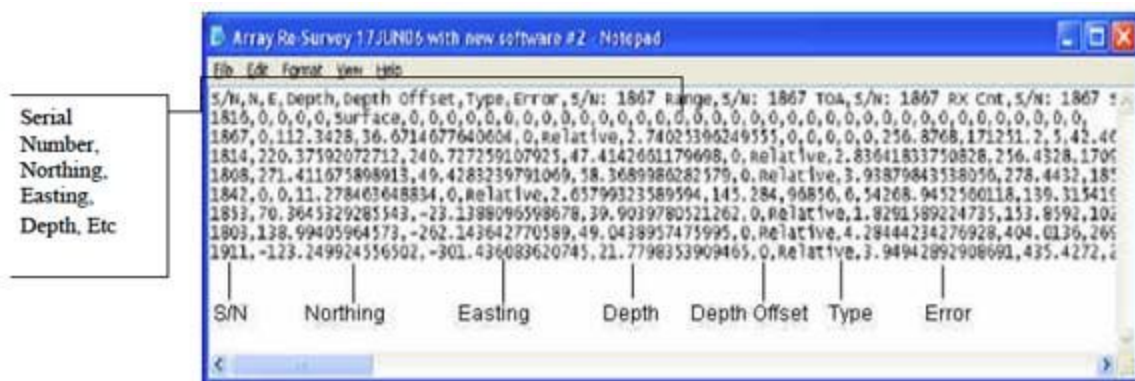


Figure 6: How To Read Array Survey Data

Use the following examples to interpret the **.log** files.

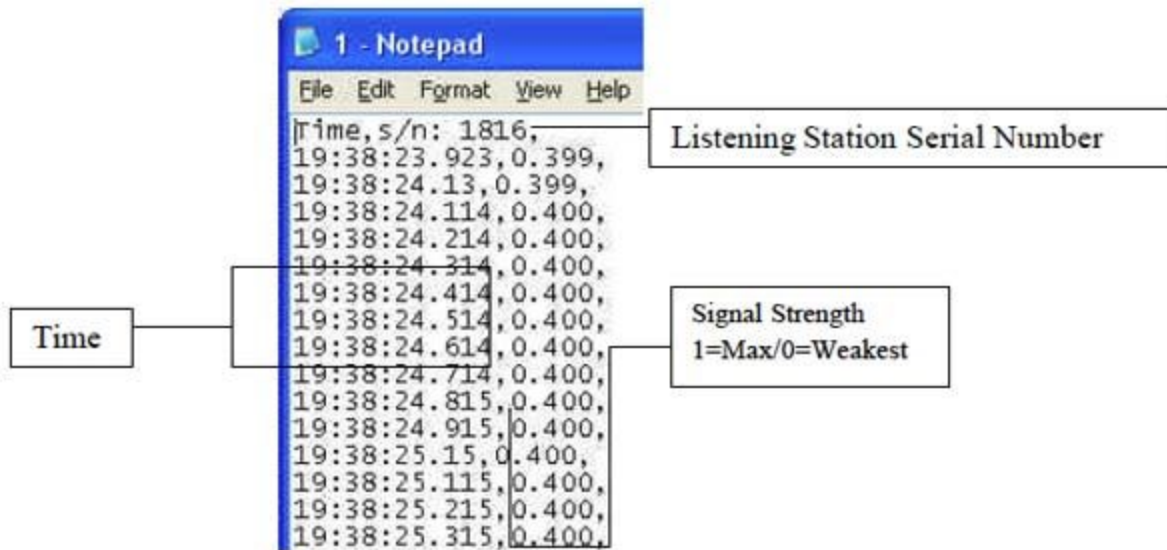
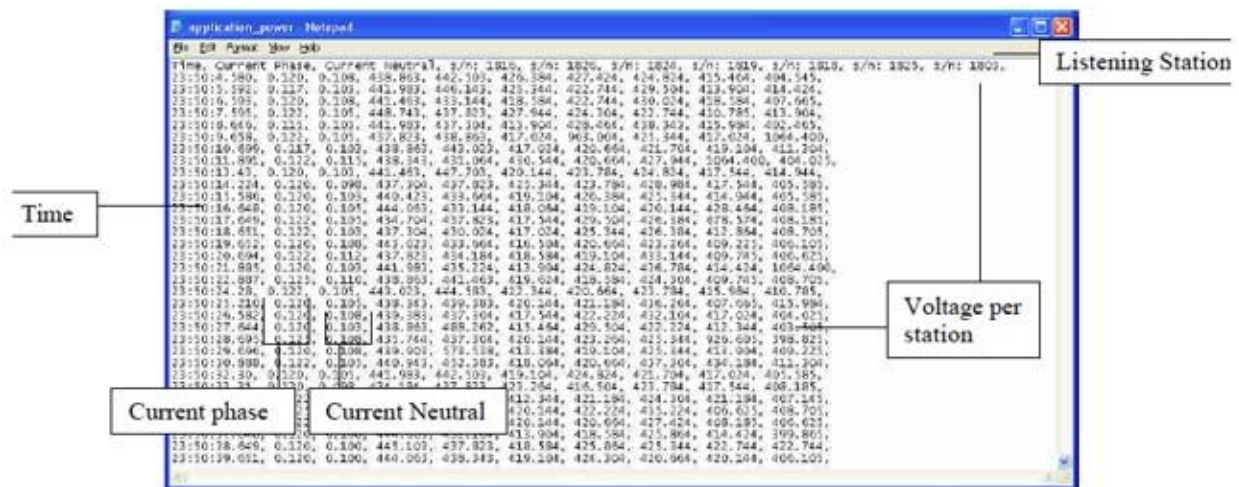


Figure 7: Signal Envelope .txt File

In the signal envelope log, you only see two different items for each listening station. You first see the time “hours:minutes:seconds” with time to a resolution of 0.001 seconds. Then you see the signal strength itself. On the relative scale, scale 0 is the weakest and 1 is the maximum signal strength. The top line or the log provides the interpretation and station serial number sequence.



supply rail voltages measured at the individual listening stations. The first line provides the interpretation and list of listening station serial numbers.

Other log files may be added in future software versions. If not listed here, refer to the first line of a log file as the key for interpretation.

## 4. DiveBase RangeNav™ Computer Requirements

- At least 1GB of free hard drive space
- At least 512 MByte of RAM
- Supported & Tested Operating Systems:
  - Windows XP Service Pack 2
  - Newer version of Windows will be tested as they become available and reach a reasonable state of maturity (target: 1 year). Please inquire with Desert Star Systems.
  - Older versions of Windows including Windows XP (no service pack), Windows 2000 etc. may work but are not tested by Desert Star Systems.

### **Caution about using old & overloaded computers**

Desert Star's experience has shown that the reliability of Windows machines declines as more application software is installed, or as they progress in age. These problems are often very hard to diagnose. We recommend that a dedicated surface station computer with a fresh Windows installation is used for RangeNav™ operations in order to maintain maximum reliability.

While Desert Star does offer tech support to get RangeNav™ running on your old jalopy, we will most definitely charge for it and it will probably cost more than just buying a new machine ;)

# STM-100

**RangeNav™ Surface Station Junction Box**

*Technical Reference Manual*



**Rev.1**

**November 2006**

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# 1. Introduction to the STM-100 Surface Station Junction Box

The STM-100 surface station junction box is designed to use with the RangeNav™ system for underwater tracking. It serves as the junction between the PC and the RPD cable which supplies the array. Its main job is generation and relay of electric power for the array, power monitoring functions and the relay of data between the array and the PC. The STM-100 also includes a GPS timing signal input, through which the entire array can optionally be synchronized to GPS time. This GPS time synchronization is an option used for geo-referencing the location of the listening stations. The connection between the STM-100 and the PC is via a USB port. The STM-100 links to the upstream end of the acoustic array through a six-pin connector, which accepts the standard underwater mateable connector of a RPD cable section.

Not only is the STM-100 durable, it is also splash proof and very simple to master. With that said, it is not intended to be used as an umbrella. The STM-100 is factory configured for 440VAC or 880VAC operation, 50/60Hz.



Figure 1: STM-100 with controls: status light, fuse, power switch, power light

## 2. Unpacking The Surface Station

Please ensure that your STM-100 shipment contains these components.

### STM-100 Component List

- STM-100 surface station

- AC Power Cable

**Table 1: Component List**

The surface station requires that you have a PC operating on, at least, Window XP and the RangeNav software. These items are not a part of the station itself, and must be purchased separately.

Please contact Desert Star Systems immediately if you are missing any components.

## **3. Surface Station Installation And Activation**

### **Connections**

STM-100 installation is straightforward: Connect the station to AC power (110VAC or 220VAC as factory configured and indicated on the label), connect to the array via the Data/Power cable connector and connect to the PC via the USB port. For GPS timing synchronization (optional, refer to the RangeNav™ Operator's Manual) connect the GPS receiver using a cable that Desert Star will custom manufacture for your GPS receiver.

### **Activation**

After that, start the RangeNav™ software on the PC, select the correct COMM port (in the hardware manager, it's designation will be a Sealink device), flip the power switch on the STM-100 and the system ready to go. Check the status and power light to make sure everything is in working order. Failure of the red power light to glow indicates no power or a blown fuse. Check and correct. The green status LED should emit a blink pattern. If that doesn't happen, then the STM-100 electronics has not booted or is not working. In that case, switch the STM-100 power switch OFF, wait 15 seconds and then switch it ON again.

## **3.1. Installing And Configuring Surface Station Software**

### **DiveBase RangeNav™ Software**

The STM-100 surface station junction box works in conjunction with a PC running the 'DiveBase RangeNav™' software (also referred to as simply the RangeNav™ software). This software is normally installed by Desert Star Systems on the PC shipped with your RangeNav™ system. If you are using your own PC, install the software using the DiveBase RangeNav™ install disk and following standard Windows install procedures.

### **STM-100 Firmware Installation**

The STM-100 itself contains firmware that is stored on its internal FLASH memory. Desert Star will update that firmware on occasion or to provide custom capabilities for your system. New firmware is downloaded to the STM-100 along with the entire connected array through a function in the DiveBase RangeNav™ software. Refer to the RangeNav™ Operator's Manual for details.

### **STM-100 Configuration**

The STM-100 operations are fully controlled by the PC through the DiveBase RangeNav™ software. So, operation of the device is limited simply to operating the ON/OFF switch.

## **4. Connectors, Indicators And Controls**

The following tables and figures explain the STM-100 switch and connector functions.

<b>Connector</b>	<b>Function</b>
A/C	A/C power terminal for STM-100 operation. Factory configured and labeled for either 110VAC or 220VAC input voltage. 50/60 Hz.
Array Data/Power Cable Connector	Use to connect the upstream end of the listening station array to the STM-100.
USB Connector	The STM-100 connects to the PC via this port.
GPS Time Signal Connector	Optional GPS time signal input. Used for one method of geo-referenced surveying of the array.
Power Switch	Flip this switch ON to activate the STM-100. Keep it OFF for at least 15 seconds to re-start the STM-100.
Status LED (Green)	Indicates operation of the STM-100 electronics. This indicator should emit one short blink once per second. Switch the STM-100 OFF, wait 15 seconds and switch ON again if the blinking does not occur.

Power Indicator (Red)	This indicator will light when AC power is connected. Check the AC outlet, the power cable and the STM-100 fuse if this indicator does not light.
Fuse Knob	Remove to replace the fuse. Fuse rating is 5 Ampere for 110VAC operation and 2.5 Ampere for 220VAC operation.

Table 2: Connector Functions

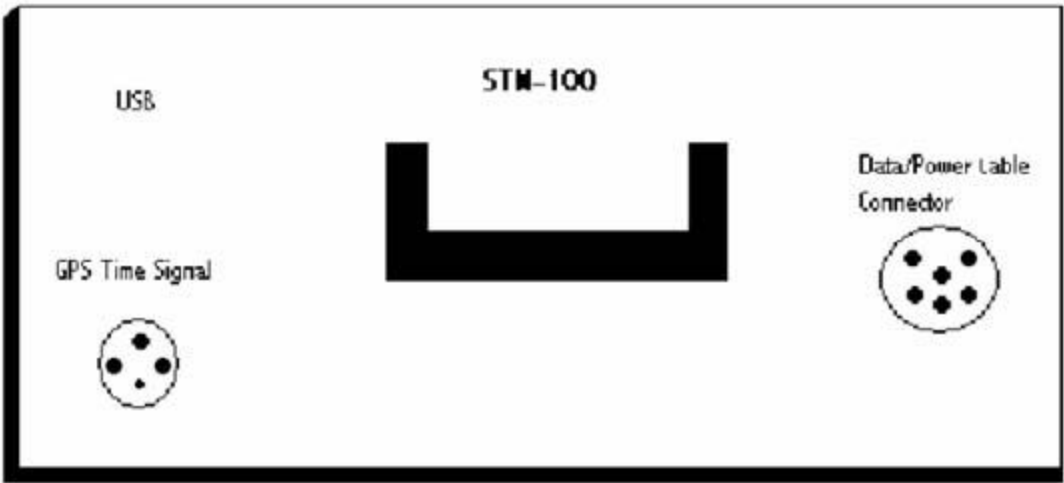
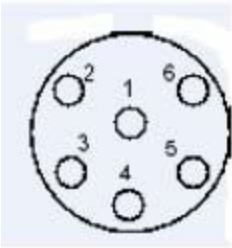


Figure 2: STM-100 Front Panel Connectors



- 1- Data pair #1 (RS485 -)
- 2- VAC neutral
- 3- Data pair #2 (RS485 -)
- 4- Data pair #2 (RS485 +)
- 5- Data pair #1 (RS485 +)
- 6- VAC phase

Figure 3: Data/Power Cable Adapter



- 1: Ground
- 2: GPS Time Signal Input (3V or 5V TTL or short to ground)
- 3: Not In Use



Figure 4: GPS Time Signal port



Figure 5: STM-100 Power Inlet (30Ampere Marine Style)

## 5. Maintaining The Surface Station

The STM-100 is virtually maintenance free. Always make sure that the connectors remain free of debris and use a dry or somewhat damp cloth to remove dust. With the STM-100 panel closed, the station is rather water resistant and should operate fine even in ongoing rain. With the panel open, water resistance is more limited and any standing water should be mopped up at once.

If the station should come in contact with significant quantities of salt water (such as it gets completely swamped by a wave), you have some chance of rescuing it by instantly removing it from the power source, rinsing it thoroughly with fresh water and shaking it dry.

## 6. Model STM-100 Specifications & Order Numbers

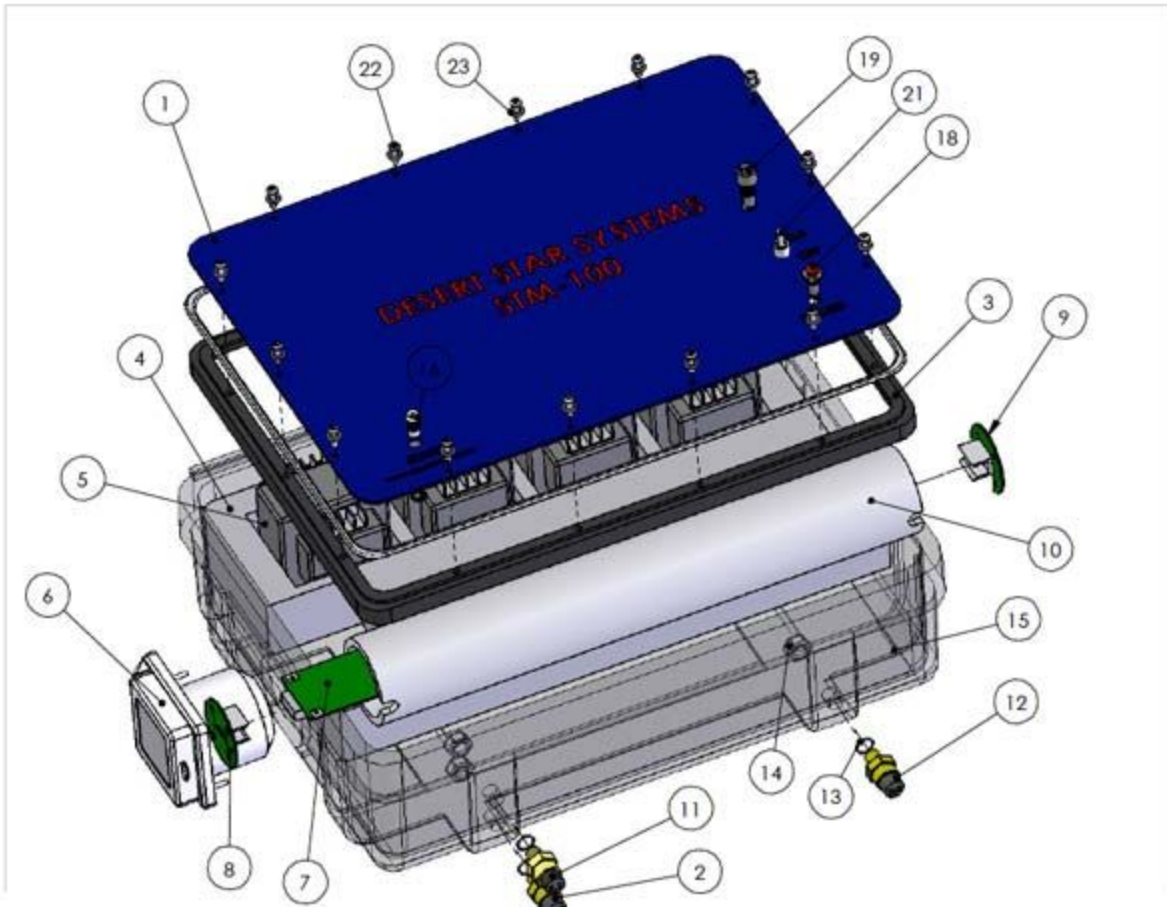
<b>Size:</b>	49cm L x 19cm W x 36cm H
	Housed in a rugged, splash-proof carrying case
<b>Weight:</b>	16kg
<b>Operating temperature:</b>	0-50 degrees Celsius

<b>Data I/O:</b>	Connected and controlled via USB port from PC
	RS-485 interface to the listening station array
	GPS Time Signal port (3V TTL, 5V TTL or short to ground – open collector)
<b>Status Indicators:</b>	Power indicator on main panel (red)
	Processor system status LED on main panel (green)
<b>External power input:</b>	Factory configured for 110VAC or 220VAC operation, 50/60 Hz
	WARNING: Do not operate at voltage other than indicated on the STM-100 label. Wrong voltage may damage equipment.
<b>Power to array:</b>	Factory configured for 440VAC or 880VAC nominal.
	WARNING: The voltage configuration of the RBS listening stations and the STM-100 must match. Mismatch may result in equipment damage.
<b>Array power monitoring:</b>	STM-100 monitors current on phase and neutral line to array
	Listening stations report AC voltage at each node
<b>Ground Fault Interruptor:</b>	STM-100 cuts power to the array when the mismatch between the phase and neutral conductor exceeds a specified limit.

**Note: all specifications are subject to change without notice**

**Order Numbers** STM-100: Surface Station Junction Box

CBL00046: U.S. Power Cord for STM-100 (110V Single-Phase power plug to 30Ampere Marine Plug)



ITEM NO.	PartNo	DESCRIPTION	QTY.
1	HOU01440	STM-100-PANNEL	1
2	CON00380	3-Pin BULKHEAD 3/4" Post, Brass	1
3	CAS00003	PANNEL RING KIT STM-10	1
4	CAS00056	STM-100 Internal Foam	1
5	XFM00320	Harsh Environmen 240/480V Input	4
6	CON00517	50A 125/250V Non-Metallic Inlet	1

7	EM100PCA	EM100 Listening Station Module	1
8	EMBU100	EMBU100 PCB Assembly	1
9	EMBD100	EMBD100 PCB Assembly	1
10	HOU01391	RBS-100 Housing	1
11	CON00302	5-PIN-CONN	1
12	CON00345	6-PIN, 3/4" POST, FEMALE, BRASS	1
13	ORI00006	O-Ring 2-014 E515	3
14	HDW00245	HDW-SS-7/16-20-LG HEX MACH NUT	3
15	CAS00002	CASE PELICAN STM-10 NO RING	1
16	LED00314	LED-STM-10	1
18	LED00326	Red Indicator Light-Neon 105-125V	1
19	FUS00261	Screw-Cap Panel-Mount Fuse Holder	1
21	SWT00320	D.P.D.T. ON-OFF-ON Toggle Switch	1
22	HDW00617	8-32 5/8" Button Head Socket Cap	14
23	ORI00056	O-Ring 2-104	14

# RPD-275/550/1100

*RangeNav Power & Data Cable Technical Reference Manual*



Rev. 1

November 2006

Desert Star Systems

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## 1. Introduction Of RPD-275/550/1100

The RPD-275/550/1100 (RangeNav Power & Data cable) is designed for use with the RangeNav™ system, where it serves to interconnect the RBS-100 listening stations. The RPD comes available in 3 different sizes: 275 meters, 550 meters, and 1100 meters. This includes 10% slack for nominal

station spacing of 250m, 500m, and 1000m. The cable sections weigh 85lbs, 170lbs, 340lbs each respectively.

The copper based cable carries both data and power. Two twisted wire pairs support two RS-485 formatted independent data channels. Controlled by the systems firmware, one pair may carry data in the downstream and one in the upstream direction, or a single pair may switch between the downstream and upstream direction to route data around a failure affecting the other pair. The system's supply voltage is carried by the final two conductors. The cable supply voltage rating is 900 VAC and 50/60 Hz power is used. The cables polyurethane jacket provides strong abrasion and cut resistance. A Kevlar braid and additional strength member yield a working load of 500lb and a breaking strength of 2000lb. The cable sections are equipped with a "chinese-finger" strain relief system that protects its connectors and the listening stations. . When pulling on each end it tightens up, and when released it releases the pressure. Through the cable's clear jacket you can visibly see the water swelling tape whose job it is to slow down water intrusion in case of damage.



Figure 1: deployment, shore section, spools of cable, and yet another caught fish hook

## 2. Unpacking

Please ensure that your shipment does contain these components.

### RPD-275/550/1100 Component List

- Section of desired cable (ie-275m, 550m, 1100m)

Table 1: Components List



If a shipment is incomplete, please immediately contact Desert Star Systems. If you are missing any components required for system operation, obtain these components before proceeding.

### 3. Connector Termination

The RPD cable sections are terminated with SEACON micro series six-pin underwater mateable connectors. The male MCIL6M connector is used on the upstream end, and the female MCIL6F version on the power carrying downstream end. The pin assignment is as follows.

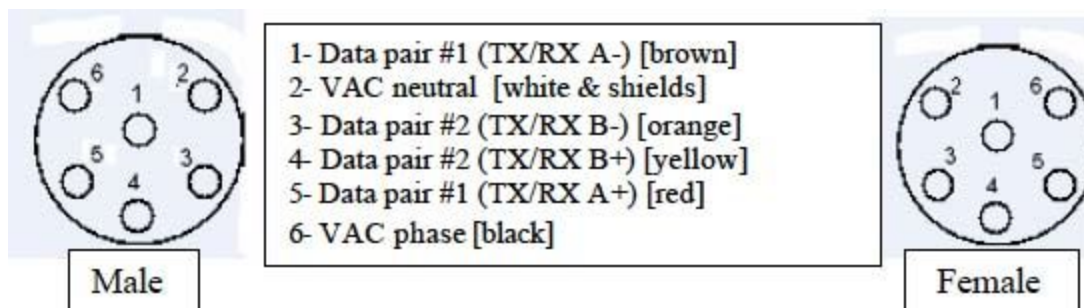


Figure 2: Data/Power Cable Connectors and Adapters

### 3. Preparations For Operation

Follow these steps to get the cable ready for operation.

- Depending on your method of deployment, gather the cable and ready it (mount it on spool, etc.). Keep in mind that one section is needed for each listening station.
- Connect the first listening station. Apply a thin film of silicone grease before mating the connector, mate all the way and ensure the locking sleeve is threaded to a full stop.
- Securely fasten the cable to the strong back using cable ties. This is essential to prevent failure of the connector termination due to repeated flexing at the connector.
- Link the loop of the strain relief system to the strong back using a stainless steel shackle.
- Link the listening station to the next cable section using the same method.
- Attach the hydrophone and float to the listening station.
- Lead the boat in the desired direction, letting the cable feed into the water over the stern.
- Follow this process until all the listening stations are in the water.
- The upstream end of the first listening station must be connected to the STM-100 junction box.

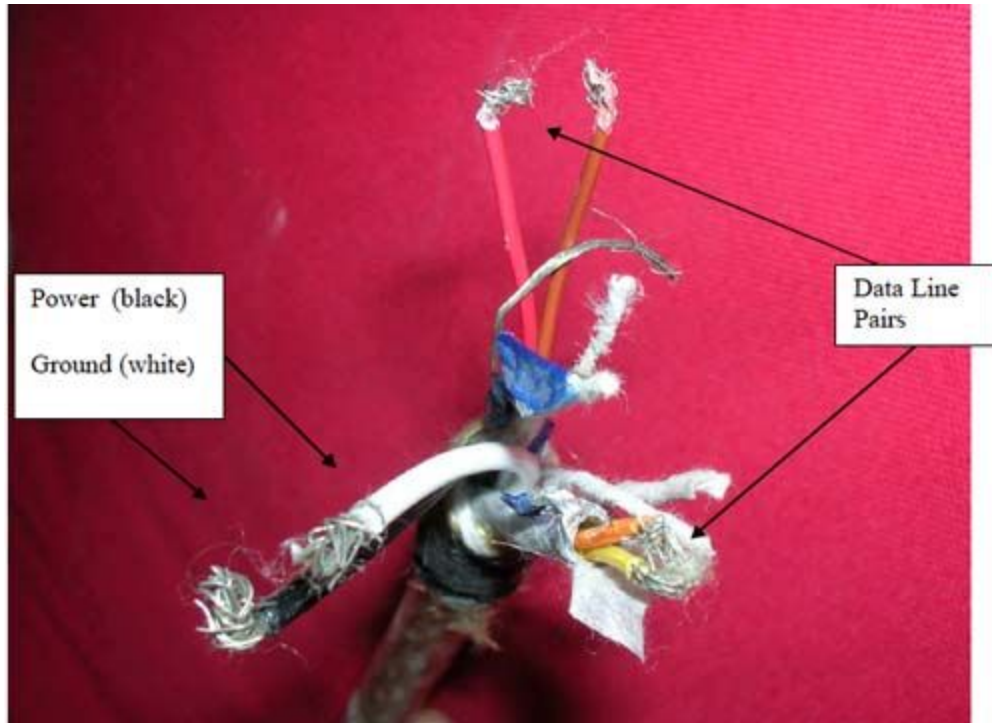


Figure 3: The inside wiring of the CABLE

#### 4. RPD-275/550/1100 Specifications & Order Numbers

<b>Size:</b>	250m length
	550m length
	1100m length
<b>Weight in air:</b>	85lbs
	170lbs
	340lbs
<b>Weight in water:</b>	All cable sections are negative buoyant

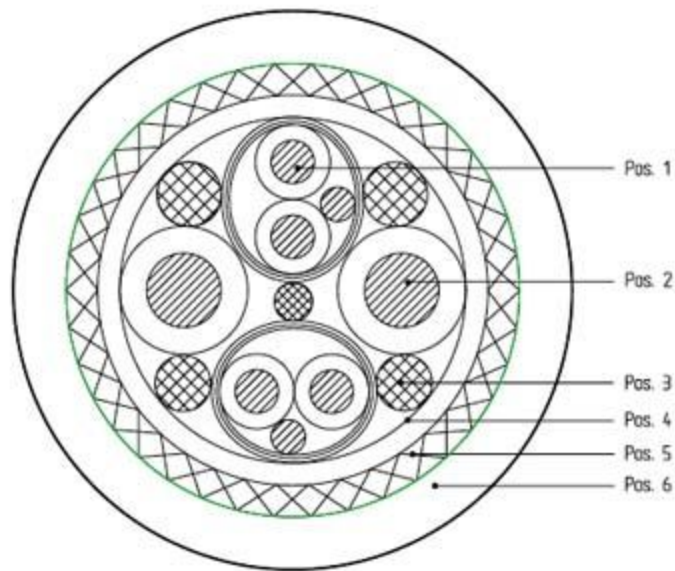


<b>Depth Rating:</b>	Full ocean depth
<b>Connectors:</b>	SEACON MCIL6M (upstream end) and MCIL6F (downstream end), underwater mateable, secured by locking sleeves.
<b>Working load:</b>	500lbs max.
<b>Breaking strength:</b>	2000lbs typical
<b>Min. bend radius:</b>	15 cm (6")
<b>Strain relief:</b>	"Chinese finger" system, 2500lbs rating
<b>Design:</b>	Polyurethane jacket, Kevlar braid and strength members, water swelling tape, conductors with Teflon insulation.
<b>Operating temp.:</b>	-20 - 70 degrees Celsius
<b>Data conductors:</b>	Two twisted, shielded pairs. 22AWG. For RS-485 or other signaling standards.
<b>Power conductor:</b>	Two conductors (phase and neutral), 16 AWG
<b>Max. supply voltage:</b>	1000 VAC RMS

**Note: all specifications are subject to change without notice**

Hybrid Round Cable  
 EHRK 34594 Rev. 1

7 Dec. 2004



maximum cable diameter 10.6 mm = 0.420"

### Hybrid Round Cable 7 Dec. 2004

EHRK 34594 Rev. 1

#### Pos 1

2 pairs of insulated wires

0.38 mm<sup>2</sup> / AWG 22

conductor	(19 x 0.16 mm) tin plated copper
insulation	TPE
colour	brown/red, orange/yellow
drain wire	0.25 mm <sup>2</sup> / AWG 24
conductor	(19 x 0.127mm) tin plated copper
screen	
material	aluminized polyesterfoil; foil side in optical coverage 100%
binder	polyester

Pos 2	
2 insulated wire	1.23 mm <sup>2</sup> / AWG 16
conductor	(19 x 0.29 mm) tin plated copper
insulation	TPE
colour	black, white

Pos 3	
fillers	water swelling; as required for roundness

Pos 4	
binder	water swelling

Pos 5	
braided support mesh	
material	kevlar
working strength	greater than 3200 N (500 lbf)
break strength	approx. 11000 N (2500 lbf)

Pos 6	
outer jacket	
material	polyurethane
wall thickness	1.0 mm (0.040")
colour	clear printed with black characters
	custom print -TBD

**Hybrid Round Cable 7 Dec. 2004**

**EHRK 34594 Rev. 1**

**Technical Data:**

	Pos 2	Pos 1
operating voltage:	1000 V	600 V
test voltage conductor/conductor:	5000 V/DC	3000 V/DC
test voltage conductor/shield:	3000 V/DC	2500 V/DC
operating temperature:	-50° C to +90° C	[-58°F to +194°F]
weight	107 g/m = 72 lb/1000ft	
pair nominal impedance:	55 Ohms	

**Bending radius:**

fixed installation: 2 x diameter

minimum bending radius at continuous flex: 5 x diameter

best bending radius at continuous flex: 10 x diameter

**CABLE IS USED IN LENGTHS OF:** 275 metres

**REVIEWED AND APPROVED:**

**COMPANY NAME:** Deesert Star Systems LLC

**SIGNATURE:**

**NAME:** Marco Flagg

**DATE:** 07DEC04

# RBS-100 & RBS-101

Listening Stations

Technical Reference Manual



Rev. 1

October 2006

Desert Star Systems

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## 1. Introduction To The RBS-100/101

The RBS-100/101 are broadband listening stations designed for use with the RangeNav system. They both gather ping information and send that to the surface station via the RS-485 copper based

RPD cable. The difference between the two is that the RBS-101 also has the ability to record raw acoustic data on an internal CF FLASH card (1 GB standard and 8 GB optional). Stored acoustic data can then be uploaded to the PC as bandwidth is available. Though you do have the capability to send the raw acoustic data straight to the PC, these data are treated as lower priority by the system (to maintain tracking capabilities at all times) and uninterrupted real-time transmissions may not be possible.

The RBS-100/102 listening stations are linked in a daisy-chain fashion, with up to one hundred stations per chain. The maximum supported chain length is twenty nautical miles if they are spaced in 1km intervals. In the future, the support of multiple chains by RangeNav™ will extend coverage up to a 20nm x 20nm.

The listening stations receive acoustic signals from the pingers of the targets to be tracked through the broadband hydrophone. A combined hydrophone and transmit transducer assembly is attached to the listening stations for this purpose. The attachment is by a 1.2m cable, and a flotation sphere allows the transducer to float above the listening station on the sea floor for better reception of acoustic signals. The listening stations filter and process all acoustic data using their powerful on-board digital signal processor (DSP). Processing is done per instructions from the surface station, and the stations need only report brief 'ping descriptor packages' via the cabled link to the surface. On-board signal processing greatly reduces the amount of data that needs to be transmitted to the surface station, thus allowing RangeNav™ to rely on inexpensive and rugged copper cables as compared to the expensive fiber & copper technology used by many tracking ranges. At the same time, the on-station processing greatly reduces the performance requirements of the surface station, allowing a powerful PC to perform that job. Overall, a RangeNav™ system with its distributed and DSP powered listening stations can be considered a networked supercomputer for acoustic signal processing under the sea.

The stations also include an array self-survey capability. They simply use their acoustic transmitter and transducer, which operate at 16kHz-24kHz, to measure distances among station pairs. Each station is also equipped with a pressure sensor of 500 PSIA, supporting their 300m depth rating while reading station depth with an accuracy of 0.3m. The stations run at 50/60Hz AC power and are factory configured along with the STM-100 surface station junction box to operate at 880VAC or 440VAC. The lower voltage (440VAC) is the safest solution when tracking targets in an area where human contact is a possibility. The 880VAC option provides greater range.

## 2. Unpacking

Please ensure that your shipment does contain these components.

### **RBS-100/101 Component List**

- RBS-100 or RBS-101 Remote Baseline Station
- Hydrophone assembly with cable
- Metal strong-back

- Two stainless shackles for securing the strain relief system
- Two 5lb lead weights
- Two rubber pieces (works as washer between RBS and strong-back)
- Two hose clamps
- One trawl float, providing 3.8lb flotation for the hydrophone assembly.

**Table 1: Components List**

If a shipment is incomplete, please immediately contact Desert Star Systems. If you are missing any components required for system operation, obtain these components before proceeding.



**Figure 1: Listening Station and STM-100 with Hydrophones**

### 3. Preparations For Operation

Follow these steps to get the listening station ready for operation.

- Unpack the baseline station and make sure you've got all the parts.
- Run a system test on the stations prior to deployment by wiring them up and operating on shore.
- Mount the metal strong-back, fasteners, and weights.
- Attach the Hydrophone with its cable and trawl float.
- Activate and deploy the baseline station.



Refer to the RangeNav™ Operator's Manual for detailed instructions of connecting the listening stations.

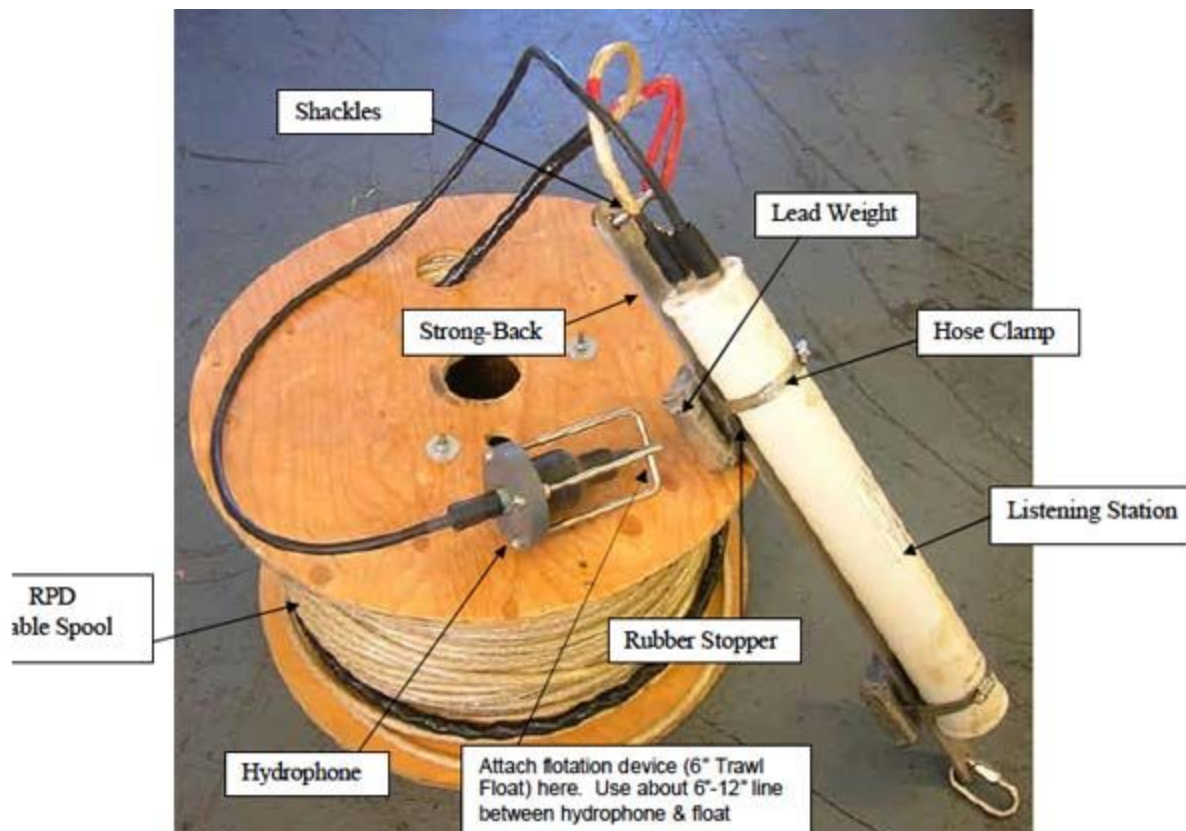


Figure 2: Listening station components

### 3.1 Configuring and Operating The Listening Stations

The listening stations are configured by the surface station to perform specific operations such as the detection and decoding of pinger signals or array survey functions. The surface station also directs the power-up sequence and guides firmware update downloads to the array. Please refer to the RangeNav™ Operator's Manual for details.

## 4. RBS-100/RBS-101 Connectors

The listening stations are equipped with three connectors:

1. The upstream data & power connector links the listening station via a section of RPD cable to the next station upstream, i.e. closer to the surface station. This connector receives power and it is therefore (for electric hazard safety purposes) male. The connector has six pins and is a SEACON model MCBH6M.

2. The downstream data & power connector links the listening station via a section of RPD cable to the next station downstream, i.e. closer to the end of the chain. This connector transmits power and it is therefore (for electric hazard safety purposes) female. The connector has six pins and is a SEACON model MCBH6F.
3. The hydrophone connector links the listening station via a 1.2m cable to its combined hydrophone and transmit transducer unit. This connector carries the supply voltage for the hydrophone pre-amplifier, the hydrophone signal and the transmit sonar transducer driver signal. The female connector has four pins and is a SEACON model MCBH4F.

The following diagrams provide the pin assignment of the connectors.

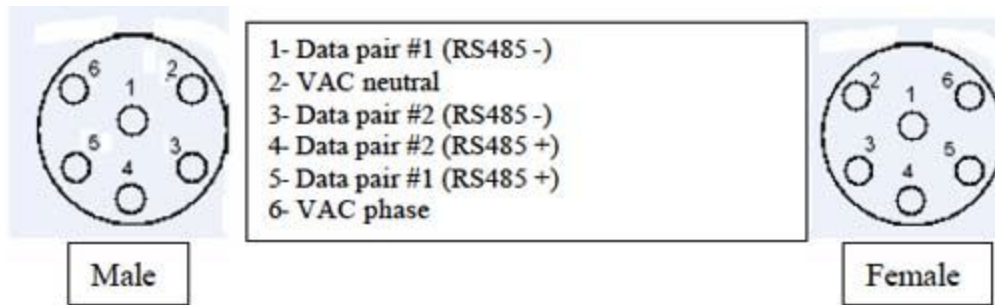


Figure 3: Data/Power Cable Connectors

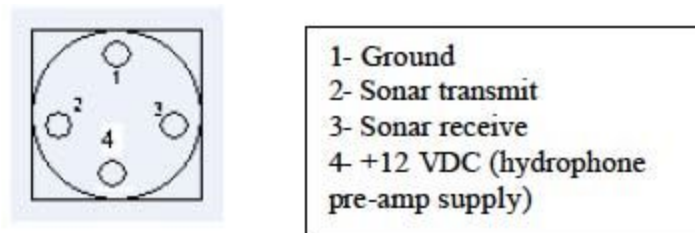


Figure 4: Hydrophone Connector

## 5. Listening Station Maintenance

Your RBS-100/101 is a rugged instrument that requires only little maintenance. However, please do observe the following points to ensure long and proper operation.

- Rinse the instrument with fresh water after each deployment. Pay special attention to the area around the connectors and transducers on the end caps. The transducers, connectors, screws, mounting ring, and other hardware are brass and stainless steel. Even though the housing is of Derlin plastic, some corrosion may still occur at the points where the metal meets the plastic if the station is not cared for properly. This corrosion

can be minimized through proper rinsing and drying. Corrosion around this area will rarely be severe enough to affect operation. It may however be a cosmetic consideration.

- Make sure that debris does not block the hole in the depth sensor on the connector end cap. If this should happen, rinse the sensor with a strong stream of water in order to dislodge the debris. Do not try to pick it out with a pin or something with a sharp end, you could damage the sensor.
- The listening station's housing is sealed with a number of O-rings. The O-ring rubber has a limited lifetime. **We recommend that you return your listening station to Desert Star Systems every three years for service.**

## 6. RBS-100/101 Specifications

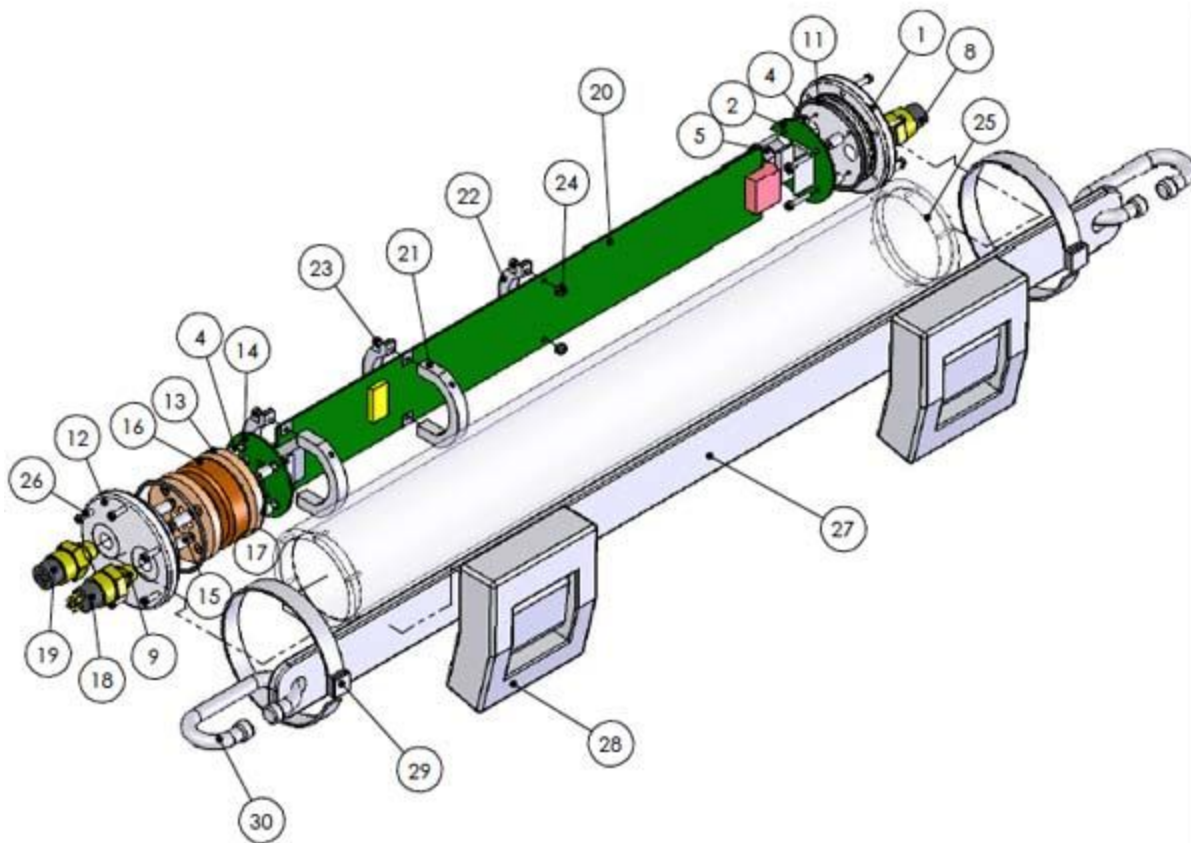
<b>Size:</b>	425 mm L x 75 mm D (20.75" L x 3" D)
<b>Weight:</b>	Weight of the RBS-100/101 2.04 kg (on land) -.27 kg (in water)
	Weight of supplied equipment (fasteners, hydrophone, cable, strong-back): 2.353 kg (on land) .379kg (in water)
<b>Depth Rating:</b>	300 meters (1000 feet)
<b>Operating temperature:</b>	0-70 degrees Celsius
<b>Power Supply:</b>	Power supplied via RPD series data/power cable
	Factory configured for 440VAC or 880VAC operation, 50/60 Hz. Approx. 6 Watt consumption
<b>Data I/O:</b>	Four independent RS-485 data channels, each operating at up to 900 kbit/sec.
	· Two data channels on the upstream end of the station
	· Two data channels on the downstream end of the station
<b>Status Indicator:</b>	Via surface station PC

<b>Depth Sensor:</b>	500 PSIA, 0.1% FSO accuracy (300m max. depth, 0.3m accuracy)
<b>Processors:</b>	Texas Instruments MSP430F149 microcontroller for supervisory functions
	Texas Instruments TMS320C6203 DSP for signal processing (2 Billion Operations per Second max.)
<b>Data Storage:</b>	RBS-101 ONLY—1GB CF Flash card (8GB option) for raw acoustic data intermediate storage
<b>Sonar transmitter:</b>	For array self-survey purposes. 192 dB acoustic power, 16-24 kHz
<b>Sonar receiver:</b>	Broadband, 100 Hz – 80 kHz
<b>Sonar transducers:</b>	Combined hydrophone & transmit transducer assembly connected via 1.2m cable
<b>Sonar range:</b>	Designed for station spacing of 250m, 500m or 1000m depending on acoustic conditions and water depth.
<b>Sonar demodulation:</b>	Software defined demodulator. Currently supported is demodulation of signals from Desert Star's Frequency-hopping, pulse position depth encoded pingers.
<b>Sonar navigation:</b>	Range measurement repeatability approx. 0.15m RMS

**Note: all specifications are subject to change without notice**



To test your listening station's durability, we executed various tests such as dropping them from high elevations. To preserve your stations, DO NOT repeat those tests yourself.



ITEM NO.	PartNo	DESCRIPTION	QTY.
1	HOU01393	RBS-100 Downstream Endcap	1
2	EMBD100	EMBD-100 PCB Assembly	1
4	HDW00224	HDW-NYLON-.375" (3/8")- Spacer	8
5	SSP1	Small Smart Pressure Transducer	1
8	CON00345	6-PIN, 3/4" POST, FEMALE, BRASS	1
9	ORI00006	O-Ring 2-014 E515	3
10	HDW00345	HDW-SS-4-40-5/8-Socket Cap	8

11	ORI00008	O-Ring 2-139 E515	2
12	HOU01392	RBS-100 Upstream Endcap	1
13	HOU01394	RBS-100 Transformer Cradle	2
14	EMBU100	EMBU-100 PCB Assembly	1
15	HDW00225	HDW-Nylon-(1/2")-SPACER #4 Thread	4
16	XFTLP100	TLP-100 XFM 8-16 kHz 5P 550S	1
17	HDW00576	4-40-1 3/4 Socket Cap SS	4
18	CON00346	6-PIN 3/4" Post, Male, Brass	1
19	CON00482	4-Pin BULKHEAD 3/4" Post, Brass	1
20	EM100PCA	EM100 Listening Station Module	1
21	HOU01395	RBS-100 PCB Support Ring Top Side	2
22	HOU01396	RBS-100 PCB Support Ring Bottom S.	3
23	HDW00295	HDW-SS-4-40-1/2-Socket Cap	6
24	HDW00298	4-40 Nylon Locknut SS	2
25	HOU01391	RBS-100 Housing	1
26	HDW00186	HDW-SS-4-40-3/4-SOCKET CAP	12
27	HOU01412	HOU-EM100 StrongBack	1

28	WHT00000	5LB Hard Dive Weight	2
29	HDW00619	Hose Clamp 2- 13/16" to 3-3/4"	2
30	HDW00620	Oval Threaded Connector 3/8 Dia	2



# TLP-100/101/102

*Depth Encoded Pingers*

*Technical Reference Manual*



**Rev. 1**

**November 2006**

**Desert Star Systems**

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**<http://www.desertstar.com>**

# 1. Introduction to the TLP-100/101/102

The TLP-100/101/102 (Target Locating Pinger) are depth encoded pingers designed primarily for use with the RangeNav™ underwater tracking range. They are suitable for tracking targets such as submarines, torpedoes, AUV/UUV and ROV. The three pingers use the same operating procedures and are in many aspects identical. Other than visible differences, the main distinction is that each operates within a different frequency range, thus offering more channels for multiple target tracking and suitable selections for both long and short distance operations. The TLP-100 operates in the lowest frequency range (8-16 kHz), which allows its signal to travel the farthest. Yet at 475mm L x 127mm D and 7.4 kg in air, it is also the largest and heaviest of the family. The TLP-101 and TLP-102 operate at 16-24kHz and 34-42kHz respectively. They use the same housing measuring 300mm L x 82.5mm D, and have a weight of approximately 1.8 kg. All pingers offer a 'high power' transmit mode of 192 dB, and can also be operated at regular power of about 182 dB. Battery life is 12 hours in high power mode at one transmission per second, and exceeds 24 hours in regular power mode. All pingers have internal, re-chargeable batteries which charge in about 12 hours. The three pingers are equipped with precision depth sensors. The depth sensors offer a resolution of 0.3 meters and read correctly up to the pinger family's operational depth of 300m. The pingers are equipped with a rugged, waterproof on and off power switch. The configuration and installation of each pinger is quite easy and can be accomplished onsite or offsite. Simply mount the pinger on the target in a vertical orientation using suitable brackets or clamps.

## TLP-100/101/102 Characteristics

- Target Locating Pinger, designed to track targets from a variety of sizes and depths.
- Straightforward installation and configuration in minutes.
- Rechargeable batteries provide the luxury of less maintenance resulting in more field time.
- Simple yet rugged design allows for maximum uses yet minimizing installation and configuration time.
- Frequency specific pingers allow for accurate measurements of up to eight targets.
- GPS time signal availability provides the opportunity to coordinate land and sea targets together.
- Equipped with a precision 500 PSIA depth sensor, which has an accuracy of 0.5 PSI, allows for better pinpoint accuracy.

Figure 1 shows the TLP-100/101/102 (in order 102-100-101). The sonar transducer is located toward the bottom of the pinger, protected by a cage. The depth sensor is located on the top portion of the pinger. Also located on top, is the power switch and a two-color status LED. The pingers were designed so that all controls are readily available.



Figure 1: TLP-100/101/102

## 2. Unpacking

Please ensure that your shipment does contain these components.

### TLP-100/101/102 Component List

- Target Locating Pinger (TLP-100/101/102)
- Multi-function adapter plug

### Accessory Kit (sold separately)

- MCU-5 (multiple charging unit with 5 adapters. This unit also has a built in USB plug (hooks directly to the PC with only a USB cable) suitable for configuration and firmware download.

If a shipment is incomplete, please contact Desert Star Systems.

In order to operate your TLP-100/101/102 effectively you will also need the other components within RangeNav as well as the RangeNav software and a PC running Windows XP or a later version.

## 3. Preparations For Operation

Follow these simple steps to get your target locating pinger ready for operation.

### **Preparations For Operation**

- Unpack the pinger and make sure you have all the components.
- Configure and test the pinger using the provided software.
- Fully charge the pinger prior to each and every deployment to insure full battery availability.
- Mount the pinger on the target by following the instructions.
- Switch the pinger on prior to releasing or launching the target.

### **CAUTION:**

These pingers support high transmit power. Other than for brief tests, make sure to place the stations in water when pinging in order to reduce stress on the sonar transducer. When operated in air, this stress can eventually crack or otherwise destroy the sonar transducer.

## **3.1 Charging The Battery**

Nickel Cadmium rechargeable batteries power the TLP-100/101/102. The batteries of the pinger are recharged using a trickle charge over 12 hours. This method, while slow, assures that the batteries are at 100% charge each and every time. We recommend charging the battery prior to each use. If the pinger sits unused for an extended period of time, the battery will eventually (after a few weeks) be exhausted due to the standby current. Charging the battery prior to each deployment will prevent this.\

When first receiving your pingers, we recommend that you condition the battery by charging the battery, operating the pinger until discharged (place in water, see CAUTION above) and then repeating that cycle 3-5 times.

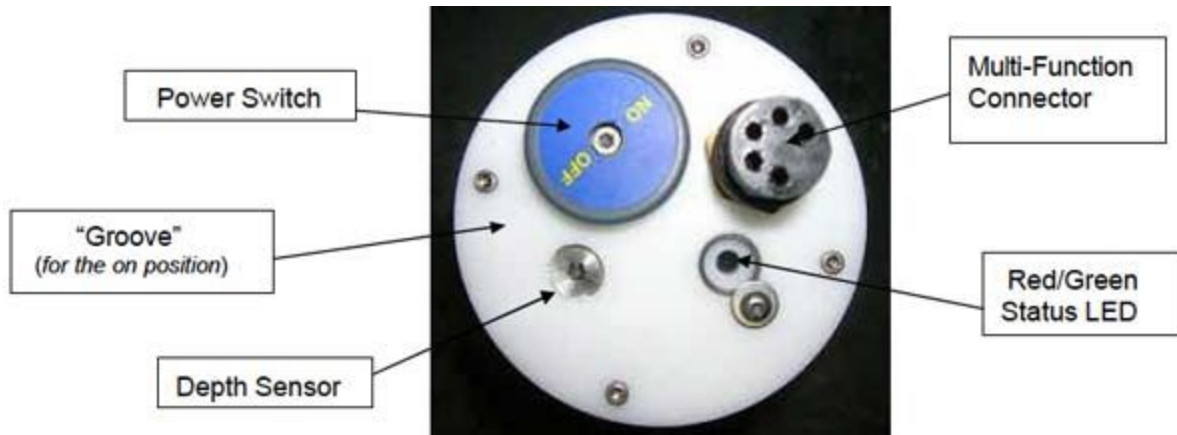


Figure 2: TLP-100/101/102 Top Profile

To charge the battery, follow these instructions.

1. Wipe the multi-function connector as well as the adapter free of debris.
2. Connect the charger cable to the multi-function connector on the pinger.
3. The green LED in the sensor emits a flash once every second signaling that it's charging.
4. When the pinger is fully charged the Green LED will emit a solid glow. The approximate charging time is 12 hours. The approximate battery life of a pinger is 12 hours in high-power mode, and more than 24 hours in regular transmit power mode.

## 3.2 Pinger Activation

A power switch is used to turn the TLP-100/101/102 on. It is a very simple method of just turning the power switch until the ON position on the switch meets the mark on the housing. At this point the Red LED will start to flash once every second, unless the battery is low in which case you will see rapid flashing. Do not leave the pinger on and pinging while out of water for an extended period of time. Doing so will eventually damage the sonar transducer.

## 3.3 Status LED Blink Patterns

The TLP-100/101/102 uses a two color (red/green) status LED. Here is a guide to the blink patterns.

Blink Pattern	Interpretation
RED rapid blinking	The battery is low. Recharge the pinger.

RED single blink once per second	The transponder is operating normally and is pinging.
RED triple blink	Hardware error. This blink patterns currently indicates a depth reading too far from zero. Causes could be a defective depth sensor, or you switched the transponder ON while submerged. Transponder functions will still work, although the depth reporting may be faulty.
GREEN single blink once per second	The pinger is charging.
GREEN continuously ON	Battery charging is completed.

**Table 1: Status LED Blink Patterns**

### 3.4 Configuring and Testing the TLP-100/101/102

The TLP-100/101/102 are configured from a PC through a serial data interface. When using the MCU-5 multi-station charger and configuration box, connect the pinger to the MCU-5 connector marked COM, and connect the USB port of the MCU-5 to the PC. Then, enter HyperTerm (a standard PC utility), select the correct COMM port on the PC and configure for 4800 baud, 8 data bits, no parity, one stop bit.

Now, switch the pinger on. You will see this print out:

```

Pinger V1.2 Current Settings:
Ping 1 Band & Channel: HF, 1
Time Between Pings: 2000
Ping Length: 1
Depth Coded Mode Set

?: This menu
#c: Configuration
#p: Print Current Configuration
#st: Self Tests
#st

EM-40 Test V2.0:
1 = LED
2 = High Power Test
3 = Ping
4 = Depth Sensor
5 = Charge
6 = Knob
? = This Menu
x = Exit
LED Test (x=exit, t=toggle, r=red, g=green)

```

Figure 3: Print-out after power up, followed by #st user entry to initiate self tests

At this point you can enter **#c** to configure the printer, **#st** to initiate some self tests or choose a few other self-explanatory options. The primary configuration parameters of interest are the pinger's operating frequencies (channels) as well as the length of the pings. For single target tracking, always use channel 1 and set the frequency band associated with the pinger model: LF for the TLP-100, MF for the TLP-101 and HF for the TLP-102. The length of each ping for optimized tracking with RangeNav should be set to 1 ms, the default value.

The configuration menu also includes diagnostic capabilities, which are engaged through the **#ST** (self test) command.

The tables list the available self tests, configuration functions and ping channel frequency assignments.

<u>Self Test Menu</u>		
1.	LED	You are able to toggle the red and the green LED on and off to check to make sure they both emit the correct glow.

2.	High Power Test	You are able to make sure that your boost regulator is in proper working condition.
3.	Ping	You are able to select the frequency channel and test the ping's frequency in relation to that channel. You can tweak the frequency up or down one kHz, too.
4.	Depth Sensor	You are able to see at which depth and temperature the pinger is reading at the moment. Because you will be at a different elevation, there is no standard depth to watch for.
5.	Charge	You are able to read the voltage that your power supply is producing to make sure that it is producing the proper voltage.
6.	Knob	You are able to test the on and off power switch by simply rotating it toward the built-in groove.
?	This Menu	Brings up the current menu.
X	exit	Exits the current menu.

**Table 2: Self-Test Menu & Screen Shot**



Current Settings:

Ping 1 Band & Channel: HF, 1  
Time Between Pings: 2000  
Ping Length: 1  
Depth Coded Mode Set

Control:

- 1) Set LF Band (8-12 kHz)
- 2) Set MF Band (16-24 kHz)
- 3) Set HF Band (32-41 kHz)
- 4) Set Channel
  
- 5) Set Interval between Transmissions (ms)
- 6) Set Ping Length (ms)
- 7) Set Ping Frequency Mode
- 8) Set Depth Coded Mode
- r) Reset to Factory Defaults
- x) Exit and Save Settings

<u>Configuration Test Menu</u>		
Symbol	Option Within Configuration Test Menu	Its Purpose
1.	Set LF Band (8-16 kHz)	1. Always goes with TLP100
2.	Set MF Band (16-24 kHz)	2. Always goes with TLP101
3.	Set HF Band (34-42 kHz)	3. Always goes with TLP102
4.	Set Channel (1-8)	For single target tracking, use channel 1

5.	Set Interval Between Transmissions (mS)	This allows you to change the time between pings.
6.	Set Ping Lengths (mS)	This allows you to change the length of the pings. Though if running specialty ping filters on the listening stations you may have to change the ping lengths to adapt; meanwhile, leave it at 1mS.
7.	Set Ping Frequency Mode	This allows you to switch from Depth Coded Mode to single ping (frequency) Mode where your application does not need to know the depth of the target.
8.	Set Depth Coded Mode	This is the default mode, which is used under normal operations; unless you do not need to know the depth of your target, use it.
R	Reset to Factory Defaults	In case of changing the settings unknowingly, you can revert back to the factory settings with this.
X	Exit and Save Settings	Exits the screen

**Table 3: Configuration Test Menu & Screen Shot**

	Low Frequency kHz	Medium Frequency kHz	High Frequency kHz
<b>Channel 1</b>	8.4925 & 10.498	16.5289 & 18.5185	34.4828 & 36.3636
<b>Channel 2</b>	9.5011 & 11.4943	17.4672 & 19.5122	35.3982 & 37.3832
<b>Channel 3</b>	12.5000 & 14.4925	20.5128 & 22.4719	38.4615 & 40.404
<b>Channel 4</b>	13.5135 & 15.5039	21.5054 & 23.5294	39.604 & 41.6667
<b>Channel 5</b>	8.0000 & 10.0000	16.000 & 18.018	33.8983 & 36.036

<b>Channel 6</b>	9.00901 & 10.9890	17.0213 & 18.9573	35.0877 & 37.037
<b>Channel 7</b>	12.012 & 13.9860	20.000 & 21.978	38.0952 & 40.000
<b>Channel 8</b>	12.987 & 14.9813	21.0526 & 22.9885	38.835 & 40.8163

Note: Each 'channel' encompasses two frequencies, for the first and second ping respectively. The pingers transmit a two ping sequence to encode the depth. The time elapsed between the first and second ping is proportional to the depth.

**Table 4: Channel Frequency kHz**

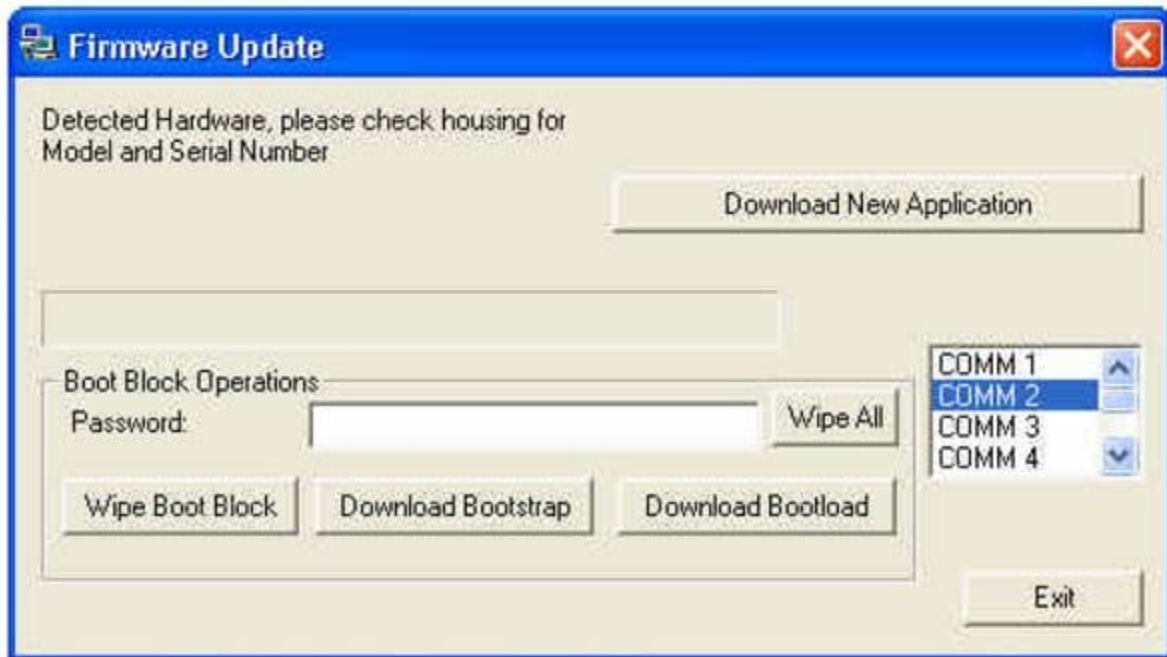
## 3.5. Firmware Update



**FirmwareUpdate.exe**

The TLP firmware determines the behavior of the device. Follow this procedure to update the firmware.

1. Link the pinger to a COM port of the PC via the MCU-5 charger and configuration box.
2. Start the **FirmwareUpdate** utility and select the COM port you are using.
3. Switch the pinger ON.
4. Hit the 'Download New Application' and select the new firmware file. Firmware files have the extension .vc and are supplied by Desert Star Systems.
5. A progress bar appears during the download process.



## 4. Pinger Mounting

For best tracking performance, the pinger should be mounted along the bottom of the target. This ensures the best transmission of pings to the sea floor mounted listening stations. However, in many case mounting options will be restricted due to hydrodynamic considerations, available space etc. In these cases, other mounting options such as along the top are valid and may result in similar performance.

In any case, the main considerations as far as RangeNav performance is concerned is to avoid 'sonar shadows' and ensure proper alignment of the pinger's sonar transducer beam pattern with the array of listening stations. It is helpful here to consider the sonar transducer to be similar to a cell phone antenna. Some placements will yield better results than others.

- The **sonar transducer beam pattern** is strongest out the sides of the pinger (radial direction), but exhibits a dip along the length axis of the pinger. In order to most efficiently transmit energy to the listening stations, mount the pinger vertically. Mount it with the transducer facing up when on top of the vehicle, or the transducer facing down when mounted on the bottom of a vehicle.
- The body of the target that the pinger is mounted on will cast a sonar shadow. This shadow may prevent ping energy from reaching listening stations that are effectively located 'behind' the target. This can impact tracking performance. Ideally, mount the pinger on the bottom of the target so that it has a 'clear line of sight' in all directions and to directly below. If not practical, mount it along the top with the sonar transducer facing up. Due to the sonar shadow, you may lose the benefit of listening stations located

almost directly below, but there will probably be a sufficient numbers of listening station 'in sight' out to the sides.

Besides acoustics, consider issues such as mechanical stability, interference with other acoustic systems (the pingers will not receive interference, but they may disturb other systems), protection against impact during handling etc. The table provides some guidance.

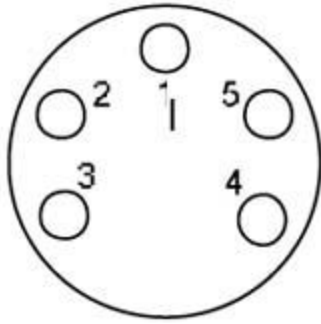
#### **Guidelines For Mounting TLP-100/101/102 Mounting On A Target**

- The sonar transducer should not be shielded by any part of the target. It is ideal to mount the pinger near the bottom of the target, vertical with the transducer facing down, to obtain an unobstructed view of the listening stations. Use a placement that comes close to this ideal.
- Keep the pinger away from moving parts for both hazard avoidance and because they can sometimes generate an acoustic shield due to cavitations and possibly other physical processes as well.
- Maximize the space between the pinger's sonar transducer and other sonar transducers on the target. Interference to other systems may result if transducers are spaced too closely. If using a scanning or imaging sonar, mount the pinger out of the beam pattern of that instrument.
- Always mount the pinger vertically, typically with the transducer facing away from the target.
- Use custom manufactured brackets, hose clamps or similar means to secure the pinger. Mount securely so that the drag of water will not move the pinger.
- Consider impact areas. The pingers are quite rugged but they still prefer to be treated gently.

## **5. The Multi-Function Connector**

The multi function connector is a SEACON model MCBH5F. This connector is used to wire the station to an umbilical (for remote power), to connect a battery charger, to configure the pinger via the PC or to supply a GPS timing signal for special applications. The connector must be terminated before the transponder is submerged to prevent corrosion. If the station is not connected to the umbilical, terminate it with the supplied dummy plug.

For GPS time synchronized pinging, apply the GPS time signal to pin 5 and the ground return to pin 1. The pinger is compatible with 3V or 5V TTL signals or an open collector (short to ground) signal. The pinger will transmit a fixed time following the rising or falling edge of the synchronization signal, depending on its configuration.



- 1: Ground (0V)
- 2: Receive Data (RS-232 RXD)
- 3: Transmit Data (RS-232 TXD)
- 4: Charger Input (+15V)
- 5: GPS time synchronization input.  
(3V TTL, 5V TTL or short to ground)

Figure 5: Multi-Function Connector Pin Assignment

## 6. TLP-100/101/102 Maintenance

Your pinger is a rugged instrument that requires very little maintenance. However, please do observe the following points to ensure long and proper operation.

### Maintenance Instructions

- Rinse pinger with fresh water after each deployment.
- Make sure that the depth sensor access hole in the end cap of the housing does not get clogged. Rinse with fresh water after use to minimize corrosion of the metal sensor housing.
- Wipe the plug area dry as well to get rid of the possibility of corrosion.
- Charge the device before use and at least once every six months for battery maintenance purposes.

## 7. TLP-100/101/102 Specifications

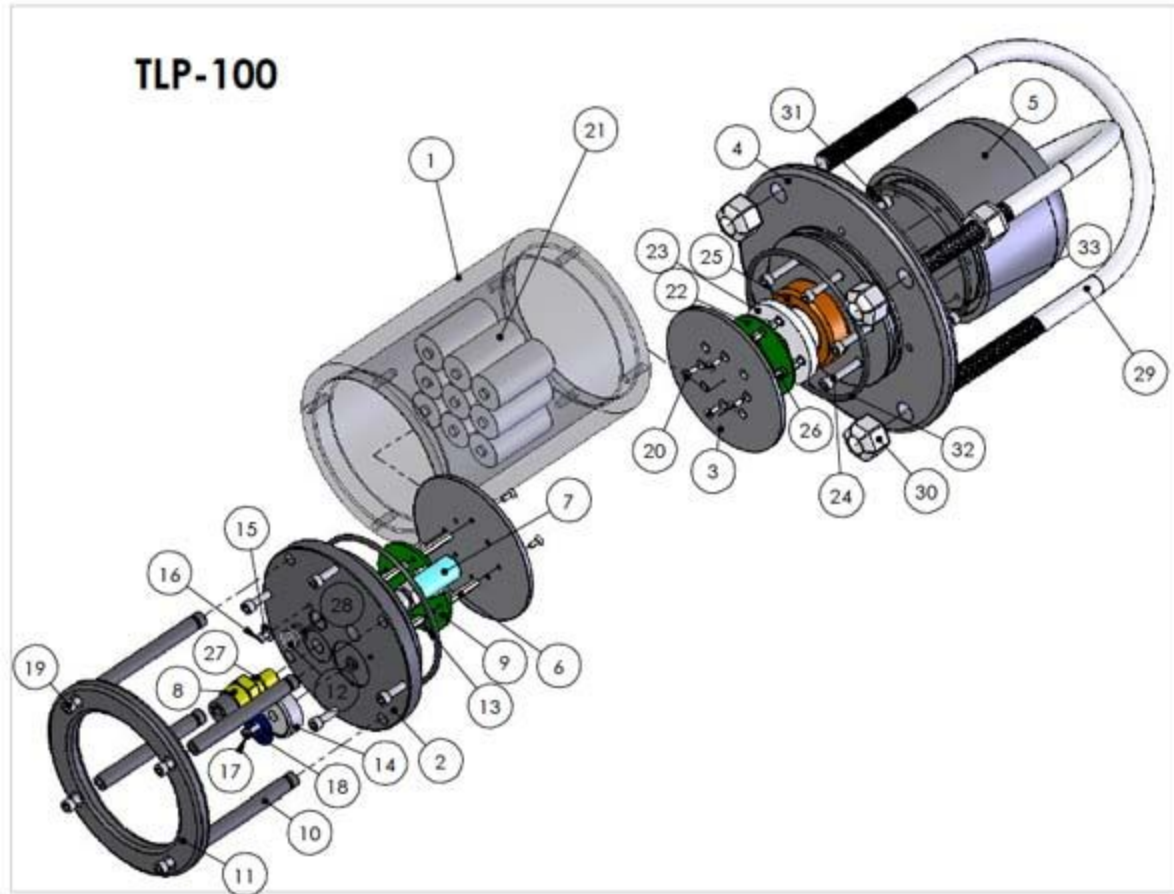
Size:	TLP-100	475mm L x 127mm D	18.7in L x 5in D
	TLP-101	300mm L x 82.5mm D	11.8in L x 3.25in D
	TLP-102	300mm L x 82.5mm D	11.8in L x 3.25in D

<b>Weight:</b>		<b>Weight on Land</b>	<b>Weight in Water</b>
	TLP-100	7.399 kg	3.979 kg
	TLP-101	1.984 kg	.772 kg
	TLP-102	1.786 kg	.574 kg
<b>Depth Rating:</b>	300 meters max. working depth		
<b>Operating temperature:</b>	0-50 degrees Celsius		
<b>Configuration &amp; control:</b>	Power Switch and multi-function connector		
<b>Status Indicator:</b>	Dual color RED/GREEN status LED		
<b>Sensors:</b>	Depth sensor for depths of 300 meters, with accuracy of .3 meters		
<b>Sonar Transmitter:</b>	Frequency hopping, pulse-position coded. 192dB transmit power in high power mode, approx. 182dB with regular power.		
<b>Sonar Transducer:</b>	Near omni directional transducer mounted on end cap.		
<b>Power supply:</b>	TLP-100	(9 Nickel Cadmium	

		D-cell batteries)	
	TLP-101/102	(8 Nickel Cadmium C-Cell batteries)	
<b>Battery Life (approx.):</b>	TLP-100 12 HRS in high power mode, more than 24 hours in regular power mode		
	TLP-101 12 HRS in high power mode, more than 24 hours in regular power mode		
	TLP-102 12 HRS in high power mode, more than 24 hours in regular power mode		

**Note: all specifications are subject to change without notice**

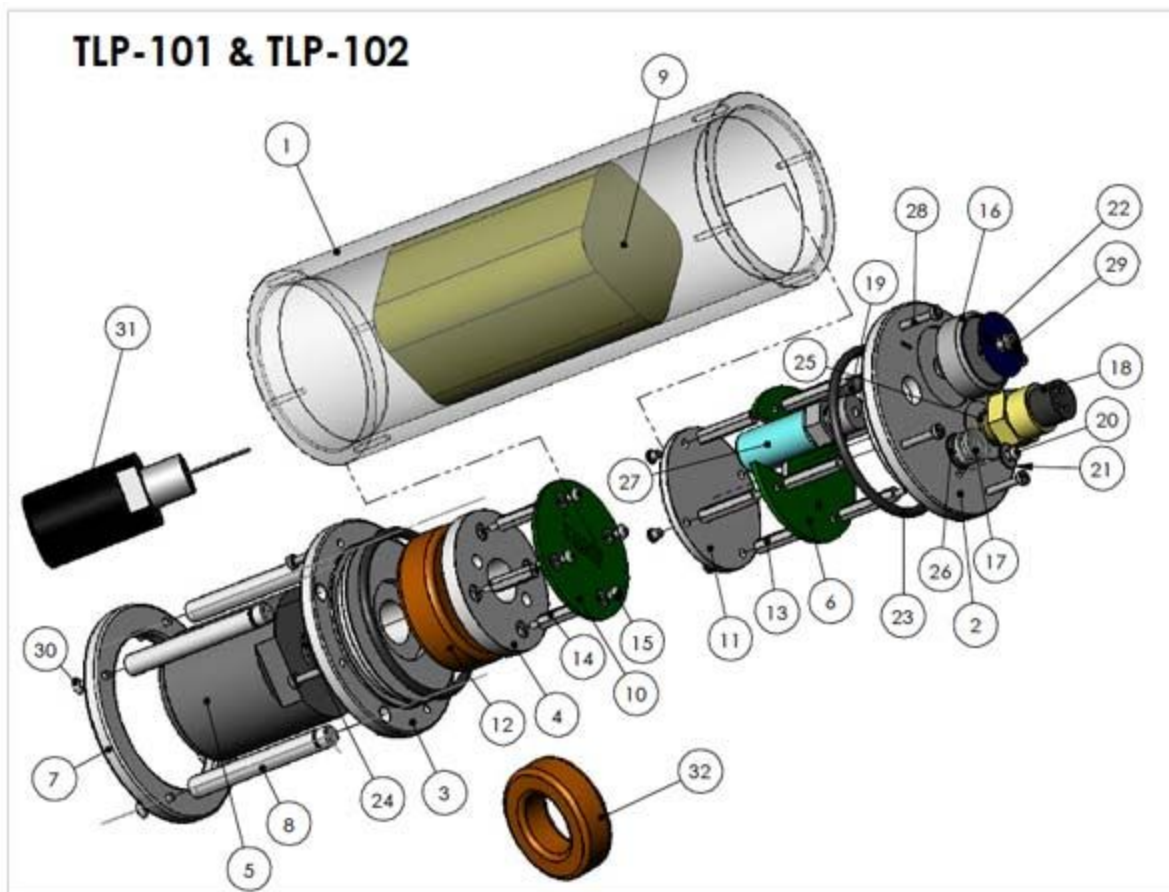




ITEM NO.	PartNo	DESCRIPTION	QTY.
1	HOU01314	PLATTS TLP-100 Housing	1
2	HOU01211	RBS-2 Connector End Cap	1
3	HOU01415	TLP-100 Battery Plate	2
4	HOU01473	TLP-100 8KHz-16KHz Transducer Endcap	1
5	TDC00024	8KHz-16KHz Oil Filled Sonar TDCR	1
6	HDW00583	HDW-stand off-3/16D 1"L SS #4 TLP	8

7	SSP1	Small Smart Pressure Transducer	1
8	CON00302	5-PIN BULKHEAD, 1/2" POST, BRASS	1
9	EM40PCA	Module for TLP-10X Pingers	1
10	HOU01219	RBS-2/2D Cage Posts	4
11	HOU01213	RBS-2 Cage Ring	1
15	HDW00174	HDW-SS-6LG-FLAT WASHER	1
16	HDW00202	HDW-SS-6-32-1/4-BUTTON CAP	1
17	HDW00188	HDW-6-32-3/8-SS-Socket Cap	1
18	LBL00000	LBL-SPORT-TX-Knob	1
19	HDW00342	HDW-10-24 1/2" SS Socket Cap	4
20	HDW00264	HDW-SS-4-40 18-8 1/4"L Flat Head	8
21	BP-TLP-0	TLP-100 BP Ni-Cd 9 C-Cell	1
22	EMBU100	EMBU-100 PCB Assembly	1
23	HOU01407	TLP-101 Transformer Cradle	1
24	HDW00342	HDW-10-24 1/2" SS Socket Cap	6
25	TLP100XF	8-16 kHz XFM 5P 550S	1
26	HDW00582	HDW-stand off 3/16D 3/4L #4 SS TLP	8

27	ORI00006	O-Ring 2-014 E515	1
28	ORI00004	O-Ring 2-012 E515	1
29	HDW00348	SS U-Bolt 5 5/8" for RBS-2	2
30	HDW00324	SS-Nylon Lock Nut 1/2-13	6
31	HDW00196	HDW-10-24 5/8" SS Socket Cap	8
32	ORI00035	O-Ring 2-241 E515	2



**TLP-101 Configuration**

ITEM NO.	PartNo	DESCRIPTION	QTY.
1	HOU01404	TLP-101 HOUSING	1
2	HOU01405	TLP-101 Connector Endcap	1
3	HOU01408	TLP-101 Transducer Endcap	1
4	HOU01407	TLP-101 Transformer Cradle	1
5	TDC00057	16-24 KHz Omni Tdcr w/ 3/4-16 Stem	1
6	EM40PCA	Module for TLP-10X Pingers	1
7	HOU01410	TLP-101 Ring	1
8	HOU01409	TLP-101 Post	4
9	BP-RBS-1 Battery Pack RBS-1	1	
10	EMBU100	EMBU-100 PCB Assembly	1
11	HOU01406	TLP-101 Battery Plate	1
12	TLP101XF	16-24 kHz XFM 10P 400S	1
13	HDW00583	HDW-stand off-3/16D 1"L SS #4 TLP	8
14	HDW00582	HDW-stand off 3/16D 3/4L #4 SS TLP	4
15	HDW00252	HDW-SS-4-40-1/4" Button Cap	4
16	HOU01204	Rotating Switch	1

17	HOU01226	LED View Port RBS, TLT	1
18	CON00302	5-PIN-CONN	1
19	SWT00316	SWITCH-Magnetic (TLT/RBS)	1
20	HDW00202	HDW-SS-6-32-1/4-BUTTON CAP	5
21	HDW00174	HDW-SS-6LG-FLAT WASHER	1
22	LBL00000	LBL-SPORT-TX-Knob	1
23	ORI00011	O-Ring 2-228 E515 or E540	2
24	ORI00007	O-Ring 2-020 E515	1
25	ORI00006	O-Ring 2-014 E515	1
26	ORI00004	O-Ring 2-012 E515	1
27	SSP1	Small Smart Pressure Transducer	1
28	HDW00168	HDW-SS-4-40-3/4-Socket Cap	8
29	HDW00188	HDW-6-32-3/8-SS-Socket Cap	1
30	HDW00378	HDW-SS-4-40×1/2"-Flat Cap	4
<b><i>TLP-102 Configuration</i></b>			
31	TDC00006	38 kHz Omni Tdcr w/ 3/4-16 Stem	1
32	TLP102XF	34-42 kHz XFM 5P 230S	1

# TLP-103

*Miniature Target Locating Pinger*

***Technical Reference Manual***



**Rev. 1 November 2006 Desert Star Systems**

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# 1. Introduction

The TLP-103 target locating pinger is a miniature pinger designed primarily for use with the RangeNav™ underwater tracking range. It is used in field for tracking small vehicles (AUV, UUV or ROV), divers and other underwater targets. The TLP-103 is a self-contained instrument which is housed in a cylinder measuring just 40 mm (1.6") diameter and 135 mm (5.3") long. It weighs just 50g in the water. A 9V alkaline battery powers the pinger, which is sufficient for about 8 hours of active tracking. The pinger operates in a frequency of 34kHz-42kHz. A magnetic swipe switch activates the pinger and a LED indicates instrument status. The TLP-103 is easy to install, just mount the small cylinder on some opportune part of the target using hose clamps, cable ties or even duct tape. The RangeNav™ surface station will track the position and depth of the target as soon as it enters the water.

The TLP-103 works at depths to 300 meters and RangeNav™ listening stations spaced at 250m will in most cases easily pick up the signal. Using the TLP-103 with 500m station spacing is a possibility under good conditions, but should be tested at your site first.

## **TLP-103 Design Characteristics**

- Target Locating Pinger, for tracking of small vehicles, divers and equipment.
- Straightforward installation in minutes.
- Miniature, self-contained, rugged design.
- Designed for use with 250m listening station spacing, depth to 300 meters.
- Powered by user replaceable 9V alkaline battery.
- Supports sub-meter 3D tracking accuracy.
- Equipped with a 500 PSIA (300m) depth sensor, which has an accuracy of 5 PSI (3m).
- Selectable frequency channels for support of multiple target tracking.

Figure 1 shows the TLP-103 Target Locating Pinger. The sonar transducer and the depth sensor are integrated into the lower part of the housing. The dual-color status LED is visible through one hole in the outer cover, and the other hole designates the location of the power/configuration magnetic swipe switch. The top end cap can be removed to access and replace the 9V battery.

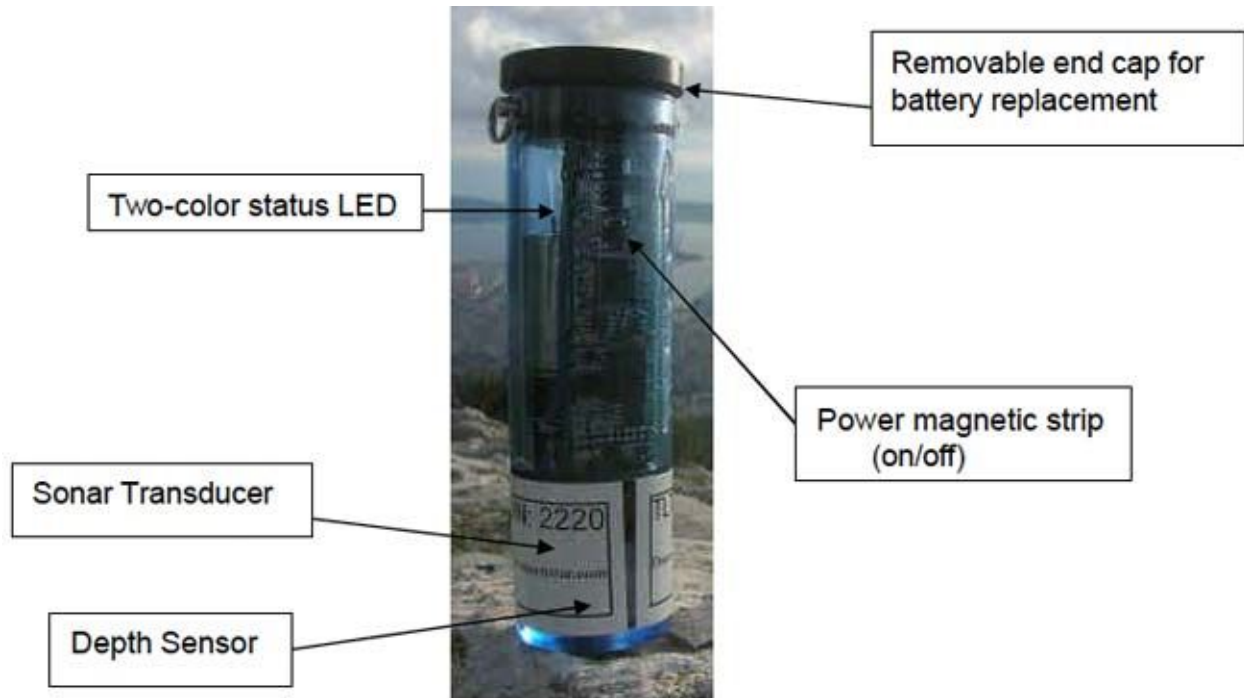


Figure 1: TLP-103 Target Locating Pinger

## 2. Unpacking

Please ensure that your shipment does contain these components. **TLP-103 Component List**

- TLP-103 Target Locating Pinger
- Pinger equipment case (yellow box)
- Power/configuration switch actuation magnet on lanyard
- This manual is available at [www.desertstar.com/downloads](http://www.desertstar.com/downloads)





Figure 2: TLP-103 Shipping Configuration

If a shipment is incomplete, please contact Desert Star Systems.

In order to operate your TLP-103 you will also need the RangeNav™ system components including the STM- 100 surface station junction box, PC, RBS-100 listening stations, RPD cable sections and the DiveBase RangeNav™ software for the Windows PC.

## 3. Preparations For Operation

Follow these simple steps to get your target locating transponder ready for operation.

### Preparations For Operation

- Unpack the pinger and make sure you've got all the parts.
- Install a 9V alkaline battery.
- Configure the TLP-103 using the magnet switch with LED feedback. (SKIP this step if you don't need to change the channel number, 1...8)
- Mount the TLP-103 on the target.
- Switch the pinger on prior to launching the target.

### 3.1 Changing The Internal Batteries

**CAUTION!** Installing or changing the TLP-103 battery requires opening the pinger. This will expose the electronics and make them vulnerable to damage due to water intrusion, static electricity discharge, contamination, strike etc. Improper re-assembly also risks a leak in the housing and consequential flooding, which will lead to almost certain destruction of your TLP-103. Always work at a clean, reasonably static free work station when opening the transponder. Pay attention to detail. Desert Star Systems cannot accept responsibility for operator error resulting in equipment damage.

A 9V battery powers the pinger. The brand of the battery does not matter so long as it is Alkaline. We use Energizer just because we like musical rabbits.

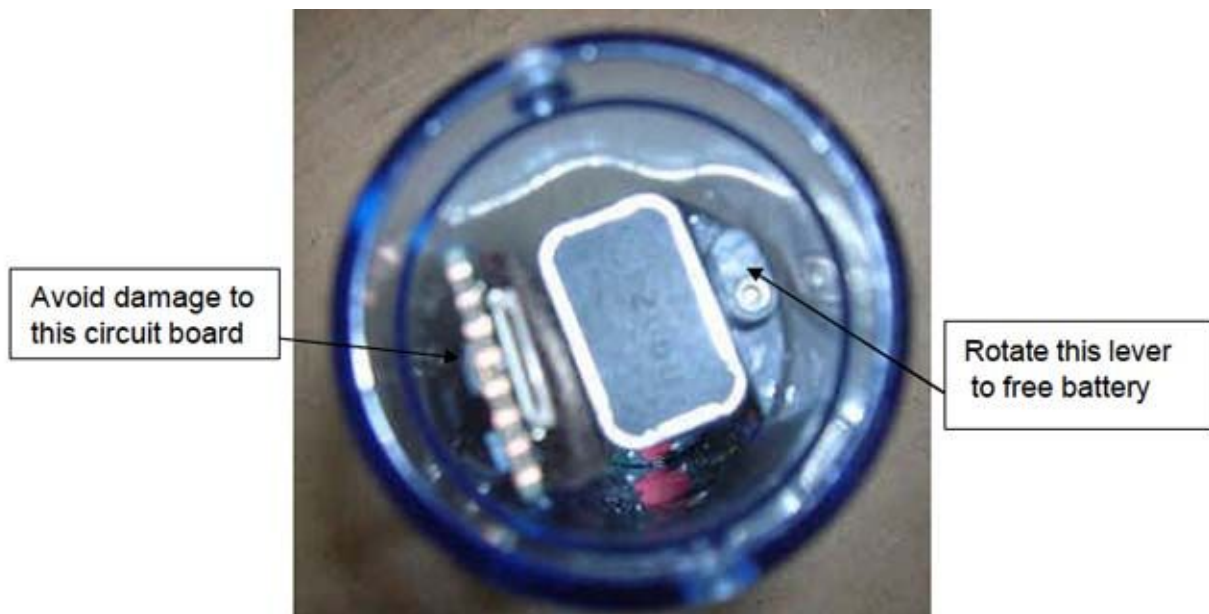


Figure 3: The Battery Compartment

To change the battery, follow these instructions.

- Wipe the TLP-103 dry prior to opening.
- Remove the spiral ring from the retaining pin, and remove the retaining pin.
- Open the end-cap by combining a gentle motion of twisting and pulling. Be aware that water drops that may have accumulated just outside of the O-ring will get sucked in by a temporary relative vacuum. Prevent that by watching the O-ring area through the clear housing, wiping away drops and slowly removing the end cap.
- Turn the lever switch that secures the battery, pull the battery out (you may have to thump the open side of the housing against the palm of your hand to encourage the battery to move) and replace. Watch the battery polarity. The + contact must match with the red post, the – contact with the black post. Reversed insertion will not do any

damage, but the transponder will not work. Make sure to lock the battery by rotating the lever.

**CAUTION:** You will notice the configuration connector along the leading edge of the board. It incorporates a brown lever that may flip open or possibly break off if disturbed. You should avoid that from happening, but the transponder function will not be affected.

- Clean the O-ring and apply a thin film of silicone grease if dry. Also, inspect the O-ring mating surface.
- Insert the end-cap and secure with the retaining pin and spiral ring.
- Inspect the O-ring through the clear housing. A proper seal is characterized by an unbroken shiny black area (the O-ring compression area). Watch for any contaminants and correct if there is a problem.

### 3.2 Station Activation and Magnet Switch Operation

A magnetic switch is used to switch the TLP-103 ON, OFF and. To operate the switch, swipe the magnet included with your transponder past the right marking hole in the outer cover. You may have to experiment a bit to find the best spot for actuation, but the green LED will light to indicate when you 'made contact'. If you lose the magnet do not worry, any magnet will do.

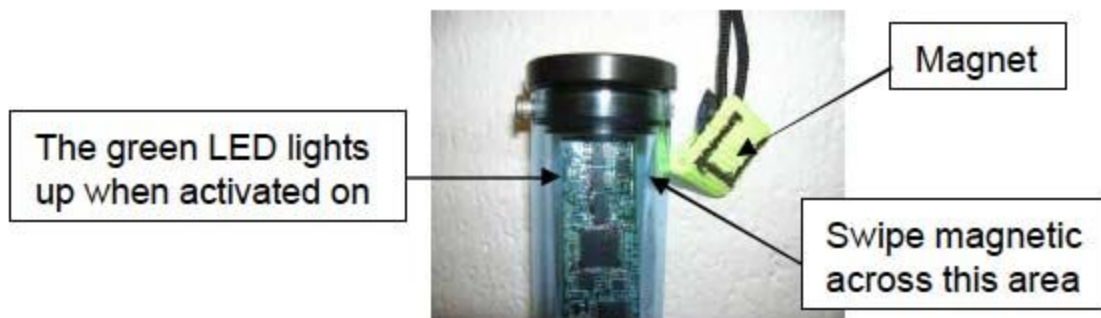


Figure 4: Operating the Magnetic Switch

Table 1 lists the various actions that can be initiated with the magnetic switch.

Action	How to initiate	Status LED feedback
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Switch TLTP-103 ON	Briefly hold magnet over switch	Green LED lights when switch is actuated. Red status blink pattern when magnet is removed.
Switch TLP-103 OFF	Hold magnet over switch for 3 to 9 seconds.	Green LED lights when switch is actuated. LED OFF when magnet is removed.
Configure the TLP-103	Hold magnet over switch for 10 or more seconds.	Green LED lights when switch is actuated. Red LED lights when configuration mode is activated.
Enter a configuration parameter	When correct amount of LED blinks occur, swipe magnet.	See section 3.4

**Table 1: Switch Operation**

### 3.3 Status LED Blink Patterns

The TLP-103 uses a two color (red/green) status LED. Here is a guide to the blink patterns.

<b>Blink Pattern</b>	<b>Interpretation</b>
RED rapid blinking	The battery is low. Replace it.
RED single blink once per second	The pinger is operating normally.
RED triple blink	Hardware error. This blink patterns currently indicates a depth reading too far from zero. Causes could be a defective depth sensor, or you switched the transponder ON while submerged. Transponder functions will still work, although the depth reporting may be faulty.

GREEN LED lights solid	Magnet switch actuation has been detected
RED and GREEN LED light solid	When holding the magnet switch for 10+ seconds next to the switch, this pattern indicates that the configuration mode has been enabled.
RED one to eight blinks.	In configuration mode, indicates a current Channel setting. See section 3.4.

**Table 2: Status LED Blink Patterns**

## 3.4 Configuring The TLP-103

The TLP-103 is configured through the use of the combined power/configuration magnet switch. Use the lanyard with the magnet embedded in the yellow pouch to operate the switch. The only thing that you would actually be configuring is the channel definition. If you are tracking a single target this step is not needed.

1. To initiate transponder configuration, hold the magnet over the switch for up to ten seconds. The green LED will light as soon as the switch is triggered. Keep holding the magnet until the red LED lights solidly (not blinking), indicating that transponder configuration has been initiated. Now, remove the magnet.
2. Transponder Channel setting: The TLP-103 can be set to one of eight Channels, 1...8. This allows simultaneous tracking of up to eight TLP-103 pingers. If you are using a single pinger, always use channel #1. If you are tracking multiple transponders, assign each a unique Channel number. For best operating convenience (and least confusion), assign a solid block of Channels starting at #1. The TLP-103 will blink the red LED in an endless pattern sequence of one to eight blinks, with the number of blinks corresponding to the Channel code. Select a Channel code by triggering the switch in the pause after that Channel code has been transmitted as a blink pattern. The lighting of the green LED confirms your selection.

## 4. Pinger Mounting

The sonar transducer of the TLP-103 is the antenna of the system. The transducer is integrated into the bottom of the housing, in the area of the white label. Proper placement and mounting of the transducer is required for good tracking.

Mount the TLP-103 so that the sonar transducer remains un-obscured, or shielding by any nearby hardware or the acoustic shadow of the diver's body (for tracking) is minimized. The TLP-103 should also be mounted vertically, typically with the sonar transducer facing away from the surface the pinger is mounted on. This is recommended to align the doughnut shaped beam pattern of the transducer with the horizontal plane. Of course, at times vertical mounting may not be practical and so the recommendation is to come as close to that ideal as possible. The system will in general still work, but effective distance from the listening stations may be reduced, or listening stations in one particular direction may not be able to pick up the signal.

For small vehicles, the best performing mounting areas are generally the bottom or the top of the vehicle. For diver mounting, consider floating the TLP-103 above the diver (use a small float) or dropping it below the diver (consider attaching some weight). You can also attach the TLP-103 directly to the diver's tank or possibly even place it in a b/c pocket. However, due to the resulting signal shielding, the effective tracking range will probably be less (similar to the result of having your cell phone antenna in a poor location or inside a shielded building). As shown in the figure below, the pinger was attached to the diver's tank and we still tracked fine; although range may have been reduced.

#### **Guidelines For TLP-103 Mounting on a Small Vehicle**

- The sonar transducer, which is located in the bottom of the housing around the area of the white identification label, should not be shielded by any part of the vehicle. It is preferred to mount the TLP- 103 near the top of the vehicle, vertical with the transducer facing up, or the bottom with the transducer facing down. This affords a near unobstructed view of the seafloor mounted listening stations.
- Keep the pinger away from the thrusters as these may produce some disturbances that could shield the pinger's signal.
- Maximize the space between the TLP-103 sonar transducer and other sonar transducers on the vehicle. While the TLP-103 will not receive or be disturbed by any interference, its signals may interfere with other acoustic systems. If using scanning or imaging sonar, mount the TLP-103 out of the beam pattern of that instrument.
- For best performance, mount the TLP-103 vertically, with the transducer facing away from the vehicle.
- Use a bracket or another rigid structure to secure the pinger. Use the area between the sonar transducer and the status LED and magnetic switch to mount securing hardware (this area does not require access).



**Figure 5: Mounted TLP-103 on Diver**

Though the TLP-103 is NOT mounted vertically, AND is clearly obscured by the diver's sonar shadow, we still tracked this diver over the shorter test distances.

## 5. TLP-103 Maintenance

Your TLP-103 is a rugged instrument that requires very little maintenance. However, please do observe the following points to ensure long and proper operation.

### Maintenance Instructions

- Rinse the pinger with fresh water after each deployment.
- Remove the battery if the pinger will not be used for a significant amount of time.
- The TLP-103 chassis is sealed by a single O-ring; keep the O-ring clean and lubricate with a thin film of silicone grease if dry. Inspect for any cuts or abrasion, and replace the O-ring if damaged.
- Keep the small depth sensor hole in the bottom label free of debris. Rinse with a water stream if obstructed. DO NOT penetrate with a sharp object to clean. This tiny sensor uses a very soft gel membrane which is very easily damaged by mechanical attack.

## 6. TLP-103 Specifications

<b>Size:</b>	135 mm L x 40 mm D (5.3" L x 1.6" D)
<b>Weight:</b>	230g in air

	50g in water
<b>Depth Rating:</b>	300 meters max. working depth
<b>Operating temperature:</b>	0-50 degrees Celsius
<b>Configuration &amp; control:</b>	Magnet swipe switch
<b>Status Indicator:</b>	Dual color RED/GREEN status LED
<b>Sensors:</b>	Depth sensor for depths of 0-300 meters, calibrated to within 0.7 m in the range from 0m to 70m
<b>Sonar Transmitter:</b>	Frequency hopping, operating at 33.8 kHz to 42 kHz
	Source Level >= 177dB re. 1 $\mu$ Pa
<b>Sonar Transducer:</b>	Near omni directional transducer (hollow cylinder) integrated in housing.
<b>Power supply:</b>	Powered by single 9V alkaline battery. Battery life (approximately):
	Tracking mode with one transmission per second: 8 hours

Note: all specifications are subject to change without notice

ITEM NO.	PartNo	DESCRIPTION	QTY.
1	HOU01101	Scout TX Housing	1
2	BRB-1	BOTTOM BOARD,TLT-REV.B	1
4	TDC00036	38kHz Omni Ceramic Element,12" lead	1



5	HOU01444	TLT-2 TRANSFORMER SUPPORT	1
6	TRB-1	TLT-1 REV. B, TOP ROUND BOARD	1
7	BAT00327	9V BATTERY FOR SPORT RX	1
8	HOU01445	TLT-2 Battery Cradle	1
9	HOU01446	TLT-2 Battery Secure	1
13	EM-41	TLT-Rev.B Main Board	1
15	XFM00319	FT-114-67 Toroidal Core Ferrite	1
16	HOU01443	TLT-2 ENDCAP	1
17	HDW00281	HDW-Clevis Pin-New Scout TX	1
19	ORI00015	O-Ring 2-122 E515 New Scout	1
20	HDW00282	HDW-SPLIT RING 0.430" FOR NEW SCOUTS	1
21	HDW00362	HDW-SS-2-56 1/2 SOCKET CAP	4
22	SSS00059	Scout Tx Bottom label & Micro TLT	1

