

NetTrack™ Operators Manual

Precision Acoustic Fishing Net Measurement System



Version 0.8

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1. Introduction

NetTrack™ is a precision acoustic geometry and area (square meters) measurement system for use in marine environments. The primary application of the system is to determine the size of net openings during trawls. This is significant for example for fish sampling nets, where the opening area of the net multiplied by the distance trawled yields the volume of water sampled. Other applications may include fishing net manufacturing, where the performance of a new product can be evaluated under real-world conditions.

Principal Components of the NetTrack™ System

- **Responders** measure the distance between one another using sound. They are placed at the four corners of the net and measure its area.
- A **Junction Box** joins the responder cables together into one cable which goes to the **Surface Station**.
- The **Surface Station** provides power, a sea ground, and communication to the **Responders** through the cable coming from the **Junction Box**. This component communicates with the PC running **NetTrack™** through a standard USB cable.
- **NetTrack™** is the software component of the system. It runs on Windows and shows the system status, real-time area, data logging to a file, configuration options, and serial data output for easy integration into larger systems.



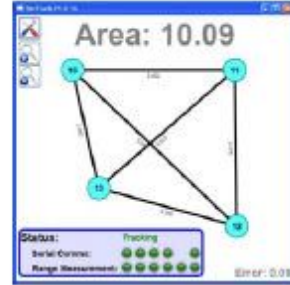
Responder(x4)



Junction Box



Surface Station Box



NetTrack™ Software

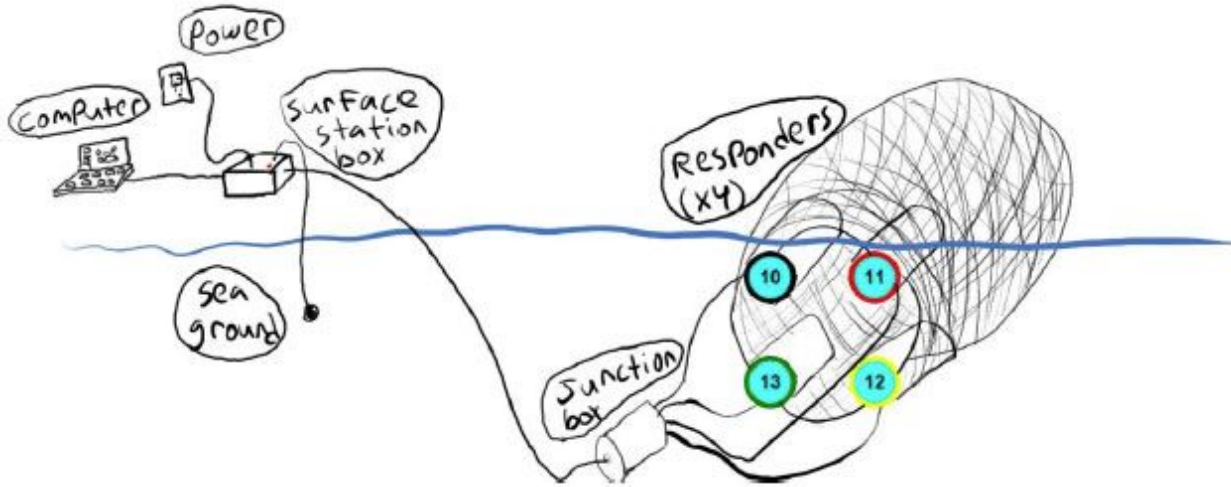


Figure 1: Principal System Components and System Overview

2. Quick Start Guide

Reading the captions under all of the images in this manual will give you good idea of how this system is set up. At a minimum you must do the following:

- Install the NetTrack™ software on the surface computer running Windows XP or Vista.
 - Copy the NetTrack™ folder to your computer, run dotnetfx35.exe, reboot the computer
- Attach the responders to the net.
 - Look at the colored tape on the responders and zip tie them to the corners of the net as follows:

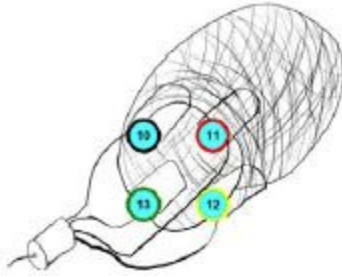


Figure 2: Responder positions

- Connect cables from the responders to the junction box and from the junction box to the surface station.
 - Apply silicone grease to the all of the connector ends
 - Tighten the connectors all the way
 - Create a strain relief at each connector using zip ties, tape, or rope; avoid tight cable bends
- Connect a sea ground, power adapter, and USB cable to the surface station box
 - Connect the sea ground connector to the black(negative) connector on the top of the surface station box
 - Attach the sea ground clip to a metal surface on the boat that is also in contact with the water(grounded)
 - Connect the power cable to the connector in the middle of the top side of the surface station box
 - Connect the USB cable from the surface station box to a Windows computer
- Start NetTrack.exe

After completing those steps you should see a status message similar to this:



Figure 3: Out of Water Status

Your **Status** should be “Tracking” and all **Serial Comms** lights should be green. This tells you that your computer is able to communicate over the serial port to all responders. Your **Range Measurement** lights should be red or yellow depending on how close together your responders are. This is because the responders don’t communicate out of the water. If you put them all in the water then the Status screen should look like the following:



Figure 4: Status Green

If your **Status** isn't "Tracking", or if you don't see all green lights, check the responders to make sure they have red and green lights blinking inside them. The red light indicates the responder is powered and the green light indicates that it can talk to the other responders. A more in depth troubleshooting guide is provided at the end of this document.

The last thing to check is your error number on the main screen

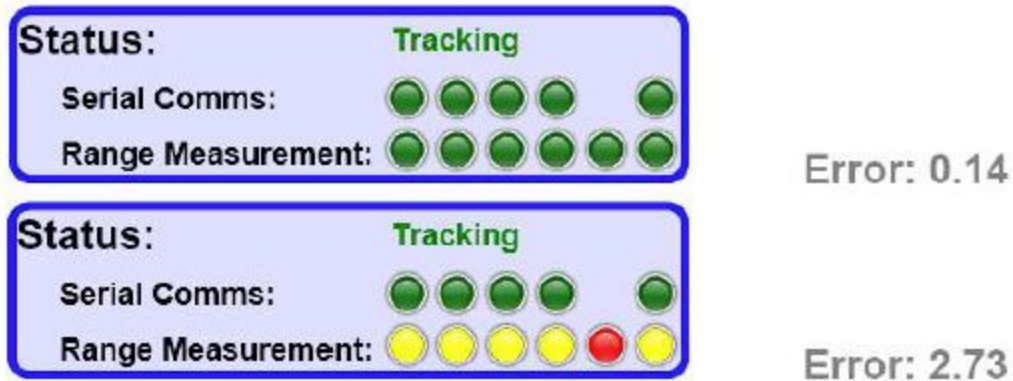


Figure 5: Error Values

If the error is greater than ~0.3 for more than one measurement cycle(outliers are normal) while your responders are in the water then increase the detection threshold in the sonar tab under the settings menu. Do this by right clicking on one of the slider bars to change them all at once and raise them. This will decrease your systems performance but allow it to overcome ambient noise better.

3. Setting up the System

Installing the Software

1. Copy the NetTrack™ software from the CD to your computer
2. Run dotnetfx35.exe to install the Microsoft .NET Framework
3. Reboot the computer

4. Run NetTrack.exe

Attaching Responders to the Net

Responders should be attached to the four corners of the net using available materials of suitable strength as shown in fig. 6. Responders are color coded with electrical tape to reduce setup time. As shown in fig. 1 and fig. 2, Black goes in the top left corner, red in the top right, yellow in the bottom right, and green goes in the bottom left. If this tape wears out you can purchase more at an electronic store.



Figure 6: Attaching and Color Coding Responders

Connecting the Cables

Before attaching any of the waterproof cables ensure the rubber end connectors are lubricated with a thin layer of silicone grease to prevent the rubber from drying out. Connect a cable to each of the responders and tighten the locking sleeve all the way. Attach the opposite side of the cables to the junction box. Before connecting the longest cable to the junction box check to make sure you're not connecting the PC (non-waterproof) side of the cable to the junction box. See fig. 7 below for more details.



Lubricating the connectors



Connecting the responders



Connecting the responders to the junction



All responders connected with strain relief for each cable



System overview



The computer side of the surface station cable

Figure 7: Connecting the Cables

Connecting the Surface Station

The surface station(fig. 8) needs to be connected to four different cables. The first is the cable coming from the junction box. This cable provides power and data to each of the responders. Next the sea water ground needs to be connected to the negative (black) connector on the top of the surface station next to the positive (red) connector. The other side of the sea ground should be connected to a surface on the boat that is conductive and in contact with the water. If this isn't available then a lead weight attached to a stainless steel cable can provide it. To provide power to the responders a third cable needs to be connected from your station's power supply to the silver

plug on the top of the surface station. Finally the USB cable needs to be connected to the computer side of the surface station.

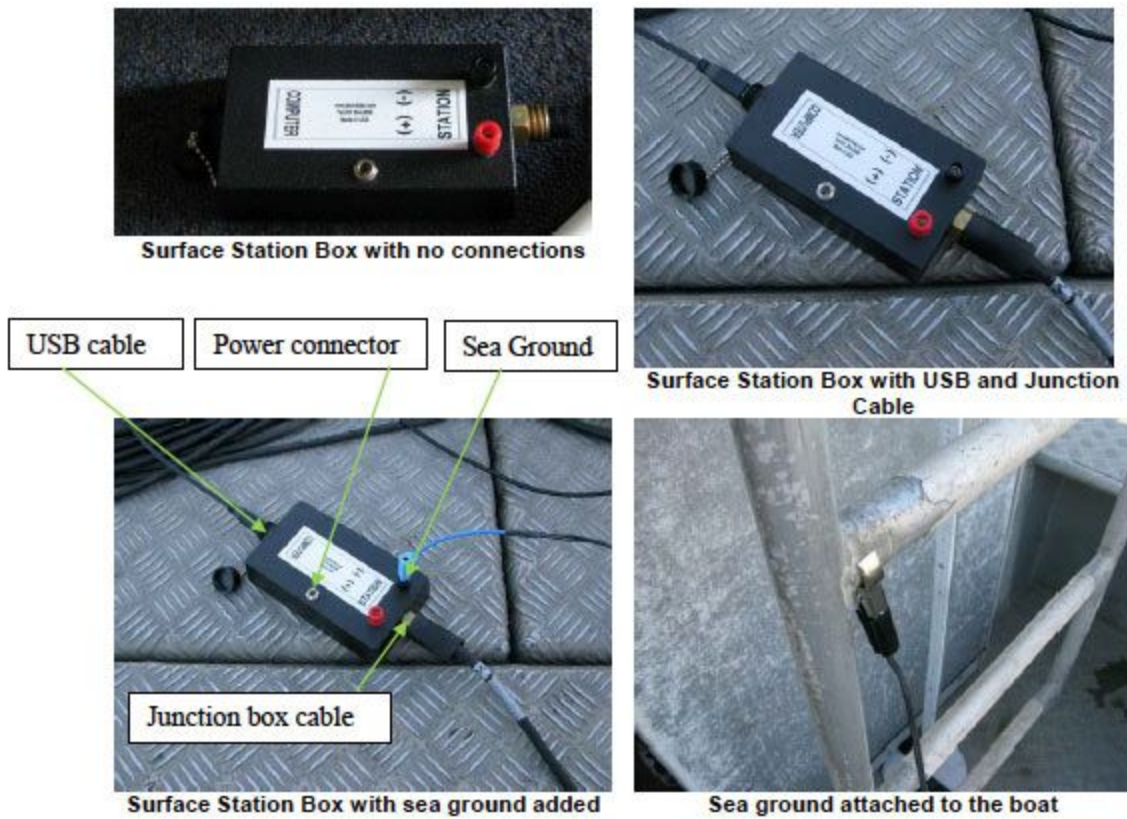


Figure 8: Connecting the Surface Station Box

4. Operating the System

Deployment

How the system is deployed will depend on the boat, net, and other factors. What's important to consider is the drag that will be created by the junction box and responder cables and the force exerted on the cables. Initial experiments showed that if cable excess is tied into loops then enough drag is created to negatively impact the net's performance. To solve this problem the cables should be extended under tension behind the boat. Using this technique requires a consideration of the force exerted on the cables and connectors. Each connector shouldn't experience more than 10 lbs of force and each cable more than 100lbs. This means each connector needs some kind of strain relief that doesn't cause a sharp bending of the cable. For best performance the cable coming from the junction box to the boat should remain under tension by attaching it to a point on the boat. Feel

free to contact Desert Star Systems for custom cable strengths and lengths to optimize your systems performance.

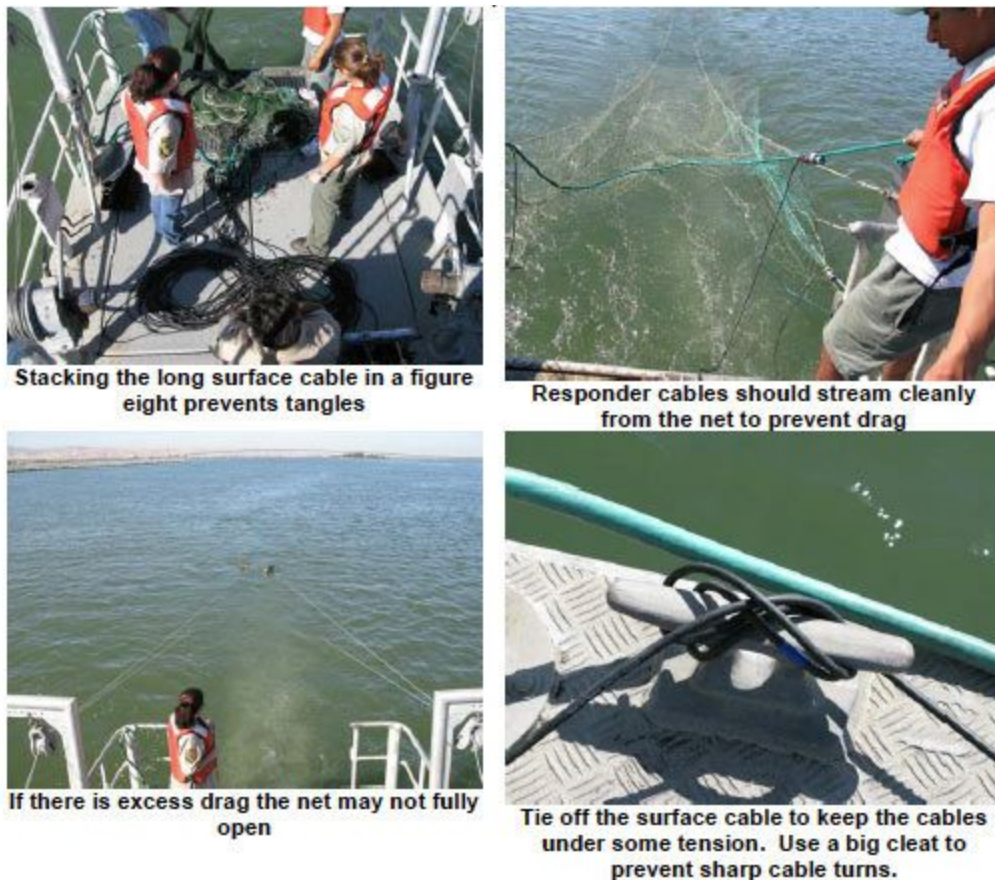


Figure 9: Net Deployment Techniques

5. NetTrack™ Software

Main Screen

The main NetTrack™ window in fig. 10 displays the net geometry, opening area in square meters, system status, error rate, along with buttons for adjusting zoom and changing settings. Observing the error rate is a good way to know if your measurements are accurate. This value should be below 0.3 during operation although some sporadic outliers are normal.

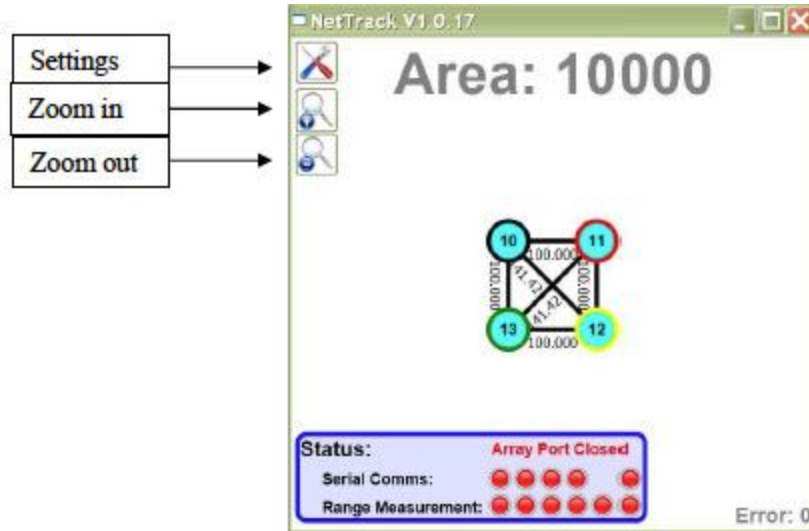


Figure 10: Main NetTrack™ Window

The lights next to “Serial Comms” indicate the communication status of each responder. There is one light for each responder and a fifth light for overall communication status. All of them should be green when the system is fully functional. Next to “Range Measurement” there is one light for each of the six distance measurements. These lights provide sonar measurement status so they will only be green if the responders are in the water or very close to each other out of the water. At the top of the screen you will also see buttons to open the settings, zoom in, and zoom out. Zooming will resize the net geometry to take up more or less of the screen. Zoom in after your system is running for the best visualization.

Net Area and Error Calculation

The net area is calculated using herons formula available [here](#) and [here](#). Specifically: $A = 1/4 * \sqrt{\{(a+(b+c)) (c-(a-b)) (c+(a-b)) (a+(b-c))\}}$. This is done for two triangles (10,11,12) and (10,12,13). These areas are then added together to give the area of the quadrilateral.

The error calculation is essentially the residual error from one of the diagonals. The system estimates the positions of all responders based upon the available ranges. The length of the diagonal from responder #10 to responder #12 is calculated based upon the estimated positions of those two responders. The difference between this calculated length and the measured length is the error metric displayed.

Range Measurements

These are made in a clockwise fashion starting with the first station at the upper left. Ranges are measured as follows with the transmitting responder(A) listed first followed by the receiving responder(B):

Range #: A → B

Range 1: 10 → 11

Range 2: 10 → 12

Range 3: 10 → 13

Range 4: 11 → 10

Range 5: 11 → 12

Range 6: 11 → 13

Range 7: 12 → 10

Range 8: 12 → 11

Range 9: 12 → 13

Range 10: 13 → 10

Range 11: 13 → 11

Range 12: 13 → 12

In the log file the two measurements A → B and B → A are averaged and multiplied by the sound speed estimate to generate a single range estimate.

Logging

Range data logging can be viewed in real-time by double clicking inside the status box. It is also available via a COM (serial) port. (See **Communication Settings** below for details).

The data logs will follow this format: Time, Area, Error, Range 1, Range 2, Range 3, Range 4, Range 5, Range 6. Example logged data: "2008-09-26 17:44:00.43,10000.000,138.559,1.682,3.477,2.918,2.228,375.070,2.862". Log files are stored in /data/track inside your NetTrack™ folder. These files will have a name similar to this example: "09_25_08_03_50_36.ntk". Time will be in the GTM (Greenwich Mean Time). Post-processing of the logs in another program can filter out measurements with high error rates for higher data quality. Figure 11 below describes which ranges correspond to which parts of the net.

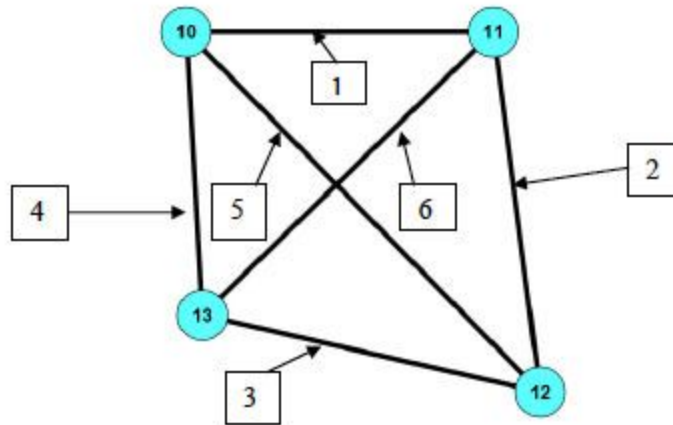


Figure 11: Log File Range Measurement Numbers

Sonar Settings

The Sonar Settings tab (fig. 12) allows for **performing a noise test, adjusting the detection thresholds of the responders, and configuring the speed of sound. Performing a noise test** will show the current level of ambient noise in the environment. Click the noise test button again to end the noise test. By holding the right mouse button on a detection level slider you can adjust all of the sliders at once to be at a level above that of the ambient noise. Ideally, the detection sliders should be all the way to the left to provide maximum precision. The higher you set this threshold the less precise the system will be. Unreasonably short distances mean the system is picking up electric interference or acoustic noise. Make sure your system's sea water ground is good. If the problem persists, raise the detection threshold.

Next to the **detection threshold sliders** are values corresponding to the station identification numbers. The colors in these fields correspond with the colored tape on each of the responders. Black is at the top left of the net, red is at the top right, yellow is at bottom right, and green is at bottom left. If a responder breaks or otherwise needs to be replaced you would need to change this ID value to match that of your new responder.

The value entered in the **sound speed** field is used to convert the acoustic signal travel times into range measurements. The fields for Temperature, Salinity, and Depth (which are available when the Estimate button is pressed) are used as inputs into a polynomial to provide an estimate for sound velocity which is then set in the sound speed field. The polynomial used is from K.V. Mackenzie, Nine-term equation for the sound speed in the oceans (1981) J. Acoust. Soc. Am. 70(3), pp 807-812. This approximation may not be perfect. If a better estimate of sound speed is available, for example from a CTD or sound velocimeter, it can be entered in the sound speed field. So to be clear, the values in the fields **Temperature, Salinity, and Depth** do not necessarily have to be entered, the

import field is the sound speed field. The others are just used to help put a hopefully realistic approximation into the main sound speed field.

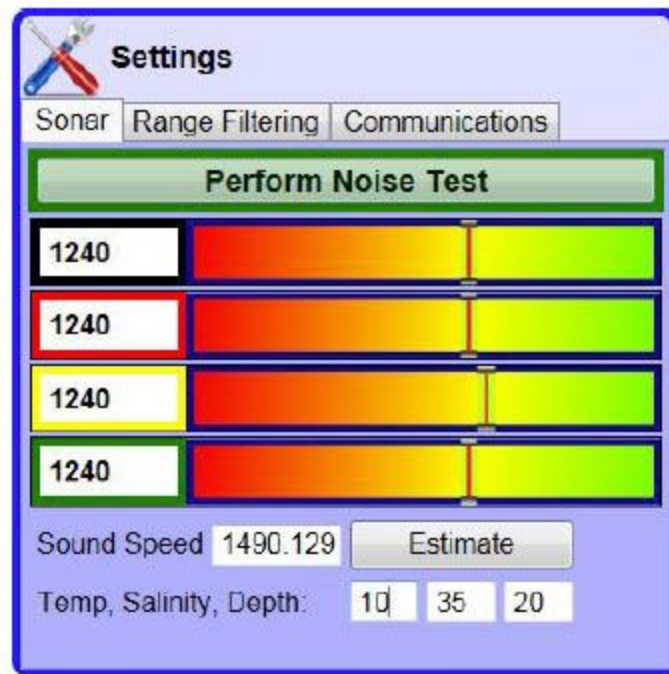


Figure 12: Sonar Settings Tab

Communications Setting

Under the communications settings(fig. 13) you can **set the serial port that is connected to the surface station, set an output port to send distance data to, and view the raw commands going back and forth between the responders** (Show Raw Input – available mainly for engineering purposes). For most configurations the output serial port will be closed.

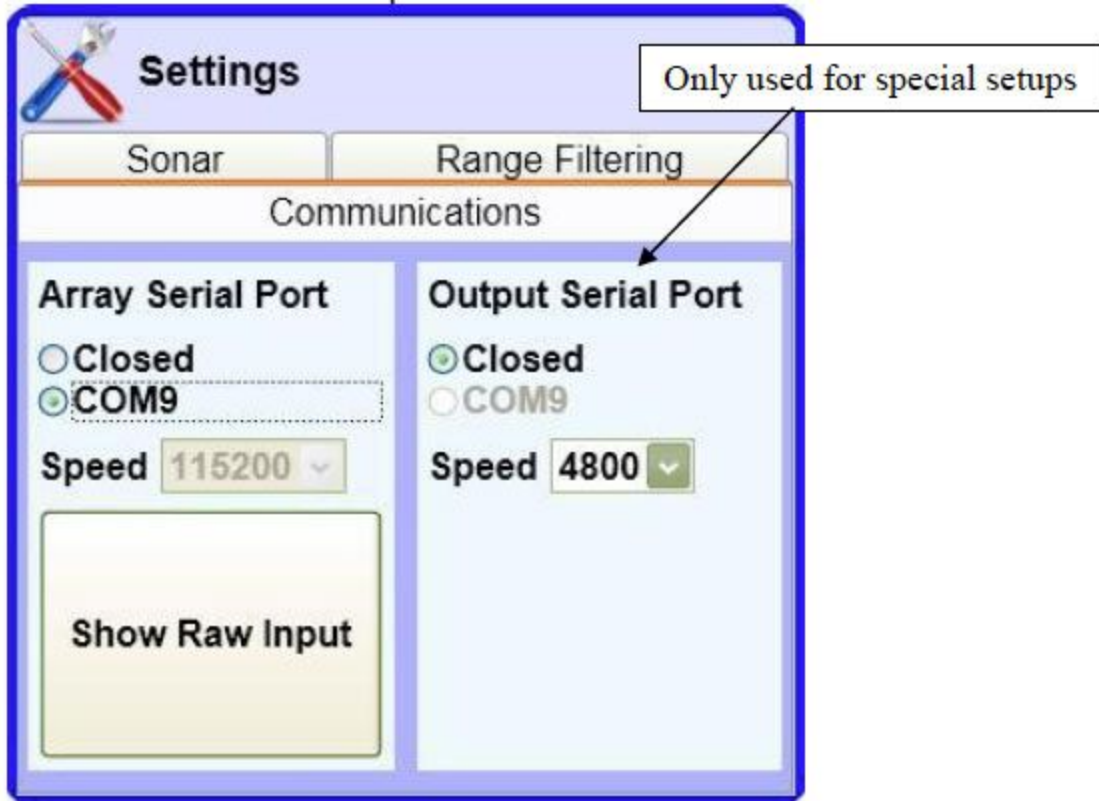


Figure 13: Communications Settings Tab

Range Filtering Settings

Setting a **minimum** and **maximum** for the lengths of your net can be done through this screen. Set the numbers to reflect the limits of reasonable measurements. The system will then automatically reject outlier measurements that do not fall within your specified limits.

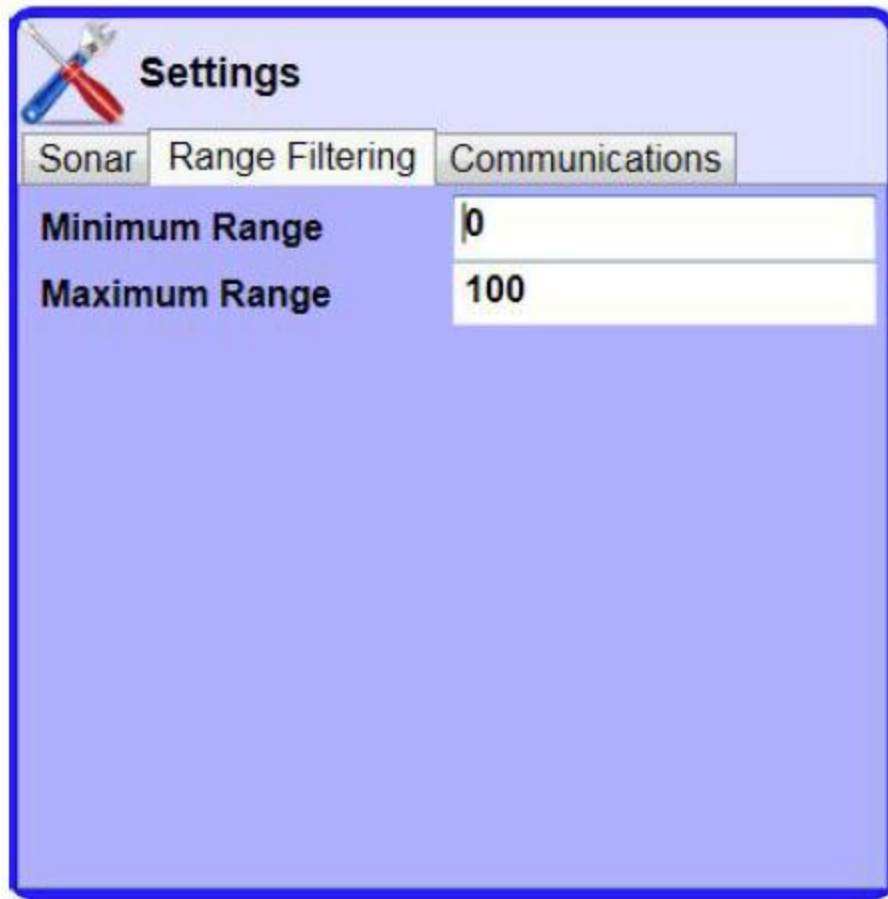


Figure 14: Range Filtering Settings Tab

Maintenance and Spares

Maintenance

Maintaining your system will help to prevent premature failure. Here are a few simple things you can do or not do to get the most out of your system:

- Apply a silicone grease(available at a scuba shop and used on o-rings) before each system assembly to prevent the rubber from drying out.
- Rinse the water proof components in fresh water after use in a salt water environment to prevent corrosion.
- Apply colored tape to each of the responders to make it easier to remember their positions on the net.
- Be sure you don't over tighten the responder screws (normally hidden under the color tape) because it will crack the plastic and your responder will flood. If the screws are

going to fall out gently tighten them. Otherwise there should be no reason to open the responder or adjust the screws.

- Inspect the outside of the responder before each use to ensure that the plastic has no cracks (maybe you over tightened the screws recently?) and is in good working condition.
- Inspect all of the cables for cuts that may have allowed water to enter into them.

Recommended Spares

Stations and cables can be crushed under a net door, impact the ground, or otherwise experience severe forces. Cables may wear out quickly if flexed repeatedly at the same point, subjected to high tension forces, or used without proper strain relief. It is therefore important to have spare parts around so that your research can continue uninterrupted. Here is a list of recommend spares that covers the most likely single point failures and will save you from having to wait for new components:

- 1 spare TLT-32 responder
- 1 spare responder cable (30' cable)
- 1 spare surface power/data cable (300' cable)
- 1 spare junction box
- 1 spare surface station
- A spare PC with NetTrack™ installed in case your main one crashes

Appendix A: Troubleshooting

Array Port Closed

Solution: Connect the surface station box to your computer with a USB A-B cable.

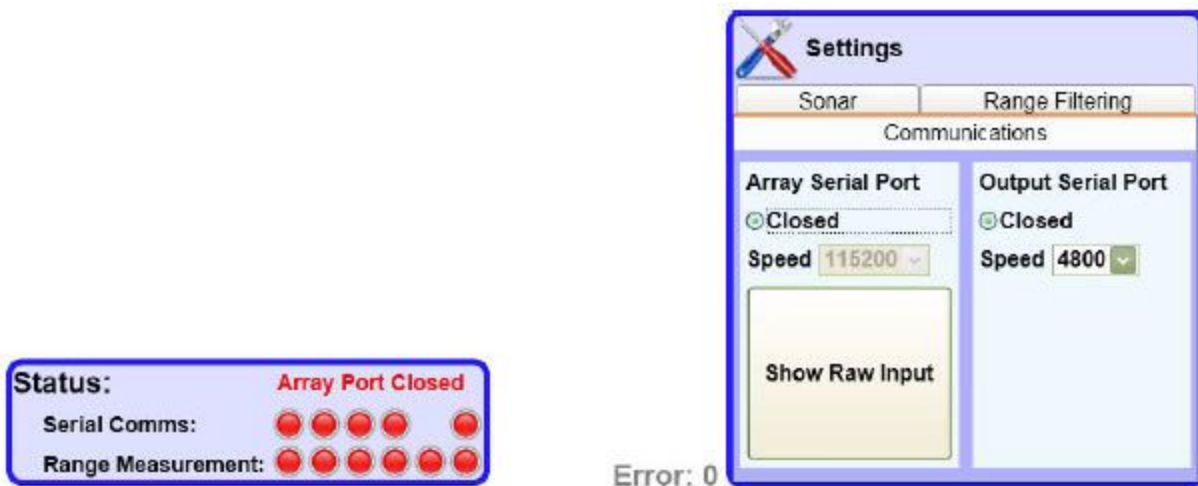


Figure 15: Array Port Closed

Array Not Detected

Solution: This means that your computer isn't communicating with the responders. Check all of the cables between the surface station box, junction box, and responders. Look at each responder and make sure they have a red light blinking on each of them. This means they have power. Also look for a blinking green light. This indicated they are talking to each other(synchronizing).



Figure 16: Array Not Detected

High Error Value

Solution: This can occur because the responders are not in the water or because of environmental noise. Make sure they're all in the water and then raise the detection threshold in the sonar settings tab (described in the software section). The error can be high because of outlier measurements that last one measurement cycle.



Figure 17: High Error Value

Thread Error Message:

Solution: Run dotnetfx35.exe to install the Microsoft .NET Framework, restart the computer, and try everything again. If you continue to get this or any other error message then contact Desert Star Systems so we can fix the problem.



Figure 18: Thread Error

Appendix B: Customer Questions and Answers

What is the minimum water depth the responders need to function?

Being in shallow water will limit the maximum range between responders. The system should 'work' in any water depth, however, the range will between responders may become limited.

Will the system work without all responders connected?

If less than four responders are connected then the system will still measure raw ranges. The area calculations and error metric will not work with less than four responders. It will also take longer for measurement updates. An assumption was made that all four responders would be used at all times.