SONAR SYSTEM INTEGRATION GUIDELINES

For Sonars on Hosted Platforms

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1. Introduction

The purpose of this document is to provide guidelines for OEM Integration of Special Sonar Systems manufactured by EdgeTech, into larger systems for host platforms manufactured by other Companies. These guidelines are of significantly greater importance when a Sonar System is purchased in "component" form and not as an integrated sonar system. The host platform Integrator is responsible for the Integration of the components of the Sonar System into vehicle, including retaining the performance thereof. It needs to be understood that EdgeTech does not have the design details of the vehicle, or other systems being integrated therein, for consideration in the design and manufacture of the Sonar System being supplied.

These guidelines support the principle that the earlier a problem or potential problem is identified in the Integration process, the easier it will be to correct the problem and minimize loss in terms of materials, labor and time. Therefore preparation for Integration needs to start in the final stages of manufacture of a deliverable system. The most common Integration problem is electronic noise being induced into the sensitive sectors of the Sonar System. In order to be able to evaluate the extent of this potential problem, a reference file of sonar data is recorded in the final factory testing of the system, which can then be used as a baseline for comparative testing during the Integration process.

Similarly, sonar data files need to be recorded at progressive stages of the Integration process. These records should be maintained for future reference during support of the fully integrated and delivered product throughout the life cycle thereof.

This document also provides guidelines on other aspects of Integration and has appendices containing general tips and examples of problems and solutions encountered during Integration of sonar systems.

Below is a visual representation of the product life cycle including the Integration period:

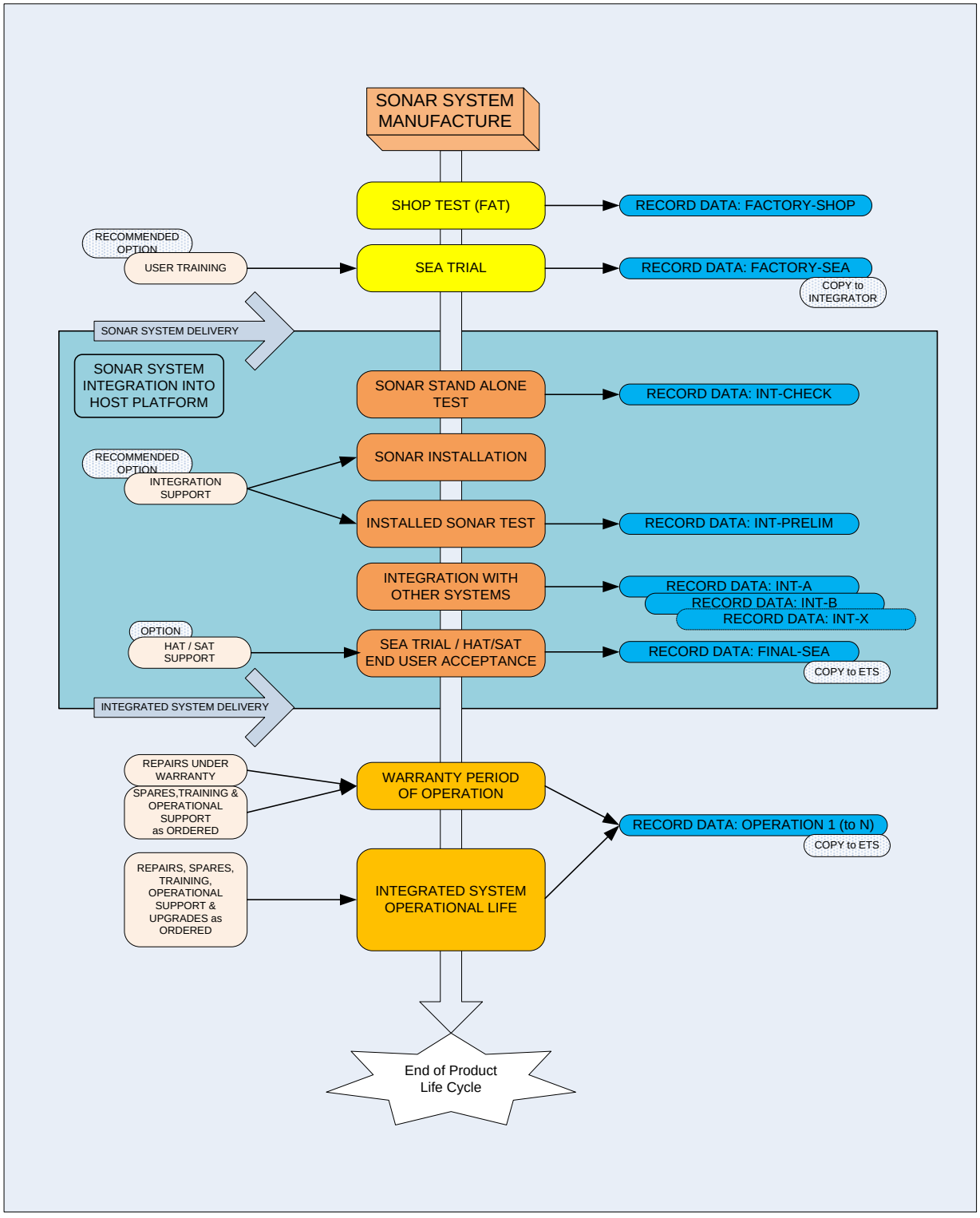


Figure 1: Sonar System Integration Flow Diagram

2. Common Terminology

The following terminology & definitions have been adopted by EdgeTech:

"System"
A System is a combination of sub-systems and/or assemblies that form the complete and functional deliverable product as defined in the relevant sales order / contract.

"Sonar System"
A Sonar System is a combination of components that perform the sonar functions. This could range from a fully integrated stand alone sonar system to a set of PCB's, transducer arrays and cables for Integration into a higher level system.

"Special System"
A Special System or Special Sonar System is a system that is custom built to customer specific requirements (not a standard production system).

"Integrated System"
An Integrated System is fully functional system with all components of the system interfaced and operational in accordance with the relevant system specifications.

"Host Platform"
UW Vehicle on which sonar is to be Integrated, such as AUV, ROV, USV, UUV, etc.

"Integration"
Integration is the process of taking components of a system (sub-systems) and combining these physically, mechanically, electrically and electronically into a fully functional system.

"FAT"
Factory Acceptance Testing (FAT) is system level acceptance testing performed on completion of system manufacture. This testing is to verify that the system conforms to the system specifications per contract / purchase order.

"Sea Trial"
A Sea Trial of a system is performed to verify or calibrate functional or performance requirements which can not be tested / calibrated in the factory environment. Typically sea trials are used for evaluation of the sonar self noise levels, range and resolution as well as functionality of sensors such as pressure, motion and GPS. A sea trial is an extension of FAT.

"HAT/SAT"
Harbor Acceptance and/or Sea Acceptance Testing (HAT/SAT) may be contractual requirements for system testing after installation of a system in the host vessel / vehicle. Testing is performed in accordance with a test procedure generated for the specific project either by ET or the customer, in accordance with the sales order / contract where HAT and SAT test requirements and responsibilities are defined.

3. Preparation for Integration

Documentation

Copies of User Manuals for the standard/generic form of sonar system are provided on delivery of a sonar system (on CD). An Addendum to the User Manual is also generated and provided (hard copy and on CD) for most Special Sonar Systems, wherein custom detail and information is provided for the specific system. The Addendum contains a system specific block diagram and wiring diagrams as required for installation of the system. Use of the Addendums during Integration and field support work is highly recommended. Note: EdgeTech would appreciate any feedback on errors in documentation or suggestions for improvement of documentation that can be provided.

Manufacturing Sonar Data Records

It is important that there is a clear understanding that the performance of a sonar system (target detection/definition) is largely dependent on the level of noise generated within the system or induced into the system by an external source, either by conduction or radiation. Any noise in the system within the frequency band of operation of the system will have an adverse impact on the performance of the system. Sonar systems have very low level analog signal inputs for processing and are designed for minimal internal noise to maximize performance. Consequently, sonar systems are sensitive and susceptible to external noise if they are not correctly integrated into a vehicle. The sector of the sonar system that is most susceptible to noise pickup is the signal path from the receiving transducers (arrays/hydrophones) through to the T/R switch (side scan) and/or data acquisition board (sub bottom). It is in these stages of processing that very low level signals are being processed and any in-band noise that gets coupled with these signals will result in system performance degradation. To ensure that this does not happen during system Integration, it is vital for the system to be systematically tested to verify that the noise in the system is within the design boundaries. To be able to do this during Integration, a snippet of sonar data is recorded during FAT, when the noise in the system is at acceptable / design levels. This data is then available as a reference for testing by comparison during Integration. A record of sonar data is also taken during the sonar system sea trial (if applicable) before delivery. This will provide an indication of the performance / range achieved in the specific environment where the sea trial is done. Note that this sonar data can not be used for direct comparison with acoustic images obtained at a later stage as the environmental conditions are unlikely to be the same, even in a similar location (seafloor backscatter variation).

To be effective for comparison, all data recording for test purposes needs to be done with the same system setup / configuration. So testing is to be done using “JSTAR” software (in J-Star Diagnostics folder) suitably configured by loading the JStar initialization file (xxx_yyy.jni) provided to set up the relevant default parameters. Using the same triggering, pulse selection, pulse power, ping rate, range selection, etc. as used in the recorded manufacturing data files, a direct comparison of sonar data being monitored/recorded during system Integration can be made with the playback of the manufacturing data file. Software required for testing will be

available in the sonar processor memory and a copy will also be provided on a CD with the delivered sonar system.

Note that if the graph tab is used to view envelope data during testing, the RMS value over the mid to full range sector of the noise (in air) is typically less than or equal to 7 counts.

The folder structure for software and recorded data is typically as shown below. Files have been created for recording of data (*.jsf) as the Integration and operational phases progress.

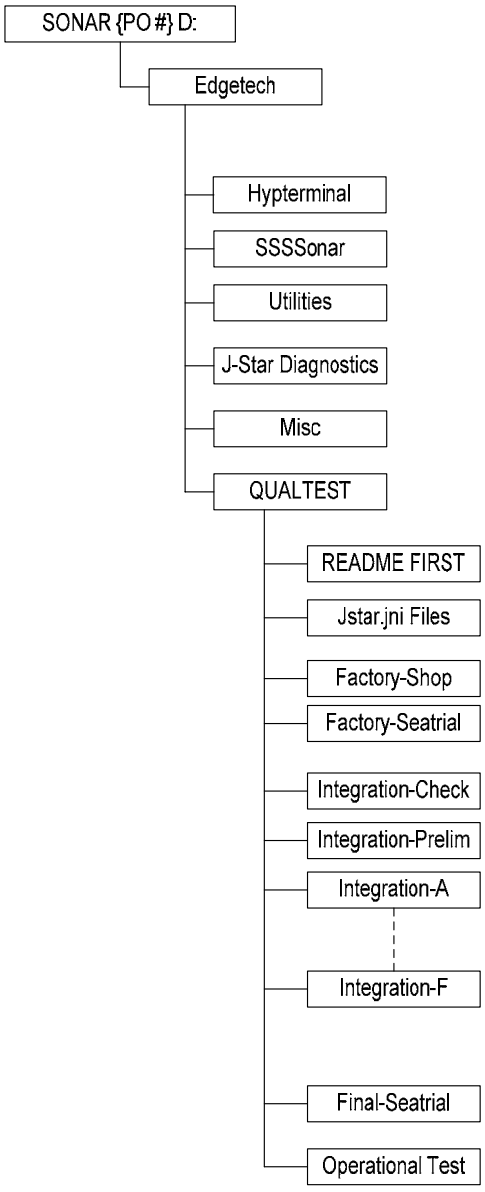


Figure 2: Software Folder Structure

4. Sonar System Stand Alone Testing

Check of Deliverables

On receipt of a Sonar System, the delivered items need to be checked to verify that all components and documentation required for Integration have been delivered. The delivered system should then be hooked up as a stand alone system and tested to verify that the delivered equipment is still functional and has not incurred any damages in transit.

Deliverable System (Integration_Check) Testing

The first Integration test is to verify that the delivered sonar system is in the same functional state as when shipped and is ready for Integration. When the system is set-up as a stand alone system, the functionality can be verified by doing a “rub test” and the noise levels can be verified to be the same as the data recorded during manufacturing. Note: Recommended procedure for the side scan sonar rub-test is to first rub the port side array, then the starboard side followed by again rubbing the port side. This ensures that arrays have been correctly connected by observing that the rub signal is displayed in this order.

If the system does not have a Topside (display processor and monitor), testing can be done using a PC or laptop, running the provided JStar software and JStar test initialization file, connected to the sonar processor Ethernet port. The rub test is done when the sonar system is operational, by rubbing the arrays (in air) and verifying that a significant signal is observed on the monitor for the relevant array. The noise level can then be compared with the playback of the Factory_Shop.jsf file. For more information on using JStar for Noise Level Comparison, see Appendix D (Software). If the system is working as expected, a recording of the sonar data in file Integration_Check.jsf can be made (snippet of data for about 2 minutes of recording). EdgeTech Customer Support Services can be contacted should any problems be encountered with the delivered system.

Note: The guidelines for side scan sonar systems more specifically described in this document apply equally for sub bottom profiling sonar systems where the sensitive areas are between the hydrophones and data acquisition boards.

5. Sonar System Installation

Hardware Location

It is essential to ensure that the noise sensitive sections of the sonar system (arrays through T/R Switch PCB's) are installed in a manner where their location and wiring affords them the minimum exposure to electro-magnetic interference (radiated or conducted). The T/R Sw's need to be located as far away as possible from the sonar system power supply and digital PCB's as well as components of other systems which have electro-magnetic radiation (eg, all digital circuits with clocking or switching and other power supplies).

Note: When a standard or proven chassis is not used and a new custom chassis is designed for mounting of the electronics, a number of unknown factors are introduced into the design. Adequate time should be allowed for design and development of the chassis prior to manufacture, as well as for additional time for extra testing required. Provision should also be made for having suitably experienced persons available during vehicle Integration for performance (noise) test and evaluation.

Wiring

Wiring between the side scan arrays and T/R Sw's or sub bottom hydrophones and data acquisition boards need to be kept as short as possible and need to be screened from end to end as far as is possible. ***Important Note:*** Wires for sensitive signal that are unshielded for more than one inch are likely to result in noise problems. This wiring should not be run with other wiring that may induce noise into this wiring (preferably run independently of other wiring). Wires that cross over other wires should cross at right angles where possible. The chassis provided with the sonar system components is an integral part of the low noise design of the system. The chassis is at isolated 0Vdc potential of the Sonar power supply and it needs to be electrically isolated from the vehicle chassis when mounted.

Provision of a single point "Sea Ground" for the sonar system is recommended. Special provisions for power supply and interfacing signals for the sonar system have to be made when the host vehicle chassis is run at a potential other than the sea ground potential. Mechanical coupling of noise into the system also needs to be avoided, specifically for arrays and hydrophones.

Support

When installation assistance is needed or advise/recommendations required, EdgeTech Customer Service can be contacted in this regard and persons with suitable knowledge and experience in the relevant domain can be consulted in order to ensure that installation is effected in the best possible manner. If Integration Support is included as a line item in the Sales Order/Contract for purchasing the Sonar System, the cost of providing assistance with installation and Integration is covered and it is expected that this service is requested and rendered.

6. Installed Sonar System Testing

Preliminary Integration (Integration_Prelim) Testing

Once the sonar system has been installed and powered up in the host platform, the functional (rub) and noise tests as done for the stand alone testing should be repeated (see section 4). This should be done without other systems already installed in the platform being operational (where possible). Sonar data should again be viewed and the noise level compared with the levels in the playback of the Factory_Shop.jsf file. When the system is installed in the vehicle and running off vehicle power and using vehicle interfaces, and has noise levels similar to that obtained for factory testing, a recording of the sonar data in file Integration_Prelim.jsf can be made. If the noise level is noted to be significantly higher than in the playback of the manufacture recorded data, this needs to be attended to. If fundamental checks and changes do not provide satisfactory reduction of the noise level, contact Customer Support at EdgeTech to arrange for assistance with this matter. A copy of the Sonar Testing folder, including a recording of sonar data under these conditions, needs to be copied to the EdgeTech FTP site and notice thereof provided in an e-mail. {Upload to: ftp.edgetech.com/incoming. Use an anonymous login and no password is required}

Progressive Integration (Integration_A to Integration_F) Testing

Once preliminary testing has been successfully completed, tests should be repeated and data recorded as each other system is installed on the vehicle, individually powered up and made operational. Data should be recorded in files Integration_A to Integration_F (as required) and the file naming can be changed to replace the A/F with the name of the system which is being brought into operation at that point. Again, should noise problems be encountered, Customer Support at EdgeTech should be contacted to arrange for assistance and a copy of the folder placed on the EdgeTech FTP site.

7. Installed Sonar System Sea Trials

For completion of the vehicle Integration phase, sea trials are normally performed to verify the functionality and performance of all systems in a typical operational environment. Depending on the nature of the project, sea trials could be either informal (Integrator only) or formal (Customer Acceptance). The requirement for EdgeTech support for sea trials or final acceptance testing of the Integrated System is also typically determined by the nature of the project. Complex sonar systems or sonar systems involving new technologies or designs may warrant having EdgeTech support included in the project sales order/contract. Even if this is not included in the acquisition agreement, EdgeTech Customer Service can be contacted in this regard and arrangements can be made to have persons with suitable knowledge and experience available for sea trials and/or acceptance testing.

The overall responsibility for sea trials and HAT's/SAT's is with the Integrator. The extent of EdgeTech's participation in planning, co-ordination, testing, documentation and recording that may be required for sea trials, HAT's and/or SAT's is determined by contractual or sales order requirements that are agreed to.

Final Operational (Integration_F) Testing

When shop testing of the integrated system has been completed and sea trials are undertaken, a recording of sonar data needs to be made with the system fully functional in typical operating conditions. It would be appreciated if a copy of this data could be uploaded to the EdgeTech FTP site and Customer Service notified by e-mail of the availability. This operational data recording is extremely useful as a reference should a future problem be encountered with the performance of the system. This data can be compared with the recorded data from the manufacturing phase. Note that the comparison should be focused on the noise levels encountered (especially at the extremes of the range of the specific system). A direct comparison of the return signal (picture of sea bottom) is not feasible as the acoustic environment is not the same and a comparison can be misinterpreted. However, persons with knowledge of sonar and the test environment could offer a creditable opinion on the performance of the integrated sonar system by viewing these data files.

8. Integrated Sonar System Support

Problem Reporting

If a noise or performance problem is noted with a sonar system when it is operational, where possible a representation of the problem should to be captured by recording of a snippet of sonar data (saved in Operational Test folder) with the system configured in the same way that it was configured for Integration testing. A copy of the EdgeTech Folders including the recorded data showing the problem should to be returned to the EdgeTech Customer Support representative (upload to EdgeTech FTP site), together with email notice of data availability and a summary of the nature of the problem. This will provide a good source of information that can assist with analyzing the problem and expediting the resolution of the problem.

Warranty

EdgeTech offers a warranty that covers the repair/replacement of supplied equipment that becomes defective during the warranty period (typically one year from delivery of the sonar system). This warranty does not cover equipment that fails as a result of improper use or inappropriate installation during Integration or equipment that is modified for/during Integration. Defective equipment is to be returned to EdgeTech Customer Service. In some cases “hot swap” replacements can be provided with the understanding that the replacement is billable if the item defect is not covered under warranty.

Operational Support

EdgeTech offers Training courses which can be tailored to meet customer’s specific requirements. Courses persons with varied levels of skill can be provided which address operational, maintenance, technical, sonar principles or combinations of these as required.

Field support can also be provided when required. Arrangements can be made by contacting EdgeTech Customer Support.

9. APPENDICES

Appendix A: System Noise Reduction

Eliminating or Reducing Electrical Noise

The most common ways of reducing eliminating or reducing electrical noise are:

- Shielding
- Cancellation
- Filtering
- Suppression
- Grounding

9.1.1.1. Shielding

Almost any metal will offer some shielding. A shield basically blocks the noise, just as the name implies. Metal enclosures are common for inverters and some other equipment. But metal conduit will also act as a shield. Shielding is effective but not always possible, and will not do much to stop any noise carried on the wiring to and from the device. When using cables with shields, these need to have the shielding continued through to or as close as possible to connectors in the cable path – less than one inch of cable should be exposed. Cable shielding is typically designed for grounding at all ends so that these can be either connected to ground (DC or AC coupled) or left floating, as is most appropriate to the system.

9.1.1.2. Cancellation

Cancellation might not be the best term. This is also known as common mode rejection. This is relatively simple to do and quite effective in some cases. It is basically a matter of twisted wire pairs and balanced signal lines. Noise in twisted pairs tends to cancel itself out at each twist. It does not work in all cases, but is simple, cheap, and usually easy to do, so that is often the first method to try. Some cables, mainly for such things as signal wires (in particular for low level sonar input signals) should be shielded twisted pairs. This type of cable is very effective in keeping noise in or out of wires.

9.1.1.3. Filtering

Filtering has been around since electronics was invented. The most common method is to use capacitors across a signal line or wire to ground to get rid of the noise. Inductors are sometimes used also, but they have some frequency limits and can also get rather bulky and expensive. One limitation of using capacitor filters is that you usually must have a good ground nearby for one side of the capacitor. If you have long leads between what you are filtering and ground, you could even make the problem worse.

9.1.1.4. Suppression

This is relatively new and often the most effective. The most common method uses Ferrite chokes, cores, and beads. Ferrites are powdered molded metal powders cast into various shapes and sizes. Ferrites are actually ceramics which can be simply opened up and snapped around the wires or cables. They are usually made of powdered Iron Oxide (Fe2O3), along with Zinc, Copper, Zinc, and other metal oxides.

You can stack as many as you want and stack different types if you have severe problems. You don't need one for each wire unless you have really fat wires - they work just as well if snapped onto a pair or bundle of wires. There are non-conductive so can be used almost anywhere, including on 115 volt power lines and battery or inverter cables.

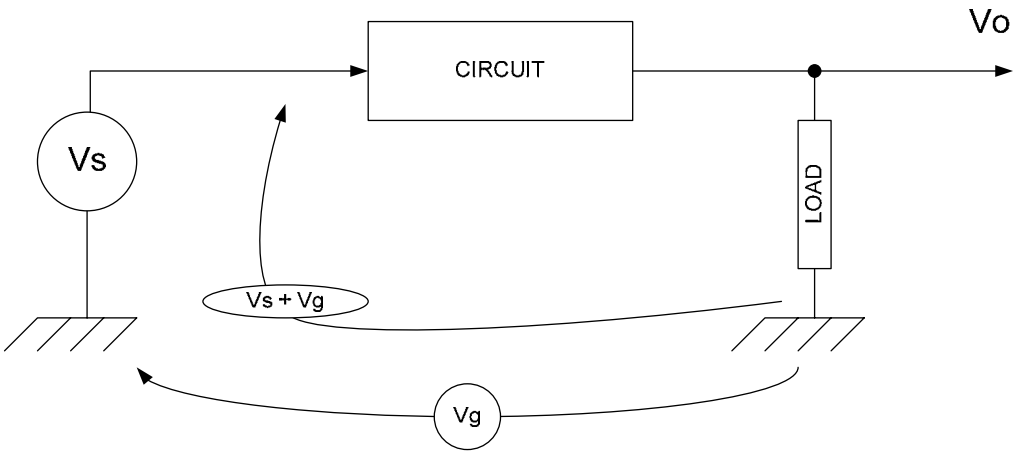
Appendix B: System Wiring, Grounding and Screening

Grounding

The most common noise problem encountered in electronic systems stems from a lack of good grounding practice. Grounding is a major concern to practicing design and systems engineers. An extensive body of literature has been published on these subjects. Here are some basic practices to avoid grounding problems in your circuits.

If several points are used for ground connections, differences in potential between the points can cause troublesome "ground loops" which will cause errors in voltage readings. This is illustrated in the figure below, where two separated chassis grounds are used. Vg represents a voltage existing between signal ground and the load ground. If voltage measurements are made between the load ground and the input signal, Vs, an erroneous voltage, (Vs + Vg) will be indicated.

Generation of Ground Loops



A common sign that a ground loop(s) exists, or that a ground is missing, is the presence of induced power supply signal of some frequency, which adds noise in the circuit.

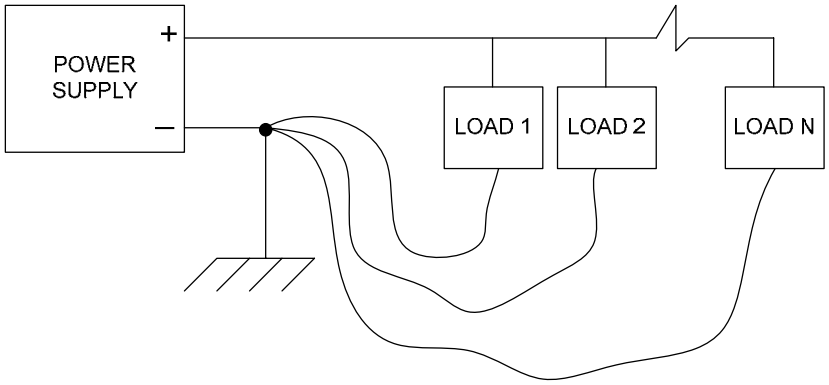
Finding and eliminating troublesome ground loops in complex electronic systems can be a difficult and frustrating task; it requires an expertise gained largely through experience. This is why grounding, in many cases, is referred to as a "black magic art".

Basic Grounding Practices

a. Circuit Grounding

The ideal "single point ground" concept insures that no ground loops are created. As the name implies, all circuit grounds are returned to a common point. This concept is shown in the figure below.

Concept of "Single Point Ground"

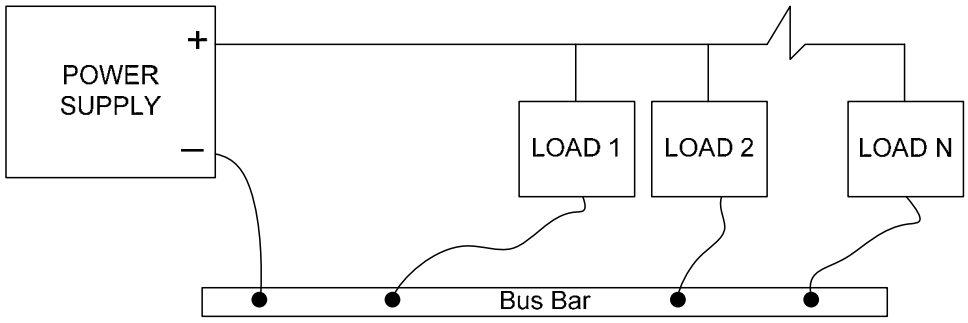


While this approach looks good on paper, it is usually not practical. Even the simplest circuits can have 10 or more grounds, and connecting them at a common point becomes a physical challenge. The next best thing is a ground bus.

b. Ground Bus

Bus bars are available or can be constructed to serve as an adequate substitute for single point ground. The bus bar is simply a heavy wire or copper bar of low resistance which can carry the maximum sum total of the load current back to the power supply. The bus can be extended along the length of the circuitry so that convenient connections can be made at various points. The use of a ground bus is shown in the figure below.

Bus Bar Grounding



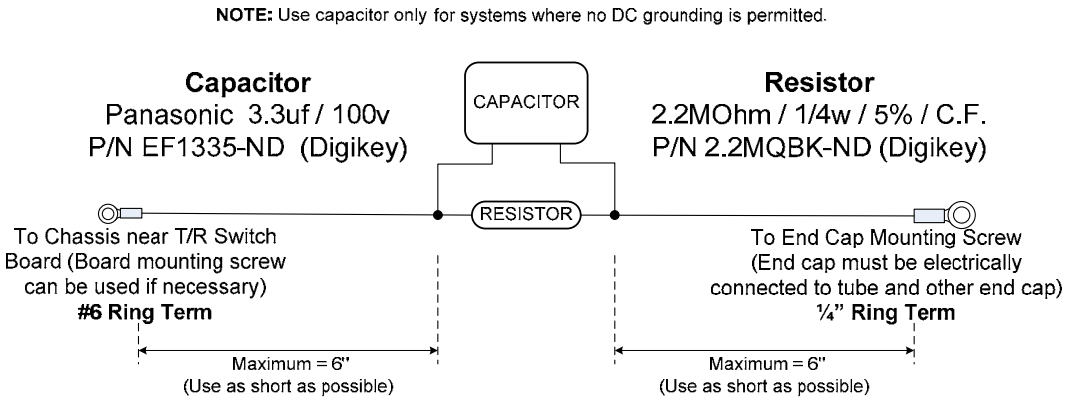
Analog/Digital Grounds

In general, analog and digital grounds should be kept separated and connected together only at one single point.

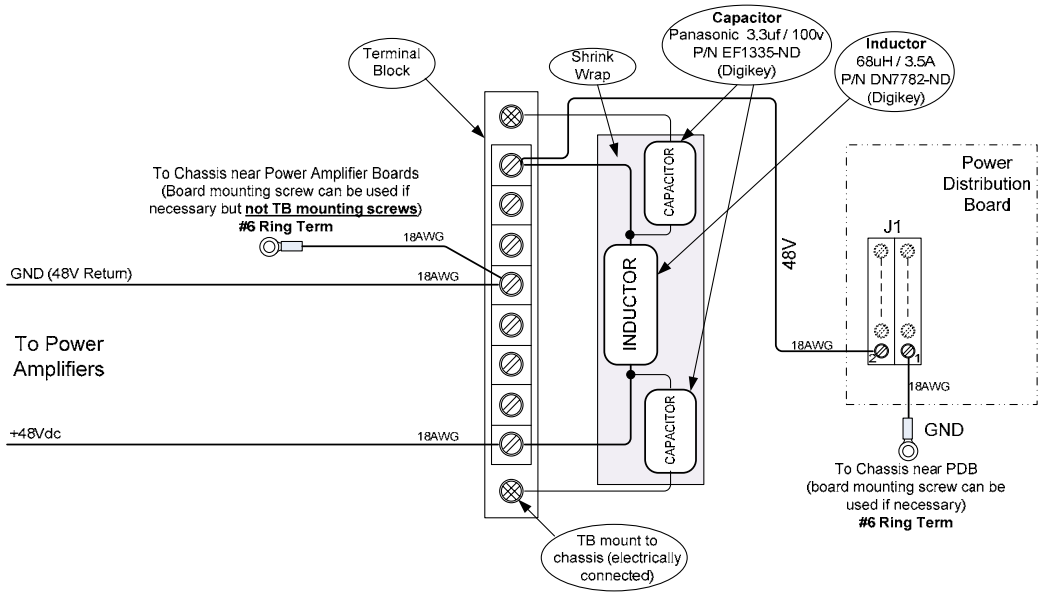
Typical Grounding and Filtering used by EdgeTech.

The following diagrams show grounding and filtering that can be found in EdgeTech Sonar Systems.

The diagram below shows a typical ground link to the "Sea Ground" required to couple the 0vdc potential of the sonar system chassis to the sea ground. This example is applicable where a pressure housing with end caps is used containing an electrically isolated chassis for the sonar boards. This link provides a path to conduct noise induced in the chassis to the sea ground. A similar sea ground link is provided on the 0Vdc line (GND) of DC power being provided to the Sonar System by the vehicle. ***Note:*** The power input is isolated from the sonar system power via an isolating power converter on the power distribution board.



The diagram below shows the typical filtering to ground of noise on the 48V power lines to the power amplifiers of a sonar system. ***Note:*** The return (ground) path from the power board to the TB is via the chassis (used as a bus bar) and a common ground point for the amplifiers is created at the TB.



Appendix C: Mechanical Interfaces and Component Layouts

Transducers and Arrays

Care needs to taken when transducers and arrays are mounted on a vehicle to ensure that electrical bonding or isolation is effected in a manner that will ensure that electrical current does not flow in a manner that would lead to corrosion of any of the relevant components. This requires taking into account the potential at which certain components or housings are maintained at and the mating of dissimilar materials.

When mounting the transducers and/or arrays on a vehicle, care must be taken to ensure that an appropriate acoustic window is provided and the water flow across the faces of these devices is laminar (no turbulence) and free of bubbles, motion generated or otherwise. Generally transducers and/or arrays should be located away from the drive/propulsion mechanism of the vehicle and on a base that is vibration free. Interconnecting cables should also be firmly secured to avoid generating noise by movement as a result of vehicle motion. Note that typically side scan arrays are mounted at a depression angle in the order of 26 degrees and sub bottom transducer faces should horizontal.

Range vs Frequency

A Sonar System may be operating normally but performance can be misinterpreted as either being very good when ideal acoustic conditions prevail, or very bad when the environment is not suitable for acoustic applications. However, typical ranges can be expected from a sonar system, primarily determined by the frequency that the system operates at, as shown in the table below. These ranges are typical for clear saltwater (30ppm) at temperature of 20 deg Celcius (68 deg Farenheit).

FREQUENCY	TYPICAL RANGE
75 KHz	500-700M
120KHz	400-500M
230KHz	200-250M
410KHz	100-140M
540KHz	60-80M
850KHz	50-60M

Note: System noise evaluation should not be done by viewing noise at a range beyond the typical operational range applicable for the system frequency.

Appendix D: Software

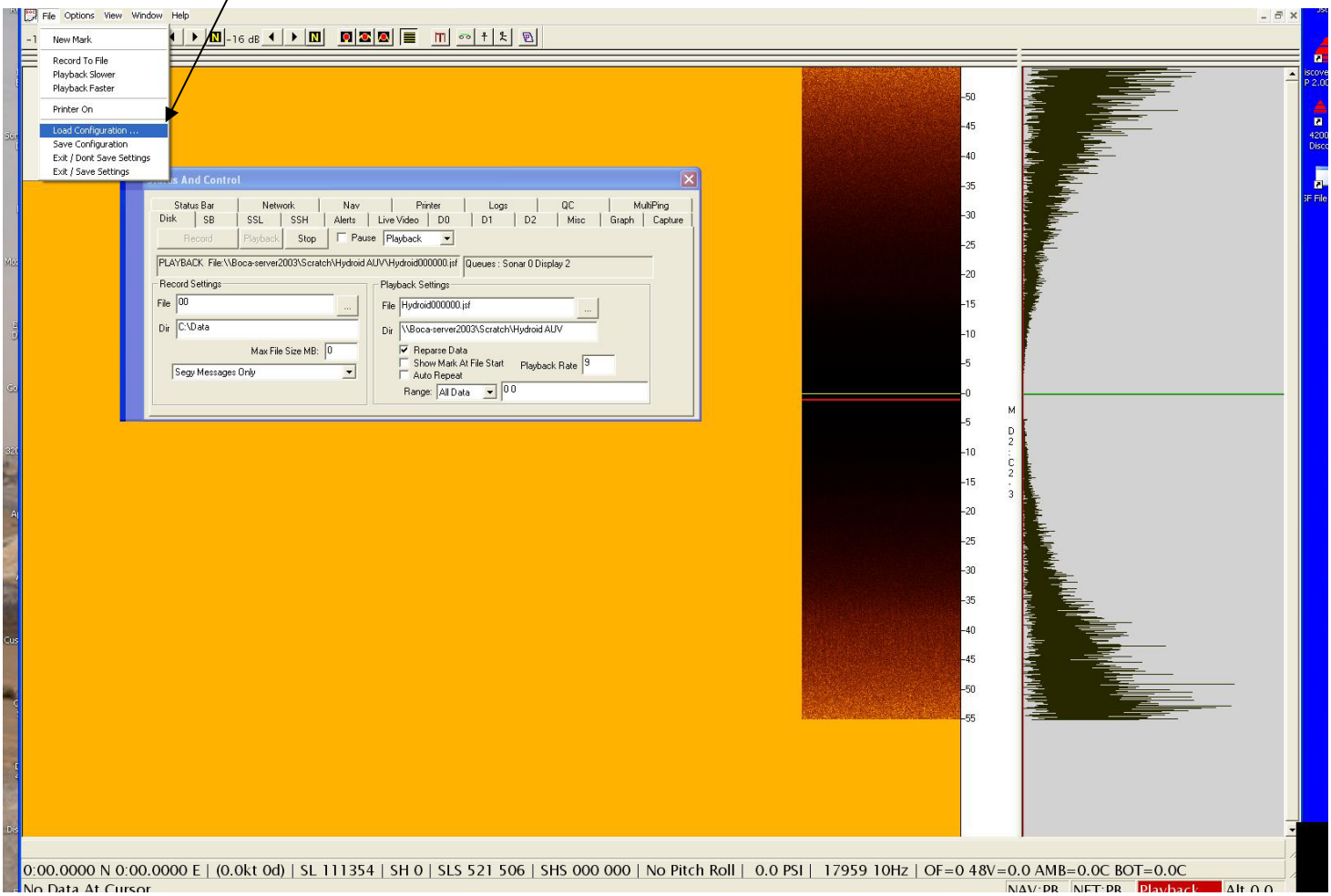
Sonar Systems are delivered with the latest tested version of available software installed. Software is delivered under licensed agreement and maintenance contracts for upgrades are available. Software utilities that are delivered at no cost such as the diagnostic tool JStar.exe, are not subject to any agreements and can be used as the customer decides. These utilities are not necessarily appropriate for the customer's applications and although suggestions for changes or upgrades are appreciated as feedback, new requirements will only be addressed at EdgeTech's discretion and when the software development schedule permits.

Note: Files created for recording sonar data must be of the form xxx_yyy.jsf (no spaces or -).

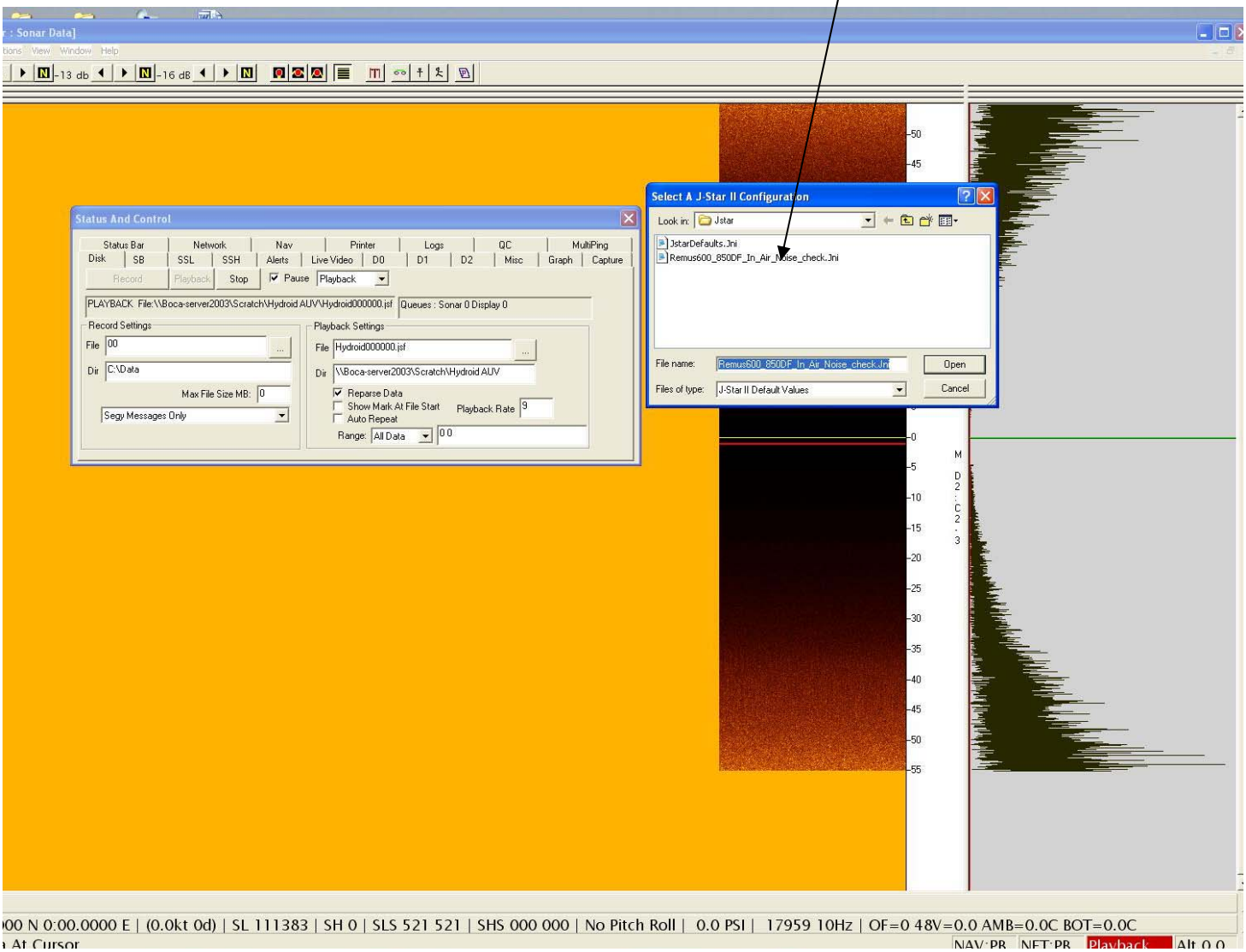
Using JStar for Noise Level Comparison

The following examples show the use of JStar with appropriate settings and what to expect in terms of noise…

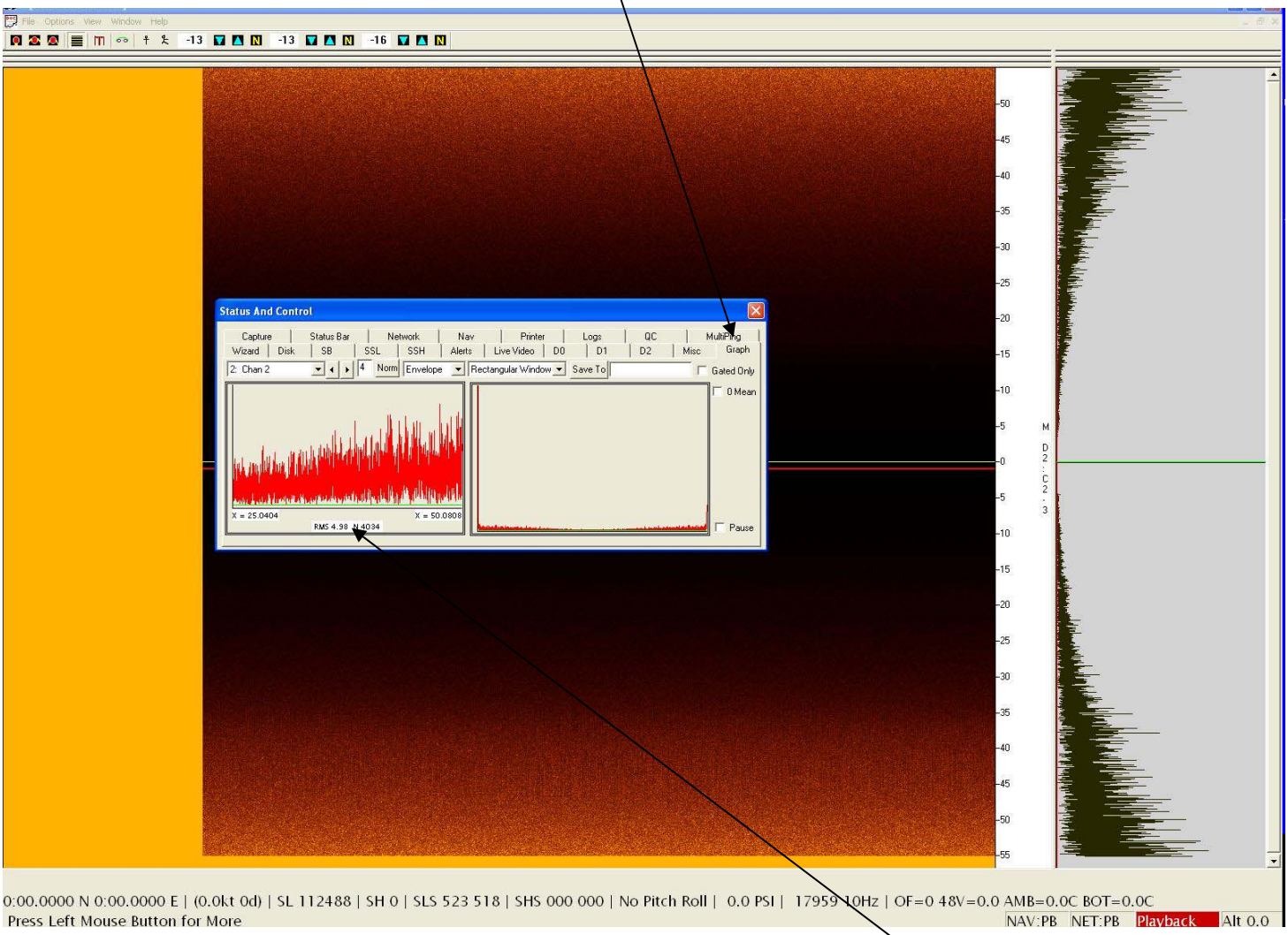
Start JStar (JStar.exe from J-Star Diagnostics folder). From the File tab, select Load Configuration.



Load the .jni file provided in the JStar.jni Files folder to obtain the required test setup and configuration. This file sets up the various parameters (transmit output power, sample widows, graph settings, etc) in order to have the same configuration as used in the factory for looking at the noise on the receiving section of the sonar system.

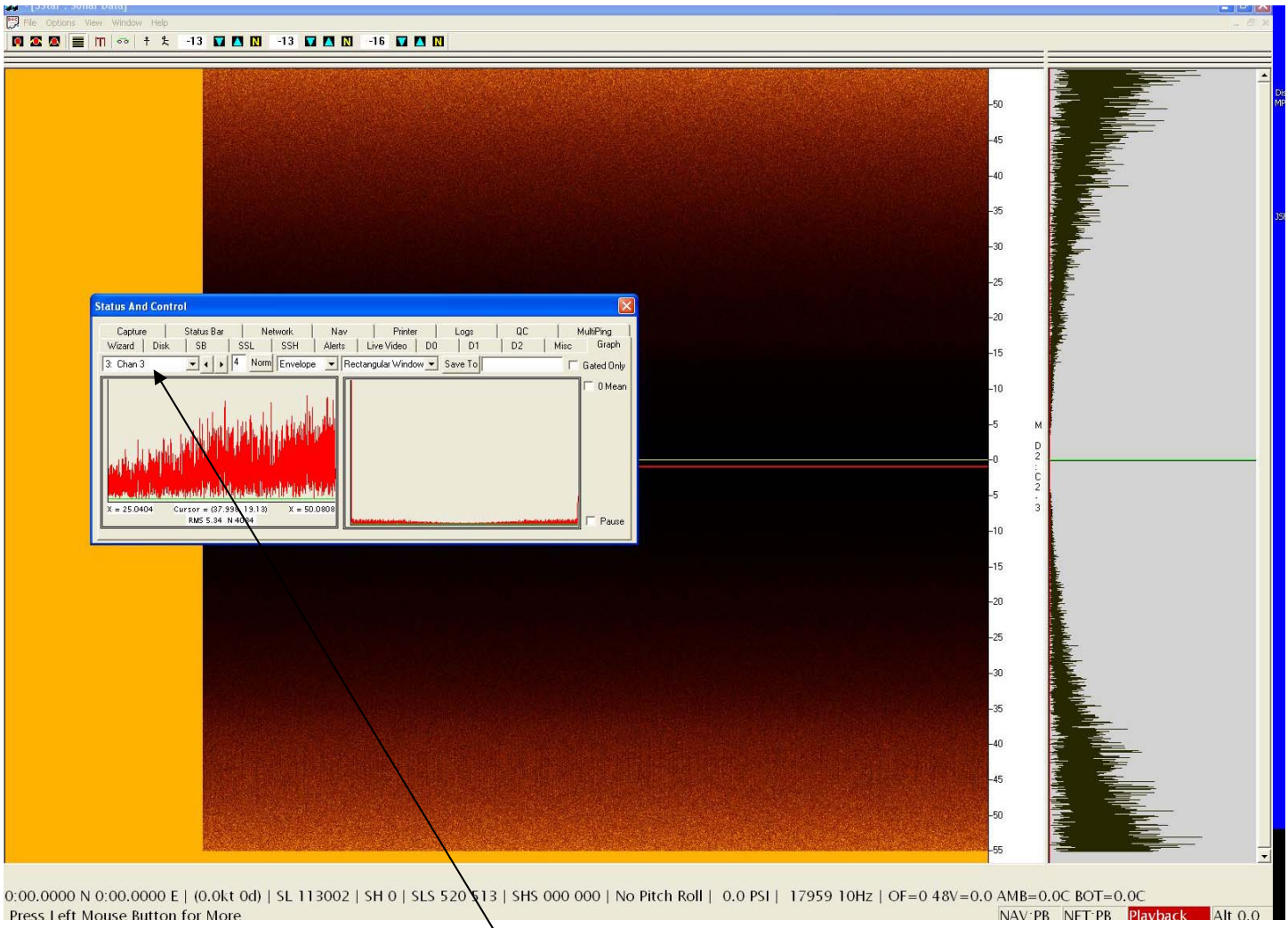


Go to the Disk tab in the Status and Control window and select Playback. In the Playback Settings, enter the baseline Factory_Shop.jsf file shipped with the system and start the playback. Then go to the Graph Tab…



In this example, the Port Side signal (Channel 2) above is showing noise level at RMS Counts of 4.98 (low noise level). Typically noise level RMS Counts less than 8 are acceptable.

Note: These are noise levels for arrays in air and low transmission power. Array shielding should be provided if external acoustic interference is noted by observing noise changes when an array is moved.



Similarly the Starboard Side (channel 3) signal can be viewed and this is showing RMS Counts 5.34. Typical counts are 4-8. Using the same setup and configuration, actual noise levels of the system in its current state can be viewed and compared with what was observed from the recorded data. If you observe a reading of 8 or more counts or find a notable difference between the recorded noise level and the current noise level, the system noise level is higher than desired and steps need to be taken to reduce noise levels, such as considering relative location of electronic boards and wiring. Re-routing or re-locating these components generally helps to resolve noise problems that are inherent in the integration of the system. If noise levels are satisfactory, data needs to be recorded and saved.

Note: Noise levels are best viewed over system mid to full range (see Appendix C for range table) where noise becomes more pronounced with application of TVG (increasing gain).

Appendix E: EdgeTech Support Services

SERVICE & SUPPORT RATES

EdgeTech provides qualified technicians and engineers for Integration support, preventive maintenance, repair and calibration of equipment as well as installation, field service, operator training and for other assistance as needed.
Scheduling of service activities usually requires advance lead times of two weeks, however emergency field service can also be provided.

EdgeTech Policy for Engineering Services

EdgeTech provides technical advice and support, at no charge for the following activities:

- Explanation and clarification of EdgeTech Product specifications.
- Answering questions on EdgeTech's specifications, documentation and interfaces. (within reason)
- Understanding customer requirements and recommending/explaining the right product solution.
- Command & Control and Data Formats for EdgeTech systems and sub-systems (under terms of a Confidentiality Agreement).

EdgeTech charges for:

- Participating in the system design, with the customer, where EdgeTech helps to determine the customer's other system components and how they may be integrated by the customer.
- Creating specifications and or code for system elements that EdgeTech does not supply.
- Troubleshooting/debugging of the system beyond EdgeTech's interfaces or including EdgeTech's sub-systems when the root cause of the problem is outside the elements supplied by EdgeTech.
- Troubleshooting and repair to EdgeTech sub-system elements where customer's other systems/elements have damaged the EdgeTech systems/components.
- Participation in changing overall system designs to correct system design failures.
- Expenses related to chargeable items. (travel, subsistence, telephone, etc.)
- Operational and System Maintenance Training

Applicable Service Rates

In–house Evaluation & Repair for Boards and Sub-Assemblies: $125 per hour with $375 Minimum Charge.
In–house Evaluation and Repair for Products: $125 per hour with $1000 Minimum Charge.
In-house Evaluation and Repair for Special Systems: $150 per hour with $1,500 Minimum Charge.

Other In-house Service: Technician @ $800 per day; $125 per hour or Engineer @ $1,000 per day; $150 per hour.
Travel, Standby, Field Service Time: All Field Personnel @ $1,250 per day

Expenses incurred by the EdgeTech field representative in connection with the service are billed at cost plus 10%. This includes all travel and lodging expenses as well as meals and other items incidental to the service.
Time spent in preparation and/or generating a field service report is charged at the field service rates.
Daily or hourly charges are applicable from the time the field representative leaves office/home until the time he/she returns.

The rates and policies outlined above are subject to change at the Company's discretion and without prior notice.

EdgeTech also provides training courses which are recommended for persons doing system Integration work. Courses can be arranged which focus on specific topics pertaining to the Integration of a sonar system to ensure that these persons are familiar with the characteristics of the product they are dealing with.

EdgeTech also provides remote customer support for systems in the field by facilitating remote connection of sonar systems over the internet. Online support is effected using ***GoToMeeting*** to connect the sonar system to EdgeTech Customer Support and/or Engineers. This allows a virtual meeting to be take place for discussion, analysis and assistance with issues of concern regarding the sonar system.

Contact EdgeTech Customer Services for any further support information that may be required or to schedule provision of any services required.

Appendix F: Contracts and Specifications (Responsibilities)

Integration

A Sonar System is normally purchased as a deliverable system that conforms to specifications that are defined in the relevant purchase order or contract. The system is factory tested to verify that the system conforms to the requirements of the specification and is delivered as such with warranty cover for a stand alone system. Should the Sonar System require changes or modifications for Integration in a customer's vehicle, these changes and/or modifications and the consequences of implementing these, are the customer's responsibility. If the customer requires support during the vehicle Integration, these requirements need to be addressed in the relevant contract or purchase order and clearly defined areas of responsibility should be noted. Note that the Sonar System can not be perceived to be specifically built for Integration into a vehicle if the specifications and design details of the vehicle and all interfacing or interacting components thereof are not provided. A schedule for vehicle Integration and support required should be maintained and distributed to ensure that any joint undertakings can be effectively and efficiently completed.

Communication

It is recommended that a single point of contact for routing of all communication is established early in all projects for both the Customer and EdgeTech. Unless other project specific arrangements are made, EdgeTech communication after delivery of a system and during the Customer's Integration phase, is effected via the Customer Services Manager. Feedback on progress of Integration and any problems that may be encountered would be appreciated.