

SeaBat T-Series Subsea T20/50-S Deep/Shallow High-Resolution Multibeam Sonar System OPERATOR'S MANUAL



Part Number 1009737

Version 12

December 2021

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PREFACE – ABOUT THIS MANUAL

This manual is designed to give detailed procedures for the correct installation, operation, and maintenance of the SeaBat T-Series Subsea sonar system and is equally useful for both the first time user and the experienced technician.

Read this manual thoroughly and follow the steps provided to maintain optimal safety standards and to obtain the best system performance.

If you require additional information or need clarification of any part of this document, please contact Teledyne RESON Customer Support for assistance at reson-support@teledyne.com.

Document Conventions

The following information will make it easier for the reader to interpret the document content.

Convention	Definition
<i>Hyperlink</i>	Indicates a cross-reference to Ctrl+Click to reach the specified item.
Numbered list	Indicates stepwise instructions to be followed in a particular order.
Bulleted list	Indicates items of a list without any particular order.

Notes, Cautions, and Warnings

Notes, Cautions, and Warnings are included to provide valuable information and to help the operator prevent damage to the sonar or to personnel. These are the formats:

NOTE
Note boxes provide explanatory information that may be useful to the operator, but is not necessarily vital to the operation of your Teledyne RESON system.

CAUTION
Caution boxes provide important information regarding your Teledyne RESON system. Disregarding Cautions may result in accidental misuse or damage to the system.

WARNING!
Warning boxes provide important information regarding your Teledyne RESON system. Disregarding Warnings may prove harmful to personnel working with or near the system.

Conversion of Units of Measurement

Metric Conversion

All measurements in this manual are referenced in metric terms.

Use this reference table to convert between metric (e.g. cm, m, and km) and imperial (e.g. in, ft, and yd) measurements.

Metric Unit	Imperial Unit
Millimeter (mm)	0.0394in
Centimeter (cm)	0.3937in
Meter (m)	1.0936yd
Kilometer (km)	0.6214mi
Kilogram (kg)	2.2046lb

Temperature Conversion

All temperatures in this manual are referenced in degrees Celsius.

This is the formula for converting Celsius (°C) to Fahrenheit (°F).

$$\text{Formula: } ^\circ\text{F} = 1.8 \times ^\circ\text{C} + 32$$

Example:

If Temperature = 30°C, then:

$$^\circ\text{F} = 1.8 \times 30^\circ + 32$$

$$^\circ\text{F} = 86^\circ$$

Glossary of Terms

Entry	Definition
7k	SeaBat 7000 series of multibeam sonars
AUV	Autonomous Underwater Vehicle
BITE	Built-In Test Environment
CE	Conformité Européenne
CFE	customer-furnished equipment
CW	Continuous wave
Cylindrical loss	The loss of sound by spreading in the form of a cylinder
DFD	Data Format Definition
DWG	Drawing
EA	Equiangular
ED	Equidistant
FM	Frequency modulation
FRDH	Full Rate Dual Head
LED	light-emitting diode
N/A	not available or not applicable
OM	Operator's Manual
PN	Part Number
RMA	Return Material Authorization
ROV	Remotely Operated Vehicle
Rx	receiver
SNR	signal-to-noise ratio
Spherical loss	The loss of sound by spreading in the form of a sphere
SSP	Subsea Sonar Processor
SV	sound velocity (or surface vessel)
SVP	Sound Velocity Probe
TBD	To Be Defined
TPU	Total Propagated Uncertainty
TVG	Time-Variied Gain is a control intended to vary the gain of an amplifier over a predetermined time period (usually from a low to a high gain state)
Tx	transmitter
UI	user interface
UUV	Unmanned Underwater Vehicle
VAC	volts alternating current
VCC	Vehicle Control Computer
VDC	volts direct current
WEEE	Waste Electrical and Electronic Equipment

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1 INTRODUCTION

1.1 System Overview

The SeaBat T-Series Subsea is a new addition to the leading SeaBat product range engineered from the ground up to evolve with your business. The SeaBat T-Series Subsea sonar system is designed for mounting on an Unmanned Underwater Vehicle, an AUV or ROV. The series is available in various configurations.

- **SeaBat T20-S:** Combined with a Subsea Sonar Processor (SSP), the T20-S provides the highest quality survey data in a fully integrated sonar processing and data storage unit housed in a subsea pressure vessel.

The SeaBat T20-S yields a smaller form factor and reduced operational power to extend UUV mission time.

- **Deep operation** with TC2160 and TC2163 (optional) projectors (shown).
 - **Shallow operation** alternative with TC2181 projector.
- **SeaBat T50-S:** Combined with a Subsea Sonar Processor (SSP), the T50-S produces unprecedented clean data, providing faster operational surveys and reduced processing time in a fully integrated sonar processing and data storage unit housed in a subsea pressure vessel.
 - **Deep operation** with TC2160 and TC2163 (optional) projectors.
 - **Shallow operation** alternative with TC2181 projector (shown).
- **Subsea Sonar Processor:** For both SeaBat T20-S and T50-S, the SSP provides internal data storage for self-contained survey solution and interfacing via standard Ethernet to reduce integration time.

All solutions include a powerful software feature set to increase operational efficiency, with the option for future feature expansions to grow with your needs.

For both SeaBat T20-S and SeaBat T50-S, the SSP is available in an extended version with Integrated Dual Head support for dual sonar head configurations.



For available configurations, see *section 1.6 below*.

For available options, see *Appendix G SeaBat T-Series Subsea System Options*.

1.2 System Architecture

The SeaBat T-Series Subsea sonar system consists of a Subsea Sonar Processor (SSP), a receiver unit, and a projector unit (or two projector units). The receiver and projector units each connects to the SSP via a dedicated cable. With AUV operation, the SeaBat T-Series Subsea sonar system is installed and configured to operate autonomously requiring only a startup command to function. With ROV operation, user displays and system control originate within the customer-furnished survey laptop. To feed 22-60VDC power and control the operation of the sonar, the SSP provides an Ethernet and power input connector. Sensor data may be interfaced to the SSP via dedicated ports.

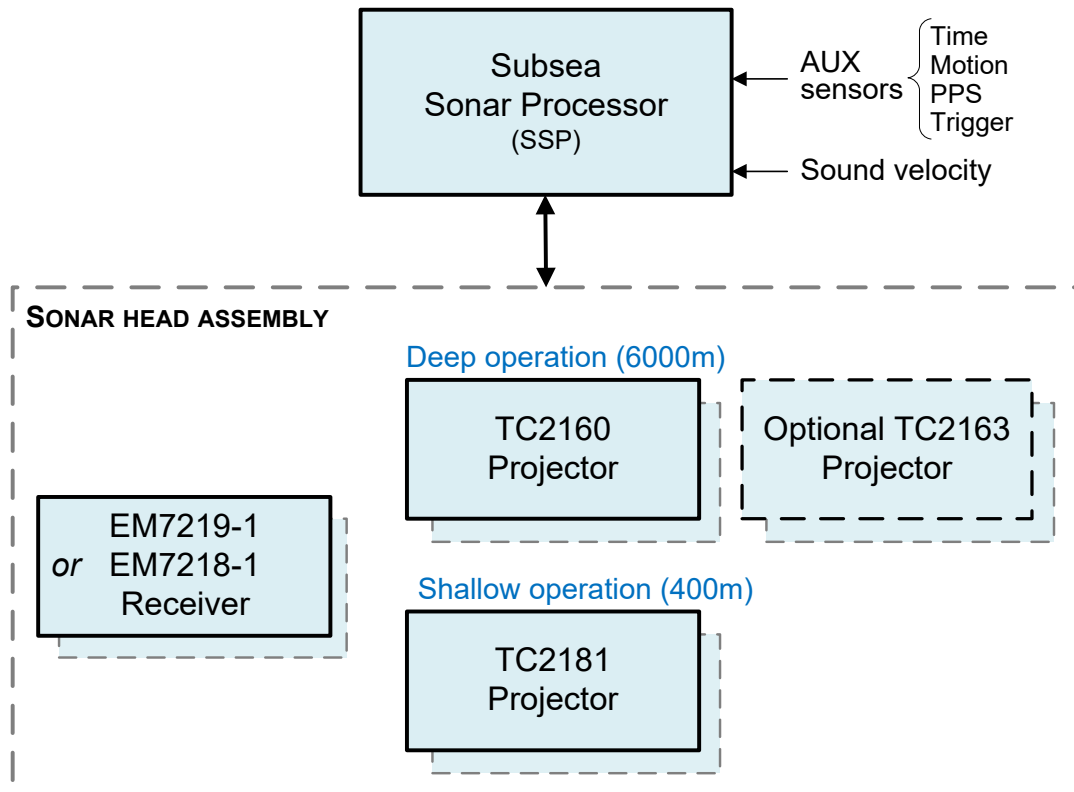


Figure 1: SeaBat T-Series Subsea System Configuration

1.3 System Operation

The projector unit of the sonar head assembly transmits a pulse of acoustic energy, which travels through the water medium and is reflected by the seafloor or any objects in its path. The reflected signal is detected by the receiver unit of the sonar head assembly, digitized by internal electronics, and sent to the SSP for beamforming and processing. The SSP can act as a single point of interfacing for sonar and sensor data for precise time stamping of these data prior to broadcast over standard Ethernet connection to the logging system.

1.4 System Features

Table 1: SeaBat T-Series Subsea Feature Pack

Feature	Base	Optional
Channel normalization	✓	
Data logging internal to the SSP	✓	
Dual head, full rate (FRDH) ¹		✓
Dual head, standard	✓	
FlexMode		✓
Head tilt	✓	
Manual gates	✓	
Max. 1024 beams	✓	
Multi-detect		✓
On the fly frequency change	✓	
On the fly mode selection	✓	
Pipe detection and tracking ²		✓
Quality filter	✓	
Roll stabilization	✓	
Sonar User Interface	✓	
Selectable beam density	✓	
Tracker	✓	
Uncertainty output	✓	
Variable frequency (for shallow system)	✓	
Vari-swath	✓	
X-Range (FM)		✓

NOTE

The Base feature package can be upgraded after installation.

The main features of the SeaBat T-Series Subsea system are summarized below.

- **1PPS pulse handling and time stamping:** Data time stamping is referenced to an incoming 1PPS and associated time message.
- **Adaptive gating:** Three different gate settings are available to assist the bottom detection process: No Gates, Absolute Gates, and Adaptive Gates, thus minimizing data processing time. Adaptive gates adapt to the trend of the seafloor and maximize swath performance by directing the bottom detection algorithm to search for the seafloor where it is most likely to be found. The result is maximum swath coverage and ultra-clean data.

¹ Includes X-Range. The Integrated Dual Head configurations are delivered with FRDH (see Table 2).

² Includes FlexMode.

- **Beamforming:** The beamformer performs initial signal processing: a combination of time delay and phase rotation techniques to maximize performance.
- **Bottom detection:** The special bottom detection algorithm uses a combination of center-of-energy and phase-zero crossing algorithms to detect the bottom in each individual beam with the highest possible robustness. Selection of amplitude or phase detection is automatic for each beam, based on signal analysis, generating optimal results over all seabed types.
- **Built-In Test Environment (BITE):** The Built-In-Test-Environment (BITE) is an integral part of the sonar processing unit which monitors the status of the internal electronic sub-systems and wet-end units. The BITE function is designed to inform the operator that the system is performing normally and, therefore, that vehicle time is being utilized effectively. In the event of any errors, the system will report this immediately for rapid troubleshooting.
- **Channel normalization:** This feature ensures equal performance across the receiver channels which minimizes side lobe levels in the beamforming process. The result is superlative beamforming with ultimate acoustic performance and maximum power in the main beams.
- **Depth rating:** The SeaBat T-Series Subsea system is depth rated to 6000 or 400 meters.
- **Dual frequency:** 400kHz or the optional 200kHz frequency may be selected, allowing the operator to choose the most appropriate frequency for the task. Systems with the shallow configuration operate over the entire frequency range from 200 to 400kHz.
- **External trigger:** The system may be triggered using a standard 7k Center software remote command or by a TTL incoming trigger pulse, allowing the system to be used simultaneously alongside a multitude of other acoustic systems.
- **Fast update:** The entire swath is illuminated with a single transmission at an update rate of up to 50Hz (range selection dependent). This allows compliance with IHO SP44Ed 5 coverage requirements even at high speed.
- **FlexMode:** FlexMode allows the operator to select an ultra-high density sector and direct it anywhere in the swath while maintaining full swath coverage.
- **Full rate dual head:** FRDH uses X-range (FM) to achieve dual-head operation with the double effect of increased swath coverage and ping rate. With FRDH the systems are synchronized and ping simultaneously at a high rate.
- **Hardware sync pulse out:** A TTL pulse (synchronous with the transmit pulse) is available from the SSP for synchronization purposes, allowing the system to be used simultaneously alongside a multitude of other acoustic systems. This output is referred to as Trigger Out.
- **Multi-detect:** This feature provides multiple detections within each beam to capture highly detailed images of complex objects and seabed terrain. Easier and faster than water column processing, the feature reduces the need for collecting large water column sets.
- **Operator selectable beam density:** Within each beamforming mode, the operator has full control over how many beams to form, ranging from high density down to just a few. This produces highest detail where necessary, and allows improved efficiency at low altitudes by deploying fewer beams. A special option is the ability to define the desired spacing between beams on the seafloor. The system will “hold” this automatically, varying the number of beams as depth changes.
- **Operator selectable beamforming mode:** The operator is able to select from a number of different preset modes with up to 1024 beams, including Equi-Distant and Equi-Angle. Equi-Distant provides uniform data density across the swath and leads to greatest efficiency by minimizing overlaps, thereby minimizing the number of lines required to survey a given area.

- **Processing architecture:** State-of-the-art processing architecture based on the standard Microsoft Windows® environment ensures genuine new features and productivity enhancements may be released over the life of the system in a user-friendly manner.
- **Quality filters:** Real-time bottom detection quality tests are performed to speed up processing and reduce time and costs. The SeaBat system flags all soundings based on two tests: the first analyses proximity to neighboring soundings and the second tests the signal level of the bottom detection. If both tests are passed the sounding is flagged as high quality. If any test fails, the sounding is flagged and the user may accept or reject it in the postprocessing stage. The process is fully automated to generate the cleanest possible data automatically and speed up processing.
- **Real-time pipe detection and tracking:** This SeaBat feature automatically detects pipes within the multibeam swath, displays them in real time during survey, and generates pipeline deliverables directly from SeaBat. The feature builds on the robustness of FlexMode for relaying a high-density profile of the pipe. A special gating method focuses on the pipeline to improve the quality of detection of the pipe.
- **Resolution:** Dynamic, focused beamforming maintains ultra-high resolution, even at short ranges. A receiver sample rate of 34/66kHz provides excellent range resolution and complements the narrow beam, thus providing the user with ultimate data quality and resolution.
- **Roll stabilization:** Dynamic roll stabilization may be selected for up to $\pm 15^\circ$ roll, ensuring that uniform coverage is maintained, independent of vehicle motion. This leads to maximum efficiency by minimizing the number of survey lines required for a given survey area.
- **Standard data output:** The SeaBat T-Series Subsea system exports bathymetry, side-scan, snippets backscatter, and water column backscatter in a standard format for easy interfacing. With multiple deliverables, the system adheres to the “survey once, use many times” philosophy, thereby optimizing vessel time.
- **Steerable swath:** The swath sector may be electronically steered to focus on a particular region of interest to achieve optimal performance, coverage, and data density.
- **Time stamping of sensor data:** Data time stamping of sensor data interfaced to the SSP (position, motion, and heading) is referenced to an incoming 1PPS and associated time message (either serial or network), ensuring that each data is time stamped to UTC to better than 1 millisecond, prior to broadcast over standard Ethernet to the UUV logging system.
- **Tracker:** This feature is a complete automated mode of operation where the system sets sonar control parameters, including range, gain, power, and swath width based on the quality of the data being collected.
- **Uncertainty output:** Uncertainty estimations are automatically calculated on a beam-by-beam basis and exported to allow for robust estimations of Total Propagated Uncertainty (TPU) in data acquisition and processing packages. This feature enables advanced statistical processing routines to perform optimally and thus speed up processing time while reducing manual efforts.
- **Variable swath coverage:** This feature allows the swath angle to be adjusted by the operator. Optimizing the swath ensures that the appropriate sector is insonified for the selected range, which maximizes ping rate and thus survey speed, and minimizes processing time and costs by providing the cleanest possible data.
- **Water column recording:** The SeaBat T-Series Subsea system is capable of recording water column data for advanced scientific research. The water column data may be written to an optional external Network Attached Storage (NAS) drive. Recorded data may be played back and analyzed using the standard operating software provided with the system.

- **X-range:** The basis of X-Range is a frequency modulated (FM) transmission combined with advanced signal processing to extract the maximum possible range while maintaining ultra-high resolution. A further benefit of FM is increased immunity to external noise, as often encountered in marine environments, resulting in cleaner data.

NOTE

Some features may require operator intervention and as such may have limited functionality when in use in AUVs.

1.5 Typical Applications

The SeaBat T-Series Subsea system provides support for a wide range of applications including:

- As-built surveys
- Breakwater mapping
- Coastal mapping
- Harbor mapping
- Hydrographic surveys to IHO Special Order and to U.S. Army Corps of Engineers Special Order
- Pipeline inspection surveys
- Pipeline route surveys
- Pre- and post-dredging and condition surveys
- Revetment surveys
- River surveys
- Search and recovery
- Site clearance surveys
- Underwater inspection and object location

1.6 Available SeaBat T-Series Subsea Configurations

Table 2: SeaBat T-Series Subsea Available Configurations

Configuration	Frequency (kHz)	Depth rating (m)
T20-S 88017030: T20-S deep single head	single: 400	6000
OPT-3030: change of frequency	single: 200	6000
OPT-3033: upgrade to dual freq.	dual: 200/400	6000
88017034: T20-S shallow single head	wideband: 200-400	400
88017032: T20-S deep integrated dual head	single: 400	6000
OPT-3030: change of frequency	single: 200	6000
88017036: T20-S shallow integrated dual head	wideband: 200-400	400
T50-S 88017040: T50-S deep single head	single: 400	6000
OPT-3030: change of frequency	single: 200	6000
OPT-3033: upgrade to dual freq.	dual: 200/400	6000
88017044: T50-S shallow single head	wideband: 200-400	400
88017042: T50-S deep integrated dual head	single: 400	6000
OPT-3030: change of frequency	single: 200	6000
88017046: T50-S shallow integrated dual head	wideband: 200-400	400

2 SAFETY PRECAUTIONS

WARNING!

If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Teledyne RESON assumes no liability if this product is operated in an unsafe manner.

CAUTION

Use of the equipment in a manner not specified by the manufacturer may affect warranty situation (see *Appendix H Standard Warranty Information*).

2.1 Operator Safety

The SeaBat T-Series Subsea system should be handled with attention to operator safety as well as protection of the hardware components. General precautions include:

- **DO NOT** connect or disconnect cables with the power on.
- **DO NOT** attempt to open and service the projector or receiver units.
- **DO NOT** attempt to open and service the SSP without specific instructions from Teledyne RESON.
- **DO NOT** operate the system while divers are in the water and closer than two meters from the projector and receiver units. High-powered ultrasonic energy can be hazardous to human physiology.

2.2 Equipment Safety

Each SeaBat T-Series Subsea component is sufficiently robust for shipboard storage while in its own transit case or shipping box, which may include handles and tie-down rings. Use appropriate discretion in lifting, as the cases may be awkward and heavy.

2.2.1 Safe Handling

To ensure safe handling of the equipment:

- Inspect each transit case or shipping box for physical damage prior to opening, and each component for physical damage before installation.
- Use original shipping boxes to provide adequate packaging and shock absorption when shipping or storing the equipment.
- Do not drop the equipment.
- Do not connect or disconnect cables from the SSP or from the sonar head assembly while the SSP is running. This can damage the internal workings.
- Do not bend cables beyond the recommended limits.
- Do not place the sonar head in an area where the face may be scratched or damaged. If an array must be placed on the ground, it should be placed on a flat surface and covered with a protective plastic sheet.
- Ensure that the equipment is properly secured before putting out to sea.

- When the sonar head is in air and switched on, the transmit power should be switched off except when performing system checks, where power should be increased to a level which is audible for a short time only on a slow repetition rate and using very short pulse lengths. A higher setting may damage the transmit array ceramics. **The SSP system can be operated in air for very short to medium periods of time.**

CAUTION

If the SSP is run on deck for the purpose of offloading data, Deck mode should be enabled in the Sonar UI. It is also recommended that a water bath, wet towels, or other heat mitigation solution is employed to prevent overheating of the computer electronics in the pressure housing.

The temperature of the computer electronics can be monitored using the system's BITE feature while offloading data. A red LED indicator will notify the user that temperatures are approaching a critical level.

- Unused connectors should be sealed with dummy plugs.
- Do not exceed operating and storage temperature limits.

2.2.2 Cleaning and Maintenance

2.2.2.1 Projector and Receiver

The acoustic window molded over the front of the projector and receiver arrays is made of high-density polyurethane.

These recommendations are made to protect the arrays while in use or in storage.

- For cleaning, use a mild, nonabrasive soap, fresh lukewarm water, and a soft brush.
- Rinse the sonar with fresh water after every use.
- Do not clean the array or sonar by using hot or cold pressure washers. The high-velocity water spray will cut through the polyurethane or damage the interface between the polyurethane and the sonar metal housing.
- To scrape away marine growth from the arrays, use only a wooden tool.
- Do not apply any antifouling paint on the acoustic window unless the type is recommended by Teledyne RESON. The antifouling paint will affect the acoustic performance. Teledyne RESON recommends:
 - For high-frequency transducers (>100kHz) use ClearSignal®.
 - For low-frequency transducers (<100kHz) use SigmaGlide.

NOTE

As these products are subject to technical modifications, it is recommended that the most up to date Product Data Sheet and Material Safety Data Sheet are acquired prior to commencing the coating work.

CAUTION

A long range of chemicals will destroy the polyurethane, which includes, but are not limited to:

- Acids
- Automotive brake fluid
- Base
- Grease
- Halogenated hydrocarbons (carbon tetrachloride, trichloroethylene)
- Hydraulic fluids
- Ketones (MEK, acetone)
- Nitro hydrocarbons (nitrobenzene, aniline)
- Oil
- Ozone
- Petrol
- Phosphate ester

2.2.2.2 Wet-End Connectors

Use the wet connector lubrication kit (PN 1007252) to protect the wet-end connectors. Follow these guidelines:

- Lubricate female connectors and dummy plugs with a silicone oil or equivalent (silicone oil based). Observe the instructions provided with the lubrication kit.
- Lubrication intervals depend on mission type and frequency.
 - Lubricate every 5 matings.
 - Lubricate at regular intervals, even if the connectors are not mated/unmated, in particular for UUVs where the dive tends to rub and wash out the lubricant.
 - Lubricate twice a year when equipment is in storage.
- DO NOT grease mating surface.
- Avoid nicks and cuts around contacts, as these are the sealing surfaces.
- Elastomers can be seriously degraded if exposed to direct sunlight or high ozone levels for extended periods of time.
- Do not overtighten bulkhead nuts.
- Grip main body of connector during mating or unmating. Do not pull on cable to disconnect.
- Avoid sharp bends at cable entry to connector.

2.3 Corrosion Avoidance

All metal parts of the SeaBat™ exposed to seawater are made of corrosion-resistant alloys. This is to ensure long operational life of the system. Combining these noble and corrosion-resistant metals with less noble metals in a saline environment will cause a cathodic reaction.

We therefore recommend electrical isolation between the sonar head and mounting structure.

CAUTION

Do not use sacrificial anodes on a SeaBat™ bracket. Sacrificial anodes lead to unwanted cathodic reaction and does not offer electrical isolation.

2.4 Electrical Isolation

Electrical isolation for titanium components may be achieved by using nonconductive bushings, washers, and isolation plates to insulate them from the mounting brackets. Materials such as FR4, G-10, and G-Etronax EP11 are ideal, as they combine high mechanical strength with a complete electrical isolation. Unreinforced plastic materials such as PVC, Delrin, and polyamide will work from an electrical point of view but offer limited mechanical strength and have a tendency to relax over time causing interfaces to become loose.

CAUTION
If the sonar head is not isolated, galvanic corrosion will result in the mounting structure.

NOTE
Contact Teledyne RESON for additional information on schemes for electrical isolation.

2.5 Exposure to Sunlight

Do not allow the projector and receiver arrays to sit in direct sunlight when not in use, but cover the arrays with a bag. In addition to furthering corrosive effects, continued exposure to ultraviolet (UV) rays will damage the polyurethane array face.

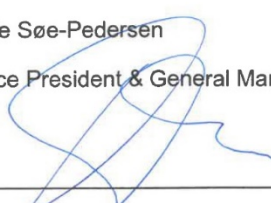
2.6 Safe Disposal of Waste (WEEE Directive)



The use of the crossed-out dustbin logo indicates that this product is subject to directive 2012/19/EU, known as the Waste Electrical and Electronic Equipment Directive. The WEEE Directive specifies that used electric/electronic equipment may not be treated as household waste, but must be sorted separately for disposal. These rules concern all your Teledyne RESON products (computer, monitor, transducer, processor, probe, etc.) and also all accessories (keyboard, mouse, etc.). By ensuring this product is disposed of correctly, you will help protect the environment.

For more detailed information about the recycling of this product, please contact your local authority, your household waste disposal service provider, or Teledyne RESON Customer Support (reson-support@teledyne.com).

2.7 CE Marking

EC DECLARATION OF CONFORMITY		
We	Teledyne RESON A/S Fabriksvangen 13 3550 Slangerup Denmark	 TELEDYNE RESON Everywhere you look™
<i>in accordance with the following directive(s):</i>		
2014/30/EU	Electromagnetic Compatibility (EMC)	
<i>hereby declare that the following equipment:</i>		
<u>SeaBat T-Series Subsea sonar system (deep or shallow, single or dual head),</u>		
<u>SeaBat F-Series Subsea sonar system (deep or shallow)</u>		
<i>is in conformity with the applicable requirements of the following standards:</i>		
REF. No.	TITLE	EDITION/DATE
EN 60945 §9 and §10	Maritime navigation and radio communication equipment and systems - General requirements - Methods of testing and required test results.	2002
EN 60533	Electrical and electronic Installations in ships – Electromagnetic compatibility.	1999
IACS E10	Unified environmental test specification for testing procedure for electrical control and instrumentation equipment, marine computers and peripherals covered by classification.	2007
EN 61000-4-8	Electromagnetic compatibility (EMC) - Part 4: Testing and measurement techniques – Power frequency magnetic field immunity test.	1993 AMD 1: 2001
ISO 25862	Ships and marine technology – Marine magnetic compasses, binnacles and azimuth reading devices	2009
<u>NOTE regarding EMC Compliance:</u>		
To ensure full EMC compliance with regards to conducted emission, a customer-provided filter should be placed close to the power source. (Please refer to appropriate Operator's Manuals.)		
I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all applicable essential requirements of the directives.		
Location:	Slangerup, Denmark	
Date:	1 February 2021	
Name:	Ole Søre-Pedersen	
Position:	Vice President & General Manager	
Signature:		
		CE 21 Document No. CERT22224

3 SYSTEM STARTUP AND SHUTDOWN

3.1 Chapter Overview

This chapter includes detailed instructions on the following subjects (click the emphasized hyperlink to be taken to the section):

- **Pre-dive Checks:** Consists of details on the procedure to follow prior to deploying the system.
- **System Startup Instructions:** Consists of startup details for both AUV and ROV systems.
- **System Shutdown Instructions:** Consists of details on stopping the system for both AUV and ROV systems.
- **Post-dive Checks:** Consists of details on the procedure to follow once the system has been recovered to deck.

NOTE
For information on installation (including configuration of hardware), see <i>Appendix B Installation Instructions</i>. For a brief introduction to the Sonar UI, details on remote operation and folder management, see <i>section 4 System Configuration with User Interface</i>. For information on UUV system operation, see <i>section 5 UUV System Operation</i>. For information on system configuration and user interface navigation, refer to the RESON Sonar UI User Manual (see <i>Appendix F Reference Documentation</i>). For information on the practical use of the sonar, see <i>section 6 Active Sonar Usage</i>.

3.2 Pre-dive Checks

Prior to deploying the SeaBat T-Series Subsea system into the water, perform the following checks.

1. Inspect all system cables for signs of chafing or damage.
2. Inspect the transducer arrays for any signs of damage or oil leakage.
3. Inspect the SSP for any signs of damage.

3.3 System Startup Instructions

3.3.1 AUV System

After the SeaBat hardware has been installed (see *Appendix B Installation Instructions*), the system may be started.

1. Apply power to the SSP. The SeaBat T-Series Subsea will automatically start the AUV operating system.
2. The 7k Center will start. Once started the 7k Center will configure itself to match the sonar operating parameters present when the system was last shut down. Thus, if the sonar was pinging when the system was last shut down, the sonar will resume pinging. The factory default power setting is Power OFF to prevent accidental damage of the projector.
3. Optional:
 - a. Access the SSP operating system via remote control software and configure the system operating parameters as appropriate for the mission (see *section 4 System Configuration with User Interface*).
 - b. Close the remote control software connection.
4. The system is ready to be deployed.

NOTE

Configurable in the AUV section of the Hardware pane:

Hardware	
AUV	
Power saving mode	Normal
Blanking percentage	25
Normalize at startup	☐
Restore power level	☐
Restore ping rate	☒
Sound velocity interlock	☐
Ignore PPS errors	☒

- Power saving mode:
 - Normal
 - Range blank: reduce power consumption
- Blanking percentage
- Normalize at startup (default: enabled)
- Restore power level: use last session's setting
- Restore ping rate: use last session's setting
- Sound velocity lock: prevent pinging when SV input is below 1400m/s
- Ignore PPS errors

CAUTION

The SSP is designed for operation under water. Operation in air for extended periods of time will result in overheating and severe damage to the system. Transmitting in air should be limited to low power levels and should be **no longer** than 1 minute in length with power ON.

NOTE

If the 7k Center is shut down during setup and test, it may be restarted by double-clicking the 7k Center icon on the control computer.

3.3.2 ROV System

After the SeaBat hardware has been installed (see *Appendix B Installation Instructions*), the system may be started.

1. Apply power to the SSP.
2. Double-click the Sonar UI icon on the customer-provided computer/laptop to start the Sonar User Interface.
3. Connect to the SSP.
4. Select the appropriate settings for the mission.
(For further details, see *section 4.2 Sonar User Interface (SUI)*.)



3.4 System Shutdown Instructions

3.4.1 AUV System

Simply cutting power to the SSP can result in corrupted data files and problems with restarting the SSP Windows® 7-based operating system. Follow the shutdown instructions in this section carefully to prevent this from happening.

To shut down the system via the VCC:

1. Send remote control command 1000 to the 7k Center.
Please refer to the Data Format Definition document for instructions (see *appendix F.1 SeaBat T-Series Subsea Documentation*).
2. Wait at least 10 seconds, and then remove power from the SSP.

To shut down the system via remote desktop:

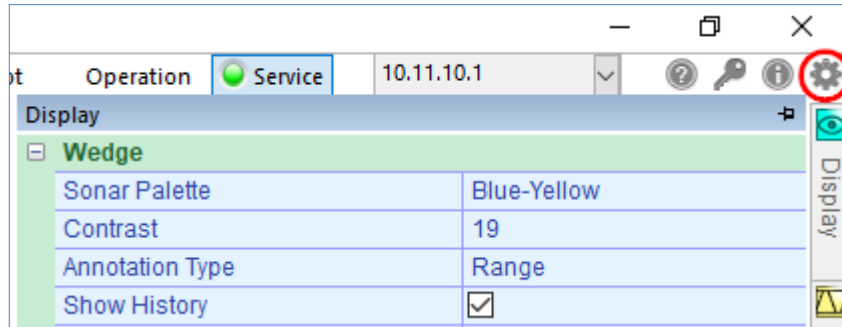
1. Access the SSP operating system via remote control software.
2. Activate the 7k Center application window.
3. Press Esc (on the keyboard). This will initiate shutdown of the sonar.
4. Once the 7k Center application window has closed, click Start.
In the Search Programs and Files, enter: "Shutdown -s -t 1" and press Enter on the keyboard. Wait for the remote desktop window to terminate.
5. Once the remote desktop window has terminated, power may be removed from the SSP.

3.4.2 ROV System

CAUTION

Ensure that the SSP is shut down correctly.

1. Click the Application Settings button in the top right corner of the Sonar UI.



2. Select Shutdown in the Application Settings dialog to shut down the sonar system.

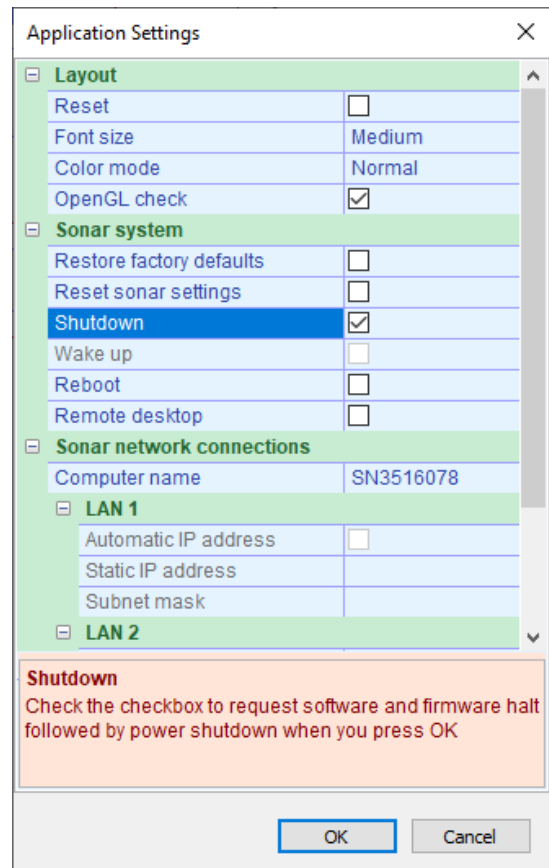
3. Click OK.

This will terminate the connection to the SSP/sonar system from laptop/PC.

4. Click the cross in the upper right corner of the Sonar UI to terminate the session.

The Sonar UI will reload the same selection of sonar settings, once the system is started again.

5. To shut down the laptop/PC, press the power button (or follow Windows procedure).



3.5 Post-dive Checks

Once the SeaBat T-Series Subsea system is recovered to deck, perform the following checks.

1. Shut off all power to the SeaBat T-Series Subsea system.
2. Using fresh water, wash down all system components to minimize salt accumulation and the development of localized corrosion pits.

CAUTION
Do not use hot or cold pressure washers. The high-velocity water spray will cut through the polyurethane or damage the interface between the polyurethane and the metal housings.

3. If necessary, schedule troubleshooting and/or repair of the suspected unit.
4. Inspect all cables for signs of twisting or abrasion.
5. Inspect the cables, transducer arrays, and SSP for any signs of damage or oil leakage.

4 SYSTEM CONFIGURATION WITH USER INTERFACE

4.1 Chapter Overview

NOTE
With a ROV system, the Sonar UI is used for system configuration and operator control. Refer to the RESON Sonar UI User Manual (see <i>Appendix F Reference Documentation</i>). With an AUV system, the Sonar UI is needed for operator control during system setup and test only. Refer to the RESON Sonar UI User Manual (see <i>Appendix F Reference Documentation</i>). During AUV system operation, all communication will be between the SSP and the customer-provided Vehicle Control Computer. The output during operation is a data stream in accordance with the Data Format Definition document (see <i>appendix F.1 SeaBat T-Series Subsea Documentation</i>).

This chapter includes instructions of the following subjects (click the emphasized hyperlink to be taken to the section):

- **Sonar User Interface (SUI):** Consists of brief instructions on starting the Sonar User Interface.
- **Remote Operation:** Consists of instructions on how to control the sonar from a remote PC.
- **Remote Desktop Session:** Consists of instructions on how to establish a remote desktop session.
- **Folder Management:** Consists of instructions on file sharing and renaming of computer or workgroup.

NOTE
For more details on system configuration and user interface navigation, refer to the RESON Sonar UI User Manual (see <i>Appendix F Reference Documentation</i>). For information on starting, stopping, and setting up the SeaBat sonar system, see <i>section 3 System Startup and Shutdown</i>. For information on the practical use of the sonar, see <i>section 6 Active Sonar Usage</i>. For information on installation and details on the various system components, see <i>Appendix B Installation Instructions</i>.

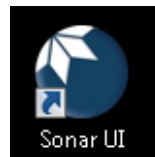
4.2 Sonar User Interface (SUI)

After the SeaBat hardware has been installed (see *Appendix B Installation Instructions*), the system may be started.

NOTE

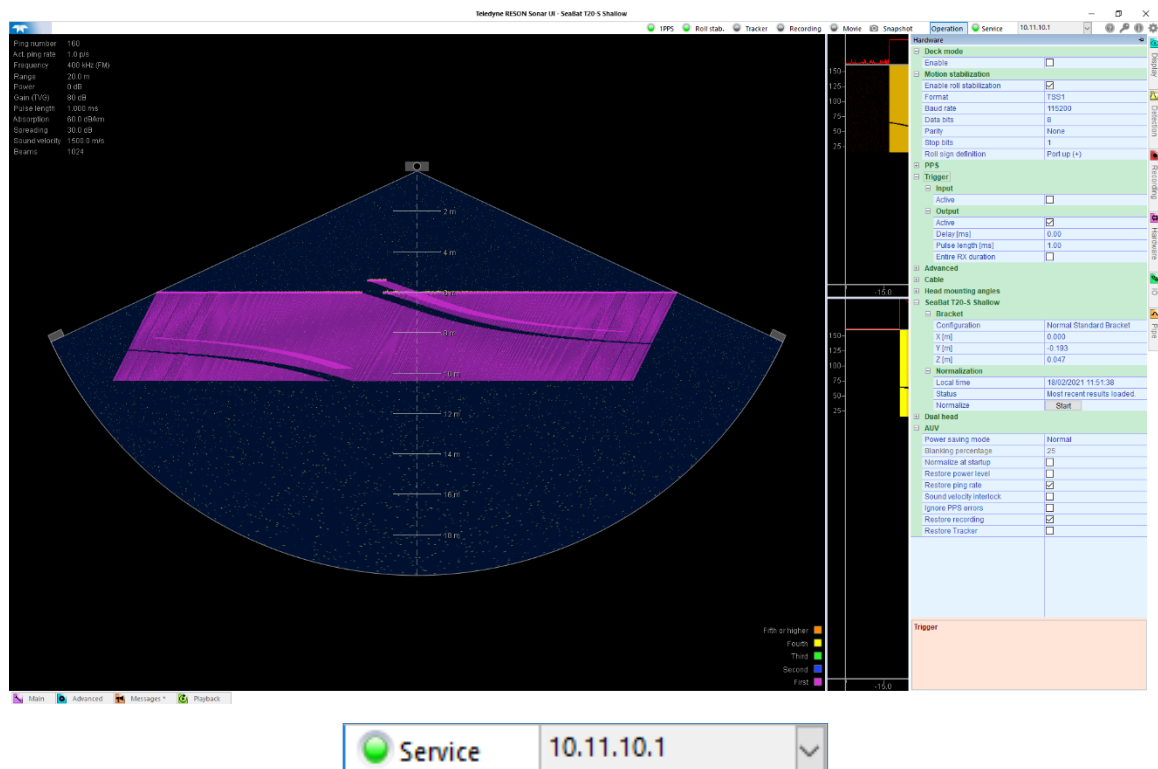
As per the nature of AUV systems, during typical operations the Sonar UI will not be used; however, it may be used when monitoring or testing the system while the SSP is on deck.

1. Double-click the Sonar UI icon on the customer-provided computer/laptop to start the Sonar User Interface.



2. In the top right corner of the UI, click the Sonar address drop-down menu, and select the IP address of the connected SSP/sonar system from the list.

The SeaBat T-Series Subsea system can be identified by its serial number next to the IP address. The serial number can be found on the front of the SSP.



**NOTE**

The laptop/PC/vehicle controller and SSP should be directly connected using an Ethernet cable to the HOST or LAN 2 port of the SSP, or through a Switch. (For further information, see *appendix B.5.7 Wet-End Cable Connections*.)

By factory default, the SSP is set up with fixed IP addresses: 10.11.10.1 for HOST and 10.11.10.2 for LAN 2.

If the SSP is configured to acquire an automatic IP address (assigned by a DHCP server), but fails, the two Ethernet ports will revert to the static IP addresses 10.11.10.1 (HOST) and 10.11.10.2 (LAN 2), both with subnet mask 255.255.255.0, after typically up to 1m30s of trying to acquire DHCP contact.

Make sure that the laptop/PC/vehicle controller IP address is set to an **unused** IP address within the 10.11.10.XXX subnet, subnet mask 255.255.255.0.

- Recommended is 10.11.10.3 for single-head systems.
- Recommended is 10.11.10.5 for dual-head systems.

For details on IP address configuration, see *Appendix E Network Configuration*.

The laptop/PC/ vehicle controller is now connected to a running sonar system.

3. Select the settings appropriate for the present survey mission. Refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

For information on pre- and post-dive checks and shutting down the sonar, see *section 3 System Startup and Shutdown*.

NOTE

For further information on system configuration and user interface navigation, refer to the RESON Sonar UI User Manual (see *appendix F.1 SeaBat T-Series Subsea Documentation*).

4.3 Remote Operation

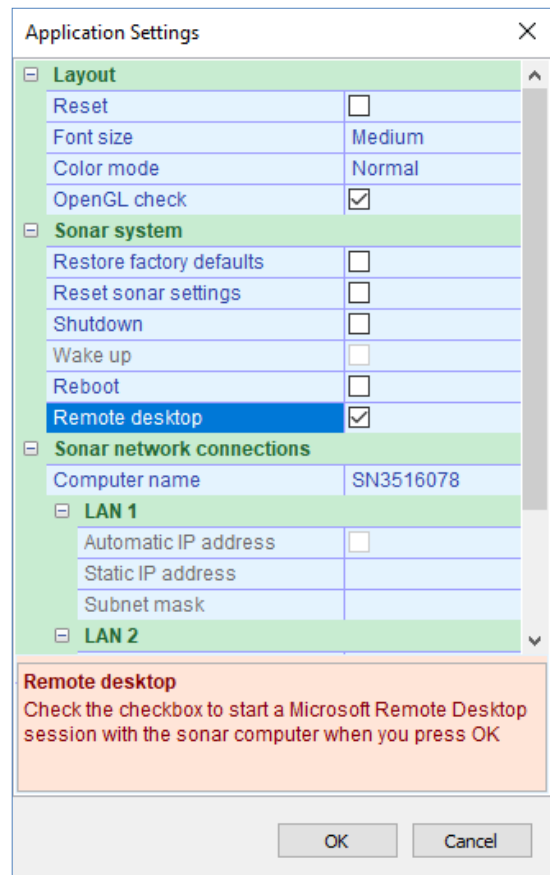
The 7k series software architecture is built on a client/server concept. The 7k Center running on the SSP controls the sonar, performs data processing, and exports data to external clients connected via TCP IP/UPD IP. The clients should control the 7k Center via remote SUI (ROV) or use of customized control applications based on DFD (AUV). Refer to the appendix section in the Data Format Definition document for example code for writing the control application (see *appendix F.1 SeaBat T-Series Subsea Documentation*).

4.4 Remote Desktop Session

1. Click the Application Settings button in the top right corner of the Sonar UI.



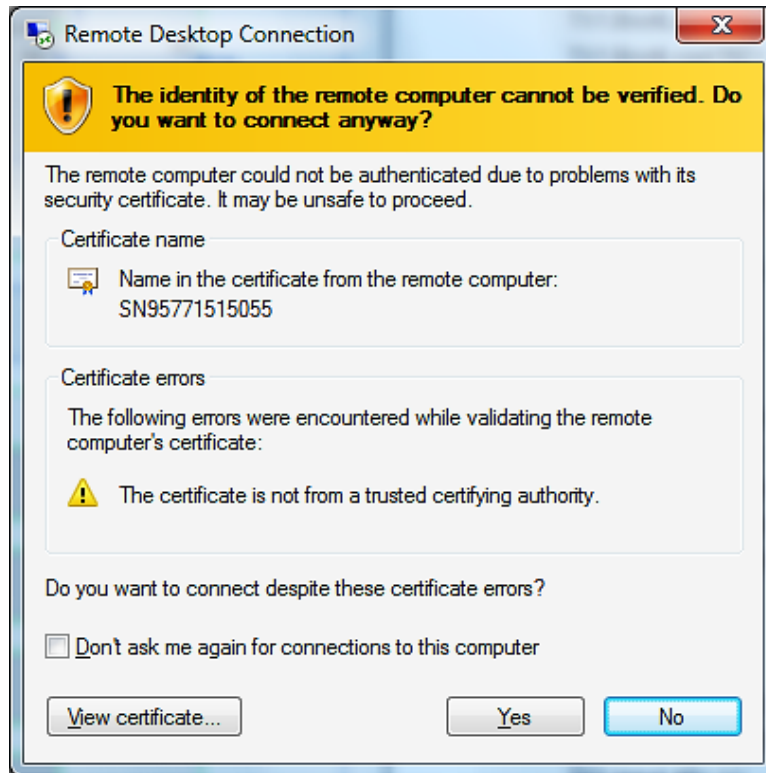
2. Select the Remote desktop option in the Application Settings dialog to establish a remote desktop session.
3. Click OK.



4. Enter credentials when prompted:
 - o User: reson
 - o Password: reppe
5. Click the arrow to accept your entry (or press Enter on the keyboard).



6. If the Remote Desktop Connection displays an identity warning, click Yes.



4.5 Folder Management

4.5.1 File Sharing on a Network

4.5.1.1 Sharing a Folder on a Network

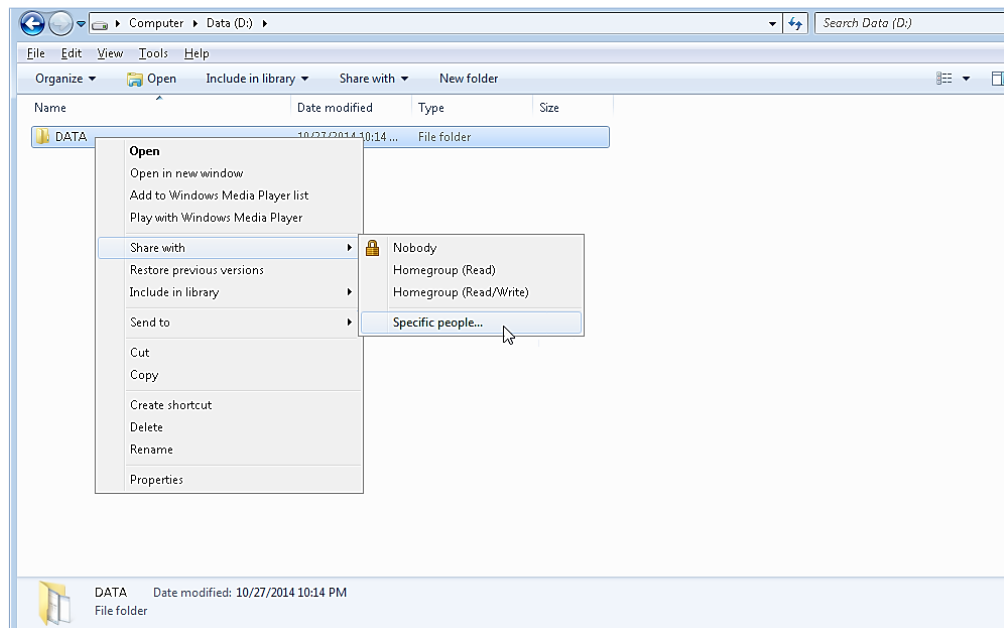
This section describes how to create a shared folder on the SSP. Shared folders allow users to access and move data off the SSP to another network-connected PC.

NOTE

A network switch is recommended for ease of file sharing and high-speed data transfer reliability.

1. Establish a remote desktop session as described in *section 4.4 above*.
2. Once the remote desktop session has been established, go to My Computer on the SSP and open the D:\ drive.

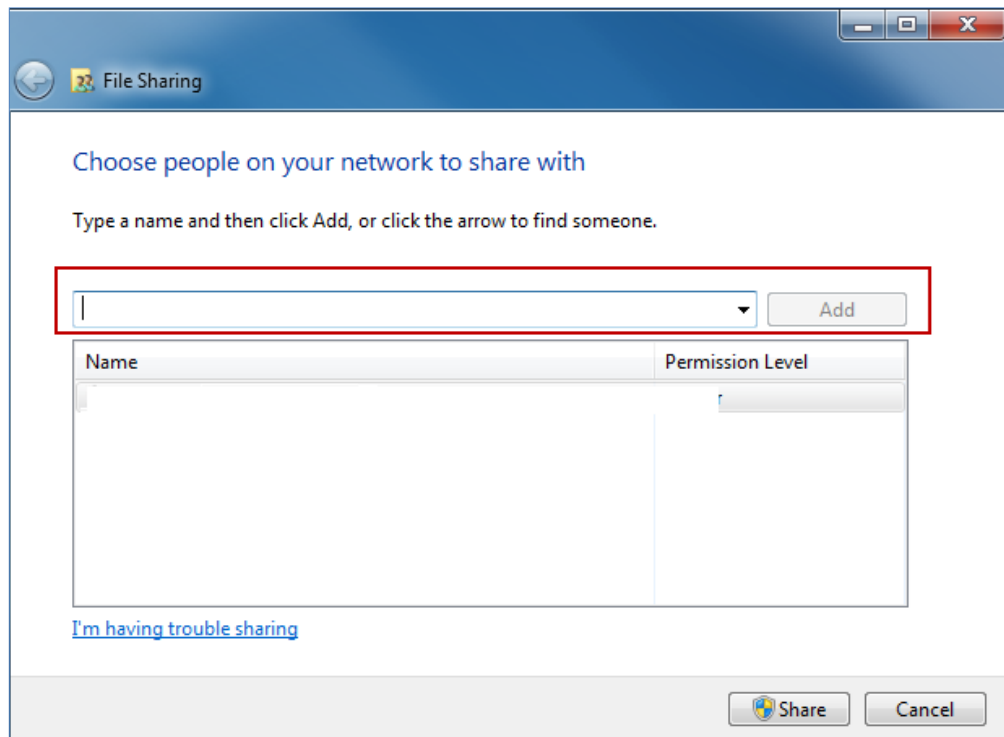
3. Right-click on the folder to be shared, e.g. DATA, and select Share with | Specific people.



NOTE

Data itself should **only** be saved to the D:\ drive.

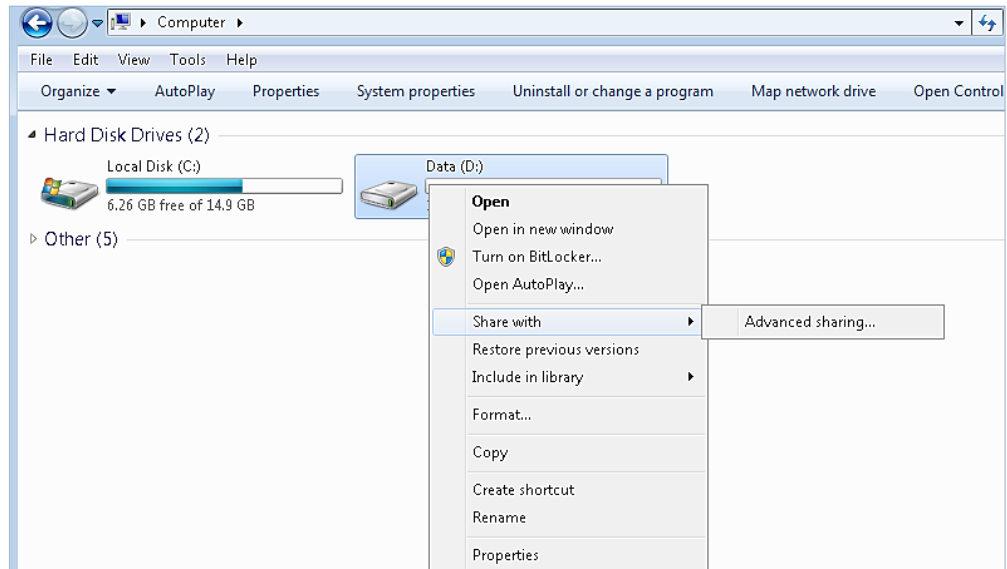
4. In the File Sharing dialog, enter a name and click add, or click the arrow to find someone.



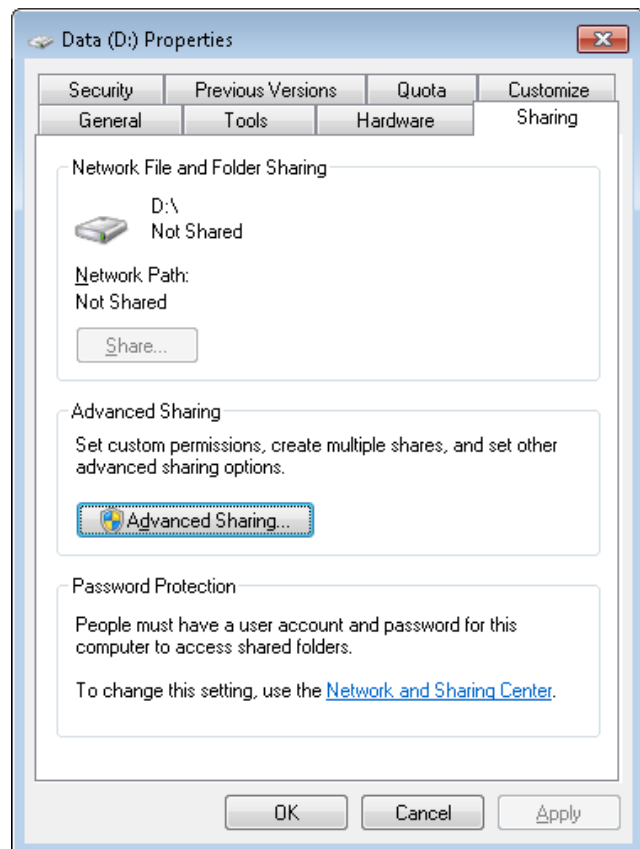
5. Click Share.

4.5.1.2 Sharing the D:\ Drive on a Network

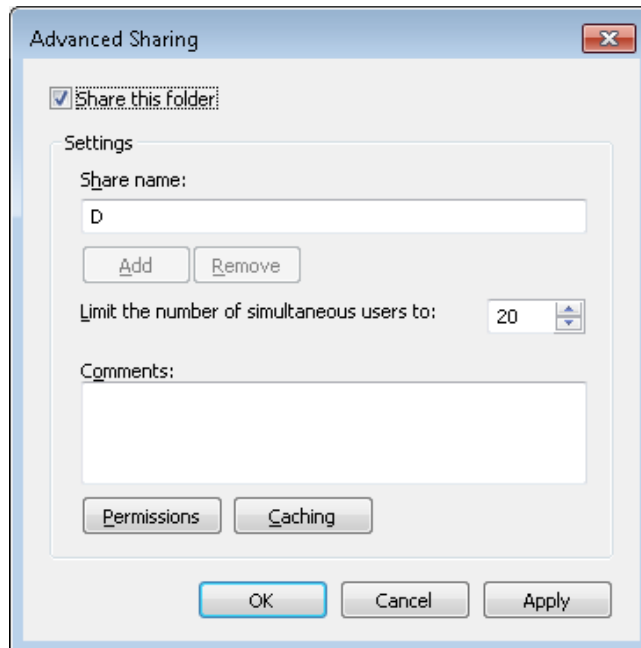
1. Establish a remote desktop session as described in *section 4.4 above*.
2. Once the remote desktop session has been established, go to My Computer on the SSP.
3. Right-click on the D:\ drive, and select Share with | Advanced sharing.



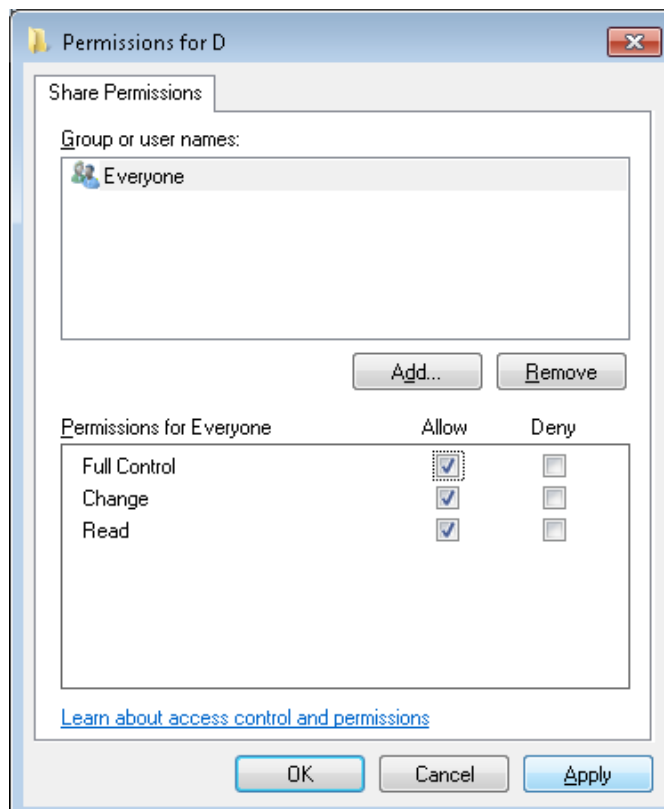
4. In the Data (D:) Properties dialog, go to the Sharing tab, and click the Advanced Sharing button.



5. In the Advanced Sharing dialog, select the Share this folder check box, and click the Permissions button.



6. In the Permissions dialog, assign the required permissions per group or user name.



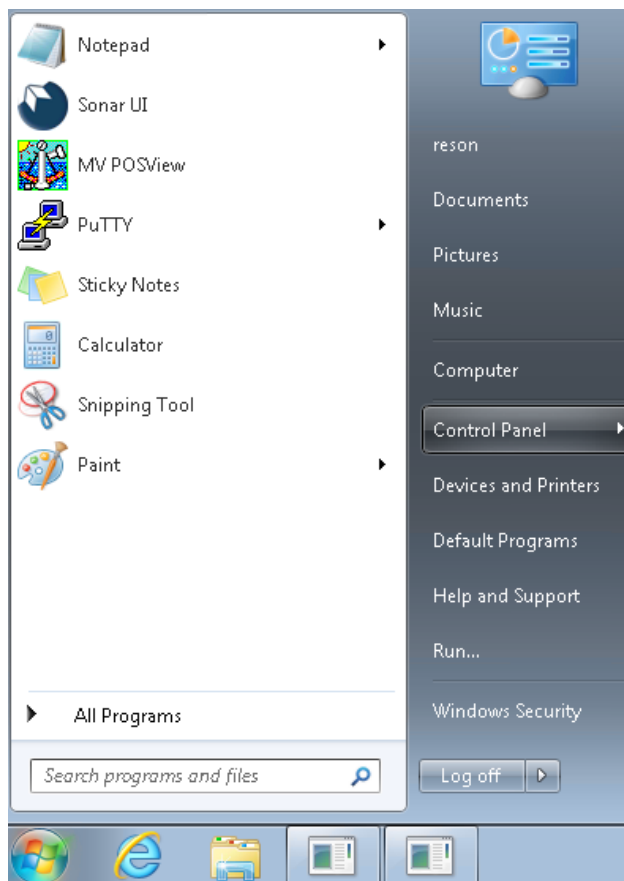
7. Click Apply.

4.5.2 Verifying or Changing the Computer Name and/or Workgroup Name

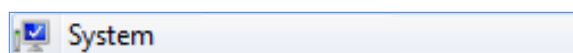
NOTE	
If changing the Computer Name, a restart of the SSP is required before the new name can take effect. By factory default, the computer name of the SSP is set to SN+serial number, which can be found on the serial number label next to the host connector, as marked on the example label to the right.	
CAUTION	
Changing the computer name will prevent IP-address configuration from the SUI (see <i>appendix E.2 Change IP Configuration</i>). For further information on system configuration and user interface navigation, refer to the RESON Sonar UI User Manual (see <i>appendix F.1 SeaBat T-Series Subsea Documentation</i>).	

The default workgroup name for the SSP is *Workgroup* and can be found on the network workgroups. Use the following steps to verify or change the computer name and/or workgroup name.

1. Establish a remote desktop session as described in *section 4.4 above*.
2. Once the remote desktop session has been established, go to the Windows Start menu and select Control Panel.

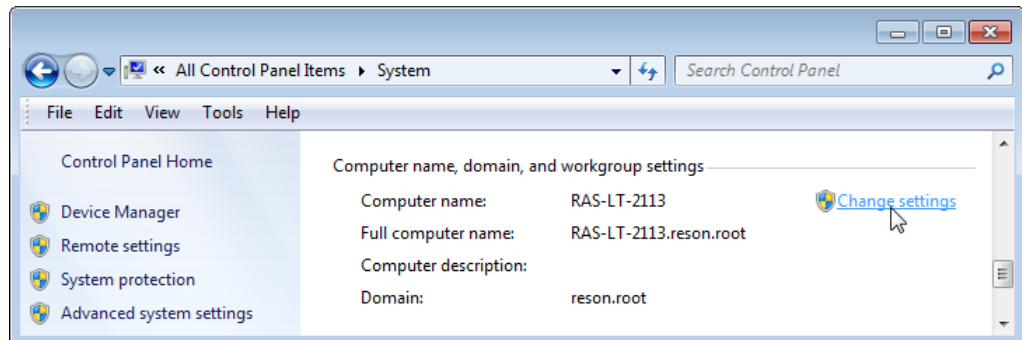


3. Select System.

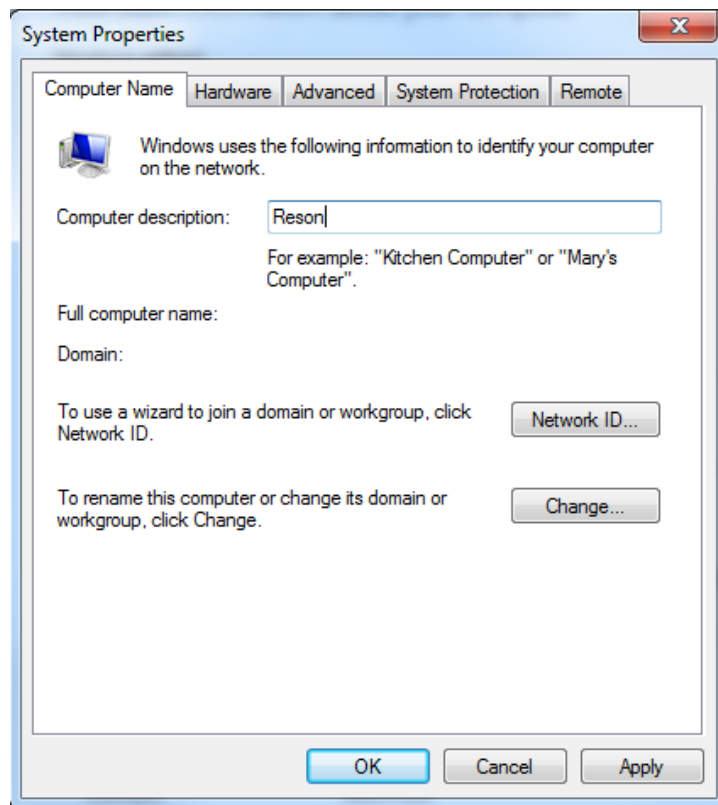


4. In the System window (towards the bottom), Computer name, Full computer name, Computer description, and the workgroup name are displayed.

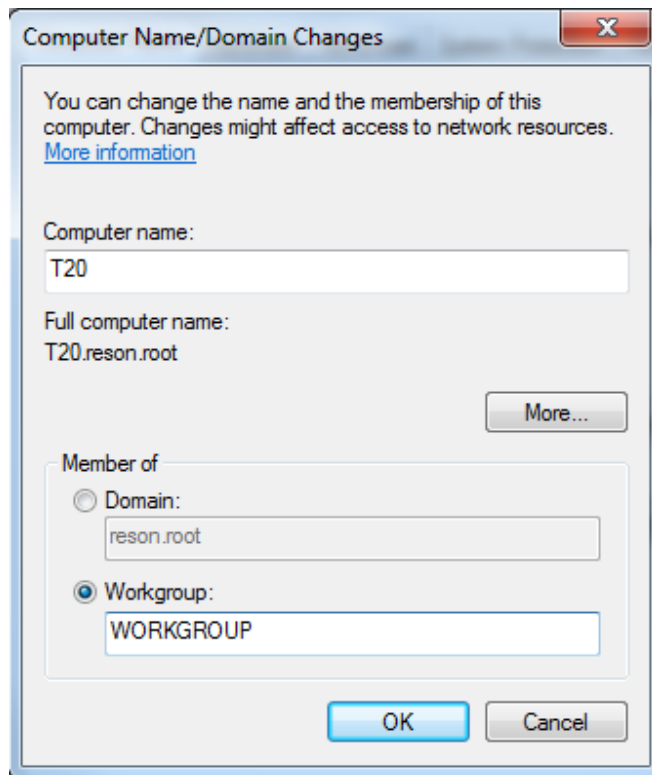
Click Change settings to open the System Properties window.



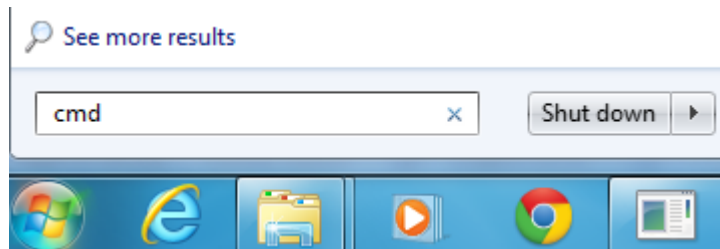
- To change the computer description: Enter the new description in the Computer description field and click OK.



- To change the computer name³ or workgroup: Click the Change button and enter a new computer name or workgroup name and click OK. Changing either of these names does not affect the IP address.

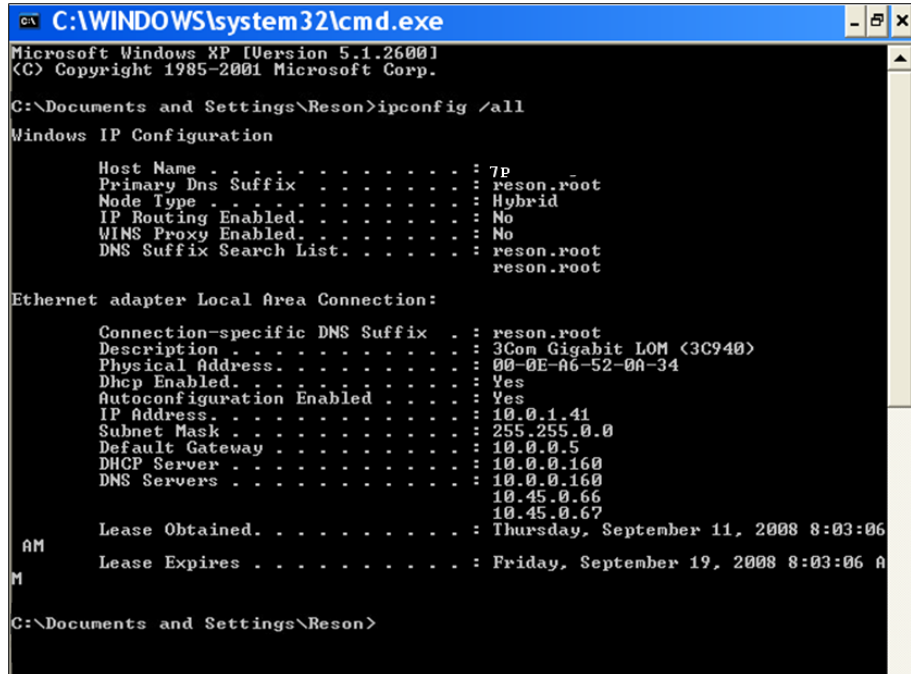


5. To view current IP address information, go to the Windows Start menu and enter CMD in the *Search programs and files* field and press Enter.



³ Computer name is by default: SN xxxxxxx (7-digit serial number).

6. In the command screen, enter ipconfig /all (be sure to enter a single space before /all) and press Enter.
 - The screen displays the connection status of all the network connections, including IP Addresses as shown in the following command screen sample.



```

C:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Reson>ipconfig /all

Windows IP Configuration

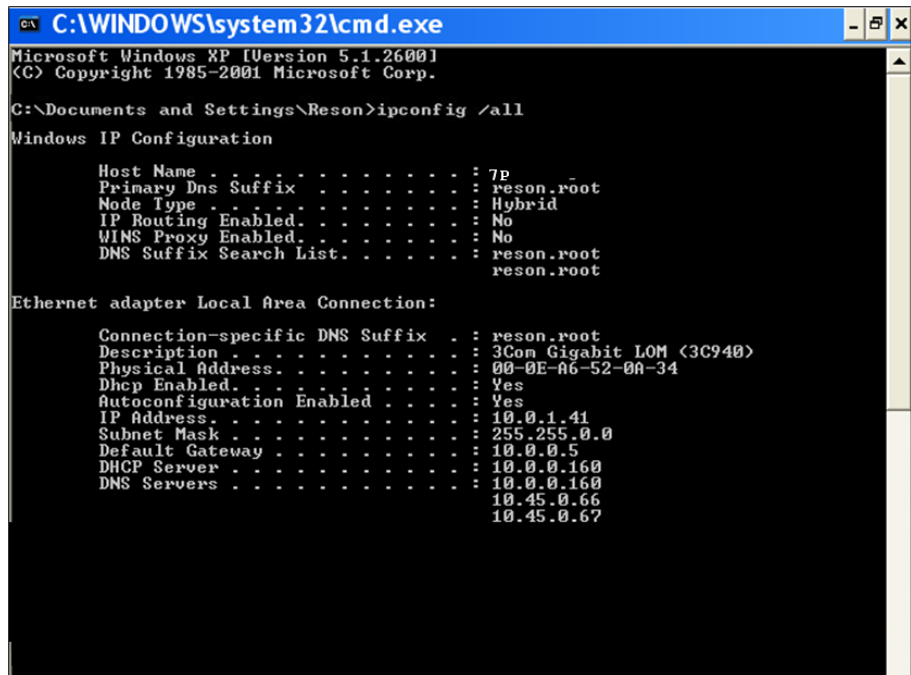
    Host Name . . . . . : 7p
    Primary Dns Suffix . . . . . : reson.root
    Node Type . . . . . : Hybrid
    IP Routing Enabled. . . . . : No
    WINS Proxy Enabled. . . . . : No
    DNS Suffix Search List. . . . . : reson.root
                                     reson.root

Ethernet adapter Local Area Connection:

    Connection-specific DNS Suffix . : reson.root
    Description . . . . . : 3Com Gigabit LOM (3C940)
    Physical Address. . . . . : 00-0E-A6-52-0A-34
    Dhcp Enabled. . . . . : Yes
    Autoconfiguration Enabled . . . . : Yes
    IP Address. . . . . : 10.0.1.41
    Subnet Mask . . . . . : 255.255.0.0
    Default Gateway . . . . . : 10.0.0.5
    DHCP Server . . . . . : 10.0.0.160
    DNS Servers . . . . . : 10.0.0.160
                           10.45.0.66
                           10.45.0.67
    Lease Obtained. . . . . : Thursday, September 11, 2008 8:03:06 AM
    Lease Expires . . . . . : Friday, September 19, 2008 8:03:06 AM

C:\Documents and Settings\Reson>
  
```

- If all connections are disconnected, only the Media State and MAC address for each connection display. The following command screen sample shows a typical disconnected SSP.



```

C:\WINDOWS\system32\cmd.exe
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

C:\Documents and Settings\Reson>ipconfig /all

Windows IP Configuration

    Host Name . . . . . : 7p
    Primary Dns Suffix . . . . . : reson.root
    Node Type . . . . . : Hybrid
    IP Routing Enabled. . . . . : No
    WINS Proxy Enabled. . . . . : No
    DNS Suffix Search List. . . . . : reson.root
                                     reson.root

Ethernet adapter Local Area Connection:

    Connection-specific DNS Suffix . : reson.root
    Description . . . . . : 3Com Gigabit LOM (3C940)
    Physical Address. . . . . : 00-0E-A6-52-0A-34
    Dhcp Enabled. . . . . : Yes
    Autoconfiguration Enabled . . . . : Yes
    IP Address. . . . . : 10.0.1.41
    Subnet Mask . . . . . : 255.255.0.0
    Default Gateway . . . . . : 10.0.0.5
    DHCP Server . . . . . : 10.0.0.160
    DNS Servers . . . . . : 10.0.0.160
                           10.45.0.66
                           10.45.0.67

C:\Documents and Settings\Reson>
  
```

5 UUV SYSTEM OPERATION

NOTE

With an **AUV system**, the Sonar UI is needed for operator control during system setup and test only (see also *section 4 System Configuration with User Interface*).

With a **ROV system**, the Sonar UI is used for system configuration and operator control (see also *section 4 System Configuration with User Interface*).

5.1 Chapter Overview

This chapter includes instructions of the following subjects (click the emphasized hyperlink to be taken to the section):

- **AUV System Operation:** Consists of brief information on typical AUV operation.
- **ROV System Operation:** Consists of brief information on ROV operation.

NOTE

For information on system configuration and user interface navigation, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

For information on starting, stopping, and setting up the SeaBat sonar system, see *section 3 System Startup and Shutdown*.

For information on the practical use of the sonar, see *section 6 Active Sonar Usage*.

5.2 AUV System Operation

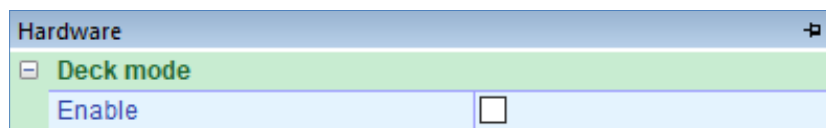
The system will normally be operated autonomously. All communications will be via the Ethernet to/from the Vehicle Control Computer (VCC).

Normal mission sequence will be:

1. System installation, setup, and checkout – done through the Sonar UI (see *Appendix B Installation Instructions, section 3 System Startup and Shutdown, and section 4 System Configuration with User Interface*). Please also refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).
2. Installation checkout – startup and diagnostics (BITE) performed by the VCC.
3. Power down and transit to deployment site (see *section 3 System Startup and Shutdown*).
4. Power up and repeat diagnostics (see step 2).
5. Vehicle deployment – sonar operates under control of the VCC.
6. Vehicle recovery – power down (see *section 3 System Startup and Shutdown*).
7. Data download – data is extracted from the disk drives for external analysis.

If the SSP is run on deck, Deck mode should be enabled in the Sonar UI⁴.

- a. Click the Hardware tab  in the UI to open the Hardware pane.
- b. Click the check box Enable Deck mode.



In this mode, no BITE will be available from the transmit module and receiver.

8. Disable Deck mode (clear the check box) to reboot the SSP to resume normal operation.

NOTE

During **AUV system** operation, all communication will be between the SSP and the customer-provided Vehicle Control Computer. The output during operation is a data stream in accordance with the Data Format Definition document (see *appendix F.1 SeaBat T-Series Subsea Documentation*).

5.3 ROV System Operation

NOTE

For information on system configuration and user interface navigation, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

For information on starting and stopping the SeaBat sonar system, see *section 3 System Startup and Shutdown*.

For information on the practical use of the sonar, see *section 6 Active Sonar Usage*.

For information on installation and details on the various system components, see *Appendix B Installation Instructions*.

⁴ Please refer the Sonar UI User Manual for additional information.

6 ACTIVE SONAR USAGE

6.1 Chapter Overview

This chapter includes detailed instructions on the following subjects (click the emphasized hyperlink to be taken to the section):

- ***Enhancing Sonar Performance:*** Consists of examples on how to use the SUI controls to enhance sonar performance.
- ***Enhancing System Efficiency:*** Consists of examples on how to use the automation, roll stabilization, and head tilt features.
- ***Compensation for Environmental Conditions:*** Consists of a thorough introduction into the environmental parameters that may affect sonar operation.
- ***Limitations:*** Consists of examples on the various physical limitations that may affect sonar operation.

NOTE
For information on starting, stopping, and setting up the SeaBat sonar system, see <i>section 3 System Startup and Shutdown</i>. For information on system configuration and user interface navigation, refer to the RESON Sonar UI User Manual (see <i>Appendix F Reference Documentation</i>). For information on the practical use of the sonar, see <i>section 6 Active Sonar Usage</i>. For information on installation and details on the various system components, see <i>Appendix B Installation Instructions</i>.

6.2 Enhancing Sonar Performance

6.2.1 Correct Range Setting

Select the appropriate range scale to keep the horizontal bottom image at or above the widest part of the sonar wedge as visualized in *Figure 2*:

If the Range is set too short the outer beams will be lost. If the Range is set too long, the results may be noisy data.

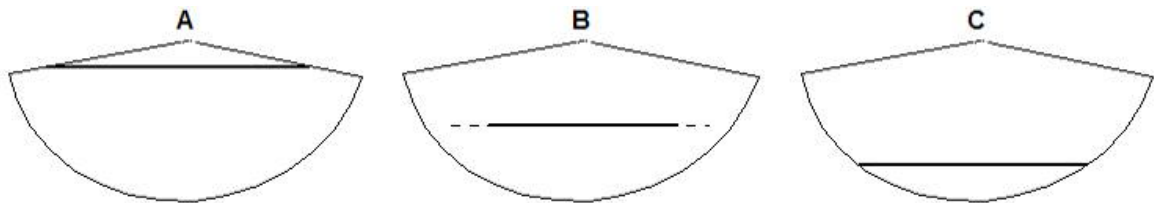


Figure 2: Range Setting Diagrams

- Diagram A depicts a proper range setting.
- Diagram B depicts an acceptable range setting for a swath that is beginning to fade due to the effects of signal loss in the outer swath.
- Diagram C depicts an incorrect range setting. Notice that the still-useable ends of the swath are being cut off by the limits of the range setting.

Note that the range setting affects ping rate: the longer the range, the lower the ping rate and thus the fewer along-track pings. Higher range settings are required for tilted heads (see also *section 6.3.4 below*).

NOTE

The Range adjusts itself automatically when Tracker is selected (see also *section 6.3.2 below*).

For additional examples on incorrect range settings and possible solutions, see *Table 3*.

Table 3: Incorrect Range Settings – Examples and Solutions

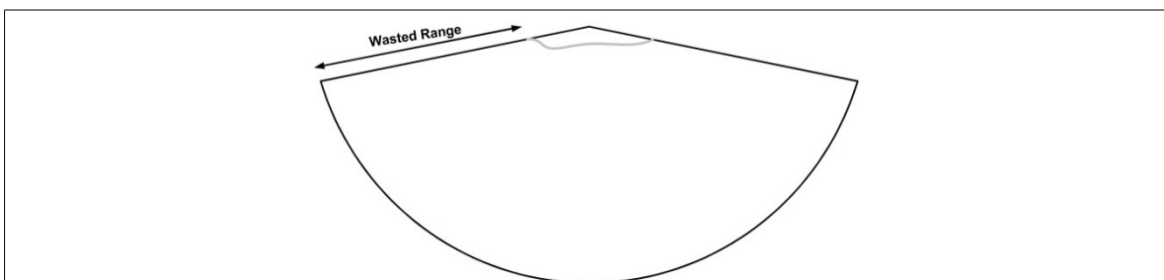


Figure 3: Range Setting – Too Long

With the Range set too long, the receivers are “open” for too long and the system is recording long after the acoustic returns from the seabed have been received. Spurious background noise can be amplified, especially when TVG is used, and this can give noisier data. The ping rate is also reduced thereby reducing sounding density. This should not be used to artificially reduce the ping rate, rather the Range should be set correctly, and the ping rate should be capped using Max rate. Refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*.)

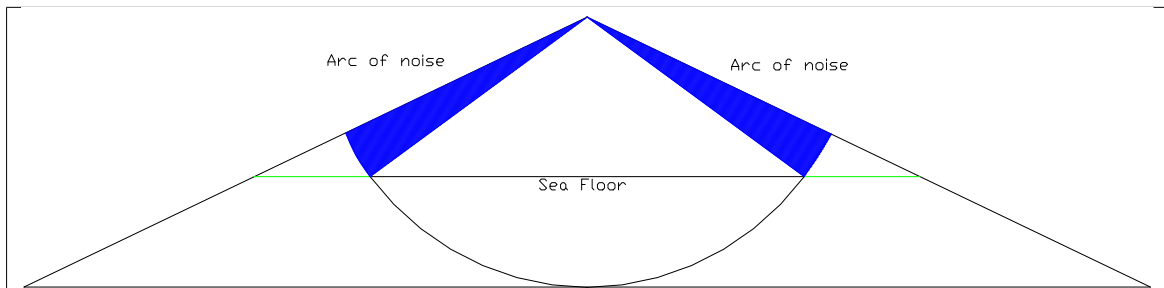


Figure 4: Range Setting – Too Short

With the Range set too short, the outer beams formed are not long enough to reach the seabed. With no seabed in these beams the bottom detection process can only lock onto the noise in the water column. An exception to this is if the seafloor to the outer parts of the swath is of no interest and the user wishes to concentrate on a smaller seafloor coverage thereby increasing the ping rate and hence sounding density. In this case the user should reduce the swath coverage of the sonar. Refer to the RESON Sonar UI User Manual (*see Appendix F Reference Documentation*.)

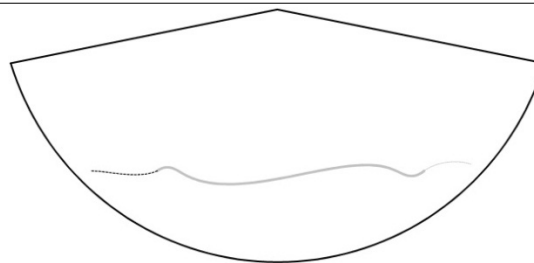


Figure 5: Range Setting – The Exception

If you are operating in relatively deep water to the limits of operation and the outer parts of the swath exceed the acoustic range of the sonar, the user should reduce the swath coverage to cover the seabed that is visible only. This will increase the ping rate and reduce noise picked up for these visible beams. Refer to the RESON Sonar UI User Manual (*see Appendix F Reference Documentation*).

6.2.2 Transmit Power

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (*see Appendix F Reference Documentation*).

NOTE

The Power adjusts itself automatically when Tracker is selected (*see also section 6.3.2 below*).

6.2.2.1 Transmit Power OFF

If the Power is set to OFF, the system will not ping, but it will continue to receive data provided that the max ping rate is not set to 0.

With the transmit power OFF, the sonar system will act as a passive sonar by only receiving data. This is a feature that is very useful for monitoring the ambient water in order to assess the level of background noise and interference from the vessel itself.

6.2.2.2 Transmit Power and Pulse Type

Power level depends on pulse type:

- In **CW mode**, typically set Power at full for the most robust bottom detection at all ranges.
- In **FM mode**, the use of power may vary with range setting. Due to longer pulse lengths in this mode, more overall energy is transmitted into the water per ping than in CW mode.
 - Less power may be required at shorter ranges. Start with 200dB at minimum Range, and increase with Range.

6.2.3 Ping Rate

Set the Max rate at 50p/s to ensure unhindered operation of the sonar. Note that this is only a ping rate limiter.

The ping rate is automatically set by the range setting (or safe duty cycle limit) (see also *section 6.2.1 above*).

NOTE

If Max rate is set to 0, the system will not ping or receive data.

If Max rate is set to a value higher than the range-determined ping rate (or the duty cycle-determined ping rate), the sonar will ping at the rate determined by the range setting (or calculated duty cycle).

If Max rate is set to a value lower than the range-determined ping rate, the sonar will ping at the rate specified by Max rate.

In some instances it may be beneficial to force a lower ping rate than the normal rate associated with a particular range. Examples of this would be instances when too much data is being received at short ranges; when the vessel is moving at a very slow rate and the operator wants to reduce the quantity of data generated; or when the sonar is operating in a high-reverb environment where echoes of the previous ping are contaminating the current ping.

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

6.2.4 Receiver Gain

The Gain setting adjusts the amount of receiver gain applied to the returned signal. Typically set between 20dB and 40dB.

NOTE

The Gain adjusts itself automatically when Tracker is selected (see also *section 6.3.2 below*).

The SeaBat system utilizes Time-Variied Gain (TVG) which counteracts the diminishing echo strength of signals that originate from farther away. The TVG data contains the applied gain at each range (sample) and is available in record 7010. Refer to the Data Format Definition document for information (see *Appendix F Reference Documentation*).

The generation of the TVG curve is based on the formula in *Table 4*.

Table 4: TVG Formula

$\text{TVG} = \begin{cases} G_L & \text{for } R < R_L \\ G + S_p [\log_{10}(R) - 1] + 2(\alpha/1000)R & \text{for } R \geq R_L \\ 83 & \text{for } R \geq R_M \end{cases}$	
Where: α = Absorption loss in dB/km G = Extra gain from RxGain menu item G_L = An internally calculated gain applied until the TVG begins R = Range in meters R_L = Lowest range (in meters) from where the TVG formula operates R_M = Range in meters where the gain has reached highest possible value (which is 83dB) S_p = Spreading loss coefficient	
NOTE The values of R_L, G_L, and R_M are not accessible, but R_L is in generally limited to a few meters from the sonar. It is recommended to subscribe for record 7010 in order to obtain the TVG.	

For details on environmental conditions such as absorption and spreading, see *section 6.4 below*.

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

6.2.5 Frequency Selection

- 400kHz for highest resolution at shorter ranges.
- 200kHz for greater range performance.

For general hydrographic surveys, the switch from 400kHz to 200kHz at either end of the scale in FM mode (or 420kHz to 190kHz in CW mode) may be necessary between depths of 80m and 120m depending on conditions. Frequency selection between the upper and lower limits may be made in steps of 10kHz.

NOTE
Adjusting the frequency affects beam width. Reducing the frequency produces wider beams, increasing the frequency produces narrower beams.

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

6.2.6 Pulse Length

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

NOTE
The Pulse Length adjusts itself automatically when Tracker is selected (see also <i>section 6.3.2 below</i>).

6.2.6.1 Pulse Length and Image Resolution

For a given power setting, a narrower pulse length will provide a higher resolution at a shorter range. A wider pulse length will provide better range but a lower resolution image.

In certain conditions, for example in turbid waters, the narrower pulse length may not operate well. In such circumstances, the wider pulse length may give better short-range performance. This may also be achieved by changing from higher to lower frequency operation.

6.2.6.2 Pulse Length and Pulse Type

The pulse length setting depends on pulse type (see *section 6.2.7 below*).

- In **CW mode**, typically set Pulse Length at 30 μ s (range is 30 μ s-300 μ s), and increase with Range. The shorter the pulse in CW mode, the higher the resolution. The longer the pulse, the greater the range performance but the lower the resolution.
- In **FM mode**, typically set Pulse Length at 1ms (range is 300 μ s-10ms⁵), and increase with Range. Note that the length of the FM pulse does not affect resolution in the same way as it does for CW mode. At very short ranges a long pulse length can limit the ping rate due to the duty cycle protection mode.

6.2.7 Pulse Type

- **CW** (Continuous wave) is the traditional pulse type for multibeam survey.
 - Shorter pulses result in high resolution, but suffer in range performance.
 - Longer pulses increase range performance at the expense of resolution.
- **FM** (Frequency modulation or X-Range) is selected for greater range performance, FRDH operation, and instances where an increase in noise immunity may be required.
 - FM allows much longer pulses, and thus more energy, to be transmitted into the water, resulting in greater range performance whilst maintaining full resolution.
 - FM also provides better immunity to external noise and allows dual head sonars to ping at the same time, a feature known as Full Rate Dual Head (FRDH).

NOTE

Depending on purchased features, only CW mode may be available. X-Range is an optional add-on feature (see *Table 1*).

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

6.2.8 Vari-Swath

Vari-swath is a feature which allows the operator to select a swath width appropriate to the application in addition to electronically steering the swath.

Vari-swath is available with all beam modes and can be used in conjunction with roll stabilization and FlexMode⁶. For details on the use of the various beam modes, see *section 6.2.9 below*.

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

⁵ Max. 5ms at 66kHz for T50.

⁶ FlexMode is an optional add-on feature (see *Table 1*).

6.2.8.1 Coverage Angle

The benefits of the variable swath feature are twofold:

- Increased sounding density in a small sector may be used when tracking pipes or other linear features, where the operator is not interested in data outside a defined sector. The increased sounding density helps define small targets.
- A reduced swath width allows an increase in ping rate for any given depth.

6.2.8.2 Beam Reduction

- With beam reduction enabled, only the beams necessary to fill the given swath are formed.
- With beam reduction disabled, all beams are compressed into the selected coverage angle.

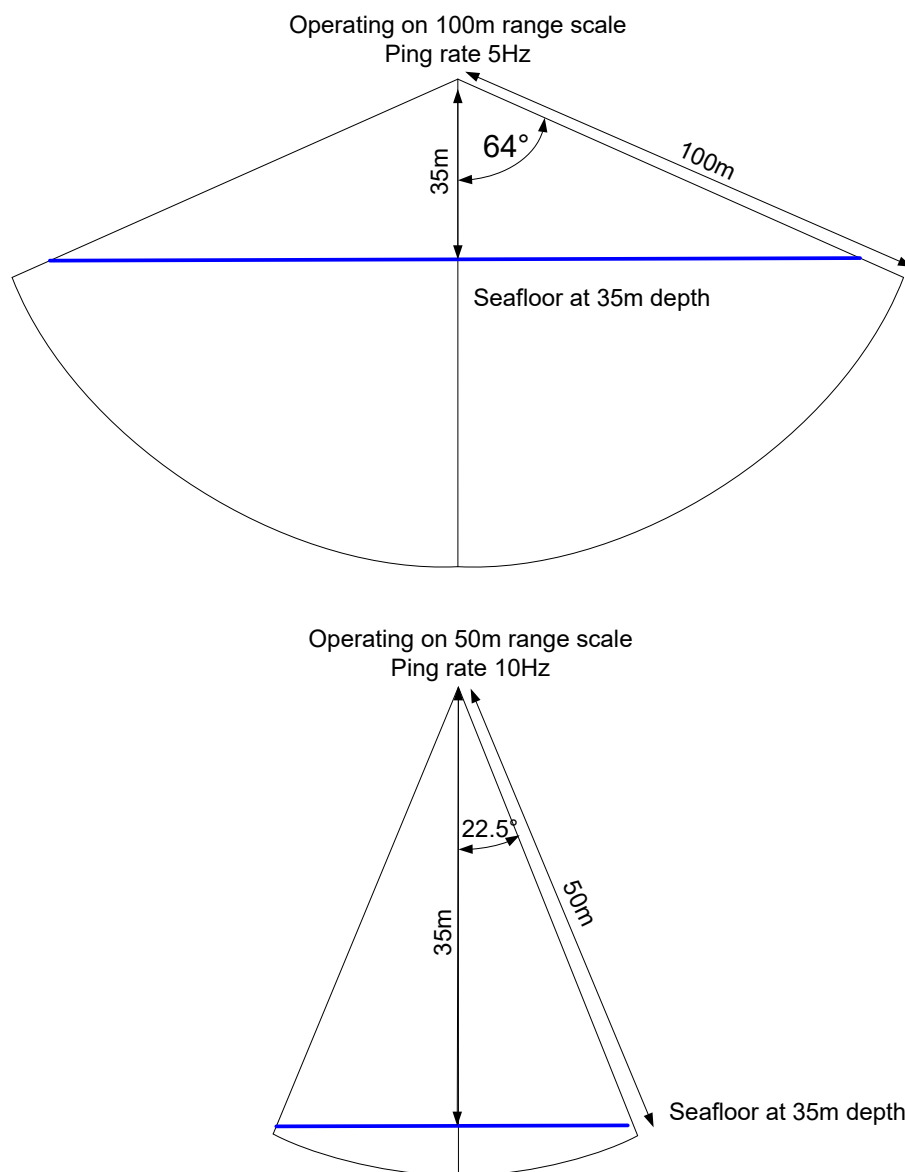


Figure 6: Example of Reduced Swath Width

6.2.8.3 Horizontal Steering

This setting allows the operator to steer the swath independently of the sonar head physical angle. The extent of steering is determined by the angle selected. The limitation is that the outer beam cannot be steered past 5° from the horizontal (see *Figure 7*). When the swath is steered this way, the individual beam widths increase with the steering angle. A beam steered at 60° is twice the width of a beam steered at 0°.

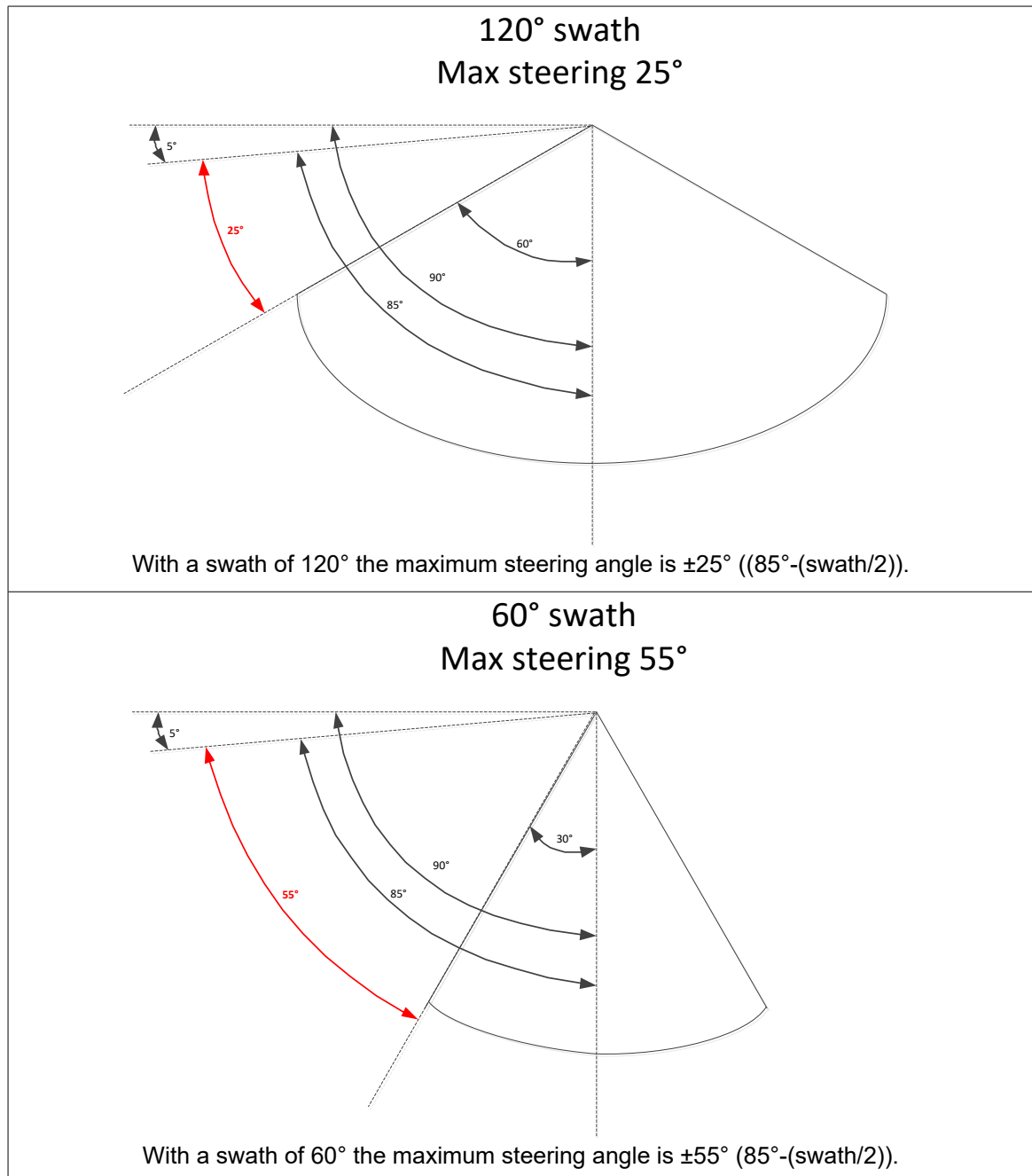


Figure 7: Horizontal Swath Steering

6.2.8.4 Minimum Grazing Angle

The minimum grazing angle is a limitation for the non-equiangular beam modes of the sonar. This limitation is especially noticeable for a sonar with a tilted head (see *section 6.3.4 below*).

With a tilted head for Equi-Angle beam mode, there is no minimum grazing angle and the outer beams can look 'upwards'. With a tilted head for the other beam modes the sonar is limited and cannot look 'upwards'.

For the beam mode Intermediate, the minimum grazing angle is 5°, and for Equi-Distant and FlexMode, the angle is 15°. For these three beam modes the outer beam cannot go higher. *Figure 8* provides a graphic illustration of the minimum grazing angle.

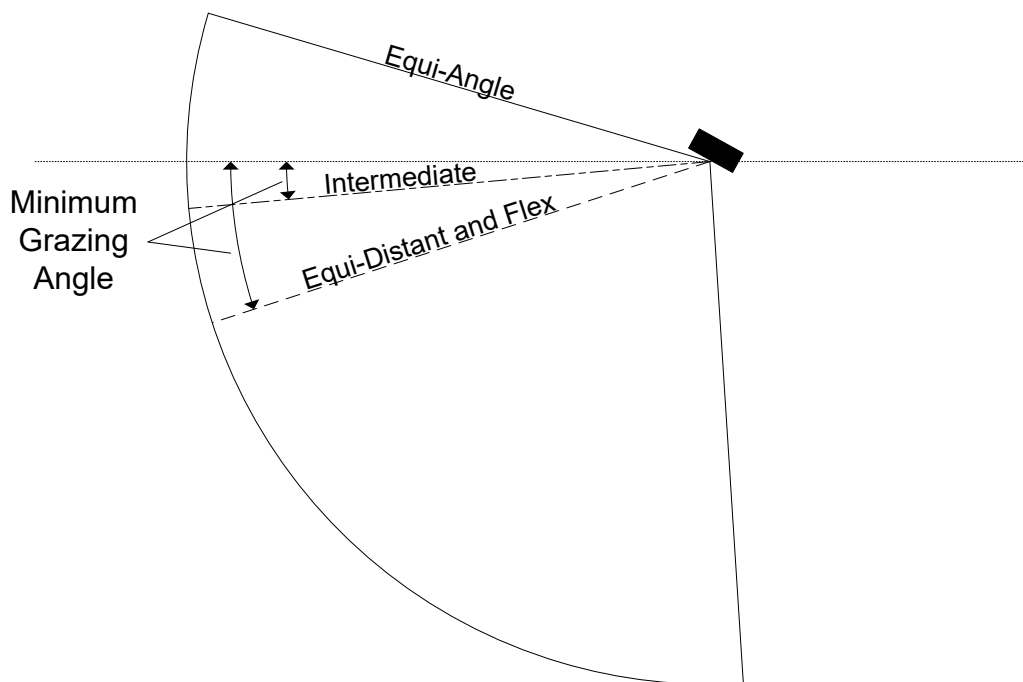


Figure 8: Outer Beams for the Different Beam Modes with a Tilted Sonar Head

NOTE

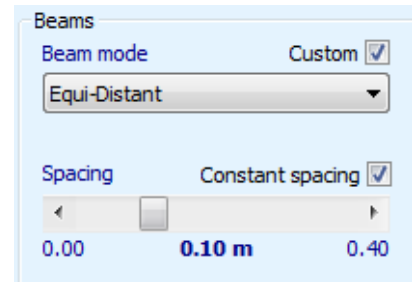
When you want to look up with a tilted sonar head you have to select Equi-Angle beam mode.

6.2.9 Use of Beam Modes

The following beamforming modes are available: Equi-Distant, Equi-Angle, Intermediate, and FlexMode (optional).

The system allows everything from high-density beams for exceptional image clarity and detail to just a few beams to deliver results faster. By deploying fewer beams in shallow water, the system allows the user to reduce storage requirements by gathering only the data you need. The system can also hold constant seafloor spacing between beams to provide the same high-quality results with minimal data volume.

In each mode (except FlexMode), the surveyor may choose the number of beams to be formed by using a slider. In Equi-Distant mode, an additional option is available which allows the surveyor to set the desired seafloor spacing with the slider. The system automatically detects the depth and sets the spacing as required by the surveyor. Adjustments may take place during survey: there is no requirement to interrupt the survey.



There is always a minimum number of beams that theoretically ensures “100% insonification” of the swath, which roughly speaking means that there are no gaps between beams; in other words, each beam adjoins or slightly overlaps its neighbor. IHO specifications no longer refer to the term “100% insonification”, as it cannot ever be proved conclusively; it is accepted that the situation may arise where “100% insonification” is not achieved.

6.2.9.1 Equi-Distant, Equi-Angle, and Intermediate Modes

- **Equi-Distant mode:** Up to 140°/150° coverage angle. Typically the default mode for general purpose surveys where it is critical to maintain a certain number of hits per cell across the maximum possible swath. Provides high-density equidistant soundings across the entire swath.
- **Equi-Angle mode:** Up to 170° coverage angle. Typically used for tilted heads to inspect upwards, water column data recording, or for minimizing the amount of data being recorded. Provides an equiangular distribution with the fewest beams.
- **Intermediate:** Up to 170° coverage angle. Designed for general purpose surveys, tilted head modes, or dual-head operations. Provides high-density soundings over the entire swath.

In Equi-Distant mode, the spacing is modified to maintain an equal horizontal distance between soundings on the seafloor assuming a flat bottom and in Equi-Angle mode the beam center-center angular spacing is constant across the swath. It is recommended that Equi-Distant mode be used for general survey applications where the requirement to achieve a specific number of sounding per cell in the across-track is critical, or where the seafloor is generally flat.

When surveying features such as wrecks and vertical structures such as harbor walls, Intermediate or Equi-Angle mode should be used in preference to Equi-Distant mode. In extreme conditions, using Equi-Distant mode over complex structures can cause magnified artifacts due to the large overlap between beams towards the edge of the sector.

In short, these are the pros and cons for the three modes, keeping in mind that in each case the negative effect is much more dramatic with a wide swath (see also *section 7.2.2 Equi-Distant, Equi-Angle, and Intermediate Modes*):

PRO	CON
• <u>Equidistant spacing:</u> ○ Constant spacing even at large angles	○ Very large number of beams
• <u>Equiangular spacing:</u> ○ Low number of beams	○ Very wide spacing at large angles
• <u>Intermediate (compromise):</u> ○ Moderate beam number ○ Moderate spacing at large angles	

6.2.9.2 FlexMode⁷

- Designed for pipeline or umbilical profiling. Provides equidistant beam spacing for the full swath coverage together with a high-density equiangular sector which may be steered toward the detail area of interest.
- In this mode the system is started with a 140° wedge and an alternative beam distribution is used which concentrates the majority of beams into a central sector.

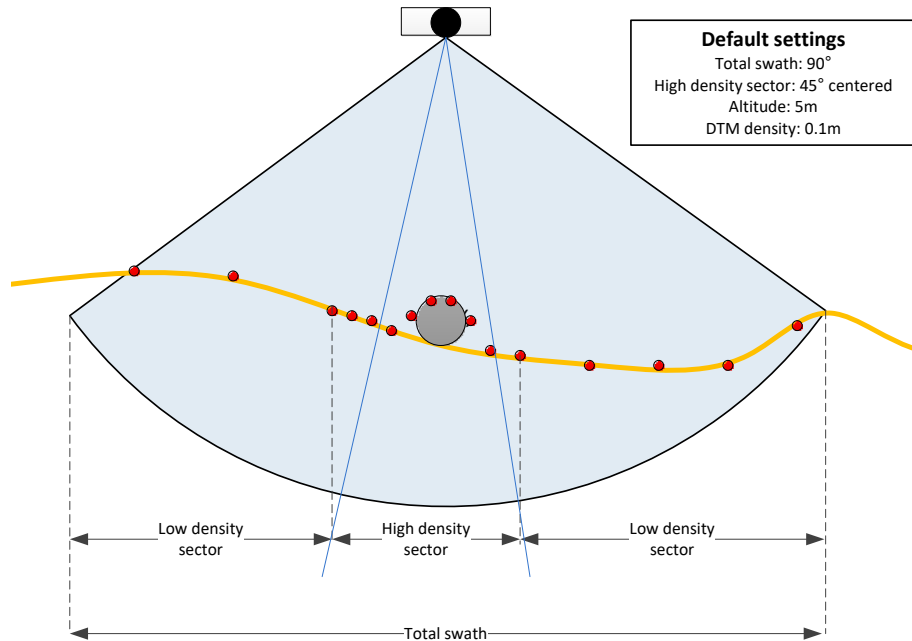


Figure 9: Graphic Illustration of FlexMode

FlexMode provides a combination of a high density of beams on and around the object location and a reduced density of soundings for the rest of the swath. The low-density spacing is defined by the operator (with the slider for Constant seafloor spacing) and the high-density spacing is computed by optimization based on survey parameters.

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

6.2.10 Use of Gates

Applying range and/or depth gates to the bottom detection process aids in noise reduction and correcting for a tilted sonar head.

- **No Gates:** The bottom detection process searches the entirety of each beam for the bottom.
- **Absolute Gates:**
 - **Depth:** Forces bottom detection to occur within the Min/Max Depth limits set. If the seabed falls outside the limits, bathymetry data will fail and cannot be recovered.
 - **Range:** Forces bottom detection to occur within the Min/Max Range limits set. If the seabed falls outside the limits, bathymetry data will fail and cannot be recovered.
- **Adaptive Gates:** Forces bottom detection to occur around the seabed profile within an adaptive gating window typically set to 15-20% (of depth). This value should be increased over rougher terrain or over a rapidly changing sea floor where bathymetry is extreme in the vertical values.

⁷ FlexMode is an optional add-on feature (see *Table 1*).

6.2.10.1 Depth Gates

Use of a motion sensor is required to rotate the depth gates with the rolling motion of the vessel to ensure soundings are not clipped as the seabed rotates with respect to the sonar.

The depth gates, with no input from a motion sensor, will orient themselves parallel to the horizontal plane of the sonar head, as shown by the Min and Max Depth lines in *Figure 10*. In this series of illustrations, the bottom detect dots are shown as a horizontal line (Line A or B) with dashed lines representing depth gates above and below the bottom and no vessel roll present. Visualize the bottom as being in the 'layer' formed by the depth gates.

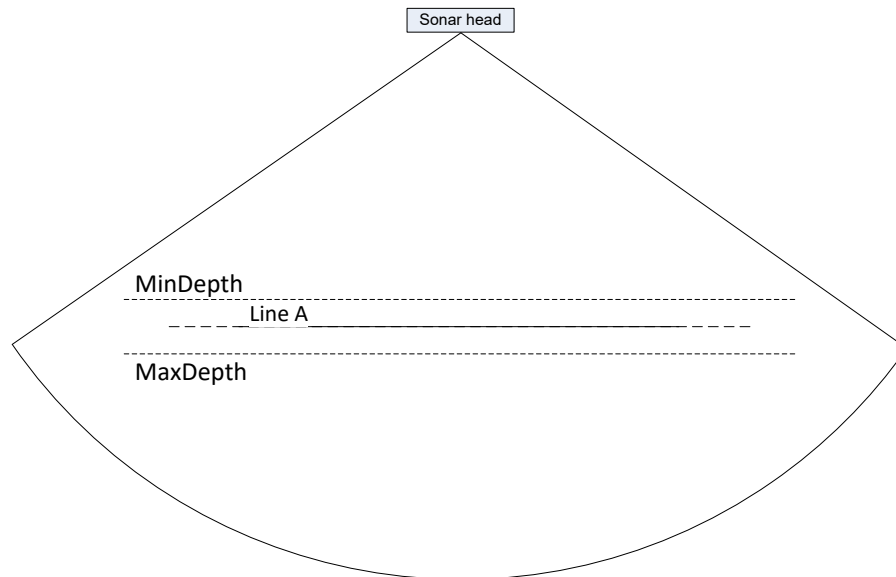


Figure 10: Depth Gates, With No Roll

Figure 11 shows the same bottom image with a small roll value to port. Notice that the ends of the swath have been cut off due to the action of the static depth gates (no motion sensor applied). In this figure, and all remaining figures in this discussion, the bottom is flat.

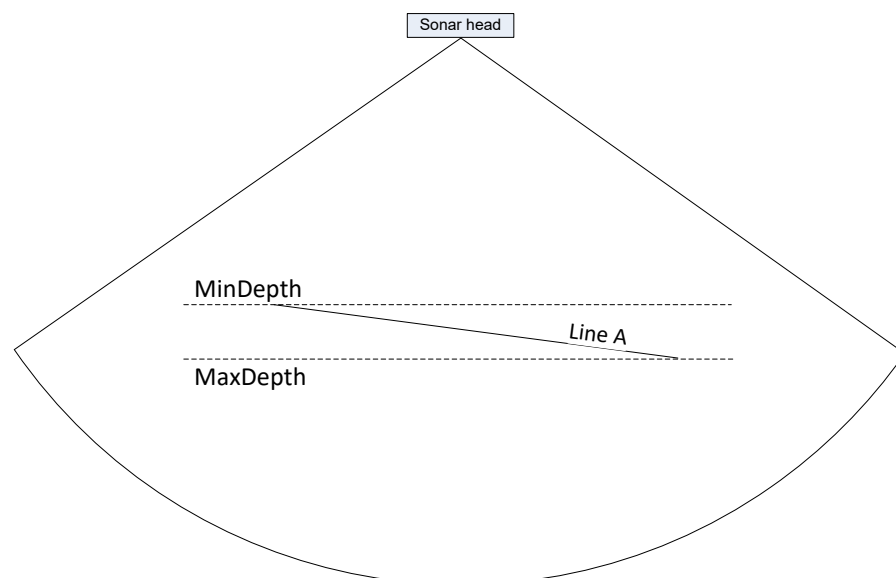


Figure 11: Depth Gates, With Roll

When controlled by a motion sensor, the depth gates will be parallel to the local horizontal plane of the earth even as the vessel rolls. *Figure 12* shows the same bottom image with dynamic depth gates applied.

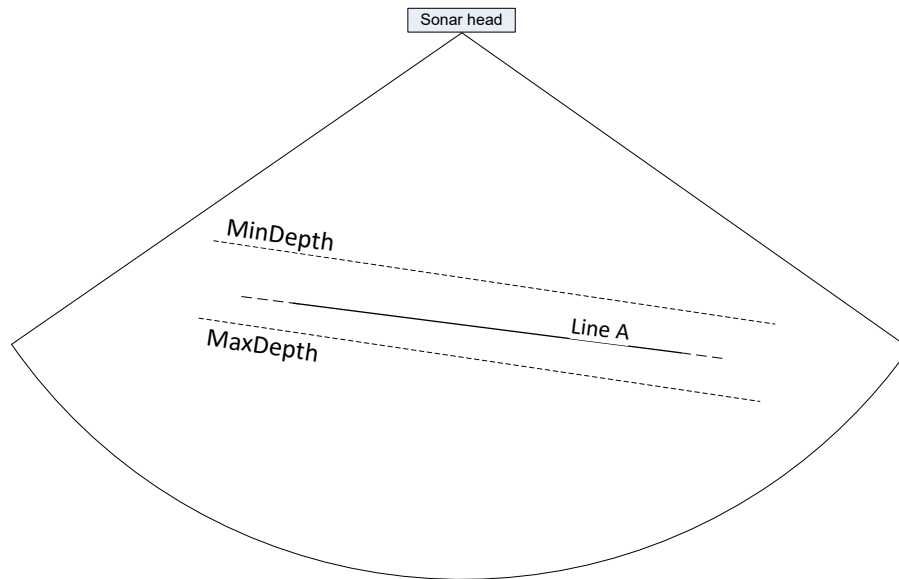


Figure 12: Depth Gates, With Roll and Motion Sensor Input

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

6.2.10.2 Depth Gate Tilt

Depth Gate Tilt is a feature that allows the operator to manually specify a tilt value for absolute gates. Tilted depth gates are beneficial when it is desirable to concentrate bottom detect operation efforts, e.g. on a sloping seafloor (see *Figure 13*).

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

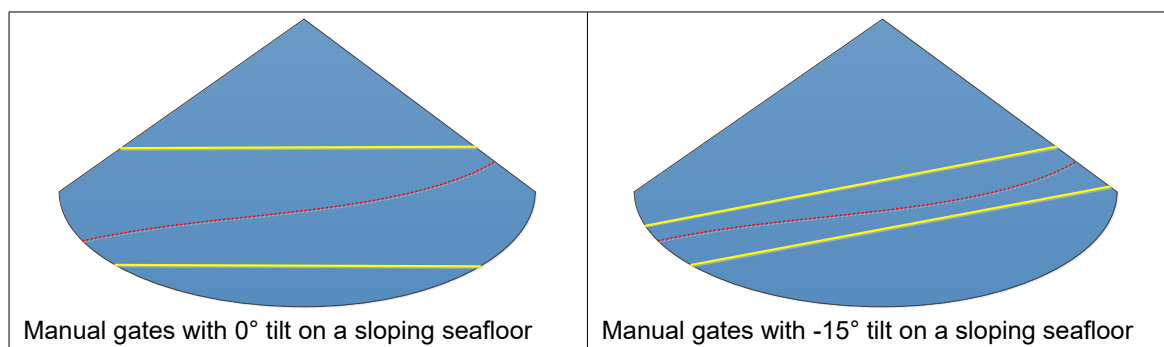


Figure 13: Depth Gate Tilt

6.3 Enhancing System Efficiency

6.3.1 Multi-Detect Operation⁸

Use of the Multi-detect feature is of great value in various applications both in terms of generated result and safety:

- Harbor surveys: safer detection
- Offshore and renewables: robust cable catenary determination
- Marine research: fish school detection
- Dredging: suspended sediment detection
- Energy industry: submerged oil detection

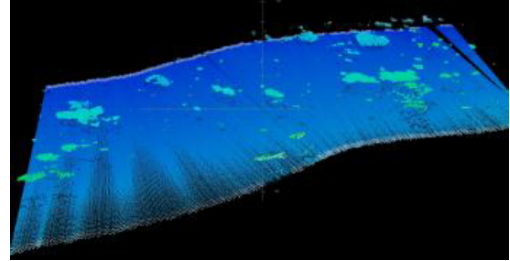


Figure 14: Submerged Oil Detected by Multi-Detect

Control the sensitivity of the Multi-detect feature with three controls:

- **Object Sensitivity:** Increase to yield more detections on smaller objects; decrease to yield fewer detections and only on larger objects.
- **Amplitude Sensitivity:** Increase to cause more objects to be detected.
- **Max Detections:** Up to 5 detections generated per beam, starting with the strongest detection to the weakest detection.

NOTE

When the setting is 1, it returns the **strongest** detection, **not** the closest detection. If the surveyor wants to find weaker detections in the water column (e.g. the mast on a sunken ship), the detection setting should be >1.

When operating in harbor environments or over wrecks, where determination of least depth (or distance to object) is critical, these sonar controls are designed to increase safety of survey missions. The controls allow the surveyor to adjust detection sensitivity in order to detect weak reflecting objects in the water column closest to the sonar head assembly in addition to the main seafloor detection.

NOTE

The standard bottom detection is always generated, such that multiple detections are provided in addition to, rather than instead of, the standard detection.

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

6.3.2 Tracker Autopilot

With “Tracker” enabled, all primary sonar control parameters such as range, power, gain, pulse length, and swath width are set by the system based on the quality of data being collected.

Furthermore, Tracker will adjust the TVG settings of Absorption and Spreading to optimize the quality of the outer beams, and open or close the swath angle accordingly; thereby ensuring that maximum swath width is delivered with the highest quality result.

⁸ Multi-detect is an optional add-on feature (see *Table 1*).

As there is a slight delay while tracker is being activated or deactivated, enabling/disabling the feature should not be done in the middle of the survey line.

Once Tracker has been selected, no further operator input is required; however, user controls makes it possible for the surveyor to limit the degree of automation:

- Constant Swath for the Tracker to maintain. This allows constant line spacing to be planned independently of depth.
- Disable Tracker control of certain settings.

For instructions, refer to the RESON Sonar UI User Manual (*see Appendix F Reference Documentation*).

6.3.3 Roll Stabilization

Roll stabilization is an important feature related directly to system efficiency which allows the swath width on the seafloor to be maximized, thus increasing line spacing and reducing vessel time.

Under zero roll conditions, the swath is vertical and the center of the swath is directly below the vessel.

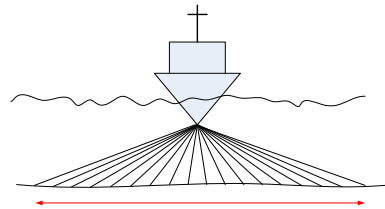


Figure 15: Swath under Zero Roll Conditions

When the vessel rolls the swath is rotated and the projected swath on the seafloor is laterally displaced.

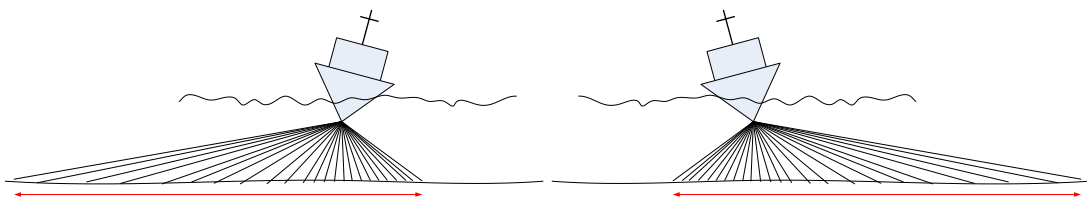
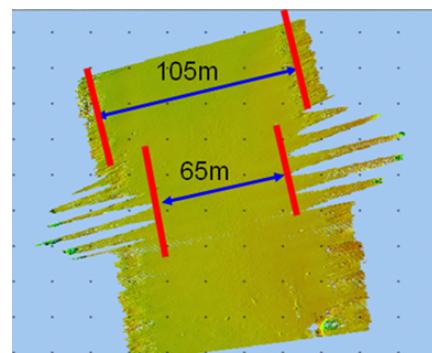


Figure 16: Laterally Displaced Swaths under Roll Conditions

This has the effect of reducing the usable swath width due to the distortions on the edge.



With the input from a motion sensor (and roll stabilization enabled) to steer each receive beam dynamically for every sample, the swath stays vertical irrespective of vessel motion thereby maximizing swath.

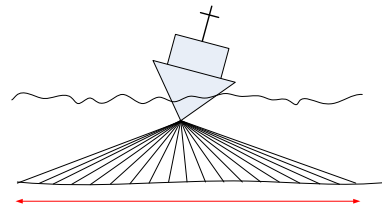


Figure 17: Swath under Roll Stabilization

It is recommended that the motion sensor data update rate is at least 50Hz and preferably 100Hz. Baud rate and protocol details can be set in Motion Stabilization, but it should be ensured that the baud rate is sufficient to allow the desired update rate.

NOTE

A warning will appear in the SUI, if the motion sensor update rate is lower than 20Hz.

For instructions on motion sensor configuration, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

6.3.4 Head Tilt

In certain applications it is desirable to physically rotate the sonar head. Instances of this are pipeline surveys where a dual head normally mounted on an ROV are inclined inwards to maximize the number of hits on a pipe. Another application is survey of harbor walls or other vertical structures where the desire is to survey as close to the waterline as possible.

NOTE

EA beams are recommended when using head tilt, as ED beams are still formed assuming a horizontal seafloor.

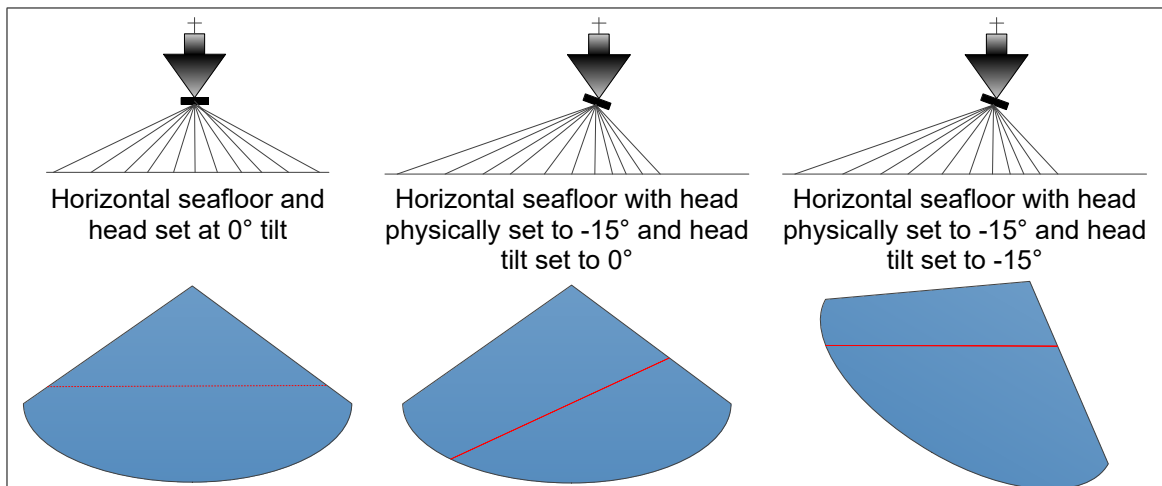


Figure 18: Head Tilt Functionality

6.3.4.1 Harbor Inspection (Quaysides, Breakwaters)

In this application a single head is typically tilted up to 30° (max. setting is $\pm 45^\circ$) from normal to register soundings as close to the waterline as possible.

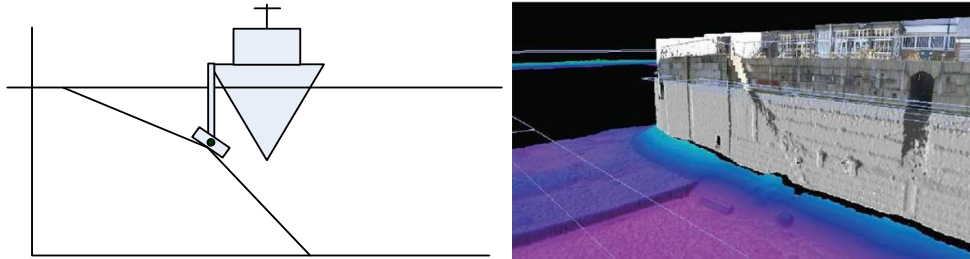


Figure 19: Head Tilt for Harbor Inspection

6.3.4.2 Pipe Inspection with Dual Head Systems

In this application each head is typically tilted up to 15° (max. setting is $\pm 45^\circ$) from normal, generally looking “in”.

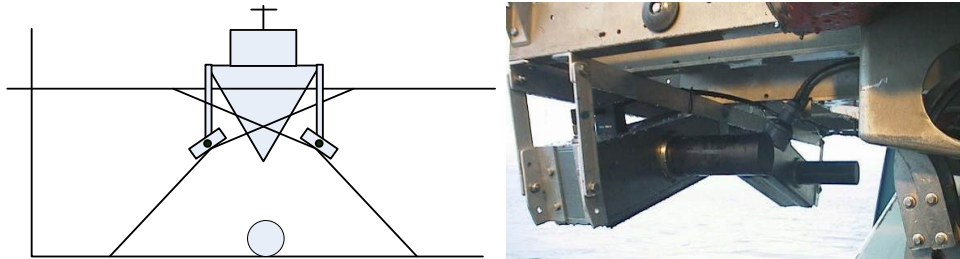


Figure 20: Head Tilt for Pipe Inspection

6.4 Compensation for Environmental Conditions

As sound propagates through the underwater environment, the energy is absorbed by the liquid caused by molecular interactions that convert acoustic energy into heat. A propagating sound field also spreads geometrically, which means that the sound pressure decreases with increasing distance from the sonar. Other mechanisms such as bubbles, plankton, tidal currents, currents from rivers etc. may influence sound propagation, but these mechanisms are difficult to measure and model, as they vary with time and only appear in a limited number of areas. However, as absorption and geometrical spreading exist everywhere in the underwater environment, they are considered to be the most important loss mechanisms.

In the SeaBat system it is possible to compensate for loss caused by absorption and geometrical spreading. In addition, the SeaBat system allows for changes in the speed of sound, a parameter which is important in the beamforming process.

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

6.4.1 Loss of Sound by Absorption

As sound moves through the water, some of the sound energy is converted into heat by absorption. The absorption loss depends on the salinity and temperature of the water as well as the depth. Finally, it also depends on the acoustic frequency. *Figure 21* shows the absorption loss for three different salinities and three different temperatures at an average depth of 20 meters⁹.

If the exact absorption loss value is not known, these are the recommended approximate values:

- 400kHz operation:
 - 110dB/km for salt water
 - 70dB/km for fresh water
- 200kHz operation:
 - 50dB/km for salt water
 - 20dB/km for fresh water

The absorption loss value is part of the formula that the SeaBat system uses to calculate the amount of gain to apply to the sonar return signal (see *section 6.2.4 above*).

Ideally, the purpose of the TVG is to ensure the receive gain increases with a rate that compensates for the continuously decaying intensity of the received sound field - a decay which is caused by geometrical spreading and sound absorption. Meanwhile, the TVG does not need to perform an exact compensation. In practice, the purpose of the TVG is only to ensure that the received signals continuously are within the dynamic range of the receiver. Therefore, the applied settings for the absorption and spreading only need to be approximate.

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

⁹ Note, that absorption and attenuation of sound in the water column caused by microbubbles and species such as, e.g., plankton and fish is not included in this consideration.

Acoustic Absorption (@ 20m depth)

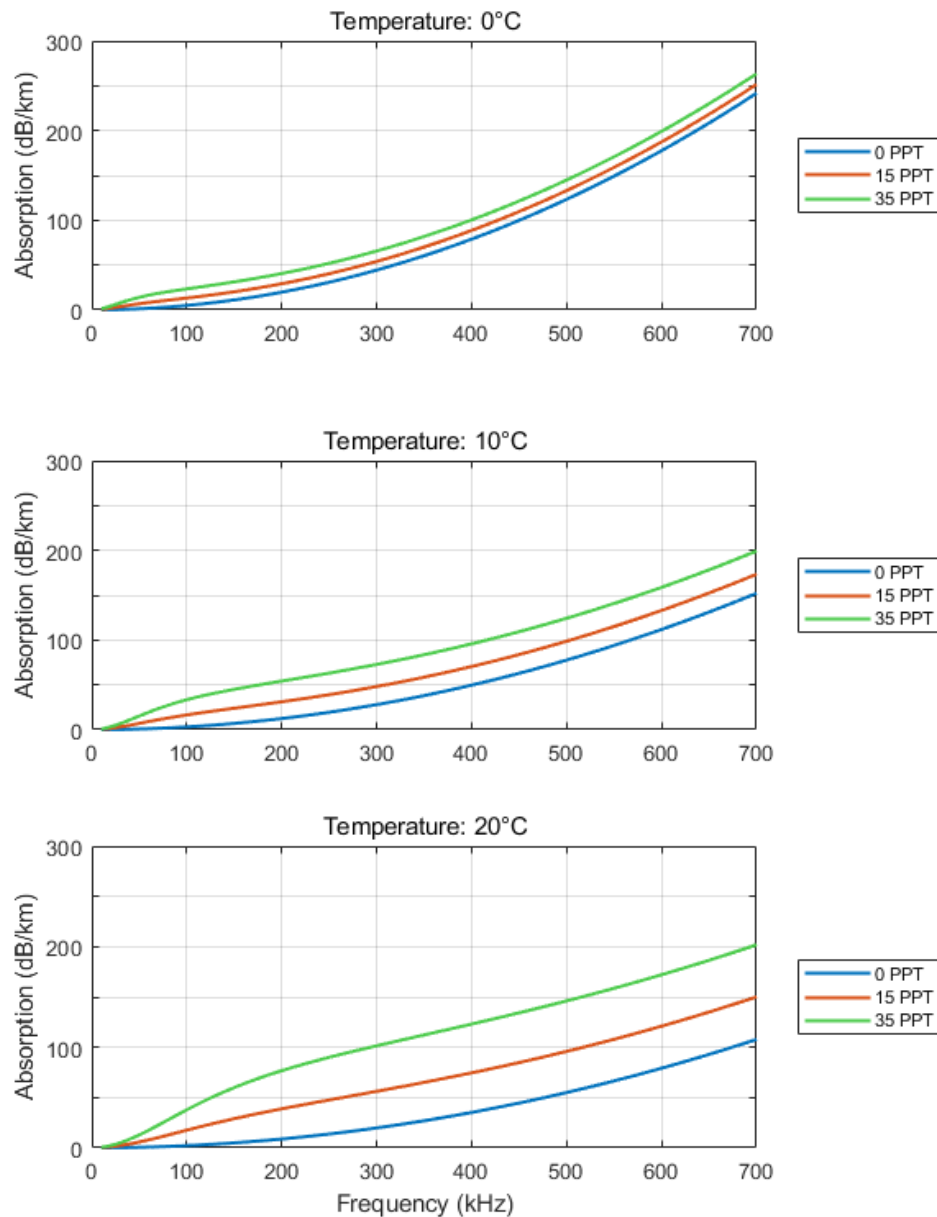


Figure 21: Acoustic Absorption Reference

6.4.2 Loss of Sound by Spreading

Spreading of sound through water may be the greatest contributor to the loss of sound. As sound moves away from its source in all directions, the acoustic pressures will decrease with range.

In deep water, where the acoustic propagation is not bounded by the sea surface or the seafloor, the spreading loss is spherical. In this case the pressure decrease is proportional to 1 divided by the range R from the sonar to a given object or surface. Thus, the acoustic pressure decays as $1/R$. As the sound is scattered back to the sonar the backscattered field also decreases as $1/R$. Consequently, for a two-travel path the acoustic pressure in a free field decays as $1/R^2$.

In shallow waters, on the other hand, the sound propagation is bounded by the sea surface and the seafloor, and the spreading loss is cylindrical. In cylindrical spreading the sound pressure only decreases as $1/R^{1/2}$, and the two-way travel path decays as $1/R$.

In practical situations the transmission loss will lie between 20 and 40dB; in other words, the spreading loss will neither be perfectly spherical nor perfectly cylindrical. Finally, if the sonar operates very close to the seabed or very close to objects in general, near-field effects may yield a transmission loss less than 20dB.

The spreading loss value is part of the formula that the SeaBat system uses to calculate the amount of gain to apply to the sonar return signal (see *section 6.2.4 above*). If the exact spreading loss value is not known, an initial value of 30dB is recommended.

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

6.4.3 Sound Velocity

For installation instructions, see *Table 12 in appendix B.4.4 Pin Designations for Host, AUX, LAN2, and SVP Connectors*.

6.4.3.1 Sound Velocity and Performance

Online sound velocity readings are crucial in the beamforming process to ensure that the beams are steered in the correct directions. Ensure that a real-time sound velocity probe (SVP) is set up to deliver the sound velocity at the sonar head.

Sound velocity varies with pressure, temperature, and salinity. An increase in these three levels increases the sound velocity. The sonar data presented in the SeaBat system is dependent on the sound velocity provided.

CAUTION

An online sound velocity probe must be used for providing up-to-date velocities to ensure optimum performance. A manual velocity may be entered instead but care should be taken to ensure the value entered is representative of the real velocity.

If the local sound velocity is not known, Teledyne RESON recommends a value of 1480 to 1500m/s for open sea areas and 1425m/s for fresh water. *Figure 22* provides a general reference for typical surface sound velocity at different temperatures and salinity.

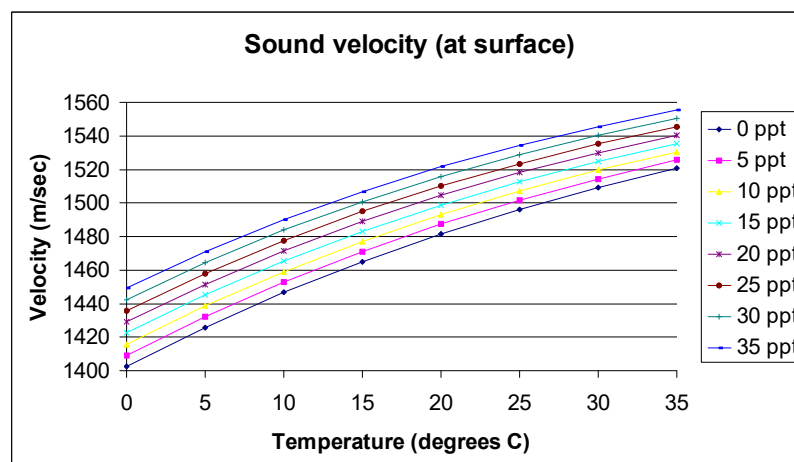


Figure 22: Typical Sound Velocity Values

6.4.3.2 Recommended Use of SVP Filter

The speed of sound impacts the beam angles. If a sonar ping is processed with a sound velocity value that is not reflecting the speed of sound right in front of the receiver, the beam angles will be wrong and hence the targets or bottom detects will have wrong coordinates.

Some software packages allows post-compensation of wrong sound velocity, but it is typically possible to avoid this extra complication of processing by setting a proper filter on the SVP data during real-time recording.

For instructions on how to adjust this setting, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

- **No Filtering:** Although this setting does not filter data in the classical sense, it still ignores readings outside the range 1350m/s to 1800m/s.

Use this filter if there is a requirement for immediate response to sound velocity changes. When using this filter any false reading will cause distinct false output. This filter may be preferred for certain scientific sonar work.

- **SVP Light:** Removes occasional false readings.

Use this filter if there is a need for fast filter response, for instance in regions with mixing waters.

If the SVP update rate is less than 10Hz it may be preferred to use this filter as the standard filter.

- **SVP Normal:** Removes single and double false readings and outliers, and smoothens the SVP value across 10 readings.

The filter is recommended for most sonar work on systems using an SVP (SVP 70) with no internal filtering and an update rate of 10-20Hz.

NOTE
The SVP Normal filter is typically the best filter to use.

- **SVP 70 Wizard:** This filter only works with the SVP 70 if the internal SVP 70 filter is set to mode 1 (low pass filtering).

Sensors with a low pass filter cause a special artifact in the output in case of outliers and invalid readings. The SVP 70 Wizard filter removes these artifacts and makes the system work well despite of the low pass filter.

It is recommended to change the SVP 70 filter mode to 0 when convenient and reset the SVP Filter to SVP Normal.

For access to filtered and unfiltered values, please see the DFD messages R7510 and R7610. Refer to the Data Format Definition document for information (see *Appendix F Reference Documentation*).

6.5 Limitations

Physical limitations in the functionality of the system have to be taken into consideration when operating sonar systems, including SeaBat systems. Some of the limitations are absolutes; others can to some degree be overcome.

The following subsections provide examples of different kinds of limitations.

6.5.1 Cavitation

Some reduction in the transmitted source level is expected to be caused by cavitation. For means of compensating for this, see subsections in 6.2 *above*.

6.5.1.1 Propeller Cavitation

Propeller cavitation can be a significant concern for two reasons. First, the frequency of propeller cavitation noise is in the operating frequency band of most sonar equipment. Second, the source levels of the propellers installed are expected to be high unless special quieting techniques have been implemented.

Propeller energy typically propagates to the forward area sonar systems via a direct or hull-grazing path. The other arrival path of propeller energy is by the bottom bounce path. This path will be more significant in shallow water depths (less than 500 meters). The potential impact can be further quantified for particular bottom depths of proposed operational test sites.

6.5.1.2 Appendage Cavitation

Appendage cavitation can result from rough or unfaired edges on the hull and can even be present at lower speeds. If the source is located near the sonar installation area, it can be a significant noise deficiency. It is difficult to predict the occurrence of appendage cavitation without under-hull drawings, pictures, or visual inspection of the ship when in dry-dock.

6.5.2 Machinery Noise

Machinery noise should not be a major factor for sonars that operate at frequencies above 5kHz. Mechanical machinery noise is usually prevalent at 2kHz and below, though it is occasionally detected at higher frequencies when fluid flow through pipes or cavitating pumps are involved.

Typically, the most important consideration for machinery noise is the proximity of the acoustic sensor to the machinery source. There has been one observed case where diesel engine piston frequency harmonics have been the controlling noise source at 12kHz, but in this situation, the engine room and the sonar compartment shared a common bulkhead. Normally, acoustic devices are sufficiently distanced from major machinery noise sources that machinery noise does not interfere.

A concern remains that there may be some auxiliary machinery (or other unusual equipment) located near the sonar that could produce noise interference. An inspection of the installation site and ship drawings to verify the position and proximity of all shipboard equipment should be conducted to determine if there is a potential for machinery interference prior to conducting at-sea testing. For means of compensating for this, see subsections in 6.2 *above*.

6.5.3 Interference from Other Sonar Systems

Interference from other sonar systems can be seen as radial lines, typically moving away the minimum to maximum range scale as these pings are not correlated with the ping repetition rate of the SeaBat system. The most typical source of interference of this type is navigational sonars (often 50kHz systems) and Doppler velocity logs.

Synchronization of acoustic systems is one means to mitigate this effect. The most effective approach is to remove the source of interference entirely, either by moving the equipment away from the SeaBat or turning it off.

6.5.4 Speed

Hydrodynamic flow noise can be a concern when operating at higher speeds. Externally mounted acoustic sensors should have fairings that are as flush (or near-flush) mounted to the ship hull as is practically possible. This way the hydrodynamic flow-induced vibration noise should be minimal. For means of compensating for this, see subsections in 6.2 above.

NOTE
A poorly designed sonar fairing can degrade the system performance by a factor of 4 for speeds above 8-10 knots. Typically, this noise source is the most common problem on all sonar installations.

6.5.5 Air Bubbles

Bubble sweep-down can be another potential noise problem. The significance of this problem is associated with the noise generated as the bubbles cascade along the hull after being ingested in the bow wave of the ship and, more importantly, with the baffling produced by the entrained air layer between the face of the sonar sensor and the water environment.

If air bubbles are present between the sonar and the water, the system will not function properly. This phenomenon is transient in nature occurring only for a few seconds per wave period. It is typically most prevalent on shallow draft ships and increases in intensity at higher sea states and ship speeds.

Modeling of this problem only indicates that air bubble noise may be present by determining the transmission vehicle of potential bubbles. Actual at-sea measurements are usually required to fully determine the presence and severity of bubble sweep-down. At-sea diver viewing has been very successful in the past to capture the bubble sweep-down characteristics of a particular ship hull on film.

Air bubbles mask some or all of the view of the sonar where the affected area will completely blank out. Common causes for bubble masking include:

- The vessel props when thrusting into reverse and pours a stream of bubbles over the sonar.
- The sonar has not been deployed deeply enough and there is bubble wash from the sea surface.
- Bubble ingestion as the vessel pitches into the sea.

6.5.6 Environment

A high-reverb environment where echoes of the previous ping are contaminating the current ping may prove to be difficult. For means of compensating for this, see *section 6.2.3 above*.

7 SYSTEM PERFORMANCE AND DATA TYPES

NOTE
There are several factors that can have a significant effect on acoustic performance. For this reason, product performance estimates are indicative of standardized conditions for temperature, salinity, bottom type or target strength, sound velocity, installation type, and assume no affect from adverse environmental conditions such as wind, precipitation, sea state, ambient or traffic noise, refraction, temporal changes or other surface effects. (Read also <i>section 6 Active Sonar Usage</i>.) To determine actual in-situ performance predictions requires a site or vessel survey and environmental measurements with performance modeling based on the resulting measurements. Costs for this survey may be quoted as part of a contract or independently.

The SeaBat T-Series Subsea sonar system produces four types of data, bathymetry, side-scan, snippets backscatter, and water column backscatter, suitable for the generation of high-resolution hydrographic charts that exceed international standards.

A single transmission from the projector unit illuminates the entire swath on the seafloor. The seabed return signal is received by the receiver unit, digitized, and transmitted to the SSP, where it is formatted for data and display output. Sonar data is stored locally or displayed remotely via the Ethernet connection TCP/IP connection (see *section 4.3 Remote Operation*).

A Windows®-based user interface controls the system, allowing the operator to select system configuration, data output, and storage options. This also provides built-in test environment (BITE) displays to assist the operator.

For available configurations, see *section 1.6 Available SeaBat T-Series Subsea Configurations*.

NOTE
Refer to the Data Format Definition document (see <i>appendix F.1 SeaBat T-Series Subsea Documentation</i>): • For information on the data records. • For information on externally controllable sonar operating parameters.

Table 5: SeaBat T-Series Subsea System Performance

Parameters	400kHz	200kHz
Operating frequency, deep	400kHz	200kHz
Operating frequency, shallow	190-420kHz (CW) / 200-400kHz (FM)	
Across-track receive beam widths Error! Reference source not found. (nominal values)	T20: 1.0° T50: 0.5°	T20: 2° T50: 1°
Along-track transmit beam widths (nominal values)	1°	2°
Number of beams	Max. 1024, min. 10	
Max. swath coverage, T20	140° ED/170° EA	
Max. swath coverage, T50	150° ED/170° EA	
Depth, typical ¹⁰	CW: 0.5-150m FM: 0.5-180m	CW: 0.5-300m FM: 0.5-450m
Depth, max. ¹¹	CW: 225m FM: 300m	CW: 400m FM: 575m
Ping rate (range dependent)	Up to 50 pings/s	
Pulse lengths CW	<u>Single head:</u> 15-300µs <u>Dual head:</u> 30-300µs	
Pulse lengths FM	<u>Single head:</u> 300µs-20ms ¹² <u>Dual head:</u> 300µs-5ms	
Depth resolution	6mm	
Depth rating	6000m or 400m	
Temperature	Operating: -2°C to +36°C Storage: -30°C to +70°C	

* Receive center beam widths¹³: T20: 1.07° (at 400) / 2.14° (at 200kHz)
T50: 0.54° (at 400) / 1.07° (at 200kHz)

¹⁰ This is a depth range within which the system is normally operated, from the minimum depth to a depth value corresponding to the max. swath -50%.

¹¹ This is a single value corresponding to the depth at which the swath is reduced to 10% of its max. value.

¹² Max. 5ms at 66kHz.

¹³ Receive center beam width mean values from far-field simulation. All beam widths measured at -3dB, center beam unsteered, with a sound velocity of 1440m/s, 30dB Chebyshev shading applied.

7.1 System Components

7.1.1 Subsea Sonar Processor

The Subsea Sonar Processor (SSP) is a high-performance unit offering a highly flexible platform that supports a number of functions, including highly accurate time-stamping, interfacing and time-stamping of external sensors, and optional beam data storage on an external Network Attached Storage (NAS) drive. It is housed inside a 6000m depth rated, titanium bottle.

For physical specifications, see *appendix B.5.1 Subsea Sonar Processor*.



Figure 23: Subsea Sonar Processor

The SSP performs the following functions:

- Receives digitized sonar data from the receiver.
- Receives operational settings from external control system.
- Provides beamforming and initial processing of acoustical data.
- Controls, formats, and generates data to external systems.
- Provides an interface and single-point time-stamping source for:
 - 1PPS and time recovery message
 - Position
 - Heading
 - Motion
 - Sound velocity sensor

7.1.2 EM7219-1 Receiver Unit (T20)

The EM7219-1 receiver unit operates at multiple frequencies between 200kHz and 400kHz.

For physical specifications, see *appendix B.5.2 EM7219-1 Receiver Unit (PN 85002536) – T20*.

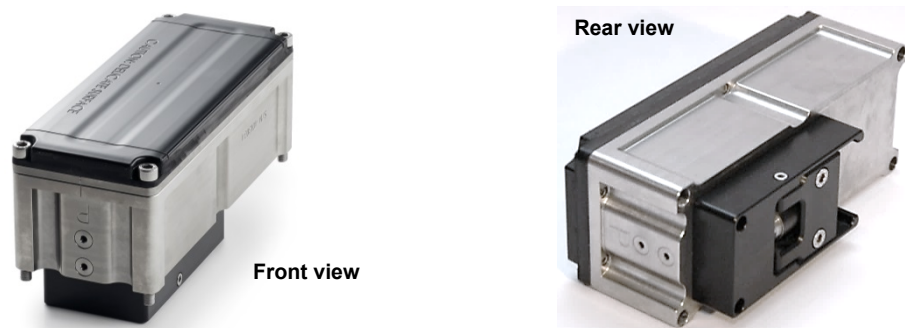


Figure 24: EM7219 Receiver Unit

7.1.3 EM7218-1 Receiver Unit (T50)

The EM7218-1 receiver unit operates at multiple frequencies between 200kHz and 400kHz.

For physical specifications, see *appendix B.5.3 EM7218-1 Receiver Unit (PN 85002538) – T50*.



Figure 25: EM7218 Receiver Unit

7.1.4 TC2160 Projector Unit (deep)

The TC2160 bathymetry projector unit operates at the frequency of 400kHz.

For physical specifications, see *appendix B.5.4 TC2160 Projector Unit (deep operation) (PN 85000328)*.

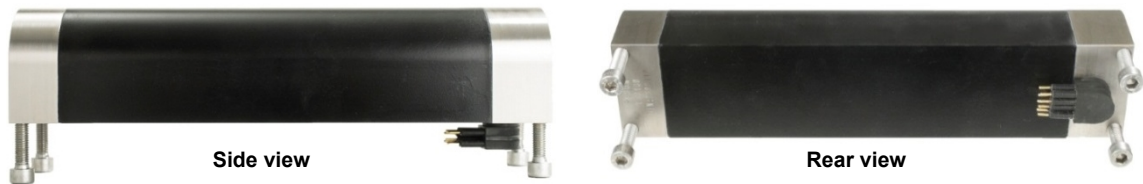


Figure 26: TC2160 Projector Unit

7.1.5 TC2163 Projector Unit (deep)

The TC2163 bathymetry projector unit operates at the frequency of 200kHz.

For physical specifications, see *appendix B.5.5 TC2163 Projector Unit (deep operation, optional) (PN 85000327)*.



Figure 27: TC2163 Projector Unit

7.1.6 TC2181 Projector Unit (shallow)

The TC 2181 projector unit operates at multiple frequencies between 200kHz and 400kHz. The entire swath is illuminated in one transmission, with the maximum ping rate of 50Hz, providing 100% bottom coverage even at high vessel speed.

For physical specifications, see *appendix B.5.6 TC2181 Projector Unit (shallow operation) (PN 85002319)*.



Figure 28: TC2181 Projector Unit

7.2 Selectable Beam Density

Selectable beam density is a feature which allows the surveyor to decide how many beams to form ranging from the maximum capability of the system down to just 10. This allows the surveyor to be able to capture the highest detail using the highest beam density available, but alternatively maximize efficiency by using fewer beams in very shallow water where data volumes traditionally become large quickly due to high beam numbers and high ping rates.

A special mode is the ability to define the desired equidistant spacing between beams on the seafloor and keep it constant. The system will “hold” this automatically, as depth varies, within the constraints defined by the minimum and maximum number of beams.

Selectable beam density adds to the flexibility of the system with several benefits:

- Optimized data volumes tailored to survey purpose/specifications
- Save of up to 75% of data volume in very shallow water
- Faster processing
- Reduced time and costs from survey to deliverable

7.2.1 Beam Modes

Beam mode selection is made on the fly via the sonar user interface. For instructions, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*). Available selections depend on options purchased (see also *Table 1*).

Table 6: Beam Modes with No. of Beams and Swath Coverage

	No. of beams			Swath
	T20/50 Min.	T20/T50 Std.	Max.	T20/50 Max.
Equi-distant (with constant no. of beams)	10	1024		140/150
Equi-distant (with constant beam spacing)	10	1024		140/150
Intermediate	10	1024		170
Equi-angle	10	1024		170
FlexMode¹⁴	1024	1024		140/150

For examples on how to use this feature, see *section 6.2.9 Use of Beam Modes*.

¹⁴ FlexMode is an optional add-on feature (see *Table 1*).

7.2.2 Equi-Distant, Equi-Angle, and Intermediate Modes

As the beam steering angle increases from nadir, the number of beams per degree of swath stays constant for equiangular spacing while it increases for equidistant spacing. *Figure 29* presents the number of beams as a function of steering angle for a 1° nadir beam spacing.

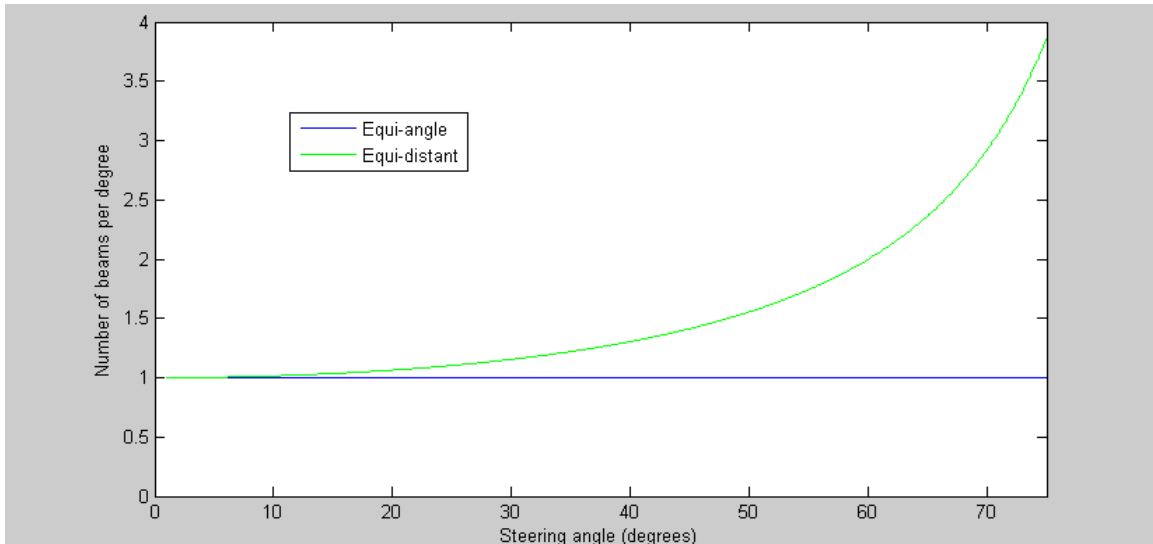


Figure 29: Beam Density

Figure 30 shows that the horizontal spacing of the Intermediate mode increases with beam angle, unlike Equi-distant mode where the spacing stays constant. However, the Intermediate mode increases the spacing much slower than the Equi-angle mode so the outer beam density is still quite good.

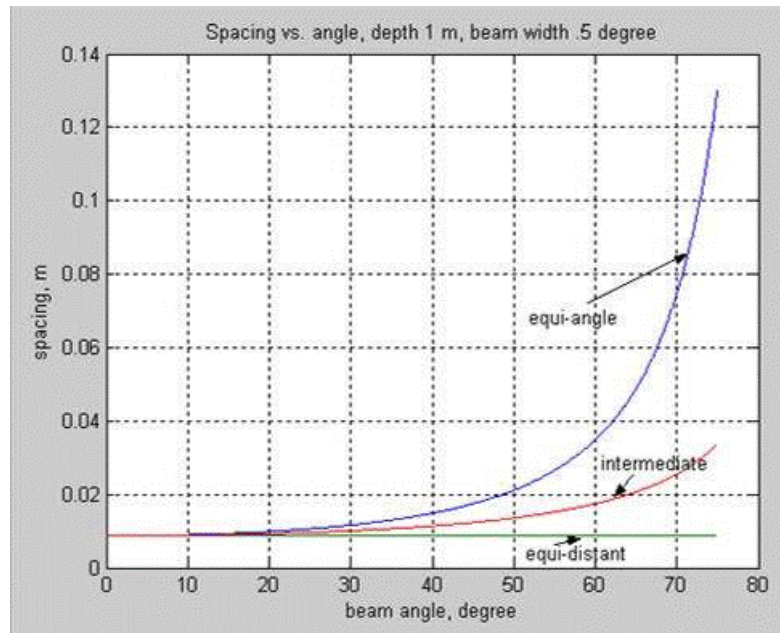


Figure 30: Beam Spacing vs. Beam Angle

Assuming a flat bottom and using the beam footprint generated by the nadir beam, it may be seen that the center-to-center spacing for each beam successively reduces as the departure from nadir increases until at $\pm 65^\circ$ the beam density is approximately 2.5 times greater than at nadir.

Assuming one sounding is generated from the intersection of the beam center with the seafloor, with equidistant spacing, the appropriate number of beams is formed to maintain this nadir sounding spacing across the entire swath. See also *Figure 31*.

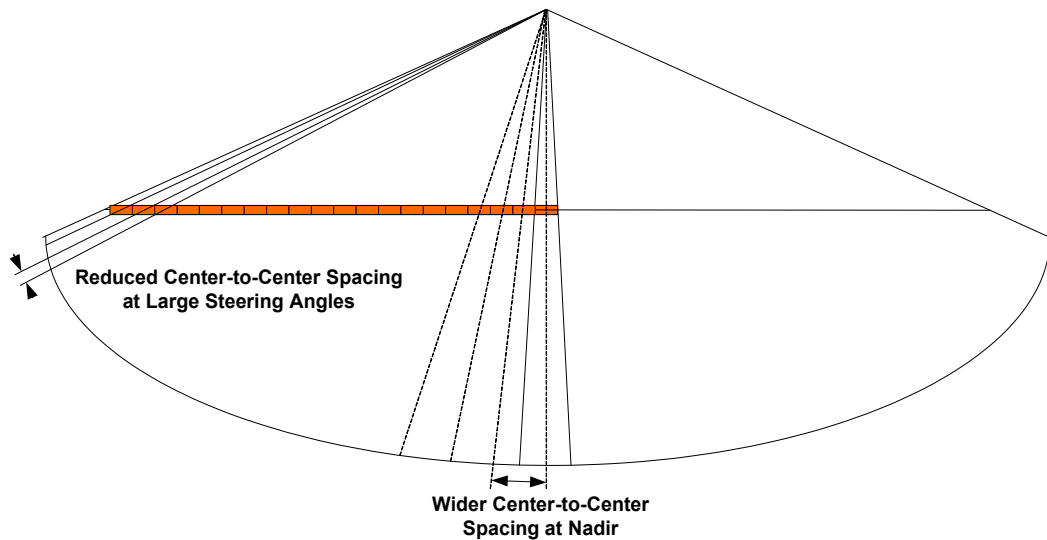


Figure 31: Beam Spacing

In order to achieve this uniform sounding spacing, it is necessary to decrease the beam center-to-center spacing which requires a significant increase in the number of beams formed.

The beamformer is able to generate a receive beam centered on any angle within the available swath and with equidistant spacing a set of coefficients is selected that form a set of receive beams that are centered on the midpoints of the footprints.

Figure 32 shows the difference in distribution between equiangular and equidistant spacing.

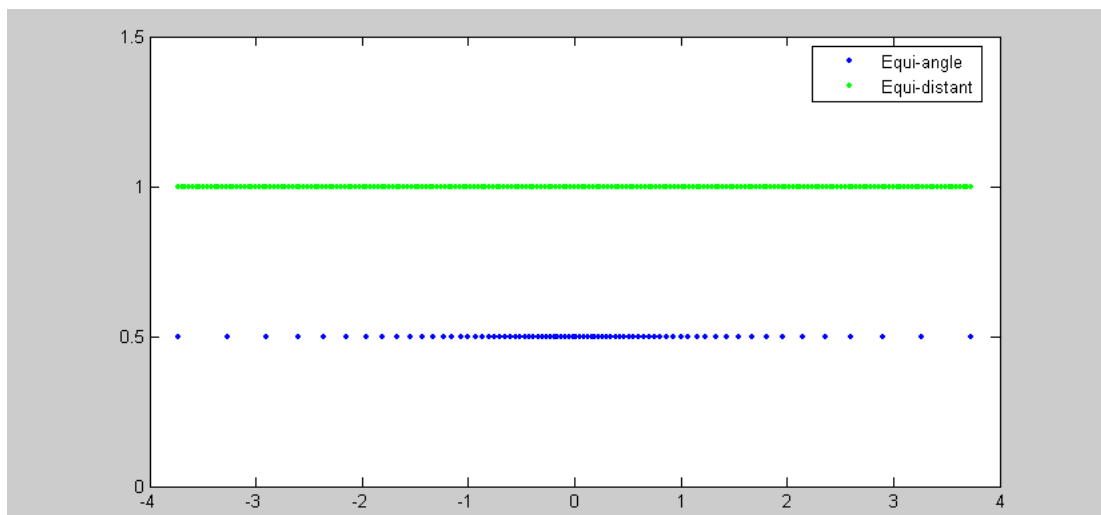


Figure 32: Across-Track Sounding Location on a Flat Bottom

7.3 Data Types

7.3.1 Bathymetry Data

The SeaBat T-Series Subsea system generates between 10 and 1024 soundings per ping.

The system broadcasts from the sonar processor to the data acquisition software, where they are corrected for mechanical offsets, motion, heading, refraction, tide or depth, and position. To perform these corrections, the appropriate sensors must be interfaced to the data acquisition software. For instructions on sensor configuration, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

Depending on the beam angle, bottom type, and signal characteristics, the bottom detection method employed may be magnitude center-of-energy, phase slope zero-crossing, or a blend of the two methods. The bottom detection method can vary from ping to ping and beam to beam.

7.3.2 Side-Scan Data

Side-scan swath is measured and displayed without degrading any of the traditional survey capabilities of the SeaBat.

NOTE

Side-scan cannot be used to measure accurate depths, but it can provide a more detailed picture of the seafloor. This image can be used together with bathymetry to identify features and to ensure that you do not miss any small but significant targets.

7.3.2.1 Side-Scan Process

The side-scan process averages adjacent pairs of beams to eliminate noise and then carries out a peak detection over beams from the left and right sides of the swath. The peak detection is done at the sample rate of the sonar.

The bathymetry and side-scan data are independent in the beamforming process and in how the output data is generated.

7.3.2.2 Side-Scan Data Output

The array of intensity values is a series of amplitudes, one for each sample interface for each side-scan beam.

The number of intensity values reported in a side-scan packet is a function of range. The number of values per packet can be calculated using the following formula:

$$\left(\frac{\text{Range}}{\frac{1}{2} \text{SoundVelocity}} \right) * \text{SampleRate} = \text{SamplesPerBeam}$$

Side-scan is one of the many records available for subscription from the 7k Center software. Refer to the 7k Data Format Definition for further information regarding side-scan data output (see also *Appendix F Reference Documentation*).

7.3.3 Snippets Backscatter Data

Snippets backscatter data is available from the SeaBat T-Series Subsea. Each snippet consists of a windowed selection of amplitudes taken from the bottom detection point of each beam.

A snippets data sample contains backscatter data from the 'footprint' on the seabed illuminated by a single sonar ping. The number of snippets in a swath is a function of the number of sonar beams. The length of each snippet depends on the operating mode, beam number, and depth. All of these settings may be selected by the operator.

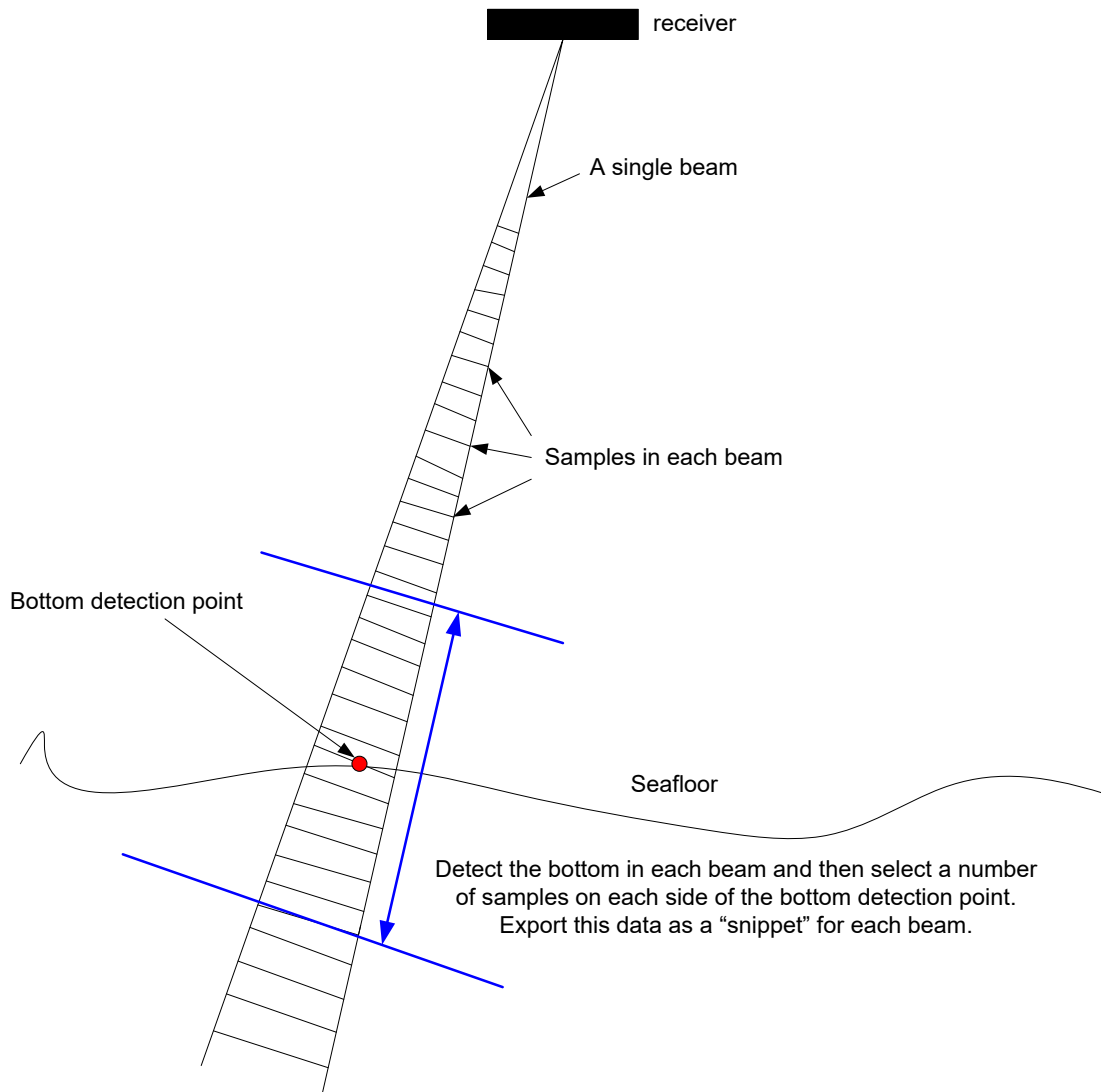


Figure 33: Graphic Illustration of Snippets Data

Each snippets data packet contains pertinent information such as time stamp, sequential ping number, sample rate, sound velocity, and operator settings such as power, gain, absorption, and range scale.

Refer to the 7k Data Format Definition for further information regarding snippet data output (see also *Appendix F Reference Documentation*).

7.4 Multi-Detect¹⁵

Multi-detect is a feature which provides multiple detections within each beam, including the full water column. It allows the surveyor to capture enhanced detail from a single survey line over a complex feature, or ensure that full detail is captured of any object in the water column, even in noisy environments. Up to five detections may occur anywhere within each beam. (See also *section 6.3.1 Multi-Detect Operation.*)

NOTE

Multi-detect is not equivalent to multiple soundings across a beam footprint on the seabed.

With the multi-detect feature you achieve:

- Enhanced detail over complex, small, and fine objects.
- Improved and faster decision making.
- Easier and faster water column processing.
- More project opportunities.

In the scenario in *Figure 36*, without multi-detect the sonar would detect either the anchor chain (blue dots) or the seabed (red dots) or flicker between the two features.

With multi-detect, the sonar can detect both the anchor chain and the seabed.

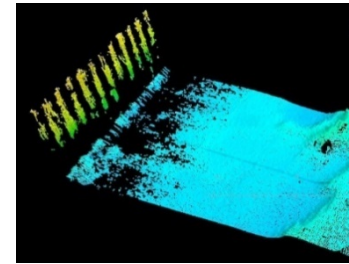


Figure 34: Standard Detection

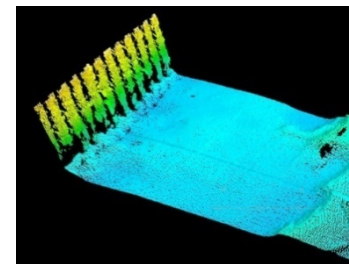


Figure 35: Multi-Detect with Enhanced Detail on Quay Wall

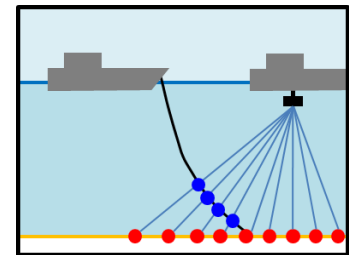


Figure 36: Multi-Detect

7.5 X-Range¹⁶ Performance

X-Range is a feature that provides extended range performance at the full range of frequencies and also significantly improves system immunity towards external noise. The basis of the X-Range feature is a frequency-modulated (FM) transmission combined with advanced signal processing techniques to extract the maximum possible performance from the system.

7.6 Full Rate Dual Head¹⁷

The Full Rate Dual Head (FRDH) feature is superior to the standard dual head implementation by providing simultaneous pinging, whereas the standard dual head feature operates with alternate pings (see *Figure 37*).

The standard dual head implementation uses time multiplexing to achieve synchronized operation. The result is reduced ping rate per head and asymmetric sea floor swaths. FRDH uses X-Range (see *7.4 above*) to achieve dual head operation which has the double effect of range and ping rate increase. In FRDH the systems are synchronized and ping simultaneously at a high rate. (See also *section 6.3.4.2 Pipe Inspection with Dual Head Systems.*)

¹⁵ Multi-detect is an optional add-on feature (see *Table 1*).

¹⁶ X-Range is an optional add-on feature (see *Table 1*).

¹⁷ FRDH is available as an upgrade to the Base license set (see *Table 1*).

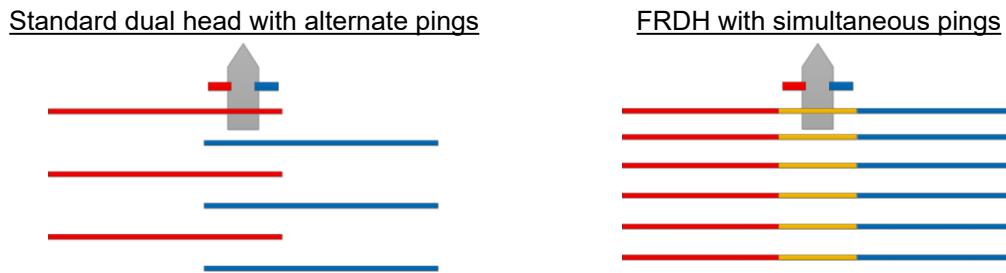


Figure 37: Dual Head Synchronization of Pings

7.7 Quality

The quality of each bathymetric bottom detection point is evaluated by the sonar. For instructions on how to customize some of the visual properties of the sonar image, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

7.7.1 Brightness Test

The brightness test measures the signal-to-noise ratio (SNR) of the signal strength (magnitude) near the bottom detection point (as determined by the bottom detection algorithm) versus the background noise in the rest of the beam.

The signal strength is the mean of the square of the sample intensity around the bottom detection point. The number of samples used is marked 'A' in *Figure 38* and is a small percentage of the total number of samples. The noise is based on a mean of the square of the samples in the second half of the "tail" of the detection window (marked 'B' in *Figure 38*) and the square of the samples in the "head" of the water column (before the first return – marked 'C' in *Figure 38*).

Beams, whose SNR is greater than a predetermined threshold, will be flagged as passing the brightness test.

For instructions on how to display the test results, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

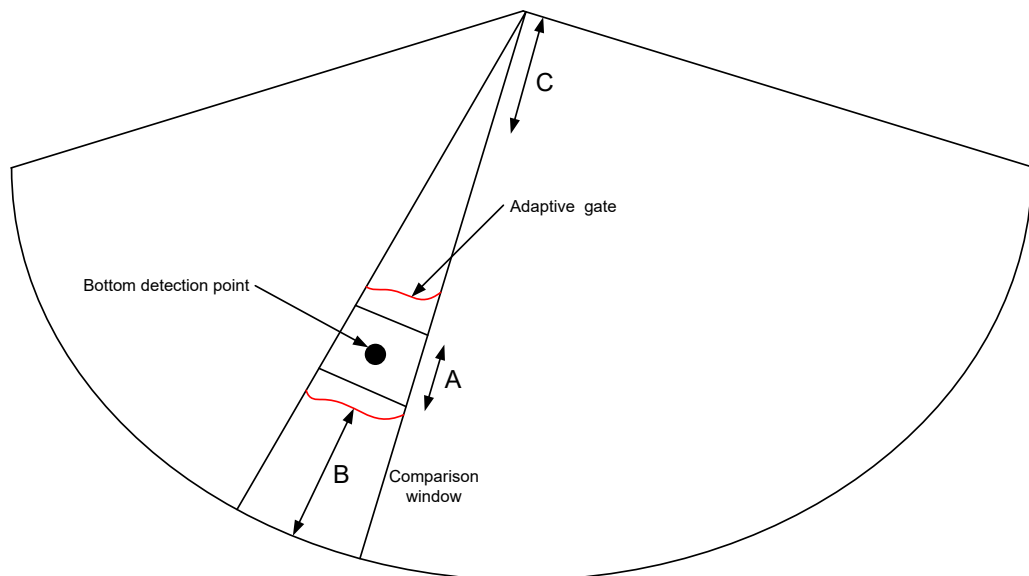


Figure 38: Brightness Test

7.7.2 Colinearity Test

In general terms, this test will pass if a bottom detection point sample number for a given beam falls on or near a line drawn through its neighboring beams' bottom detection points. This is achieved using a moving polynomial fit of the points on either side of each point. If a given point is within the window of the line fit, it is marked colinear.

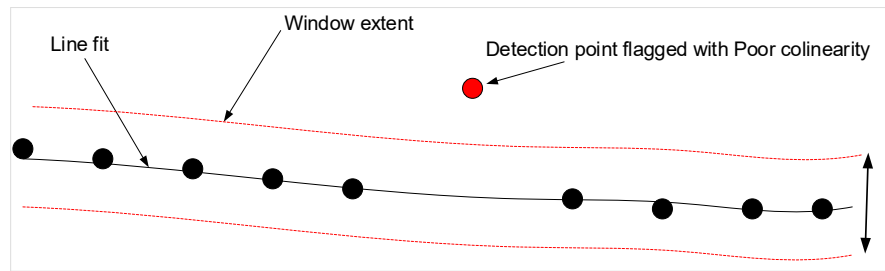


Figure 39: Colinearity Flags

This process is done in stages that begin with the central beams and moving outward on each side of the wedge in turn.

For instructions on how to display the test results, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

7.7.3 Quality Filter

A quality filter makes it possible to not display or export bottom detection points which do not pass the quality criteria. Enabling the quality filter has the following effects:

- The corrected bathymetric data record will only contain the detection points that pass the quality filtering. A flag will be set in the record to indicate that the quality filter was applied.
- The dedicated snippets record will only contain the detection points that pass the quality filtering. A flag will be set in the records to indicate that the quality filter was applied.
- Only detections points that pass the quality filtering will be shown in the various displays.

For details on settings for the quality filter, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

7.8 Uncertainty Estimation

The calculation of Total Propagated Uncertainty (TPU) is used to aid the surveyor determine the sounding quality of the bottom detection point. The calculation is done by statistical methods, typically in the data acquisition software. One input into the TPU calculation is the sounding measurement error as computed in the sonar system. Other error sources include position, draft, squat, load, tide geodetic calculations, lever arms calculations, timing offsets, speed, heading, attitude, and sound velocity.

In the sonar processor, the error associated with bottom detection is computed separately for amplitude, phase, and blended detection methods. This value is exported as a field in both raw and corrected bathymetry records.

The uncertainty value is normalized to the detection point by dividing the absolute range error (number of samples) by the detection point (fractional sample number). For example:

- Absolute range error: 0.8 samples
- Fractional sample number of detection point: 120.2
- Uncertainty = $0.8/120.2 = 0.006655574$

When the Uncertainty option is active, a color legend is shown on the wedge display.

For instructions on how to display the uncertainty, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

7.9 Hydrodynamic Drag

Hydrodynamic drag has been determined for the T20 and T50 shallow sonar head assemblies in brackets mounted on a short pole traveling through the water at a speed of 10 knots.

7.9.1 Drag Simulation Setup

- Sonar head assemblies:
 - T20 single head (shallow¹⁸) **with** front fairing (*Figure 41* and *Figure 42*) or **without** front fairing (*Figure 43* and *Figure 44*).
 - T20 dual head (shallow) **with** front fairing (*Figure 46* and *Figure 47*) or **without** front fairing (*Figure 48* and *Figure 49*).
 - T50 single head (shallow¹⁹) **with** front fairing (*Figure 51* and *Figure 52*) or **without** front fairing (*Figure 53* and *Figure 54*).
 - T50 dual head (shallow) **with** front fairing (*Figure 56* and *Figure 57*) or **without** front fairing (*Figure 58* and *Figure 59*).
- Pole mount: 350mm long, 100mm diameter pole attached to the mounting flange of the brackets. The pole mount itself also causes drag.
- Speed: 10 knots.
- Finite Element simulation tool: ANSYS was used to determine the drag and evaluate water flow around the sonar heads and brackets.

NOTE

Cable routing and accessory parts like a SVP or a motion sensor added to the bracket will influence drag.

7.9.2 Drag Simulation Conclusions

- The front fairings help reduce drag and keep a steady and clean water flow around the receiver and projector arrays. Need of fairing depends on survey and transit speed.
- The hydrodynamic drag on the system is a combination of skin friction and pressure drag. Both are within reasonable speed proportional to square of speed. With this it is possible to estimate drag figures for speeds that differ from 10 knots.
- The drag figures are relevant for a pole mount over the side, a sonar head installation through a moon pool, a sonar head mounted on an adapter bracket under the hull of the survey vessel, or a sonar head installation on a UUV.
- In general, Teledyne RESON recommends the use of the optional fairing to maintain a steady water flow around the array and reduce load on the pole/bracket.

¹⁸ The drag figures provided are also valid for a T20 deep sonar head assembly, if the installation is done in a similar way.

¹⁹ The drag figures provided are also valid for a T50 deep sonar head assembly, if the installation is done in a similar way.

7.9.3 Drag Simulation Results

7.9.3.1 T20 Single Head Drag (shallow)

Figure 41 illustrates the flow at 10 knots around the T20 single head (shallow) with front fairing. The drag on the pole, sonar head, and bracket is in the region of 490N. The same situation without front fairing is shown in Figure 43.



Figure 40: T20 Sonar Head (shallow) in Bracket with Optional Front Fairing

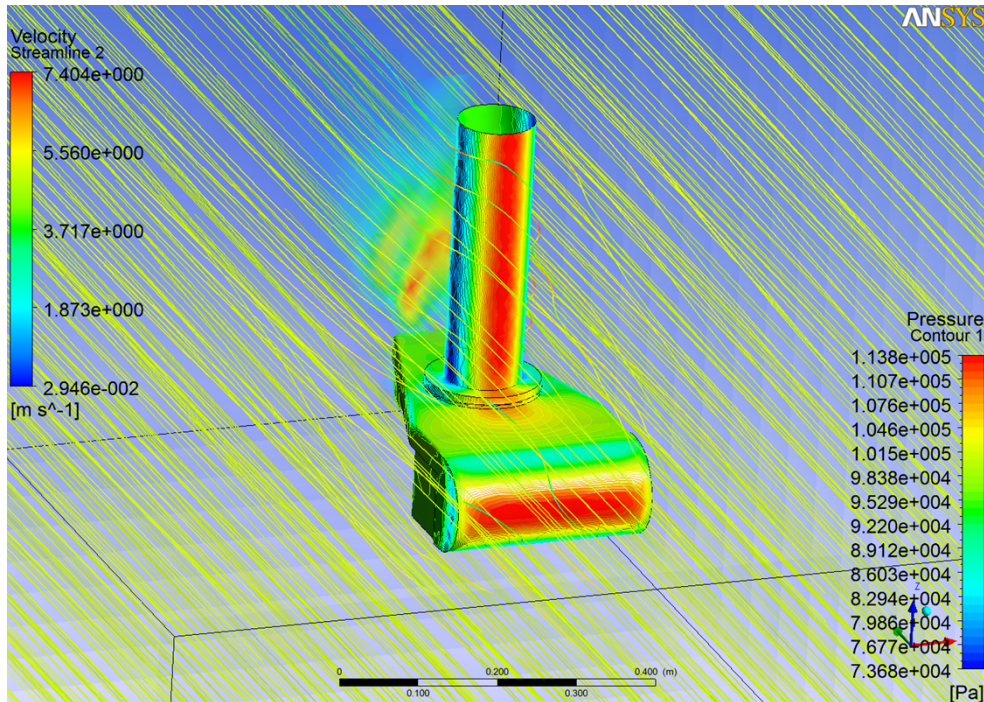


Figure 41: Flow at 10 knots around Single T20 (shallow) with Fairing

Figure 42 is a cross section of the symmetry plane of the T20 single head (shallow). The front fairing and bracket assure a steady water flow around the receiver and projector. The same situation without front fairing is shown in Figure 44.

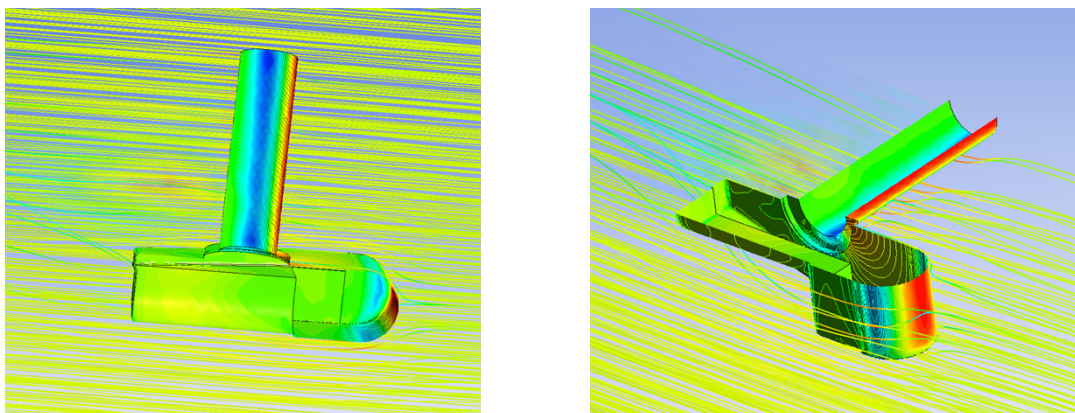


Figure 42: Flow around Single T20 (shallow) with Fairing, Cross Section of Symmetry Plane

Figure 43 illustrates the flow at 10 knots around the T20 single head (shallow) without front fairing. The drag on the pole, sonar head, and bracket is in the range of 650N. The same situation with front fairing is shown in Figure 41.

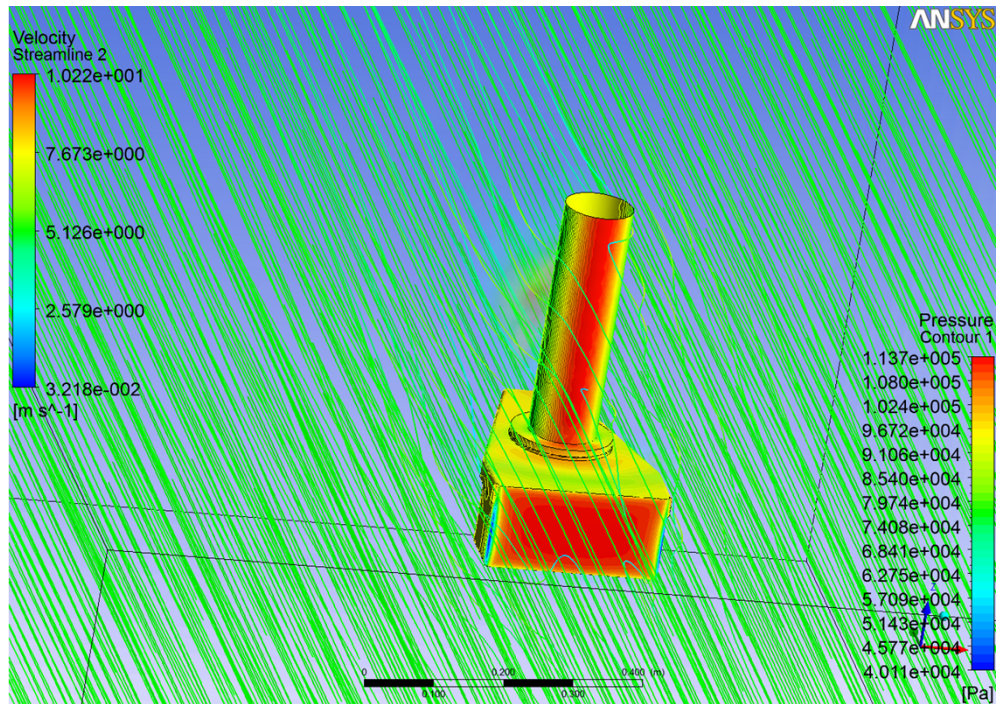


Figure 43: Flow at 10 knots around Single T20 (shallow) without Fairing

Figure 44 is a cross section of the symmetry plane of the T20 single head (shallow). Without the front fairing the flow is still reasonable, but not as steady as with the fairing in front of the receiver. The same situation with front fairing is shown in Figure 42.

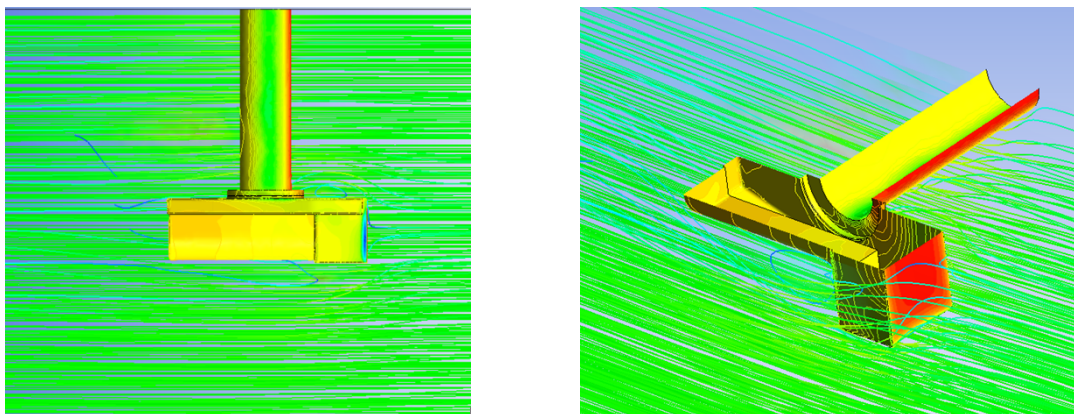


Figure 44: Flow around Single T20 (shallow) without Fairing, Cross Section of Symmetry Plane

7.9.3.2 T20 Dual Head Drag

Figure 46 illustrates the flow at 10 knots around the T20 dual head with front fairings. The drag on the pole, sonar heads, and bracket is in the region of 1100N. The same situation without front fairings is shown in Figure 48.

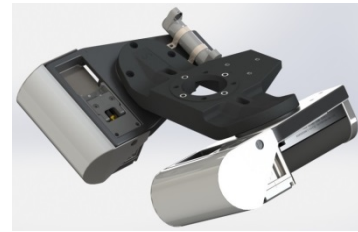


Figure 45: T20 Dual Sonar Head Assembly in Bracket with Optional Front Fairing

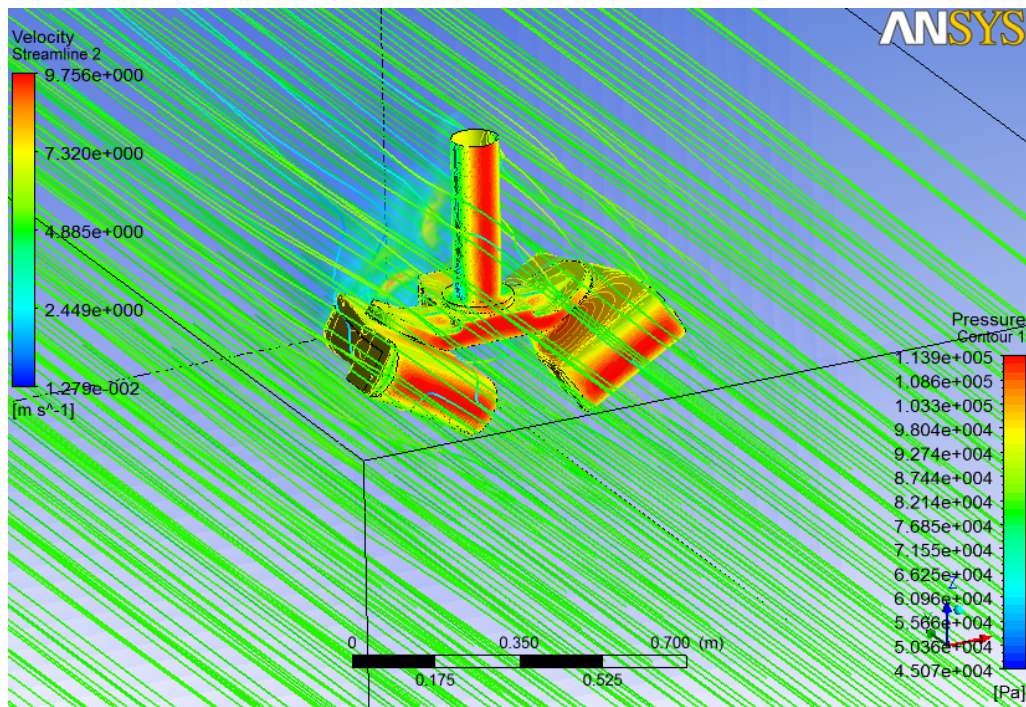


Figure 46: Flow at 10 knots around Dual T20 with Fairings

Figure 47 is a cross section of the symmetry plane of the T20 dual head. The front fairings and bracket assure a steady water flow around the receivers and projectors. The same situation without front fairings is shown in Figure 49.

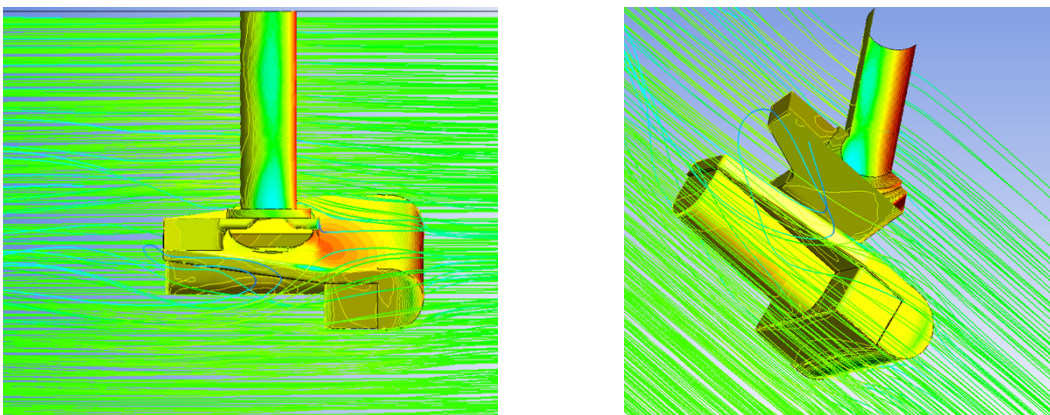


Figure 47: Flow around Dual T20 with Fairings, Cross Section of Symmetry Plane

Figure 48 illustrates the flow at 10 knots around the T20 dual head without front fairings. The drag on the pole, sonar heads, and bracket is in the region of 1550N. The same situation with front fairings is shown in Figure 46.

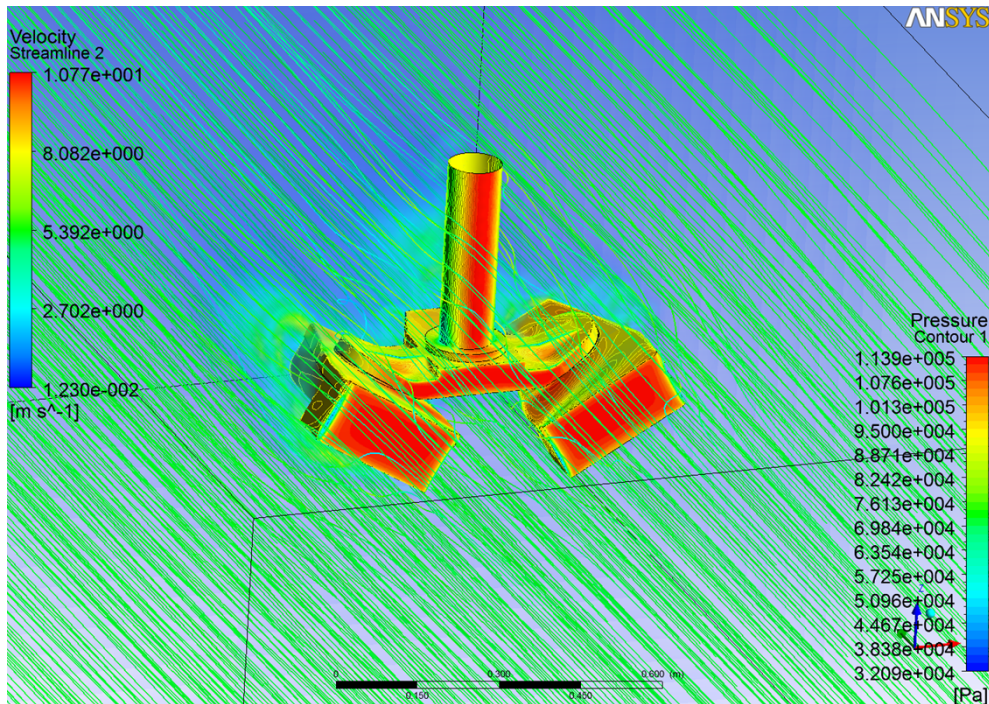


Figure 48: Flow at 10 knots around Dual T20 without Fairings

Figure 49 is a cross section of the symmetry plane of the T20 dual head. Without the front fairings the flow is still reasonable, but not as steady as with the fairings in front of the receivers. The same situation with front fairings is shown in Figure 47.

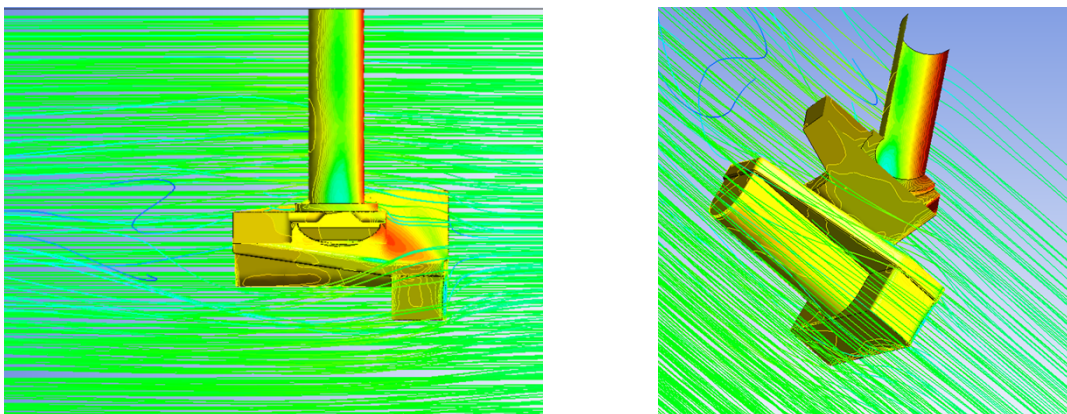


Figure 49: Flow around Dual T20 without Fairings, Cross Section of Symmetry Plane

7.9.3.3 T50 Single Head Drag (shallow)

Figure 51 illustrates the flow at 10 knots around the T50 single head (shallow) with front fairing. The drag on the pole, sonar head, and bracket is in the region of 650N. The same situation without front fairing is shown in Figure 53.



Figure 50: T50 Sonar Head (shallow) in Bracket with Optional Front Fairing

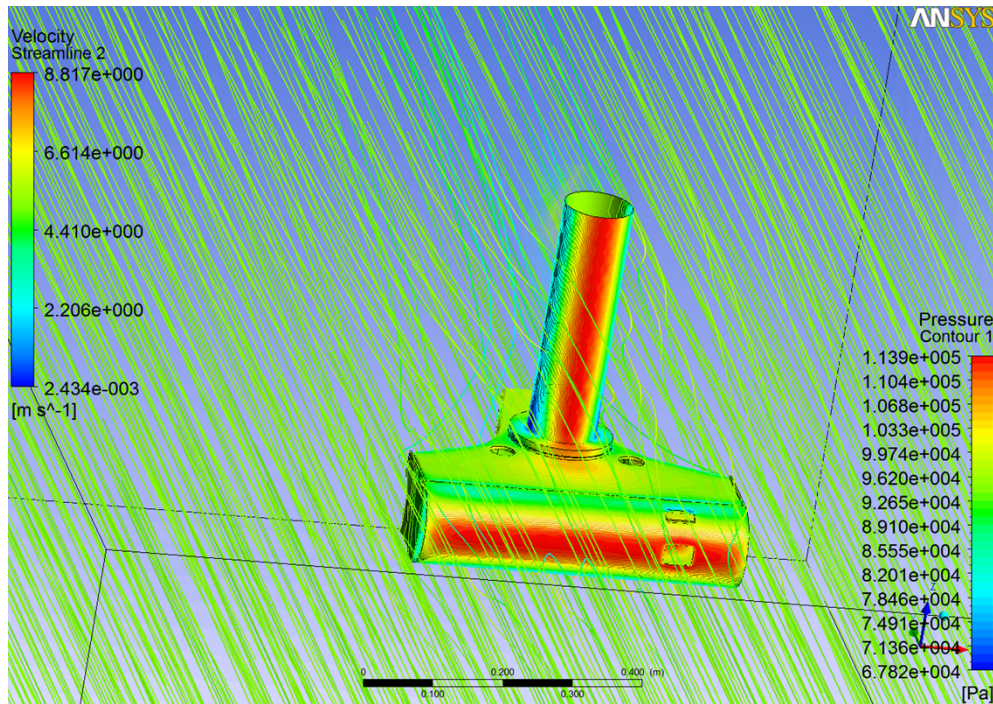


Figure 51: Flow at 10 knots around Single T50 (shallow) with Fairing

Figure 52 is a cross section of the symmetry plane of the T50 single head (shallow). The front fairing and bracket assure a steady water flow around the receiver and projector. The same situation without front fairing is shown in Figure 54.

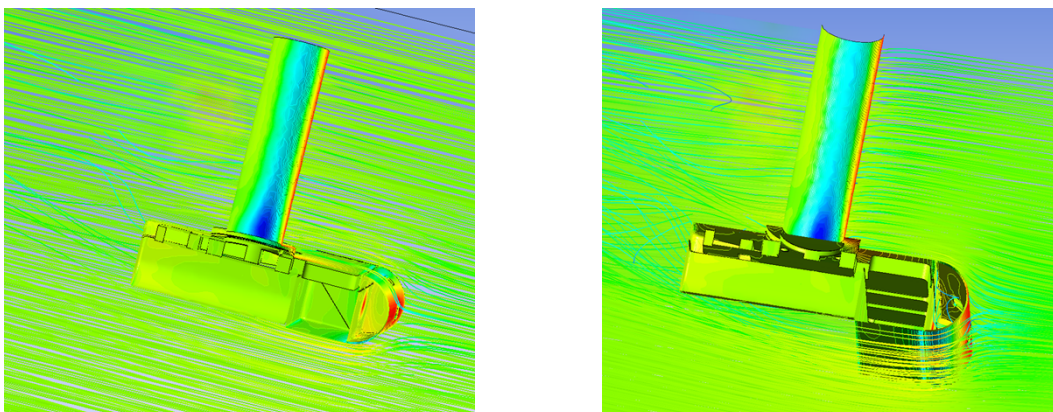


Figure 52: Flow around Single T50 (shallow) with Fairing, Cross Section of Symmetry Plane

Figure 53 illustrates the flow at 10 knots around the T50 single head (shallow) without front fairing. The drag on the pole, sonar head, and bracket is in the region of 1000N. The same situation without front fairing is shown in Figure 51.

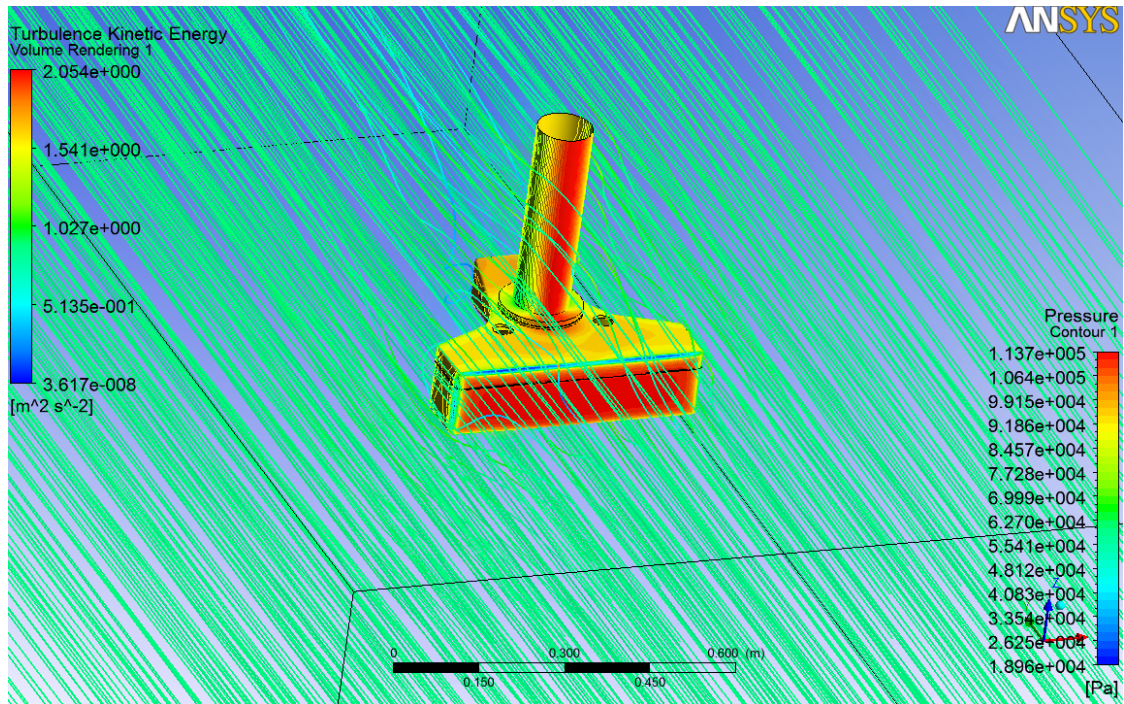


Figure 53: Flow at 10 knots around Single T50 (shallow) without Fairing

Figure 54 is a cross section of the symmetry plane of the T50 single head (shallow). Without the front fairing the flow is still reasonable, but not as steady as with the fairing in front of the receiver. The same situation with front fairing is shown in Figure 52.

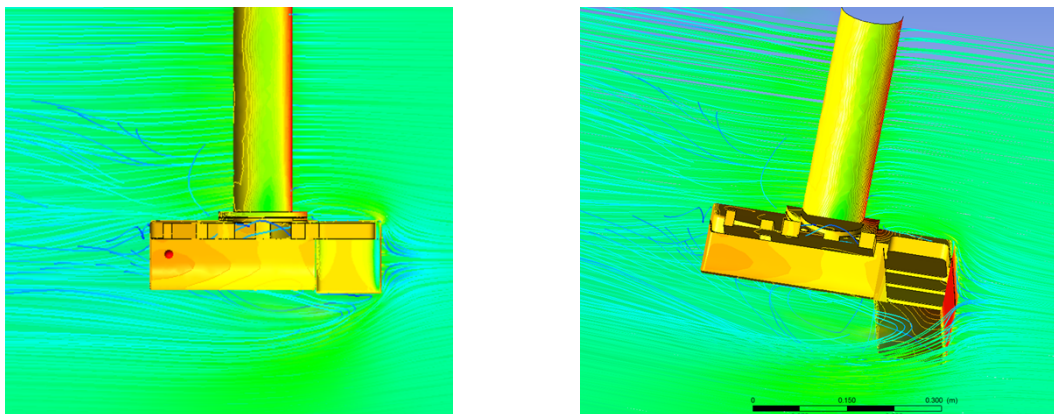


Figure 54: Flow around Single T50 (shallow) without Fairing, Cross Section of Symmetry Plane

7.9.3.4 T50 Dual Head Drag

Figure 56 illustrates the flow at 10 knots around the T50 dual head with front fairings. The drag on the pole, sonar heads, and bracket is in the region of 1530N. The same situation without front fairings is shown in Figure 58.



Figure 55: T50 Dual Sonar Head Assembly in Bracket with Optional Front Fairing

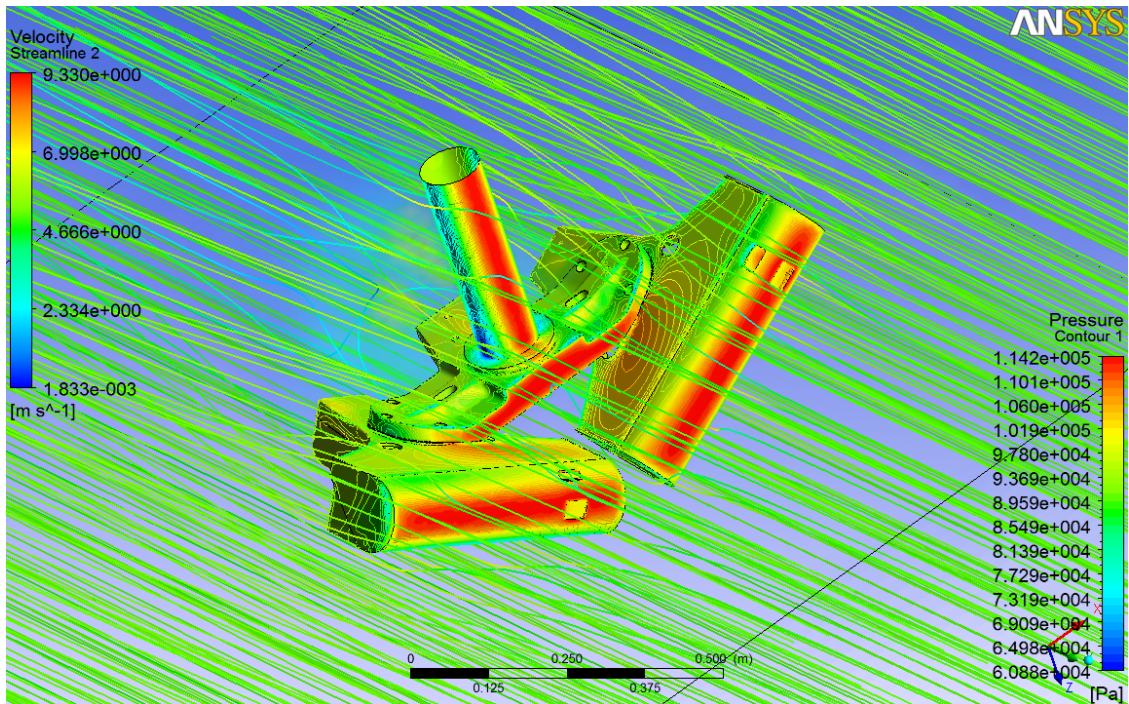


Figure 56: Flow at 10 knots around Dual T50 with Fairings

Figure 57 is a cross section of the symmetry plane of the T50 dual head. The front fairings and bracket assure a steady water flow around the receivers and projectors. The same situation without front fairings is shown in Figure 59.

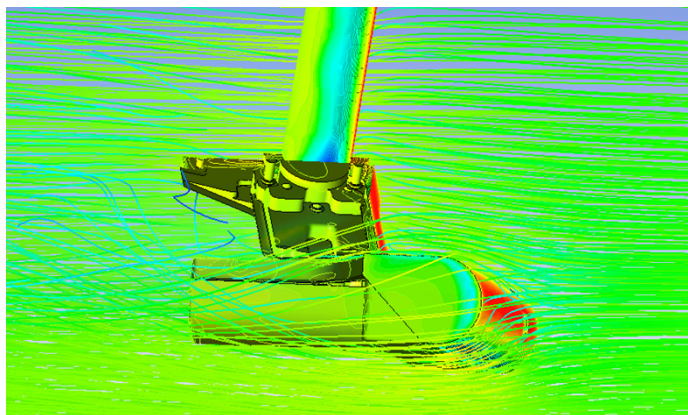


Figure 57: Flow around Dual T50 with Fairings, Cross Section of Symmetry Plane

Figure 58 illustrates the flow at 10 knots around the T50 dual head without front fairings. The drag on the pole, sonar heads, and bracket is in the region of 2250N. The same situation with front fairings is shown in Figure 56.

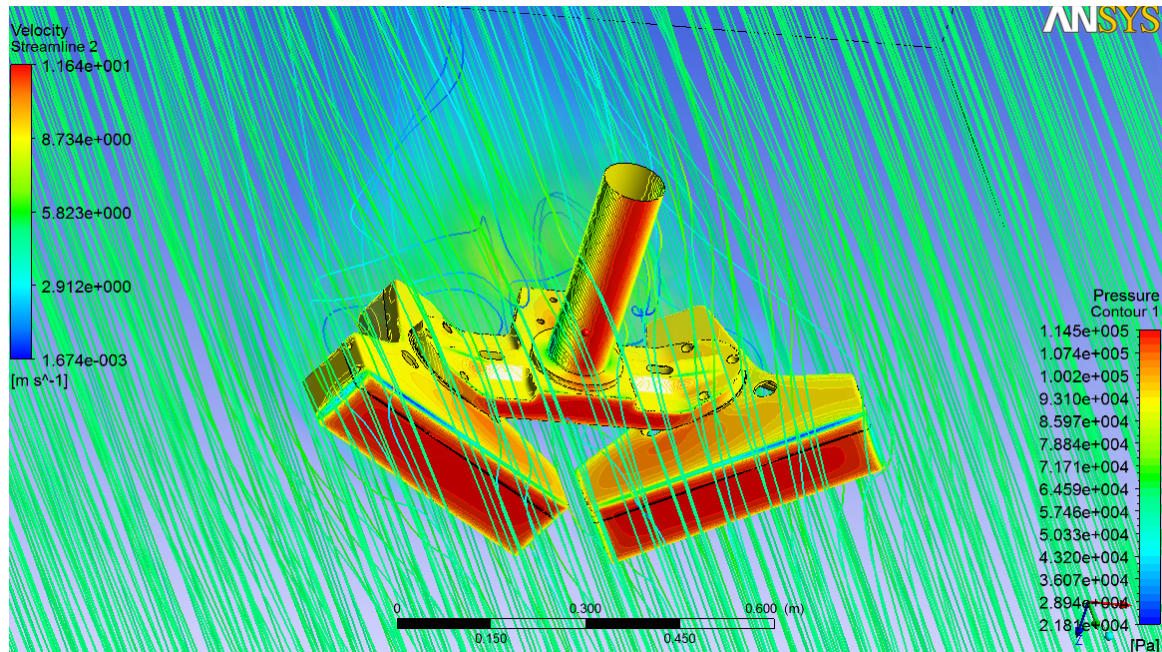


Figure 58: Flow at 10 knots around Dual T50 without Fairings

Figure 59 is a cross section of the symmetry plane of the T50 dual head. Without the front fairings the flow is still reasonable, but not as steady as with the fairings in front of the receivers. The same situation with front fairings is shown in Figure 57.

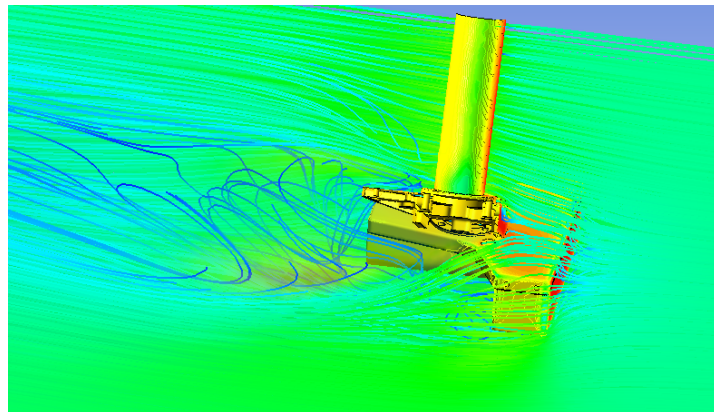


Figure 59: Flow around Dual T50 without Fairings, Cross Section of Symmetry Plane

7.10 Ping Rate Table

Table 7: Ping Rate Table

Range setting (m)	Theoretical max ping rate (1500m/s) ^[1]	Ping rate [Hz]		
		Single head	Integrated Dual Head (IDH)	Two-processor Dual Head FRDH)
5	150	50	50	50
7	107.1	50	50	50
10	75.0	50	50	45.4
15	50.0	43.6	41.6	34.5
20	37.5	33.8	32.4	27.8
25	30.0	27.6	26.5	23.3
30	25.0	23.3	22.5	20.0
35	21.4	20.2	19.5	17.6
40	18.8	17.8	17.2	15.9
50	15.0	14.4	13.9	13.0
70	10.7	10.4	10.1	9.5
100	7.5	7.3	7.1	6.7
140	5.4	5.3	5.1	4.8
160	4.7	4.6	4.5	4.2
180	4.2	4.1	4.0	3.7
200	3.8	3.7	3.6	3.4
250	3.0	3.0	2.9	2.7
300	2.5	2.5	2.4	2.3
350	2.1	2.1	2.1	1.9
400	1.9	1.9	1.8	1.7
500	1.5	1.5	1.5	1.4
600	1.25	1.2	n/a	n/a
750	1	1	n/a	n/a

NOTE

The table reflects the ping rate performance on a processor only running the 7kCenter.

^[1] The ping rate is limited to 50p/s (see Table 4).

APPENDIX A TROUBLESHOOTING

A.1 System Error and Warning Messages

NOTE	
Most errors and warnings do not result in a system failure. In the case of repeated errors or warnings, contact Teledyne RESON Customer Support (reson-support@teledyne.com).	

This chapter contains a global list of error and warning messages generated by the 7k Center software. The messages appear in the Messages pane of the Sonar UI.

For instructions on how to monitor the system, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

General information (no error/warning) is marked with an **i** in the Messages pane.

A.2 Error Messages

NOTE	
The error messages listed in this section are accurate up to the document release date. For a complete list of up-to-date error messages, contact Teledyne RESON Customer Support (reson-support@teledyne.com).	

Errors are marked with a red **✖** in the Messages pane.

A.2.1 General System Startup Errors

Message	Description	Action
ADMXRC configuration failed	The software failed to detect or configure the primary processing card.	Check PCI bus drivers for ADMXRC card.
Could not create UDP server	Indicates a network resource was unavailable to the software from the operating system.	Check user permissions, network drivers.
Could not create TCP server		
Could not create PCI server	Software detected a failure to configure the main data acquisition and distribution module (PCI). This can be caused by errors in the configuration files, or corrupted installation.	Reboot the PC, call Teledyne RESON support.
Error creating PCI Reader thread		
Error creating PCI Copier thread		
Create TCP socket failed, code...	Operating system did not allow creating of network resources.	Check Windows installation, user settings, and network resources.

Message	Description	Action
Error creating non-sonar data reader thread	BITE module has failed to initialize.	Check Windows installation and resources.
Failed to allocate memory for ADMXRC read	The software could not allocate enough system memory to perform the operation.	Make sure no other software is running on the sonar processor. Reboot the system.
Failed to allocate memory for ADMXRC transfer		
Failed to set up DMA Card 0	The software could not access the processing card device.	Check ADMXRC drivers.
Failed to set up DMA Card 1		
Internal 7k Center error	One or more startup conditions have failed.	Check previous alarms or warnings and verify software installation.
Internal error, 7kCenter NOT fully operational		
Inbound memory initialization failed	PC resources are inadequate.	Check RAM or virtual memory resources
MMF Outbound memory creation ...		
Required file: "7k_0.xml" or "7k.xml" Not found.	A critical startup configuration file was missing.	Reinstall the software.
Required file: "7k_Bite.htm" Not found.		
SET UP: FAILED TO LOAD BIT FILE "XXX" for Device <x>, Enumerator <x>		
Socket initialization failed, error code <x>	Windows has failed to allocate a network resource.	Check network permissions and resources or Reinstall operating system.

A.2.2 PCI Card Related (ADMXRC) Errors

The ADMXRC refers to the drivers that control the main processing unit within the sonar processor. This processing card sits on the motherboards PCI bus and acts as a signal processing layer between the hardware and software.

Message	Description	Action
2nd ADMXRC card not found	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.
ADMXRC card not found, ERROR =		
ADMXRC.dll not found.		
Configure FPGA failed.		
Incorrect ADMXRC board found, card_1		

Message	Description	Action
Failed to set up DMA Card 0, ERROR =		
Failed to allocate memory for ADMXRC transfer.		
Failed to set ADMXRC clock, Card_1, ERROR =		
Failed to get ADMXRC space info, Card_1, ERROR =		
Failed to configure 1st FPGA with <x>, ERROR =		
Failed to find ADMXRC info, card_0, ERROR =		
Failed to set ADMXRC clock, Card_0, ERROR =		
Failed to get ADMXRC space info, Card_0, ERROR =		
Failed to find ADMXRC info, card_1, ERROR =		

A.2.3 Data Reading Errors

Message	Description	Action
DMA Transfer Timeout. <x> of <x> bytes received	This error generally indicates that the uplink from the receiver is interrupted at some point.	Check the BITE tab for receiver BITE values to try and localize the failure to a component. Check uplink cable connections. Check temperature of the SSP via BITE. Restore factory defaults. Reboot the PC.
FATAL: DMA Read size limitation reached.	A general error occurred while transferring data to the software.	Reboot the system.
Lost sync with DMA read		

A.2.4 System Resource Errors

Message	Description	Action
Error starting <name> thread.	A module has failed to start correctly.	Reboot the system.

A.2.5 Input Signal (Timing and Triggers) Errors

Message	Description	Action
Failed to register external trigger, ERROR =	External Trigger Firmware cannot be initialized or not supported.	Reboot the system. Contact Teledyne RESON Customer Support if the problem persists.
Failed to unregister external trigger, ERROR =		
FIRMWARE does not support External Trigger. Pinging is OFF		
External triggering has failed. Check/update software installation.		
FATAL ERROR: PPS Timestamp error Check 1 PPS input	The pulse is not being detected. Time stamping will be done using system time only. 1 millisecond accuracy not possible.	Check input signal cabling.

A.2.6 Calibration Errors

Message	Description	Action
Calibration Failed: Too much noise	Calibration has failed.	Check BITE page and hardware and cable installation to the receiver. Check environmental noise. Contact Teledyne RESON Customer Support.
Calibration Failed: Over 10% dead Rx channels.		
Calibration Failed: Magnitude Error		
Calibration Failed: Phase Error		
Calibration Error: Calibration might be invalid. Repeat the calibration.		

A.3 Warning Messages

NOTE
The warning messages listed in this section are accurate up to the document release date. For a complete list of up-to-date warning messages, contact Teledyne RESON Customer Support (reson-support@teledyne.com).

Warnings are marked with a yellow  in the Messages pane.

A.3.1 Configuration Warnings

Message	Description	Action
7K Bite File cannot be Read	Software installation is corrupt.	Restore factory defaults. Reinstall software.
Cannot Read UDP Configuration file <x> Error		
Cannot Open or Create UDP Configuration file		
UDP Configuration file not available		

A.3.2 Startup Warnings

Message	Description	Action
Failed to start PCI Reader thread	One or more PCI bus or network resources has failed to initialize.	Check user permissions and sonar processor network hardware.
Failed to start PCI Copier thread		
PCI interface status: Down		
TCP interface status: Down		
UDP interface status: Down		

A.3.3 Data Processing Warnings

Message	Description	Action
***** (xxx) Dropping out-of-order ping #<x>	The data processing chain has been delayed and stale data has been discarded.	Check sonar processor hardware and resources.
PING <x> :(Lost FPGA sync...sample	One or more pings have been lost due to an error on the uplink between the receiver and the software. The system is becoming unstable and data transfer is corrupted on the PCI bus.	Reboot. Check sonar processor hardware.
PING <x> :(Lost FPGA sync...sample		
DMA Transfer Timeout. <x> of <x> bytes received		

A.3.4 Data Recording Warnings

Message	Description	Action
WARNING: Critical Disk Level: RDR - Data recording stopped	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories, as well as permissions on target files/directories.
RDR - Already in Playback/Record mode.		
RDR Record failed - No Filename		
RDR Record failed - Set file name failed: <x>		
RDR - Data recording failed to start. filename:		
RDR - Data <x> failed to stop.		
RDR - <x> already in progress.		
RDR Playback failed - No Filename		
RDR Playback failed - Set file name failed:		
RDR - Data playback failed, filename =		
RDR - Data delete failed: in Record/Playback mode.		

Message	Description	Action
RDR Data delete failed - Filename not available		
RDR - Set new file name failed		
RDR - Set Data path Failed		
Disk Level Threshold: X%.		

A.3.5 BITE Data Warnings

Message	Description	Action
ERROR : NSD	An error has occurred in reading of BITE data. The data buffer has overflowed.	No action needed.
Non Sonar Data FIFO overflow (x packet)		

A.3.6 Input Signal Warnings

Message	Description	Action
Roll Compensation is not available.	The input data for motion is not available or the feature is not enabled.	Check device inputs and cabling.
Pitch Compensation is not available.		

A.3.7 System Stability Warnings

Message	Description	Action
WARNING: PPS Time-stamp error	The internal clock may not be disciplined properly resulting in incorrect time stamp of data.	Check 1PPS connections and GPS output. If uncorrected sonar data cannot be time stamped to 1 millisecond.
WARNING: Reduce Ping Rate or Range - DROPPING ping	The system is overloaded processing data. A ping has been lost because the processing queue is full.	Restart the software. Reboot PC.

A.3.8 Data Subscription Warnings

Message	Description	Action
Subscriber UDP sendto() failed	The software was unable to send data to a connected client.	Check network resources and user permissions.
Subscriber send() failed		
Subscribers outbound MMF buffer memory overwrite error!	The link to the user interface running on the sonar processor has detected a non-critical error.	Check system resources, shutdown all non-critical software applications. Reboot processor.
Subscribers outbound MMF buffer read error!		
Subscribers outbound MMF buffer memory overwrite error!		

A.3.9 Network Components Warnings

Message	Description	Action
TCP Server - Unknown packet type	A connected client has sent an unrecognized command to the software.	Review client software source code or definitions for correct implementation of Teledyne RESON 7k Data Format.
UDP Server - Unknown packet type		
TCP Server - Warning max connections reached	The network module has become saturated with client connections and will refuse any further connections.	Close some of the connected clients.
UDP Server - Warning max connection reached		

A.3.10 External Trigger Warnings

Message	Description	Action
Trigger out length (x) is invalid	An unsupported value was received for trigger setup.	Check settings in user interface.
Trigger out offset (x) is invalid		
Trigger out offset + length (x) exceed limit of 20ms		

A.4 Error Messages – Master List in Alphabetical Order

Message	Description	Action	Alarm Type
2nd ADMXRC card not found	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
ADMXRC card not found, ERROR =	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
ADMXRC configuration failed	The software failed to detect or configure the primary processing card.	Check PCI bus drivers for ADMXRC card.	General System Startup
ADMXRC.dll not found.	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Calibration Error: Calibration might be invalid. Repeat the calibration.	Calibration has failed.	Check BITE page and hardware and cable installation to the receiver. Check environmental noise. Contact Teledyne RESON Customer Support.	Calibration
Calibration Failed: Magnitude Error	Calibration has failed.	Check BITE page and hardware and cable installation to the receiver. Check environmental noise. Contact Teledyne RESON Customer Support.	Calibration
Calibration Failed: Over 10% dead Rx channels.	Calibration has failed.	Check BITE page and hardware and cable installation to the receiver. Check environmental noise. Contact Teledyne RESON Customer Support.	Calibration
Calibration Failed: Phase Error	Calibration has failed.	Check BITE page and hardware and cable installation to the receiver. Check environmental noise. Contact Teledyne RESON Customer Support.	Calibration

Message	Description	Action	Alarm Type
Calibration Failed: Too much noise	Calibration has failed.	Check BITE page and hardware and cable installation to the receiver. Check environmental noise. Contact Teledyne RESON Customer Support.	Calibration
Configure FPGA failed.	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Could not create PCI server	Software detected a failure to configure the main data acquisition and distribution module (PCI). This can be caused by errors in the configuration files, or corrupted installation.	Reboot the PC, call Teledyne RESON support.	General System Startup
Could not create TCP server	Indicates a network resource was unavailable to the software from the operating system.	Check user permissions, network drivers.	General System Startup
Could not create UDP server	Indicates a network resource was unavailable to the software from the operating system.	Check user permissions, network drivers.	General System Startup
Create TCP socket failed, code...	Operating system did not allow creating of network resources.	Check Windows installation, user settings, and network resources.	General System Startup
DMA Transfer Timeout. <x> of <x> bytes received	This error generally indicates that the uplink from the receiver is interrupted at some point.	Check the BITE page for receiver BITE values. Restore factory defaults. Reboot the PC. Check uplink cable connections. Check temperature of the SSP via BITE. Restore factory defaults. Reboot the PC.	Data Reading
Error creating non-sonar data reader thread	BITE module has failed to initialize.	Check Windows installation and resources.	General System Startup

Message	Description	Action	Alarm Type
Error creating PCI Copier thread	Software detected a failure to configure the main data acquisition and distribution module (PCI). This can be caused by errors in the configuration files, or corrupted installation.	Reboot the PC, call Teledyne RESON support.	General System Startup
Error creating PCI Reader thread	Software detected a failure to configure the main data acquisition and distribution module (PCI). This can be caused by errors in the configuration files, or corrupted installation.	Reboot the PC, call Teledyne RESON support.	General System Startup
Error starting <name> thread	A module has failed to start correctly.	Reboot the system.	System Resource
External triggering has failed. Check/update software installation.	External Trigger Firmware cannot be initialized or not supported	Reboot the system. Contact Teledyne RESON Customer Support if the problem persists.	Input Signal (Timing and Triggers)
Failed to allocate memory for ADMXRC read.	The software could not allocate enough system memory to perform the operation.	Make sure no other software is running on the sonar processor. Reboot the system.	General System Startup
Failed to allocate memory for ADMXRC transfer.	The software could not allocate enough system memory to perform the operation.	Make sure no other software is running on the sonar processor. Reboot the system.	General System Startup
Failed to allocate memory for ADMXRC transfer.	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Failed to configure 1st FPGA with <x>, ERROR =	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card

Message	Description	Action	Alarm Type
Failed to configure 1st FPGA with <x>, ERROR =	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Failed to find ADMXRC info, card_0, ERROR =	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Failed to find ADMXRC info, card_1, ERROR =	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Failed to get ADMXRC space info, Card_0, ERROR =	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Failed to get ADMXRC space info, Card_1, ERROR =	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Failed to register external trigger, ERROR =	External Trigger Firmware cannot be initialized or not supported.	Reboot the system. Contact Teledyne RESON Customer Support if the problem persists.	Input Signal (Timing and Triggers)
Failed to set ADMXRC clock, Card_0, ERROR =	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Failed to set ADMXRC clock, Card_1, ERROR =	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Failed to set up DMA Card 0	The software could not access the processing card device.	Check ADMXRC drivers.	General System Startup

Message	Description	Action	Alarm Type
Failed to set up DMA Card 0, ERROR =	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Failed to set up DMA Card 1	The software could not access the processing card device.	Check ADMXRC drivers.	General System Startup
Failed to unregister external trigger, ERROR =	External Trigger Firmware cannot be initialized or not supported.	Reboot the system. Contact Teledyne RESON Customer Support if the problem persists.	Input Signal (Timing and Triggers)
FATAL ERROR: PPS Timestamp error Check 1 PPS input	The pulse is not being detected. Time stamping will be done using system time only. 1 millisecond accuracy not possible.	Check input signal cabling.	Input Signal (Timing and Triggers)
FATAL: DMA Read size limitation reached.	A general error occurred while transferring data to the software.	Reboot the system.	Data Reading
FIRMWARE does not support External Trigger. Pinging is OFF	External Trigger Firmware cannot be initialized or not supported.	Reboot the system. Contact Teledyne RESON Customer Support if the problem persists.	Input Signal (Timing and Triggers)
Inbound memory initialization failed.	PC resources are inadequate.	Check RAM or virtual memory resources	General System Startup
Incorrect ADMXRC board found, card_1	One or more of the processing cards has failed to initialize or is non-functional within the sonar processor.	Reboot sonar processor and try again.	PCI Card
Internal 7k Center error	One or more startup conditions have failed.	Check previous alarms or warnings and verify software installation.	General System Startup
Internal error, 7kCenter NOT fully operational.	One or more startup conditions have failed.	Check previous alarms or warnings and verify software installation.	General System Startup

Message	Description	Action	Alarm Type
Lost sync with DMA read	A general error occurred while transferring data to the software.	Reboot the system.	Data Reading
MMF Outbound memory creation ...	PC resources are inadequate.	Check RAM or virtual memory resources	General System Startup
Required file: "7k_0.xml" or "7k.xml" Not found.	A critical startup configuration file was missing or too many were found.	Reinstall the software.	General System Startup
Required file: "7k_Bite.htm" Not found.	A critical startup configuration file was missing or too many were found.	Reinstall the software.	General System Startup
SET UP: FAILED TO LOAD BIT FILE "<x>" for Device <x>, Enumerator <x>	A critical startup configuration file was missing or too many were found.	Reinstall the software.	General System Startup
Socket initialization failed, error code <x>	Windows has failed to allocate a network resource.	Check network permissions and resources or Reinstall operating system.	General System Startup

A.5 Warning Messages – Master List in Alphabetical Order

Message	Description	Action	Type
***** (xxx) Dropping out-of-order ping #<x>	The data processing chain has been delayed and stale data has been discarded.	Check sonar processor hardware and resources.	Data Processing
7K Bite File cannot be Read	Software installation is corrupt.	Restore factory defaults. Reinstall software.	Configuration
Cannot Open or Create UDP Configuration file	Software installation is corrupt.	Restore factory defaults. Reinstall software.	Configuration
Cannot Read UDP Configuration file <x> Error	Software installation is corrupt.	Restore factory defaults. Reinstall software.	Configuration
Disk Level Threshold: X%.	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
DMA Transfer Timeout. <x> of <x> bytes received	One or more pings have been lost due to an error on the uplink between the receiver and the software. The system is becoming unstable and data transfer is corrupted on the PCI bus.	Reboot. Check sonar processor hardware.	Data Processing
ERROR : NSD	An error has occurred in reading of BITE data. The data buffer has overflowed.	No action needed.	BITE Data
Failed to start PCI Copier thread	One or more PCI bus or network resources have failed to initialize.	Check user permissions and sonar processor network hardware.	Startup
Failed to start PCI Reader thread	One or more PCI bus or network resources have failed to initialize.	Check user permissions and sonar processor network hardware.	Startup

Message	Description	Action	Type
Non Sonar Data FIFO overflow (x packet)	An error has occurred in reading of BITE data. The data buffer has overflowed.	No action needed.	BITE Data
PCI interface status: Down	One or more PCI bus or network resources have failed to initialize.	Check user permissions and sonar processor network hardware.	Startup
PING <x> :(Lost FPGA sync...sample	One or more pings have been lost due to an error on the uplink between the receiver and the software. The system is becoming unstable and data transfer is corrupted on the PCI bus.	Reboot. Check sonar processor hardware.	Data Processing
PING <x> :(Lost FPGA sync...sample	One or more pings have been lost due to an error on the uplink between the receiver and the software. The system is becoming unstable and data transfer is corrupted on the PCI bus.	Reboot. Check sonar processor hardware.	Data Processing
Roll Compensation is not available.	The input data for motion is not available or the feature is not enabled.	Check device inputs and cabling.	Input Signal
Pitch Compensation is not available.	The input data for motion is not available or the feature is not enabled.	Check device inputs and cabling.	Input Signal
RDR - <x> already in progress.	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
RDR - Already in Playback/Record mode.	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
RDR - Data <x> failed to stop.	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording

Message	Description	Action	Type
RDR - Data delete failed: in Record/Playback mode.	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
RDR - Data playback failed, filename =	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
RDR - Data recording failed to start. filename:	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
RDR - Set Data path Failed	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
RDR - Set new file name failed	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
RDR Data delete failed - Filename not available	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
RDR Playback failed - No Filename	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
RDR Playback failed - Set file name failed:	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
RDR Record failed - No Filename	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording

Message	Description	Action	Type
RDR Record failed - Set file name failed: <x>	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
Roll Compensation is not available.	The input data for motion is not available or the feature is not enabled.	Check device inputs and cabling.	Input Signal
Roll Compensation is not available.	The input data for motion is not available or the feature is not enabled.	Check device inputs and cabling.	Input Signal
Subscriber send() failed	The software was unable to send data to a connected client.	Check network resources and user permissions.	Data Subscription
Subscriber UDP sendto() failed	The software was unable to send data to a connected client.	Check network resources and user permissions.	Data Subscription
Subscribers outbound MMF buffer memory overwrite error!	The link to the user interface running on the sonar processor has detected a non-critical error.	Check system resources, shutdown all non-critical software applications. Reboot processor.	Data Subscription
Subscribers outbound MMF buffer read error!	The link to the user interface running on the sonar processor has detected a non-critical error.	Check system resources, shutdown all non-critical software applications. Reboot processor.	Data Subscription
TCP interface status: Down	One or more PCI bus or network resources has failed to initialize.	Check user permissions and sonar processor network hardware.	Startup
TCP Server - Unknown packet type	A connected client has sent an unrecognized command to the software.	Review client software source code or definitions for correct implementation of Teledyne RESON 7k Data Format.	Network Components
TCP Server - Warning max connections reached	The network module has become saturated with client connections and will refuse any further connections.	Close some of the connected clients.	Network Components
Trigger out length (x) is invalid	An unsupported value was received for trigger setup.	Check settings in user interface.	External Trigger

Message	Description	Action	Type
Trigger out offset (x) is invalid	An unsupported value was received for trigger setup.	Check settings in user interface.	External Trigger
Trigger out offset + length (x) exceed limit of 20ms	An unsupported value was received for trigger setup.	Check settings in user interface.	External Trigger
UDP Configuration file not available	Software installation is corrupt.	Restore factory defaults. Reinstall software.	Configuration
UDP interface status: Down	One or more PCI bus or network resources have failed to initialize.	Check user permissions and sonar processor network hardware.	Startup
UDP Server - Unknown packet type	A connected client has sent an unrecognized command to the software.	Review client software source code or definitions for correct implementation of Teledyne RESON 7k Data Format.	Network Components
UDP Server - Warning max connection reached	The network module has become saturated with client connections and will refuse any further connections.	Close some of the connected clients.	Network Components
WARNING: Critical Disk Level: RDR - Data recording stopped	The hard drive is getting full. One or more errors have occurred in conjunction with data recording.	Check user permissions and available disk space. Check file names and recording directories	Data Recording
WARNING: PPS Time-stamp error	The internal clock may not be disciplined properly resulting in incorrect time stamp of data.	Check 1PPS connections and GPS output. If uncorrected sonar data cannot be time stamped to 1 millisecond	System Stability
WARNING: Reduce Ping Rate or Range - DROPPING ping	The system is overloaded processing data. A ping has been lost because the processing queue is full.	Restart the software. Reboot PC.	System Stability

APPENDIX B INSTALLATION INSTRUCTIONS

B.1 Components Checklist

Table 8: SeaBat T-Series Subsea Components

Part Number	Description
85000328	Projector, TC2160, 7125, 400kHz, 1 Deg (deep)
85000327	Projector, TC2163, 7125, 200kHz, 2 Deg (deep)
85002536	Receiver, EM7219-1, 128Ch, 200-400kHz, TI, 6000m (T20)
85002538	Receiver EM7218-1, 256CH, 200-400kHz, Ti, 6000m (T50)
85002319	Projector, TC2181, DF, 200/400kHz (shallow)
1009483 or 1012289	Submerged ²⁰ Sonar Processor SSP, 6000m, Ti, standard performance, single head Submerged Sonar Processor SSP+, 6000m, Ti, high performance, dual head
85001850-5	S_ASSY, CABLE, HD-PV, TX, 3m, 7K (deep)
85001763	CABLE ASSY, HD-PV, MCIL-6-FC, TX, 3m, 7K (shallow)
85002393	Cable, Conf., GB ethernet+POWER, 3m, DIL 13F, DIL 13M (Rx-SSP)
85002393	Cable, Conf., GB ethernet+POWER, 3m, DIL 13F, DIL 13M (host)
1007294	Cable, Conf., GB ethernet + POWER, 1m, SUBCONN DBH13F, RJ45, BRASS
1009794	Cable assy, MHDG-12-CPP Ti, with 5m 12xAWG20 PU cable (AUX pigtail)
1010209	SHIP CASE, KIT, STENCILED, SSP
1010206	SHIP CASE, KIT, STENCILED, WET END
1008978	Memory Stick, USB, >=16 GB, Corsair V3, tube, silver, Manuals and recovery
1008979	Strap, black, Teledyne Marine white logo
1009738	Quick Reference Guide, SeaBat T-Series Subsea
1008951	Quick Installation Guide, SeaBat UI for T-Series
1012116	Quick Installation Guide, SeaBat Updater
1007702	QUICK GUIDE, Installation, Integration to ROV electronics pod
1007252	Wet connector lubrication kit

²⁰ PN description: Submerged Sonar Processor = Subsea Sonar Processor.

B.2 Installation Checklist

NOTE
This checklist only covers the most basic, standard system installation. Depending on the system configuration or specific customer requirements, this list may or may not apply.

Follow these basic steps to install and configure your new SeaBat sonar system:

- Install the wet-end components:
 - Transducer arrays
 - SSP
- Install and connect cables:
 - Projector to SSP cable(s)
 - Receiver to SSP cable(s)
 - Auxiliary sensor cables
 - SSP to UUV cable
- Power up the system
- Test the system

For information on system configuration and operation, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).

B.3 System Interfacing

B.3.1 AUV/ROV Installation

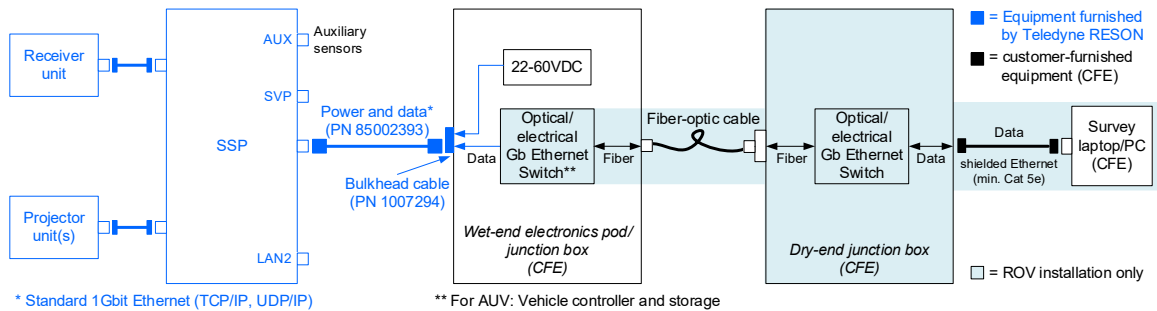


Figure 60: Typical AUV/ROV Installation



Figure 61: Bulkhead Cable Connections

Refer also to *Appendix F Reference Documentation*.

B.3.2 Interfacing Diagrams

Please refer to the appropriate interfacing diagram:

- *Figure 62: T20/50-S AUV, single/dual-head Interfacing Diagram*
- *Figure 63: T20/50-S ROV, single/dual-head Interfacing Diagram*

For further details, please refer to:

- *Appendix B.4 SeaBat T-Series Subsea Cables, incl.*
 - *B.4.4 Pin Designations for Host, AUX, LAN2, and SVP Connectors*
- *Appendix B.5 SeaBat T-Series Subsea Installation, incl.*
 - *B.5.7 Wet-End Cable Connections*
 - *B.5.11 Hardware Settings*
- *Section 4.2 Sonar User Interface (SUI)*

INSTALLATION INSTRUCTIONS

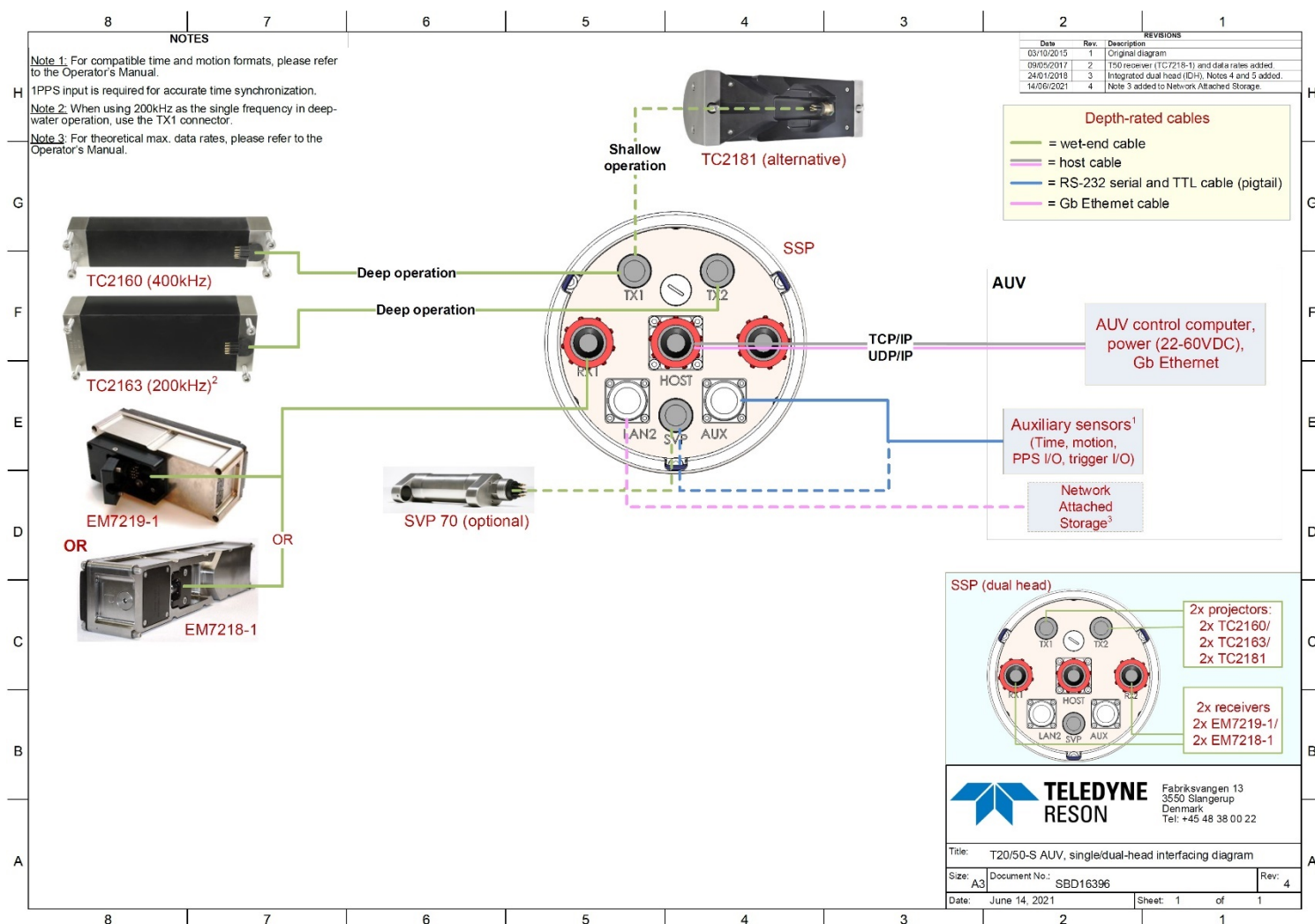


Figure 62: T20/50-S AUV, single/dual-head Interfacing Diagram

INSTALLATION INSTRUCTIONS

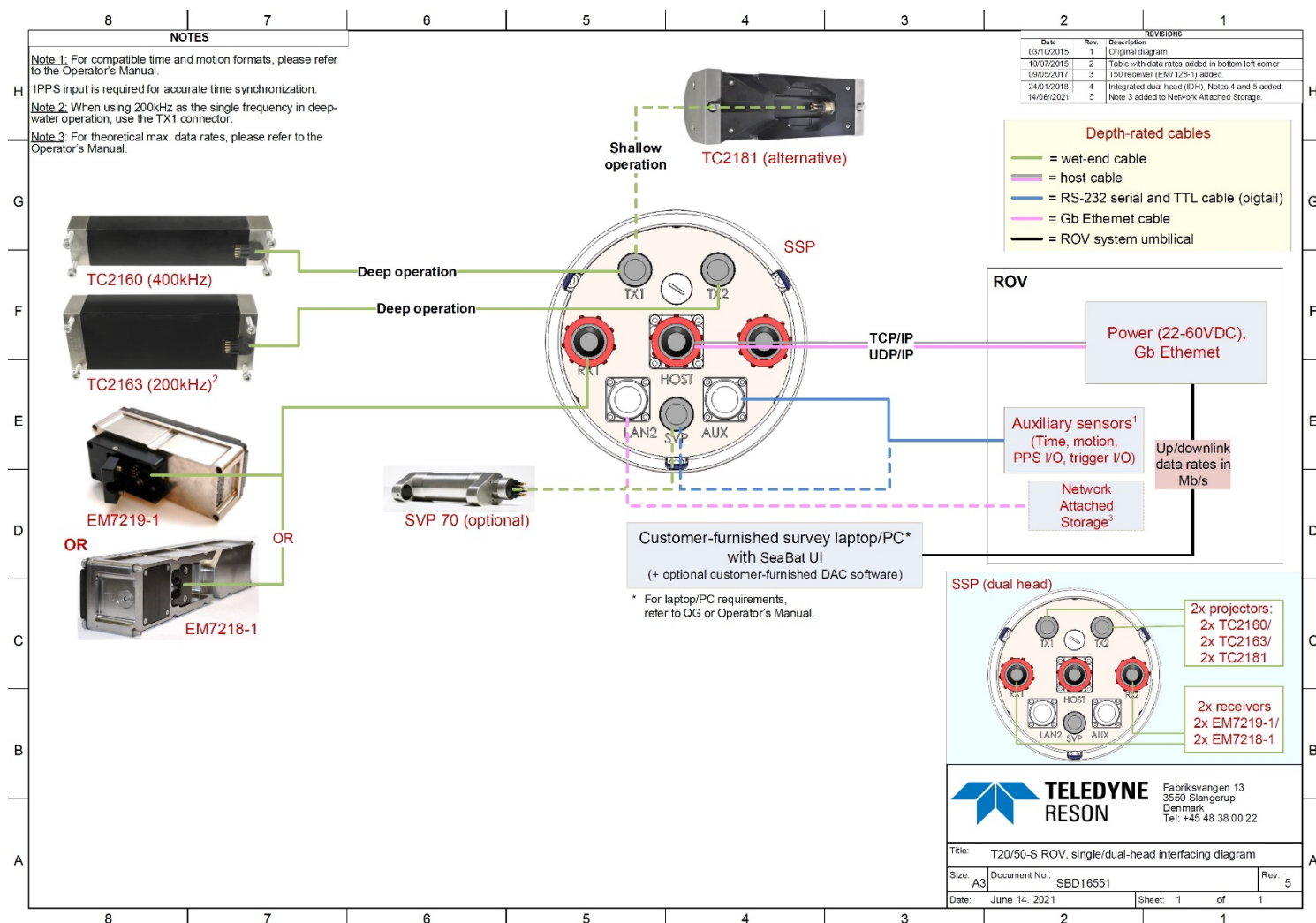


Figure 63: T20/50-S ROV, single/dual-head Interfacing Diagram

B.4 SeaBat T-Series Subsea Cables

CAUTION

The units must not be suspended from their cables. Ensure that strain relief on the cable (cable grip) is used. If the cable is very long, use an external wire or cable covered with steel flex.

B.4.1 SeaBat T-Series Subsea Transducer Cables

A standard cable set is provided to connect the SeaBat T-Series Subsea system components.

- **Projector to SSP cable:** This cable allows power and data to be passed between the projector and SSP. It has a standard length of three meters and a minimum bend radius of 63.5mm.
- **Receiver to SSP cable:** This cable allows power and data to be passed between the receiver and SSP. It has a standard length of three meters and a minimum bend radius of 100.0mm.

B.4.2 SeaBat T-Series Subsea External Sensor Cable

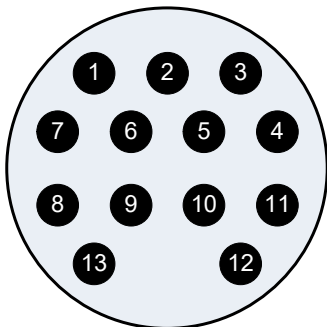
- **AUX pigtail cable:** This cable interfaces external sensors with the SSP. It has a standard length of five meters and a minimum bend radius of 105.0mm.

B.4.3 UUV Interface Cable

- **SSP to UUV host cable:** A host cable allows for power and data to be passed between the SSP and the UUV system. This cable is three meters in length and has a minimum bend radius of 100.0mm.

B.4.4 Pin Designations for Host, AUX, LAN2, and SVP Connectors on SSP

Table 9: Pin Designations for Host Connector²¹ (TIA/EIA 568B) mounted on SSP

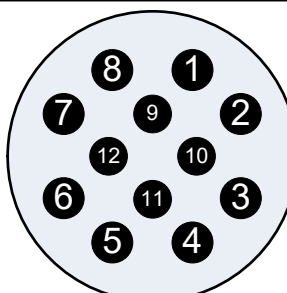
Pin	Wire Color	RJ-45 Pin No.	Signal	
1	Black		Supply RTN	
2	Orange		GND Shield	
3	White		Supply RTN	
4	Brown	8	BI_DD-	
5	White/brown	7	BI_DD+	
6	Blue	4	BI_DC+	
7	White/blue	5	BI_DC-	
8	Orange	2	BI_DA-	
9	White/orange	1	BI_DA+	
10	Green	6	BI_DB-	
11	White/green	3	BI_DB+	
12	Red		Positive supply (22-60V)	
13	Green		Positive supply (22-60V)	

Pins 1, 3, 12, 13 must all be used.

Please also refer to *Figure 75: Cable Assembly, Receiver to SSP and Host Cable*.

²¹ Host connector: MacArtney Subconn DBH13M

Table 10: Pin Designations for AUX Connector²² mounted on SSP

Pin	Signal	Pin	Signal	
1	AUX +12V Out (8W)	7	AUX RTN	
2	TX (I/O COM 4)	8	Trigger Out	
3	Motion/Attitude RS-232 RTN (I/O COM 2 + 4)	9	Trigger In	
4	Motion/Attitude RS-232 In (I/O COM 2)	10	Trigger I/O RTN	
5	Time/PPS I/O RTN (I/O COM 1)	11	PPS Out	
6	Time RS-232 In (I/O COM 1)	12	PPS In	

Please also refer to *Figure 79: Cable Assembly, AUX Pigtail*

Table 11: Pin Designations for LAN2 Connector²³ (TIA/EIA 568B) mounted on SSP

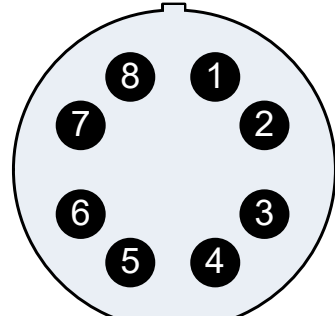
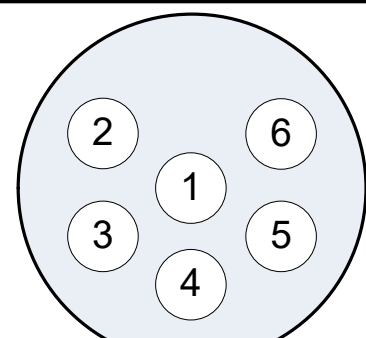
NETG Pin	Wire Color	RJ-45 Pin No.	Signal	
1	White/orange	1	BI_DA+	
2	Orange	2	BI_DA-	
3	White/green	3	BI_DB+	
4	Green	6	BI_DB-	
5	White/brown	7	BI_DD+	
6	Brown	8	BI_DD-	
7	White/blue	5	BI_DC+	
8	Blue	4	BI_DC-	

Table 12: Pin Designations for SVP Connector²⁴ mounted on SSP

Pin	Signal	
1	RS-232 RTN (I/O COM 3)	
2	RS-232 In (I/O COM 3)	
3	RS-232 Out (I/O COM 3)	
4	SUPPLY +12V Out (2W)	
5	N/A	
6	SUPPLY RTN	

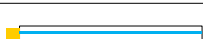
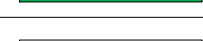
Please also refer to *Figure 80: Cable Assembly, SSP to SVP 70 (optional)*

²² AUX connector: Teledyne IMPULSE MHGD-12-FCR-Ti

²³ LAN2 connector: Teledyne IMPULSE MHGD-NETG-8-FCR-Ti

²⁴ SVP connector: Teledyne IMPULSE MCBH-6-FS-Ti

Table 13: TIA/EIA 568B Overview

RJ-45 Pin	TIA/EIA Pair	1000BASE-T Signal ID	Color Coding	Pin Nos. on RJ-45 Plug
1	2	BI_DA+	White/orange 	
2	2	BI_DA-	Orange 	
3	3	BI_DB+	White/green 	
4	1	BI_DC+	Blue 	
5	1	BI_DC-	White/blue 	
6	3	BI_DB-	Green 	
7	4	BI_DD+	White/brown 	
8	4	BI_DD-	Brown 	

B.5 SeaBat T-Series Subsea Installation

B.5.1 Subsea Sonar Processor (PN 1009483)

Table 14: SSP Technical Specifications

Specification	Value
Power requirements ²⁵	22-60VDC
Power consumption ²⁶	T20-S: Average 110W. Peak 370W. T50-S: Average 130W. Peak 390W.
Data communication	Gigabit Ethernet
Dimensions (excl. connectors)	Length: 494mm Diameter: 174mm
Weight (excl. cables)	Air: 24.4kg Water: 10.2kg
Temperature	Operating: -2° to +36°C (submerged) Storage: -30° to +70°C



- The SSP pressure housing should be mounted in a convenient location within easy reach of the projector/receiver to SSP cables.
- The SSP housing may be secured with straps.

CAUTION

The blue transport bumpers should be removed prior to installation of the SSP. The SSP should be mounted horizontally with a free flow of water around the unit.

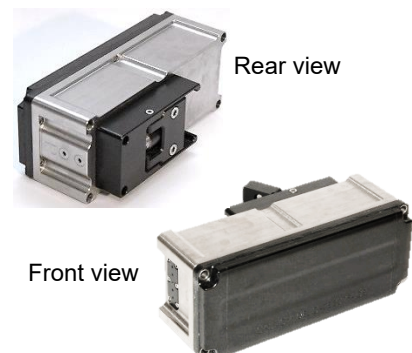
CAUTION

DO NOT OPEN the pressure housing. The SSP pressure housing is nitrogen-filled and sealed.

B.5.2 EM7219-1 Receiver Unit (PN 85002536) – T20

Table 15: EM7219-1 Receiver Unit Technical Specifications

Specification	Value
Material	Titanium (grade 2) lid Polyurethane acoustic window
Dimensions	Height: 123.2mm Length: 254.0mm Depth: 102.0mm
Weight	Air: 5.0kg Water: 2.2kg
Temperature	Operating: -2° to +36°C Storage: -30° to +70°C



- The EM7219-1 receiver unit mounts to the vessel or mounting bracket with four M8 screws already in place in the receiver.
- For ease of mounting, the ends of the housing are labeled P and S for Port and Starboard, respectively. The connector is placed on the port side.

CAUTION

Ensure free access to water inlet holes (on starboard side) for pressure equalization.

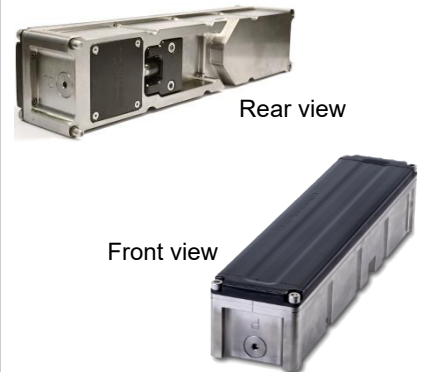
²⁵ 36-54VDC for IDH configurations.

²⁶ T20-S IDH: Average 150W. Peak 410W. T50-S IDH: Average 200W. Peak 460W.

B.5.3 EM7218-1 Receiver Unit (PN 85002538) – T50

Table 16: EM7218-1 Receiver Unit Technical Specifications

Specification	Value
Material	Titanium (grade 2) lid Polyurethane acoustic window
Dimensions	Height: 90.7mm Length: 460.0mm Depth: 102.0mm
Weight	Air: 8.2kg Water: 3.9kg
Temperature	Operating: -2° to +36°C Storage: -30° to +70°C



- The EM7218-1 receiver unit mounts to the vessel or mounting bracket with four M8 screws already in place in the receiver.
- The cable can be arranged as needed in the grooves.
- For ease of mounting, the ends of the housing are labeled P and S for Port and Starboard, respectively. The connector is placed on the port side.

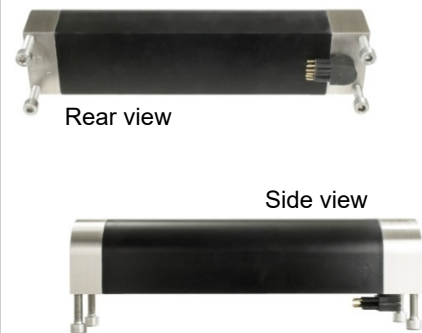
CAUTION

Ensure free access to water inlet holes (on starboard side) for pressure equalization.

B.5.4 TC2160 Projector Unit (deep operation) (PN 85000328)

Table 17: TC2160 Projector Unit Technical Specifications

Specification	Value
Material	Titanium (grade 2) lid Polyurethane acoustic window
Dimensions	Height: 77mm Length: 285mm Depth: 62mm
Weight	Air: 2.85kg Water: 1.85kg
Temperature	Operating: -5° to +40°C Storage: -30° to +70°C

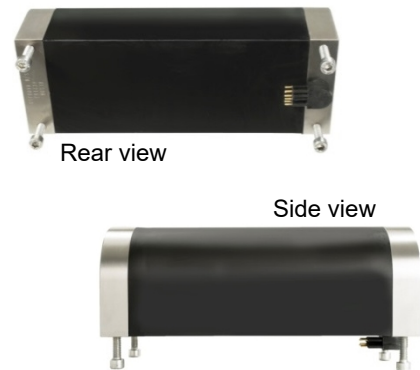


- The TC2160 projector unit mounts to the vehicle or mounting plate using four M8 machine screws of appropriate length, arranged in a rectangular pattern.

B.5.5 TC2163 Projector Unit (deep operation, optional) (PN 85000327)

Table 18: TC 2163 Projector Unit Technical Specifications

Specification	Value
Material	Titanium (grade 2) lid Polyurethane acoustic window
Dimensions	Height: 115mm Length: 280mm Depth: 100mm
Weight	Air: 7.5kg Water: 5.0kg
Temperature	Operating: -5° to +40°C Storage: -30° to +70°C



- The TC2163 projector unit mounts to the vehicle or mounting plate using four M8 machine screws of appropriate length, arranged in a rectangular pattern.

B.5.6 TC2181 Projector Unit (shallow operation) (PN 85002319)

Table 19: TC2181 Projector Unit Technical Specifications

Specification	Value
Material	Titanium (grade 2) lid Epoxy acoustic window
Dimensions	Height: 86.6mm Length: 280.0mm Depth: 93.1mm
Weight	Air: 5.4kg Water: 3.4kg
Temperature	Operating: -5° to +40°C Storage: -30° to +70°C



- The TC2181 projector unit mounts to the vessel or mounting bracket with M8 Hex screws already in place in the projector.
- The cable can be arranged as needed in the grooves designed specifically for this purpose.

NOTE

TC 2181 projectors with the label "SV2/T" below the part no. on the housing are compatible with SeaBat 7125 SV2 and SeaBat T-Series systems.

B.5.7 Wet-End Cable Connections

NOTE

The transmitter cable may induce an H-field onto the host power wires due to the high transmit power level of the sonar. This interference depends on the external cable routing.

Therefore, for full EMC compliance to conducted emission standards, it may be required that the installation includes a customer-provided filter, e. g. TE Connectivity 20EQ1.

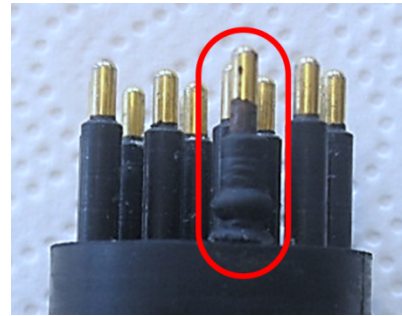
The filter must be placed close to the power source in order to minimize the risk of inducing noise on the inlet side of the filter.

CAUTION

Female connectors must be lubricated at least every 5 matings to avoid damaged male connectors (as shown here).

Follow the instructions provided with the wet connector lubrication kit.

Noncompliance may affect warranty situation (see *Appendix H Standard Warranty Information*).



- The cable connections from the receiver and projector units to the SPP should be made prior to immersing the units in water.
- A light lubrication coating on the female connector face will ensure sealing (see *section 2.2.2.2 Wet-End Connectors*).
- Unused connectors should be sealed with dummy plugs.
- Verify that all cables are securely fastened and that strain relief is provided to prevent cable damage.

CAUTION

Take care to avoid impact to the projector unit and receiver unit faces, as damage could degrade system performance.

To avoid damage to the system components, the SSP connections **must** be made according to the labelling on the bottle:

SINGLE HEAD

- **TX1:**
Dual or single frequency, deep operation:
 TC2160, 400kHz projector
or: Single frequency, deep operation:
 TC2163, 200kHz projector
or: Dual frequency, shallow operation:
 TC2181, 200-400kHz projector
- **TX2:**
Dual frequency, deep operation:
 TC2163, 200kHz projector
- **RX1:**
 EM7219-1, dual-frequency receiver
or: EM7218-1, dual-frequency receiver

INTEGRATED DUAL HEAD²⁷

- **TX1 and TX2,**
2 identical projectors:
 TC2160, 400kHz projector
or: TC2163, 200kHz projector
or: TC2181, 200-400kHz projector
- **RX1 and RX2²⁸,**
2 identical receivers:
 EM7219-1, dual-frequency receiver
or: EM7218-1, dual-frequency receiver

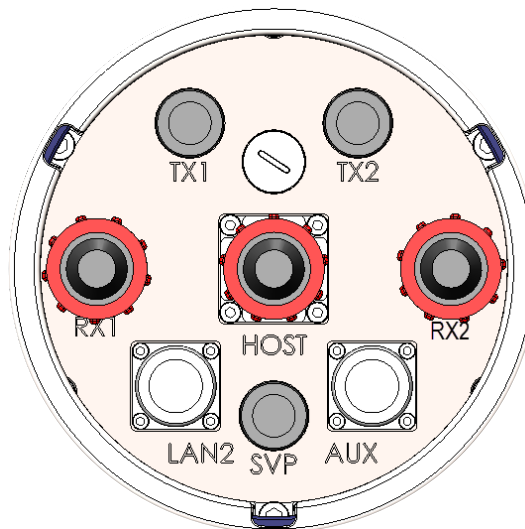


Figure 64: SSP Pressure Bottle Connections

CAUTION	
To disconnect wet-end cables from the SSP, first unscrew the locking sleeves before pulling the cables out.	
CAUTION	
Do not bend the cables beyond the recommended limits when positioning the cables. These cables are very stiff, and a smaller bend radius will damage the cable.	
CAUTION	
	Do not open the Fill valve (for Teledyne RESON use only). Noncompliance will affect warranty situation (see <i>Appendix H Standard Warranty Information</i>).

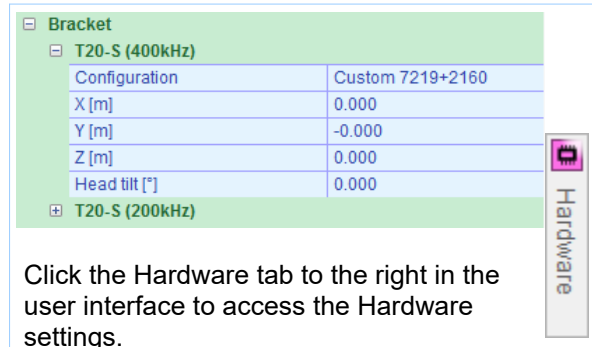
²⁷ Dual head configurations with two SSPs are also available.

²⁸ Not labelled on the bottle itself.

B.5.11 Hardware Settings

The Hardware settings controls the one-time transmit array and projector settings. These settings should be set to reflect the initial installation of your system and should not require modification unless the physical installation changes.

For instructions on navigating the user interface, refer to the RESON Sonar UI User Manual (see *Appendix F Reference Documentation*).



For details on sonar head assembly orientation, see *appendix B.5.8 above*.

Select as appropriate one of the preset bracket configurations or enter custom values.

- **Preset Configurations:**

NOTE	
Preset configurations can only be used with Teledyne RESON standard brackets for receiver and projector(s). If a standard bracket is not used the customer configuration should be used instead.	

- **Normal:** When the receiver is mounted with the connector to the port side, the Configuration selection should be Normal.
- **Reversed:** When the receiver is mounted with the connector to the starboard side, the Configuration selection should be Reversed (see *appendix B.5.8 Sonar Head Assembly Orientation*). This option reverses the beams thereby normalizing the image and the generated data output.

- **Customer Configuration:**

- For nonstandard installations, the XYZ offset of the receiver reference point to the projector reference point must be defined. For details on reference points, see *appendix B.5.9 above*.

CAUTION	
Incorrect offset settings could severely affect data quality.	

- **Head Tilt:**

- The Head tilt feature allows the user to normalize the display, gates, and bottom detect processing to reflect the physical orientation of the sonar head. For examples on how to use this feature, see *section 6.3.4 Head Tilt*.
- The angular value is entered in degrees (+ Port up/- Port down) and must be between -45° and 45° in increments of 0.5°.

B.6 System Check

Once the SeaBat T-Series Subsea has been installed, follow these steps to ensure that the system is working properly. For information on the settings, refer to the RESON Sonar UI User Manual (see *appendix F.1 SeaBat T-Series Subsea Documentation*).

NOTE

Communication with the SSP requires the use of a secondary computer via a crossover Ethernet cable.

1. Ensure that all system cable connections are mated properly.
2. Apply power to the system. The Windows® operating system will boot up and the 7kCenter (sonar control software) will start automatically.
3. Start the Sonar UI by double-clicking the icon on the operator desktop and select the correct IP address in the Hardware pane (see *section 4.2 Sonar User Interface (SUI)*).
4. Verify that the Power setting on the Main pane is set to OFF.
5. Once the system has been energized, follow these steps to verify that the system is operating correctly:
 - a. Set the Range to 150.
 - b. Set Max Rate (on the Advanced pane) to 4.
 - c. Set the Gain to 30.
 - d. Select Blue-Yellow from the Sonar Palette drop-down menu on the Display pane.
 - e. Perform a receiver check by vigorously rubbing the face of the receiver unit with fingertips while monitoring the display. A noise pattern should be barely visible on the display.
 - f. Gradually increase the Power setting on the Main pane while an assistant presses an ear against the projector face. Continue to increase the power until the assistant can hear pings (ticking sounds) emitting from the front of the projector to just below FULL for a very short period.
 - g. Turn transmit Power to OFF as soon as possible.

CAUTION

The **SSP** is designed for operation under water. Operation in air for extended periods of time will result in overheating and severe damage to the system. Transmitting in air should be limited to low power levels and should be **no longer** than 1 minute in length with power ON. Transmitting into air for any period of time may result in the damage of the ceramics of the **projector** and will result in degraded performance.

APPENDIX C PPS IN AND TRIGGER IN

C.1 Electrical Specifications for PPS In and Trigger In

Table 20: PPS In and Trigger In Signals²⁹

Parameter	Min.	Typical	Max.	Unit	Note
Absolute maximum ³⁰ signal voltage	15			V	
Absolute maximum reverse signal voltage			-1	V	
Low voltage threshold	1	1.6		V	
High voltage threshold		1.6	1.8	V	
Input current (high)					
@2V		7		mA	
@3V		8		mA	
@5V		10		mA	
@15V		20		mA	
Input current (low ³¹)		0			
Input delay		400	1000	ns	Pulse 0V to 2V, 50 Ohm

C.2 Typical PPS In and Trigger Performance

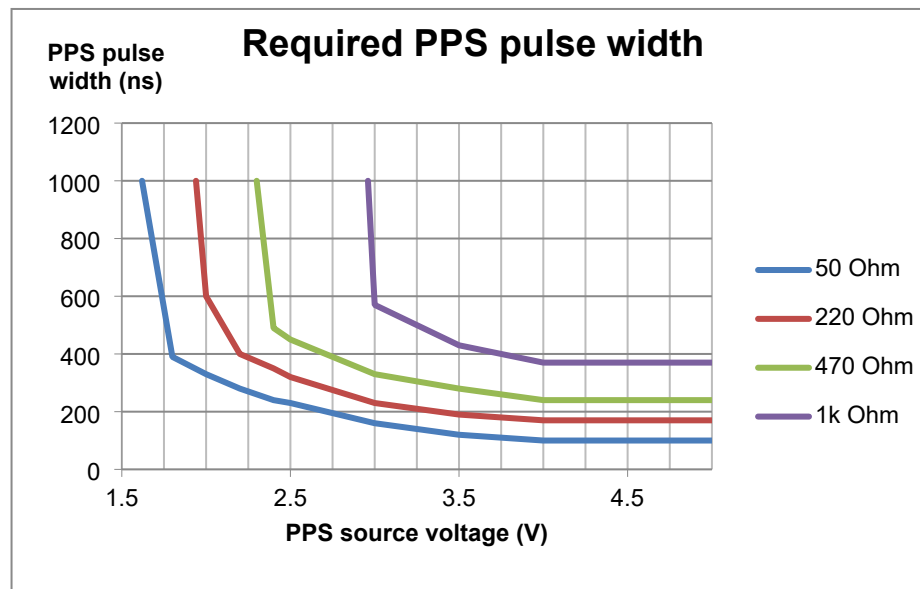


Figure 65: Required PPS Pulse Width

²⁹ Measured at the BNC terminals.

³⁰ Voltages beyond maximum limits may cause permanent damage to the input.

³¹ Completely unconnected input guaranteed to be low.

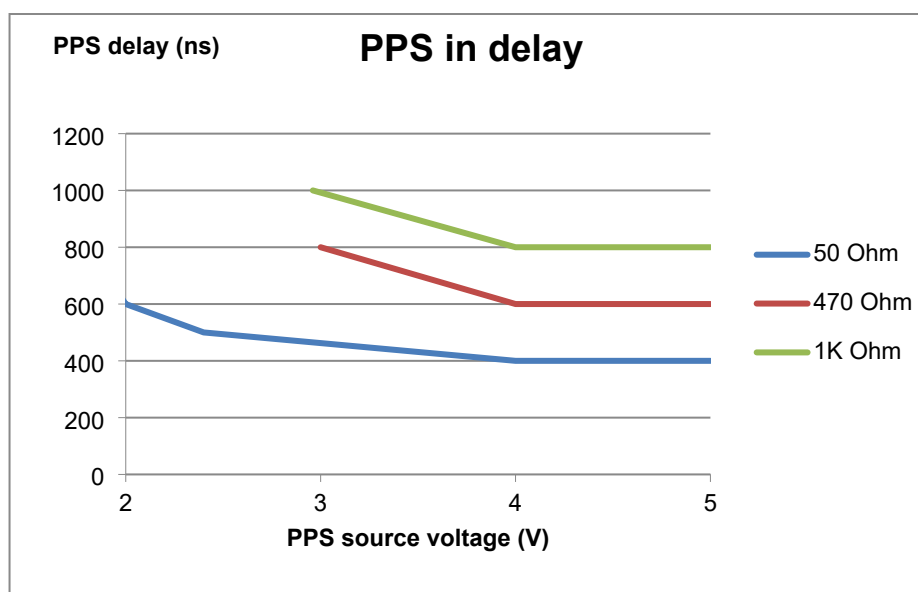
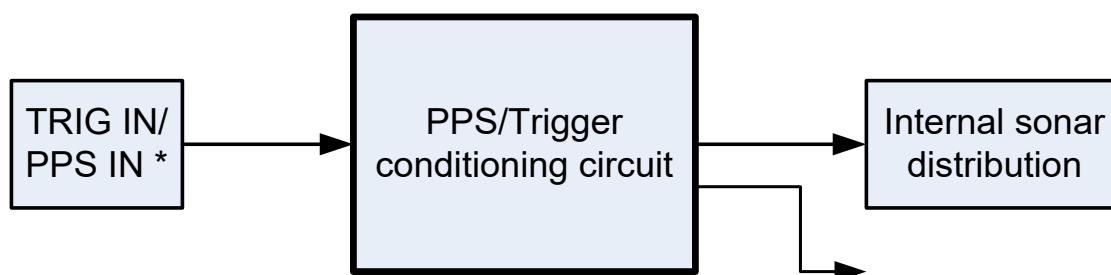


Figure 66: PPS In Delay

C.3 Hints and Advice

- The PPS and trigger inputs work with regular CMOS TTL outputs.
- The drive capability of a standard TTL output is inadequate to drive PPS and trigger high.
- When more systems use the same PPS source using BNC-T-adaptors it should be verified that its drive capability is sufficient.
- For distribution of the PPS pulse, "PPS out" may be used instead of the BNC-T-adaptor.
- Make sure the PPS source output is in accordance with the specifications listed in *Table 20*.
- Operation is ensured if the source resistance is less than 470 Ohm, the drive voltage is greater than 3V, **and** the pulse width is greater than 1 μ s.

The PPS/trigger described is the externally available signal. The signal is conditioned before it is internally distributed.



* The TRIG IN//PPS IN (or 1PPS) ports are clearly marked on the rear panel of the sonar processor.

Figure 67: PPS/Trigger Signal

APPENDIX D DATA RATES

Table 21: Theoretical Max. Data Rates – SeaBat T-Series Subsea Single and Dual Head

System and number of beams	Utilized storage GB/hour	Max. data rate Mb/s	Utilized storage GB/hour
T20/50-S, 256 beams 34kS/s	~130	~300	~5
T20/50-S, 512 beams 34kS/s	~250	~550	~6
T20/50-S, 1024 beams 34kS/s	N/A	N/A	~8
T50-S, 256 beams 66kS/s	~235	~525	~5
T50-S, 512 beams 66kS/s	N/A	N/A	~6
T50-S, 1024 beams 66kS/s	N/A	N/A	~7
Records/data: Survey + interfaced sensor data:	Incl. water column		Excl. water column

Notes:

1024 beams and 512 beams at 66kS/s exceed the Ethernet data bandwidth.

Dual-head operation only available at 34kS/s.

Data rates double with dual-head operation and logging water column data will saturate the network.

Dual-head water column logging is only available for 2*256 beams.

APPENDIX E NETWORK CONFIGURATION

E.1 Single-Head System Network Configuration

The Subsea Sonar Processor (SSP) is at delivery configured as follows:

Table 22: IP Configuration for SSP

Network port	LAN 1/Host	LAN 2
IP address	10.11.10.1	10.11.10.2
Subnet mask	255.255.255.0	255.255.255.0

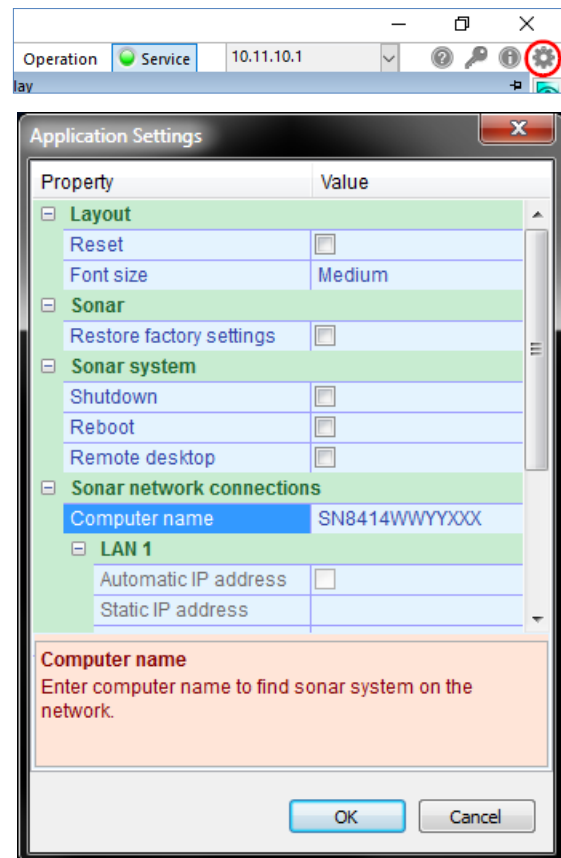
The CFE laptop/PC which runs the Sonar User Interface (SUI) should in standard systems be configured in the IP range 10.11.10.3-10.11.10.255 in the same subnet as the SSP.

E.2 Change IP Configuration

The IP configuration can be changed from the SUI installed on the CFE laptop/PC:

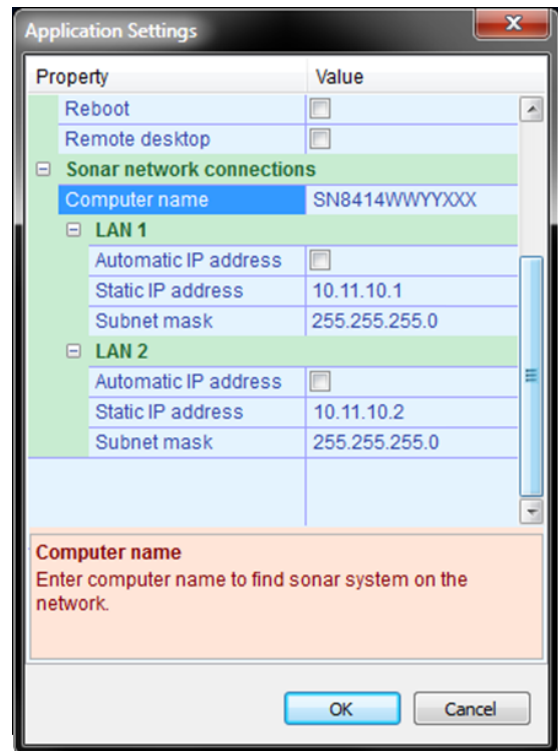
1. Click the Application Settings button in the top right corner of the Sonar UI.
2. Unfold the Sonar network connections setting.
3. If the connection has been established, the Computer name is already stated; if not, enter SN+serial number of the SSP.

Please find the serial number on the label on the SSP.



4. Press Enter on the keyboard.

After a few seconds the Configuration of LAN 1 (Host) and LAN 2 will be populated.



Manual or automatic configuration of LAN 1 and LAN 2:

Both LAN 1 and LAN 2 can be configured to obtain a manual fixed IP address or an IP address automatically from a DHCP (Dynamic Host Configuration Protocol) server.

- a. The manual fixed IP setting is freely configurable for LAN 1, but for LAN 2 the range is limited to 10.11.10.2 to 10.11.10.9 with subnet mask 255.255.255.0. If the IP for LAN 2 is configured outside this range it will revert to 10.11.10.2 with subnet mask 255.255.255.0 after the next reboot of the SSP. The factory default setting is 10.11.10.1 for LAN 1 and 10.11.10.2 for LAN 2, each with subnet mask 255.255.255.0.
- b. If Automatic IP address is selected, the SSP will request an IP from a DHCP on the network; if none is given, it will revert to alternative IP addresses, 10.11.10.1 for LAN 1 and 10.11.10.2 for LAN 2. The timeout before reverting is up to 1m30s.

2. After configuring the desired IP addresses, click OK.

NOTE

If you change the IP addresses (within the same subnet), the connection to the SSP will be lost. Shut down the UI and restart to re-establish the connection.

NOTE

The connection from the SUI to the SSP will be lost if the SSP moves to another SUBNET than the one the CFE laptop/PC is located on.

In that case, change the CFE laptop/PC IP address to a valid IP address within the same subnet, restart the SUI, and establish connection as described in *section 3 System Startup and Shutdown*.

NOTE

The outlined procedure should work even with an IP address configured in another subnet.

In the event of a problem, connect a cable directly between the LAN 2 port on the SSP and the CFE laptop/PC, change the laptop/PC to IP address 10.11.10.10 with subnet 255.255.255.0, and restart the SUI. It might be necessary to reboot the laptop/PC as well.

APPENDIX F REFERENCE DOCUMENTATION

F.1 SeaBat T-Series Subsea Documentation

In addition to this document, the following SeaBat documentation is available in Adobe Portable Document Format (.pdf) for printing.

Document Title	Document Number	Document Description
SeaBat T-Series Subsea Operator's Manual	OM16226	Version 12 or higher
SeaBat T-Series Subsea Quick Reference Guide	QG16227	Version 7 or higher
SeaBat UI for T-Series Quick Installation Guide	QG15552	Version 3 or higher
SeaBat Updater Quick Installation Guide	QG18505	Version 2 or higher
T/F-Series Subsea Integration to ROV electronics pod Installation Quick Guide	QG21497	Version 1 or higher
Sonar UI User Manual	OM14950	Version 1.4.12 or higher
Data Format Definition ³²	DFD20723 (NEW no.) (previously 11542)	Version 3.12 or higher

Each system contains a link in the Start menu to system documentation (as shown in the example in *Figure 68*).

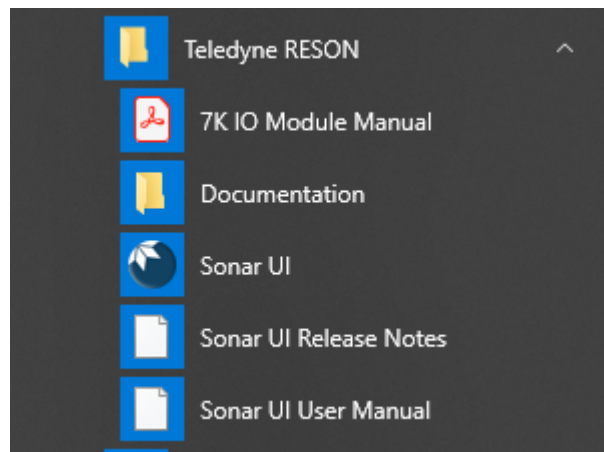


Figure 68: System Documentation Link (Example Only)

³² Also available here: <https://github.com/Teledyne-Marine/7k>

F.2 SeaBat T-Series Subsea Design Documents

The following design documents and drawings are provided for reference purposes.

Table 23: SeaBat T-Series Subsea Design Documents

Document Title	Document Number
Receiver, EM7219-1, Outline (for T20 system)	85002536M011
Receiver, EM7218, Outline (for T50 system)	85002409M011
TC2160 Outline dimension	2160M011
TC2163 Outline dimension	2163M011
TC2181 Outline dimension	85002319M011
Subsea Sonar Processor, Outline	85002507M011
Ethernet cable, Subconn DIL13M w. DIL13F (Rx to SSP cable and host cable)	85002393 0040360000-052
Cable Assembly, Tx, HD-PV, Water Blocked, 7k (deep)	85001850B011
CABLE ASSY, HD-PV, MCIL-6_FC, TX, 7K (shallow)	85001763B011
Ethernet cable, Subconn DBH13F Brass. w. DDC13M (Bulkhead connector)	1007294 0040360000-053
Cable Assy, MHDG-12-CPP, 12c AWG#20, Pigtail, 5m	1009794 PARTD17002
Cable Assy, MCIL-9-FS to MCIL-6-MP, for SVP70 to wet SVP interface (optional) ³³	PARTD16102
Sonar reference point definition	GD12899

³³ SVP 70 cable options:
 PN 1009571: 1m
 PN 1009791: 3m (standard length)
 PN 1009792: 5m

F.2.1 Receiver, EM7219-1 Outline Dimensions

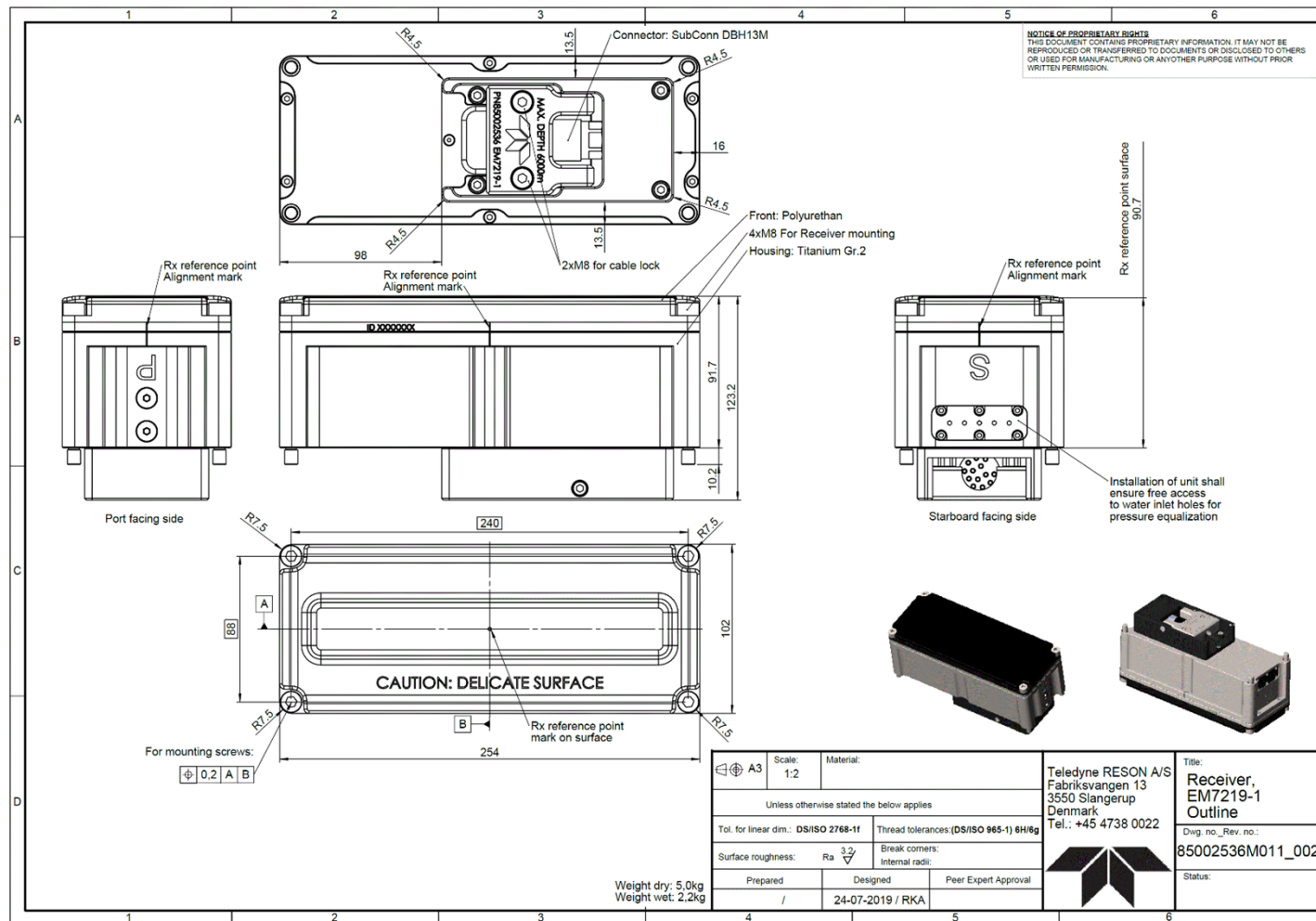


Figure 69: Receiver, EM7219-1 Outline Dimensions

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Top View:

- Overall length: 289.7
- Overall width: 250
- Groove for cable
- Connector: SubConn DBH13M
- 2xM8 for cable lock
- Alignment mark
- Dimensions: 16, 45°, 89, 21, 446, 11.2, R7.5, 102, 460

Front View:

- Front: polyurethane
- 4xM8 for Receiver mounting
- Housing: Titanium Gr.2
- For mounting screws: $\begin{matrix} \oplus & 0.2 & A & B \end{matrix}$
- Alignment mark
- Port facing side
- Starboard facing side

Exploded View:

- Lock for cable
- Groove for cable
- Weight dry: 8.2kg
- Weight wet: 3.9kg

CAUTION: DELICATE SURFACE

Scale: 1:2	Material:
Unless otherwise stated the below applies	
Tol. for linear dim.: DS/ISO 2768-1f	Thread tolerances (DS/ISO 965-1) 6H/6g
Surface roughness: Ra $\sqrt{3.2}$	Break corners: Internal radii:
Prepared 27-04-2017/NSJ	Designed 25-02-2013/NSJ
Peer Expert Approval	

RESON

RESON A/S
Fabriksvengen 13
3550 Slangerup
Denmark
Tel.: +45 4738 0022

Title: Receiver, EM7218, Outline
Dwg no./Rev no.: 85002409M011_002
Status: Released

Figure 70: Receiver, EM7218 Outline Dimensions

F.2.3 Projector, TC2160 Outline Dimensions (for deep installation)

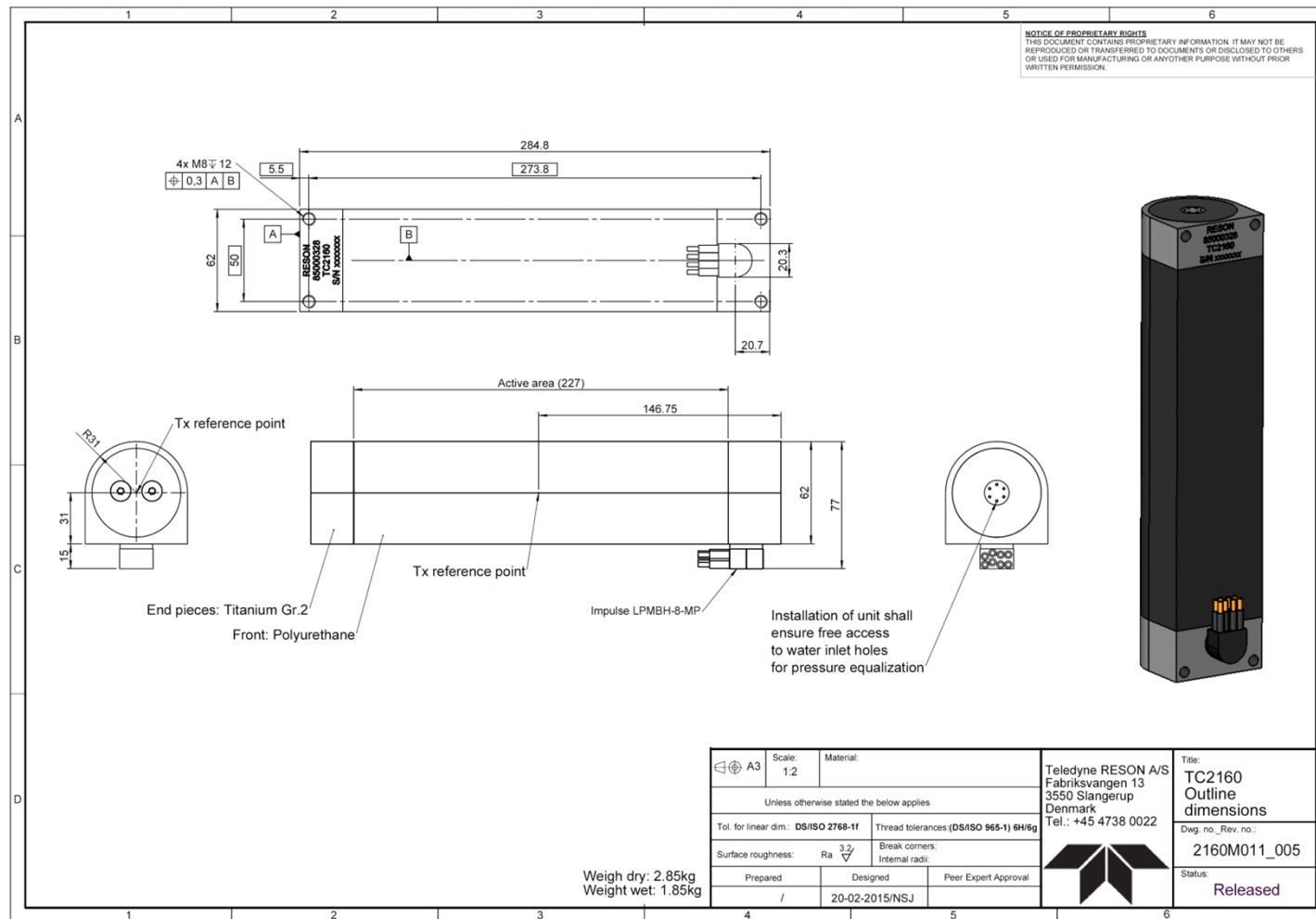


Figure 71: Projector, TC2160 Outline Dimensions (for deep installation)

F.2.4 Projector, TC2163 Outline Dimensions (for deep installation)

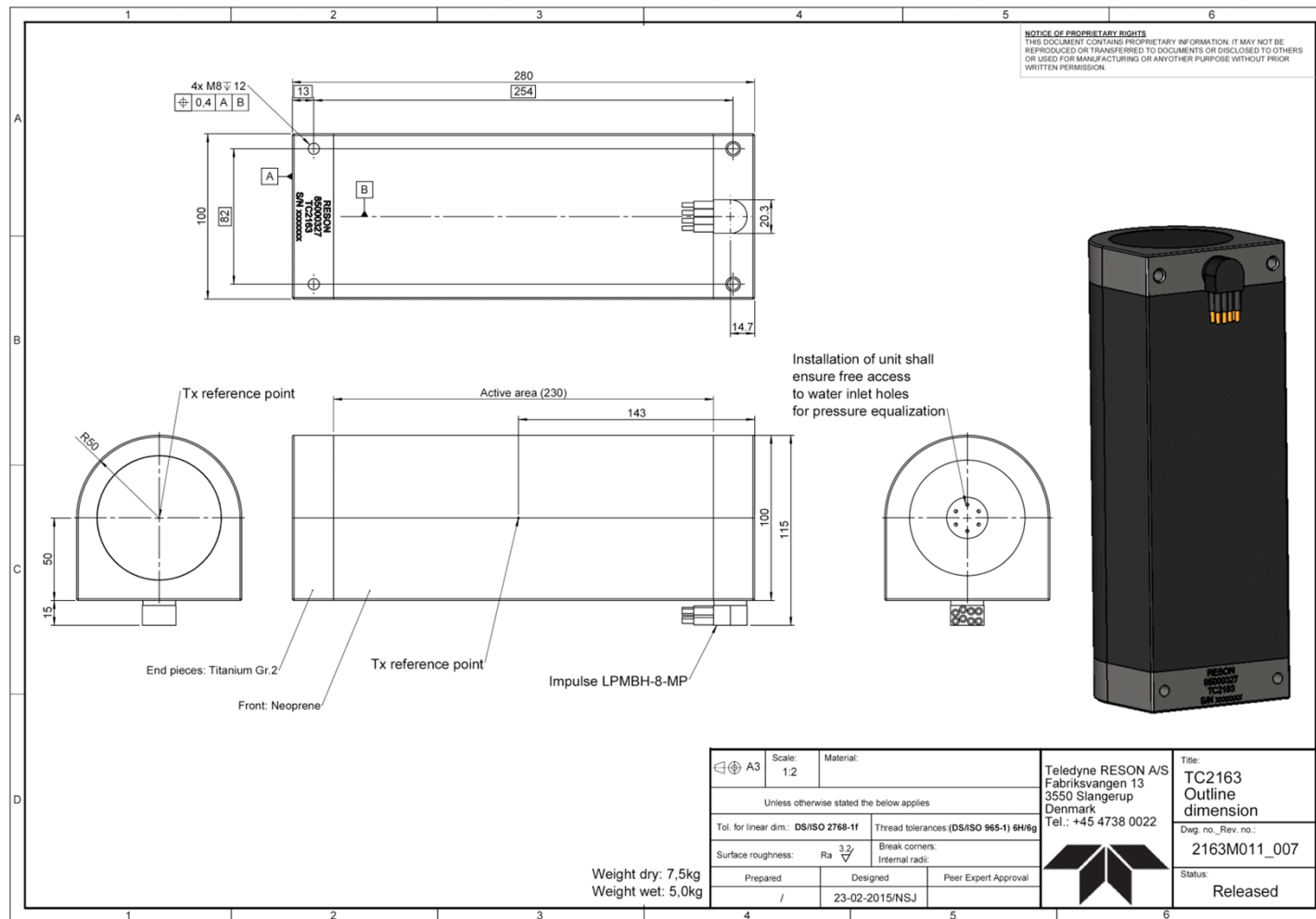


Figure 72: Projector, TC2163 Outline Dimensions (for deep installation)

F.2.5 Projector, TC2181 Outline Dimensions (for shallow installation)

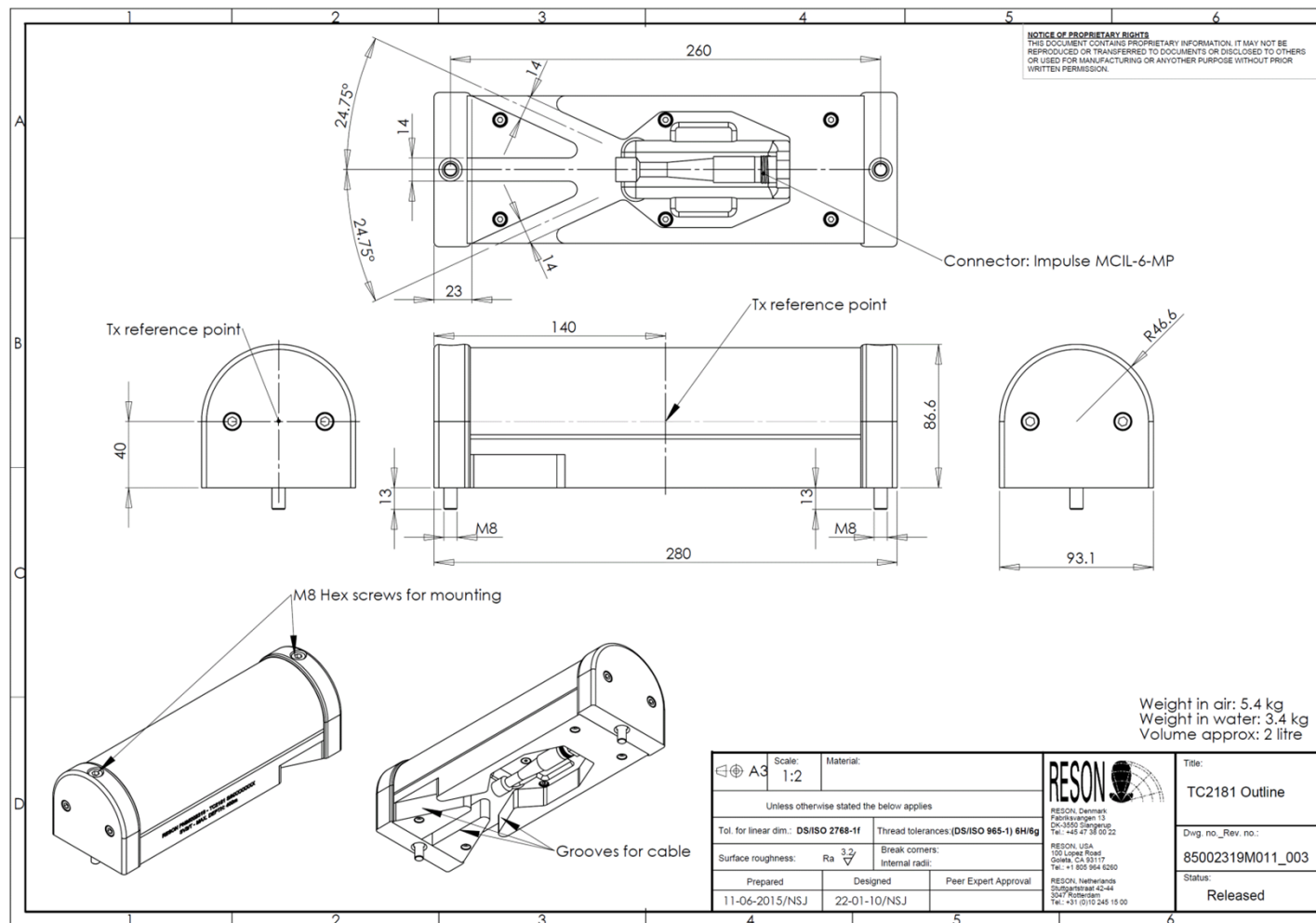


Figure 73: Projector, TC2181 Outline Dimensions (for shallow installation)

F.2.6 Subsea Sonar Processor, Outline Dimensions

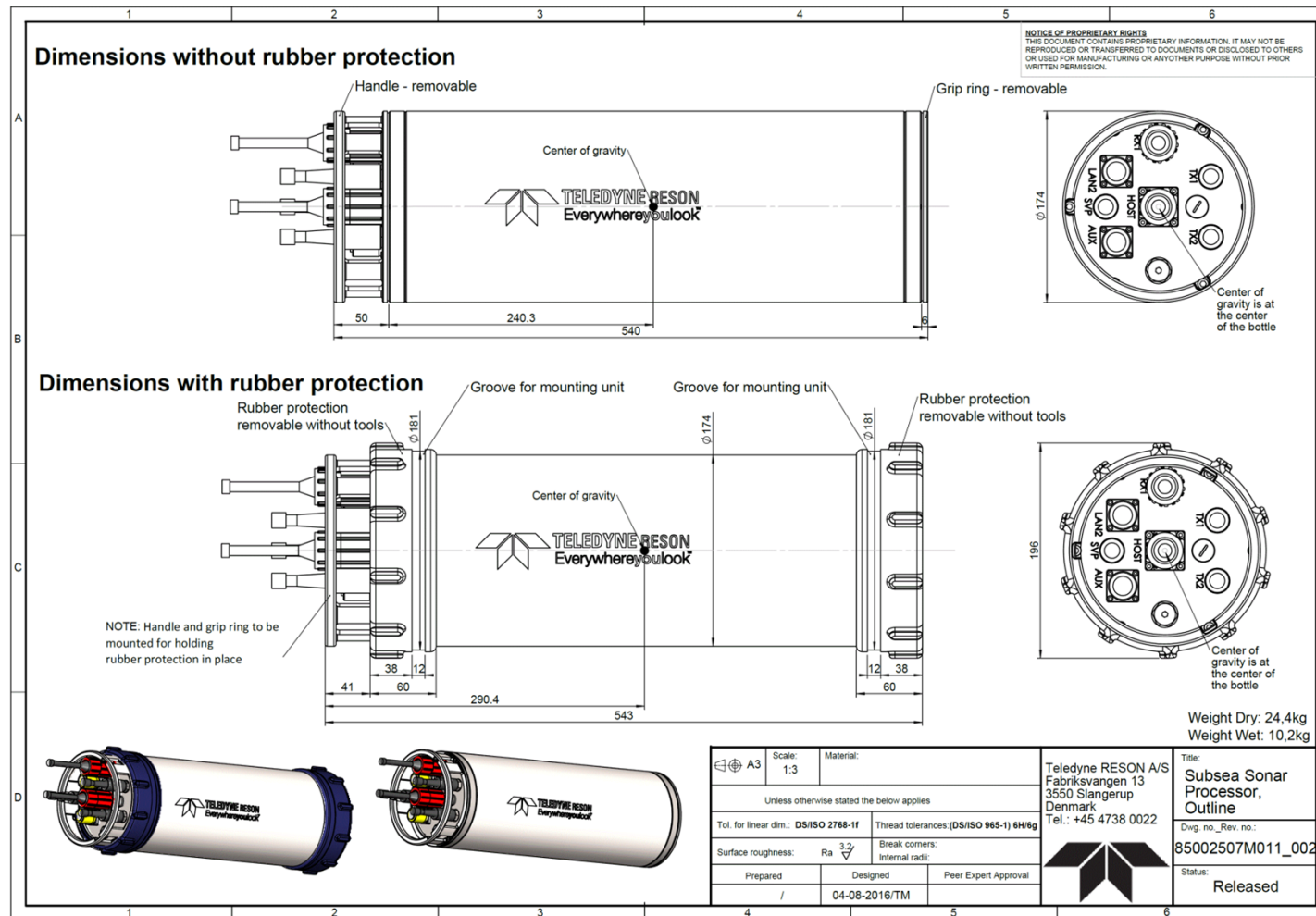


Figure 74: Subsea Sonar Processor, Outline Dimensions

F.2.7 Cable Assembly, Receiver to SSP and Host Cable

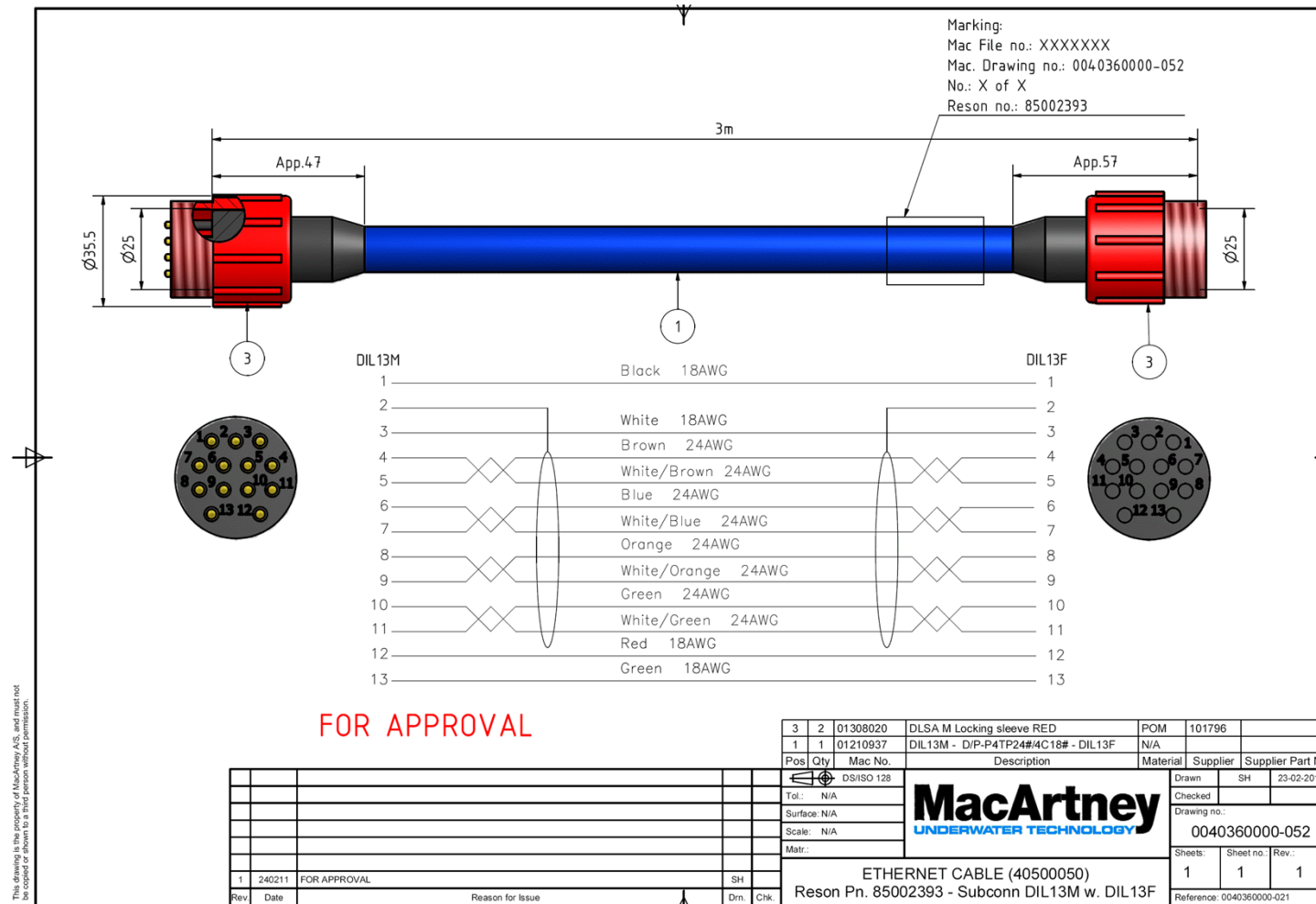


Figure 75: Cable Assembly, Receiver to SSP and Host Cable

REFERENCE DOCUMENTATION

F.2.8 Cable Assembly, TC 2163/60 Projector to SSP (deep)

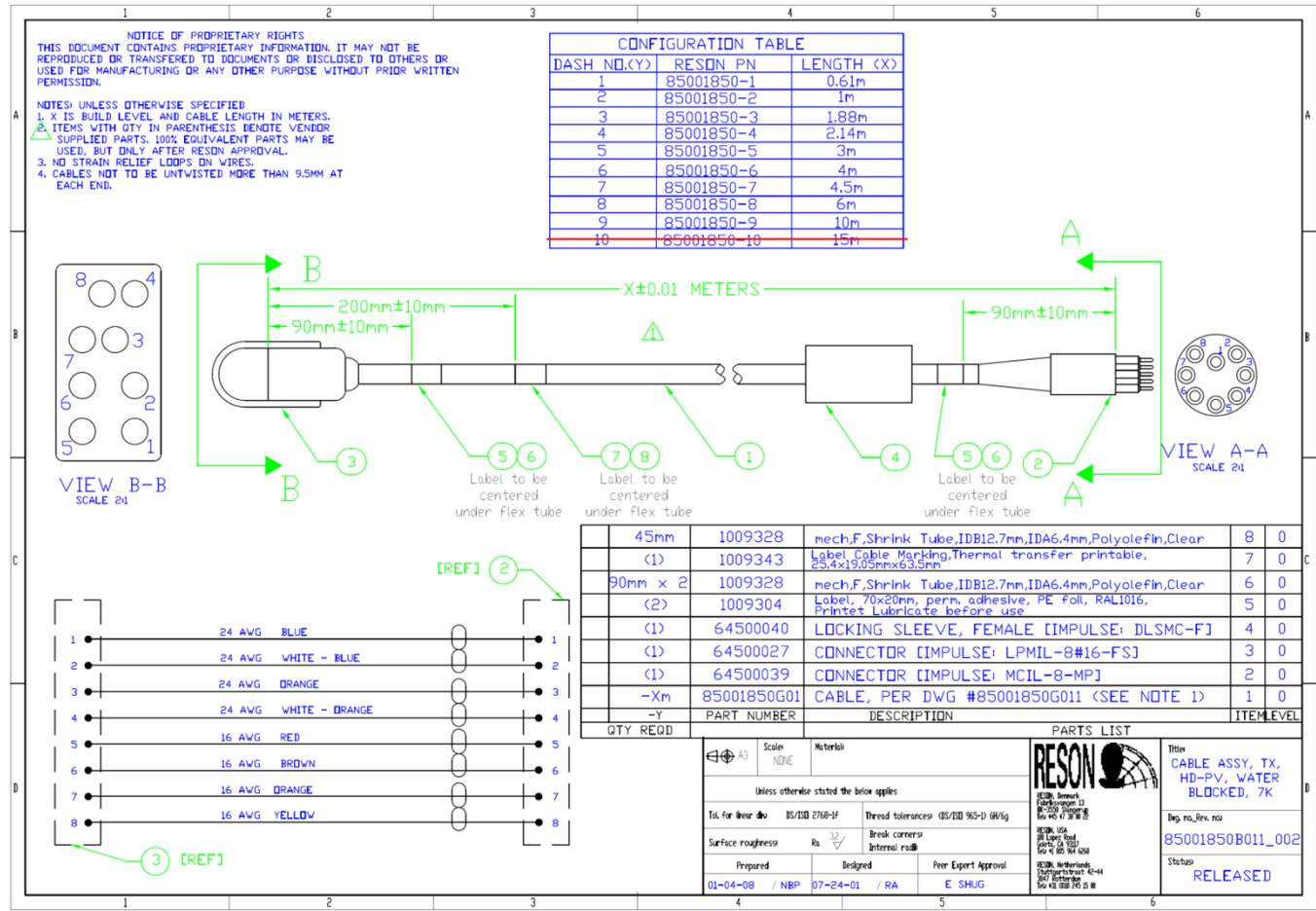


Figure 76: Cable³⁴ Assembly, TC 2163/60 Projector to SSP (deep)

³⁴ Max. cable length offered: 5m.

F.2.9 Cable Assembly, TC2181 Projector to SSP (shallow)

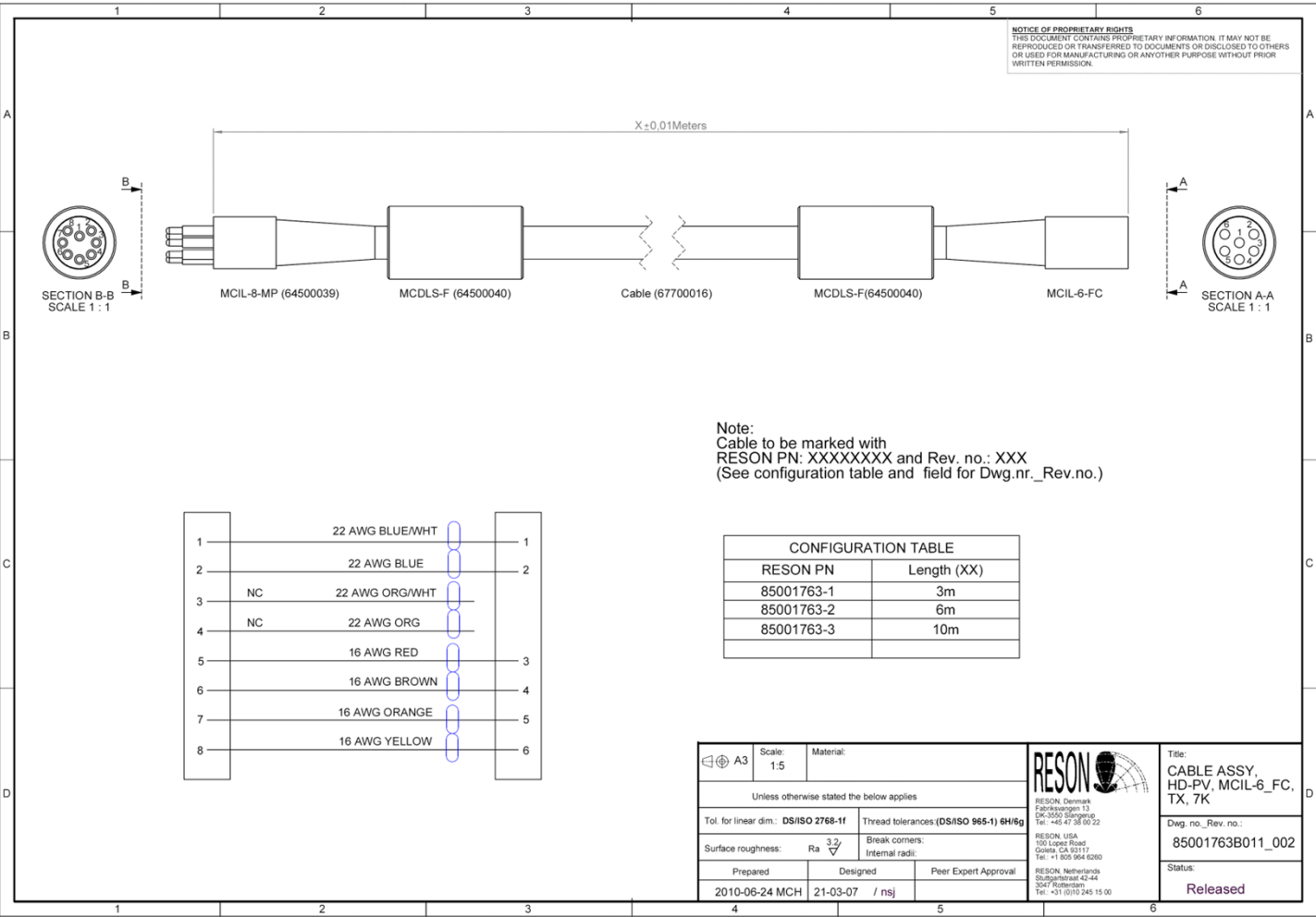


Figure 77: Cable Assembly, TC2181 Projector to SSP (shallow)

F.2.10 Cable Assembly, Bulkhead Connector for ROV

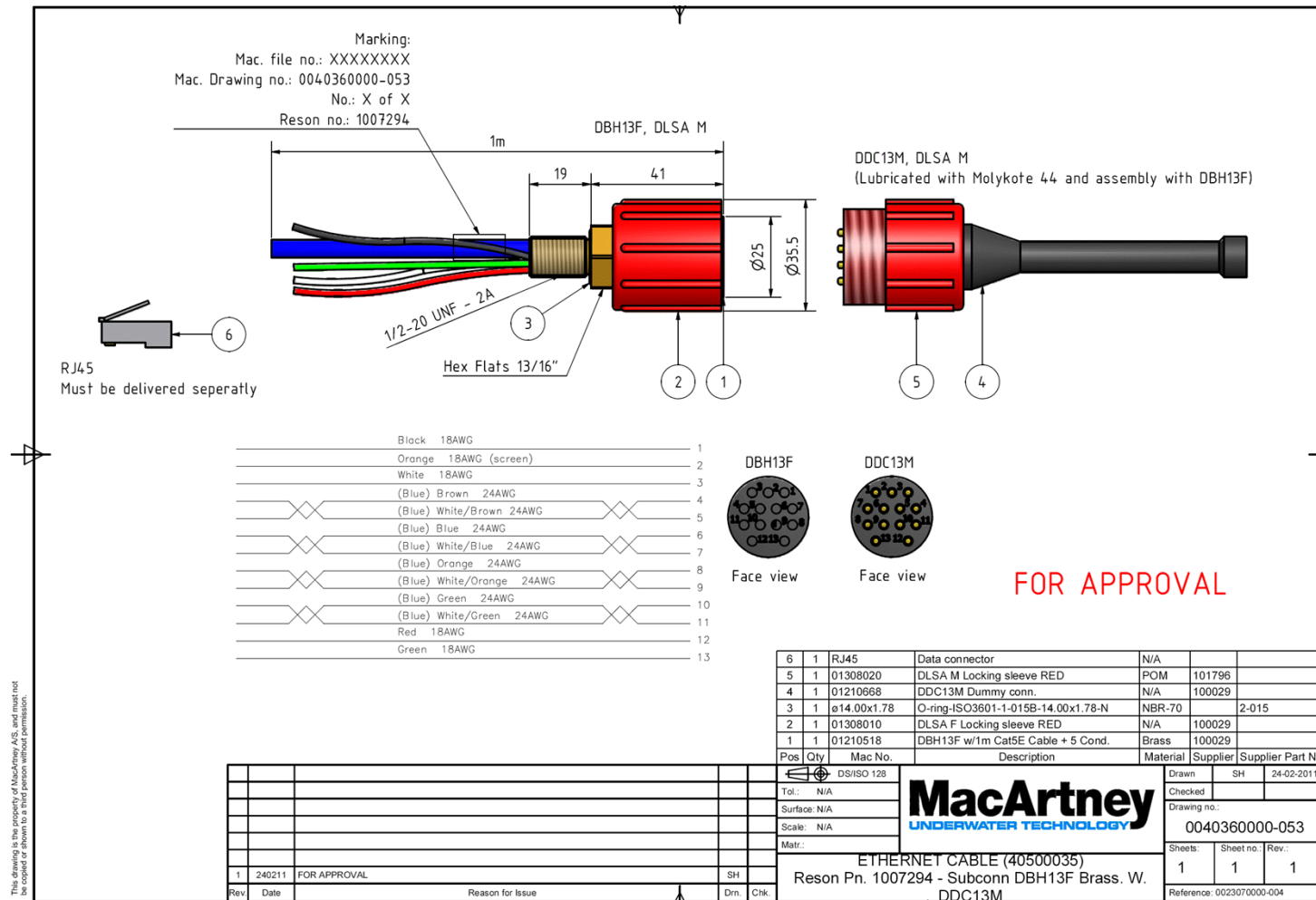


Figure 78: Cable Assembly, Bulkhead Connector for ROV

F.2.11 Cable Assembly, AUX Pigtail

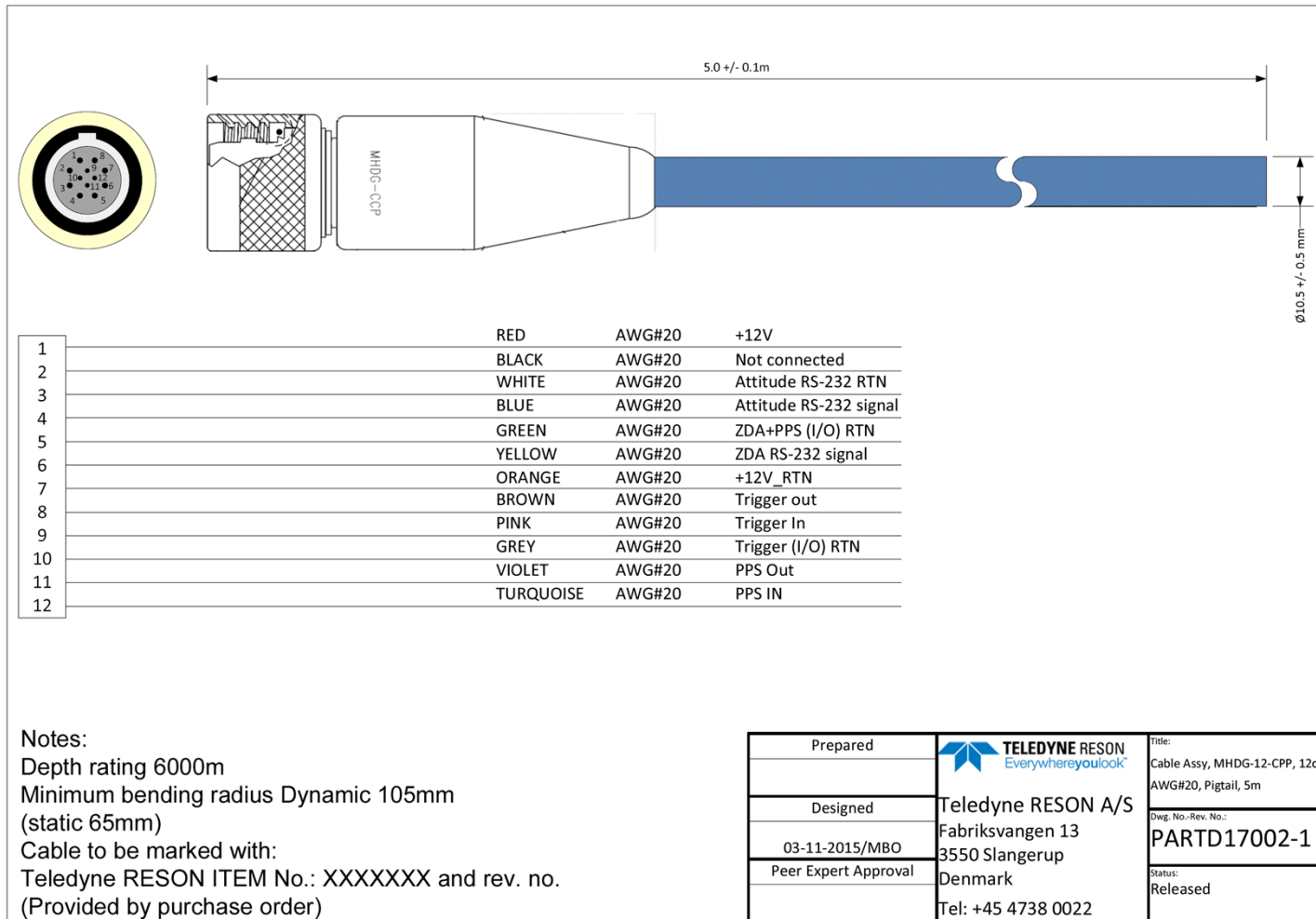


Figure 79: Cable Assembly, AUX Pigtail

F.2.12 Cable Assembly, SSP to SVP 70 (optional)

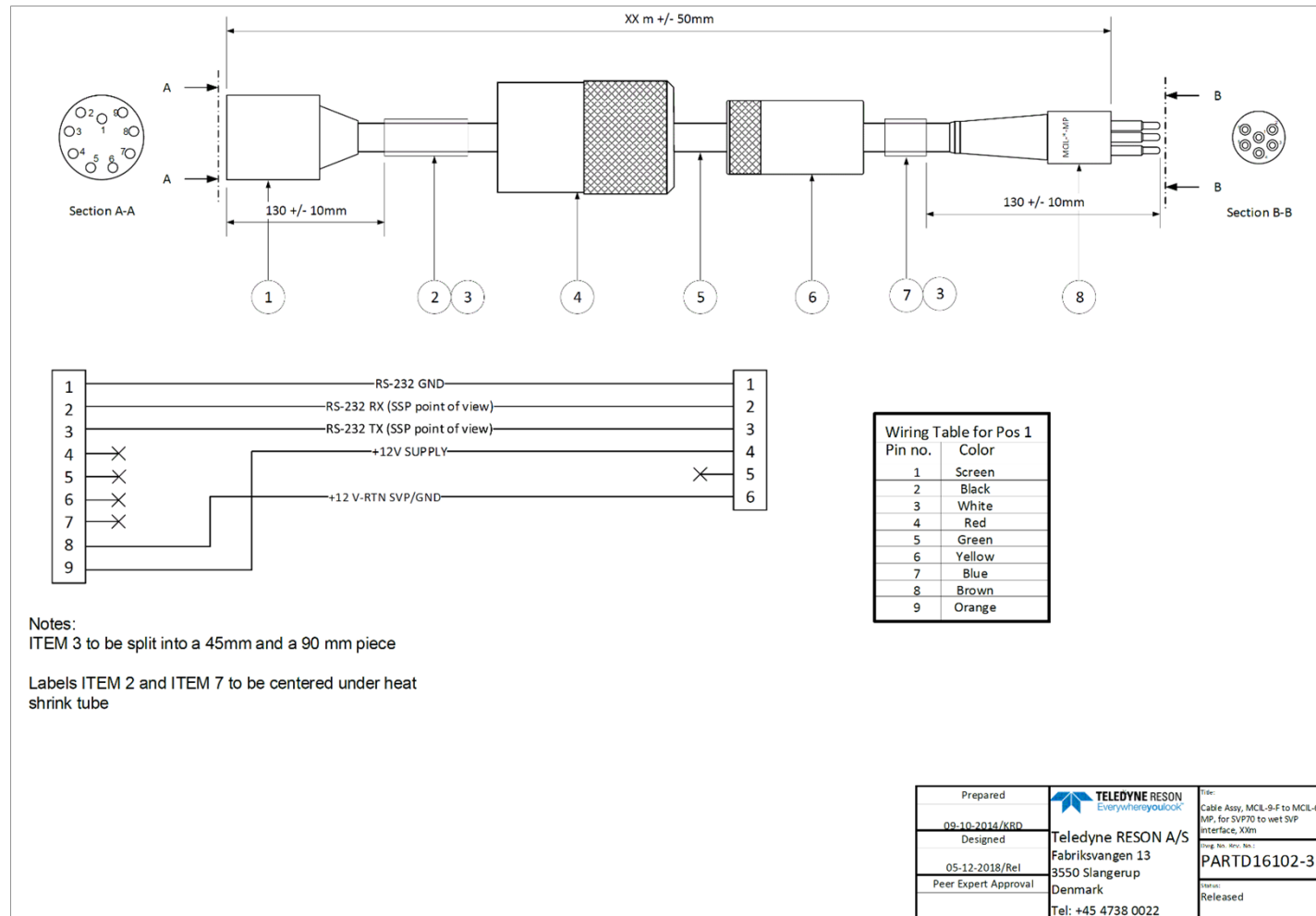


Figure 80: Cable Assembly, SSP to SVP 70 (optional)

F.2.13 Sonar Reference Point Definition

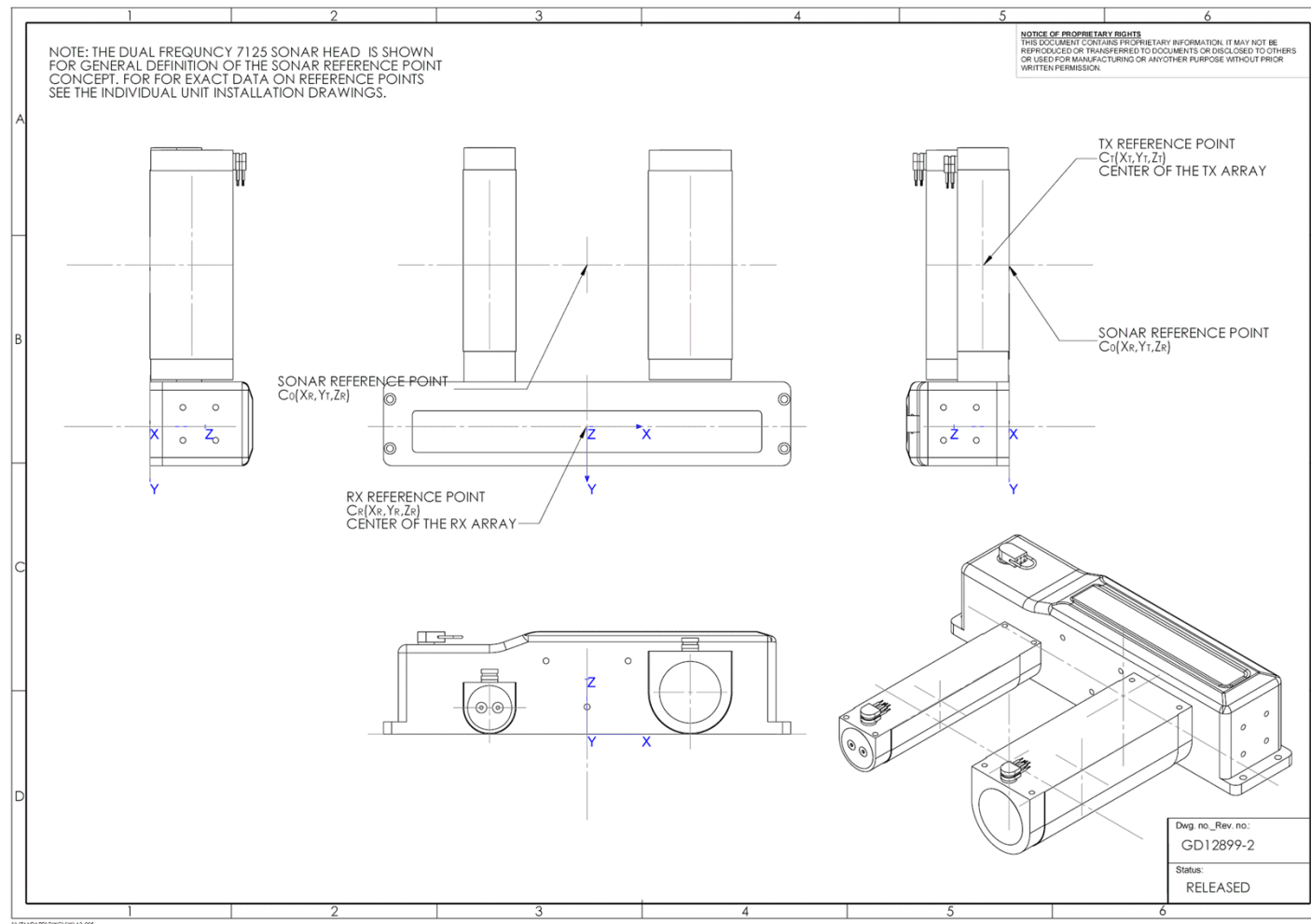


Figure 81: Sonar Reference Point Definition

F.3 7kCenter Licenses – Copyright Information

Table 24: LAPACK – Copyright Information

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APPENDIX G SEABAT T-SERIES SUBSEA SYSTEM OPTIONS

The following options are available with the SeaBat T-Series Subsea system. If you require more detailed information about any of these options, please contact Teledyne RESON Sales for assistance.

- Extended Warranty Contract
- SeaBat Cables
- Service Level Agreement
- Sound Velocity Probe
- System Integration and Training
- Teledyne PDS Data Acquisition Software
- Wet-end brackets (customized)

G.1 Extended Warranty Contract

All SeaBat T-Series Subsea systems are provided with a standard twelve-month warranty (see *Appendix H Standard Warranty Information*). This option provides the user with the possibility of purchasing additional annual support.

G.2 SeaBat Cables

Additional cables in various lengths are available for purchase.

G.3 Service Level Agreement

A Service Level Agreement (SLA) runs for annual terms of 12 months at a time, and covers a wide range of services as listed here:

- Annual system health check
- Backup system (availability depending on system)
- Factory refurbishment (preventive maintenance procedure)
- Product and software defect repair services
- Software and firmware updates
- Spare part allowance
- Telephone and email support

G.4 Sound Velocity Probe

To ensure proper beam steering, the sonar requires the input of the local sound velocity in the area of the transmitter and receiver arrays. The sound velocity probe (SVP) is used to continuously report this value to the processor unit.

The unit described below may be purchased from Teledyne RESON as an option, or a SVP of similar specifications may be supplied by the customer.

Table 26: SVP Technical Specifications

Specification	Value
Type	SVP 70
Sound velocity	Range: 1350-1800m/s Resolution: 0.01m/s Accuracy: ± 0.05 m/s (0-50m) Accuracy: ± 0.25 m/s (0-6000m)
Sampling rate	20Hz and lower, programmable
Depth	6000m
Baud rate	2400-115200
Supply	9-55VDC
Power	2W
Housing	Titanium
Dimensions	Diameter: 44mm (max) Length: 165mm (excl. connector) End cap height: 69mm (max)
Weight	1.0kg (excl. cable)
Temperature	-20° to +55°C

For further information, please refer to the appropriate manual.

G.5 System Integration and Training

Onsite installation, integration with a data acquisition system, calibration, and training of operating personnel are available from Teledyne RESON.

G.6 Teledyne PDS Data Acquisition Software

Teledyne PDS software provides a wealth of displays and data processing options. Configure the software on a separate computer and postprocess your data there.

For further information, please refer to the appropriate manual or <http://www.teledynemarine.com/pds>

G.7 Wet-End Brackets (customized)

Customized wet-end brackets are available from Teledyne RESON.

APPENDIX H STANDARD WARRANTY INFORMATION³⁵

H.1 One-Year Limited Warranty

Teledyne RESON warrants our systems against defects in materials and workmanship for a period of one year from the date of Teledyne RESON's original shipment, unless Teledyne RESON has offered an extended warranty.

During the warranty period, Teledyne RESON will, at its sole option, either repair, replace, or issue a credit for the original price of the defective system. Such repair, replacement, or credit shall be the sole remedy for a defective system. For full information about the warranty provisions, please refer to the section "Limited Warranty" in our General Terms and Conditions of Sale.

Teledyne RESON systems must be serviced by Teledyne RESON or one of Teledyne RESON's authorized service providers. Any return of nonconforming or defective systems is subject to Teledyne RESON's current return authorization process and procedures (see *section H.5 below*).

H.2 Warranty Exclusions

The warranty on Teledyne RESON systems does not apply to defects arising from:

- Improper installation, operation, or maintenance.
- Improper handling, storage, or transportation.
- Unauthorized modifications, alterations, or repairs.
- Failure to comply with Teledyne RESON's safety precautions.
- Accidental damage.
- Normal wear and tear.

H.3 Warranty Disclaimer

No warranties of merchantability or fitness for a particular purpose is intended or given.

H.4 Servicing During Warranty Period

If your system should encounter technical issues during the warranty period, please contact Teledyne RESON Support (see *section H.6 below*) to protect your warranty rights.

³⁵ Please refer to Teledyne RESON's General Terms and Conditions of Sale, available at <http://www.teledynemarine.com/reson/> > Terms and Conditions.

H.5 Equipment Return Procedure

Before returning any equipment for service, you must follow the Teledyne RESON equipment return authorization procedure stated below:

1. Contact Teledyne RESON Support (see *section H.6 below*) to obtain an approved Return Material Authorization (RMA) number. Equipment shall not be returned without Teledyne RESON's prior authorization.
2. Follow the instructions in the supplied document and pack the equipment in the original shipping containers.
3. Ship the equipment, transportation and insurance prepaid, according to the instructions issued by Teledyne RESON.
4. Ensure that the RMA number is included on all shipping documents and, most importantly, marked on the shipping container's address label.
5. Include a note which identifies the model or part number, and serial number (if applicable) along with a brief, but thorough, description of the problem.

H.6 Teledyne RESON Support³⁶

If you experience difficulties with your Teledyne RESON system, please contact Teledyne RESON Support for further instructions:

EUROPE

Tel: +45 20 999 088

e-mail: Marine-supportDK@Teledyne.com (Denmark)
Marine-supportGE@Teledyne.com (Germany)
Marine-supportNL@Teledyne.com (The Netherlands)
Marine-supportUK@Teledyne.com (United Kingdom)

UNITED STATES

Tel: +1 805 233 3900

e-mail: Marine-supportUS@Teledyne.com

Teledyne PDS support

Tel: +31 10 245 15 00

e-mail: Marine-supportNL@Teledyne.com

³⁶ Refer also to <http://www.teledynemarine.com/support>.



TELEDYNE RESON
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SeaBat T-Series Subsea Operator's Manual

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Document Number: OM16226-12
Part Number: 1009737