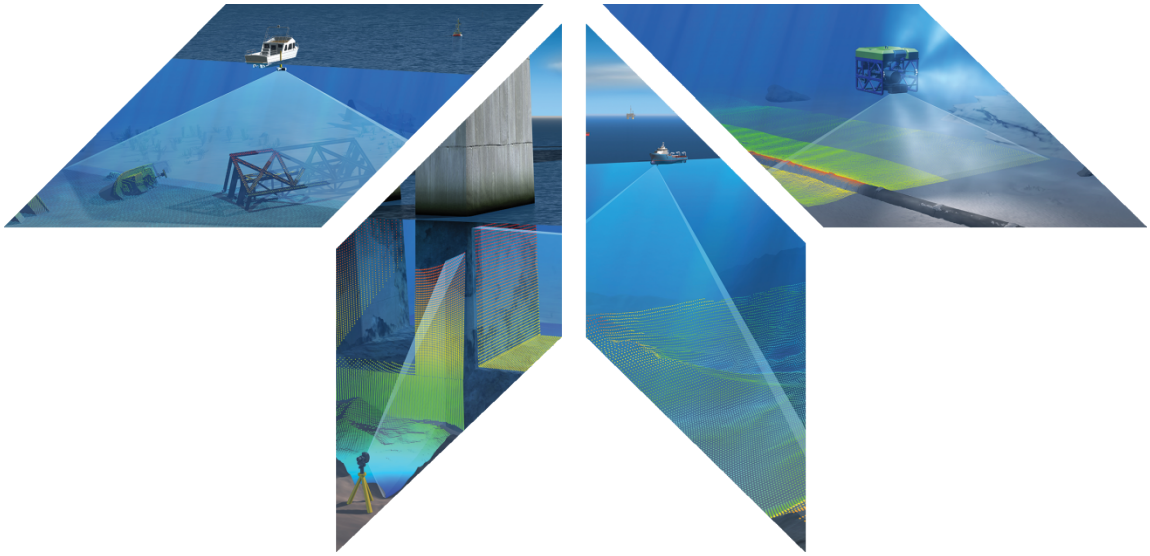
SeaBat T51-R

Product Description

Ultra-High Resolution Multibeam Echosounder



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System Overview

Introduction

The SeaBat T51-R is built on the shoulders of the SeaBat T50. With four times the resolution, the SeaBat T51-R introduces a revolutionary high-frequency band of 700-800kHz yielding the highest level of detail while maintaining a swath width of seven times water depth thereby improving the overall survey efficiency. In addition, SeaBat T51-R comes with a flexible 350-430kHz lower frequency range for the surveys requiring extended range performance.

The SeaBat T51-R is developed for users requiring ease of use but still demanding the highest quality data and a powerful feature set. It is based on a T-shaped transducer arrangement and Teledyne RESON's Rack-mounted Sonar Processor.

Typical Applications

Enhanced feature sets allow a great deal of flexibility from the SeaBat system and provide support for a wide range of applications including:

- As-built surveys
- Breakwater mapping
- Coastal mapping
- Environmental research
- Habitat mapping
- Harbor mapping and quay wall inspections
- Hydrographic surveys to IHO, LINZ, and U.S. Army Corps of Engineers requirements over the entire depth range
- Oil detection
- Pre- and post-dredging and condition surveys
- Revetment surveys
- River surveys
- Search and recovery
- Site clearance surveys
- Surface-based pipeline route and inspection surveys
- Underwater inspection and object location

Warranty

The SeaBat T51-R comes with a standard 3-year warranty.

System Architecture

SeaBat T51-R

The SeaBat T51-R is a highly integrated variable frequency sonar system designed with ease of installation and operation as a high priority. The system consists of:

- **Rack-mounted Sonar Processor (RSP).** The RSP is a powerful sonar processor designed to support wider swath with unprecedented data quality. It acts as a single point of interfacing for sonar and sensor data and precisely time stamps this data prior to broadcast over standard Ethernet connection to the survey PC/laptop. The RSP offers fully integrated Inertial Navigation System (INS) with no external sensors required. RSP is powered by 110-230VAC supplies.
- **TC2186** single broadband projector transducer
- **EM7222** single broadband receiver transducer
- Standard 25m cables run to the transducers (10m, 50m, and 100m optional).
- The Sonar User Interface is designed to run on the survey PC/laptop together with the hydrographic data acquisition software.
- Optional state-of-the-art built-in and fully integrated Inertial Navigation System (INS).

Figure 1: SeaBat T51-R

Sensor data may be interfaced to the **SeaBat T51-R** via four serial ports or Ethernet. Note that heading is not limited to a particular port; it may be interfaced via the motion or position port.

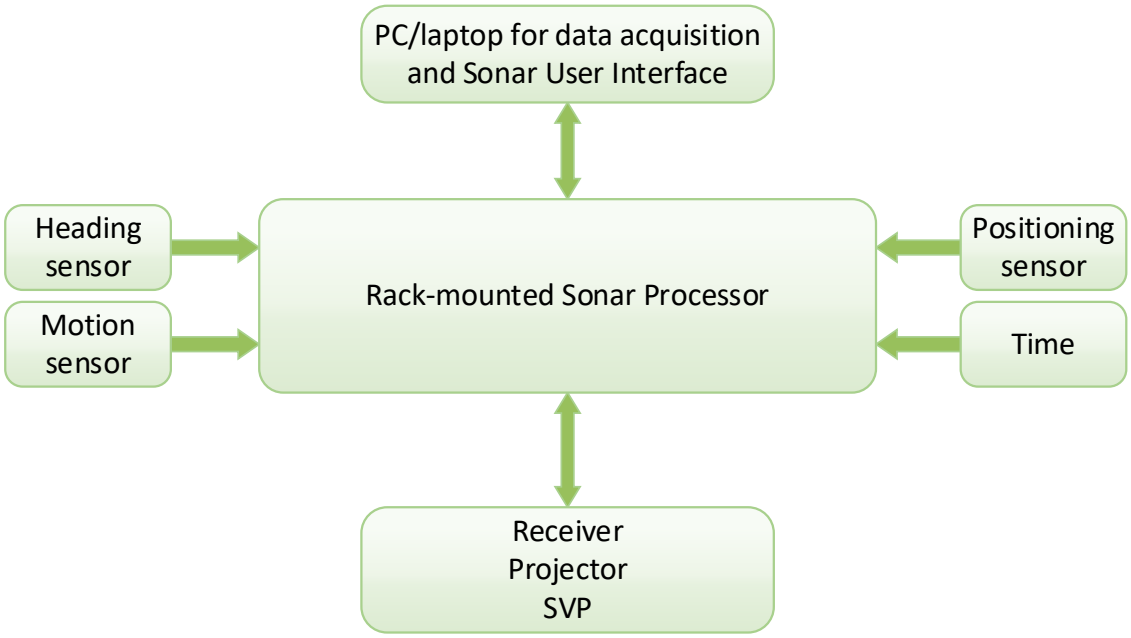


Figure 2: SeaBat T51-R System Architecture

Technical Specifications

Parameter	SeaBat T51-R low frequency	SeaBat T51R high frequency
Frequency	350-430kHz adjustable in steps of 10kHz	700-800kHz adjustable in steps of 10kHz
Across-track receive beam width[1]	0.5°	0.25°
Along-track transmit beam width[1]	1°	0.5°
Max. ping rate	50 pings/sec	
Pulse type	CW and FM	
Pulse length	30-300µs (CW); 300µs-5ms (FM)	
Number of beams	10-1024	
Max. swath angle	150° Equi-Distant; 170° Equi-Angle	
Depth resolution	6mm	
Data output	Bathymetry, snippets, side-scan, and water column backscatter, compressed water column, 7K data format, Gbit Ethernet	
Power requirements	100-230VAC 50/60Hz Up to 240W continuous load	
Transducer cable length	25m standard 10m, 50m, and 100m optional	
System depth rating	50m	
Temperature operating	Rack-mounted Sonar Processor: -5°C to +45°C Sonar wet end: -2°C to +36°C	
Temperature storage	Rack-mounted Sonar Processor: -30°C to +70°C Sonar wet end: -30°C to +70°C	

Table 1: Technical Specifications

[1] nominal values

Main Features

Feature	Description
High resolution	Dynamic beamforming with focusing at sample level maintains high resolution, even at short ranges. A receiver sample rate of up to 66kHz provides high range resolution and complements the narrow beam, thus providing the user with high data quality and resolution.
State-of-the-art beamforming	The beamformer performs initial signal processing: a combination of time delay and phase rotation techniques to maximize performance.
Variable frequency	Frequency may be selected between 430kHz and 350kHz in steps of 10kHz or between 800kHz and 700kHz (CW pulse), allowing the operator to choose the most appropriate frequency for the task. In FM mode, the maximum center frequency is 775kHz and the minimum 400kHz.
Beamforming modes	The operator is able to select from several beamforming modes (Equi-angle, Equi-distant, Intermediate, and FlexMode), all providing up to 1024 beams. Equi-Distant provides uniform data density across the swath and leads to greatest efficiency by minimizing overlaps, thereby reducing the number of lines required to survey any given area.
Constant seafloor spacing	Within each mode, the operator has full control over how many beams to form, ranging from high density (1024 beams) down to just a few beams. This produces highest detail where necessary, and allows improved efficiency in very shallow water by deploying fewer beams. Furthermore, the feature allows the operator to define the sounding spacing on the seafloor making the sonar automatically change the number of beams to maintain that spacing.
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. The bottom detection algorithm seamlessly uses amplitude- or phase detection, or a combination of both, for optimum results over all seabed types.
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 analyzes 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 accordingly, and the user may accept or reject it in the postprocessing stage. The process is fully automated to generate the cleanest possible data and speed up processing.
Beam 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 for optimal performance and thus speeds up processing time while reducing manual efforts.
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. Adaptive gates are under continuous development and the SeaBat T51-R utilizes the latest developed technology.
Roll stabilization	Dynamic roll stabilization may be selected for up to ±15° roll, ensuring that uniform coverage is maintained, independent of vessel motion. The use of roll stabilization increases survey efficiency by reducing the number of survey lines, thus reducing the vessel time required for a given survey area.

Feature	Description
Variable swath selection	The SeaBat system allows the swath angle to be adjusted dynamically 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, thereby minimizing processing time and costs by providing the cleanest possible data. Swath coverage may also be controlled automatically by the Tracker autopilot.
Electronic head tilt	The swath may be electronically steered to focus on and achieve optimal performance, coverage and data density over a particular area of interest.
Fast update	The entire swath is insonified 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 speeds.
Standard data output	The SeaBat system provides bathymetry, snippets backscatter, and side-scan 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.
Water column visualization and recording	The SeaBat system is capable of displaying and recording water column data for advanced scientific research. The water column data may be written to an optional external Network Attached Storage (NAS) drive.
Compressed water column	Incorporating intelligent and user configurable data reduction algorithms, the SeaBat T51-R can record water column backscatter data at significantly reduced data volumes, potentially allowing for continuous recording of compressed water column data (which due to the very significant data volume is challenging with traditional full water column data logging).
Tracker autopilot	Based on the reflectivity of the seabed the Tracker autopilot automatically optimizes all sonar settings. The Tracker maximizes the ping rate and optimizes other sonar settings for both bathymetry and backscatter data acquisition by ensuring that returning echoes are not saturated. The Tracker is designed to reduce operator workload and skill level requirements, and thus reduce risk of operator error.
Real-time QC display	The system generates a real-time sonar intensity image with bottom detection data overlaid for quality control. The user can verify bottom detection performance against the image display for confidence that the system is generating the highest data quality. The image display also allows the water column to be visible to the operator at all times.
Channel normalization	Channel normalization 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.
Hardware sync pulse out	A TTL pulse (synchronous with the transmit pulse) is available from the Rack-mounted Sonar Processor for synchronization purposes, allowing the system to be used simultaneously alongside a multitude of other acoustic systems.
External trigger	The system may be triggered using a standard 7K software remote command or by a TTL incoming trigger pulse, allowing the system to be used simultaneously alongside a multitude of other acoustic systems.
1PPS pulse handling and time stamping	Data time stamping of sonar data is referenced to an incoming 1PPS signal 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 data acquisition PC/laptop.

Feature	Description
Time stamping of sensor data	Data time stamping of sensor data interfaced to the Rack-mounted Sonar Processor (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 survey PC/laptop. With the optional built-in fully integrated INS, all time tagging will be handled by the INS.
Built-in-Test-Environment (BITE)	The Built-In-Test-Environment (BITE), an integral part of the sonar processing unit, monitors the status of the internal electronic sub-systems and transducers. The BITE function is designed to inform the operator that the system is performing normally and, therefore, that vessel time is being utilized effectively. In the event of any errors, the operator is informed immediately for prompt troubleshooting.
Processing architecture	State-of-the-art processing architecture based on the standard Microsoft Windows® environment ensures that genuine new features and productivity enhancements may be released over the life of the system in a user-friendly manner.

Table 2: Main Features

Optional Features

Feature	Description
FlexMode	FlexMode allows the operator to select an ultra-high density sector of beams and direct it anywhere in the swath, while maintaining full swath coverage. Equi-angular beams are formed inside the FlexMode sector, while the remaining beams are formed with equi-distant spacing at a user-defined sounding density. The width of the FlexMode sector is controlled by the operator. FlexMode is particularly useful in pipeline inspection surveys where the aim is to achieve maximum hits on the pipe.
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 is often encountered in marine environments, resulting in cleaner data. X-Range technology is also used when operating two SeaBat T51-R systems in Full Rate Dual Head mode – allowing simultaneous pinging and providing more than 1000 beams per ping without reducing the ping rate.
Real-time pipe detection and tracking	Real-time pipe detection and tracking automatically detects pipes within the multibeam swath, displays them in real-time during survey, and generates pipeline data deliverables directly from SeaBat. A special gating method focuses on the pipeline to improve the quality of detection of the pipe. The high-density sector produced by using FlexMode is automatically steered to the pipe ensuring very high data density on the object of interest.
Multi-detect	The multi-detect feature provides multiple detections within each beam to capture highly detailed images of complex objects in the water column while maintaining seabed coverage. Multi-detect can eliminate the need for storage and processing of water column data by mapping water column features (fish, kelp, oil etc.) in real time.

Table 3: Optional Features

Component Description

Overview

The standard SeaBat T51-R consists of the following components:

Component	SeaBat T51-R
EM7222 dual-frequency array receiver	✓
TC2186 broadband projector	✓
Rack-mounted Sonar Processor (RSP)	✓
Standard cable set	✓
Mounting bracket	✓
Shipping cases, software, manuals, and accessories	✓

Table 4: Main Components

The sonar system is operated from a commercial off the shelf, customer provided, survey computer/laptop.

Transducers

EM7222 Receiver

The EM7222 receiver unit is constructed with a grade 2 titanium housing on which the receive ceramics are mounted and protected by a polyurethane acoustic window. The EM7222 receiver is a dual-array unit that operates at multiple frequencies, 350-430kHz and 700-800kHz. It 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 designed specifically for this purpose.

Figure 3: EM7222 Receiver

Specification	Value
Dimensions	Height: 86.8mm Length: 460.0mm Depth: 102.0mm
Weight	Air: 8.7kg Water: 5.3kg
Temperature	Operation: -2° to +36°C Storage: -30° to +70°C
Note: Refer to outline drawings for tolerances	

Table 5: EM7222 Receiver

TC2186 Projector

The TC2186 transducer is a wideband, high performance single projector for the SeaBat T51-R system. The projector operates at multiple frequencies between 400 and 800kHz. The entire swath sector is illuminated in one transmission. It mounts to the vessel or mounting bracket with M8 Hex screws already in place in the projector. The cable connection is not exposed, as the design of the unit provides an integrated cable protection.

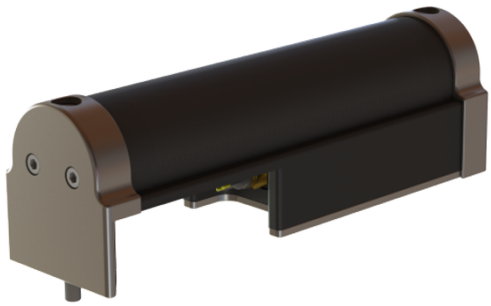


Figure 4: TC2186 Projector

Specification	Value
Dimensions	Height: 88.4mm Length: 280.0mm Depth: 79.0 mm
Weight	Air: 4.2kg Water: 3.0kg
Temperature	Operation: -5° to +36°C Storage: -30° to +70°C
Note: Refer to outline drawings for tolerances	

Table 6: TC2186 Projector

Rack-mounted Sonar Processor (RSP)

The Rack-mounted Sonar Processor (RSP) is a high-performance unit that manages data flow and signal processing using state-of-the-art FPGA processing architecture. This highly integrated design offers reliability, maintainability, and high performance in a small size.

The RSP offers 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 in a small form factor (2U) standard 19" rackmount, but is also equipped with non-slip rubber feet. The RSP performs the following functions:

- Receives digitized sonar data from the receiver.
- Receives operational settings running on a remote PC/laptop.
- Provides beamforming and initial processing of acoustic data.
- Controls, formats, and generates output data to external systems.
- Provides an interface and single point time stamping source for serial sensor data:
    - 1PPS and time recovery message (GNSS)
    - Position
    - Heading
    - Motion
    - Sound velocity sensor

Specification	Value
Dimensions	Height: 88 (2U)mm Width: 478mm* Depth: 462mm
Weight	12.3-13.8kg
Temperature	Operating: -5° to +40°C Storage: -30° to +70°C
Note: Refer to outline drawings for tolerances **Standard 19'' rack-mount*	

Table 7: Rack-mounted Sonar Processor

The rear panel houses standard PC type connectors for data such as time, position, motion, heading, and online sound velocity.

Selecting the optional and fully integrated INS (as depicted) will make time, position, motion, and heading readings immediately available via network and no additional interfacing will be required.

Figure 5: Rack-mounted Sonar Processor (front)

Figure 6: Rack-mounted Sonar Processor with integrated INS (rear)

Sonar User Interface

The Sonar User Interface (SUI) provides the user with a means of configuring and controlling the sonar system together with a number of displays for monitoring data. Each pane within the user interface shows a different aspect of sonar data. The example below shows the main sonar wedge display (top left), real time water column visualization (bottom left), side-scan backscatter (top right), and snippets backscatter (bottom right). Each pane may be enabled or disabled according to operator preference.

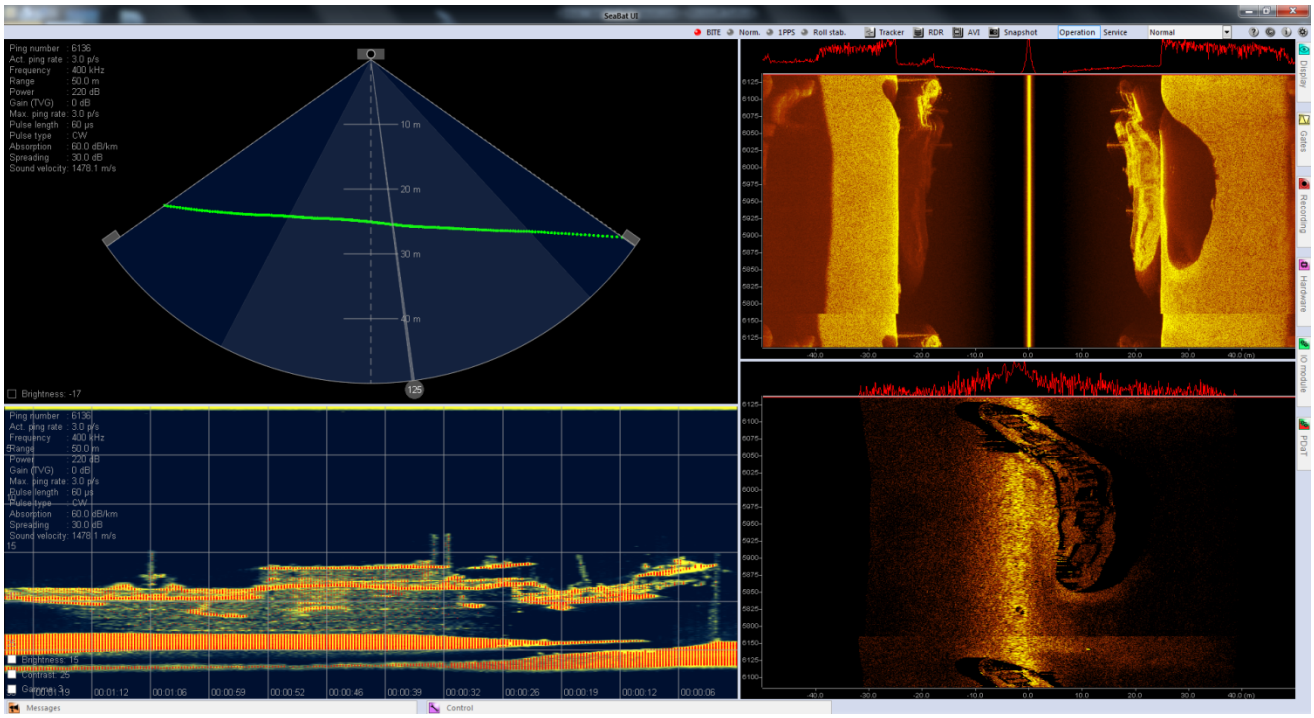


Figure 7: Sonar User Interface

Built-In-Test Environment (BITE)

BITE is an integral part of the SeaBat system and provides the operator with continuous monitoring of critical temperatures, voltages, and communications status. BITE is implemented on several modules within the system and provides immediate information on the system status. Depending on the particular system, a number of parameters are monitored and presented to the operator through the BITE tab on the SUI.

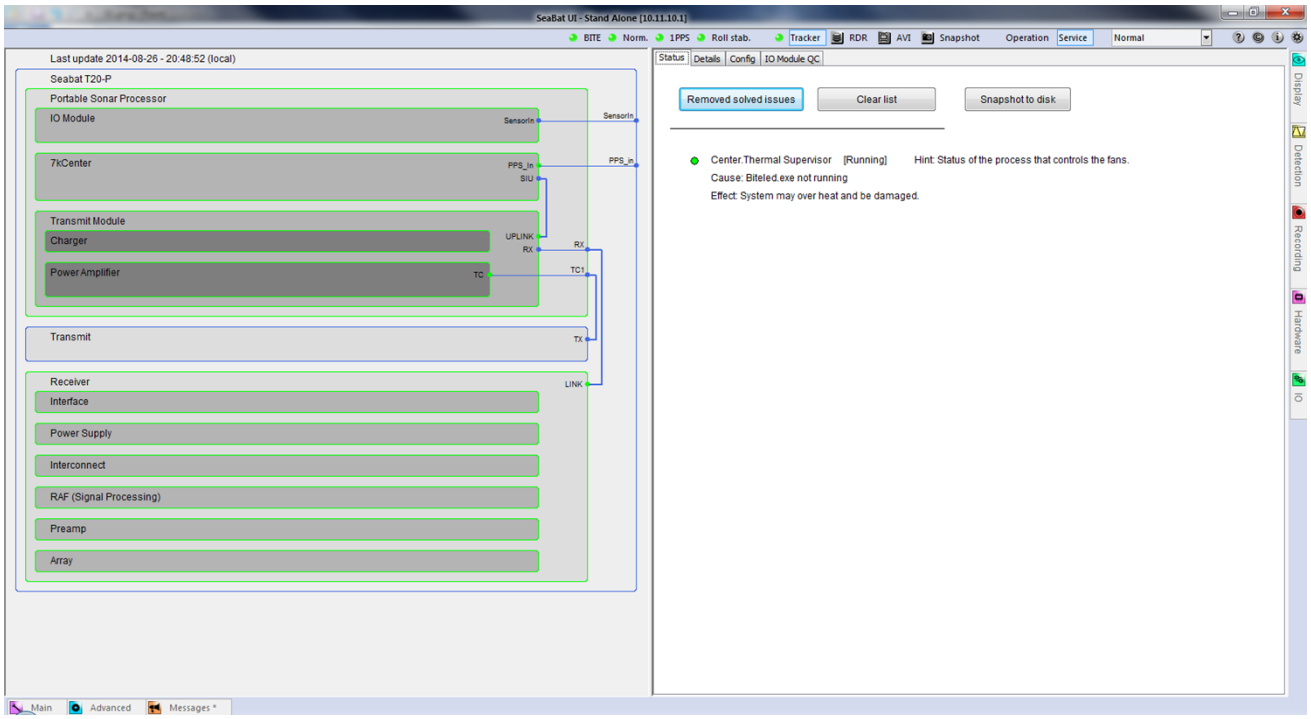


Figure 8: Built-In-Test-Environment (BITE)

An out-of-tolerance parameter turns the appropriate module or connection to red on the block diagram and, when clicked, provides detailed information to the operator on the right-hand pane. The BITE pages can also be used to verify an installation, firmware update or to diagnose installation problems. For instance, if no wedge display is present after software start-up, checking the BITE pages can help localize the failure. If a firmware update is done in the field, the BITE page is useful for verifying that the new version has been accepted.

Standard Data Products

The SeaBat system is capable of producing several types of data during normal survey operations which may be logged on or broadcasted from the sonar software over Gigabit Ethernet using UDP or TCP/IP protocols.

- Bathymetry
- Snippets backscatter
- Side-scan backscatter
- Water column backscatter

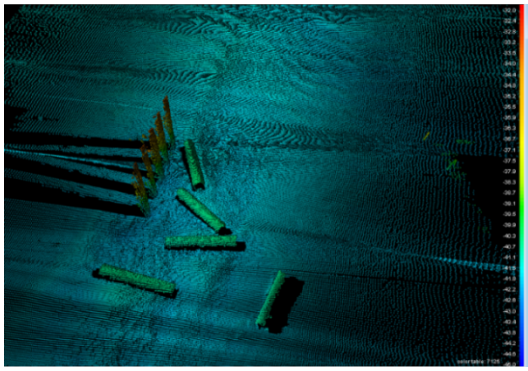


Figure 9: Bathymetry

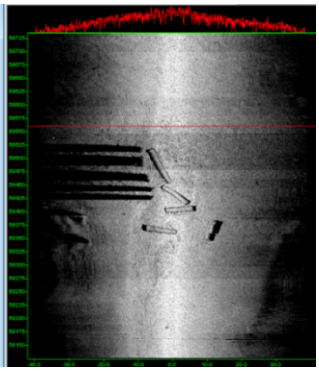


Figure 10: Snippets

Bathymetry

The SeaBat generates a number of equi-angle or equi-distant bathymetry soundings per ping and broadcasts them from the sonar software 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. 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.

Snippets Backscatter

The intention of snippets is to capture backscatter specifically from the seabed, or any feature detected by the bathymetry. Each beam has a snippet packet (or window), which is centered at the beam's bathymetric point, and is designed to cover the beam footprint: it may be convenient to think of a snippet as a backscatter record across the beam footprint. When the snippet packets for all beams are stitched together and geo-referenced, the result is the complete snippets record for the swath: a continuous record of backscatter across the seabed.

Side-scan Backscatter

Side-scan forms an image of the sea floor which can be used to locate and identify features and bottom conditions. Each sonar ping is used to generate a line of data. Each line contains a series of amplitudes representing the signal return versus time or range. When a series of these lines are combined and displayed as the vessel moves along the track, a two-dimensional image is formed, providing a detailed picture of the bottom along either side of the vessel.

Water Column Backscatter

The SeaBat system produces and displays water column backscatter in real time during survey. The data may be logged at full ping rate for advanced applications such as wreck investigation or marine research. The addition to being used for advanced applications, the water column image may be used to quality control the bottom detection performance.

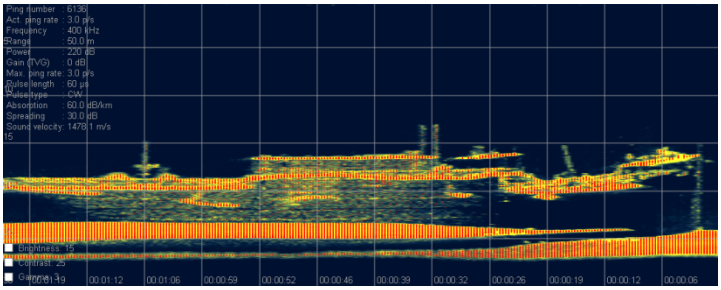


Figure 11: Water Column

Optional Data Products

The SeaBat system is capable of producing additional application specific data products to enhance survey deliverables. The optional data products are

- FlexMode
- Multi-detect
- Real-time pipe detection and tracking
- X-Range

FlexMode

FlexMode is a combination of ultra-high density and standard density beams optimized for pipeline and cable work, or any other application requiring a combination of wide swath and a high density sector for detailed mapping. The user sets the seafloor spacing between equi-distant soundings for the full swath and then all remaining beams are concentrated into a narrow equi-angle sector which may be steered anywhere within the swath.

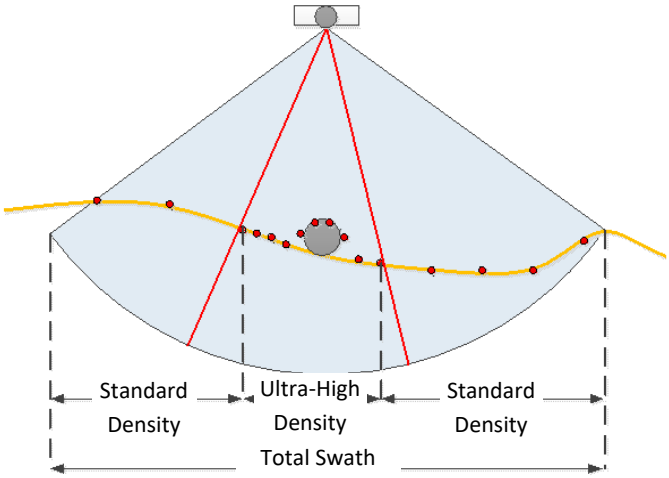


Figure 12: FlexMode Principle

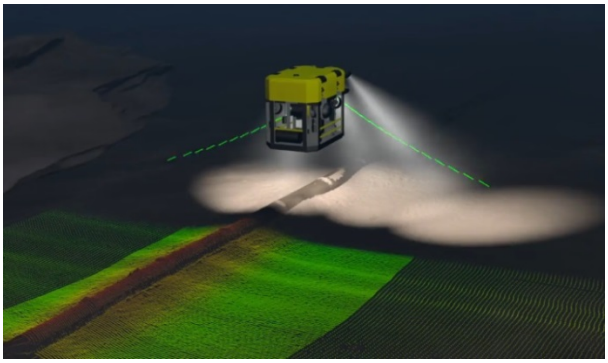


Figure 13: FlexMode Example

Multi-Detect

The multi-detect 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, multi-detect reduces the need for collecting large water column sets. Typical applications for multi-detect include wreck surveying, submerged oil, marine life, and habitat mapping.

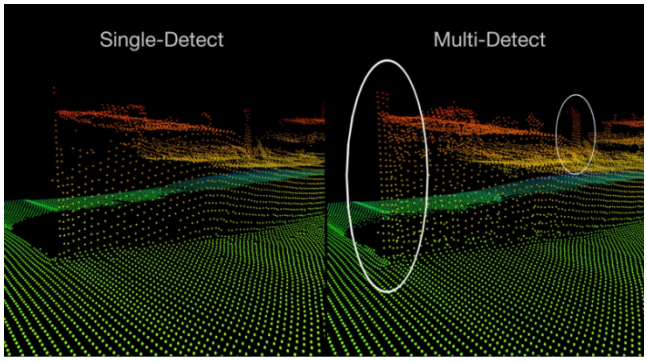


Figure 14: Multi-Detect – Wreck Survey

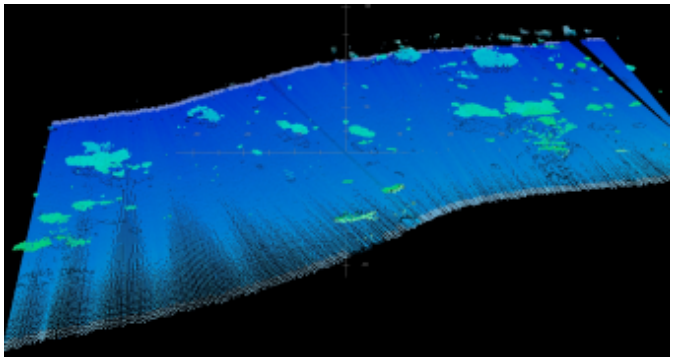


Figure 15: Multi-Detect – Submerged Oil

Real-Time Pipe Detection and Tracking

Real-time pipe detection and tracking automatically detects pipes within the multibeam swath, displays them in real time during survey, and generates pipeline data deliverables directly from SeaBat. A special gating method focuses on the pipeline to improve the quality of detection of the pipe. Note that FlexMode is supplied automatically with this feature.

The data output follows the 5-point standard format:

- Top of pipe position and depth
- Adjacent seabed depths
- Mean seabed depths

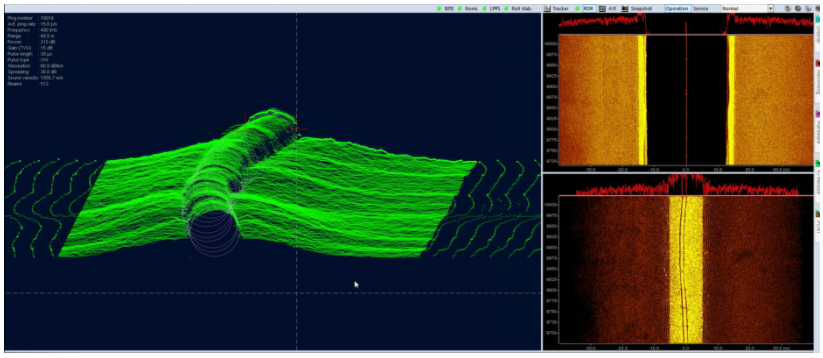


Figure 16: Real-Time Pipe Detection and Tracking

X-Range

X-Range is a feature which provides extended range performance and also significantly improves system immunity to external noise. The basis of X-Range is a frequency-modulated transmission combined with advanced signal processing techniques to extract the maximum possible performance from the system. On average X-Range provides 25-30% additional swath coverage; however, this varies with depth and frequency. Refer to *System Performance*.

System Performance

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.

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 T51-R provides the following depth performance over a swath angle of up to 170°:

	350-430kHz	700-800kHz
Typical depth (CW)	0.5m-200m	0.5m-85m
Max. depth (CW)	300m	125m[2]
Typical depth (X-Range)	0.5m-225m	0.5m-85m
Max. depth (X-Range)	350m	150m[2]

Table 8: SeaBat T51-R System Performance[3]

The graphs below show swath width in relation to depth for both standard and optional X-Range modes.

NOTE: Sonar performance is highly dependent upon environmental and installation conditions which may adversely affect achievable swath width. The performance graph is indicative of performance under typical conditions of 10°C and salinity of approximately 30ppt. The installation used is assumed to have no adverse effect. Increasing flow noise, bubbles, engine / drive-train noise, and vibration may all contribute to reduced performance.

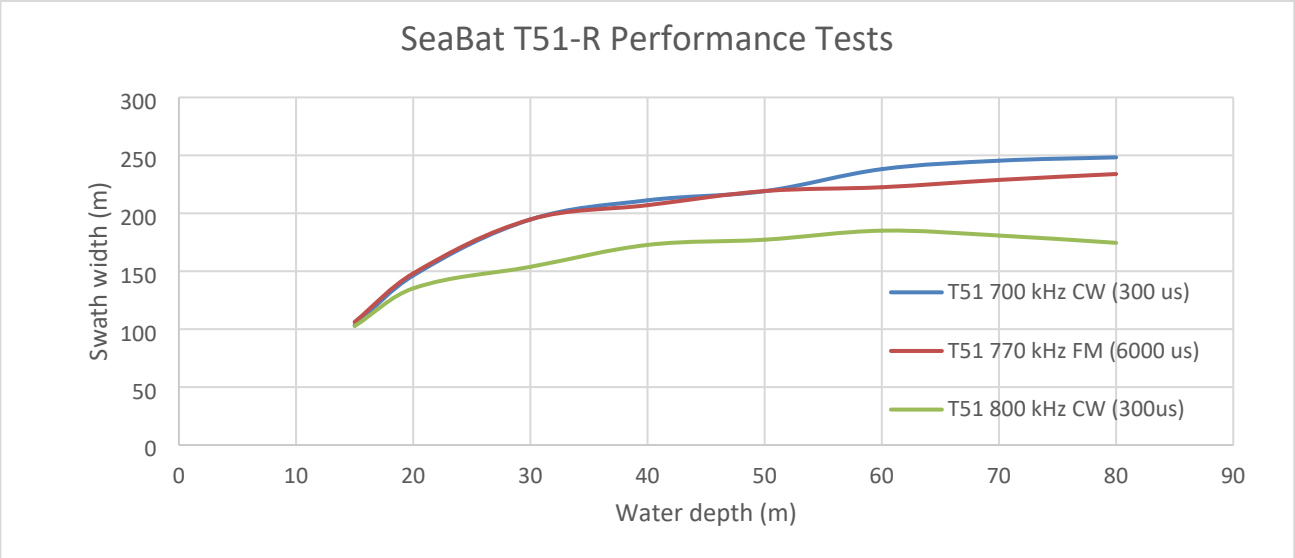


Figure 17: SeaBat T51-R 700-800kHz Performance Results

[2] Estimated

[3] Note that the values stated for "typical" refer to the range of depths over which the system is normally expected to be operated. It consists of the minimum depth to a depth corresponding to 50% of maximum swath. Max depth is a single value corresponding to the depth at which the swath is reduced to 10% of its maximum value.

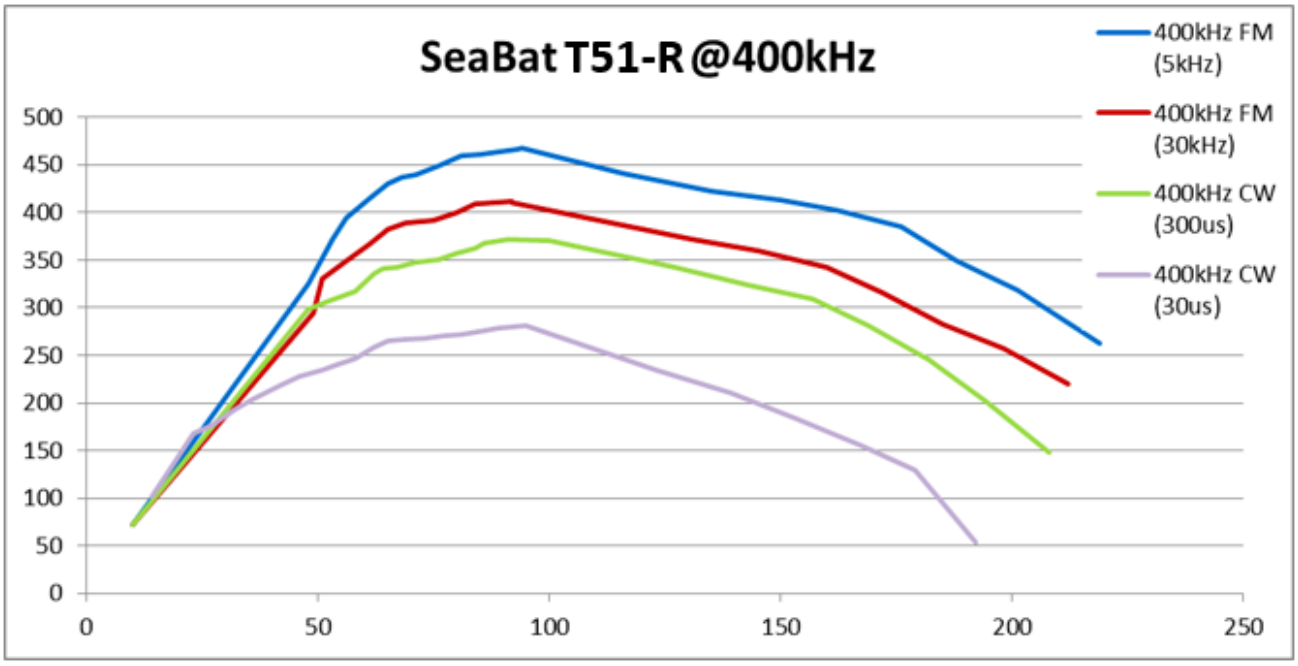


Figure 18: SeaBat T51-R 400kHz Performance Graph

Installation

Sonar Head Assembly

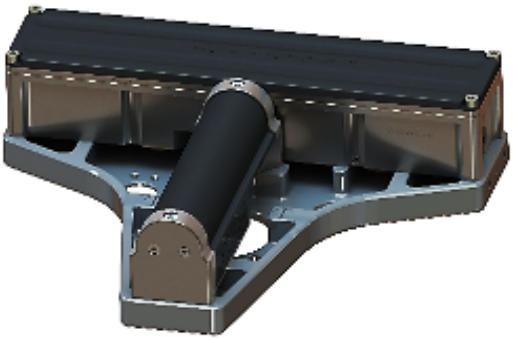


Figure 19: SeaBat T51 in Mounting Bracket

It is recommended that the SeaBat T51-R be mounted in Teledyne RESON's standard mounting bracket delivered with the system. This provides a stable assembly with a standard flange interface to a mounting assembly on the vessel or vehicle.

The sonar head assembly should typically be mounted with the faces of the arrays oriented vertically downwards. The receiver is mounted across track, while the projector is mounted along track and aft of the receiver.

If necessary, the projector may be oriented forward or the sonar head assembly rotated away from vertical, however allowances must be made in the setup and data acquisition software. In addition, an alternate mounting makes the head more susceptible to impact damage and collection of trailing debris.

Mounting Bracket and Hydrodynamic Fairing

Figure 20: SeaBat T51 in Mounting Bracket with Fairing

The sonar head assembly is not designed to be hydrodynamic and at speeds in excess of two knots, vibration and oscillation may become evident, if the projector and receiver are not rigidly mounted.

Fairings will improve hydrodynamic performance by reducing drag and keeping a laminar water flow around the receiver and projector arrays. Teledyne RESON generally recommends the use of the optional fairing – especially on moon pool and over-the-side pole installations where the fairing will reduce the drag on the sonar head by up to 35%.

You may enquire about hydrodynamics and fairings at your local Teledyne RESON office or Reseller.

Installation

Mounting on a surface vessel may be over the side, over the bow, through a moon pool, or directly on the hull. The sonar head assembly should be immersed in water to a depth of at least 0.8 m to ensure that noise from the surface (waves) and turbulence generated by the mounting structure do not degrade performance. The depth should also be sufficient to avoid shadows from the keel, hull, or other obstacles. Cable length between the RSP and transducers is 25m standard with 10m, 50m, and 100m options. Take care that the sonar head assembly is electrically isolated from the structure to avoid corrosion problems.

System Options

Options available for the SeaBat system include:

- Additional or shorter/longer SeaBat cables
- Hydrodynamic fairing
- Integrated INS
- Service Level Agreement
- SVP 70 Sound Velocity Probe
- System integration and training

Additional SeaBat Cables

You may purchase additional standard length cables (10m, 25m, 50m, or 100m) from your Teledyne RESON office or Reseller.

Hydrodynamic Fairing

Hydrodynamic fairings reduce the drag on the sonar, and consequently on the installation, significantly. Hydrodynamic simulations show drag reduced by up to 35% at 10 knots – simply by installing a hydrodynamic fairing.

Inertial Navigation System

The Rack-mounted Sonar Processor can also be configured with a fully integrated Inertial Navigation System for accurate sensor time tagging and motion stabilization. The INS uses GPS for position and time, and IMU for measuring roll, heave, and acceleration. The INS generates True Heave output and is fully compliant with Applanix POSPac MMS.

	INS Type-20	INS Type-30
Internal INS	✓	✓
External IMU Type-20	✓	
External IMU Type-30		✓
IMU Wet-end cable	✓	✓
2 GNSS antennas	✓	✓
2 Antenna cables	✓	✓
Roll/Pitch	0.02°	0.01°
Heading[4]	0.015°	0.010°
Heave[5]	5cm/5%	5cm/5%
TrueHeave[5]	2cm/2%	2cm/2%
Fugro MarineStar (optional)	✓	✓

[4] With a 4m GNSS baseline
[5] Whichever is greater for periods of ±20 seconds

Service Level Agreement (SLA)

A Service Level Agreement (SLA) is designed to prolong the life of your multibeam system and minimize operational downtime resulting from accidental damage or breakdown. An SLA runs for annual terms of 12 months at a time, and covers the services listed in points below.

- Annual system health check
- Backup system
- Factory refurbishment
- Product and software defect repair services
- Software and firmware updates
- Spare part allowance
- Telephone and email support

SVP 70 Sound Velocity Probe

To ensure correct beam steering, the sonar requires the input of the local sound velocity at the transducers. A sound velocity probe (SVP) continuously reports this value to the sonar processor. The SVP 70 described below may be purchased from Teledyne RESON as an option, or an SVP of similar specifications may be supplied.

Specification	Value
Sound velocity	Range: 1350-1800 meters per second Resolution: 0.01m/sec Accuracy: ±0.25m/sec Sampling rate: 20Hz (programmable)
Depth rating	6,000m (operational)
Ultrasonic transmitter	Frequency: 2MHz (nominal)
Cable length	25m (typically same as transducer cables)
Connector	Birns MCBH9MTT* (Titanium)
Data interface	True RS-232 and True RS-422 (MCBH9M) Baud rate 2400-115200 Standard setup RS-232 configured as 9600,n,1
Operating temperature	-20 to +55°C
Power consumption	150mA at 12V
Operating power	9-55VDC
Housing	Titanium
Weight	Approx. 1kg (excluding cable)
Dimensions	Tube diameter: 44mm Length: 165mm (excluding connector) End-cap height: 69mm (maximum)

Table 9: SVP 70

Figure 21: SVP 70

System Integration and Training

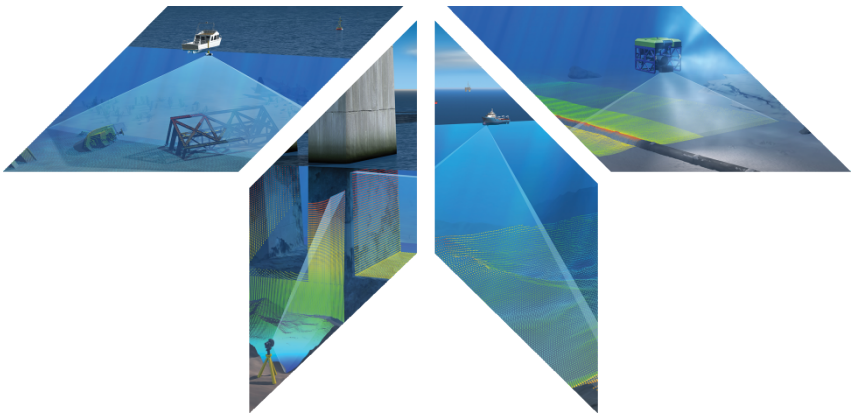
Teledyne RESON Engineering Services offer a wide range of services and products customized to meet your project requirements which are designed to ensure that your systems are installed, integrated and commissioned for ultimate performance and quality. The following services are offered:

- Acceptance tests
- Certified training
- Installation design
- Installation support
- Project engineering
- Modular training
- Mounting fabrication
- Sensor offsets and alignments

Figure 22: Training Program

SeaBat T51-R

Product Description



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