Appendix VII

Final Report: Scientific echosounder review for instream tidal turbines

Final Report: Scientific Echosounder Review for In-Stream Tidal Turbines

Prepared for: Offshore Energy Research Association of Nova Scotia

Prepared by: John K Horne, University of Washington

Service agreement: 190606

Date submitted: August 2019

Objectives:

The overall goal of this exercise is to evaluate features and performance of current and future scientific echosounders that could be used for biological monitoring at in-stream tidal turbine sites. Specific objectives include:

1. Reviewing literature for desired characteristics of scientific echosounders used in marine renewable energy monitoring applications.
2. Communicating with scientific echosounder manufacturer representatives to confirm current and future performance features of scientific echosounders.
3. Evaluating and reporting findings.

Introduction and Overview

Environmental monitoring is a required component of Marine Renewable Energy (MRE) licensing and operations throughout the world. Biological monitoring at instream tidal sites is the most challenging of all MRE industry sectors due to challenges associated with sampling. Biological monitoring at MRE sites is constrained by hydrodynamics that limits traditional sampling (i.e. nets) due to high water flow velocities and remote sensing (i.e. active acoustics) that is constrained by entrained air and turbulence. As a result, little historical data are typically available to characterize biological constituents, and the choice, timing, and deployment of monitoring equipment requires additional planning compared to less dynamic environments.

The primary challenge when choosing any remote sensing instrument is maximizing the signal to noise data ratio. This generic statement has three relevant components when using active acoustics to monitor aquatic animals at instream tidal sites: near boundary interfaces, target resolution, and target detection (i.e. false targets). Returned or backscattered energy (i.e. echoes) from animals (e.g. fish, macrozooplankton) close to any interface (e.g. surface, bottom) may coincide with strong reflections from the interface. Integration of backscatter from the interface will lead to large overestimates of aquatic animal densities (MacLennan et al. 2004; Totland et al. 2009). To minimize bias due to interface inclusion a layer close to the interface is excluded from the integration (often called the acoustic deadzone). To compensate for the exclusion of targets within the acoustic deadzone, echo intergrals are positively scaled by a correction factor to compensate for targets that were not included in the echo integrals (e.g. Ona and Mitson 1996; Lawson and Rose 1999; McQuinn et al. 2004).

The extent of the acoustic deadzone can be minimized by reducing the duration of the transmitted acoustic pulse. Reduction of the pulse duration also maximizes the resolution of detected targets. The extent of the deadzone is determined by the sound speed c multiplied by the pulse duration τ divided by 2 (i.e. $c\tau/2$). For a given c and τ, the backscattered energy from an interface will overlap that from any target less than a range of $c\tau/2$ from the interface. A short pulse duration also has the advantage of maximizing the resolution between any two targets. To resolve any two targets at slightly different ranges from a transducer (R_1, R_2), the range

difference (i.e. R_2 - R_1) must exceed half the pulse duration to be resolve the two targets as single echoes.

The challenge of detecting focal from unwanted acoustic targets is exacerbated at MRE tidal turbine sites. Anything with a density different than water will reflect sound energy. These reflections will include energy from entrained air bubbles and water turbulence, two features commonly encountered around tidal turbine devices. Two strategies are available to minimize detections from unwanted targets: avoid resonance frequencies of entrained air bubbles, and maximize signal-to-noise ratios (SNR) of backscattered energy using wideband signals and matched filters. Backscattered energy from air bubbles at or near the resonant frequency can equal that backscattered by fish at the same frequency but in the geometric scattering region. The backscatter region of a target depends on the target dimensions L (and material properties) relative to the acoustic wavelength λ. If the L/λ ratio is close to 1, then the target falls within the resonance backscattering region. For a spherical target (e.g. air bubble) the backscattered energy increases approximately as the square of the sphere radius (Simmonds and MacLennan 2005). When the target is much larger than the wavelength (e.g. a turbulent or density front), the energy is reflected at the same angle of incidence. The acoustic resonance frequency of an air bubble can be found using the Minnaert (1933) equation where resonance is a function of the bubble radius *a*, the polytropic coefficient γ (i.e. expansion and contraction coefficient), ambient pressure p_A, and the density of water ρ.

$$f = \frac{1}{2\pi a}\left(\frac{3\gamma p_A}{\rho}\right)^{\frac{1}{2}}$$

This equation can also be used to estimate the resonant frequency of a bubble cloud with *a* as the bubble cloud radius and ρ the density difference between water and the bulk density of the bubble cloud (Greene and Wilson 2012). As an approximation under typical water conditions, this equation simplifies to $fa \approx 3.26$ ms^{-1}, where *f* is the bubble resonant frequency. In practice knowing the distribution of bubble radii to then estimate bubble resonant frequency is rare. Bubble resonant frequencies typically range from hundreds of Hertz (Hz) to a few kilohertz (kHz). This contrasts to a range of scientific echosounder operating frequencies spanning 10's to 100's of kHz.

The ability to detect a target depends on the backscattered energy (i.e. echo) from the target being larger than the ambient noise level. Five different approaches can be used to maximize the probability of a received echo: increase source level; reduce range to targets; match transmit frequency to intended target resonance peak; increase SNR; and process data to remove noise. If the source level (i.e. power) of a signal is increased, then amplitude of returned echoes from all ambient noise is also increased and target detection may not be improved. Echo amplitudes can be increased by reducing the distance between the transducer and intended targets. This strategy may be possible at tidal turbine sites using bottom mounted instrument packages. As described

above, all targets have a resonant frequency. For fish this frequency is in the 110s of Hz to a few kHz range. This frequency range requires very large transducers, which introduces operational constraints and may also conflict with legislation and/or regulations imposed to protect marine mammal hearing (e.g. US Marine Mammal Protection Act 1972).

The most advantageous way to increase echo amplitude SNR from aquatic organisms is to combine broadband transmit signals with matched filters on the received echoes. Broadband pulses are frequency modulated (FM) where the transmit energy is distributed across a band of frequencies. Categories of broadband pulse types include linear (e.g. up and down sweeps) or nonlinear (e.g. parabolic, exponential) over time. These signals are often called 'chirp' signals as they sound like the chirp of a bird when played through a speaker. Broadband pulses consist of several cycles over the frequency bandwidth of the instrument but the energy within the pulse is not distributed evenly across all frequencies. The strategy of increasing target resolution by reducing pulse duration (see above for details) will reduce the overall SNR at long ranges as the total energy within each pulse will result in lower amplitude echoes. To balance the tradeoff between high target resolution and low SNR, broadband FM chirp signals are often combined with a matched filter that results in a pulse compression and maximizes the SNR. Matched filtering is a demodulation technique with linear time invariant filters (Van Vleck and Middleton 1946) in environments with stochastic additive noise. The matched filter delays frequencies within the transmit signal so that the pulse is compressed in time and increased in amplitude (Erhenberg and Torkelson 2000). The resulting pulse duration τ is a function of the bandwidth BW of the frequency range ($f_2 - f_1$):

$$\tau = \frac{1}{f_2 - f_1} = \frac{1}{BW}$$

The resulting SNR amplitude ratio gain is proportional to the square root of the number of independent samples in the coded signal (Clay and Medwin 1997). A conservative estimate results in a 15 dB gain over a comparable continuous wave transmit pulse (Ehrenberg and Torkelson 2000).

The final approach to increasing echo amplitudes of acoustic targets is to process the backscatter data to remove noise. Ambient noise removal can be achieved by increasing the noise threshold so that only targets with a minimum acoustic size are processed, include an ambient noise filter, mask unwanted targets, or extract targets from within noise features. A noise threshold will filter all backscattered energy below an analyst-chosen. The challenge is to choose the appropriate threshold to exclude unwanted targets. Many equations are available that have used empirical data to quantify relationships between acoustic size (i.e. echo amplitude) and animal size, typically indexed using animal length. The standard form of the equation to convert acoustic size, measured as Target Strength (TS, units dB) and fish body length (L, units m) is:

$$\mathrm{TS} = m \log \mathrm{L} + b$$

where the slope *m* and intercept *b* are constant for a given species. A large effort has gone into determining *m* and *b* values for many groups of fishes (e.g. see Tables 6.3 – 6.6 in Simmonds and MacLennan 2005). Values of *m* generally range between 18 and 30 while *b* values can range from the -80s to -50s depending on species and life history stage.

Development of acoustic data processing software (e.g. Echoview, LSSS, SonarX) has increased the number of filtering techniques available to remove unwanted targets. A variety of techniques have been developed to remove noise (e.g. Korneliussen 2000; DeRobertis and Higginbottom 2007; Ryan et al. 2015) and isolate target groups (e.g. Sato et al. 2015). As one example, a bitmap mask can be applied to the data to isolate targets of interest. A bitmap mask changes the sample value to an arbitrary value (e.g. -999) for samples that do not meet the filter criteria, while leaving data values corresponding to true values unchanged. When bitmap mask(s) are applied to backscatter data, only intended targets remain in the modified data file. The final approach (Fraser et al. 2017) uses multifrequency acoustic data to delineate turbulent regions and then extracts biological targets from within these regions.

Technology Assessment Rubric

See attached file 190225 Technology Assessment Rubric jkh.xlsx

Echosounders to Eliminate from Consideration

Kaijo/Sonic: scientific market not a large part of business plan, limited support for instruments

Furuno: No active instrument development at this time

Imagenix: very limited support for instrument, limited use on alternate platforms

Summary and Recommendations

Instrumentation Category:	**Echosounders**
Prepared By:	Dr. John Horne
Affiliation:	University of Washington; School of Aquatic and Fishery Sciences
Completion Date:	8/21/2019

***Best-in-Class* Instrument(s) recommendation(s):**

Recommended best-in-class echosounder is the Kongsberg – Simrad EK80 scientific line of echosounders. EK80 echosounder models include the EK80, WBAT, WBT Mini, and the WBT Tube. All of these echosounders are built using a common architecture with shared design features: actively transmit in continuous wave (i.e. CW) or wideband mode and 'listen' in passive mode on 4 or 8 channels using singlebeam and/or splitbeam transducers. There are also differences among models that target different deployment strategies. The WBAT and WBTmini can be controlled using EK80 software and have an autonomous operation mode using the Mission Planner software. The WBAT and WBT Tube are housed in a pressure container rated to 1000 or 4000 metres. See Table X for a comparison of model options.

Approaches to the physical use of the instrument:

Multiple housing configurations enable multiple deployment strategies with this line of echosounders. The EK80 is designed for traditional vessel deployment with transducer(s) mounted in the hull, on a pole mount, or on a towbody. The WBAT pressure-rated housing is designed for autonomous deployments on moorings or in bottom instrumentation packages, while the WBT Tube are designed for alternate platform deployments on ROVs or AUVs with an external power supply. The WBT Mini configuration can be placed in a pressurized housing (e.g. underwater glider) or mounted in a small footprint package for surface deployments.

Other key considerations:

The combination of packaging flexibility, transmission pulse types, processing software options, and international community vetting make this current generation of Simrad echosounders the default choice for Marine Renewable Energy (MRE) applications.

Software and data processing considerations for *best-in-class* instrument:

The EK80 acquisition software is common among these echosounder models (and common to all Simrad sonars). The Mission Planner software is used with the WBAT and optionally with the WBT Mini. Data processing for all of the EK80-based echosounders can be completed using commercial software packages including: Echoview (www.echoview.com), LSSS (https://www.marec.no/products_iwf.htm), SonarX (http://folk.uio.no/hbalk/sonar4_5/), and recently developed open-source software ESP3 (https://sourceforge.net/p/esp3/wiki/ESP3/) and Matecho (https://org.uib.no/wplib/PREFACE%20Lanzarote2018%20S4%20P%20Perrot.pdf). For active acoustic data acquired at MRE site deployments, the most common processing software used is Echoview, followed by LSSS.

Key Literature Reviewed for Future Reference

Additional Information Sources

Jeff Condiotty Simrad (Jeff.Condiotty@km.kongsberg-us.com)
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Tim Acker BioSonics (TAcker@BioSonicsInc.com)
Jan Buermans and Steve Pearce ASL (jbuermans@aslenv.com, spearce@aslenv.com)

Appendices (if applicable)

See manufacturer specification sheet or
https://www.simrad.com/www/01/NOKBG0240.nsf/AllWeb/941F9CBFD32D266EC1257C220047E755?OpenDocument

x	Slide presentation outlining the contents of this report is attached.
x	I acknowledge that the information shared in this report may used in the Annex IV State of Science Report II (to be released 2020). All work used for the Annex IV Report will be cited appropriately.

INSTRUMENT CATEGORY SUMMARY AND *BEST-IN-CLASS* RECOMMENDATION

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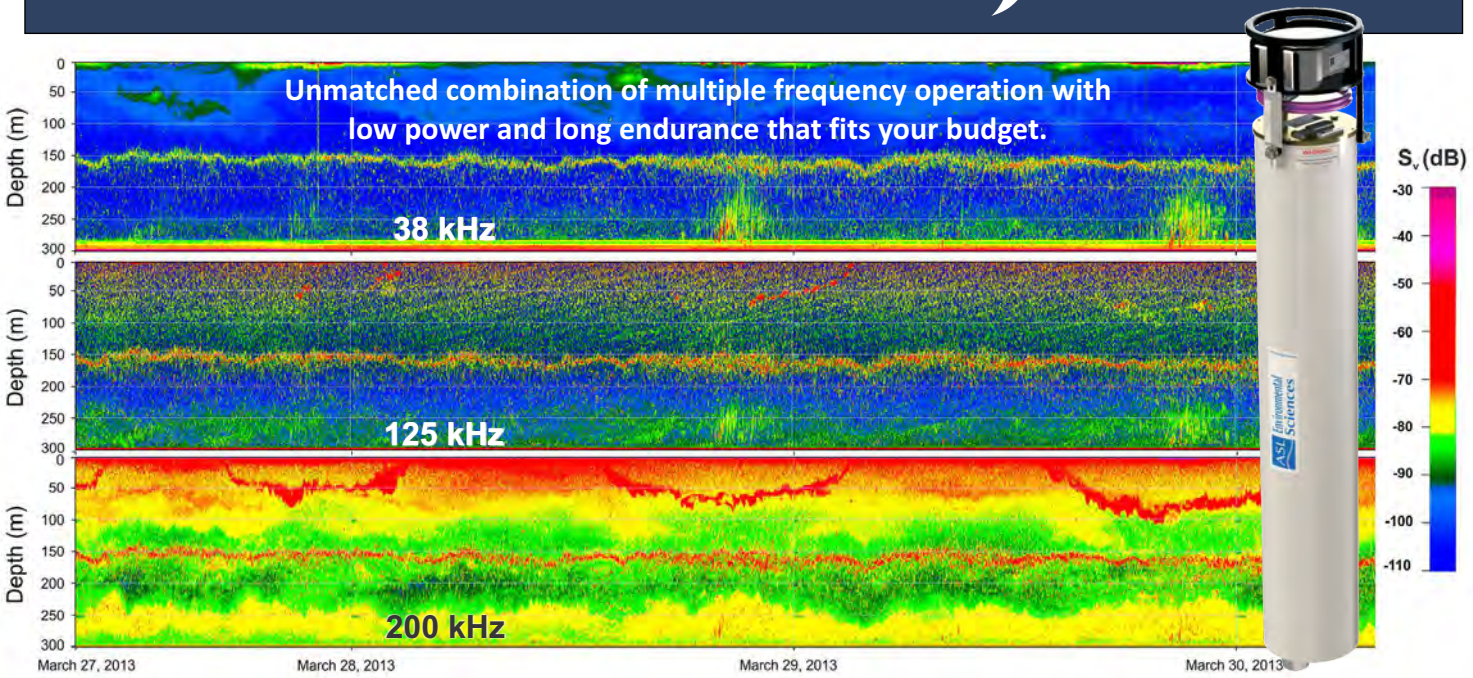
Appendices

Manufacturer instrument specification sheets are attached if available.

Acoustic Zooplankton Fish Profiler™

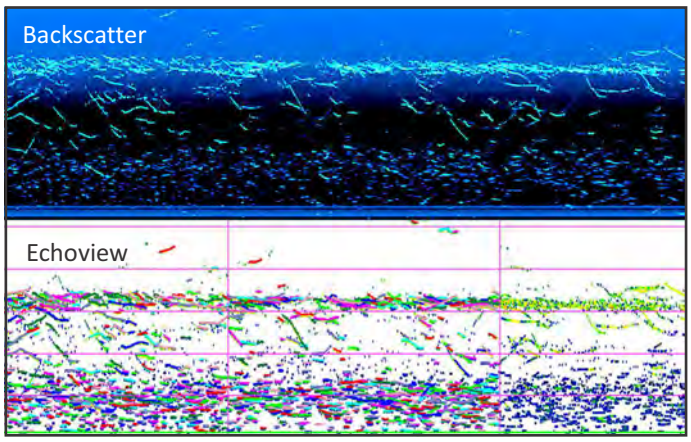


Applications

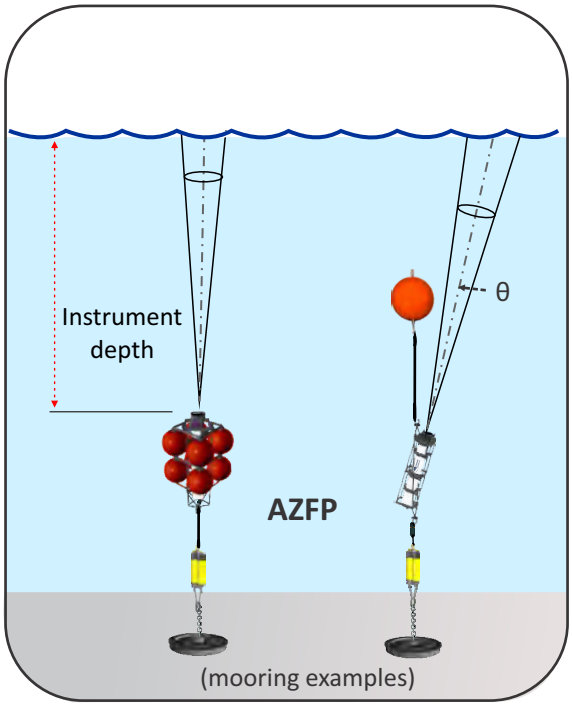
The Acoustic Zooplankton Fish *Profiler*™ can monitor the presence and abundance of zooplankton and fish within the water column by measuring acoustic backscatter returns with ultrasonic frequencies. Other sonar targets realized from the sonar backscatter data include bubbles and suspended sediments.

Features

- Can collect data continuously for periods of up to one year at high temporal and spatial resolution.
- Available with up to four frequencies in a single transducer housing.
- Can be operated in bottom-mounted, upward looking mode or in downward looking mode from a buoy.



Backscatter data showing fish arches (Echoview software)



Acoustic Zooplankton Fish Profiler™

AZFP Specifications

- Deployment phases (12 max) by date or duration (with repeat & sleep)
- Configurable ping rate up to 1 Hz (depends on frequencies and range)
- A/D Digitization rate: 64,000, 40,000 or 20,000 Hz
- User selectable pulse length: 100 to 1000 microseconds
- Range lockout to ignore near targets
- Range averaging into bins (minimum bin size is 0.011m) and ping averaging over time
- Anodized aluminum underwater pressure housing rated to 600 m

TILT SENSOR

Range ±45° with an accuracy of ± 3°

DATA STORAGE

16 GB CompactFlash

SIZE

Pressure case: 170mm diameter x 1000mm long

POWER

Example with standard battery pack: ping for 150 days with 4 frequencies every 2 seconds over a 100 m range)

ACOUSTIC PERFORMANCE of the AZFP

Estimated Minimum Detectable Volume Backscatter Strength (dB)

Frequency (kHz)	Nominal Source Level(dB)	Nominal -3dB Beam Angle	1m	2m	5m	10m	20m	50m	100m	200m	300m	500m
38	208	12	-136	-130	-122	-116	-110	-101	-94	-87	-82	-74
67.5	205	10	-131	-125	-117	-110	-104	-95	-87	-77	-70	-58
125	210	8	-136	-129	-121	-115	-108	-98	-88	-75	-64	-
200	210	8	-130	-124	-115	-109	-102	-91	-79	-63	-48	-
333	211	8	-121	-115	-106	-100	-92	-79	-65	-43	-	-
455	210	7	-116	-110	-101	-94	-86	-71	-54	-	-	-
769	210	7	-106	-99	-90	-81	-71	-48	-	-	-	-
1250	211	7	-91	-83	-72	-61	-	-	-	-	-	-
2000*	212	7	-80	-71	-55	-	-	-	-	-	-	-

NOTES

- Sidelobes are -15 dB or better
- Limits of detectable volume backscatter strength are estimates; individual units may vary by +/- 3 to 4 dB
- Receiver dynamic range is >85 dB each channel (* receiver dynamic range is 75 dB for 2000 kHz)
- The above specifications are subject to change without prior notice
- Volume backscatter is calibrated to +/- 1dB, Sv resolution is +/-0.1 dB

SOFTWARE

- Includes AZFPLink to configure the instrument and plot hourly single frequency echograms
- AZFP's raw data format is compatible with Echoview and Sonar5
- AZFP's comma delimited ASCII format (CSV) is compatible with Matlab and other software.

OPTIONAL FEATURES

- 32 GB Compact Flash
- 1000 m rated versions
- RS422 serial communication with optical isolation for real-time applications
- Bottom frames
- Compact AZFP packages for Mid-ocean floats, gliders and AUVs and towed bodies
- Short pressure case without batteries
- Taut-line mooring frame
- Pressure Sensor
- Tilt pinger for use with bottom frame
- Deployment and recovery services
- Deepwater versions available up to 6000 m

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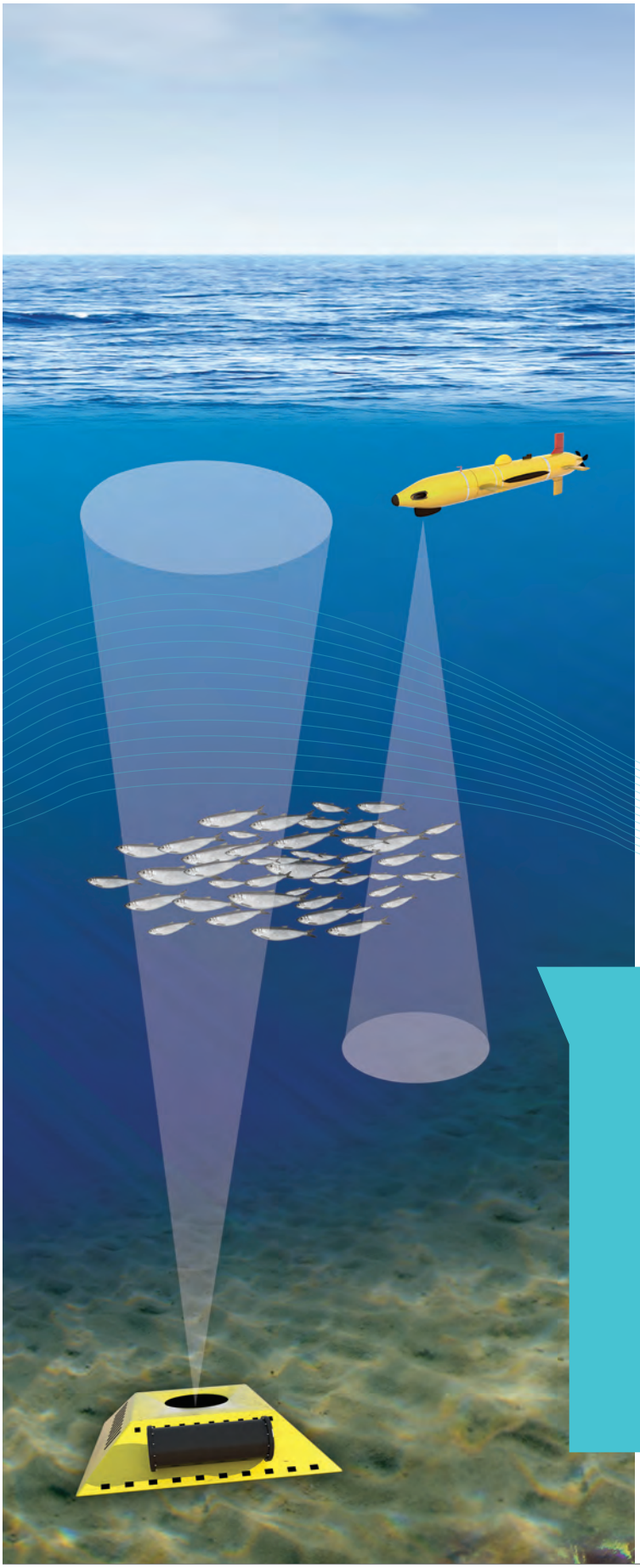

DT-X SUB

AUTONOMOUS SUBMERSIBLE ECHOSOUNDER

Applications

- Ideal for AUV or ROV instrumentation
- Deploy as a complete seafloor observatory system, tripod mount and batteries available
- Monitor migration and evaluate temporal patterns in distribution and abundance
- Gain insight into behavior variations and event response

Product Highlights

- Monitor and assess fish, marine mammals, zooplankton, other aquatic organisms
- Completely autonomous with no external cables
- Fully functional DT-X split beam echosounder packaged for seafloor or unmanned vehicle deployments
- Programmable duty-cycle and wake/sleep timer for extended deployments
- OEM version available for integration

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DT-X SUB AUTONOMOUS SUBMERSIBLE ECHOSOUNDER

Performance Features

- System Noise Floor: Extremely quiet -140dB
- Dynamic Range: Greater than 160dB
- Adjustable Ring Rate: 0.01 to 30 pps
- Adjustable Pulse Duration: 0.1 to 1.0 ms
- Adjustable Range: >2000m
- Transmit Power: 100 to 1000 Watts RMS

Dimensions

- Housing: 10” diameter x 22” length
- Digital transducer:
  - 7.2” diameter x 6.25” (200, 420 kHz)
  - 10.3” diameter x 8.5” (38, 70, & 120 kHz)

Power System

- External Battery, 11-24 Volts DC
- SMART power control eliminates surges and ensures safe shut-down when power is low and reboot only after recharge

Communication and Data Storage

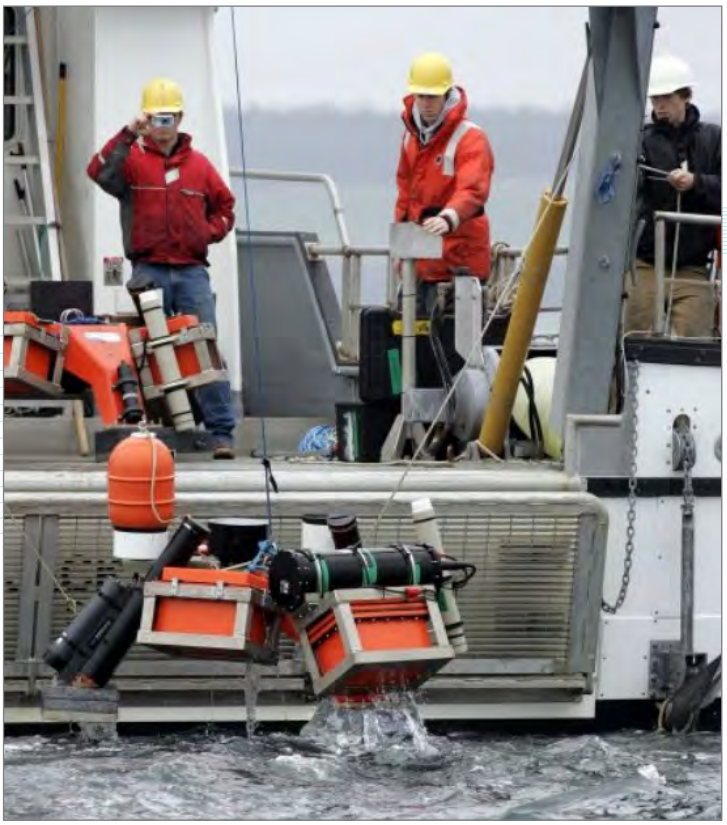
- High-capacity storage drives
- USB and Ethernet ports for echosounder configuration and data retrieval
- Integrated data storage and power management systems

Echosounder Unit

- Fully programmable
- Self diagnosis and calibration on start-up
- Fully selectable configuration options
- Integrated orientation sensor
- Programmable duty cycle

Transducer Options

- Scientific split beam technology
- Wide range of standard frequencies for numerous fisheries and habitat assessment applications; 38, 70,120, 200, 420, &1000 kHz
- Ultra-low side lobes to -35 dB
- Multiple frequencies from a single echosounder



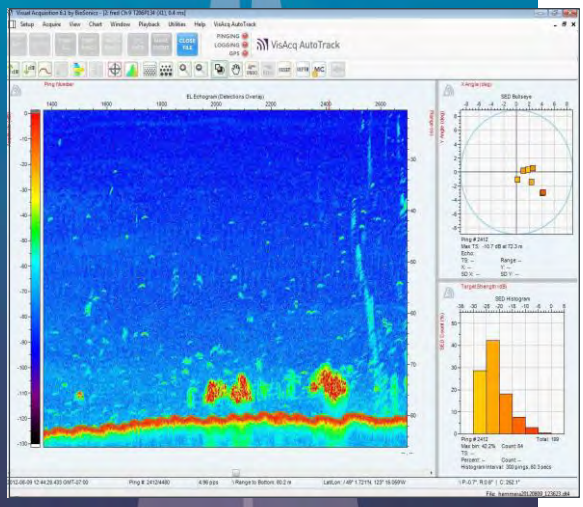
Fully rigged DT-X SUB as deployed for 5-week seafloor observatory mission.

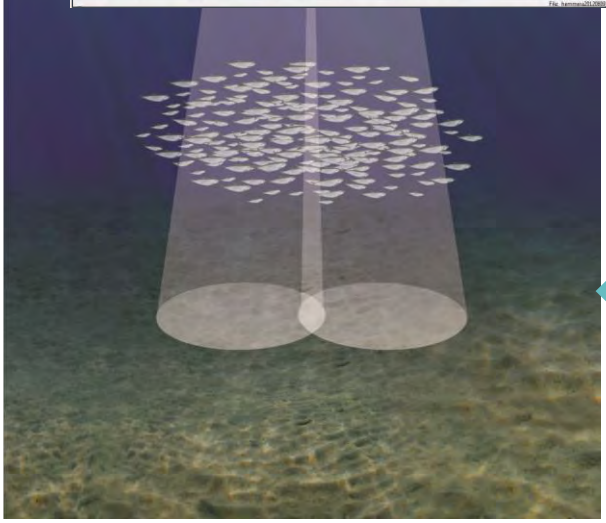
SCIENTIFIC ECHOSOUNDERS

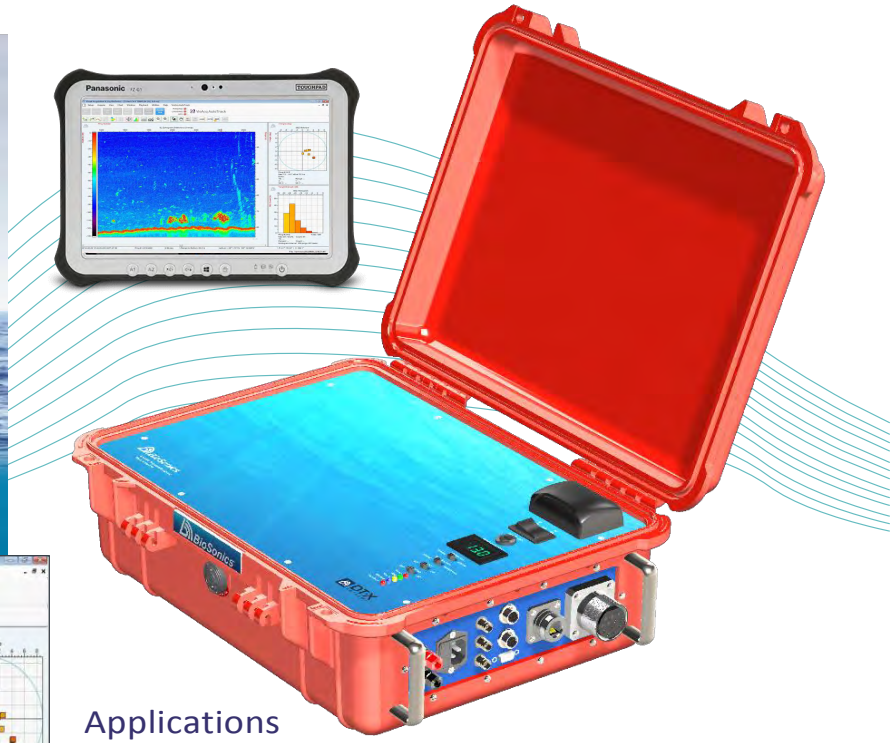
BioSonics®

DT-X EXTREME

AUTONOMOUS PORTABLE SCIENTIFIC ECHOSOUNDER







Applications

- Mobile surveys to assess fish population, biomass and size distribution
- Fixed-station monitoring at rivers, dams, water intakes
- ASV/USV surveys, surface buoys, and other unmanned or unattended deployments
- Fish passage, entrainment and migration studies
- Habitat mapping, seagrass, substrate classification and bathymetric surveys

Product Highlights

- Scientific split beam technology
- Operates with or without a PC or Tablet in autonomous mode
- Ultra-rugged IP67 metal connectors
- Log up to 30 days of data
- Programmable wake/sleep function
- Internal Wi-Fi router & DGPS, voltage monitor, and much more!

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DT-X EXTREME AUTONOMOUS PORTABLE SCIENTIFIC ECHOSOUNDER

Echosounder Specifications

- Programmable LINUX-based embedded processor
- Wired or wireless ETHERNET control
- Real-time depth and speed output via NMEA 0183
- Internal DGPS with optional external interface
- Metal IP67 connectors
- High resolution, full color echogram
- System Noise Floor: Extremely quiet -140dB
- Dynamic Range: Greater than 160dB
- Selectable Ping Rates from 0.01 to 30 pps
- Selectable Pulse Duration: from 0.1 to 1.0 ms
- Split Beam Detection Range: 0.5 to 2,000 meters
- Transmit Power: 1000 Watts RMS
- Input Power: 11-26 VDC or 90-264 VAC
- Power Consumption:
  Active mode: 30 Watts; Sleep mode: <1 Watt
- Weights and Dimensions
  L: 49 cm (19”) W: 39 cm (15”) H: 19 cm (8”); Wt.: 11.4kg (22 lbs.)

Digital Transducer Specifications

- Signal digitization provides improved SNR and overall superior data quality
- Integrated Orientation Sensor included
- Wide range of frequencies:
- 38, 70, 120, 200, 420, & 1000 kHz
- Scientific grade split beam or single beam
- Ultra-Low side lobes to -35 dB
- Network up to 10 separate transducers at various frequencies
- ***NEW*** stainless steel bulkhead and cable connectors
- Anodized aluminum housings
- Weights and Dimensions:

  200, 400, 1000 kHz
  D: 18 cm (7.2”) H: 17 cm (6.3”) W: 4kg (9.5 lbs.)
  38, 70, 120 kHz
  D: 26 cm (10.3.”) H: 22 cm (8.5”) W: 14-17kg (30-38 lbs.)

BioSonics Data Collection, Data Analysis and Real-Time Reporting Software - INCLUDED!

Visual Acquisition	Echosounder configuration and data collection/playback
Visual Analyzer	Echo counting and echo integration for fish density and biomass estimation
VisAcq AutoTrack	Real-time processing and automated reporting for fisheries applications
Visual Habitat	Aquatic habitat mapping and assessment, measure plant canopy height and % coverage, SAV and substrate classification

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MODEL 244 MULTI-FREQUENCY SYSTEM

The HTI *Model 244 Multi-Frequency System* is a powerful digital split-beam/single-beam hydroacoustic system designed specifically for fisheries and plankton evaluations. Combining powerful digital signal processing hardware with a MS *Windows2000/XP*–based user interface, the *Model 244 System* produces results in real time, with multiple data display and storage options. The following components are housed in a single compact enclosure:

Digital Echo Sounder
Digital Data Tape Interface
Digital Chart Recorder
Digital Multiplexer

The menu-driven *Windows2000/XP* user interface permits the operator to enter calibration, operation, and data processing parameters, as well as select real-time data display and output options. Five levels of output data files (available individually or in combination) are written to disk, providing permanent data records ready to import into spreadsheets or data bases.

A Brief Overview:

- Sub-meter, three-dimensional resolution over time (e.g., once every second).
- Very high resolution: up to 1400 range strata as small as 10 cm, summary data available as frequently as every 6 sec, ping rate up to 50 pings/sec.
- Samples up to 16 transducers at up to 5 different frequencies from 38 kHz to 1 MHz.
- Either slow (timed) or fast multiplexing (alternating pings) sampling among transducers.
- Records the complete, raw, unthresholded digital split-beam samples.
- A compact, 12VDC-powered M241 Portable Digital Ech Sounder is also available.

HTI - HYDROACOUSTIC TECHNOLOGY, INC.
715 NE Northlake Way, Seattle, WA 98105 USA
Tel. 206.633.3383 | 206.633.5912 Fax
support@HTIsonar.com www.HTIsonar.com

MODEL 244 MULTI-FREQUENCY SYSTEM

Power Supply:	Nominal 120 VAC standard (240 VAC optional).
Dimensions:	500 mm length x 282 mm width x 522 mm height (19.7 x 11.1 x 20.6 inches).
Weight:	28 kg (62 lb) for 120 VAC version.
Operating Frequency:	Up to 16 transducers at 5 frequencies, in any combination of beam widths, split-beam (38, 60, 120, 200, 307, and 420 kHz) or single-beam (38-420 kHz, and 1 MHz).
Operating Temperature:	0-50°C (32-122°F).
Power Consumption:	200 watts without echogram PC printer; approximately 300 watts with printer.
Transmit Power:	38-200 kHz = 1000 watts, 300-420 kHz = 500 watts.
Dynamic Range:	Total dynamic range is 140 dB.
Chirp/FM Slide Option:	Increases non-reverberant signal-to-noise ratio by up to 15 dB (PW = 1.25, 2.5, 5.0 msec).
Transmit Level:	Output power is variable over a 9 dB range in 3 dB steps (+18 dB to +33 dB dep. on frequency).
Receiver Gain:	Overall receiver gain is adjustable in five 6 dB steps over a 24 dB range (-12, -6, 0, +6, +12 dB).
Time Varied Gain:	Simultaneous 20 log R + 2□R and 40log R + 2 □R functions. Spreadir programmable to nearest 0.1 dB. Total TVG range is 120 dB. Start/end TVG 0.5-1000 m.
Receiver Blanking:	Start and stop range blanking is selectable to the nearest 0.1 m.
Pulse Width:	Selectable from 0.1 to 10 msec. Receiver bandwidth automatically adjusted to optimize system performance for the selected pulse width.
System Synchronization:	Externally or internally triggered. Internal rate varies from 0.5-50 pings/sec.
Bottom Tracking:	Fixed, manual, and automatic bottom tracking modes.
Signal Outputs:	Detected outputs maximum calibrated output of 10 volts, suitable for display on oscilloscopes or chart recording. Undetected outputs maximum calibrated sine wave output of 20 volts peak-to-peak main beam, 10 volts peak-to-peak formed beams (at center frequency of 12 kHz). Suitable for use with data recorders. Four signal outputs can be user-designated from any of the following: 20 log R detected out (composite beam) 40 log R detected out (composite beam) Undetected composite beam, as well as undetected up, down, left, or right beam. One output displays processed strata/bottom/echo monitor w/selected echo indicators for o'scope.
Real Time Data Displays:	Echogram, echoscope, and several others, including System Status: Indicates operation, sample, data, file status, disk space, and GPS position. Fish Densities: Relative fish/plankton density by range bins. Total Echoes: Raw and tracked echoes by range bins. Stacked Bar Chart: Fish frequency vs. range (e.g, depth), and TS color bin. Horizontal Stacked Bar: Fish frequency vs. angle off axis, and TS color bin. Scatter Plot: Echo X-Y location (angle off axis) in the beam (also X-Z and Y-Z). 3D Display: User-controlled rotation.
Angular Resolution:	<+/- 0.1° (6° beam width, 200 kHz), using quadrature demodulation.
Echo Integration:	Simultaneous digital echo integration in up to 1400 total range-dependent echo level thresholds: Number of echo integration layers: 1400 total surface locked (100 bottom locked optional). Ping based (i.e., specific number of pings), or time based (i.e., number of minutes).
Target Tracking:	Simultaneous three-dimensional echo target tracking with real-time screen displays: Real-time updates of important values (at selectable intervals): mean target strength of tracked targets, cumulative number of echoes received, current bottom depth. Up to 1400 total range-dependent echo level thresholds.
Multiplexer:	*Digital Multiplexer* samples up to 16 transducers optionally. Switching by time (i.e., slow multiplexing), or ping-by-ping (i.e., fast multiplexing).
Digital Chart Recorder:	Internal *Digital Chart Recorder*, using a PC printer to create echograms.
Data Recording:	Complete recording of the digital split-beam samples directly to disk (optional) or Digital Audio Tape (DAT) recorder via *Digital Tape Interface*.
Transducers:	See *Model 540 Split-Beam Transducer* specification sheet for beam widths, maximum depths, and available cable lengths. All HTI transducers are preamplified to maximize signal-to-noise ratio.
Positioning:	GPS position recorded to data file or to DAT (GPS unit not included).
Remote Operation:	Modem and communication software permits full remote operation, data transfer, and quality control of the *Model 244 System* from anywhere in the world with reliable telephone communication.
Computer Requirements:	Minimum desktop 2 GHz, 128 MB RAM (256 MB recommended), *Windows2000/NT*, 50 GB HD (100 GB recommended), *Lantastic*. Contact HTI for more detailed specifications.
Note:	Specifications subject to change without notice.

IMAGENEX MODEL 852
ULTRA-MINIATURE 6000 m ECHO SOUNDER

APPLICATIONS:

- ROV Navigation
- Diving Support
- Inspection
- Search & Recovery

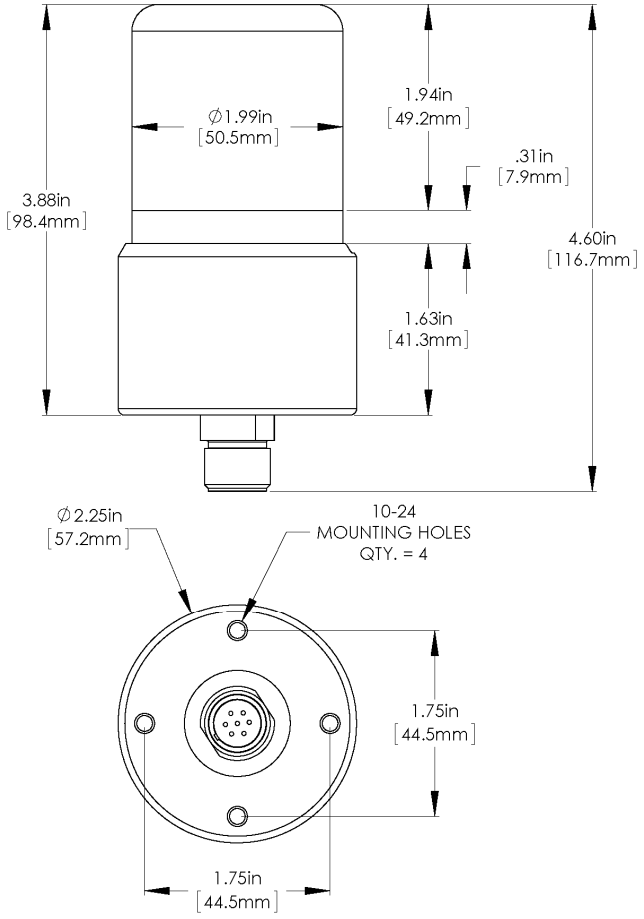
FEATURES:

- Ultra-miniature size is ideal for mounting on today's micro ROV's
- Low cost
- Direct connection to laptop computer
- External trigger available

The Model 852 Digital Echo Sounder was designed for use with the smallest of ROV's. For maximum flexibility, the unit requires approximately 1.5 Watts from 24 VDC, or optional 48 VDC. Serial communication is utilized, RS-485 or RS-232 at 115.2 kbps. The maximum operating range is 50 meters.

HARDWARE SPECIFICATIONS:	
FREQUENCY	675 kHz or Optional 330 kHz
TRANSDUCER BEAM WIDTH	9° x 9° (20° conical for 330 kHz)
RANGE RESOLUTION	20 mm
MIN. DETECTABLE RANGE	500 mm
MAX. OPERATING DEPTH	6000 m
MAX. CABLE LENGTH	1000 m on typical twisted shielded pair
INTERFACE	RS-485 @ 115.2 kbps (RS-232 optional)
CONNECTOR*	IE55-1204-BCR
POWER SUPPLY	22 – 30 VDC at less than 1.5 Watts Optional 40 – 56 VDC
DIMENSIONS	See drawing
WEIGHT: In Air **In Water**	0.53 kg (1.2 lbs) ~0.34 kg (~0.75 lbs)
MATERIALS	6AL4V Titanium, PVC, Epoxy
FINISH	Natural

SOFTWARE SPECIFICATIONS:	Win852.exe
WINDOWS™ OPERATING SYSTEM	Windows™ XP, Vista, 7, 8, 10
MODES	Echosounder
RANGE SCALES	5 m, 10 m, 20 m, 30 m, 40 m, 50 m
EXTERNAL INPUT	Depth, Heading, Turns
FILE FORMAT	(filename).852
RECOMMENDED MINIMUM COMPUTER REQUIREMENTS:	100 MHz Pentium 16 MB RAM 1 GB Hard Disk 800 x 600 x 256 colour graphics



ORDERING INFORMATION:		
6000 m UNIT	Standard	852-000-142
330 kHz	Option	-001
RS-232	Option	-006
40 – 56 VDC	Option	-013
External Trigger*	Option	-023

*External Trigger option comes with MKS(W)-307-BCR connector.

IMAGENEX MODEL 853
SCIENTIFIC ECHO SOUNDER with DATA LOGGER

APPLICATIONS:

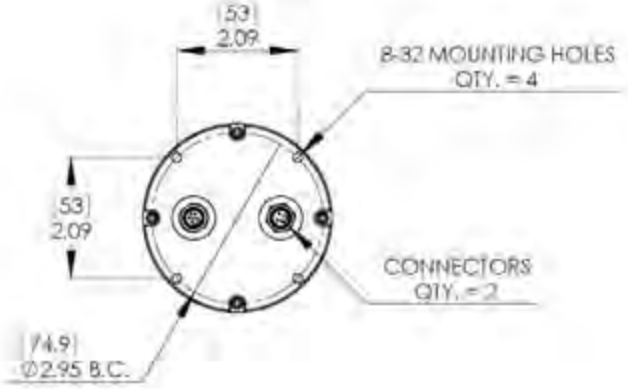
- Seaglider Installation
- ROV, AUV & UUV
- Offshore Oil & Gas
- Surveying
- Scientific Research
- Fisheries Research

FEATURES:

- Programmable
- High performance
- Low power
- Simple set-up and installation
- Digital telemetry
- 25, 50 or 100 m operation
- Compact size
- Communication format available to user
- USB Data download

HARDWARE SPECIFICATIONS:	
FREQUENCY	120 kHz
TRANSDUCER	Conical
TRANSDUCER BEAM WIDTH	10°
TRANSDUCER SOURCE LEVEL	210 dB re 1 µPa @ 1 m (nominal)
TRANSDUCER RECEIVE SENSITIVITY	-180 dB re 1 V/µPa (nominal)
RECEIVE BANDWIDTH	10 kHz
PULSE LENGTH	100 µs
MAXIMUM INPUT LEVELS	with 20 dB Gain: 35 mV_{RMS} with 40 dB Gain: 3.5 mV_{RMS}
NOISE FLOOR	with 40 dB Gain: -96 dB re 1 V_{RMS}
RANGE BINS	200
DATA STORAGE	200 Days before Download
MIN. DETECTABLE RANGE	0.5 m
MAX. DETECTABLE RANGE	100 m
MAX. OPERATING DEPTH	1000 m
MAX. CABLE LENGTH	15 m (RS-232), 3 m (USB)
TELEMETRY/ PROGRAMMING INTERFACE	RS-232 Serial Interface @ 115.2 kbps (or as ordered)
DOWNLOAD INTERFACE	USB
CONNECTORS	Impulse IEW55-1004-BCR / IEW55-1006-BCR
POWER SUPPLY	22 – 32 VDC at less than 0.25 Watts (Glider mode only)
TEMPERATURE	-5 to +35 °C (operational) -40 to +50 °C (storage)
DIMENSIONS	See drawing
WEIGHT: In Air In Water	~ 1 kg (2.2 lbs) ~ 0.55 kg (1.2 lbs)
MATERIALS	6061-T6 Aluminum, PVC
FINISH	Hard Anodize

SOFTWARE SPECIFICATIONS:	Programming/Download/Viewing program: Win853.exe
WINDOWS™ OPERATING SYSTEM	Windows™ XP, Vista, 7
MODES	Normal (interrogate to ping) Glider (one ping every 4 seconds) Stand Alone (one ping per second)
RANGE SCALES	25 m, 50 m, 100 m
FILE FORMAT	(filename).853
RECOMMENDED MINIMUM COMPUTER REQUIREMENTS:	2 GHz Pentium 4 256 MB RAM 20 GB Hard Disk 1024 x 768 screen resolution

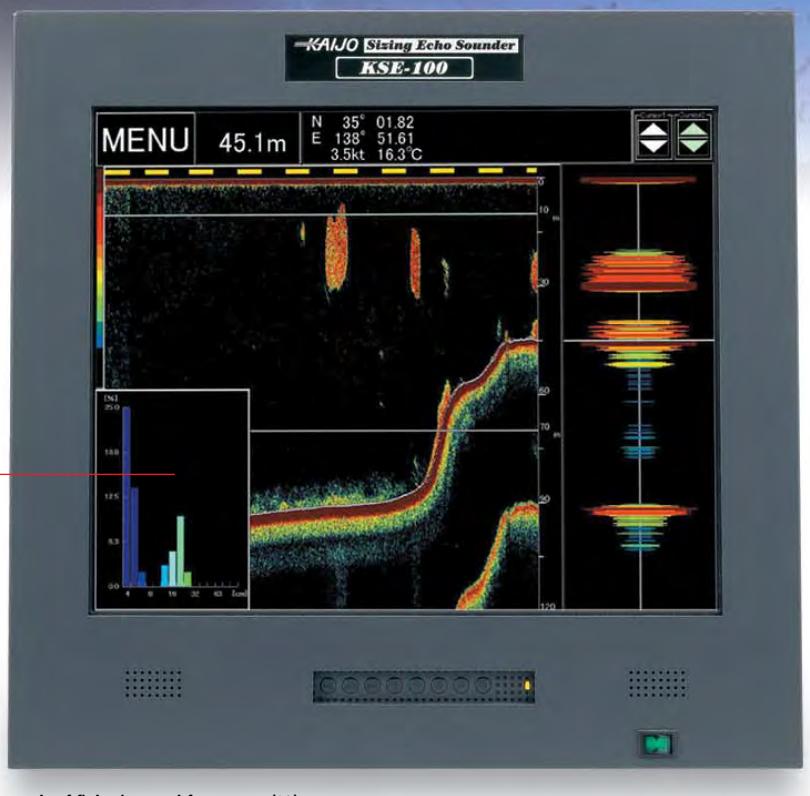


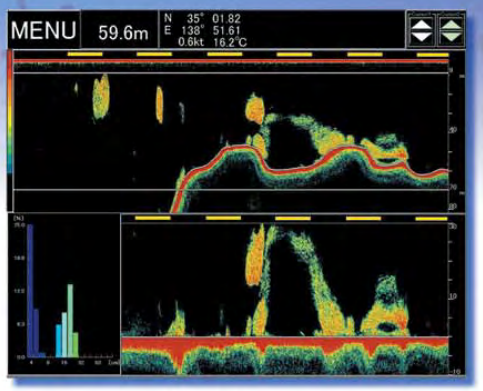
ORDERING INFORMATION:		
1000 m UNIT	Standard	853-000-140

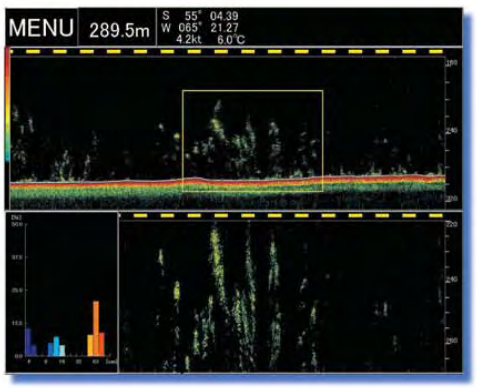
KAIJO

KSE-100

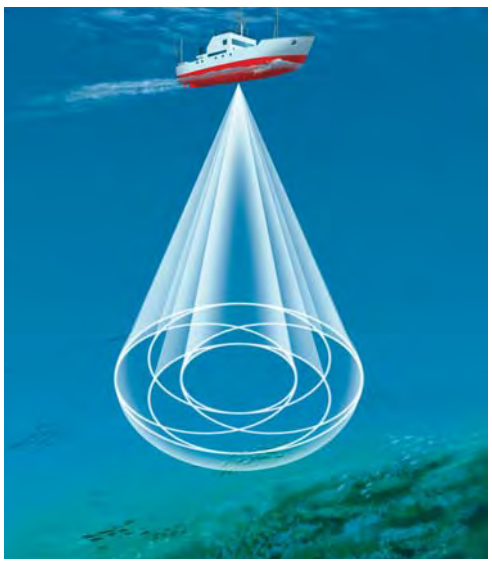
Kaijo Sonic Sizing Echo Sounder with Split beam transducer







Bar graph of fish size and frequency(%) with split beam technology



The latest Technology! High Performance split beam fish-sizing echo sounder

Features:

- Easy control using a trackball
- High precision digital TVG
- LCD monitor with high resolution picture
- Selectable display area enclosed by Graphic User Interface
- Instant saving and retrieval for user settings

KAIJO SONIC CORPORATION

Kaijo Sonic Sizing Echo Sounder with Split beam transducer KSE-100

■Specification

Operation: Menu operation by a trackball

Display: High resolution 17" LCD color monitor

Display composition:

Fish length graph	Display of the fish length in a selected area
Standard picture	Single picture/split picture display(Max.3pictures)
Enlarged split picture	Expanded picture, Sea bottom fixed picture(non-display available)
Information	Navigation information data, Command display
Menu	Operation menu in a variety of settings

Fish length graph: Graph types Bar Graph
Measurement range: Max. 600m
Fish length range: Max. 200cm
Selected range: Operational range, Depth layer, Depth layer from sea bottom
Range: 5−2000m(setting in each 10m step)
Shift: 0−3000m(setting in each 10m step)
Scale: Selected by m.fathom
Color: 16colors
Color expansion: 5 steps
Clutter: 16 steps
TVG: Fish school mode, optional mode
Marker: Minute, time, distance(3 kinds)
Picture-advance speed: 2 times, 1 time, 1/2 time, 1/5 times. pause(4 kinds)
Interference removal: Correlation way
Memorized function: Settings storage(2 kinds), picture memorize(6 kinds)
Character: Vertical cursor(2 kinds), horizontal cursor, A scope
Net finder water depth display
Information: Navigation information(latitude, longitude, ship speed, water temperature, net finder, water depth), operation command display
Language: English,Japanese(set by KAIJO SONIC before shipment)
Outer synchronization: Synchronous input, output trigger(TTL level or current)
Navigation info. Input: NMEA0183(latitude, longitude, GLL, fish speed VTG, water temperature, MTW)
IF-17 Interface format(Latitude, longitude, water temperature)
I-50 net finder signal(Net finder water depth)
Navigation info. output: NMEA0183(fish finder sea depth DBT)
Frequency: 38kHz, 70kHz
Transducer: Split beam way, transmission output 3kw

Standard system composition:

Composition	Measurement (W×H×D)	Weight
I-125 Display	340×369×157mm	4.1kg
PRC-45 Processor	365×470×141mm	13kg
Trackball	119×190× 60mm	0.3kg
SR-78 TX/ RX	387×565×330mm	40kg
T-178 Transducer	**φ342.5×134mm**	**27kg**
T-181 Transducer	**200×220×120mm**	**20kg**

Operating conditions: PRC-45 processor(**AC100V, 200VA, 0～50℃**)
SR-78 TX/RX(**AC100V, 800VA, −5～55℃**) ＊Option:AC220V

Fish finder option
Frequency: 15, 24, 50, 75, 200kHz
Number of connection: Max. two frequencies
Transducer: Single beam
Transmission output: 2 kW

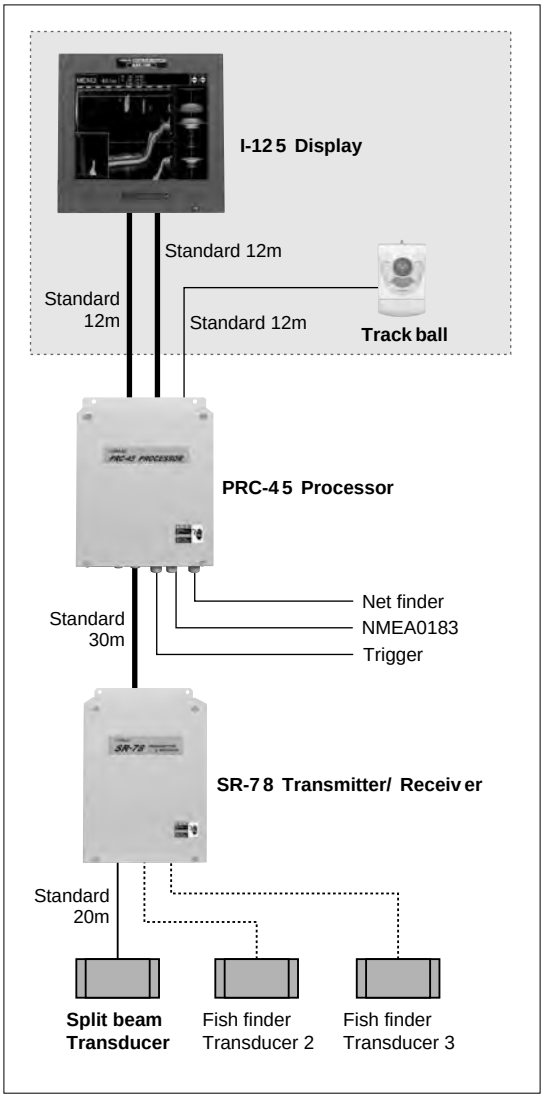
■Type

KSE-100-○□□

Fish finder frequency
A:15kHz C:24kHz
H:50kHz K:75kHz
R:200kHz

Frequency
38 or 70kHz

■System diagram



⚠SAFETY PRECAUTION: Please be sure to read the Instruction Manual before operating

●Specifications are subject to change without prior notice for improvement.

JQA-EM0607 EMS Accreditation Certicate No. RE006

ISO 14001

KAIJO SONIC CORPORATION
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9TH FLOOR, KANDABASHI PARK BLDG,
1-19, KANDA-NISHIKICHO CHIYODA-KU, TOKYO, JAPAN 101-0054
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OVERSEAS DISTRIBUTOR

KAIJO CORPORATION
SEOUL BRANCH TEL 82-2-563-3345～6 FAX 82-2-563-3347
TAIPEI BRANCH TEL 886-2-2709-3538 FAX 886-2-2704-8907

Current profiler

Signature100

Long-range current profiler designed for combined current profile and biomass measurements

The Signature100 combines a four-beam current profiler operating at 100 kHz with an optional scientific echosounder.

Both the current profiler and the biomass measurements have an effective range of 300-400 m providing unprecedented insight into the dynamics of zooplankton, krill or even schools of fish. Likewise, acoustic tracer material can give new insight into small-scale physical processes.

Current profiler

Signature100

Highlights

- ✓ 300–400 m current profiling range
- ✓ Optional center beam with 70–120 kHz echosounder

Applications

- ✓ Detection of krill in the water column
- ✓ Cost-effective current profile measurements at mid-range
- ✓ Plankton migration studies
- ✓ Upwelling and downwelling studies
- ✓ Internal waves
- ✓ Suitable for buoy mounting with internal AHRS

Current profiler

Signature100

Technical specifications

⟶ Water velocity measurements	
Maximum profiling range	300-400 m*
Cell size	3–15 m
Minimum blanking	TBA
Maximum number of cells	200
Velocity range (along beam)	User-selectable 2.5 or 5.0 m/s
Minimum accuracy	1% of measured value ± 0.5 cm/s
Velocity precision	Broadband processing, consult instrument software
Velocity resolution	0.1 cm/s
Max sampling rate	1 Hz (1/2 Hz at max output power)
*Maximum range depends on acoustic scattering conditions.	
⟶ HR option (on 5th beam only)	
Velocity range	N/A
Cell size	N/A
Profiling range	N/A
Range velocity limitations	N/A
⟶ AD2CP Measurement modes*	
Single	Average
Concurrent	Average and echosounder
Alternate	N/A
* US Patent 8223588	
⟶ Echo Intensity (along slanted beams)	
Sampling	Same as velocity
Resolution/dynamic range	0.5 dB/70 dB
Transducer acoustic frequency	100 kHz

Current profiler

Signature100

⟶ Echo Intensity (along slanted beams)	
Number of beams	4 slanted at 20°, optional vertical beam for echosounder
Beam width	6.1° (slanted)
⟶ Echosounder option	
Transducer acoustic frequency	70–120 kHz
Transducer beam width	15° @ 70 kHz, 8.7° @ 120 kHz
Resolution	0.375–4 m
Number of bins	1800
Transmit pulse length	0.5–6 ms
Transmit pulse	Monochromatic 70 kHz, 90 kHz and 120 kHz or frequency chirp (90 kHz, 50% BW)
Transmit power	1.2–120 W, adjustable
Chirp signal processing	Pulse compression or binned frequency response
Raw complex data storage	Configurable rate
Resolution/dynamic range	0.01 dB / 130 dB
Linearity	TBA
⟶ Wave measurement option	
AST frequency	N/A
AST max distance	N/A
Maximum wave measurement depth	N/A
Height range	N/A
Accuracy/resolution (Hs)	N/A
Accuracy/resolution (Dir)	N/A
Period range	N/A
Cut-off period (Hs)	N/A
Cut-off period (dir)	N/A
Sampling rate (velocity and AST)	N/A
⟶ Ice measurement option	

Current profiler

Signature100

Parameters	N/A
⟶ Sensors	
Temperature	Thermistor in head (sampled at meas. rate)
Temp. range	-4 to +40 °C
Temp. accuracy/resolution	0.1 °C/0.01°C
Temp. time response	2 min
Compass	Solid-state magnetometer (Max 1 Hz sample rate)
Accuracy/resolution	2° for tilt < 30°/0.01°
Tilt	Solid-state accelerometer (Max 1 Hz sample rate)
Accuracy/resolution	0.2° for tilt < 30°/0.01°
Maximum tilt	Full 3D
Up or down	Automatic detect
Pressure	Piezoresistive (sampled at meas. rate)
Standard range	0–1500 m (inquire for options)
Accuracy/precision	0.1% FS / Better than 0.002% of full scale
⟶ AHRS option	
Accelerometer dynamic range	± 2 g
Gyro dynamic range	± 250°/sec
Magnetometer dynamic range	± 1.3 Gauss
Pitch and roll range/resolution	± 90° (pitch) ± 180° (roll) / 0.01°
Pitch and roll accuracy	± 2° (dynamic)*, ± 0.5° (static, ±30°)
Heading range/resolution	360°, all axis / 0.01°
Heading accuracy	± 3° (dynamic)2), ± 2° (static, tilt < 20°)
Sampling rate	Same as measurement rate (up to 1 Hz)
* Dynamic specifications depends on the type of motion	
⟶ Data recording	
Capacity	16 GB, 64 GB or 128 GB (inquire for larger capacity)
Data record	Consult instrument software

Current profiler

Signature100

→ Data recording	
Mode	Stop when full
→ Real-time clock	
Accuracy	
Clock retention in absence of external power	1 year. Rechargeable backup battery
→ Data communications	
Ethernet	10/100 Mbits Auto MDI-XTCP/IP, UDP, HTTP protocolsFixed IP/DHCP client/AutoIP, UPnP
Serial	Configurable RS-232/RS-422 300–1250000 bps
Recorder download baud rate	20 Mbit/s (Ethernet only) - 1 GB in 6 minutes
Controller interface	ASCII command interface over Telnet and serial
→ Connectors	
Depending on configuration	MCBH6F (Ethernet), MCBH8F (serial), MCBH2F-G2 (pwr), optional Souriau M-series metal connector for online use (14M)
→ Software	
Functions	Deployment planning, instrument configuration, data retrieval and conversion (for Windows®)
→ Power	
DC input	15–48 V DC
Maximum peak current	1.5 A
Max. average consumption at 1 Hz	15 W
Typical average consumption*	2 W
Sleep consumption	100 µA, power depending on supply voltage
Transmit power per beam	4–200 W, adjustable levels
Ping sequence	Multiplexing or parallel
* 10 min. avg. profile,1 cm/sec hor. prec., max cell size, max power, long range mode. Consult SW for other configurations	

Current profiler

Signature100

→ Batteries

Internal	One or two 540 Wh alkaline or 1800 Wh lithium

Current profiler

Signature100

→ Batteries	
Duration	Depending on configuration, consult software
→ Environmental	
Operating temperature	-4 to +40 °C
Storage temperature	-20 to +60 °C
Shock and vibration	IEC 60068-1/IEC 60068-2-64
EMC approval	IEC 61000
Depth rating	1500 m
→ Materials	
Standard model	POM with titanium fasteners. Titanium/POM transducer cups
→ Dimensions	
Maximum diameter	460 mm
Maximum length with room for internal batteries	765 mm (2 batteries)
Maximum length without room for internal batteries	N/A
→ Weight	
In air, no battery	37.5 kg
In water, no battery	13 kg
Battery	10.0 kg (2x540 Wh), 5.8 kg (2x1800 Wh)

Simrad WBAT

Wideband Autonomous Transceiver

www.simrad.com

TECHNOLOGY FOR SUSTAINABLE FISHERIES

SIMRAD

WBAT is a “cutting edge” subsea innovation rising from a need to monitor marine life and detect oil and gas leaks at virtually any corner of the world.

Description

The Simrad WBAT system is at the forefront of monitoring marine life capable of being submerged to a maximum depth of 1500 meters and prolonged periods of up to 15 months.

When deployed, the WBAT is self-contained and will record data with the acoustic settings at the given time intervals.

Between data recording events the WBAT will be in “deep sleep”, conserving energy and extending battery life.

The WBAT Transceiver comprises a rugged cylinder providing all necessary transmitter and receiver electronics, a battery and the necessary interface and control circuitry.

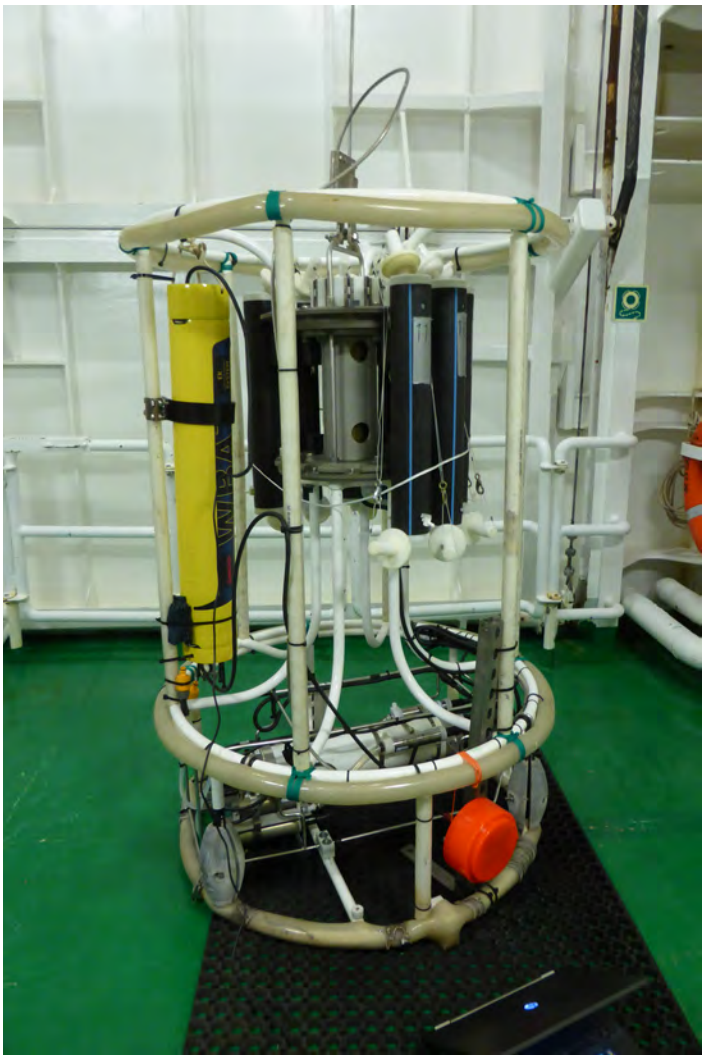
Key features

- Autonomous all-in-one echo sounder
- Advanced mission control
- Internal battery and data storage
- More than 1 year deployment
- Depth rated to 1500 m
- Frequencies from 30 to 500 kHz
- Connects two split-beam or four single-beam transducers
- Chirp and CW pulse forms
- Standardized Simrad® EK80 raw data format
- Built in calibration tool
- Wide range of transducers available

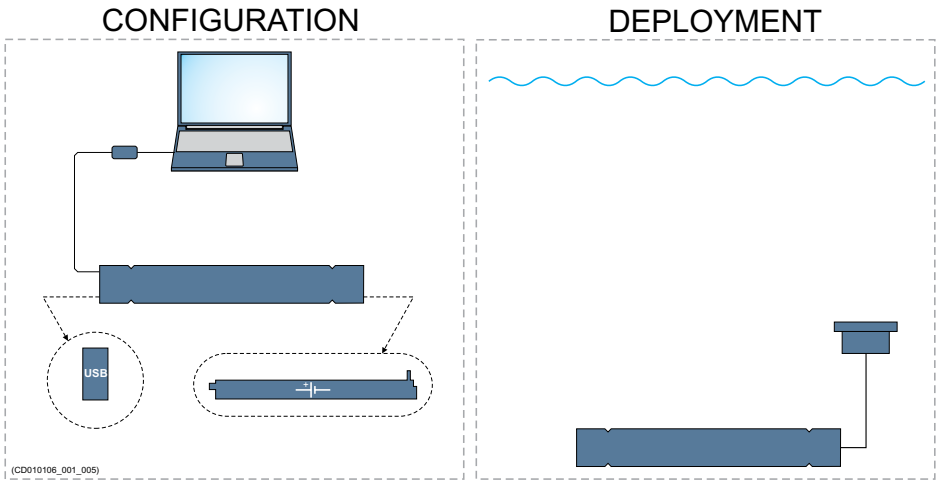
Typical applications

- Ocean observatories
- Fish migration studies
- Long-term biological studies
- Improved fish stock assessment
- Water column profiling
- Instrumentation on ROVs and AUVs

WBAT mounted on Conductivity-Temperature-Depth sensor unit.

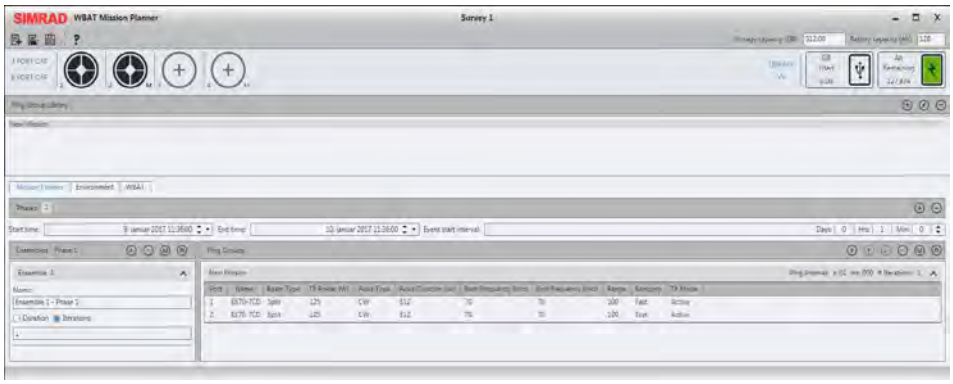


Mission Planning



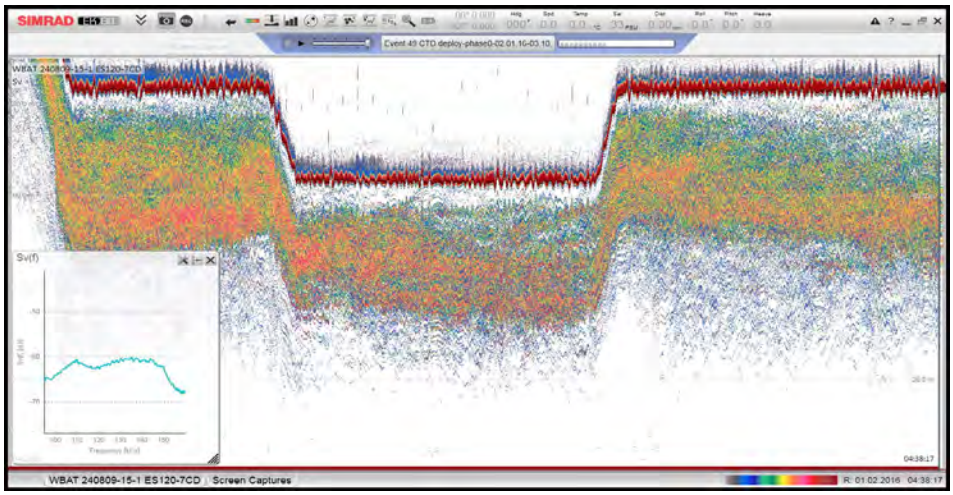
A WBAT system consists of an autonomous transceiver, one or more transducers and Mission Plan software.

Regardless if the data is collected from the ship sounders, a profiling probe, or from other platforms; the echo sounders use the same data format.



Mission Planner user interface

An advanced mission control software gives the operator a full spectre of parameters to chose from. Once uploaded into the transceiver the unit will record the data based on the acoustic settings.



EK80 echogram playback of krill from Antarctica. (Screen capture kindly provided by British Antarctic Survey, UK)

The data from the system can be viewed and calibrated with the EK80 software as the RAW data format used by these products are identical.

Technical specifications

- Physical dimensions: 100 x 16.6 cm
- Weight in air/water: 25/12 kg
- Operational frequency: 30-500 kHz
- Max Transmit power: 250 W per channel with 70Ω load at 38 kHz
- No. of channels: Four independent channels
- Pulse types: CW, FM, Active, Passive
- Pulse lengths: 128 µs to 2 ms
- Transducer types: Single and/or split-beam
- Multiplexing: Built in multiplexer on each channel
- DC voltage: 14 V (internal battery)
- Battery capacity: 128 Ah
- Current consumption active: 350 mA
- Current consumption inactive: 1.5 mA
- Control: Pre-planned mission
- External interface: RS-422
- Depth rating Transceiver: 1500 meters
- Data format: Same as EK80
- EK 80 SW: Replay, calibration
- Calibration: Calibration tool built into the mission planner. Data calibration in EK80 or 3rd party processing software.
- License required: No

WBAT assembled with transducer mount

WBAT testing onboard NOAA/Saildrone platform San Francisco Bay, CA.

WBAT calibration on Lake Washington Seattle, WA.

WBAT mounted on HUGIN Oslofjord, Norway

418953 / Rev. B / January 2017

Simrad
Kongsberg Maritime AS
Strandpromenaden 50
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SIMRAD

Simrad WBT Mini

Miniature wide band echo sounder transceiver

The WBT Mini is a compact version of the highly efficient Wide Band Transceiver (WBT) used by marine research vessels all around the world. Its compact size and energy efficient design makes it perfect as a portable echo sounder or for installation on a wide range of platforms.

Description

The WBT Mini supports chirp (FM) and continuous wave (CW) pulse forms. It contains four individual transceiver channels with multiplexing functionality, allowing for flexible setup of split- or single beam transducer configurations.

The WBT Mini is contained in a splash proof cabinet and the robust design allows long-term deployment in challenging environments.

The WBT Mini can be operated in two different modes: EK80 mode or Autonomous mode.

EK80 mode

In this mode, the WBT Mini is used with a computer running the EK80 echo sounder software. The EK80 software provides full control of the WBT mini via Ethernet in real time. When used in EK80 mode .RAW echosounder data will be recorded to the computer disk(s).

This mode requires one or more EK80 software licenses.

Autonomous mode

In this mode, the WBT Mini is programmed to perform a predefined mission. A mission will normally record data in intervals over a period of time using specific acoustic settings. The mission plan is designed using the EK Mission Planner software and downloaded to the WBT Mini before mission start.

When used in Autonomous mode the high resolution .RAW data are stored internally and retrieved after mission completion.

During a mission the WBT Mini can be remotely controlled and monitored by sending operational commands and reciving downsampled data using the serial line interface.

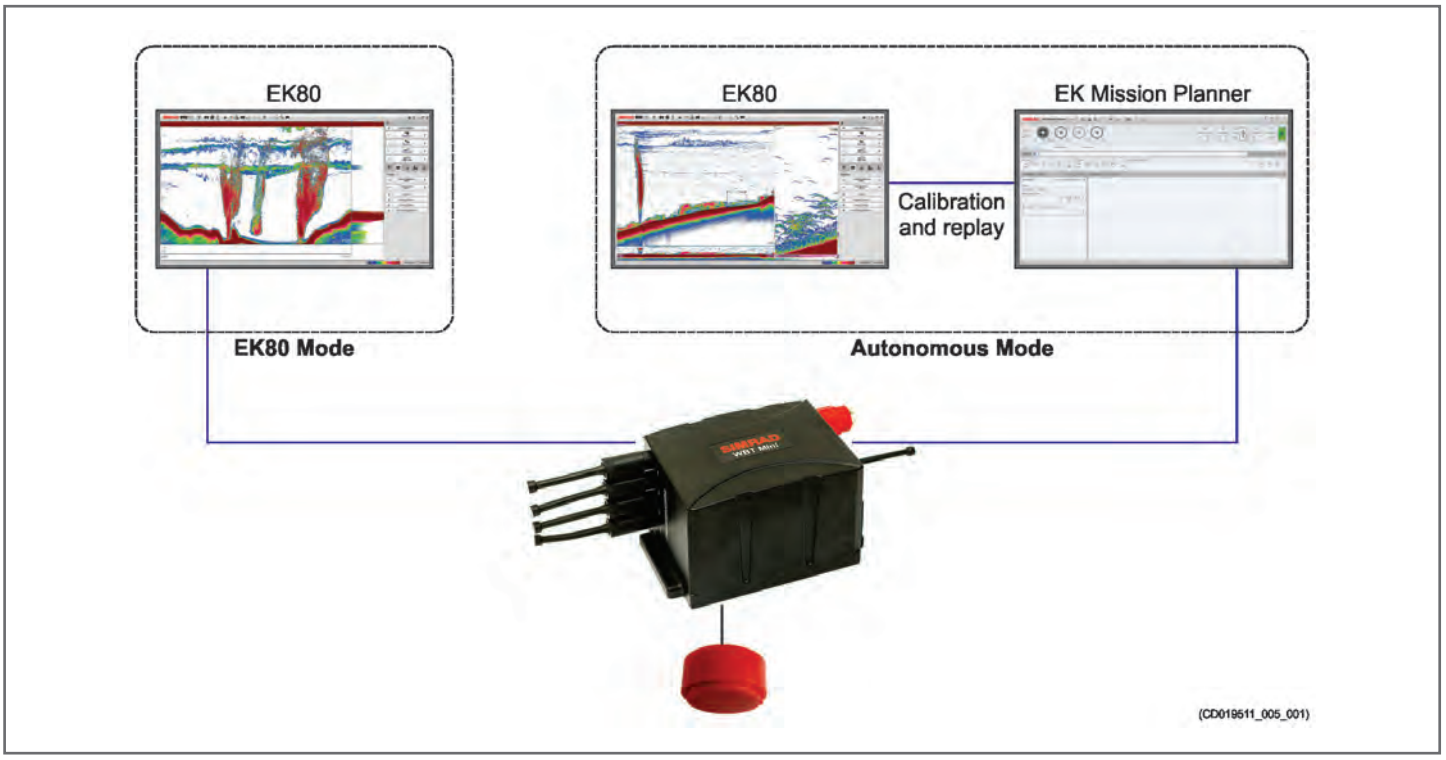
The Autonomous mode is an option that can be purchased separately.

Key features

- A member of the Simrad EK80 wideband echo sounder family
- Rugged and compact design
- Splash Proof
- Operates in EK80 or Autonomous mode
- Four independent channels with built-in multiplexing available
- Built in calibration tool
- Low power consumption
- Wide range of transducers available

Typical applications

- Unmanned Surface Vehicles
- Autonomous Underwater Vehicles
- Autonomous Underwater Gliders
- Portable configurations
- Fixed installations in challenging environments



WBT Mini onboard a Saildrone
(Image courtesy of Saildrone)

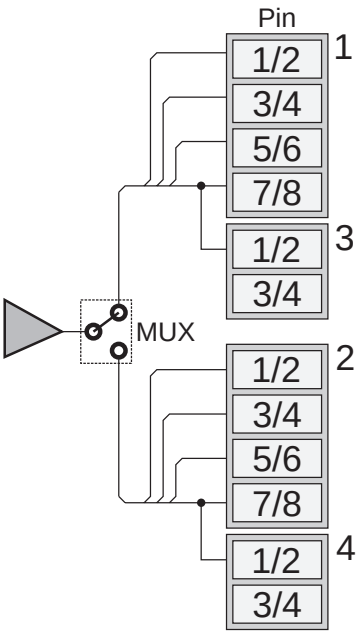
WBT Mini onboard the Jolner USV

WBT Mini onboard the Remus AUV

Transducers and multiplexing

The WBT Mini has four transducer connectors. There are two 8-pin connectors (identified as 1 and 2) and two 4-pin connectors (3 and 4).

- Connector 1 is the main connector. It is always used.
- Connector 2 is used for multiplexing with connector 1.
- Connector 3 is used to add an extra single-beam transducer when a 3-sector split-beam transducer is connected to connector 1
- Connector 4 is used for multiplexing with connector 3.



Technical specifications

Performance specifications

- Frequency range: 30 – 500 kHz
- Pulse duration: 64 – 2048 µs
- Pulse forms: CW + FM (Linear up-sweep)
- Maximum transmit power: 1000 W @ 55 Ω
- Number of channels: 4 (With multiplexer: 8)
- Transducer options: Single beam/Split beam
- Memory capacity (Autonomous mode): 512 GB

Weight and outline dimensions

- Outline dimensions:
  Depth: 145 mm
  Width: 289 mm
  Height: 127 mm
- Weight: 5.4 kg

Power requirements

- Voltage requirement: 12 – 16 VDC
- Power consumption:
  Active: 38 / 120 / 333 kHz: 6 / 3 / 3 W(*)
  Passive: 2 W
  Standby: <0.02 W (Autonomous mode)
- Maximum current: 2.5 A (Peak)

(* @ Maximum tx power, 1 ms pulse duration, and 2 ping/second)

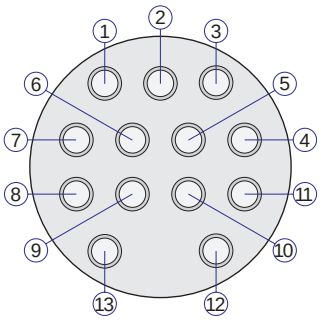
Environmental requirements

- Operational temperature: -15 to 55 °C
- Storage temperature: -20 to 70 °C
- Ingress protection (IP) rating: IP67
- Enclosure material: Aluminium

All specifications are maximum ratings. We are continuously working to improve the quality and performance of our products. The technical specifications may be changed without prior notice.

Power and Ethernet

Connector type: MacArtney male DBH13MAS

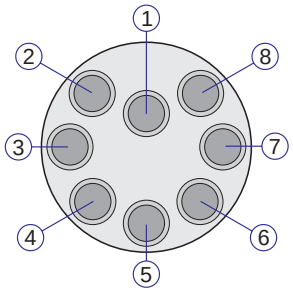


Seen towards the connector

1 +15 VDC (Black)
2 Screen
3 Ground (White)
4 RJ45/8 (Brown*)
5 RJ45/7 (Brown/White*)
6 RJ45/4 (Blue*)
7 RJ45/5 (Blue/White*)
8 RJ45/2 (Orange*)
9 RJ45/1 (Orange/White*)
10 RJ45/6 (Green*)
11 RJ45/3 (Green/White*)
12 N/C (Red)
13 N/C (Green)
*Twisted pairs

Serial RS-422

Connector type: MacArtney female MCBH8F

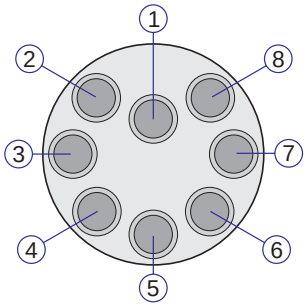


Seen towards the connector

1 WBT Mini RxD+ (Black)
2 WBT Mini RxD- (White)
3 WBT Mini TxD- (Red)
4 WBT Mini TxD+ (Green)
5 Ground (Orange)
6 N/C (Blue)
7 N/C (White/Black)
8 N/C (Red/Black)

Transducer 8-pin

Connector type: MacArtney female MCBH8F

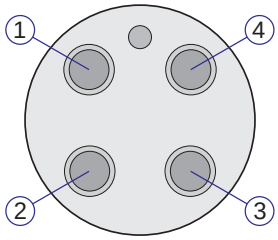


Seen towards the connector

1 Channel 1+ (Black)
2 Channel 1– (White)
3 Channel 2+ (Red)
4 Channel 2– (Green)
5 Channel 3+ (Orange)
6 Channel 3– (Blue)
7* Channel 4+ (White/Black)
8* Channel 4– (Red/Black)

Transducer 4-pin

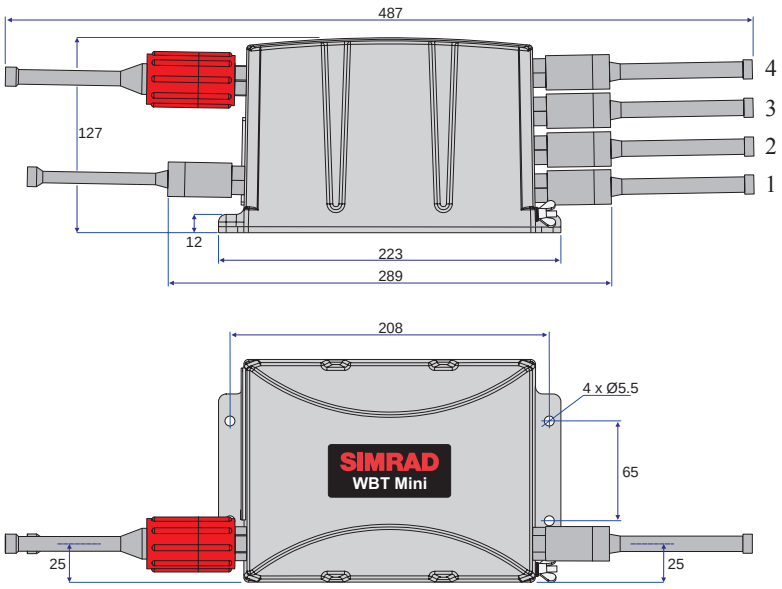
Connector type: MacArtney female MCBH4F



Seen towards the connector

1* Channel 4+ (Black)
2* Channel 4– (White)
3 N/C (Red)
4 N/C (Green)

*Pins 7 and 8 on the 8-pin transducer connector are connected in parallel with pins 1 and 2 on the 4-pin transducer connector.



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Technology Assesment
Rubric
Instrument / Sensor
Category:

No.	Instrument/ Sensor Type	Commercially Available (Can)		Manufacturer(s)/ Vendor(s)	Description and Target Use	Target or Typical Use	Other Use(s)?	Capabilities & Limitations	Anticipated Range	Sector(s) Use	Experience/ Robustness in High Flows			Experience with High Flows	Software Considerations	
		CA	R&D?			survey=census, distribution, possible size frequency		CW=continuous wave transmit pulse	dependent on frequency and power input		0-3 m/sec	3-5 m/ sec	5+ m/sec		Required or Additional Software	Data Processing & Analysis Considerations
	Simrad EK80	x		Kongsberg/Simrad	shipboard surface mount, needs power	survey		CW, multifrequecy, broadband, matched filter, splitbeam	max 900 m	all sectors but autonomous	x		x (previous generation echosounder EK60)	Bay of Fundy Survey (Melvin), Admiralty Inslet (Horne), the Fall of Warness Scotland (Williamson)	Acquisition, Processing (Echoview, LSSS, SonarX)	Python packages for data processing under development (e.g. echopy, ESP3, PyEcholab); R package for Echoview scripting; MatLab package Matecho
	Simrad WBAT	x		Kongsberg/Simrad	autonomous, underwater mount, battery included	survey/monitoring		CW, multifrequecy, broadband, matched filter, splitbeam	max 450 m	autonomous deployments only	x	x	x	Admiralty Inlet (Horne), Bay of Fundy (FORCE)	Acquisition, Processing (Echoview, LSSS, SonarX)	Python packages for data processing under development (e.g. echopy, ESP3, PyEcholab); R package for Echoview scripting; MatLab package Matecho
	Simrad WBT Tube	x		Kongsberg/Simrad	underwater mount needs power	survey/monitoring		CW, multifrequecy, broadband, matched filter, splitbeam	max 450 m	ROV and AUV, could be used on mooring and bottom packages	x				Acquisition, Processing (Echoview, LSSS, SonarX)	Python packages for data processing under development (e.g. echopy, ESP3, PyEcholab); R package for Echoview scripting; MatLab package Matecho
	Simrad WBT Mini	x		Kongsberg/Simrad	surface or pressurized container mount, needs power	monitoring		CW, multifrequecy, broadband, matched filter, splitbeam	max 450 m	surface and glider deployments	x				Acquisition, Processing (Echoview, LSSS, SonarX)	Python packages for data processing under development (e.g. echopy, ESP3, PyEcholab); R package for Echoview scripting; MatLab package Matecho
	HTI Model 244	x		HTI Vemco	shipboard surface mount, needs power	survey/monitoring		multifrequency, wideband with matched filter, splitbeam	max 800 m	all sectors but autonomous	x				Acquisition, Processing (Echoview, SonarX)	
	BioSonics DTX Extreme	x		BioSonics	shipboard surface mount, needs power	survey/monitoring		CW, multifrequency, splitbeam	max 2000 m	all sectors but autonomous	x				Acquisition, Processing (Echoview, SonarX)	
	BioSonics DTX Extreme Sub	x		BioSonics	pressurized container mount, battery included	survey/monitoring		CW, multifrequency, splitbeam	max 2000 m	autonomous deployments only	x	x		Admiralty Inlet (Horne)	Acquisition, Processing (Echoview, SonarX)	
	ASL AZFP	x		ASL	autonomous, underwater mount, battery included	survey/monitoring		CW, multifrequency, single beam only	max 500 m	moorings and bottom mojnted packages	x	x		Chukchi Sea (Horne), Saanich Inslet (Sato)	Acquisition, Processing (Echoview)	some MatLab and Python development
	ASL AZFP glider	x		ASL	autonomous, pressurized container mount, needs power	survey/monitoring		CW, multifrequency, single beam only	max 500 m	glider only	x				Acquisition, Processing (Echoview)	some MatLab and Python development
	Nortek Signature 100	x		Nortek	autonomous, underwater mount, battery included	survey/monitoring	ADCP included	multifrequency choice with wideband	max 400 m	new instrument, initlal focus on moorings	x	?		Bransfield Strait (Reiss)	Acquisition	MatLab processing

	Kaijo/Sonic KSE-100			Sonic	shipboard surface mount, needs power	survey		CW, multifrequency, splitbeam	max 2000 m	limited use in Japanese surveys	x				Acquisition, Processing (Echoview)	
	Furuno FQ80			Furuno	shipboard surface mount, needs power	survey		CW, split beam; file format not directly supported		historic use in Japan, no longer available	x					FQ80 Analyser software converts to HAC format, then Echoview
	Imagenix 852/853	x		Imagenix	surface or pressurized container mount, needs power	survey/monitoring		CW, single frequency 120 kHz, single beam	max 100 m	limited use in autonomous gliders	x					MatLab processing

Supplemental / Other Details	References/ Web Links
NOAA effort for NetCDF format for data archive	https://www.simrad.com/www/01/NOKBG0240.nsf/AllWeb/941F9CBFD32D266EC1257C220047E755?OpenDocument
NOAA effort for NetCDF format for data archive	see spec sheet
NOAA effort for NetCDF format for data archive	see spec sheet
NOAA effort for NetCDF format for data archive	see spec sheet
no active development on instruments,	see spec sheet
broadband echosounder under development (due 2020)	see spec sheet
broadband echosounder under development (due 2020)	see spec sheet
second generation echosounder under development (due 2020)	see spec sheet
second generation echosounder under development (due 2020)	see spec sheet
potential development of alternate platform (e.g. glider) version (date unknown)	see spec sheet

	see spec sheet
not heavily supported, calibration difficult	see spec sheet