



Passive Acoustic Monitoring Equipment



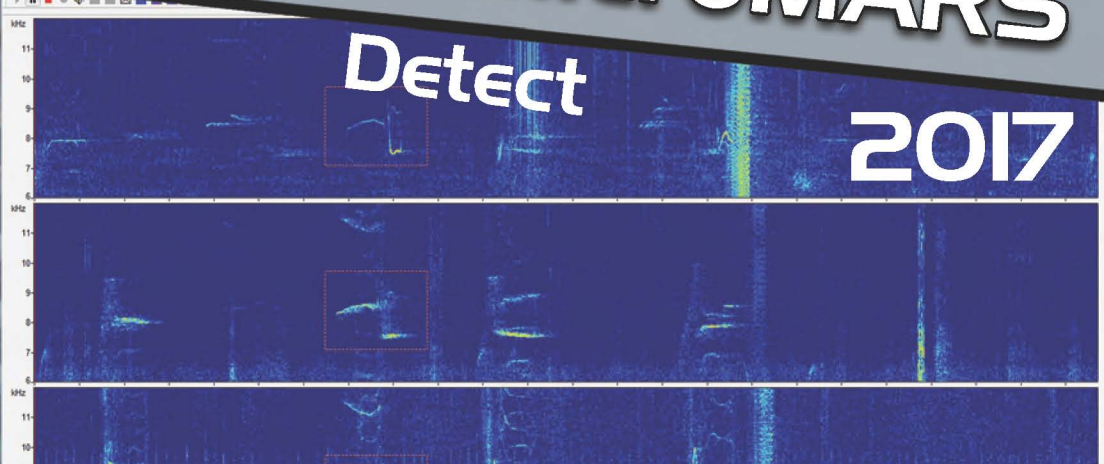
Record

SonarPoint™ Precision Sound Localization System & microMARS™

Long Endurance Recorder

Detect

2017



Localize

Bio-Waves Incorporated

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Made in Monterey Bay CA, USA

Dear Researcher,

Our first PAM product, the original microMARS recorder came out of a NOAA/ASTWG requirement for compact and affordable long-endurance recorders that would make the deployment and servicing of larger recorder arrays with minimal marine resources (small boats) a realistic proposition. Last summer, our team enjoyed testing not only the latest generation of our highly portable PAM equipment in the San Juan Islands (WA), but an extension to passive acoustic localization (PAL) as funded by the Office of Naval Research's marine mammal program (ONR/MMP) and resulting now in the new SonarPoint™ system.

Upon reported KW sightings, 2 or 3 of us would quickly speed our 18' RIB to the site and deploy an array of three or four SonarPoint™ recorders in drifter mode within minutes. One day, we deployed and recovered the array 6 times, tracking a pod of killer whales as they migrated north through the Haro Strait. Other times, we dropped the recorders over the side as a seafloor array, later recovered by acoustic release. We also tested static moored deployments with a solar powered surface buoy; intended for semi-permanent monitoring.

This brochure provides an introduction to the two related and modular systems:

microMARS™, now in its second generation, has been updated to enhance endurance by 1.5x - 3x with a given battery configuration, extending now to four month continuous recording in some realistic configurations. Mechanical improvements have improved reliability, and servicing at sea is now a matter of removing three screws to access the SD cards and battery for a quick swap and re-deploy. Sampling rates are extended from 250kHz to 416kHz for the highest frequency vocalizing species, and recording is at highly precise data rates without data loss, for a wider variety of SD cards.

SonarPoint™ introduces precision sound source localization using time-synchronized recordings from an array of recorders. Synchronization methods include built-in GPS coupled with high precision oscillators and optional acoustic synchronization to enable drifter, long-term submerged seafloor, and static mooring configurations alike. Our tests in the San Juan Islands and other locations have already demonstrated localization accuracy on the order of 3m vs. GPS reference.

Both systems are designed in recognition of the need for acoustic sampling at tighter grid spacing, for tasks from cetacean density estimates and behavioral response studies, to the monitoring and mitigation of noise associated with industrial and shipping activities, the protection of resources such as monitoring for illegal fishing or detection of activities including smuggling. Combining compact size with long endurance, simplicity of operation and affordability, I think you'll find SonarPoint & microMARS to be practical every-day tools for many purposes.



- Marco Flagg, CEO & Founder

If you have any questions, need a quotation, or perhaps want to discuss your particular requirements, please contact info@desertstar.com

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Recorders

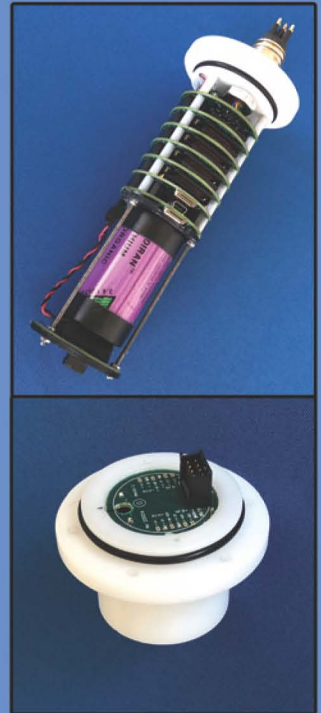
microMARS™ & SonarPoint™

Recorders are available in a 300m depth rated single battery / dual SD card configuration for shorter deployments, and a quad battery configuration with eight SD card slots for longer deployments, with options of 300m and 1000m depth rating. SonarPoint™ configurations of the recorders include a GPS receiver for clock setting and calibration, and a data/power connector linking the recorder to the RPT-1 surface repeater for ocean drifter and static mooring configurations. See Sound Localization page for details.

The recorders are designed for rapid servicing at sea, to support continuous monitoring with periodic data retrieval. Three screws are removed to access the electronics stack and battery. Replacement of the SD cards and batteries readies the recorder for its next deployment.

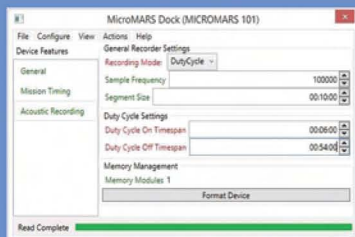
The hydrophone is replaceable. Currently available are end-cap integrated hydrophones rated for operation to 33kHz (MH33) or 125kHz (MH125). The hydrophone sensitivity, maximum accepted signal and flat (traditional) or sloped (higher sensitivity at higher frequencies) frequency response is solder jumper configurable. Selections include full-scale values at 100 Hz to over 200dB re. 1 μ Pa for measurements of strong industrial noise, and a noise floor to below 25 dB re. 1 μ Pa/ \sqrt Hz near the high-frequency cut-off to observe faint delphinid vocalizations.

Recorder endurance is dependent on the configuration and sample rate as shown for the single battery / 2 SD Card and quad battery / 8 SD Card configuration. Endurance is battery limited. Longer endurance, up to the limit of SD card capacity, is available through duty cycling or use of external power such as via the RPT-1 surface repeater. Recorders are factory equipped with 32 GB SD Cards in all slots. The recorder is tested with SanDisk Extreme Pro cards, which are user installed in the size appropriate for the recording requirement.



| Sample Rate (kHz) | Endurance (days) | Memory (GB) | SD Cards (GB) |
|-------------------|------------------|-------------|---------------|
| 25 | 27 / 115 | 108 / 463 | 64*2 / 64*8 |
| 100 | 22 / 96 | 359 / 1540 | 256*2 / 256*8 |
| 250 | 17 / 71 | 670 / 2876 | 512*2 / 512*8 |
| 416 | 13 / 56 | 871 / 3738 | 512*2 / 512*8 |

Recorders are configured via a simple Windows application, allowing setting of sample rate, recording segment length, duty cycle and other mission parameters. Auto detection of the operating mode means SonarPoint™ recorders can be switched between ocean drifter and seafloor submerged deployments without use of a computer.



Acoustic data is stored on the SD cards in a raw format, and converted to .WAV using a batch processing application on a PC.

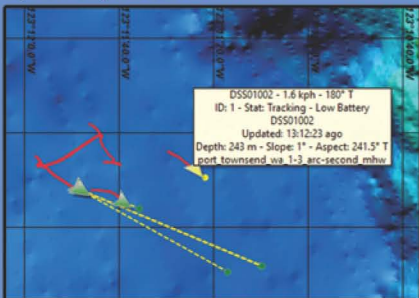
SonarPoint™

Traditional sound source localization systems can be cumbersome and expensive, often involving cabled installations. SonarPoint by contrast is an affordable and portable yet long endurance system, designed for rapid deployment from small vessels and capable of operating in a number of configurations to meet many requirements.

Top Right: SonarPoint components including here a (1) SP300-2 recorder, (2) SPP1000-34 synchronization pinger, (3) RPT-1 repeater and buoy assembly for ocean drifter mode, (4) ARC-1XD acoustic release for submerged seafloor array deployment and (5) STM-3 deck box to command the acoustic releases.

Ocean Drifter Array:

Ocean drifter deployments allow rapid response monitoring & tracking of cetaceans or their interactions with vessels and human activities in virtually any location. Typically 3-5 drifter buoys are deployed bracketing the animals, and left in place for minutes or hours. The surface buoy integrates a GPS that relays position data at 10 second intervals to the recorder submerged below. The positions are associated with the sound recording, providing the basis for sound source localization from the drifting array. Deployment and recovery of an array, typically at 200m to 1000m recording spacing is easily done within minutes, and an array can be moved one drifter at a time to follow a pod of animals. The buoys transmit their current location via an integrated short-haul radio modem, and positions of the array as well as the boat can be tracked in real-time by the Mysticetus software.



Bottom Left: The Mysticetus software tracks drifter buoy locations as reported via radio modem and projects a course for each to assist in the 'shepherding' of a drifter array tracking the progression of a pod of animals.

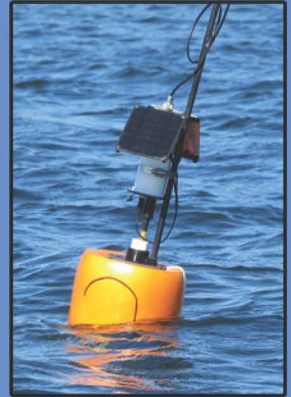
Precision Sound Localization System

Global Ocean Drifter:

Individual SonarPoint buoys can also be deployed as long-duration and distance ocean drifters, enabling ocean scale sampling. For this purpose, the RPT-1 surface repeater can accommodate an Argos satellite modem, reporting buoy location and status world-wide to enable recovery.

Semi-Permanent Hotspot Monitoring:

Semi-permanent monitoring in shallow water hotspot locations is available by deploying a moored array. Typically, this installation will consist of submerged SonarPoint recorders cabled to the RPT-1 surface repeaters and mounted on a heavy weight buoys suitable for long deployments. The RPT-1 collect and stores solar power to support continuous recording. Its GPS receiver sends synchronization signals to the recorder, keeping synchronization without drift. The Argos or short haul radio modem alerts the operator if a buoy is adrift. Depending on sample rates, the required service interval for data retrieval ranges from about 55 days (@ 416kHz) to over a year (@ $\geq 63\text{kHz}$).

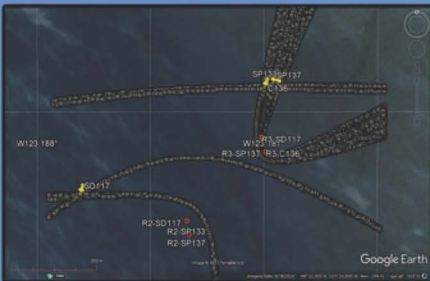


Deep Ocean Submerged Array:

In deep water locations, or in heavy traffic locations where a surface expression is not practical, SonarPoint can be deployed in a submerged configuration. See inside front cover and ARC page for more information.

Sound Source Localization:

SonarPoint's principal data product are tightly time synchronized acoustic recordings (.wav files) and recorder position streams (.csv files). A sound source can be localized from this data using time differences of arrival (TDOA) if a sound is received by three or more recorders. Automated localization is available by the Ishmael software based on importation of SonarPoint .wav recording files and .csv recorder position data.



Bottom Left:

An array of drifting recorders (red, multiple locations showing recorder positions at the time of specific localized sounds), the TDOA hyperbola from recorder pairs including a confidence region (gray), and the resulting sound source localizations (yellow) at the intersections of the hyperbola. Localized sounds here are killer whale echolocation clicks (C) and several observed varieties of songs (Sx).

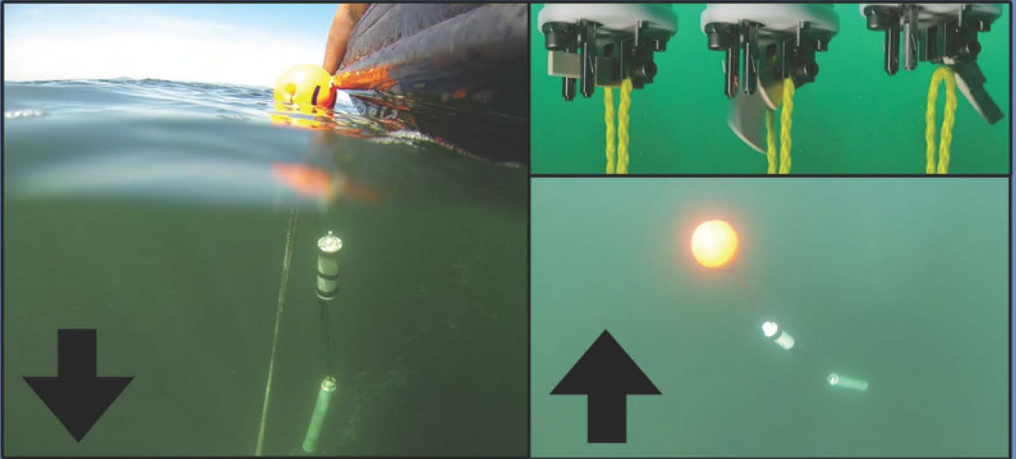


ARC-1XD

Acoustic Release

For submerged array use, SonarPoint recorders are generally paired with a ARC-1XD acoustic release. Starting at the bottom end, a subsurface mooring string consists of a sacrificial weight (e.g. sandbag), the ARC-1 release, the SonarPoint recorder, and finally a hard float (fishing trawl float) that resists the hydrostatic pressure and keeps the mooring string upright.

Due to the lightweight and small profile of the recorder and release, a 200mm (8") diameter float providing 3.23kg (7.1 lbs) of flotation generally suffices. A weight of ~9 kg (20 lbs) of lead or ~18 kg (40 lbs) of sand or concrete keeps the string anchored, yet is small enough for deployment over the side of a small vessel by one person without mechanical assistance.



To recover the string, acoustic commands are sent from the boat using the STM-3 deck box linked to a Windows computer, and an over-the-side or boat integrated through-hull sonar transducer. The process starts with activating and ranging to a release, comparing indicated distance to depth sounder information to locate the release in case it has moved and positioning the boat directly above.

The patented fusible link release mechanism is extensively proven in large scale pot fishing and instrument deployment applications, and is extremely simply. Upon command, a resistance wire is instantaneously melted using a high current but low voltage (safe) capacitor discharge. A lever is set free, releasing the sacrificial weight.



While attention to detail is needed to prevent gear fouling during deployment and the effect of ocean currents must be considered, repeat use by lobster fishers in large numbers and over several years has yielded a release rate of 99% for the best operator. In addition, fouled moorings can generally be recovered by grappling, aided by the releases ranging function.

The ranging distance and nominal maximum depth of operation of the ARC-1XD is 300m. A 1000m depth rated and ranging capable version can be provided upon request.

Bottom Left: The acoustic release command software keeps track of a large number of stations. Ranging is available to find a moved mooring string, position the boat directly above a release before actuating or grapple a fouled mooring string.



SonarPoint components including (1) MP300-2 Short Endurance Recorder in microMARS configuration, (2) SP300-8 Long Endurance Recorder, in SonarPoint configuration, (3) SPP1000-34 34kHz 1000m depth rated synchronization pinger, (4) MM1000-8 1000m depth rated recorder, (5) ARC-1XD acoustic release, (6) RPT-1 surface repeater.

Sample Pricing

microMARS™ & SonarPoint™

| Part # | Description | Cost |
|------------|--|---------|
| MM300-2 | Short Endurance Recorder, 300m depth rated, 2 SD cards (1 TB max. memory capacity), Single Battery | \$2000 |
| SP300-2 | Short Endurance Localizing Recorder, 300m depth rated, 2 SD cards (1 TB max. memory capacity), Single Battery | \$3500 |
| MM300-8 | Long Endurance Recorder, 300m depth rated, 8 SD cards (4 TB max. memory capacity), Quad Battery | \$4500 |
| SP300-8 | Long Endurance Localizing Recorder, 300m depth rated, 8 SD cards (4 TB max. memory capacity), Quad Battery | \$6000 |
| MM1000-8 | Long Endurance Recorder, 1000m depth rated, 8 SD cards (4 TB max. memory capacity), Quad Battery | \$5500 |
| SP1000-8 | Long Endurance Localizing Recorder, 1000m depth rated, 8 SD cards (4 TB max. memory capacity), Quad Battery | \$7000 |
| SPP1000-34 | Synchronization pinger, 1000m depth rating, 34 kHz, 192 dB SL | \$4000 |
| ARC-1XD | Acoustic Release, Long Endurance, 300m depth and commanding/ranging | \$1995 |
| ARC-S1 | Acoustic release surface station incl. STM-3 deck box, through-hull transducer, over-the-side transducer, control PC and control software. | \$11000 |
| SRB-RFM | Spar buoy incl. RPT-1 repeater equipped with short-haul modem and 10-30m tether for submerged recorder | \$4500 |
| SRB-SAT | Spar buoy incl. RPT-1 repeater equipped with Argos satellite modem and 10-30m tether for submerged recorder | \$5000 |

Quantity Discount Schedule: 1-9: 0%, 10-49: 15%, 50-99: 20% 100+: 22.5%

Technology Readiness Level



microMARS™ has been in commercial and research use by multiple customers since November 2014, and is now in its second generation incorporating various improvements. We are classifying this system as 'Mission verified', equivalent to DoD TRL-9.

SonarPoint™ is introduced at the 'beta test' TRL-8 stage. On-site training/support quoted and required with system purchases. Desert Star will provide a no-charge system upgrade to full production standard once TRL-9 'mission verified' status is achieved.



In Partnership with Bio-Waves:
Bio-Waves is a small business with a focus on marine bio-acoustics. Our staff has extensive experience with passive acoustic methods including the development and use of autonomous recorder systems. We have been working closely with Desert Star Systems on the development and field tests of microMARS and

SonarPoint systems. We can provide assistance in deployment and retrieval of these systems, post-processing of the data (including, semi-automated detection, classification, localization and tracking of sounds produced by marine mammals) and data analysis. We also can provide expertise on experimental design, planning field studies, and other aspects of designing and implementing a study, monitoring plan, mitigation plan, or research project. We have experience with designing acoustic-based density estimation of marine mammals, having conducted several surveys for a variety of species in remote locations. We have developed custom software that works with these systems and allows efficient processing of data. Please contact us if you would like more information.



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