Coda Octopus
Sound Underwater Intelligence

/Echoscope PIPE®

Parallel Intelligent Processing Engine

The World's Most Advanced Real Time Sonars

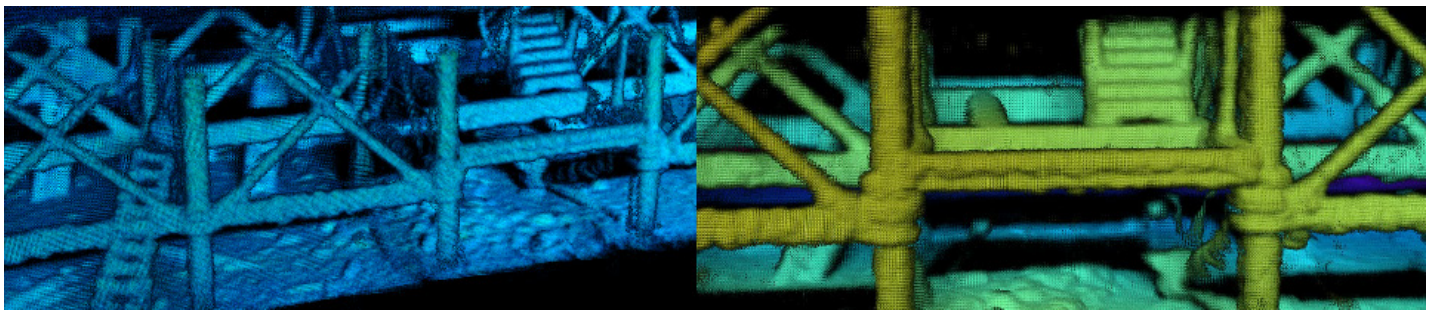
First Real Time 5-Dimensional ("5D") and 6-Dimensional ("6D") Sonars

Triple Frequency | Dual Frequency | Surface | XL

Multiple Parallel 4D Data Sets Simultaneously for Different Requirements of Underwater Operations in Real Time

Coda Octopus' 5D and 6D Echoscope PIPE® sonar series ("PIPE" sonars) significantly advances its previous real time 3D sonar series with several revolutionary innovations. At the heart of the 5D and 6D sonars capability is our Parallel Intelligent Processing Engine ("PIPE") which significantly increases the amount of data that can be processed and displayed in real time. It is designed to allow independent users, within the same underwater operations, access in real time to multiple parallel and sequential 4D Imaging Outputs. The 4D imaging Outputs can be matched to individual users' requirements by using different acoustic parameters (such as different frequency, range, filters and processing), thus providing a true multi-sensor platform from a single sonar deployment.

The Parallel Intelligent Processing Engine can capture, process and display in real time significantly higher data density with multiple parallel outputs and much higher ping rates. In addition, increased processing capability allows more advanced beamforming algorithms including phase-based processing resulting in more accurate bottom detection. An innovation of the PIPE series includes 3D full time-series data offering the capability to process up to 164 million data points per ping (256x256x2500), to generate 4D images with typically several hundred thousand 4D points per ping (depending on the insonified scene).



Coda Octopus' PIPE Sonars are 5D and 6D sonars because:

- PIPE sonars can capture and process the full time series backscatter 4D acoustic data (256x256x2500 data points) thus providing 5D data
- PIPE sonars can capture and process multiple 5D images in parallel with different processing parameters thus providing 6D data

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PIPE Features

Some of the new and innovative PIPE features available are:

- Improved Beam Detection through phase-based processing (split-aperture), greater dynamic range and incorporating full floating-point processing resolution
- Improved Image Processing with greater control and capability over image processing, greater selection of noise suppression, user selected sidelobe rejection filter and extensive array shading
- Increased Beam Density up to 256x256 compared to 128x128 (in our previous generation of sonars)
- Advanced Beamforming Mode allowing users to change beamforming method. Field of View (FoV) Focusing and Beam Density (number of beams applied to an underwater target to maximize the resolution and image definition on the fly)
- **Fine Split Aperture ("FSA") Beamforming on the fly**

  This method enhances the accuracy of the Split Aperture mode through applying direction of arrival discrimination based on beam spacing and can support higher ping rates. The Fine Split Aperture (FSA) mode can operate in horizontal, vertical and combined horizontal and vertical modes. In the combined mode, two sub-modes are available: Nominal (FSA), or Hybrid (FAT_FSA). The hybrid sub-mode returns FSA and FAT data and uses the intensity field's least-significant bit to identify which (1-FSA, 0-FAT).
- Live Real Time XYZ data point output using Coda Octopus top end software. Live Real-Time XYZ data point output also available direct from sonar with new OEM Option
- Ability to swap configuration sets instantly ping-to-ping to achieve dynamic frequency, field of view and other capture and processing functions
- Multiple real time 4D images with different capture and process parameters which can be accessed and displayed in independent views of the survey operations in real time
- Parallel Processing and Display of Real Time Images
- Availability of Full Time Series 3D Backscatter Range and Intensity Data comprising millions of data points per acoustic ping

Echoscope PIPE® Features available with 4G USE® software:

PIPE: Core Module
This module is common to all Echoscope PIPE® sonar systems and provides the core functionality including enhanced dynamic range, improved image processing and advanced beamforming with dynamic frequency and beam density adjustment in real-time.

PIPE: SEQUENCER Module
This module allows users to create a sequence of up to 10 different parameter sets for acoustic capture and processing including different frequencies allowing hands free multi-application data collection from a single deployed sonar system.

PIPE: FULL TIME SERIES Module (5D Capability)
This module provides the ability to capture and record raw 3D Full Time Series Data up to 81 million data points per acoustic ping. This FTS capability is highly beneficial for seabed coverage surveying and volumetric analysis of water column data.

Multiple 4D and 5D Images and RAW Data (6D Capability)
This module offers the ability to log RAW acoustic data and process multiple 4D images and 5D images with different imaging and acoustic parameters offline. With RAW data processing the user is in control of reprocessing any recorded data to extract required results and is highly beneficial on autonomous platforms with no human in the loop for QC and data visualization in real-time.

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Evolution of 5D and 6D Sonar

Echoscope® 3rd Generation of Sonars

Echoscope PIPE® Sonars

3D
Shape

3D Imaging typically is the scanning of an object of a sequence of images to construct a 3D Shape. The limitation of this approach is the inability to see any moving objects and having a high dependency of a stable platform to perform the imaging.

Real-Time 3D

4D
Time

Moving Objects

4D Volumetric Images represent a true volume of spatial data collected and processed at the same instant. Sequential 4D volumetric images represent a time sequence of the scene showing moving objects within the volumetric image.

5D
Depth

Time Series

5D Images are 4D images represented with multiple slices of depth data – similar to a medical CT Scan. The 5D images contain more depth information, detail and resolution of each target and sequential 5D images over time show higher resolution moving targets.

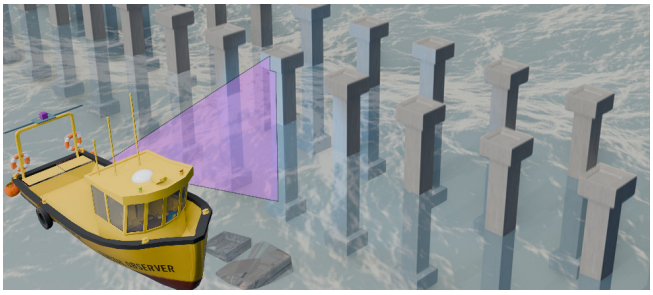
6D
PIPE

Parallel Intelligent Processing Engine

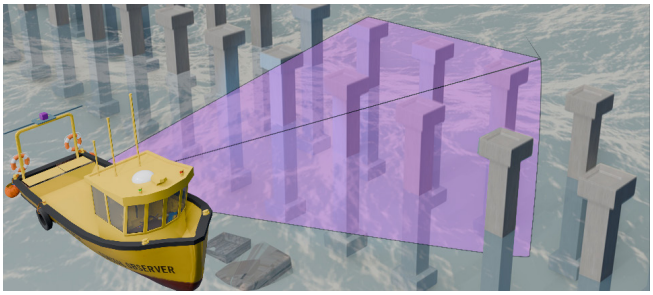
6D PIPE allows multiple parallel 5D images to be generated with different imaging and sonar parameters. This allows different processing to be performed on the RAW sonar data in parallel and extract more specific results without compromise.

Technology Competitive Advantage

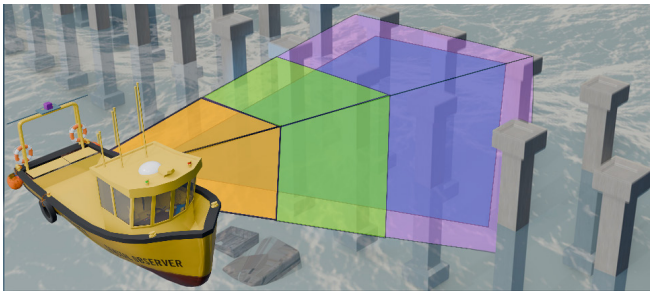
Real-Time Imaging Sonar Systems Comparison



▲ **Multibeam Echosounder**



▲ **Echoscope[4G]®**



▲ **Echoscope PIPE®**

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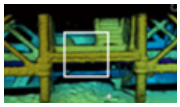
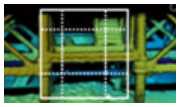
Parallel Intelligent Processing Engine

Acoustic Projector Types

Description	XD Low-Frequency	Mid-Frequency	High-Frequency	XL Wideband
				
Centre Frequency	240kHz	375kHz	630kHz	450kHz
Frequency Range	220kHz – 280kHz	315kHz - 425kHz	550kHz - 700kHz	315kHz - 700kHz
Maximum range^	150 m (492 ft)	120 m (394 ft)	80 m (262 ft)	120 m (394 ft)
^The actual working range will depend on the target's size, reflectivity, and the level of detail required for the application				
Transmit (Tx) Field of View	90°x40° 	52°x52° 	25°x25° 	52°x52° 
Switchable Coverage (Shapes)	Horizontal – Fixed Vertical – Adaptive	Fixed	Fixed	52°x52°, 52°x25°, 25°x52°, 25°x25°

Echoscope PIPE®
Technical Specifications

Performance (by Model)	Dual Frequency	Triple Frequency
Acoustic Projectors	Mid-Frequency (375 kHz) High-Frequency (630kHz)	XD Low-Frequency (240kHz) Mid-Frequency (375 kHz) High-Frequency (630kHz)
Adaptive Frequency Band	375kHz: 315kHz – 425kHz 630kHz: 550kHz – 700kHz	240kHz: 220kHz – 280kHz 375kHz: 315kHz – 425kHz 630kHz: 550kHz – 700kHz
Number of beams (Density)	Up to 256 x 256	
Number of Values Per Beam	2,500 (Dependent on Features Purchased)	
Maximum range*	120m (394ft) at 375 kHz 80m (262ft) at 630 kHz	150m (492ft) at 240 kHz 120m (394ft) at 375 kHz 80m (262ft) at 630 kHz
Minimum range*	0.5m (1.64ft)	
*The actual working range will depend on the target's size, reflectivity, and the level of detail required for the application.		

Echoscope PIPE®
Technical Specifications (Continued)

Performance (by Model)	Dual Frequency	Triple Frequency
Range resolution	3cm (1.2in)	
Update rate (ping rate)	Up to 50Hz	
Angular Beamwidth	Up to 0.6° x 0.6°	
Angular Coverage	315kHz – 425kHz: 54°x54° – 46°x46° 550kHz – 700kHz: 33°x33° – 25°x25°	220kHz – 280kHz: 100°x44° – 76°x33° 315kHz – 425kHz: 54°x54° – 46°x46° 550kHz – 700kHz: 33°x33° – 25°x25°
Physical		
Dimensions (H x W x D) (excluding connectors and handles)	Deepwater / Surface: 328 x 301 x 151mm (12.9 x 11.9 x 5.9in)	Deepwater / Surface: 361 x 301 x 162mm (14.2 x 11.9 x 6.4in)
Weight in Air	Deepwater: 21.7 kg (47.8lb) Surface: 12.1kg (26.7lb)	Deepwater: 22.3kg (49.2lb) Surface: 12.7kg (28.0lb)
Power Consumption	3 – 6 A at 24 V DC **An up to 10 A inrush for less than 20 µs may occur on start-up.	
Depth Rating	We supply Echoscope PIPE® Sonars rated at 40m (131ft), 250m (820ft), 600m(1,968ft) , 2,000m (6,561ft), and 4,000m (13,123ft) – check your packing list containing your Product Certificate which provides details such as depth rating and weight of the actual system purchased. Failure to keep within this depth rating can irretrievably damage the unit.	

Echoscope PIPE® XL
Technical Specifications

Performance (by Model)	250m Rated	600m Rated	2000m Rated	4000m Rated
Acoustic Projectors	XD Low Frequency (240 kHz) XL Wideband (450 kHz)			
Adaptive Frequency Band	240kHz: 220kHz – 280kHz 450kHz: 315kHz – 700kHz			
Number of beams (Density)	Up to 256 x 256			
Number of Values Per Beam	2,500 (Dependent on Features Purchased)			
Maximum range*	150m (492ft) at 240 kHz 120m (394ft) at 375 kHz 80m (262ft) at 630 kHz			
Minimum range*	0.5m (1.64ft)			

*The actual working range will depend on the target's size, reflectivity, and the level of detail required for the application.

Echoscope PIPE® XL
Technical Specifications (Continued)

Performance (by Model)	250m Rated	600m Rated	2000m Rated	4000m Rated
Range resolution	3cm (1.2in)			
Update rate (ping rate)	Up to 50Hz			
Angular Beamwidth	Up to 0.6° x 0.6°			
Angular Coverage	220kHz – 280kHz: 100°x44° – 76°x33° 315kHz – 700kHz: 54°x54° – 25°x25°			
Physical				
Dimensions (H x W x D) (excluding connectors and handles)	413 x 300 x 164mm (16.3 x 11.8 x 6.5in)			
Dimensions (H x W x D) (including Echoscope® Protective Cover)	418 x 310 x 167mm (16.5 x 12.2 x 6.6in)			
Weight in Air	27.7kg (61.1lb)			
Power Consumption	3 – 6 A at 24 V DC **An up to 10 A inrush for less than 20 µs may occur on start-up.			
Depth Rating	We supply Echoscope PIPE® XL Sonars rated at 250m (820ft), 600m(1,968ft), 2,000m (6,561ft), and 4,000m (13,123ft) – check your packing list containing your Product Certificate which provides details such as depth rating and weight of the actual system purchased. Failure to keep within this depth rating can irretrievably damage the unit.			

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