



# The Sound Solution for Deep-Towed Sonar



## Features

- Full Spectrum Chirp Dual Frequency Side Scan Sonar
- Full Spectrum Chirp Sub-bottom Profiler
- Full Spectrum Chirp Swath Bathymetry
- Digital Telemetry Link on Coax or Fiber Optics Cable
- Analog and Digital Channels for User Supplied Sensors
- Plug 'n Tow™ Factory Tested Optional Sensors
- Emergency Recovery

## Applications

- Deep Water Geo-hazard Surveys
- Geological/Geophysical Surveys
- Buried Pipeline and Cable Location
- Route Surveys
- Archeological Surveys

EdgeTech's Deep Towed Sonar system is an integrated underwater vehicle that gathers any combination of side scan, sub-bottom and swath bathymetry data utilizing EdgeTech's proprietary Full Spectrum CHIRP technology in water depths up to 6000 meters. User supplied sensors and a series of sensors that have been tested by EdgeTech (Plug 'n Tow) may be integrated with the system. All data is transmitted to the surface on EdgeTech's StarMux digital link via a coax cable.

## Side Scan Sonar Option

The Full Spectrum Chirp side scan sonar is a calibrated wide band digital FM sonar that provides quantitative and qualitative, high resolution, low-noise side scan imagery. It simultaneously transmits linearly swept FM pulses centered at 2 discrete frequencies. The two options are 75 kHz and 410 kHz simultaneously or 120 kHz and 410 kHz.

A Digital Signal Processor (DSP) in the Full Spectrum (FS-DW) electronics on the tow vehicle holds the two waveforms to be transmitted. At periodic intervals, the waveforms are sent to a Digital to Analog Converter (DAC) that generates an analog pilot signal. These Frequency Modulated signals are then amplified and transmitted by a set of wide band transducers. The sampled acoustic return is sent to a Digital Signal Processor (DSP) for match filter processing.

Full Spectrum signal processing technology uses a proprietary matched filter to process wideband signals. This matched filter uses special amplitude and phase weighting functions for the transmitted pulse and a pulse compression filter that maximizes the Signal to Noise Ratio (SNR) of the acoustic images over a wide band of operating frequencies. These signal processing features provide a significant SNR improvement in the acoustic image generated by other impulse and chirp sonar with band limiting components that are limited in dynamic range.



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One of the outstanding aspects of Full Spectrum signal processing is the use of a broad bandwidth transmitting pulse that sweeps out over a range of frequencies. This generates a great deal of acoustic energy in the water. Instead of trying to operate with one very sharp acoustic peak pulse, like conventional CW systems, the Full Spectrum sonar spreads the transmission out over a long time duration. In addition, to the resolution improvement, the process of correlation processing achieves a signal processing gain over the background noise. To equal the typical performance of the Full Spectrum sonar pulse, conventional pulsed sonar would have to operate at a peak pulse power 100 times higher than the Full Spectrum pulse.

An additional feature of Full Spectrum sidescan is the reduction of side lobes in the effective transducer aperture. The wide band and linearity of the FM sweep smears the side lobes of the transducer and thus achieves a beam pattern with virtually no side lobes.

### Sub-Bottom Profiler Option

The sub-bottom profiler provides sensor packages with Full Spectrum pulses in the ranges of 4-24 kHz, 2-16 kHz and 1-6 kHz. Separate hydrophones are mounted on the underside of the vehicle to provide a narrow acoustic beam width. The transmitters and receivers are custom designed and built to operate over a large contiguous bandwidth.

An important feature, which enhances the ability of the Full Spectrum Sub-bottom Profiler system to classify sediments, is realized by the built-in de-convolution of the system response from the output pulse. The sonar's system impulse response is measured at the factory and is used to design a unique output pulse that will prevent the source from ringing. In addition to this, the Full Spectrum wavelet is weighted in the frequency domain to have a Gaussian like shape. As the Gaussian shaped spectrum is attenuated by the sediment, energy is lost but its bandwidth is preserved. Thus, even after being attenuated by 20 meters of sand, the Full Spectrum pulse has approximately the same resolution as a non-attenuated pulse.

The output of the matched filter processing in the underwater electronics is transmitted to the surface on the StarMux digital link. EdgeTech records the correlated data with phase information intact. Since nonlinear operations are not done on the correlated data, one can easily derive the raw data from the stored correlated data. Storage in this form allows the user the option to exercise the post-processing feature on any properly equipped computer without the unnecessary and time-consuming requirement to pass the data through a matched filter again.

### Swath Bathymetry Option

EdgeTech uses two interferometric arrays to extract long range high accuracy bathymetric data from the side scan sonar arrays. The operating frequency is centered on the 120 kHz chirp frequency. The array resolution is 1.5 degrees using a Kaiser-Bessel weighting function to reduce side lobes to less than 25 dB. Digital filtering is used to remove cross talk and interference between the sub-bottom

and sidescan sonar channels. Digital filtering is preferred to analog since it provides phase repeatability necessary for the interferometric measurement.

Each interferometric array generates three split phase time series signals that have TVG applied using a programmable low noise pre-amplifier. Within the tow vehicle, the signals are then anti-aliased filtered and A/D converted. DSP processors in the underwater electronics accomplish matched filter compression using a properly compensated inverse filter to account for phase and frequency variations in the array to process the signals. Each of the three, split phase, individual compressed signals are then used to calculate the envelope and phase difference for each pixel. This information is sent to the surface on the StarMux™ digital link and used along with vehicle motion data to provide both side scan and bathymetric images on the topside display processor.

The operating frequency centered on 120 kHz is used to provide a 6 dB rejection improvement of interference from sub-bottom layers in soft mud type bottom conditions. Interferometric side scan sonar operating at this frequency performs well in most bottom conditions. EdgeTech's interferometric arrays are designed to utilize 3 individual phased arrays rather than the standard 2 array configuration used in most bathymetric side scan sonars. The benefits of this approach include...

1. Provides a 3 dB of improvement in noise rejection and a corresponding improvement in phase measurement accuracy. This translates to an expected range performance that is not reduced significantly over a 40 to 50 kHz system.
2. In using three arrays for the phase measurement system, we are able to provide vertical shading on transmission to reduce the sonar energy directed at the surface without affecting range performance. This is a very important feature for reducing spurious phase errors caused by surface scattering.
3. The three-array configuration provides three separate phase measurements (two at .5 wavelength and one at 1 wavelength separation) that are averaged for superior noise and interference reduction and improved accuracy in calculating the depth of the seafloor.

EdgeTech has carefully designed the analog to digital conversion and decimation process using precise digital filtering methods to prevent aliasing errors and phase uncertainty, common in analog systems, from corrupting the phase measurement process. When taken together, these features will provide superior performance in side scan and bathymetry. To improve the accuracy of the collected measurements the topside processor uses bathy-thermograph or sound velocity data.

### StarMux™ Digital Telemetry Link

The StarMux™ telemetry link allows the user to operate the system using a single coax conductor. Power to the underwater electronics, command & control, and sonar data share the same coaxial wire. The type of conductor determines the length of cable that can be expected to work. The length affects the expected bit rate. Cables to 10,000 meters long can be expected to work with the link.



The StarMux™ link is dynamically adaptive to cable characteristics. Bandwidths from 300 kilobits/sec. to 6 megabits/sec. can be expected.

### Plug 'N Tow™ Sensors

In addition to the Full Spectrum sensors, the user can also gather additional data with a series of optional Plug 'n Tow™ systems. Both EdgeTech and the product manufacturer have tested our products together. An example is a magnetometer. Both manufacturers certify that the two systems will work together without needing to contact the manufacturers.

### Emergency Recovery (Option)

An emergency recovery option is available for the system. With this option, the vehicle is towed behind a depressor weight. There is removable syntactic foam package on the vehicle to give it positive buoyancy. An emergency release system using an EdgeTech acoustic release and explosive cable cutter will permit the recovery of the tow vehicle without serious damage or loss under the deep-sea environment. A Xenon strobe and Radio Direction Finder help in surface detection and recovery.

Contact EdgeTech for Full Spectrum Systems that are available in several other deployment options:  
Hull Mount, Shallow Tow, ROV Mount, and AUV/UUV Mount.

## FULL SPECTRUM UNDERWATER TOW VEHICLE (TV-D)

<b>Length:</b>	2.3 m.
<b>Width:</b>	63 cm.
<b>Height:</b>	63 cm.
<b>Weight:</b>	295 kg.

## FULL SPECTRUM CHIRP SIDE SCAN SONAR

<b>Modulation:</b>	Full Spectrum Chirp Frequency Modulated Pulse with amplitude and phase weighting
<b>Dual Frequency Combinations:</b>	75/410 kHz or 120/410 kHz

#### Common

<b>Vertical Beam Width:</b>	70°
<b>Depression Angle:</b>	10°, 15°, 20° from vertical, adjustable
<b>A/D Resolution:</b>	16 bits
<b>Sample Rate:</b>	940 K samples per second

#### Frequency Specific

<b>Center Frequency:</b>	75 kHz	120 kHz	410 kHz
<b>Pulse Bandwidth:</b>	7.5 kHz	12 kHz	41 kHz
<b>Pulse Length:</b>	13 ms	8.3 ms	2.4 ms
<b>Range Scale Selection:</b>	50-1250 m. per side	25-500 m. per side	12.5-100 m. per side
<b>Maximum Ping Rate:</b>	15 pps	30 pps	60 pps
<b>Range Resolution:</b>	10 cm.	6.25 cm.	1.8 cm.
<b>Horizontal 3 dB Beam Width:</b>	0.8°	0.8°	0.5°
<b>Transmit Power:</b>	200 Watts	200 Watts	160 Watts
<b>Peak Source Level:</b>	210 dB (ref. 1 µPa @ 1 meter)	210 dB	216 dB
<b>Receiver Sensitivity:</b>	-190 dB (ref. 1 Volt / µPa @ center freq.)	-190 dB	-196 dB

#### Transducers - Physical

<b>Combination:</b>	75/410 kHz	120/410 kHz
<b>Size:</b>	6.4 W x 6.4 D x 99.1 L (cm)	6.4 W x 6.4 D x 99.1 L (cm)
<b>Weight in Air:</b>	27.7 kg	27.7 kg
<b>Weight in Salt Water:</b>	14.7 kg	14.7 kg

#### Options

<b>Pulses:</b>	Custom pulse bandwidths and pulse widths
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**FULL SPECTRUM CHIRP SUB-BOTTOM PROFILER**

**Modulation:** Full Spectrum Chirp Frequency Modulated Pulse with amplitude and phase weighting  
**Source Level:** 200 dB re 1 µPa at one meter  
**Transmit Power:** 200 Watts  
**Receive Sensitivity:** -204 dB re 1 µPa at one meter  
**Receiver Variable Gain:** 38 – 105 dB, automatic or manual control  
**Noise Level:** 70 dB re 1 µPa at one meter over sonar bandwidth (at hydrophone input)  
**Pulse Repetition Frequency:** 15 Hz maximum  
**Calibration:** Each system is acoustic tank tested to calibrate for reflection coefficient measurements

<b>Sensor Model:</b>	<b>DW-424</b>	<b>DW-216</b>	<b>DW-106</b>
<b>Frequency Band:</b>	4-24 kHz	2-16 kHz	1-6 kHz
<b>Number of Hydrophone Arrays:</b>	2	2	2
<b>Pulse Selections:</b>	4-24 kHz / 10 ms	2-15 kHz / 20 ms	1-6 kHz / 40 ms
	4-20 kHz / 10 ms	2-12 kHz / 20 ms	2-6 kHz / 40 ms
	4-16 kHz / 10 ms	2-10 kHz / 20 ms	1.5-4.5 kHz / 40 ms
<b>Resolution:</b>	4-8 cm.	6-10 cm.	15-25 cm
<b>Beam Width:</b>	15°- 25°	15°-25°	28°-36°

*Weight in Air*

<b>Transmitter with Bracket:</b>	10 kg	20 kg	40 kg
<b>Hydrophone Array with Bracket:</b>	6 kg	8.6 kg	12.8 kg
<b>Transmitter Alone:</b>	7 kg	14.1 kg	33.9 kg
<b>Hydrophone Alone:</b>	0.9 kg	1.4 kg	4.5 kg

*Weight in Salt Water*

<b>Transmitter with Bracket:</b>	4.3 kg	8.8 kg	21.8 kg
<b>Hydrophone Array with Bracket:</b>	3.2 kg	5.2 kg	7.4 kg
<b>Transmitter Alone:</b>	4 kg	7 kg	14.4 kg
<b>Hydrophone Alone:</b>	0.2 kg (each)	0.3 kg (each)	0.4 kg (each)

*Options*  
**Pulses:** Custom pulse bandwidths and pulse widths

**ATTITUDE SENSORS**  
**Heading:** Contact Factory  
**Roll, Pitch Angle Accuracy:** 1° RMS  
**Roll, Pitch Angle Repeatability:** 0.5°  
**Roll, Pitch Angle Linearity:** < 1% of Full Scale (FS roll = 180°, FS pitch = 90°)  
**Bandwidth:** DC – 10 Hz

*Specifications subject to change without notice.*

**USER PORTS**  
**Fast Analog Ports:** Up to 6 50 kHz ports (depends on configuration of system)  
 Ports used: SBP (1), SSS (2-4)  
 4 10 Hz each  
**Slow Analog Ports:** 4 RS-232 bi-directional ports 9600K Baud each  
**Serial Ports:** 4 RS-232 bi-directional ports 9600K Baud each  
**Hardware Trigger In:** TTL, minimum 5 µs pulse, controls 5 channels sub-bottom profiler (1), side scan sonar (4)  
**Hardware Trigger Out:** Open collector TTL, 250 µs negative going pulse  
**Software Trigger In:** Via Ethernet port, 10 ms accuracy  
**Software Time Sync In:** 10 ms accuracy typical (through Ethernet port)  
**Hardware Time Sync In:** TTL level, minimum 5 µs pulse, triggers on negative edge, normally 1 PPS

**STARMUX™ TELEMETRY**  
*Physical (Surface Module)*  
**Dimensions:** 43.5 cm. W x 9.0 cm. H x 41.0 cm. D (19" rack mountable)  
**Weight:** 7.0 Kg (15.4 lbs.)  
**Power:** 115-230 VAC (auto sensing), 50-60 Hz

*Features*

**Link Performance:**

	Estimate(m.) / MBit	
	Rate per sec.	Tested (m.)
Rochester A301241 (.68 in.)	9000 / 1-4	6000 / 4.5
Rochester A302799 (.45 in.)	5000 / 1-4	
Rochester A220327	3700 / 1-4	
Rochester 301301	2500 / 1-4	

**Optional Power Out:** 48 VDC, 50-150 watts  
**Other Features:** short-circuit shut down (self recovery on turn off), over voltage shut-down

**SURFACE DISPLAY PROCESSOR**  
 Manufacturers with support: EdgeTech, CODA Technologies Ltd., Sea Corp, TEI Inc.

\* Contact Factory  
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