Introduction

This hydrophone is designed to provide maximum sensitivity in a small size while also providing a linear response in the frequency range from 1Hz to 100kHz (±2 dB). The standard quality control allows for a +/- 3dB deviation of nominal sensitivity. It is thus well-suited for absolute underwater sound level measurements in marine and industrial environments. It can also be used as an omnidirectional reference projector. It is very durable and can interface directly with a charge amplifier or high-input-impedance voltage amplifier. It has a smaller size and much lower specific gravity than the HDP-H1A hydrophone and thus can be inserted into pipes and other tight spaces. Its low mass and full polyurethane rubber encapsulant make it highly resistant to damage caused by impact.

To maintaining negative buoyancy underwater, it is assembled with a 150g sliding stainless steel weight on the cable. There are several advantages to placing the weight on the cable rather than building it into the hydrophone. When the hydrophone is dropped, the cable flexes and absorbs any stress from impact, making the hydrophone more durable. The weight can be moved if need to allow insertion into a pipe. Both of these attributes are especially useful to the leak finding specialist. Moving the weight away from the hydrophone dampens acceleration noise that is transmitted down the cable from handling and it also minimizes response irregularities caused by material resonances and sound reflections. It can also be used for mounting a shroud tube to minimize flow noise over the hydrophone. To move the weight, turn the black plastic thumbscrew counter-clockwise to loosen the internal rubber compression sleeve and slide the weight where needed. Wet the cable if this is difficult. Secure again by turning the thumbscrew clockwise. Be Advised: Finger-tighten thumbscrew only and always leave a minimum spacing of 5 cm between hydrophone and weight!

The hydrophone is passive. There is no preamp or impedance buffer circuit within it. The advantages are that the hydrophone remains as simple and low cost as possible, it does not require any power supply, and it offers a very wide dynamic range. It can work under either charge mode or high impedance voltage mode.

With Low Noise Cable: 9m (default)

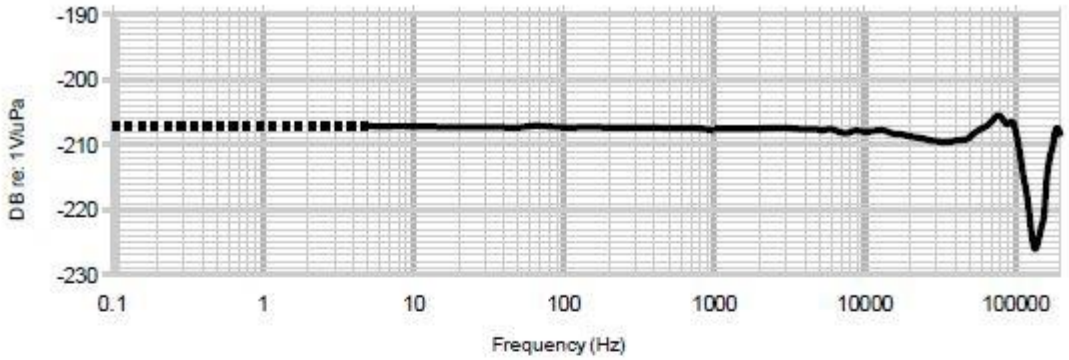
Specifications

Transducer Type	Piezo Element
Linear Frequency Range	1Hz~100kHz (±2dB)
Nominal Receiving Sensitivity	-208dB re: 1V/μPa (i.e. 4.0 ×10^{-5} V/Pa)
Nominal Transmitting Sensitivity	140dB re 1μPa, 1Vrms input at 1m, 90kHz

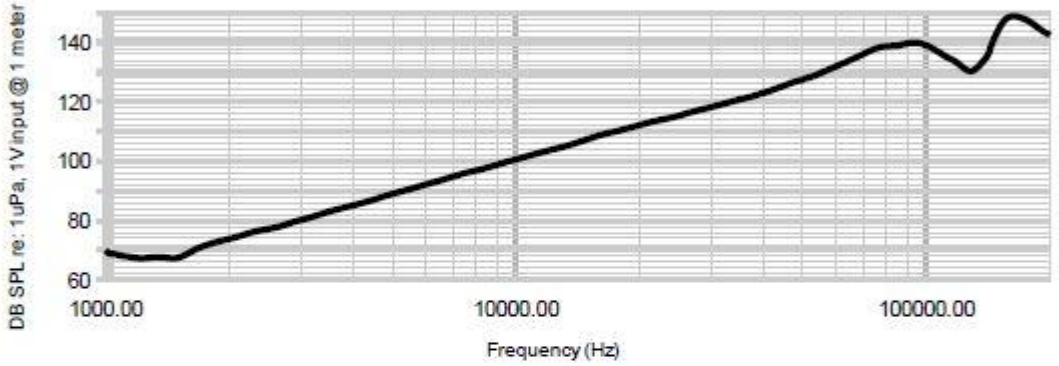
Max. Input Voltage	30Vpp (continuous); 150Vpp (duty cycle <10%, <100kHz)
Horizontal Directivity (20kHz)	±0.2dB
Horizontal Directivity (100kHz)	±1dB
Vertical Directivity (20kHz)	±1dB
Vertical Directivity (100kHz)	-11dB ~ +6dB
Nominal Capacitance	5.4nF ±20% (plus cable @118pF/m) (e.g. total capacitance is 6.5nF for the hydrophone with a 9m cable)
Nominal Charge Sensitivity	0.26 pC/Pa
Operating Depth	<200m
Survival Depth	<350m
Operating Temperature Range	-10℃ ~ +80℃
Size	Φ12mm × 40mm
Weight	8g (plus cable @ 28g/m)
Specific Gravity	close to neutral buoyancy
Added Weight	150g
With Built-In Preamp	No
Connector	BNC
Cable Jacket	Polyurethane, OD: 4.5mm
Encapsulant	Polyurethane

Note: Factory quality control includes a pressure test of a minimum two hours at 30 meters equivalent water depth, a capacitance tolerance measurement, an in-air sensitivity comparison to a calibrated reference (passed if within ± 3dB of mean, <±2dB typical), and a listening test. It can also be sold with a precision calibration from the US Navy Underwater Sound Reference Division at an additional cost (see below example).

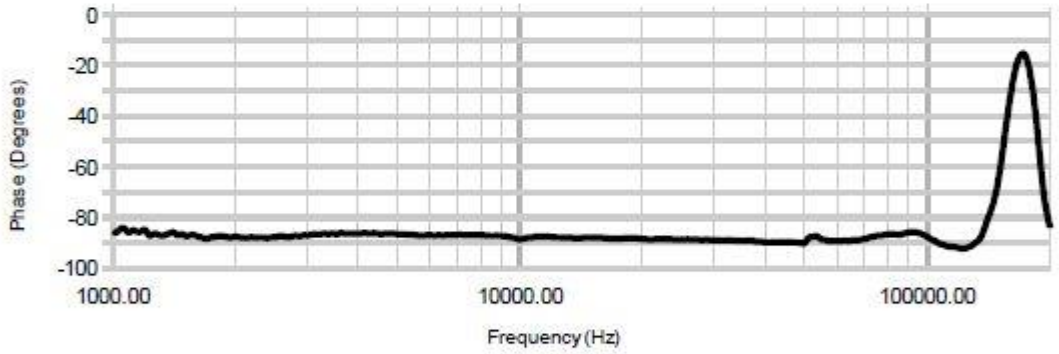
Free Field Voltage Sensitivity



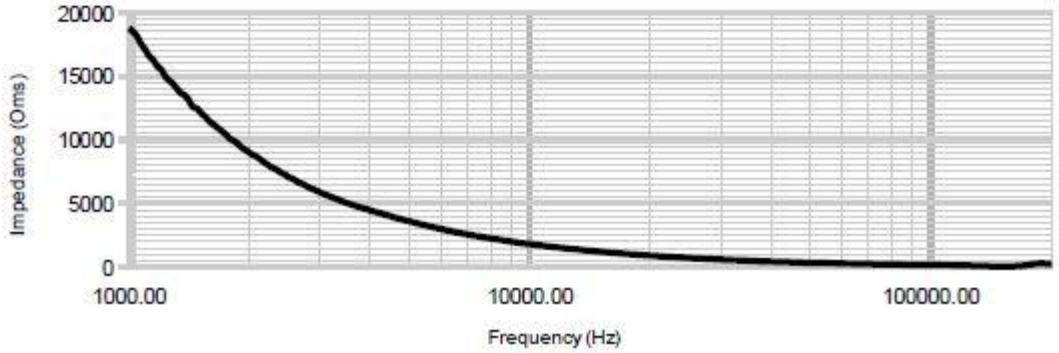
Transmitting Voltage Response



Impedance Phase



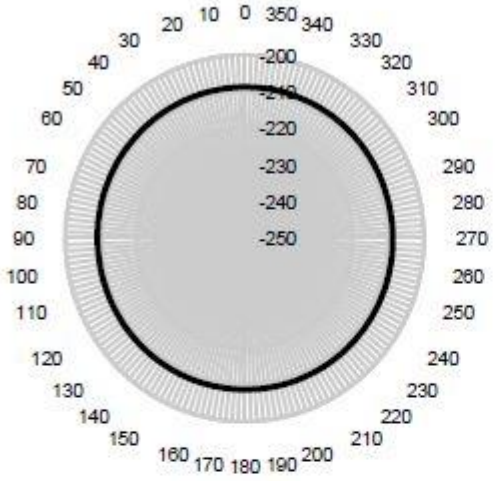
Impedance Magnitude



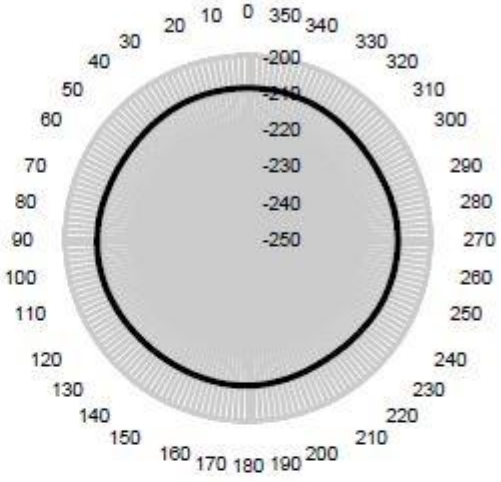
FFVS: Nominal 5Hz – 100KHz, -207.6 (+2.1 / -2.0) dB re: 1V/uPa. Not tested (theoretical) below 5Hz.

SN#: (typical)

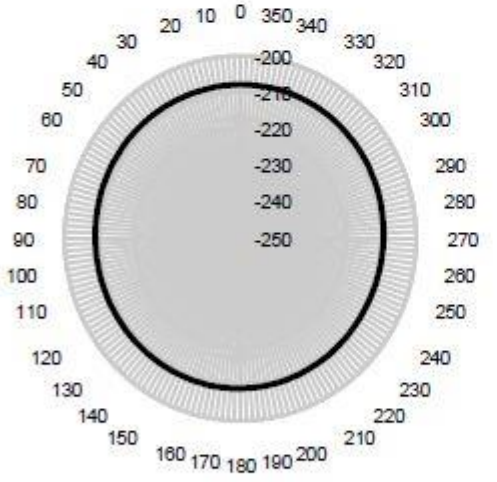
Directional Response, 20KHz XY (Horizontal)



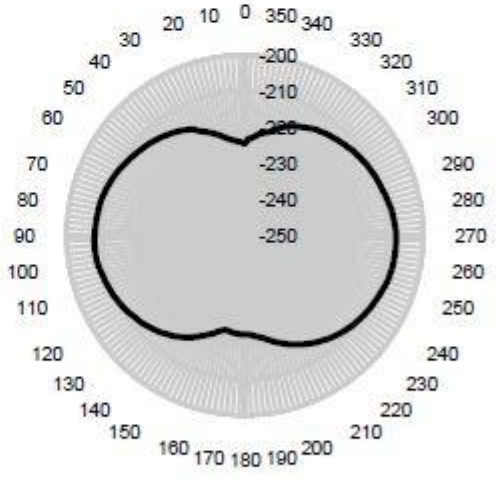
Directional Response, 20KHz XZ (Vertical)



Directional Response, 100KHz XY (Horizontal)



Directional Response, 100KHz XZ (Vertical)



NOTES:
Data obtained from US Navy, Underwater Sound Reference Division, Newport. Average of three samples measured, June 2013.

Measurements taken at end of 9-meter cable

FFVS Low frequency response is limited by amplifier input impedance. Fc= 1/4.71e-8(amplifier input impedance) – Approximately 1Mohm for 20Hz cutoff; 22Mohm for 1Hz; 220Mohm for 0.1Hz.

Directional Response: Hydrophone rotated on same axis as the cable for XY measurements. XZ measurements are made with rotation perpendicular to the cable and with origin (0 degrees) facing end opposite the cable.

Used under Charge Mode

When the hydrophone is used with a charge amplifier followed by a data acquisition device, such as CAMP-2G05, the underwater sound level measurement range will be determined by the

sensitivity and measurement range of the hydrophone as well as the full-scale input charge and signal-to-noise ratio of the data acquisition device. For example, if the charge sensitivity of the hydrophone is 0.26 pC/Pa and the full-scale measurement range of the charge data acquisition device is 250 pC, then the maximum underwater sound level measurable would be: $20\times\log_{10}((250/1.414)/0.26/(1\times10^{-6}))\approx 177$ dB, where 1.414 is used to convert peak value to RMS value, and 1×10^{-6} Pa is the 0 dB reference in water. If the charge data acquisition device has multiple full-scale charge ranges (e.g. VT CAMP-2G05): 250pC, 500pC, 1nC, 2.5nC, 5nC, 10nC, 25nC, 50nC, 100nC, 250nC, 500nC, 1μC, then the maximum underwater sound level measurable would be 177dB, 183dB, 189dB, 197dB, 203dB, 209dB, 217dB, 223dB, 229dB, 237dB, 243dB and 249dB, respectively.

The advantage of using a charge amplifier is that the signal will not be attenuated by cable capacitance unlike the case of a voltage amplifier. A charge amplifier usually has an ultra low high-pass cutoff frequency, thus the extreme low frequency noise of the hydrophone resulting from the movement by towing or waves may get through.

Used under High Impedance Voltage Mode

It is possible to use the hydrophone with a high-input-impedance voltage amplifier followed by a data acquisition circuit, such as a DSO which usually has an input impedance equal to or greater than 1MΩ. The higher the input impedance and the shorter the cable, the lower the high-pass cutoff frequency. For this hydrophone with a cable length of 9m, the cutoff frequency can be estimated by:

$$f_c = 1/(0.000000038\times R)$$

where R is the input impedance of the voltage amplifier. For example, if R=1MΩ, the f_c=26Hz.

Voltage sensitivity is normally given with the default cable length. If the voltage sensitivity of the hydrophone is 4.0×10^{-5} V/Pa and the full-scale measurement range of the voltage data acquisition device is 0.01V, then the maximum underwater sound level measurable would be: $20\times\log_{10}((0.01/1.414)/0.00004/(1\times10^{-6}))\approx 165$ dB.

Maintenance

No special care is required for the hydrophone. It is designed to withstand corrosion from seawater and the impact of accidental drops. Although it is quite tough for what it is, but note that it is a sensitive instrument. Avoid throwing it into the water, or any other activity that may result with an impact to the hydrophone. Try to keep the output plug clean and dry and avoid unnecessarily rough handling to ensure the long-term stability of the product. It is best NOT to store the hydrophone in a waterproof enclosure. Doing so will trap moisture, salts and minerals that are left on the hydrophone and cable after deployment and prematurely corrode the output plug. Making an extra effort to coil the cable neatly when retrieving the hydrophone will help avoid problems with tangles as the cable ages. Most importantly, protect the cable from cuts and abrasions! The hydrophone uses a custom-made cable with a very durable PU jacket. However, it is also designed to be compact and flexible. Kinking the cable, walking on it, or dragging it over a sharp or abrasive surface may damage the cable sheath and eventually cause the hydrophone to fail. Both aquatic and terrestrial animals may attack the cable in an unattended application. Using some kind of cable conduit, such as plastic tubing, can help to protect the hydrophone in long-term installations.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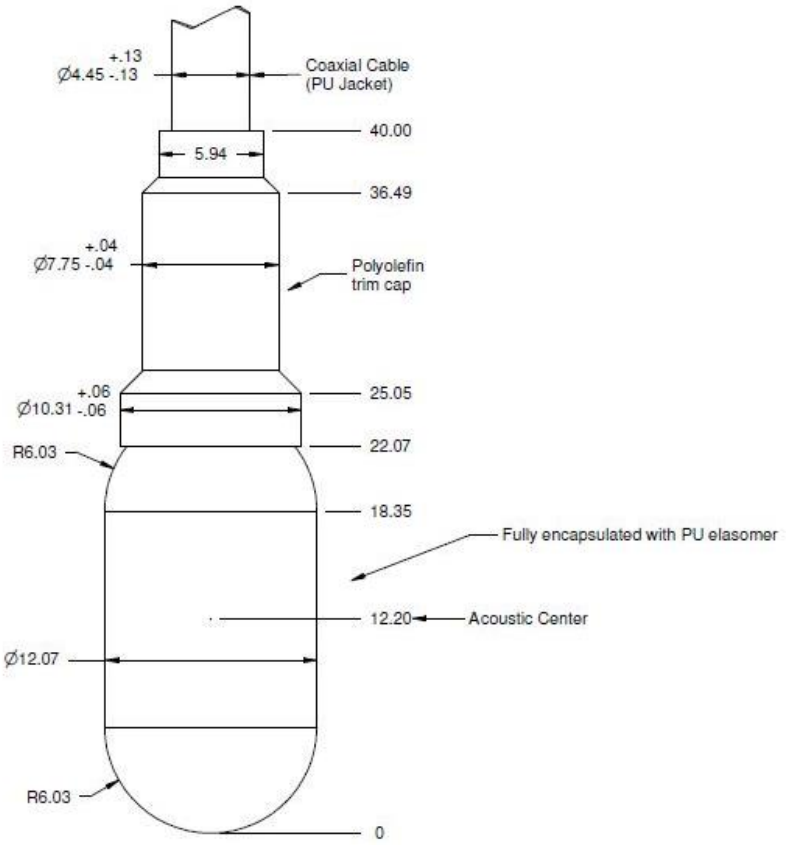
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Ø4.45 -.13
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+.04
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Polyolefin
trim cap
+.06
Ø10.31 -.06
25.05
22.07
R6.03
18.35
Fully encapsulated with PU elasomer
12.20
Acoustic Center
Ø12.07
R6.03
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