BII SE=SL-TL+AG-NL

Benthowave Instrument Inc.

Underwater Sound Solutions www.benthowave.com Revised on 2024/11/27

BII7180 Series Miniature Probe Hydrophone and AE Sensor: Φ1.0 to Φ3.0mm Aperture

BII7180 Series Miniature Probe Hydrophone and AE Sensor

Underwater Sounds: BII7180 series are miniature hydrophones with small aperture size and usable up to 3 MHz. Conical and omnidirectional directivity patterns are available. Multiple miniature probe hydrophones can be configured as a vector hydrophone (vector sensor) or array for uses in extraction of directional information (source location), measurement of particle velocity, particle acceleration and pressure gradient.

The probe hydrophones are practical and handy tools for research and application of Helmholtz Integral Equation in underwater acoustics and for the measurement of pressure or intensity distribution of near-field and far-field radiated from vibrational and acoustical sound sources underwater.

NDT in Solids: receiving audible and ultrasonic sounds, acoustic emission (AE), structural health monitoring (SHM), metallurgical properties of metals, etc... The couplant such as water or gel is a must-have material to provide efficient acoustic coupling between the receiving face of the hydrophone and the piece under test (the subject). The hydrophones can be glued on or inside subject permanently with adhesives such as epoxy.

NDT in Fluids: uses in waterlike and airlike fluids for the analysis of their macroscopic and microscopic, physical and chemical properties.

BII7180 series should not be used with flammable and/or explosive materials, and not used in Solvents such as hydrochloric acid, isopropyl alcohol, ethyl lactate, acetone, xylene, Iso hexanes, mineral spirits, etc...

Technical Notes:

Particle Velocity in x direction ux = - 1/(jωρ)*(ap/ax); ρ: Density; ap/ax: Pressure Gradient in the x direction.

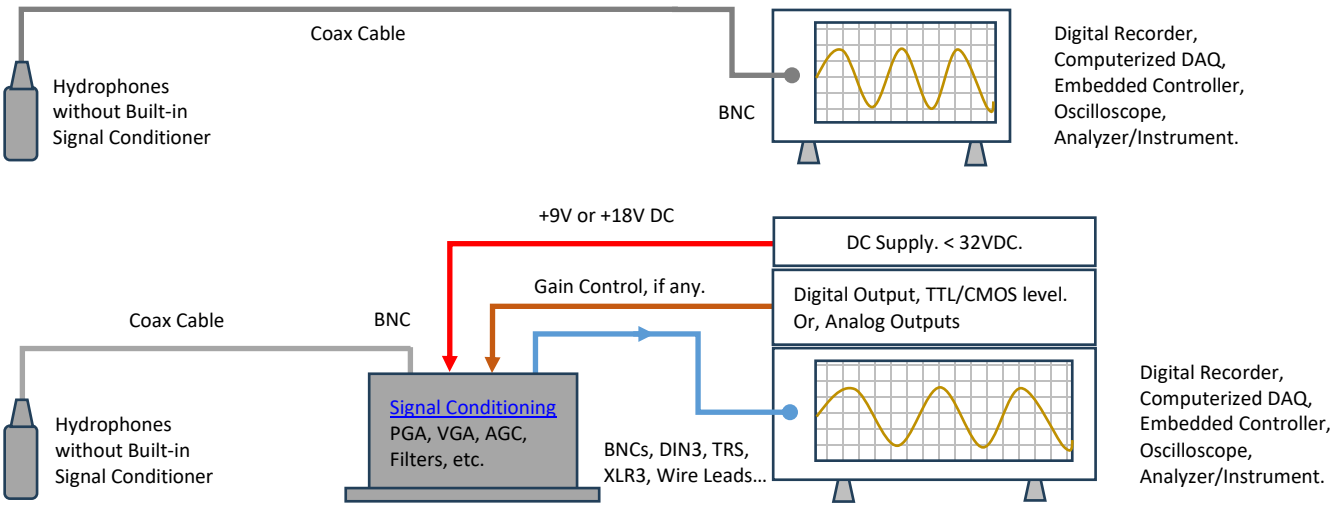
Dipole Vector Hydrophone: Voltage Response V=M*(d/λ)*cosθ; M: Amplitude Constant related to element sensitivity; d: spacing distance between two elements; θ: Arriving angle from the axis of the two elements.

Helmholtz Integral: $p(\vec{r}) = \frac{1}{4\pi}\iint\left[\frac{e^{-jkR}}{R}j\omega\rho u(\vec{r_0}) + p(\vec{r_0})\frac{\partial}{\partial n_0}\left(\frac{e^{-jkR}}{R}\right)\right]dS_0$

Typical Applications

Study of Acoustic Radiation Field	General Purpose Hydrophone, Reference Hydrophone
Ultrasonic Testing and Analysis	Acoustic Emission (AE), Structural Health Monitoring (SHM), Thermoacoustic Tomography
Helmholtz Integral in Acoustics	Near-field Calibration and Measurement
Elements of Vector Hydrophones/Array	High Sound Level Measurement (Warning: Cavitation will damage hydrophone)
Research in Boundary Element Acoustics	Trouble-shooting, Maintenance and Development of Transducers and Array

System Configuration of Receiving Sounds and Waves.



Specification

The hydrophone is tested in water unless stated otherwise.			
Part Number:	**BII7185**		
Sensitivity @ 1kHz:	1m Coax, BNC: -267.0 dB V/μPa, ± 10 dB,	0.5m Coax, BNC: -262.0 dB V/μPa, ± 10 dB.	0.3m Coax, BNC: -258.0 dB V/μPa, ± 10 dB,
	Sensitivity Loss over Extension Cable (dB) = 20*log[C_h/(C_h+C_c)]. Valid for hydrophone without preamplifier. C_h: Hydrophone Capacitance; C_c: Capacitance of Extension Cable. Cable is of 100 pF/meter roughly.		
FFVS:	Free-field Voltage Sensitivity, Refer to Graph of FFVS vs. Frequency.		
Usable Frequency: in Water.	8 Hz ~ 2 MHz		
	C_h and R_i constitute a high pass filter. -3dB high pass filter $f_{-3dB} = 1/(2\pi R_i C_h)$. R_i: Input Resistance or Impedance of Preamp. C_h: Capacitance of hydrophone at 1 kHz. For example: A BII7185 and a BII1041 preamp of R_i = 22 MΩ are used to detect sounds, -3dB high pass frequency of detection = 36.2 Hz.		
Usable Frequency in Air:	36.2 Hz ~ 215 kHz at -6 dB V/μPa.		

Capacitance C_h @ 1kHz:	200.0 pF ± 10%	110.0 pF ± 10%	68.0 pF ± 10%
Dissipation @ 1kHz:	0.003		
Noise Density at f << fs: dB µPa/√Hz	79.0 – 10*log f		
	1. f in kHz; fs: Resonance Frequency which is close to the frequency of maximum FFVS. 2. Noise densities in this datasheet are calculated values with transducer parameters being measured in water. 3. As hydrophones works with preamps or data acquisition modules, total noise density is determined by all noise sources. Generally, the total noise density is much higher than the ones stated in this datasheet.		
Directivity Pattern:	Conical Beam		
Beam Width:	θ_{-3dB} = 88344°/f(kHz); θ_{-6dB} = 121920°/f(kHz); θ_{-10dB} = 159000°/f(kHz). f: Operating Frequency in kHz.		
Side Lobes:	< -17.8 dB with $\theta_{-3dB} \leq 49°$; No side lobe with $\theta_{-3dB} > 49°$.		
Signal Output Type:	Single Ended		
Acceleration Sensitivity:	132.0 dB µPa/(m/s²) at acoustic axis. ≤ 129.0 dB µPa/(m/s²) at other directions.		
Underwater Projector:	Yes.		
Resonance fs:	1.62 MHz ± 10%		
TVR at fs:	128 dB µPa/V at 1m.		
	Approximately, TVR drops 12dB/octave below fs and drops 6dB/octave above fs.		
Maximum Drive Voltage:	200 Vpp		
Maximum Pulse Length:	100 mS at Maximum Drive Voltage		
Duty Cycle:	10% at Maximum Drive Voltage. 100% at ≤ 30 Vpp or 10.6 Vrms.		
Operating Depth:	1 m, Maximum.	0.5 m, Maximum.	0.3 m, Maximum.
	Limited by the cable length if the cable has wire leads or a non-waterproof connector.		
Mounting Options:	Free Hanging (**FH**). Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.		
Cable Options:	Coax, ΦD=1.4 mm (**MiniCoax**).		
Cable Length:	1 m.	0.5 m.	0.3 m.
Connector:	Male BNC (**BNC**), Max. Diameter Φ14.3 mm.		
Size:	ΦD = Φ3.0 mm, Length = 15 mm.		
Weight:	16 g with 1m Coax/BNC Male. Actual weight depends on Mounting Parts, Cable Types and Length.		
Operation Temperature:	-10°C to +60°C or 14°F to 140°F.		
Storage Temperature:	-20°C to +60°C or -4°F to 140°F.		
Underwater Projector Application: for 50Ω BNC/SMA/SMC connector, it is buyer's sole responsibility to make sure that the BNC/SMA/SMC shield of the signal source is firmly grounded for operating safety before hooking up transducer/hydrophone to the signal source. Coax with BNC/SMA/SMC is not intended for hand-held use at voltages above 30Vac/60Vdc.			
Do NOT use the hydrophone as a sound projector in the air otherwise the hydrophone will be damaged.			
Sound Measurement in Air: The hydrophones can be used to detect sounds in air. The sensitivity in air is same to the one in water in low frequency range.			

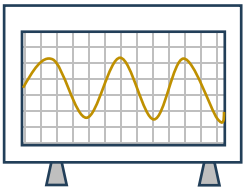
How to Order Standard Hydrophones. BII Keeps Standard Products in Stock**.**

Hydrophone Part Number	**-Mounting Part**	**-Cable Length**	**-Cable Type**	**-Connector Type**
BII7185	**FH**: Free Hanging.	0.3 m, 0.5 m, 1 m.	Mini Coax	BNC
Example:	**Description**			
BII7185-FH-1m-MiniCoax-BNC	BII7185 Hydrophone, Free Hanging, 1m Mini Coax, BNC Male.			
BII7185-FH-0.5m-MiniCoax-BNC	BII7185 Hydrophone, Free Hanging, 0.5m Mini Coax, BNC Male.			
BII7185-FH-0.3m-MiniCoax-BNC	BII7185 Hydrophone, Free Hanging, 0.3m Mini Coax, BNC Male.			

Wirings

Single Ended Output:	**BNC**
Signal	Center Contact
Signal Common and Shielding	Metal Shell

Typical Components of an Acoustic Receiving System. **Depending on the system requirements, the signal conditioner is optional.**



Digital Recorder, Computerized DAQ, Embedded Controller, Oscilloscope, Analyzer/Instrument.

Question:

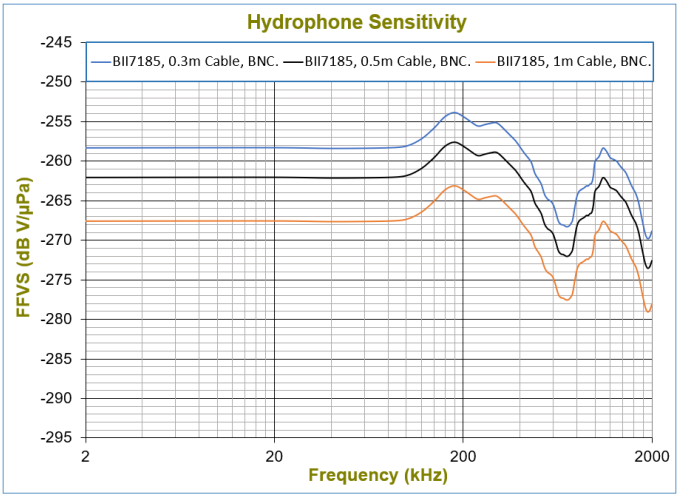
What if the mating connector of my DAQ module or recording device is NOT available from BII? A bespoke connector adaptor might be assembled by BII and BII ships the adaptor to buyer as accessory of the device. Please contact BII for customizations. Many adaptors for standard connectors are available in worldwide electronic suppliers such as BNC to SMA, BNC to SMC, XLR to TRS, etc. Check out your local suppliers.

What if the connector of my analyzer (instrument) is SMA or SMC Connector? Buyer may order a SMA (or SMC) to BNC (Male) adaptor from local electronic distributors in buyer's country. BII may ship the adaptor as accessory of the device if buyer requests when ordering. **By default, BII does NOT supply the adaptor as accessories.**

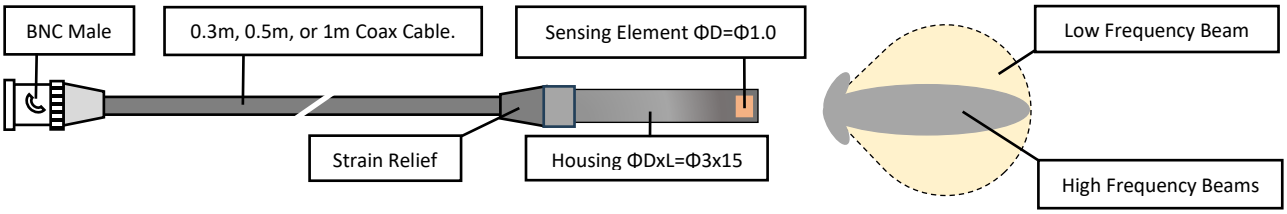
Is impedance matching necessary between hydrophones/sensors and preamplifiers/Recorders/Analyzers? it is NOT necessary to do impedance matching in low frequency range applications in which electromagnetic wave lengths are much greater than the cable length. High frequency transducers such as NDT pulsing transducers need 50Ω impedance matching among transducers, cables, and analyzers/digitizers.

Can BII explain why the capacitance of my hydrophone/transducer affect high pass filtering? (1). Hydrophone/transducer is high impedance devices in low frequency range. Its simplified complex impedance = $j/(2\pi fC_h)$, C_h is the capacitance of hydrophone/transducer, f is frequency in Hz. This impedance is in series with preamp R_i and can reach several MΩ to hundreds MΩ depending on C_h and f. (2). Most high-performance operational amplifiers (IC chips) can use input resistors R_i up to 1 to 200 MΩ to avoid bumping into saturation issue.

Free-field Voltage Sensitivity (FFVS) in Water:



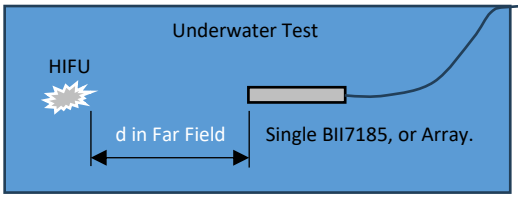
Physical Size (Dimension Unit: mm)



Application Notes.

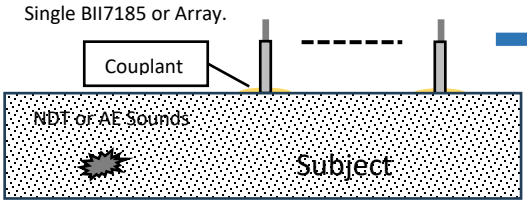
1. Underwater Hydrophones: Measure HIFU (High Intensity Focused Ultrasound) or High Intensity NDT Diagnostic Sounds.

Distance d of Acoustic Far Field of a Transducer:	**Planar Transducer**: d ≥ Radiation Area/λ. **Line (linear) or Thin Cylinder:** d ≥ (Length*Length)/λ and d ≥ Length.



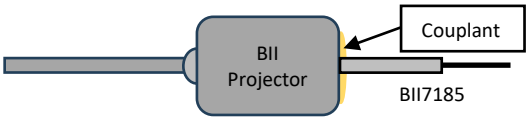
Optional Amplifier → Oscilloscope, DAQ, or Recorder.

2. Acoustic Contact Sensor: NDT and AE Applications, and Structural Health Monitoring (SHM).



Optional Amplifiers. → Oscilloscope, DAQ, or Recorder.

3. Test BII7185 as Acoustic Contact Sensor at BII Laboratory: BII7185 contacts with radiation face of a transducer (projector), water as couplant.



Extra Amplifiers. → Oscilloscope, DAQ, or Recorder.

BII Projector	f	Signal Type	Driving Voltage	Receiver	Extra Preamps	Output Voltage
BII7562/200	200 kHz	SINE and Sine Pulse	5Vpp	BII7185	40dB BII1042 + 40dB BII1051	0.6 Vpp
BII7562/200	630 kHz	SINE and Sine Pulse	5Vpp	BII7185	40dB BII1042 + 40dB BII1051	0.7 Vpp
BII7560Q/1000	1 MHz	SINE and Sine Pulse	5Vpp	BII7185	40dB BII1041 + 40dB BII1042	2.6 Vpp
BII7184EF	2.5 MHz	SINE and Sine Pulse	5Vpp	BII7185	40dB BII1041 + 40dB BII1042	1.0 Vpp