SE=SL-TL+AG-NL

Benthowave Instrument Inc.

Acoustical Solutions: SONAR, NDT/AE, HIFU. benthowave.com Revised on 2025/4/17

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.

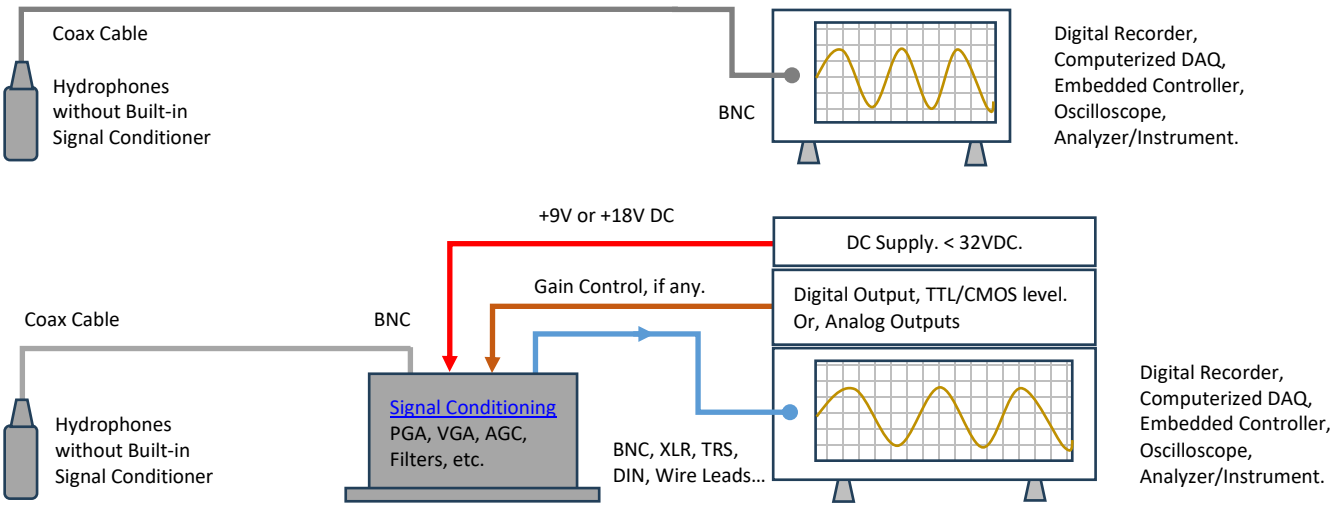
Dipole Vector Hydrophone: Voltage Response V=M*(d/λ)*cosθ; M: Amplitude Constant related to element sensitivity; d: spacing distance between two elements; θ: Arriving angle from the axis of the two elements.

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:	**BII7182**	**BII7182HT**
Aperture Size:	Sensing Element: ΦDxL = Φ1.5x1.5 mm	
Sensitivity @ 1kHz:	-231.0 ± 2 dB V/μPa, with 2m Coax/BNC.	
	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, at ±6 dB V/μPa.	15 Hz ~ 1.6 MHz, at ±3 dB V/μPa.	
	C_h and R_i constitute a high pass filter. -3dB high pass filter f_{-3dB} = 1/(2πR_iC_h). R_i: Input Resistance or Impedance of Preamp. C_h: Capacitance of hydrophone at 1 kHz. For example: A BII7182 and a BII1041 preamp of R_i = 22 MΩ are used to detect sounds, -3dB high pass frequency of detection = 16 Hz.	
Usable Frequency in Air:	15 Hz ~ 25 kHz, at -3 dB V/μPa.	

Capacitance C_h @ 1kHz:	0.46 nF with 2m Coax/BNC, ± 10%.	
Dissipation @ 1kHz:	0.005	
Noise Density at f << fs: dB µPa/√Hz	58.3 – 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:	Omnidirectional Beam to Toroidal Beam, Refer to Graph of **Directivity Pattern**.	
Signal Output Type:	Single Ended	
Acceleration Sensitivity:	125.0 dB µPa/(m/s²) at acoustic axis. ≤ 119.0 dB µPa/(m/s²) at other directions.	
Underwater Projector:	Yes.	
Resonance fs:	790 kHz	
TVR at fs:	140 dB µPa/V at 1m. Approximately, TVR drops 12dB/octave below fs and drops 6dB/octave above fs.	
	100 Vpp	
Maximum Drive Voltage:	100 mS at Maximum Drive Voltage	
Maximum Pulse Length:	10% at Maximum Drive Voltage. 100% at ≤ 30 Vpp or 10.6 Vrms.	
Duty Cycle:	10% at Maximum Drive Voltage; 100% at ≤ 30 Vpp or 10.6 Vrms.	
Operating Depth:	Maximum: 300 m or 3 MPa pressure and, and Limited by the cable length if the cable has wire leads or a non-waterproof connector.	
Mounting Options:	1. Default: Free Hanging (**FH**). 2. Thru-hole Inch Mounting with Single O-ring Sealing (**THM-7/16"**). 3. Thru-hole Inch Mounting with Double O-ring Sealing (**THDO-7/16"**). 4. Bolt Fastening Mounting (Plastics) (**BFMP-M12**). 5. Bolt Fastening Mounting (Stainless Steel) (**BFM-7/16"**).	
	Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.	
Cable Options:	Coax RG174/U (**RG174**).	Coax RG178/U (**RG178)**.
Cable Length:	1. Default: 2 m. 2. Custom-fit Cable Length.	
Connector:	1. Default: Wire Leads (**WL**) 2. Male BNC (**BNC**) (Max. Diameter Φ14.3 mm). 3. SMA (Plug, Male Pin) (**SMA**), Voltage Rating: 335 V_{RMS} Continuous. (Max. Diameter Φ9.24 mm). 4. SMC (Plug, Female Socket) (**SMC**), Voltage Rating: 335 V_{RMS} Continuous. (SMC) (Max. Diameter Φ6.4 mm). 5. Underwater Mateable Connector **UMC2P** is made by global manufacturers, buyer may search online to get detailed specs of these connectors from their manufacturers. Available in-stock options (the customized is available upon request): 2 pin (**UMC2P = MCIL2M + MCDLS-F.**), Max. Diameter Φ21.5 to Φ35 mm. Depth Rating: 950 m.	
	Underwater Mateable Connectors are for underwater uses. Other connectors/wire leads are for dry uses and are not waterproofed.	
1. **BNC**: "Bayonet Neill–Concelman" is a miniature quick connect/disconnect radio/audio frequency connector used for coaxial cable. **Fastening Type**: Bayonet Lock. 2. **UMC**: Underwater Mateable Connectors, interconnection solution for high power or weak signals. **Fastening Type**: Threaded. Underwater Uses.		
Size:	ΦD x L = Φ6.0 x 17 mm.	ΦD x L = Φ5.5 x 17 mm.
	Actual length depends on Mounting Parts if any.	
Weight:	37 grams with 2m 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.	-10°C to +120°C or 14°F to 248°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.		

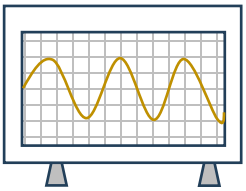
Wirings

Output Signals	**Wire Leads**	**Underwater Connector**	**BNC/SMA/SMC**	**Coax with Wire Leads**
Signal	White or Red	Pin 2	Center Contact	Coax Center Contact
Signal Common	Black	Pin 1	Shield	Coax Shield
Shielding	Shield	Pin 3	Shield	Coax Shield

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

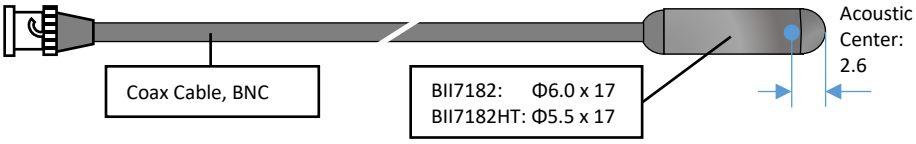
Hydrophone Part Number	**-Mounting Part**	**-Cable Length**	**-Cable Type**	**-Connector Type**
BII7182	**FH**: Free Hanging.	2 m	RG174 Coax	BNC
BII7182HT			RG178 Coax	
Example:	**Description**			
BII7182-FH-2m-RG174-BNC	BII7182 Hydrophone, Free Hanging, 2m RG174 Coax, BNC Male.			
BII7182HT-FH-2m-RG178-BNC	BII7182HT Hydrophone, Free Hanging, 2m RG178 Coax, BNC Male.			

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

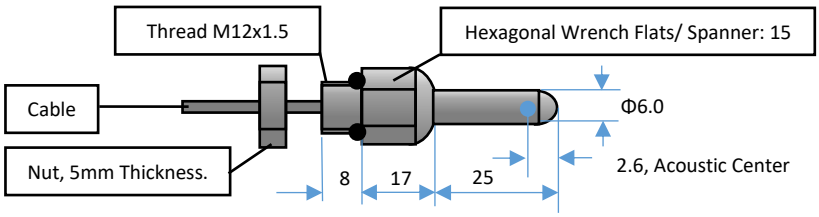


Digital Recorder, Computerized DAQ, Embedded Controller, Oscilloscope, Analyzer/Instrument.

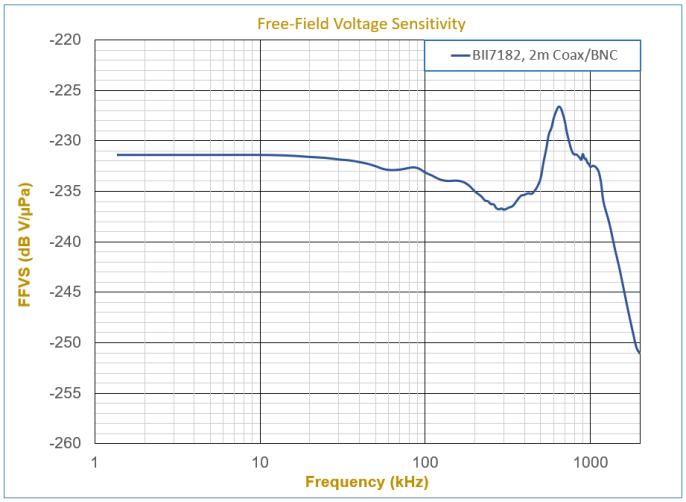
Physical Size (Dimension Unit: mm):
Free Hanging (Depth Rating limited by cable length).



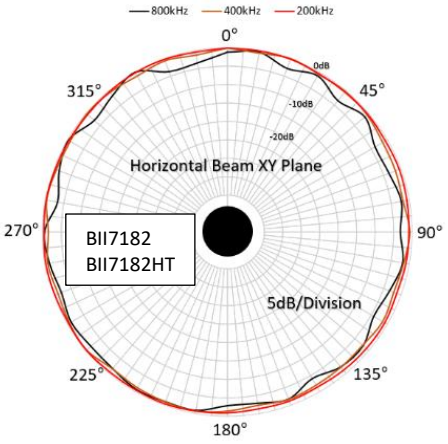
Bolt-fastening Mounting (Plastics) BFMP (300m Depth or 3MPa Ratings) or Thread Mounting into a submersible enclosure (IP68, tighten with o-ring).

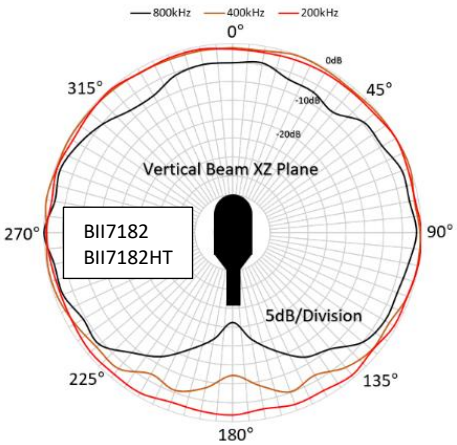


Free-field Voltage Sensitivity (FFVS):



Directivity Pattern:





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.

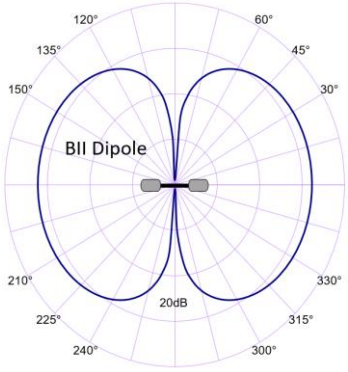
What if the connector of my analyzer (instrument) is SMA or SMC Connector? Buyer may order a SMA (or SMC) to BNC (Male) adaptor from local electronic distributors in buyer's country. BII may ship the adaptor as accessory of the device if buyer requests when ordering. **By default, BII does NOT supply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

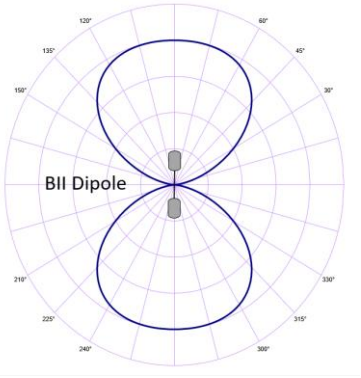
Is impedance matching necessary between hydrophones/sensors and preamplifiers/Recorders/Analyzers? it is NOT necessary to do impedance matching in low frequency range applications in which electromagnetic wave lengths are much greater than the cable length. High frequency transducers such as NDT pulsing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

Simple Array Consisting of 2 or 3 Hydrophones.

"Figure 8" Pattern of a Dipole (Pressure-Gradient).





Cardioid Pattern= Omnidirectional Hydrophone + Dipole.