



BII7010 Series Broadband Hydrophone: Low Noise, Low Power, and Low Frequency

The directional response patterns are omnidirectional in low frequency range and toroidal in high frequency range. Typical quality factor Q are 2 in useful frequency range. Pulsed sounds reach stable state quickly with short ringing. Custom-fit hydrophones with [low power preamplifiers](#) consume 1 to 2mA which is a great merit for battery-powered portable acoustic system.

These hydrophones provide low cost solutions for field recording, field listening, and acoustic research in laboratory from 0.2Hz to 500 kHz. They come with coax/shielded cables and underwater mateable/BNC/TRS/XLR/DIN/MIL-5015 style connectors, and are ready to be integrated into underwater acoustic systems. They support digital recorders and DAQs (A/D Converter). the output signal can be used for speaker system and headphones.

Small size and broadband of bespoke BII7015 offers benefit for uses in parabolic receivers underwater to achieve the highest pressure gain and the narrowest beam width which are the merits in weak signal detection and searching, directional high speed communication, etc.

Hydrophones with integrated low power preamplifiers and filters are ideal gears to amplify weak underwater sounds and reject ambient noises. Some [preamplifiers](#) can drive cable up to 1000m without significant signal loss. These features allows them to be used in long line arrays (streamers) and large planar arrays.

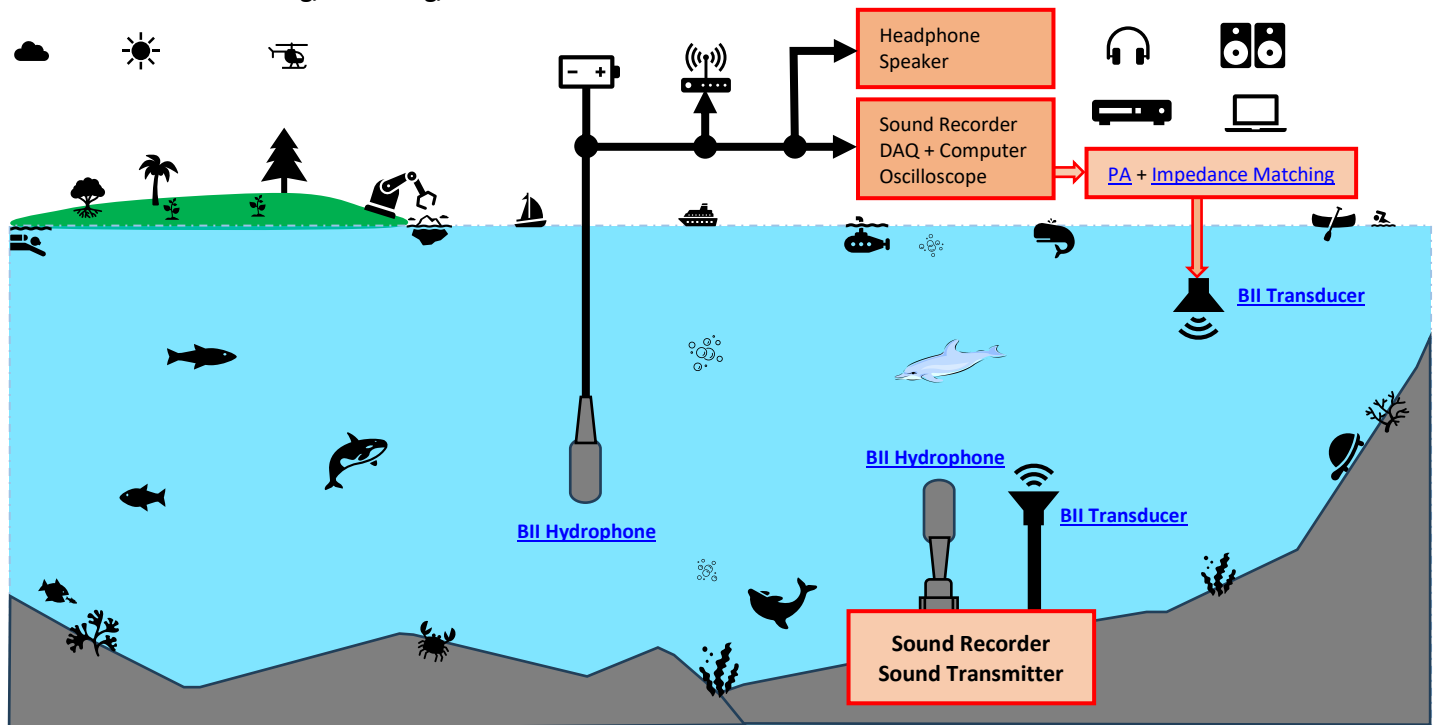
The smooth dome and small size reduce interferences to acoustic field under test. Hydrophone body possesses streamlined hemispherical domes which minimize the drag force and the hydrodynamic noise caused by the hydrophone in motion or the flow past the hydrophone. They can measure the sound radiations and pressure changes in turbulent processes and flows: surface waves (Wave-height Sensor), turbulences, seismic, ocean traffics, industrial noises, precipitations, biologics, ...

Sound Excitation by Turbulence: $\frac{1}{c^2} \frac{\partial^2 p}{\partial t^2} - \Delta p = \rho \frac{\partial^2 v_i v_k}{\partial x_i \partial x_k}$ v-Velocity of Turbulence Flow; c-Sound Speed in Fluid; p-Pressure; ρ-Fluid Density; x-Position.

Typical Applications

Towed/Dipping Hydrophone, Sonobuoy, LBL/SBL/USBL Positioning. Reference Hydrophone, Noise Measurement. Signal Detection in Strong Currents. Underwater Parabolic Antennas. Passive Acoustic Monitoring (PAM System).	Detection of Ultrasonic Cavitation Noise, Thermoacoustics in Gas. Linear and Planar Array Element, Vector Hydrophone Element. Marine Bioacoustics, Phantom-power Hydrophone, Sound Recording. Studies of Ocean Turbulence and Flow, Marine Hydrodynamics.
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Underwater Sound Listening, Recording, and Communication



Typical Applications

Underwater Sounds Recording, Listening, and Communication, Noise Measurement, Marine Bioacoustics, Passive Acoustic Monitoring (PAM System).
Coastal/Offshore Processes, Engineering & Management, Wave-Structure Interaction, Wave-height Sensor, Wave and Tide Recorder/Logger.
Surface Waves, Ocean Turbulences, Hydrodynamics, Marine Geophysics, Battery-Powered Instruments: Sonobuoy, Recorder, Transponder, Acoustic Release...

Questions

How do I set up my professional sound recorders to work with BII Hydrophones?

- BII hydrophones have their own DC power supply to support **Line Input** of recorders, and **Do NOT** use phantom power 48V which may destroy the hydrophones.
- Maximum Input Level (Line Input)** of recorders should be large enough to avoid saturation or clipping during recording.
Equivalent Input Noise of recorders should be low enough for the recorders to be sensitive to weak signal of the interest.
- Sampling Rate** of the recorder should be fast enough to avoid missing high frequency sound of the interest. Generally, the **Sampling Rate** should be at least two times greater than the maximum frequency of sound.
- Calculate the **memory size of data storage** according to sampling rate, resolution, sampling channels, and recording time, and use suitable recording media.

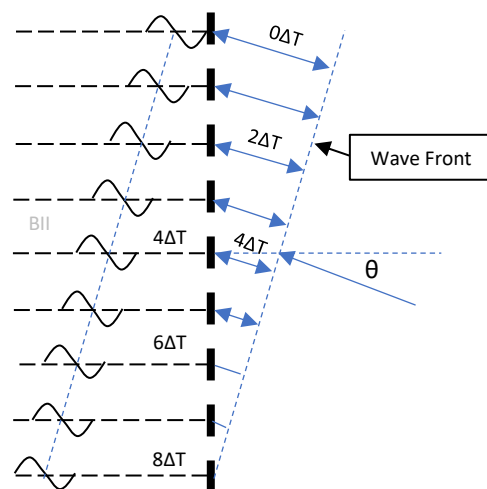
5. Calculate **battery service life** according to battery power and consuming current.

6. When the cable is greater than 5m, **balanced signal or differential signal** is recommended to be in use over the cable.

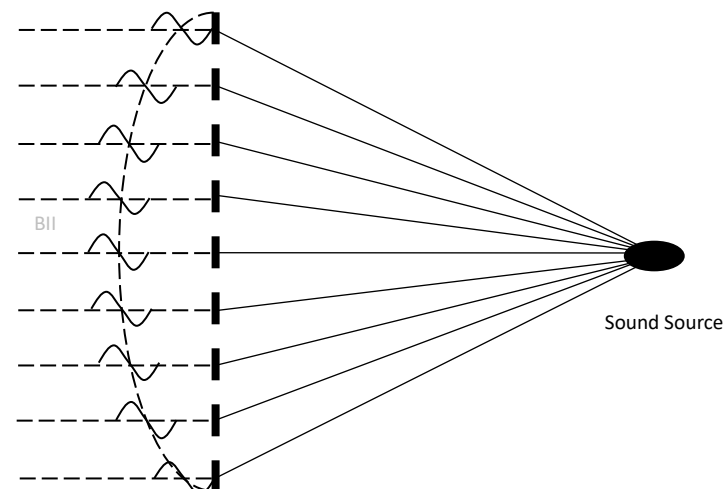
How do I playback the recorded sounds in water?

System Setup: Recorder (Recorded Sounds) with **Line or Phone Output** -> [Audio Power Amplifiers](#) -> [Impedance Matching Device](#) -> [Transducers \(Projectors\)](#).

Linear (Rectangular) Array Beam Steering

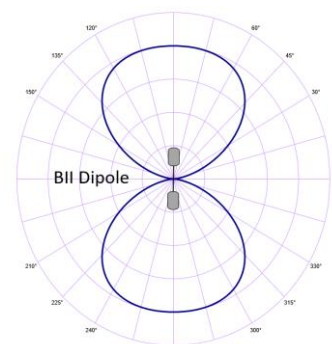
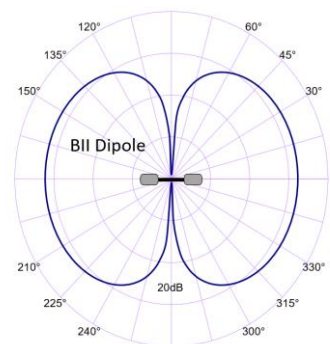


Linear, Annular, and Planar Array Beam Focusing

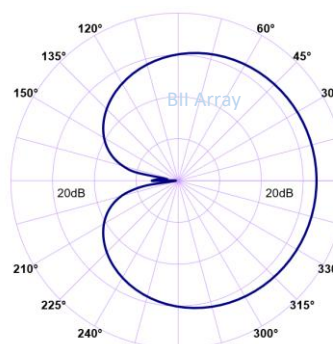


Simple Array Consisting of Hydrophones.

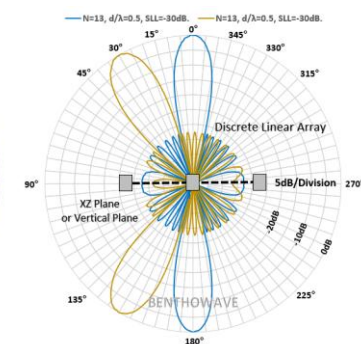
"Figure 8" Pattern of a Dipole (Pressure-Gradient).



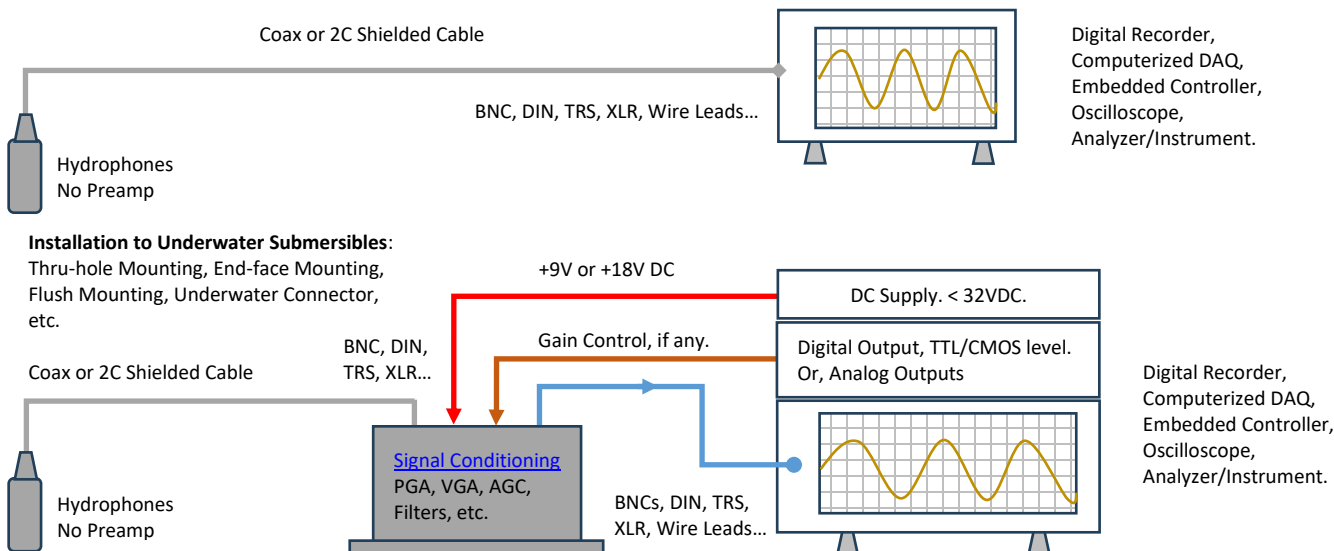
Cardioid Pattern



Linear Array with BII Discrete Hydrophones



System Configuration of Receiving Sounds and Waves.



Specification

The hydrophone is tested in water unless stated otherwise. SE: Single ended Output, DF: Differential Output, DW: Deep Water, UMC: Underwater Mateable Connector, FFVS: Free-field Voltage Sensitivity, TVR: Transmitting Voltage Response.	
Part Number:	BII7014
Sensitivity @ 1kHz:	-213.0 dB V/ μ Pa $\pm$ 2 dB Sensitivity Loss over Extension Cable (dB) = $20 \cdot \log[C_h/(C_h+C_c)]$. Valid for hydrophone without preamplifier. C_h : Hydrophone Capacitance; C_c : Capacitance of Extension Cable. Cable is of 100 pF/meter roughly.
Sensitivity Matching: (at 1 kHz)	When hydrophones are used as array elements, it is necessary for array elements to possess uniform sensitivities. Available Options of Sensitivity Tolerance: a. ± 2.0 (Default); b. ± 1.0 ; c. ± 0.5 ; d. ± 0.3 ; e. ± 0.1 ; in dB V/ μ Pa. 1. Sensitivity is tested at 1 kHz in water. 2. Hydrophones whose sensitivity variations are out of specified tolerance are rejected.
FFVS:	Free-field Voltage Sensitivity, Refer to Graph of FFVS vs. Frequency .
Usable Frequency: in Water, at ± 3 dB V/ μ Pa.	1 Hz ~ 250 kHz 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 BII7014 and a BII preamp of $R_i = 100$ M Ω are used to detect sounds, -3dB high pass frequency of detection = 0.63 Hz.
Usable Frequency in Air:	1 Hz ~ 12 kHz at -3dB V/ μ Pa.
Capacitance C_h @ 1kHz:	2.53 nF $\pm$ 10%
Dissipation @ 1kHz:	0.005
Noise Density at $f \ll f_s$: dB μ Pa/VHz	38.6 – $10 \cdot \log f$ 1. f in kHz; f_s : 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 and Toroidal. Refer to Graph of Directivity Pattern .
-3dB Beam Width:	Refer to Graph of Directivity Pattern .
Side Lobe Level:	No side lobes.
Signal Output Type:	Single Ended
Acceleration Sensitivity:	116.7 dB μ Pa/(m/s ²) at Acoustic Axis or XZ Direction; $\leq$ 115 dB μ Pa/(m/s ²) at Horizontal or XY Direction.
Underwater Projector:	Yes.
Resonance f_s:	190 kHz
TVR at f_s:	144.6 dB μ Pa/V at 1m. Approximately, TVR drops 12dB/octave below f_s and drops 6dB/octave above f_s .
Maximum Drive Voltage:	250 Vpp
Maximum Pulse Length:	100 mS at Maximum Drive Voltage
Duty Cycle:	10% at Maximum Drive Voltage. 100% at $\leq$ 30 Vpp or 10.6 Vrms.
Operating Depth:	Maximum: 300 m or 3 MPa pressure 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. Free-hanging with Male Underwater Connector (FHUWC-2P). 3. Thru-hole Inch Mounting with Single O-ring Sealing (THM-7/16"). 4. Thru-hole Inch Mounting with Double O-ring Sealing (THDO-7/16"). 5. Bolt Fastening Mounting (Plastics) (BFMP-NPT3/8"). 6. Bolt Fastening Mounting (Stainless Steel) (BFM-7/16", BFM-5/8"). Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.
Cable Options:	1. Default: Coax RG174/U, Φ D=2.8 mm (RG174). 2. Coax RG178/U, Φ D=1.8 mm (RG178) up to 200°C. 3. Coax RG316/U, Φ D=2.5 mm (RG316) up to 200°C. 4. Coax RG58/U, Φ D=4.9 mm (RG58). 5. Shielded Cable with PUR or Rubber Jacket, Φ D= Φ 4.7 to Φ 6.5 mm (SC47 to SC65), (SE or DF). Use with Underwater Connector 3 pins UMC3P = MCOM3M + OMBMC + MCDLS-F, Depth Rating: 300 m . 6. Original Two Conductor Unshielded Cable (USC) for Underwater Connector UMC2P (MCIL2M + MCDLS-F) and UMC3P (UMC3P = MCIL3M + MCDLS-F). Depth Rating: 950 m .
Cable Length:	1. Default: 6 m. 2. Custom-fit Cable Length.
Connector:	1. Default: Wire Leads (WL). 2. Male BNC (BNC), Max. Diameter Φ 14.3 mm, for SE ONLY. BNC with RG178 Coax: Service Temperature up to 165°C or 329°F . 3. 1/8" (3.5mm) TRS Plug (TRS), Max. Diameter Φ 10.5 mm, for SE or DF. 4. DIN Receptacle with 3 Male Pins (DIN3), (Max. Diameter Φ 17 mm), for SE or DF. 5. XLR Receptacle with 3 Male Pins (XLR3), Max. Diameter Φ 20.2 mm, for SE or DF. 6. Underwater Mateable Connector UMC2P and UMC3P are 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 Φ 21.5 to Φ 35 mm, for SE. Depth Rating: 950 m . 3 pin (UMC3P = MCIL3M + MCDLS-F.), Max. Diameter Φ 21.5 to Φ 35 mm, for SE or DF. Depth Rating: 950 m . 3 pin (UMC3P = MCOM3M + OMBMC + MCDLS-F.), Max. Diameter Φ 21.5 to Φ 35 mm, for SE or DF. Depth Rating: 300 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. 3.5mm TRS stand for Tip, Ring, and Sleeve, miniature, quick connect/disconnect, audio frequency connector used for shielded cable. Fastening Type: None. 3. DIN: Electrical cylindrical connectors, 3 to 14 contacts, Φ 20mm diameter, used for audio, RF, digital, and DC or AC power signals. Fastening Type: Threaded. 4. XLR: Employed for balanced audio and DC or AC power signal interconnections, 3 to 7 contacts. Fastening Type: Latch Lock.	
Size:	Free Hanging: Φ D = Φ 9.0 mm, Length = 32 mm. Other Mounting Types: Actual length depends on Mounting Parts.

Weight:	85 grams with 6 m Coax/BNC Male. Actual weight depends on Mounting Parts, Cable Types and Length.
Operation Temperature:	1. Default: -10°C to +60°C or 14°F to 140°F. 2. Bespoke: -10°C to 120°C, or 14°F to 248°F. Append -HT120 to part number. Maximum Pressure at 120°C or 248°F: 1 MPa. 3. Bespoke: -10°C to 200°C, or 14°F to 392°F. Append -HT200 to part number. Maximum Pressure at 200°C or 392°F: 0.5 MPa.
Storage Temperature:	-20°C to +60°C or -4°F to 140°F.
Array Design Service:	Line (Linear) Array, Rectangular Planar Array, and Circular Planar Array design: Side Lobe Level SLL , -3dB Beam Angle θ_{-3dB} ; Array Element Spacing d ; Array Element Number N ; Beam Steering, FFVS loss, and mutual effects among these parameters.
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
BII7014	FH, BFMP-NPT3/8", BFM-7/16".	6 m (19.7ft)	RG174 Coax	WL, BNC.
	FH, BFM-7/16", BFM-5/8".	0.6 m (2 ft)	SC47 to SC65, or USC	UMC2P, UMC3P.
	THM-7/16".	0.6 m (2 ft)	RG174 Coax	WL.
In-Stock Examples:	Description			
BII7014-FH-6m-RG174-BNC	BII7014 Hydrophone, Free Hanging, 6m RG174 Coax, BNC Male.			
BII7014-BFMP-NPT3/8"-6m-RG174-BNC	BII7014 Hydrophone, Bolt-fastening Mounting: BFMP-NPT3/8", 6m RG174 Coax, BNC Male.			
BII7014-FH-0.6m-SC65-UMC3P	BII7014 Hydrophone, Free Hanging, 0.6m Shielded Cable SC65 , 3-pin Underwater Mateable Connector UMC3P.			
BII7014-BFM-5/8"-0.6m-USC-UMC2P	BII7014 Hydrophone, Bolt-fastening Mounting BFM-5/8", 0.6m Unshielded Cable USC , 2-pin Underwater Mateable Connector UMC2P.			
BII7014-THM-7/16"-0.6m-RG174-WL	BII7014 Hydrophone, Thru-Hole Mounting THM-7/16", 0.6m RG174, Wire Leads.			
Non-stock Examples:	Description			
BII7014-FH-2m-USC-UMC2P	BII7014 Hydrophone, Free Hanging, 2m Unshielded Cable USC, 2-pin Underwater Mateable Connector UMC2P.			
BII7014-HT200-FH-6m-RG178-BNC	BII7014 Hydrophone, Service Temperature: -10 °C to 200 °C (14 °F to 392 °F). Free Hanging, 6m RG178 Coax, BNC Male.			
BII7014-FHUWC-2P	BII7014 Hydrophone, Free-hanging with Male Underwater Connector FHUWC-2P.			

Wirings

Single Ended Output:	Wire Leads	UMC3P, UMC3S.	UMC2P	DIN3	BNC/SMA/SMC	Coax with Wire Leads
Signal	White or Red	Pin 2 or Socket 2	Pin 2	Pin 3	Center Contact	Coax Center Contact
Signal Common	Black	Pin 1 or Socket 1	Pin 1	Pin 1	Shield	Coax Shield
Shielding	Shield	Pin 3 or Socket 3	N/A	Pin 2	Shield	Coax Shield

Components of an Acoustic Receiving System.



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.**

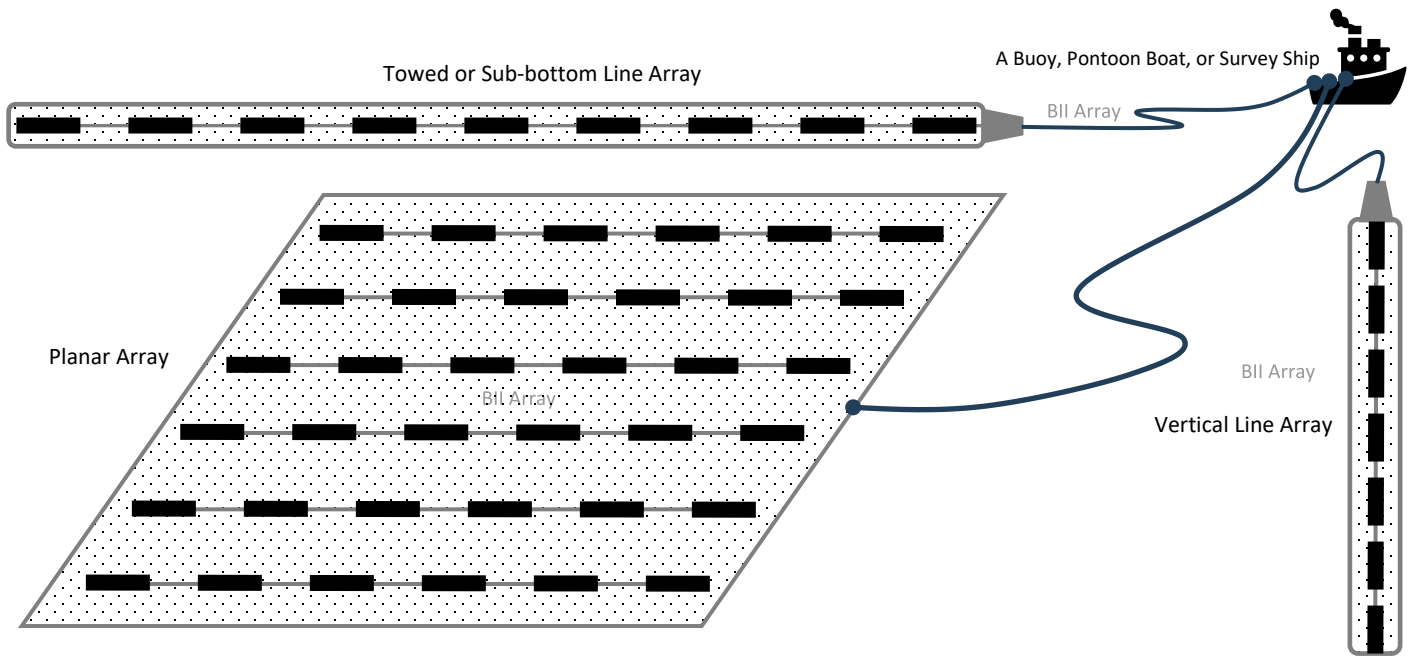
Is impedance matching necessary between hydrophones/sensors and preamplifiers/Recorders/Analyzers? it is NOT necessary to do impedance matching in low frequency range applications in which electromagnetic wave lengths are much greater than the cable length. High frequency transducers such as NDT pulsing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

My acoustic sensors generate differential signals in MHz range, are TRS connectors suitable for my applications? BII's test shows TRS connectors (Plug and Jack) of BII preamps can be used up to 20 MHz. Test Conditions: TRS Jack with 0.2m cable and TRS plug with 1m cable. Oscilloscope: 1MΩ || 20pF, Signal Source: DDS Signal Generator. **Can 3.5mm (1/8") TRS be configured for single-ended signal of a hydrophone/transducer which does not have built-in preamplifier?** Yes, the preamp with differential-input TRS can accept single-ended signals from hydrophones/transducers whose TRS wiring should be like followings: **TRS Tip:** Signal. **TRS Ring and Sleeve:** Both terminals are soldered together for Signal Common and Shielding. Common and shielding should be "one-point" contact.

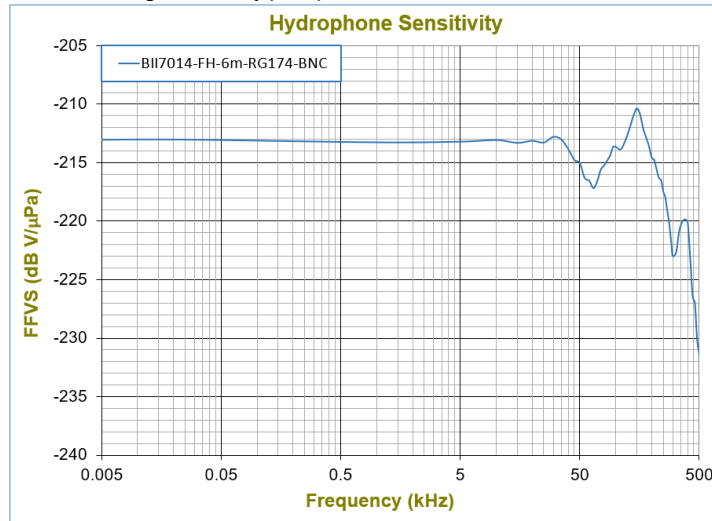
Can BII explain why the capacitance of my hydrophone/transducer affect high pass filtering? (1). Hydrophone/transducer is high impedance devices in low frequency range. Its simplified complex impedance = $j/(2\pi f C_h)$, C_h is the capacitance of hydrophone/transducer, f is frequency in Hz. This impedance 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.

Can BII explain more on Single-ended (SE) and Differential (DF) measurement? (1). **SE hydrophone + coax + BNC/SMA/SMC** is compatible to most instruments such as oscilloscope, signal generators, and DAQ modules, etc.. Quick setup of SE measuring system and low cost with coax/BNC are the significant merits besides 50Ω matching in MHz range measurement. The shortcomings are weak rejection on common-mode noise and inductive coupling of EMI. (2). **DF hydrophone + Twisted-Pair Shielded Cable + WL/TRS/XLR/DIN** is compatible to most audio recording and analyzing instruments, etc.. Efficient rejection of common mode noises and inductive coupling noise of EMI are the significant merits, especially over the long cable. The shortcomings are higher costs on hydrophones, cables, and differential signal processing circuits such as differential preamp and differential DAQ modules.

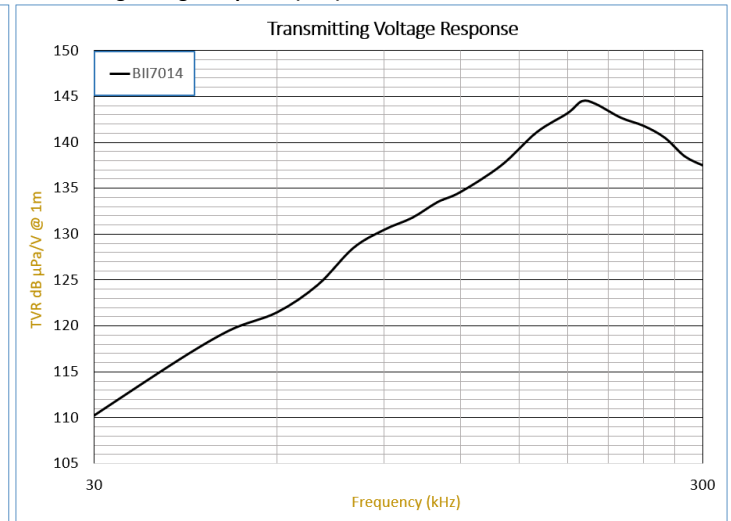
Array Elements for Underwater Linear and Planar Arrays



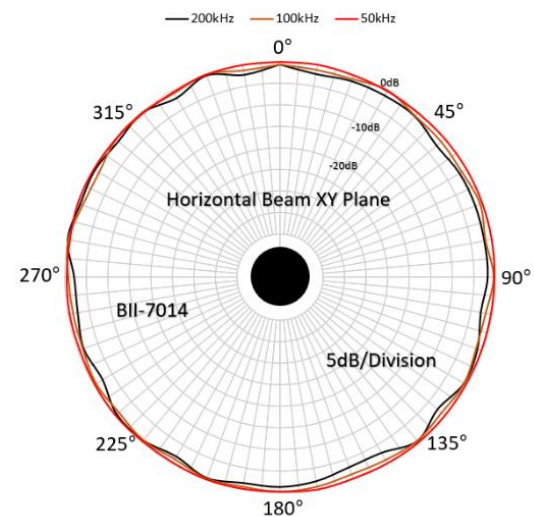
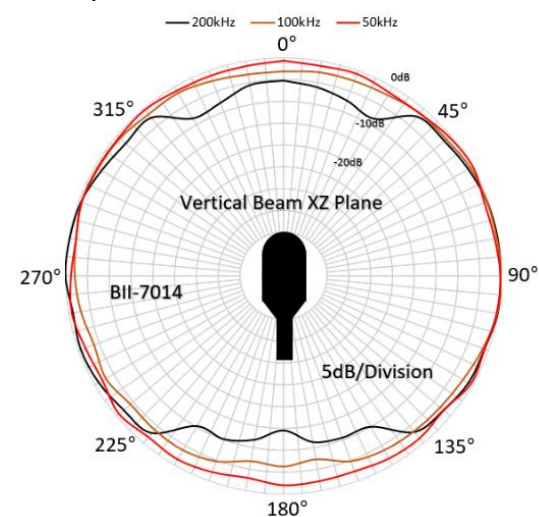
Free-field Voltage Sensitivity (FFVS):



Transmitting Voltage Response (TVR):

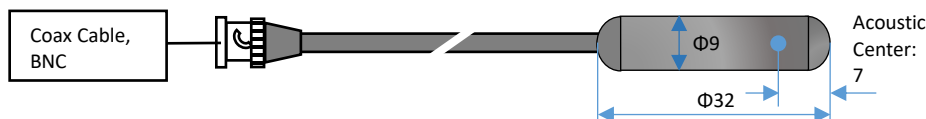


Directivity Pattern



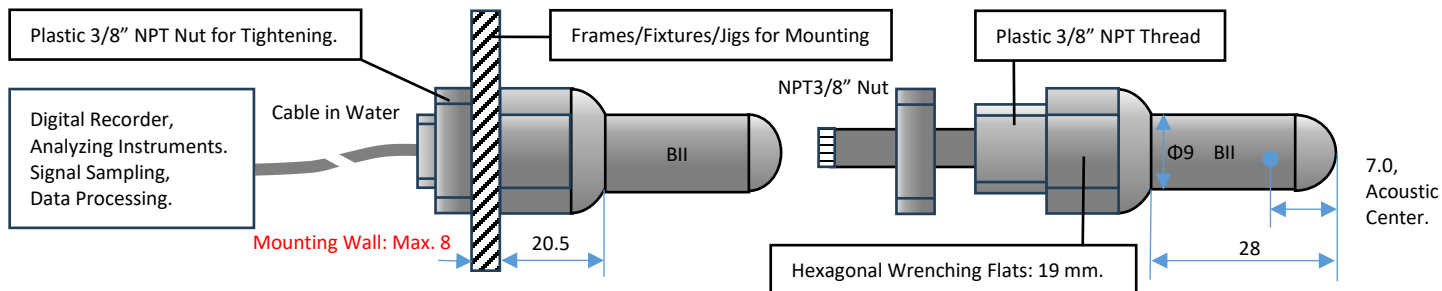
Physical Size (Dimensional Unit: mm, Illustration ONLY, Scale is NOT 1:1): The overall length varies with the length of the mounting part.

1. Free Hanging with Smooth Domes.

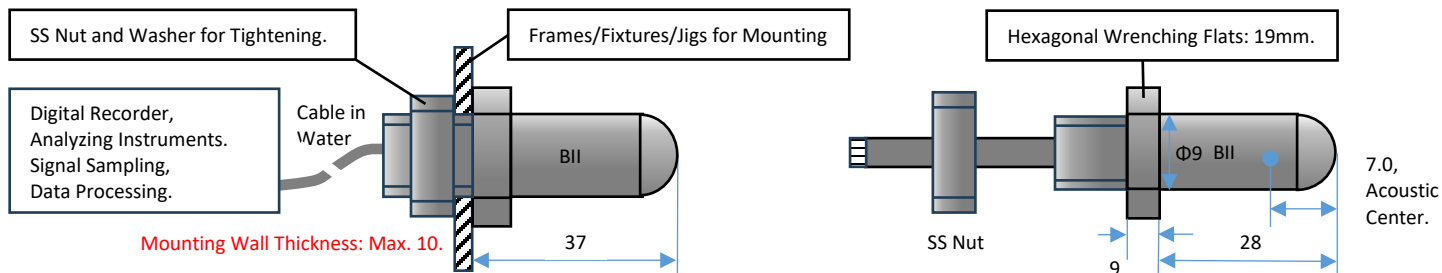


The hydrophone body has streamlined hemispherical domes which minimize the drag forces and the hydrodynamic noise caused by the hydrophone in motion or the flow past the hydrophone.

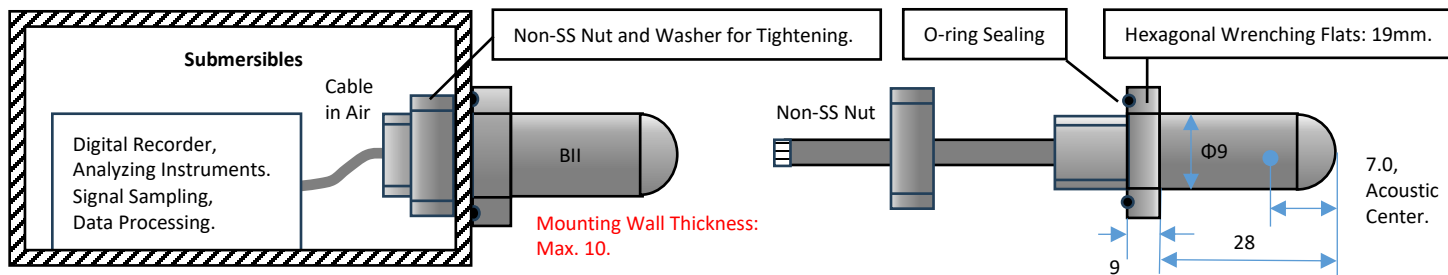
2. Bolt-Fastening Mounting BFM-NPT3/8", 3/8" NPT Thread Length: 15mm. Nut Height: 5mm. Tips: Plastic material has less sound reflection.



3. Bolt-Fastening Mounting BFM-7/16" (7/16"-20x22 UNF-2A).

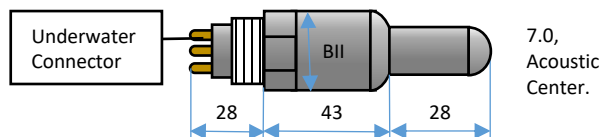
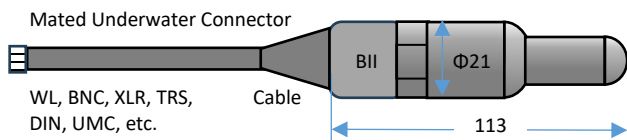


3. Thru-hole Mounting (Inch Thread) with Single O-ring Sealing THM-7/16" (7/16"-20x22 UNF-2A).



5. Free-hanging with Underwater Connector (FHUWC-2P), 2 Pins.

Mating Connector and Cable	UWC-Cable Length-Connector: Underwater Connector with Socket insert and Internal-Thread Mating Parts + customized-length shielded cable + a Connector (WL, XLR, TRS, DIN, MIL, UMC, etc.) to DAQ devices or Digital Recorders.
	How to order cable with mating underwater connector? for example:
	UMC2S-20m-WL: 20 m cable with Underwater Mateable Connector 3 Sockets (UMC2S) on one end and wire leads (WL) on other end. UMC2S-20m-BNC: 20 m cable with Underwater Mateable Connector 3 Sockets (UMC2S) and BNC Male.



6. More Mounting/Installation Options: Please refer to online document [AcousticSystem.pdf](#) for a complete list of Mounting Options and details.