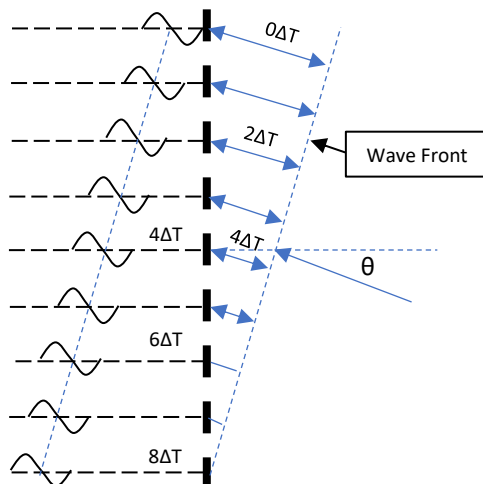


### BII7070 Series Directional Hydrophone (Acoustic Sensor) and Planar Array Element

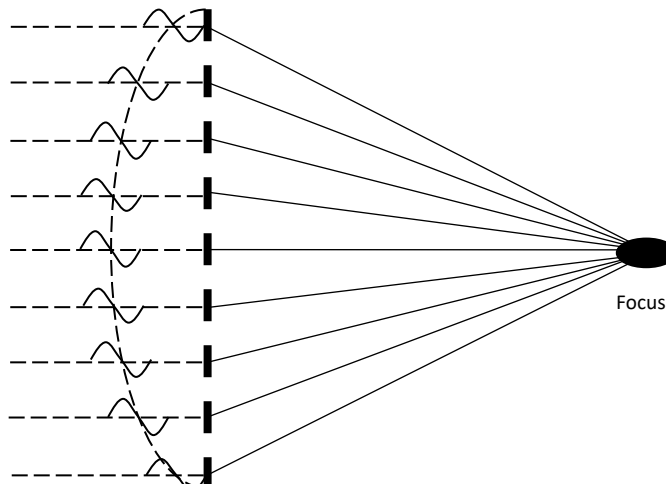
BII's directional hydrophones have conical beams for uses in detection of weak signals, broadband signals, pipeline leaks, and tracking of sound sources underwater. Low noise hydrophone (below sea-state zero) is available for noise measurement. These acoustic sensors are also designed for applications in air to detect acoustic emission and stress waves. (Note: The couplant such as water or gel is a must-have material to provide efficient acoustic coupling between the Hydrophone face and the piece under test in air applications.)

Below the critical frequency  $f_c$ , the hydrophones are of single beam without side lobes. This feature makes the hydrophone be an ideal candidate for target angle estimation systems or sound source tracking systems. With built-in preamplifiers, the hydrophones have higher sensitivity and can transmit signal over long cable.

#### Linear (Rectangular) Array Beam Steering



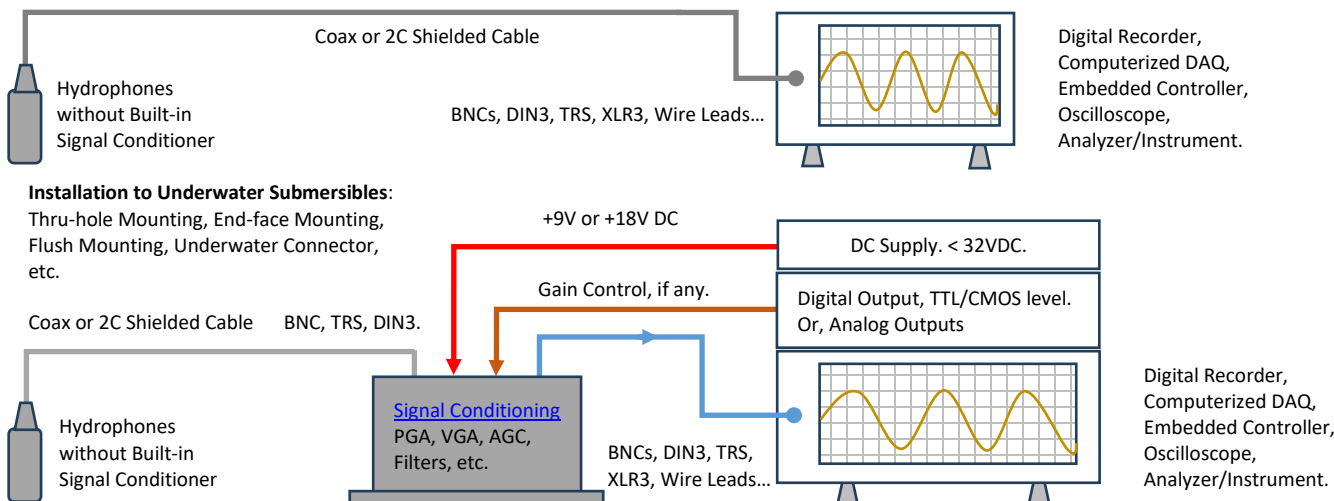
#### Linear, Annular, and Planar Array Beam Focusing



#### Typical Applications

Direction-finding Sonar, Tracking of Acoustic Tags LBL/SBL/USBL Positioning System Locating Marker/Pinger/Beacon/Transponder Acoustic Pipeline Leak Detection	Array elements for Array Focusing and Beam Steering Noise Measurement, Bioacoustic Research of Marine Animals Structural Health Monitoring, Acoustic Emission Detection/AE Sensor Monitoring Aquarium/Pool Safety/Alarm System
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#### System Configuration of Receiving Sounds and Waves.



#### Specification

The hydrophone is tested in water unless stated otherwise.					
Part Number:	BII7071	BII7072	BII7073	BII7074	BII7074DF
Sensitivity @ 1kHz:	-200.5 dB V/μPa ± 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.				-194.5 dB V/μPa ± 2 dB.
FFVS:	Free-field Voltage Sensitivity, Refer to Graph of <a href="#">FFVS vs. Frequency</a> .				
Usable Frequency:	1Hz ~ 300kHz at ±3dB V/μPa.				

in Water.	$C_h$ 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 BII7071 and a <a href="#">BII preamp</a> of $R_i = 100\text{ M}\Omega$ are used to detect sounds, -3dB high pass frequency of detection = 9.4 Hz. A BII7074DF and a <a href="#">BII preamp</a> of $R_i = 200\text{ M}\Omega$ are used to detect sounds, -3dB high pass frequency of detection = 1.3 Hz.				
Usable Frequency in Air:	1Hz ~ 16kHz	1Hz ~ 8kHz	1Hz ~ 6kHz	1Hz ~ 3kHz	1Hz ~ 3kHz
Capacitance $C_h$ @ 1kHz:	0.17 nF	0.62 nF	0.95 nF	2.55 nF	0.63 nF
Dissipation @ 1kHz:	0.026 @ 1 kHz.				
Noise Density at $f \ll f_s$ : dB $\mu\text{Pa}/\sqrt{\text{Hz}}$	$43.8 - 10 \cdot \log f$	$38.1 - 10 \cdot \log f$	$36.0 - 10 \cdot \log f$	$31.8 - 10 \cdot \log f$	$32.0 - 10 \cdot \log f$
	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.				
Signal Conditioning:	If your project need extra signal conditioning before data acquisition, please refer to <a href="#">signal conditioning</a> , and order separately. 1. <a href="#">Programmable Gain Amplifier</a> (PGA), 0/20/40/60 dB, etc. 2. <a href="#">Variable Gain Amplifier</a> (VGA): 60 to 70 dB Range. 3. <a href="#">Automatic Gain Control</a> (AGC) Amplifier: 100 dB Gain Dynamic Range. 4. <a href="#">Amplifiers</a> with Built-in, High-pass, Low-pass, and Band-pass Filters. <b>Packages: Standalone Devices</b> for portable uses, and <b>Coated PCB</b> with Wire Bundles for underwater submersibles.				
Receiving Face:	Circular Planar Face				
Directivity Pattern:	Conical Beam. Refer to Graph of <a href="#">Directivity Pattern</a> .				
Side Lobe Level:	1. Default: < -17.8 dB when $f > f_c$ ; No side lobe when $f \leq f_c$ . 2. Bespoke Sidelobe Suppression is available for BII7074: $\leq -30$ dB. Main lobe is about 1.1 to 1.28 times wider.				
-3dB Beam Width:	$9900^\circ/f(\text{kHz})$	$4650^\circ/f(\text{kHz})$	$3200^\circ/f(\text{kHz})$	$1700^\circ/f(\text{kHz})$	$1700^\circ/f(\text{kHz})$
Frequency $f_{-3dBML}$ :	74 kHz	41 kHz	32 kHz	15 kHz	15 kHz
	$f_{-3dBML}$ : Main Lobe drops -3dB at $\pm 90^\circ$ normal to acoustic axis.				
Critical Frequency $f_c$ :	180 kHz	100 kHz	78 kHz	36 kHz	36 kHz
	$f_c$ : Side lobes exist in the case of operating frequency $f > f_c$ ; The hydrophone has no side lobe in the case of $f \leq f_c$ .				
$\pm 90^\circ$ Sidelobe Frequency $f_n$ :	240 kHz	133 kHz	104 kHz	49 kHz	49 kHz
	$f_n$ : First Side Lobes exist at $\pm 90^\circ$ normal to acoustic axis in the case of operating frequency $f = f_n$ .				
Signal Output Type:	Single Ended				Differential Output
	Differential signal has better capability to reduce and reject EMI noise, especially over long cable.				
Acceleration Sensitivity: $\mu\text{Pa}/(\text{m/s}^2)$	148.7 dB along acoustic axis.				142.7 dB
	Other directions: 141.0 dB.				141.0 dB
	<b>Bespoke Vibration Compensation, available upon request:</b> When suspended from a ship or boat, buoy, or used in towed array, the hydrophone experiences a large movement and induced vibration resulting from surface waves, currents, hydrodynamic flow turbulence, cable movement, etc... The translational acceleration in axial direction can be cancelled with special design and construction, and acceleration sensitivity in other directions are also lower (partially cancelled). Spurious signals caused by induced vibration can be reduced. Acceleration Sensitivity with Compensation: 1. $\leq 80$ to 100 dB in axial direction of the hydrophone. 2. $\leq 90$ to 110 dB in other directions of the hydrophone.				
Underwater Projector:	Yes. Do NOT use the hydrophone as a sound projector in the air.				No
Resonance $f_s$ :	200 kHz				N/A
TVR at $f_s$ : $\mu\text{Pa}/\text{V}$ at 1m.	$\geq 130$ dB	$\geq 135$ dB	$\geq 140$ dB	$\geq 160$ dB	N/A
	Approximately, TVR drops 12dB/octave below $f_s$ and drops 6dB/octave above $f_s$ .				
Maximum Drive Voltage:	600 Vpp				N/A
Maximum Pulse Length:	100 mS at Maximum Drive Voltage				N/A
Duty Cycle:	10% at Maximum Drive Voltage. 100% at $\leq 30$ Vpp or 10.6 Vrms.				N/A
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. Thru-hole Mounting with Single O-ring (THM-7/16", or THM-5/8".) 3. Thru-hole Mounting with Double O-ring (THDO-7/16".) 4. Bolt Fastening Mounting (Stainless Steel) (BFM-7/16", or BFM-5/8".) 5. Bolt Fastening Mounting (Plastics) (BFMP-NPT3/8".) 6. Bolt-Fastening Mounting with Free Hanging (BFM-FH-M6, BFM-FH-M8, BFM-FH-M10.) 7. Free-hanging with Male Underwater Connector (FHUWC-4P) 8. End-face Mounting (EFMS) 9. Flange Mounting (FGM- $\Phi 110$ ) Please refer to online document <a href="#">AcousticSystem.pdf</a> for a complete list of Mounting Options and more details.				
Cable Options:	<b>SE:</b> Single Ended Output Hydrophones. <b>DF:</b> Differential Output Hydrophones. 1. <b>Default:</b> Coax RG174/U, $\Phi D=2.8$ mm (RG174) (SE). 2. Coax RG58/U, $\Phi D=4.9$ mm (RG58) (SE). 3. Shielded Cable with Polyurethane Jacket, $\Phi D=2.6$ mm (SC26). (SE). 4. Shielded Cable with Rubber Jacket, $\Phi D=6.5$ mm (SC65). (SE). 5. <b>Default:</b> Shielded Cable with Twisted Pair and PVC Jacket, $\Phi D=3.6$ mm (SC36). (DF). 6. Shielded Cable with Twisted Pair and PVC Jacket, $\Phi D=6.0$ mm (SC60). (DF). 7. Shielded Cable with Twisted Pair and Polyurethane Jacket, $\Phi D=4.7$ mm (SC47). (DF). 8. Coax RG178/U, $\Phi D=1.8$ mm (RG178) up to 200°C. (SE). 9. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, $\Phi D=3.2$ mm (SC32), up to 200°C. <b>Non-waterproof, for dry use ONLY, (DF).</b> 7. Two or Three Conductor Unshielded Cable (USC) for Underwater Connector 2 pins or 3 pins.				

	Differential/balanced signals over shielded twisted pair cable is recommended to reject Electromagnetic Interference (EMI).				
Cable Length:	1. Default: 6 m. 2. Custom-fit Cable Length.				
Connector:	<b>SE:</b> Single ended Output, <b>DF:</b> Differential Output. 1. Default: Wire Leads ( <b>WL</b> ) 2. Male BNC ( <b>BNC</b> ), Max. Diameter $\Phi 14.3$ mm, for SE ONLY. <b>BNC with RG178 Coax:</b> Service Temperature up to 165°C or 329°F. 3. 1/8" (3.5mm) TRS Plug ( <b>TRS</b> ), Max. Diameter $\Phi 10.5$ mm, for SE or DF. 4. DIN Receptacle with 3 Male Pins ( <b>DIN3</b> ), (Max. Diameter $\Phi 17$ mm). for SE or DF. 5. XLR Receptacle with 3 Male Pins ( <b>XLR3</b> ), Max. Diameter $\Phi 20.2$ mm, for SE or DF. 6. Underwater Mateable Connector (2 pin) ( <b>UMC2P</b> ), Max. Diameter $\Phi 21.5$ to $\Phi 35$ mm, for SE. Underwater Mateable Connector (3 pin) ( <b>UMC3P</b> ), Max. Diameter $\Phi 21.5$ to $\Phi 35$ mm, for SE or DF. <b>UMC3P</b> is from global manufacturers of underwater connectors. Its part number is listed in quote in detail.				
	Underwater Mateable Connectors are for underwater uses. Other connectors/wire leads are for dry uses and are not waterproofed.				
	Size:	$\Phi 21 \times 25$ mm	$\Phi 27 \times 25$ mm	$\Phi 33 \times 25$ mm	$\Phi 60 \times 25$ mm
	Other Mounting Types: Actual length depends on Mounting Parts.				
Weight:	100 grams	150 grams	210 grams	550 grams	550 grams
	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 <b>-HT</b> to part number. <b>Maximum Operating Depth at 120°C or 248°F: 100 m.</b>				
Storage Temperature:	-20°C to +60°C or -4°F to 140°F.				
<b>Underwater Projector Application:</b> 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.					
<b>Sound Measurement in Air:</b> 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
BII7071, BII7072, BII7073, BII7074.	FH: Free Hanging.	6m (19.7ft)	RG174 Coax	BNC
BII7074DF			SC60 Shielded Cable with Twisted Pair	WL, TRS, XLR3, DIN3.
Example:	Description			
BII7071-FH-6m-RG174-BNC	BII7071 Hydrophone, Free Hanging, 6m RG174 Coax, BNC Male.			
BII7074DF-FH-6m-SC60-XLR3	BII7074DF Hydrophone, Free Hanging, 10m Shielded Cable with Twisted Pair SC60, XLR Receptacle with 3 Male Pins.			

**How to Order Bespoke Hydrophones.** Non-stock.

Hydrophone Part Number	-Mounting Part	-Cable Length	-Cable Type	-Connector Type
BII7071, BII7072, BII7073, BII7074, BII7074DF.	Mounting Options.	in meter.	Cable Options.	Connector Options.
<b>Example:</b>	<b>Description</b>			
BII7071-THM-7/16"-0.6m-SC36-WL	BII7071 Hydrophone, Thru-hole Mounting THM-7/16", 0.6m Shielded Cable SC36, Wire Leads.			
BII7071-HT-FH-6m-RG178-BNC	BII7071 Hydrophone, Service Temperature: -10°C to 120°C (14°F to 248°F), Free Hanging, 6m RG178 Coax, BNC Male.			
BII7074DF-BFM-5/8"-10m-SC60-WL	BII7074DF Hydrophone, Bolt-fastening Mounting BFM-5/8", 10m Shielded Cable <b>SC60</b> , Wire Leads.			
BII7074DF-FH-0.6m-SC65-UMC3P	BII7071DF Hydrophone, Free Hanging, 0.6m Shielded Cable <b>SC65</b> , 3-pin Underwater Mateable Connector.			

**Wirings**

Differential Output:	Wire Leads	UMC3P	DIN3	TRS	XLR3
Signal +	White or Red	Pin 2	Pin 3	Tip, Positive/Hot	Pin 2, Positive/Hot.
Signal -	Black	Pin 1	Pin 1	Ring, Negative/Cold	Pin 3, Negative/Cold.
Common & Shielding	Shield	Pin 3	Pin 2	Sleeve, Ground/Common	Pin 1, Shield/Ground.
<b>Single Ended Output:</b>	<b>Wire Leads</b>	<b>UMC3P</b>	<b>DIN3</b>	<b>BNC/SMA/SMC</b>	<b>Coax with Wire Leads</b>
<b>Signal</b>	<b>White or Red</b>	<b>Pin 2</b>	<b>Pin 3</b>	<b>Center Contact</b>	<b>Coax Center Contact</b>
<b>Signal Common</b>	<b>Black</b>	<b>Pin 1</b>	<b>Pin 1</b>	<b>Shield</b>	<b>Coax Shield</b>
<b>Shielding</b>	<b>Shield</b>	<b>Pin 3</b>	<b>Pin 2</b>	<b>Shield</b>	<b>Coax Shield</b>
<b>Wiring of Unshielded Cable:</b>	<b>Wire Leads WL</b>	<b>UMC2P</b> (0.6m USC Cable originally coming from manufacturer of the connector, Fixed.). Locking Sleeve: DLSA-M.			
Signal	White	Contact 2			
Signal Common	Black	Contact 1			

**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 50 $\Omega$  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: 1M $\Omega$  | 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.

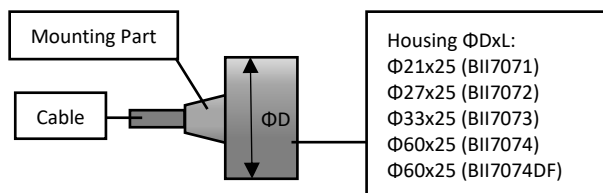
**Can BII explain why the capacitance of my hydrophone/transducer affect high pass filtering?** (1). Hydrophone/transducer is high impedance devices in low frequency range. Its simplified complex impedance =  $j/(2\pi f C_h)$ ,  $C_h$  is the capacitance of hydrophone/transducer,  $f$  is frequency in Hz. This impedance is in series with preamp  $R_i$  and can reach several M $\Omega$  to hundreds M $\Omega$  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 M $\Omega$  to avoid bumping into saturation issue.

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

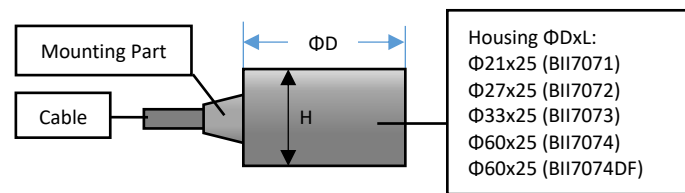


**Physical Size (Dimensional Unit: mm):** The overall length varies with the length of the built-in preamplifier and mounting parts.

**a. General Size information.**

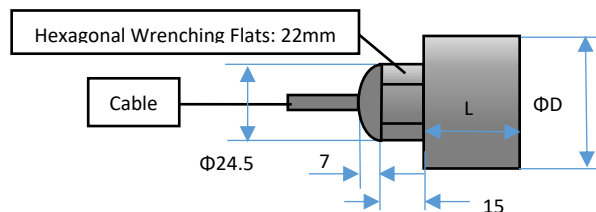


**b. Size information of Customized Cable Orientation: Side Wall.**

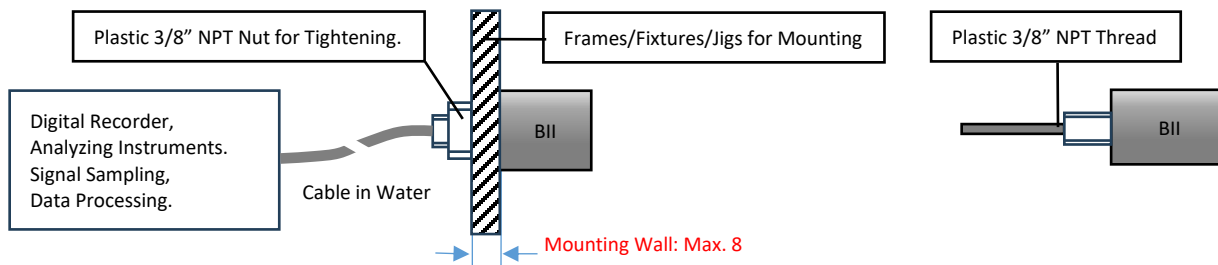


**Physical Size (Dimensional Unit: mm):** The overall length varies with the length of the built-in preamplifier and mounting parts.

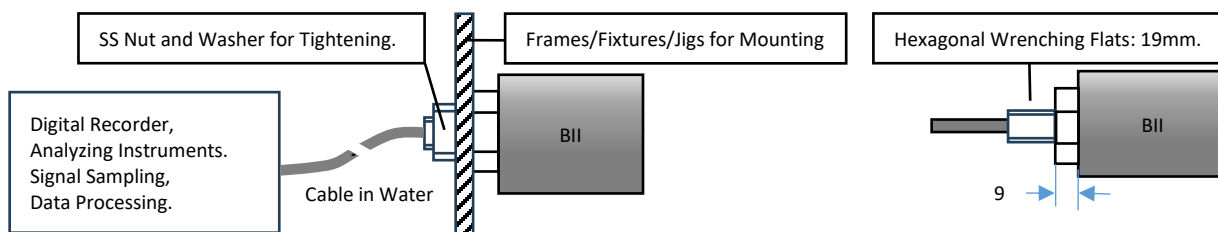
**1. Free Hanging.**



**2. Bolt-Fastening Mounting BFM-NPT3/8", 3/8" NPT Thread Length: 15mm. Nut Height: 5mm.**

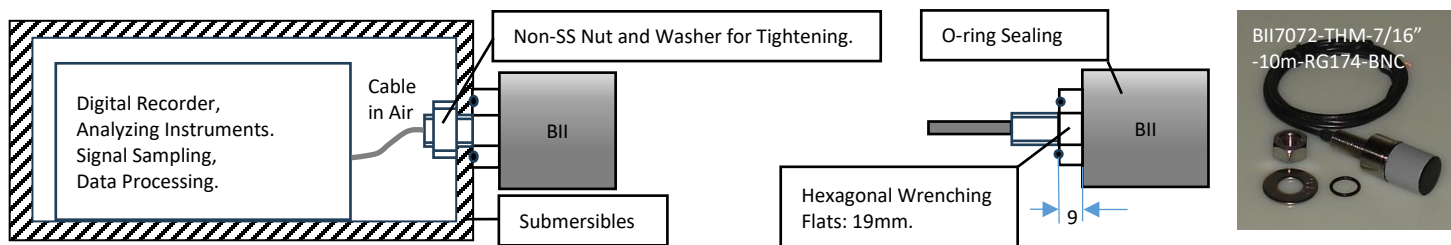


**3. Bolt-Fastening Mounting BFM-7/16" (7/16"-20x22 UNF-2A), or BFM-5/8" (5/8"-18x22 UNF).**





**4. Thru-hole Mounting (Inch Thread) with Single O-ring Sealing THM-7/16" (7/16"-20x22 UNF-2A), or BFM-5/8" (5/8"-18x22 UNF).**



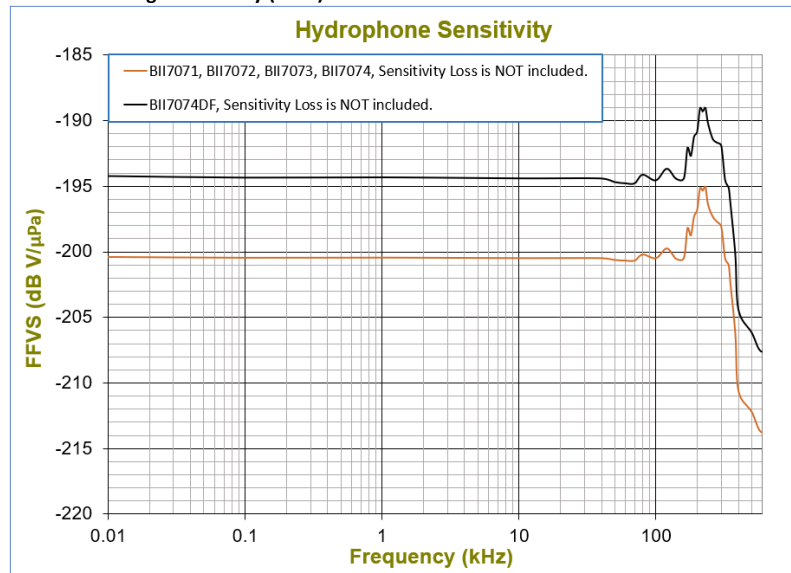
**5. Free-hanging with Underwater Connector FHUWC-4P, 4 Pins (Fixed Sensitivity) (P: Pin, S: Socket.)**

Mating Connector and Cable	<b>UWC-Cable Length-Connector:</b> 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.
	<b>How to order cable with mating underwater connector?</b> for example: <b>UMC4S-20m-WL:</b> 20 m cable with Underwater Mateable Connector 4 Sockets ( <b>UMC4S</b> ) on one end and wire leads ( <b>WL</b> ) on other end. <b>UMC4S-20m-XLR3/BS:</b> 20 m cable with and Underwater Mateable Connector 4 Sockets ( <b>UMC4S</b> ) on one end and XLR Receptacle with 3 Male Pins ( <b>XLR3</b> ) and Two +9V Battery Snaps on other end.

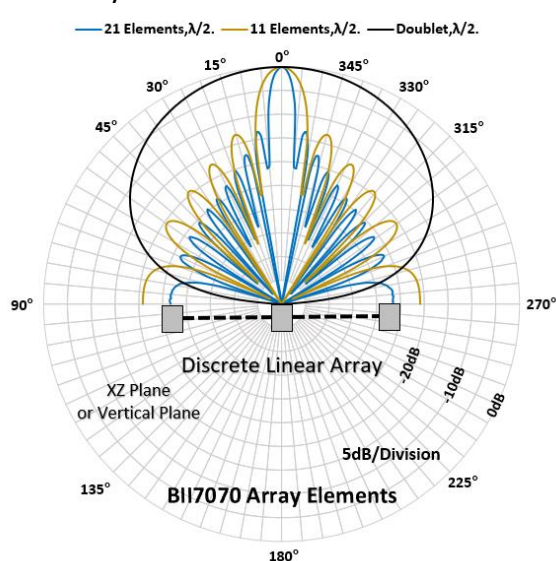


**6. More Mounting/Installation Options:** Please refer to online document [AcousticSystem.pdf](#) for a complete list of Mounting Options and details.

**Free-field Voltage Sensitivity (FFVS):**



**Linear Array with BII7070 Series Elements**



**Directivity Pattern**

