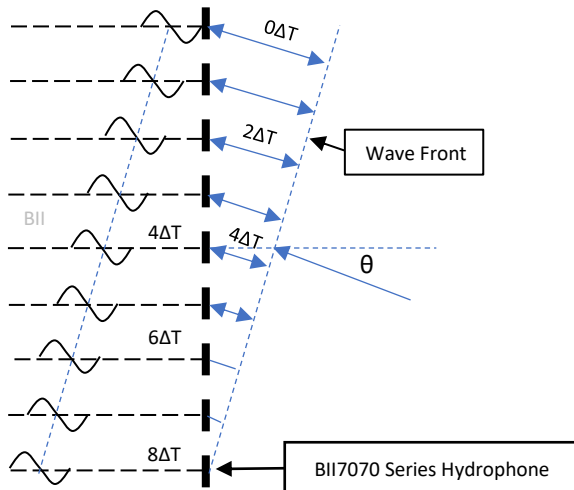


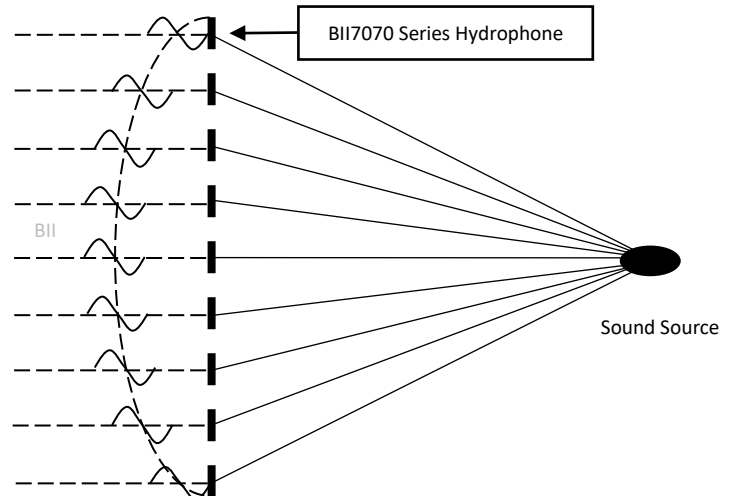
BII7070 Series Directional Hydrophone (Acoustic Sensor) and Planar Array Element

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 aerial applications to detect acoustic emission and stress waves. (Note: The couplant such as water or gel is a necessary 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 as of linear and planar array elements 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



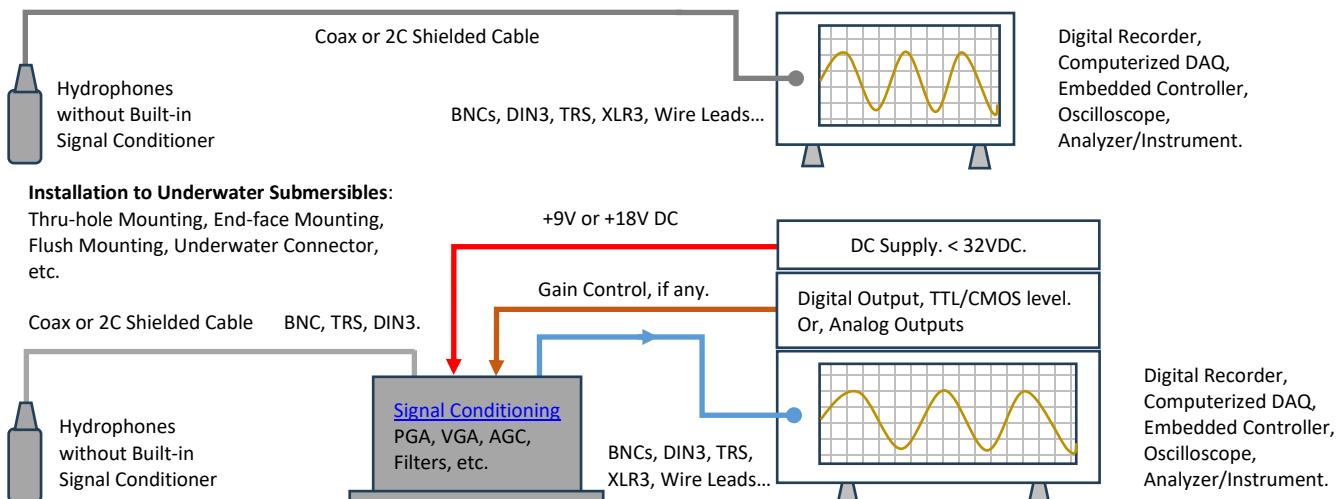
Linear, Annular, and Planar Array Beam Focusing



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.				-194.5 dB V/μPa ± 2 dB.
FFVS:	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.				
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 BII preamp 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 BII preamp 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 signal conditioning , and order separately. 1. Programmable Gain Amplifier (PGA), 0/20/40/60 dB, etc. 2. Variable Gain Amplifier (VGA): 60 to 70 dB Range. 3. Automatic Gain Control (AGC) Amplifier: 100 dB Gain Dynamic Range. 4. Amplifiers with Built-in, High-pass, Low-pass, and Band-pass Filters. Packages: Standalone Devices for portable uses, and Coated PCB with Wire Bundles for underwater submersibles.				
Receiving Face:	Circular Planar Face				
Directivity Pattern:	Conical Beam. Refer to Graph of Directivity Pattern .				
Side Lobe Level:	1. Default: $< -17.8\text{ dB}$ when $f > f_c$; No side lobe when $f \leq f_c$. 2. Bespoke Sidelobe Suppression is available for BII7074: $\leq -28\text{ dB}$. Main lobe is about 1.167 times wider. Note ⁽¹⁾: Bespoke BII7074 with sidelobe less than -28 dB can NOT be used as underwater sound projector.				
-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: $\mu\text{Pa}/(\text{m}/\text{s}^2)$	148.7 dB along acoustic axis.				142.7 dB
	Other directions: 141.0 dB.				141.0 dB
	Bespoke Vibration Compensation, available upon request (ONLY for BII7071 and BII7072): 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. ≤ 80 to 100 dB in axial direction of the hydrophone. 2. ≤ 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.	$\geq 130\text{ dB}$	$\geq 135\text{ dB}$	$\geq 140\text{ dB}$	$\geq 160\text{ dB}$ Refer to Note⁽¹⁾ .	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 $\leq 30\text{ Vpp}$ 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-1/4", BFM-FH-3/8".) 7. Free-hanging with Male Underwater Connector (FHUWC-2P, FHUWC-3P) 8. End-face Mounting (EFMS) 9. Flange Mounting (FGM-Ø110) Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.				
	SE: Single Ended Output Hydrophones. DF: Differential Output Hydrophones.				
Cable Options:	1. Default: Coax RG174/U, $\Phi D=2.8\text{ mm}$ (RG174), (SE). 2. Coax RG58/U, $\Phi D=4.9\text{ mm}$ (RG58), (SE). 3. Shielded Cable with Polyurethane Jacket, $\Phi D=2.6\text{ mm}$ (SC26), (SE). 4. Shielded Cable with PUR or Rubber Jacket, $\Phi D=\Phi 4.7$ to $\Phi 6.5\text{ mm}$ (SC47 to SC65), (SE or DF). Use with Underwater Connector 3 pins UMC3P = MCOM3M + OMBMC + MCDLS-F, Depth Rating: 300 m. 5. Default: Shielded Cable with Twisted Pair and PVC Jacket, $\Phi D=3.6\text{ mm}$ (SC36), (DF). 6. Shielded Cable with Twisted Pair and PVC Jacket, $\Phi D=6.0\text{ mm}$ (SC60), (DF). 7. Shielded Cable with Twisted Pair and Polyurethane Jacket, $\Phi D=4.7\text{ mm}$ (SC47), (DF).				

	8. Coax RG316/U, Φ D=2.5 mm (RG316) up to 200°C, (SE). 9. Coax RG178/U, Φ D=1.8 mm (RG178) up to 200°C, (SE). 10. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, Φ D=3.2 mm (SC32), up to 200°C. Non-waterproof, for dry use ONLY, (DF) . 11. Two-conductor High Temperature Shielded Cable: -94 to 302°F (-70° to 150° C), Φ D=5.1 mm (HTSC150), (DF or SE). 12. Original Two Conductor Unshielded Cable (USC) for Underwater Connector 2 pins MCIL2M + MCDLS-F. Depth Rating: 950 m. 13. Original Three Conductor Unshielded Cable (USC) for Underwater Connector 3 pins MCIL3M + MCDLS-F. Depth Rating: 950 m. 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:	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 135°C or 275°F. 3. XLR Receptacle with 3 Male Pins (XLR3), Max. Diameter Φ 20.2 mm, for SE or DF. 4. 1/8" (3.5mm) TRS Plug (TRS), Max. Diameter Φ 10.5 mm, for SE or DF. 5. DIN Receptacle with 3 Male Pins (DIN3), (Max. Diameter Φ 17 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 aerial 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. XLR : Employed for balanced audio and DC or AC power signal interconnections, 3 to 7 contacts. Fastening Type: Latch Lock. 3. 3.5mm TRS stand for Tip, Ring, and Sleeve, miniature, quick connect/disconnect, audio frequency connector used for shielded cable. Fastening Type: None. 4. 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. 6. UMC : Underwater Mateable Connectors, interconnection solution for high power or weak signals. Fastening Type: Threaded. Underwater Uses.					
Size:	Φ 21x25 mm	Φ 27x25 mm	Φ 33x25 mm	Φ 60x25 mm	Φ 60x25 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 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 50 Ω 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
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.
Example:	Description			
BII7071-THM-7/16"-0.6m-SC36-WL	BII7071 Hydrophone, Thru-hole Mounting THM-7/16", 0.6m Shielded Cable SC36, Wire Leads.			
BII7071-HT200-FH-6m-RG178-BNC	BII7071 Hydrophone, Service Temperature: -10°C to 200°C (14°F to 392°F), Free Hanging, 6m RG178 Coax, BNC Male. Note: Service Temperature of BNC $\leq$ 135°C or 275°F.			
BII7074DF-BFM-5/8"-10m-SC60-WL	BII7074DF Hydrophone, Bolt-fastening Mounting BFM-5/8", 10m Shielded Cable SC60 , Wire Leads.			
BII7074DF-FH-0.6m-SC65-UMC3P	BII7071DF Hydrophone, Free Hanging, 0.6m Shielded Cable SC65 , 3-pin Underwater Mateable Connector.			

Wirings

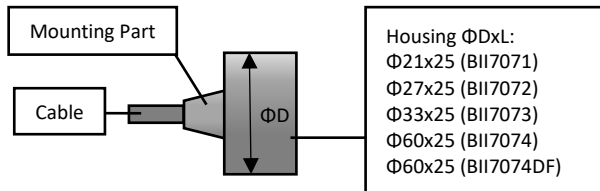
Differential Output:	Wire Leads	UMC3P, UMC3S, FHUWC-3P.	DIN3	TRS	XLR3
Signal +	White or Red	Pin 2 or Socket 2	Pin 3	Tip, Positive/Hot	Pin 2, Positive/Hot.
Signal -	Black	Pin 1 or Socket 1	Pin 1	Ring, Negative/Cold	Pin 3, Negative/Cold.
Common & Shielding	Shield	Pin 3 or Socket 3	Pin 2	Sleeve, Ground/Common	Pin 1, Shield/Ground.
Single Ended Output:	Wire Leads	UMC3P, UMC3S, FHUWC-3P.	UMC2P, FHUWC-2P.	DIN3	BNC/SMA/SMC
Signal	White or Red	Pin 2 or Socket 2	Pin 2	Pin 3	Center Contact
Signal Common	Black	Pin 1 or Socket 1	Pin 1	Pin 1	Shield
Shielding	Shield	Pin 3 or Socket 3	N/A	Pin 2	Shield
					Coax with Wire Leads
					Coax Center Contact
					Coax Shield
					Coax Shield

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

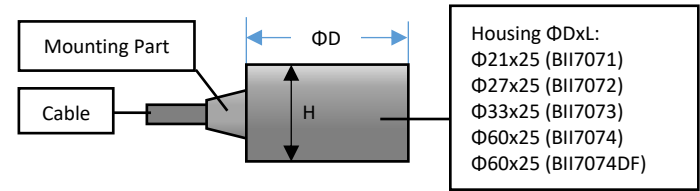


Physical Size (Dimensional Unit: mm): The overall length varies with the length of the built-in preamplifier and mounting parts.

a. General Size information.

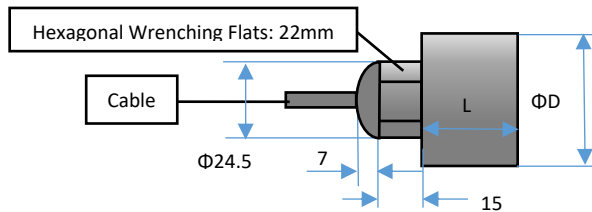


b. Size information of Customized Cable Orientation: Side Wall.

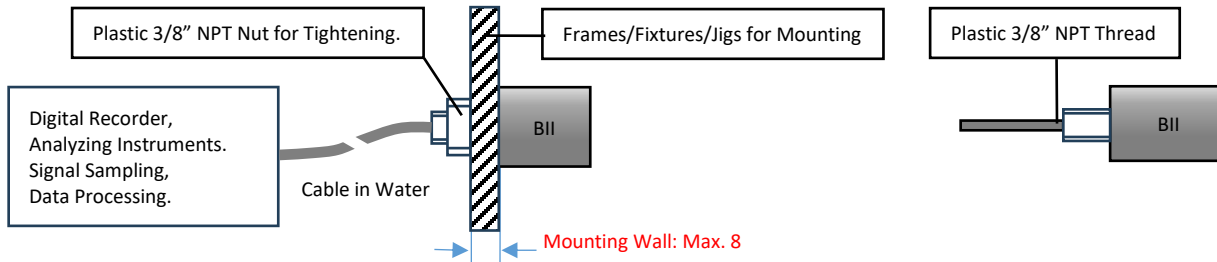


Physical Size (Dimensional Unit: mm): The overall length varies with the length of the built-in preamplifier and mounting parts.

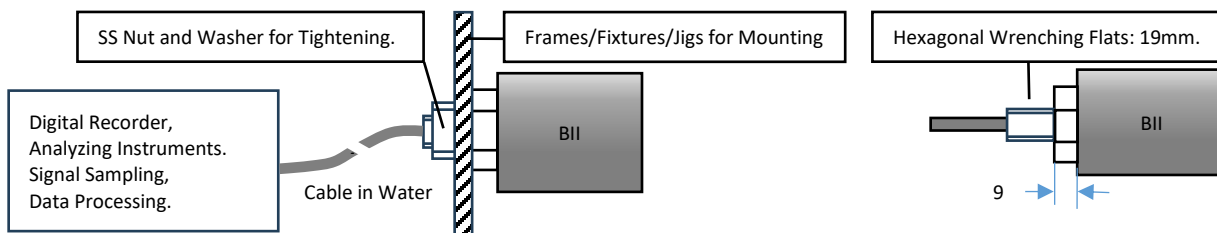
1. Free Hanging.



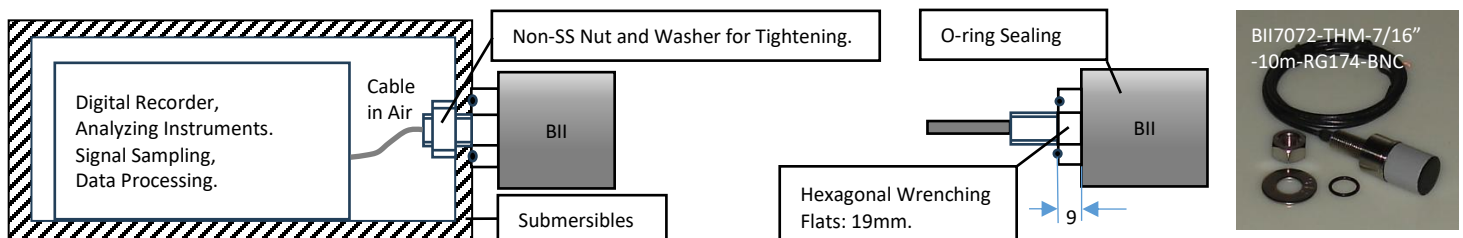
2. Bolt-Fastening Mounting BFM-NPT3/8", 3/8" NPT Thread Length: 15mm. Nut Height: 5mm.



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

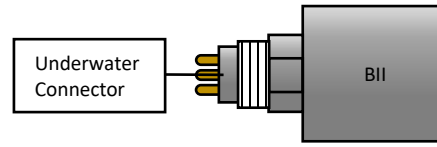
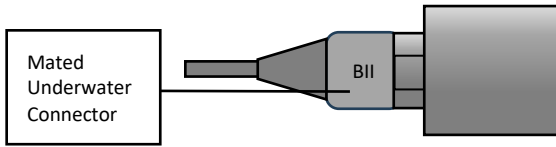


4. Thru-hole Mounting (Inch Thread) with Single O-ring Sealing THM-7/16" (7/16"-20x22 UNF-2A), or BFM-5/8" (5/8"-18x22 UNF).



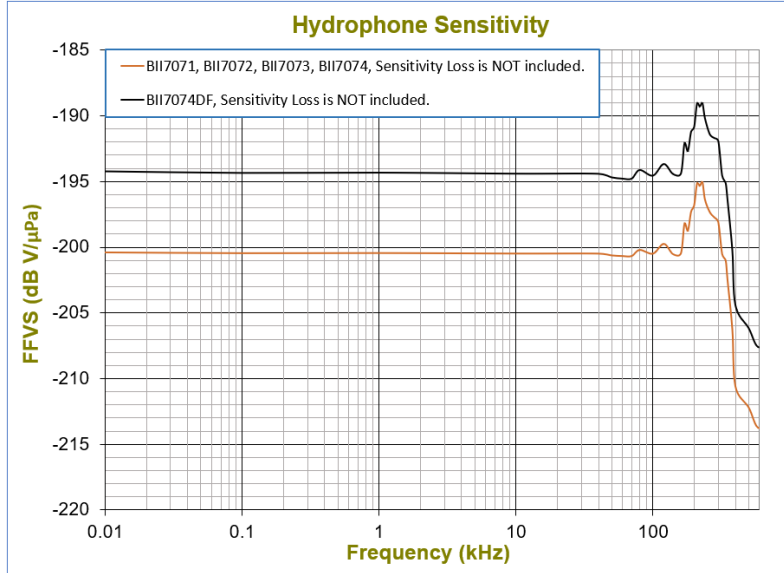
5. Free-hanging with Underwater Connector FHUWC-4P, 4 Pins (Fixed Sensitivity) (P: Pin, S: Socket.)

Mating Connector and Cable	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: UMC4S-20m-WL: 20 m cable with Underwater Mateable Connector 4 Sockets (UMC4S) on one end and wire leads (WL) on other end. UMC4S-20m-XLR3/BS: 20 m cable with and Underwater Mateable Connector 4 Sockets (UMC4S) on one end and XLR Receptacle with 3 Male Pins (XLR3) and Two +9V Battery Snaps on other end.

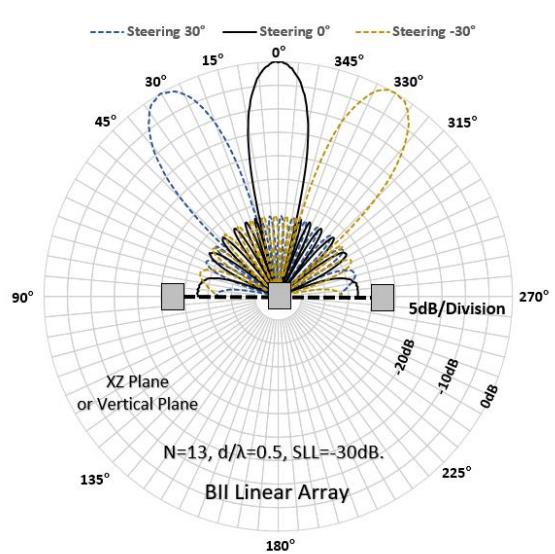


6. More Mounting/Installation Options: Please refer to online document [AcousticSystem.pdf](#) for a complete list of Mounting Options and details.

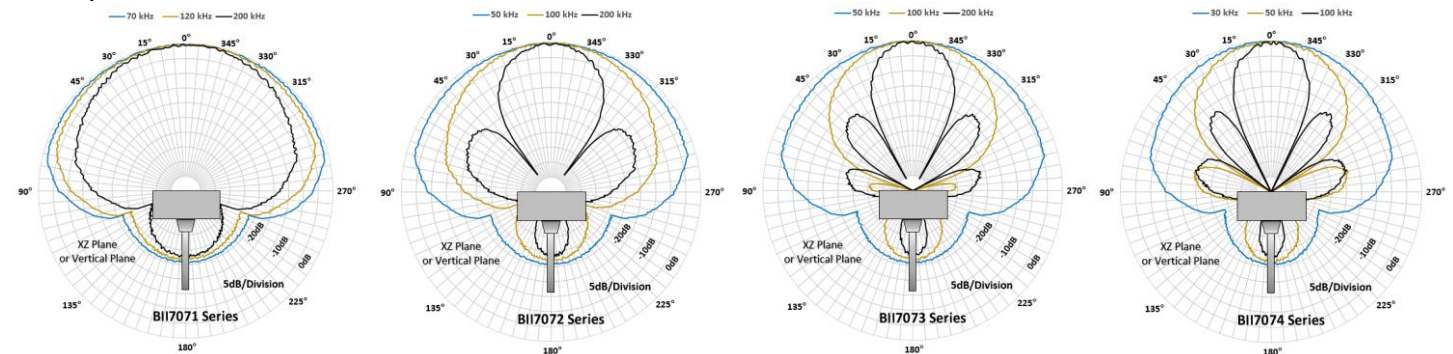
Free-field Voltage Sensitivity (FFVS):



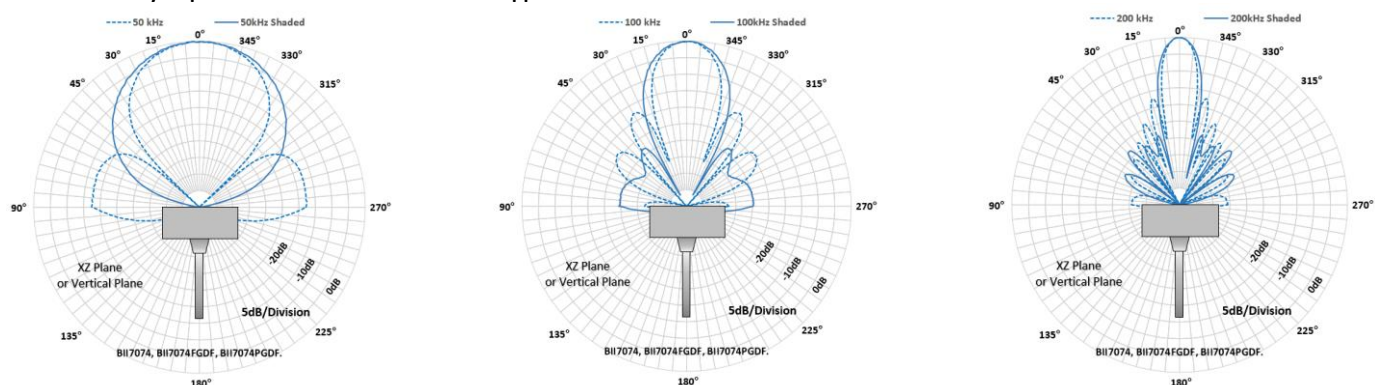
Linear Array Example with BII7070 Series Elements



Directivity Pattern



BII7074 Series Hydrophone without and with Sidelobe Suppression



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.