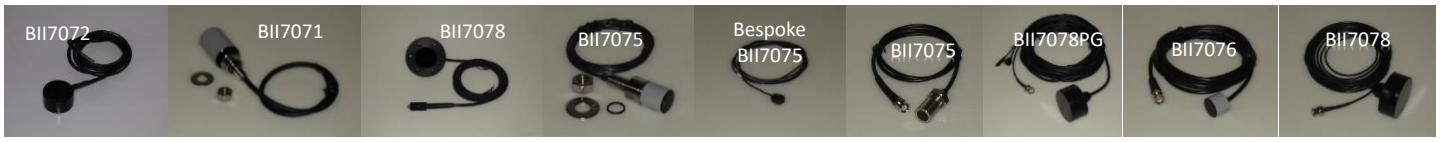
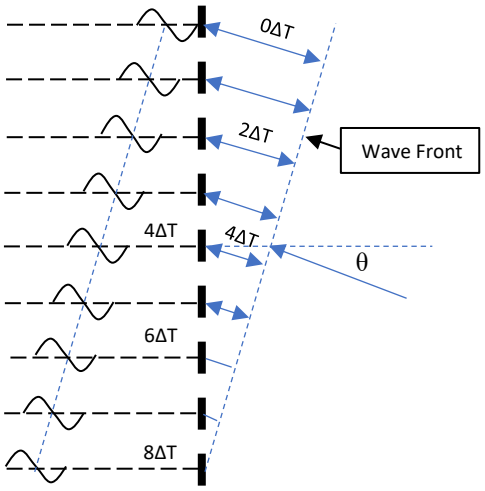


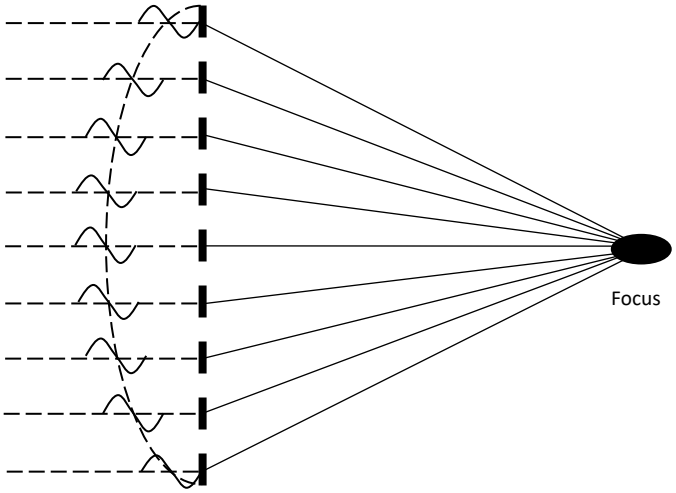
BII7070 Series Directional Hydrophone (Acoustic Sensor) and Planar Array Element

BII's directional hydrophones have conical beams and low Qm for uses in detection of weak signals, broadband signals, pipeline leaks, and tracking of sound sources underwater. Hydrophones with low noise below sea-state zero are available for directional sound measurements such as Dolphins' whistles and clicks (about 0.2 to 150 kHz, 50 to 128 µS.) in a long distance. These acoustic sensors are also designed for applications in air to detect acoustic emission and stress waves. The couplant such as water or gel is necessary material to provide efficient acoustic coupling between the hydrophone face and the piece under test in air applications.
Below the critical frequency fc, the hydrophones are of single beam without side lobes. This feature makes hydrophones be ideal candidates for target angle estimation systems or sound source tracking systems. The hydrophones have higher sensitivity and can transmit signal over long cable with built-in preamplifiers.

Linear (Rectangular) Array Beam Steering



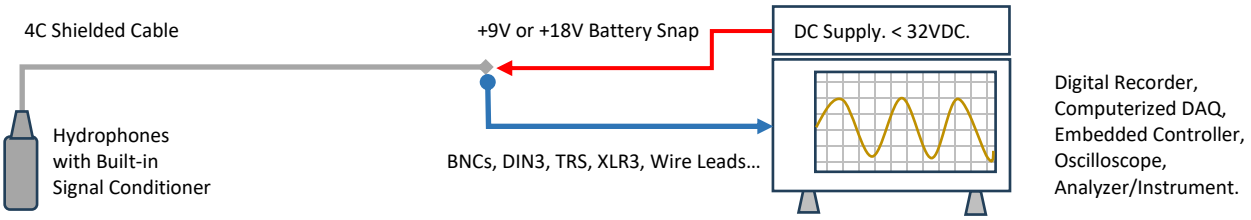
Linear, Annular, and Planar Array Beam Focusing



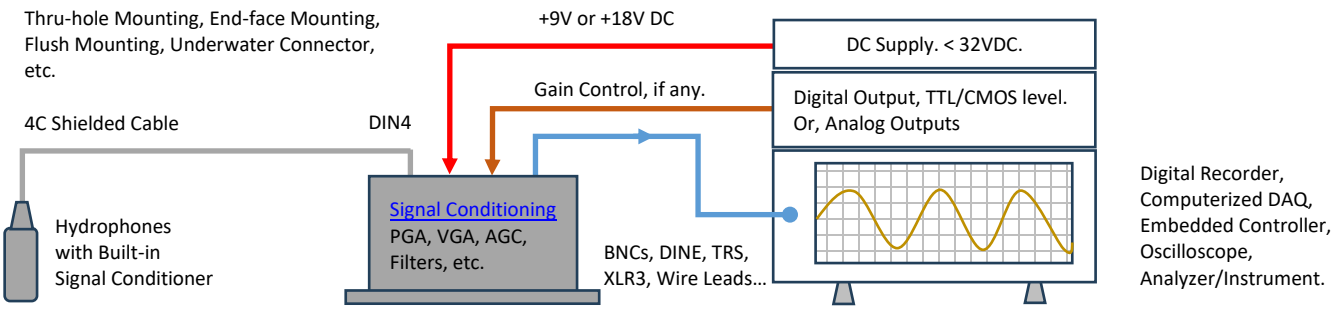
Typical Applications

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.

System Configuration of Receiving Sounds and Waves.



Installation to Underwater Submersibles:
Thru-hole Mounting, End-face Mounting, Flush Mounting, Underwater Connector, etc.



Specification

The hydrophone is tested in water unless stated otherwise.					
FG: Fixed Gain; **PG:** Programmable Gain; **DF:** Differential Output; **SE:** Single Ended Output; **BPF**: Band Pass Filter; **HPF**: High Pass Filter; **LPF**: Low Pass Filter.					
Part Number:	**BII7075FGDF**	**BII7076FGDF**	**BII7077FGDF**	**BII7078FGDF**	**BII7078FGDFLN**
Sensitivity @ 1kHz:	-194.0 + Preamp Gain, V/µPa. Variation: ± 3 dB.				-188 + Preamp Gain

		-160.0 dB				-160.0 dB
FFVS:		Refer to Graph of FFVS vs. Frequency. Free-field Voltage Sensitivity.				
Pressure Noise Density:		Refer to Graph of Pressure Noise Density, Referred to Input (RTI), in µPa/√Hz.				
Filter Types:		Bespoke HPF, or BPF.				
Minimum High Pass Filter:		10 Hz	3 Hz	2 Hz	1 Hz	3 Hz
Built-in Filters: -3dB V/µPa.	in Water:	10 Hz to 450 kHz	3 Hz to 450 kHz	2 Hz to 450 kHz	1 Hz to 450 kHz	3 Hz to 450 kHz
	in Air:	10 Hz ~ 16 kHz	3 Hz ~ 8 kHz	2 Hz ~ 6 kHz	1 Hz ~ 3 kHz	3 Hz ~ 3 kHz
1. Reduce Noise. Both ocean ambient noises and the self-noises of electronic devices decrease when frequency increases. It is recommended to choose a built-in high pass filter to reject noises in low frequency range. For example, if you are interested in the signals greater than 1 kHz, you may specify a high pass filter with -3dB cut-off frequency at 100 Hz to improve signal to noise ratio of the signals of the interest. 2. Avoid Saturation. When there are strong low frequency noises, disturbances, and/or vibrations, resulting from rough surface waves and/or mechanical movements of the platform, it is recommended to specify a high pass filter to avoid hydrophone saturation in these low frequency ranges.						
Preamp Gain (dB):		Fixed Gain Preamp.				
		Default: 34 dB.				Default: 28 dB.
		Bespoke Gains: 10, 20, 30, 40, or 50 dB, etc.				
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 Response Pattern.				
-3dB Beam Width:		9900°/f(kHz)	4650°/f(kHz)	3200°/f(kHz)	1700°/f(kHz)	1700°/f(kHz)
Frequency f_{-3dBML}:		74 kHz	41 kHz	32 kHz	15 kHz	15 kHz
		f_{-3dBML}: Main Lobe drops -3dB at ±90° 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 > fc; The hydrophone has no side lobe in the case of f ≤ fc.				
±90° Sidelobe Frequency f_n:		240 kHz	133 kHz	104 kHz	49 kHz	49 kHz
		f_n: First Side Lobes exist at ±90° normal to acoustic axis in the case of operating frequency f = fn.				
Sidelobe Level:		1. Default: < -17.8 dB when f > fc; No side lobe when f ≤ fc. 2. Bespoke Sidelobe Suppression is available upon request for BII7078FG: ≤-30 dB. Main lobe is about 1.1 to 1.28 times wider.				
Signal Output Type:		Differential. Differential signal has better capability to reduce and reject EMI noise, especially over long cable.				
Maximum Output V_{omax}:		Supply Voltage V_s - 4, in Vpp.				
Overload Pressure Level:		194 or (20*log(V_{omax}/2.828) – Sensitivity) whichever is less. in dB µPa.				
Acceleration Sensitivity: µPa/(m/s²).		143.6 dB along acoustic axis.				138.0 dB.
		Other directions: 141.0 dB.				135.0 dB.
		Bespoke Vibration Compensation, available upon request: 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.				
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-Φ110)**				
		Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.				
Cable Options:		Four Conductor Shielded Cable (**SC**)				
Cable Orientation:		1. Default: Perpendicular to end face of hydrophone. 2. Customization: Perpendicular to side wall of hydrophone (Generally, this is used to reduce the overall length of hydrophone), Appending **SW** to the part number.				
Cable Length:		1. Default: 20m (65.6ft) for Non-Underwater Connector; 0.6m (2ft) for Underwater Connectors. 2. Custom-fit Cable Length up to 200m or 305 m.				
Connector:		1. Default: Wire Leads (**WL**) 2. Two Male BNCs (**BNC**) (Max. Diameter Φ14.3 mm) for Output+ and Output- Signals. 3. DIN Receptacle with 3 Male Pins (**DIN3**), (Max. Diameter Φ17 mm). DIN Receptacle with 4 Male Pins (**DIN4**), (Max. Diameter Φ17 mm). 4. 1/8" (3.5mm) TRS Plug (**TRS**) (Max. Diameter Φ10.5 mm). 5. XLR Receptacle with 3 Male Pins (**XLR3**), (Max. Diameter Φ20.2 mm). XLR Receptacle with 4 Male Pins (**XLR4**), (Max. Diameter Φ20.2 mm). 6. Underwater Mateable Connector (4 pins) (**UMC4P**) (Max. Diameter Φ21.5 to Φ35 mm). **UMC** is from global manufacturers of underwater connectors. Its part number is listed in quote in detail.				

	7. +9VDC Battery Snap (**BS**), for +9VDC or +18VDC power supply. 8. 4mm Banana Plug Pair (Red and Black Color) (**BP**), for DC power supply ONLY.
	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, Φ20mm 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.	
Supply Voltage V_S:	+8.5 to +32 VDC.
Suggested DC Supply:	+9VDC Battery, Marine Battery, Automobile Battery, Fixed DC Linear Power Supply, Not Included. DO NOT use variable power supply whose maximum supply voltage is higher than the rated voltage. DO NOT use switching mode DC power supply.
Current (Quiescent):	4.8 to 9.8 mA
Size:	Φ21x50 mm / Φ27x50 mm / Φ33x50 mm / Φ60x30 mm / Φ60x30 mm Other Mounting Types: actual length depends on Mounting Parts.
Weight:	≥ 1.0 kg with 20m cable. 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.
AE (Acoustic Emission) Applications: These hydrophones are tested and calibrated in water. It is buyer's responsibility and liability to calibrate and maintain the AE sensors according to the acoustic emission national standards of buyer's country.	
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**.**

FG: Fixed Gain; **DF:** Differential Output; **BPF**: Band Pass Filter; **HPF**: High Pass Filter; **LPF**: Low Pass Filter.					
Part Number	**-Gain and Filter**	**-Mounting**	**-Cable Length**	**-Connectors for Signal**	**/DC Supply**
BII7075FGDF, BII7076FGDF, BII7077FGDF, BII7078FGDF, BII7078FGDFLN.	Default.	Free Hanging.	20 m (65.6 ft)	WL, BNC, TRS, or XLR3, XLR4, BS.	
Example of Part Number:	**Description**				
BII7078FGDF-FH-20m-WL	BII7078FGDF Hydrophone, Free Hanging, 20m Shielded Cable, Connector: None, Wire leads.				
BII7078FGDF-FH-20m-BNC/BS	BII7078FGDF Hydrophone, Free Hanging, 20m Shielded Cable, Connector: Two BNC Male for Output+ and Output- Signals, 9V Battery Snaps for DC Supply.				
BII7078FGDF-FH-20m-TRS/BS	BII7078FGDF Hydrophone, Free Hanging, 20m Shielded Cable, Connector: TRS for Signal, 9V Battery Snaps for DC Supply.				
BII7078FGDF-FH-20m-DIN3/BS	BII7078FGDF Hydrophone, Free Hanging, 20m Shielded Cable, Connector: DIN3 for Signal, 9V Battery Snaps for DC Supply.				
BII7078FGDF-FH-20m-XLR3/BS	BII7078FGDF Hydrophone, Free Hanging, 20m Shielded Cable, Connector: XLR3 for Signal, 9V Battery Snaps for DC Supply.				
BII7078FGDF-FH-20m-DIN4	BII7078FGDF Hydrophone, Free Hanging, 20m Shielded Cable, Connector: DIN4 for Signals and DC Power Supply.				
BII7078FGDF-FH-20m-XLR4	BII7078FGDF Hydrophone, Free Hanging, 20m Shielded Cable, Connector: XLR4 for Signals and DC Power Supply.				

How to Order Bespoke Hydrophones. Non-stock.

FG: Fixed Gain; **PG:** Programmable Gain; **DF:** Differential Output; **SE:** Single Ended Output; **BPF**: Band Pass Filter; **HPF**: High Pass Filter; **LPF**: Low Pass Filter.						
Part Number	**-Preamp Gain**	**-HPF or HPF/LPF**	**-Mounting**	-Shielded Cable Length	**-Connectors for Signal**	**/DC Supply**
BII7075FGDF, BII7076FGDF, BII7077FGDF, BII7078FGDF, BII7078FGDFLN.	Fixed, in dB.	-3dB High Pass or Bandpass Filter frequencies, in Hz, kHz.	Mounting Options.	in meter. Up to 200m (656 ft) or 305m (1000 ft).	Connector Options for Signals, and DC Supply.	

Example of Part Number:	**Description**
BII7078FGDF-40dB-10Hz/30kHz-FH-30m-WL	BII7078FGDF Hydrophone, Gain: 40dB, Band Pass Filter: 10Hz to 30kHz, Free Hanging, 30m Shielded Cable, Connector: none, Wire leads.
BII7078FGDF-40dB-10Hz/30kHz-FH-30m-BNC/BS	BII7078FGDF Hydrophone, Gain: 40dB, Band Pass Filter: 10Hz to 30kHz, Free Hanging, 30m Shielded Cable, Connector: Two BNC Male for Output+ and Output- Signals, 9V Battery Snaps for DC Supply.
BII7078FGDF-26dB-10Hz-BFM-5/8”-100m-DIN3/BS	BII7078FGDF Hydrophone, Gain: 26dB, High Pass Filter: 10Hz, Bolt Fastening Mounting BFM-5/8”, 100m Shielded Cable, Connector: 3-pin DIN for Signals and Battery Snap for +9VDC Batteries.
BII7078FGDF-26dB-10Hz-BFM-5/8”-100m-XLR3/BS	BII7078FGDF Hydrophone, Gain: 26dB, High Pass Filter: 10Hz, Bolt Fastening Mounting BFM-5/8”, 100m Shielded Cable, Connector: 3-pin XLR for Signals and Battery Snap for +9VDC Batteries.
BII7078FGDF-26dB-10Hz-BFM-5/8”-100m-DIN4	BII7078FGDF Hydrophone, Gain: 26dB, High Pass Filter: 10Hz, Bolt Fastening Mounting BFM-5/8”, 100m Shielded Cable, Connector: 4-pin DIN for Signals and DC Power Supply.
BII7078FGDF-26dB-10Hz-FH-0.6m-UMC4P	BII7078FGDF Hydrophone, Gain: 26dB, High Pass Filter: 10Hz, Free Hanging, 0.6m Shielded Cable, Connector: 4-pin Underwater Mateable Connector for Signals and DC Power Supply.

Wiring Information of Hydrophones with Fixed-gain Preamps:

Differential Output:	**Wire Leads**	**UMC4P/XLR4P**	**DIN4P**	**DIN3/XLR3 + 9V BS**		**BNC + 9V BS**	**TRS + 9V BS**
+VDC	Red	Pin 3	Pin 4	Battery Female Snap		Battery Female Snap	Battery Female Snap
Common	Black	Pin 1	Pin 1	Battery Male Snap		Battery Male Snap	Battery Male Snap
Signal+	White	Pin 2	Pin 3	DIN3 Pin 3	TRS Tip	#1 BNC Center	TRS Tip
Signal-	Blue, Green, or Yellow	Pin 4	Pin 2	DIN3 Pin 1	TRS Ring	#2 BNC Center	TRS Ring
Signal Common	N/A	Pin 1	Pin 1	DIN3 Pin 2	TRS Sleeve	BNC Shell	TRS Sleeve
Shielding	Shield	Metal Shell	Metal Shell	DIN3 and XLR3 Metal Shell		N/A	N/A

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.

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 the hydrophone with differential outputs be wired to single-ended inputs of a DAQ device (Data Acquisition Equipment) such as an Oscilloscope? Yes, output+ and Common of a BII hydrophone can be used a single-ended signal, or Output- and Common of the hydrophone can be used a single-ended signal. But, neither output+ nor output – of the hydrophone can be wired to common which is going to destroy the hydrophone by short circuit.

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.**

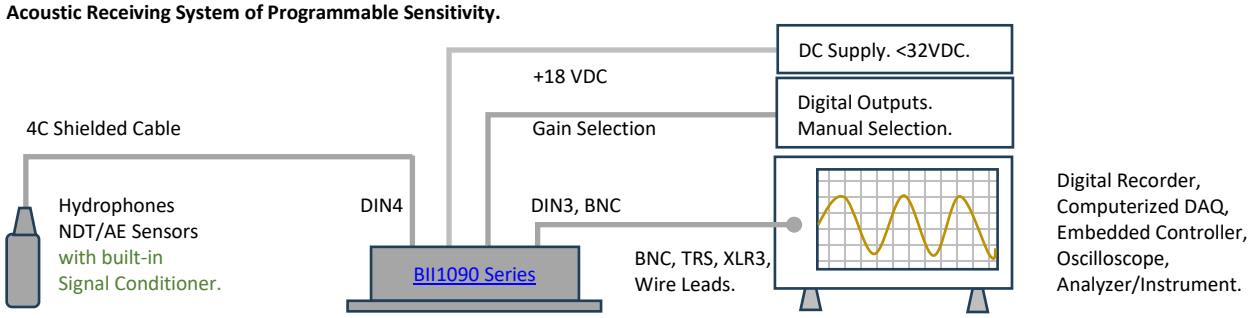
How to increase hydrophone sensitivity for extremely weak sounds?

BII low noise hydrophone with built-in preamp (Differential Output) -> Long Cable -> Standalone Preamp -> Analyzing Instrument or Recorder.

What components are necessary to compensate the propagation and spreading loss?

A low noise hydrophone + PGA amplifier with gain of 0/20/40/60 dB.
A low noise hydrophone + VGA amplifier with gain of 0 ~ 70 dB.
A low noise hydrophone + AGC amplifier with gain of -20 ~ 80dB.

Acoustic Receiving System of Programmable Sensitivity.

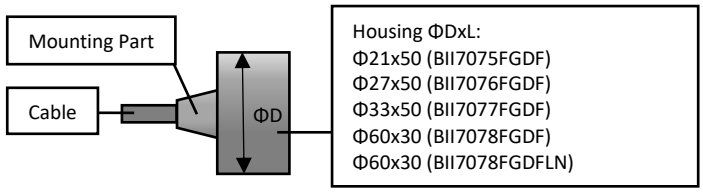


How do I use Gain Selection wires of a standalone PGA in field?

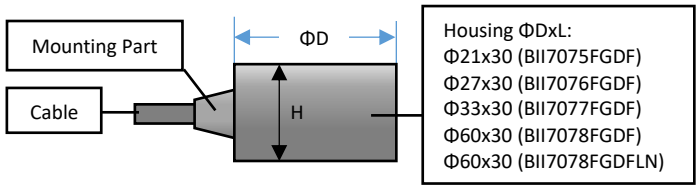
(1). **Manual Gain Selection.**
When a **Gain Selection wire** is floating or open, its digital logic is High or "1". When a **Gain Selection wire** is short to **Digital Common**, its digital logic is Low or "0". Sensitivity of a Hydrophone is fixed when its Gain Selection wires are fixed to **Digital Common** or open (floating) during operation.
(2). **Gain Selection with Digital Outputs.** Digital Outputs of a DAQ (data acquisition device) select gains with TTL/CMOS logic levels.

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

a. General Size information.

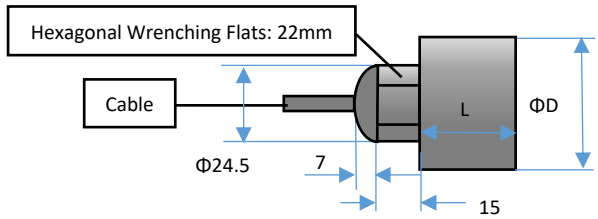


b. Size information of Customized Cable Orientation: Side Wall.

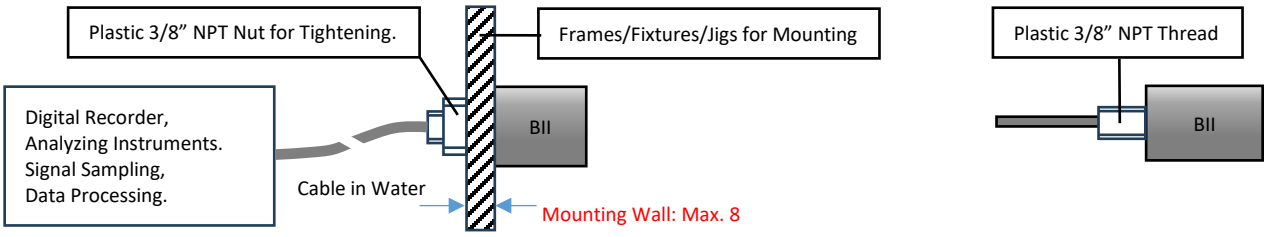


Physical Size (Dimensional Unit: mm): The overall length varies with the length of the built-in preamplifier and mounting parts.

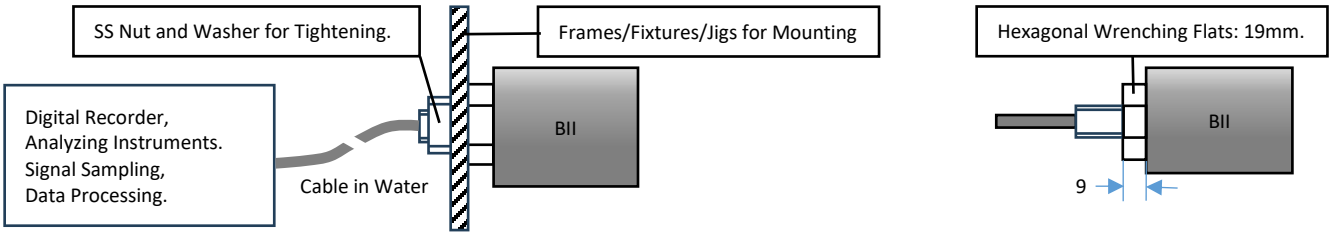
1. Free Hanging.



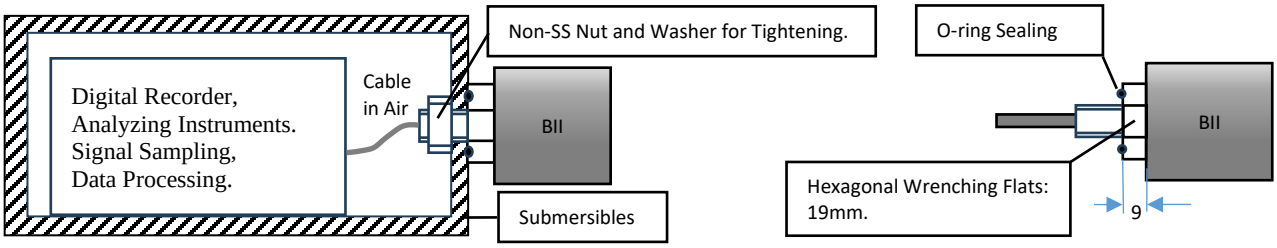
2. Bolt-Fastening Mounting BFM-NPT3/8", 3/8" NPT Thread Length: 15mm. Nut Height: 5mm.



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).

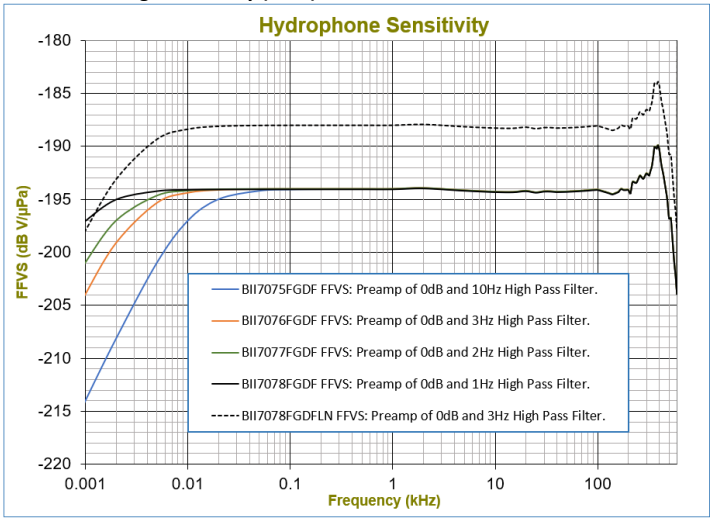


5. Free-hanging with Underwater Connector FHUWC-4P, 4 Pins (Fixed Sensitivity) (P: Pin, S: Socket.)

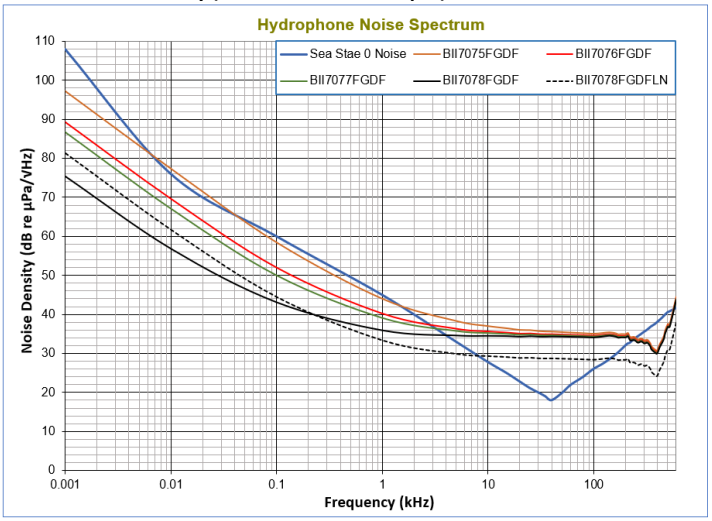
Mating Connector and Cable	**UWC-Cable Length-Connector:** Underwater Connector with Socket insert and Internal-Thread Mating Parts, customized-length shielded cable, a Connector (WL, XLR, TRS, DIN, MIL, UMC, etc.) to DAQ devices or Digital Recorders.
	How to order cable with mating underwater connector? 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.

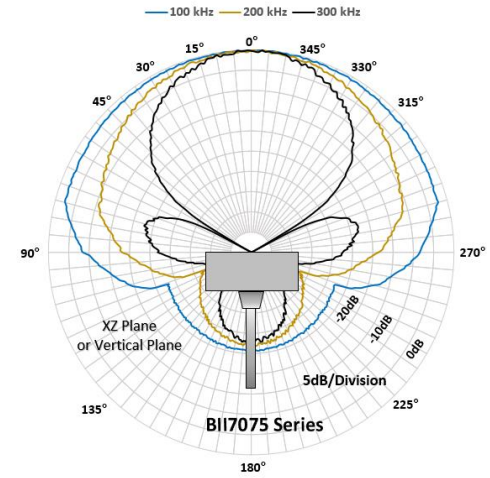
Free-field Voltage Sensitivity (FFVS)

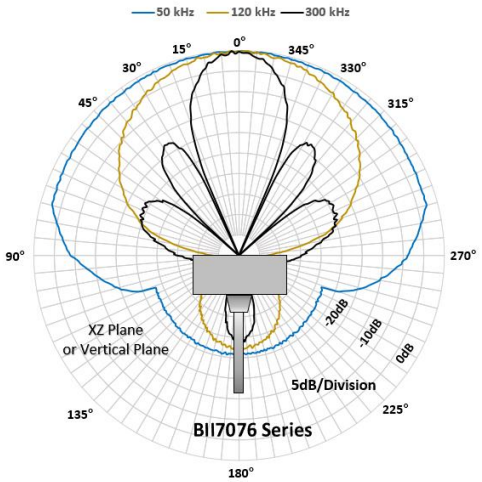


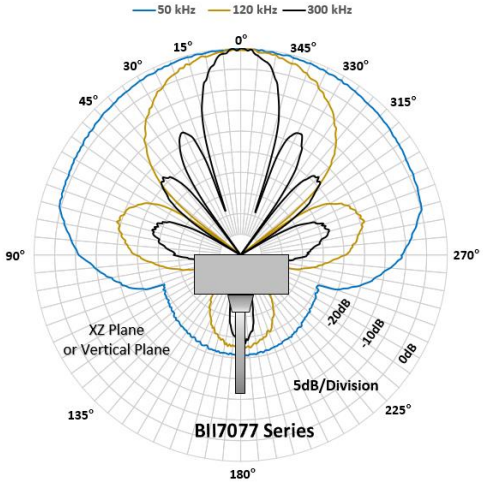
Pressure Noise Density (RTI, referred to the input)

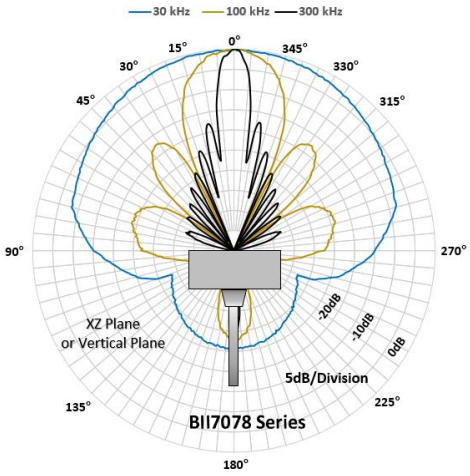


Directivity Pattern









Linear Array with BII7070 Series Elements.