



### Omnidirectional Spherical Hydrophone

BII's spherical hydrophones provide omnidirectional responses up to 700kHz and offer excellent acoustic characteristics of low noise and durability, which make these hydrophones ideal for a wide range of oceanography applications. Bespoke built-in preamplifiers allow the hydrophones to be used with long extension cables with no loss in sensitivity. The customized built-in filters increase Signal-to-Noise Ratio, reject unwanted noise, and avoid saturation.

#### Typical Applications

Sonobuoy, Dipping Hydrophone. LBL, SBL, USBL Positioning, Communication. Parabolic Antennas Underwater. Reference Hydrophone, Noise Measurement.	Detection of Ultrasonic Cavitation Noise, Thermoacoustics in Gas. Passive Acoustic Monitoring (PAM System). Array Element, Vector Hydrophone Element. Marine Bioacoustics, Phantom-power Hydrophone, Sound Recording.
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#### Specification

<b>The hydrophone is tested in water unless stated otherwise.</b>		
<b>FG:</b> Fixed Gain; <b>PG:</b> Programmable Gain; <b>DF:</b> Differential Output; <b>SE:</b> Single Ended Output; <b>BPF:</b> Band Pass Filter; <b>HPF:</b> High Pass Filter; <b>LPF:</b> Low Pass Filter.		
<b>Part Number:</b>	<b>BII7002FGDF</b>	<b>BII7002PGDF</b>
Sensitivity @ 1 kHz:	-190.0 + Preamp Gain, $\pm 2$ dB V/ $\mu$ Pa. -160.0 dB V/ $\mu$ Pa.	-180.0 and -140 dB V/ $\mu$ Pa.
FFVS:	Refer to Graph of <a href="#">FFVS vs. Frequency</a> . Free-field Voltage Sensitivity.	
Pressure Noise Density:	Refer to Graph of <a href="#">Pressure Noise Density</a> , Referred to Input (RTI), in $\mu$ Pa/VHz.	
<b>Built-in Filters:</b> at -3dB V/ $\mu$ Pa.	Bespoke HPF, or BPF.	
	Minimum HPF: 0.1 Hz.	Minimum HPF: 0.5 Hz.
	<b>In Water:</b> 0.1 Hz ~ 80 kHz.	<b>In Water:</b> 0.5 Hz ~ 80 kHz.
	<b>In Air:</b> 0.1 Hz ~ 3.2 kHz.	<b>In Air:</b> 0.5 Hz ~ 3.2 kHz.
	<p>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.</p> <p>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.</p>	
<b>Preamp Gain (dB):</b>	30 dB.	10, 50 dB.
Bespoke Preamp:	<a href="#">Low Power Fixed Gain Preamp.</a>	<a href="#">Low Noise Programmable Gain Preamp.</a>
	Buyer may specify a specific preamp to be used in the hydrophone. For example, when low power consumption is critical to your project instead of low noise, you may consider <a href="#">BII1011</a> , or <a href="#">BII1012</a> to be installed inside hydrophone.	
Gain Selection Voltage:	N/A	CMOS/TTL Compatible Logic Low 0: Gain Selection Wire to COM or 0 to +0.8 VDC. Logic High 1: Gain Selection Wire Open or +2.4 VDC to $V_s$ .
Directivity Pattern:	Omnidirectional. Refer to Graph of <a href="#">Directivity Response Pattern</a> .	
Side Lobe Level:	No side lobes.	
Signal Output Type:	Differential	Differential
	<i>Differential signal has better capability to reduce and reject EMI noise, especially over long cable.</i>	
Maximum Output $V_{omax}$ :	Supply Voltage $V_s$ - 4, in Vpp.	$V_s$ - 3.4, in Vpp.
Overload Pressure Level:	$20 \cdot \log(V_{omax}/2.828)$ - Sensitivity, in dB $\mu$ Pa.	
Acceleration Sensitivity:	137.0 dB $\mu$ Pa/(m/s <sup>2</sup> ) at Acoustic Axis; $\leq 135$ dB $\mu$ Pa/(m/s <sup>2</sup> ) at other directions.	
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.	
<b>Mounting Options:</b>	<p>1. Default: Free Hanging (FH).</p> <p>2. Free-hanging with Male Underwater Connector (FHUWC-3P, FHUWC-4P, FHUWC-6P).</p> <p>3. Thru-hole Inch Mounting with Single O-ring Sealing (THM-7/16").</p> <p>4. Thru-hole Inch Mounting with Double O-ring Sealing (THDO-7/16").</p> <p>5. Bolt Fastening Mounting (Plastics) (BFMP-M12).</p> <p>6. Bolt Fastening Mounting (Plastics) (BFMP-NPT3/8").</p> <p>7. Bolt Fastening Mounting (Stainless Steel) (BFM-7/16").</p> <p>8. Bolt Fastening Mounting (Stainless Steel) (BFM-5/8").</p>	
	Please refer to online document <a href="#">AcousticSystem.pdf</a> for a complete list of Mounting Options and more details.	
<b>Cable Options:</b>	Four Conductor Shielded Cable (SC)	Six Conductor Shielded Cable (SC)
<b>Cable Length:</b>	<p>1. Default: 20m (65.6ft) for Non-Underwater Connector; 0.6m (2ft) for Underwater Connectors.</p> <p>2. Custom-fit Cable Length up to 305 m.</p>	
<b>Connector:</b>	<p>1. Default: Wire Leads (WL)</p> <p>2. Two Male BNCs (BNC) (Max. Diameter <math>\Phi 14.3</math> mm) for Output+ and Output- Signals.</p> <p>3. DIN Receptacle with 3 Male Pins (DIN3), (Max. Diameter <math>\Phi 17</math> mm). DIN Receptacle with 4 Male Pins (DIN4), (Max. Diameter <math>\Phi 17</math> mm). DIN Receptacle with 6 Male Pins (DIN6), (Max. Diameter <math>\Phi 17</math> mm).</p> <p>4. 1/8" (3.5mm) TRS Plug (TRS) (Max. Diameter <math>\Phi 10.5</math> mm).</p> <p>5. XLR Receptacle with 3 Male Pins (XLR3), (Max. Diameter <math>\Phi 20.2</math> mm). XLR Receptacle with 4 Male Pins (XLR4), (Max. Diameter <math>\Phi 20.2</math> mm).</p>	

<p>XLR Receptacle with 6 Male Pins (<b>XLR6</b>), (Max. Diameter <math>\Phi 20.2</math> mm).</p> <p>6. Underwater Mateable Connector (4 pins) (<b>UMC4P</b>) (Max. Diameter <math>\Phi 21.5</math> to <math>\Phi 35</math> mm). Underwater Mateable Connector (6 pins) (<b>UMC6P</b>) (Max. Diameter <math>\Phi 21.5</math> to <math>\Phi 35</math> mm). <b>UMC</b> is from global manufacturers of underwater connectors. Its part number is listed in quote in detail.</p> <p>7. +9VDC Battery Snap (<b>BS</b>), for +9VDC or +18VDC power supply.</p> <p>8. 4mm Banana Plug Pair (<b>Red</b> and Black Color) (<b>BP</b>), for DC power supply ONLY.</p> <p>Underwater Mateable Connectors are for underwater uses. Other connectors/wire leads are for dry uses and are not waterproofed.</p>		
<p>1. <b>BNC</b>: "Bayonet Neill–Concelman" is a miniature quick connect/disconnect radio/audio frequency connector used for coaxial cable. <b>Fastening Type</b>: Bayonet Lock.</p> <p>2. <b>3.5mm TRS</b> stand for Tip, Ring, and Sleeve, miniature, quick connect/disconnect, audio frequency connector used for shielded cable. <b>Fastening Type</b>: None.</p> <p>3. <b>DIN</b>: Electrical cylindrical connectors, 3 to 14 contacts, <math>\Phi 20</math>mm diameter, used for audio, RF, digital, and DC or AC power signals. <b>Fastening Type</b>: Threaded.</p> <p>4. <b>XLR</b>: Employed for balanced audio and DC or AC power signal interconnections, 3 to 7 contacts. <b>Fastening Type</b>: Latch Lock.</p>		
Supply Voltage $V_s$ :	+8.5 to +32 VDC	+9 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):	9.8 mA	18 mA
Size:	Free Hanging: $\Phi D = \Phi 21$ mm and $\Phi 34$ mm, Length $\geq 70$ mm. Other Mounting Types: actual length depends on Mounting Parts.	
Weight:	$\geq 0.55$ kg with 10m 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.	
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; PG: Programmable Gain; DF: Differential Output; BPF: Band Pass Filter; HPF: High Pass Filter; LPF: Low Pass Filter.						
Part Number	-Preamp Gain	-HPF Filter	-Mounting	-Cable Length	-Connectors for Signal/Gain Selection	/DC Supply
BII7002FGDF	30 dB.	0.1 Hz.	FH: Free Hanging.	20 m (65.6 ft)	<a href="#">Connector Options</a> for Signals, Gain Selection, and DC Supply.	
BII7002PGDF	10/50 dB.	0.5 Hz.				
Example of Part Number:			Description			
BII7002FGDF-30dB-0.1Hz-FH-20m-WL			BII7002FGDF Hydrophone, 30dB Gain, High Pass Filter: 0.1Hz, Free Hanging, 20m Shielded Cable, Connector: None, Wire leads.			
BII7002FGDF-30dB-0.1Hz-FH-20m-BNC/BS			BII7002FGDF Hydrophone, 30dB Gain, High Pass Filter: 0.1Hz, Free Hanging, 20m Shielded Cable, Connector: Two BNC Male for Output+ and Output- Signals, 9V Battery Snaps for DC Supply.			
BII7002FGDF-30dB-0.1Hz-FH-20m-XLR3/BS			BII7002FGDF Hydrophone, 30dB Gain, High Pass Filter: 0.1Hz, Free Hanging, 20m Shielded Cable, Connector: XLR3 for Signal, 9V Battery Snaps for DC Supply.			
BII7002FGDF-30dB-0.1Hz-FH-20m-XLR4			BII7002FGDF Hydrophone, 30dB Gain, High Pass Filter: 0.1Hz, Free Hanging, 20m Shielded Cable, Connector: XLR4 for Signals and DC Power Supply.			
BII7002PGDF-10/50dB-0.5Hz-FH-20m-WL			BII7002PGDF Hydrophone, 10/50dB Gain, High Pass Filter: 0.5Hz, Free Hanging, 20m Shielded Cable, Connector: None, Wire leads.			
BII7002PGDF-10/50dB-0.5Hz-FH-20m-XLR3/WL/BS			BII7002PGDF Hydrophone, 10/50dB Gain, High Pass Filter: 0.5Hz, Free Hanging, 20m Shielded Cable, Connector: XLR3 for Signal, Wire Leads for Gain Selection, 9V Battery Snaps for DC Supply.			
BII7002PGDF-10/50dB-0.5Hz-FH-20m-XLR6			BII7002PGDF Hydrophone, 10/50dB Gain, High Pass Filter: 0.5Hz, Free Hanging, 20m Shielded Cable, Connector: XLR6 for Signals, Gain Selection, 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/Gain Selection	/DC Supply
BII7002FGDF	30 dB.	High Pass or Bandpass Filter. -3dB frequencies, in Hz, kHz.	Mounting Options.	in meter.	<a href="#">Connector Options</a> for Signals, Gain Selection, and DC Supply.	
BII7002PGDF	10/50 dB.			Up to 200m (656 ft) or 305m (1000 ft).		
Example of Part Number:			Description			
BII7002FGDF-30dB-10Hz/200kHz-FH-30m-WL			BII7002FGDF Hydrophone, 30dB Gain, Bandpass Filter: 10Hz to 200kHz, Free Hanging, 30m Shielded Cable, Connector: none, Wire leads.			
BII7002FGDF-30dB-2kHz-FH-30m-BNC/BS			BII7002FGDF Hydrophone, 30dB Gain, High Pass Filter: 2kHz, Free Hanging, 30m Shielded Cable, Connector: Two BNC Male for Output+ and Output- Signals, 9V Battery Snaps for DC Supply.			
BII7002FGDF-30dB-100Hz-BFM-7/16"-100m-XLR3/BS			BII7002FGDF Hydrophone, 30dB Gain, High Pass Filter: 100Hz, Bolt Fastening Mounting BFM-7/16", 100m Shielded Cable, Connector: 3-pin XLR for Signals and Battery Snap for +9VDC Batteries.			
BII7002FGDF-30dB-100Hz-FH-0.6m-UMC4P			BII7002FGDF Hydrophone, 30dB Gain, High Pass Filter: 100Hz, Free Hanging, 0.6m Shielded Cable, Connector: 4-pin Underwater Mateable Connector for Signals and DC Power Supply.			
BII7002PGDF-10/50dB-10Hz/200kHz-FH-30m-WL			BII7002PGDF Hydrophone, 10/50dB Gain, Bandpass Filter: 10Hz to 200kHz, Free Hanging, 30m Shielded Cable, Connector: none, Wire leads.			
BII7002PGDF-10/50dB-1kHz-BFM-7/16"-100m-XLR3/WL/BS			BII7002PGDF Hydrophone, 10/50dB Gain, High Pass Filter: 1kHz, Bolt Fastening Mounting BFM-7/16", 100m Shielded Cable, Connector: 3-pin XLR for Signals, Wire Leads for Gain Selection, and Battery Snap for +9VDC Batteries.			
BII7002PGDF-10/50dB-10Hz-FH-0.6m-UMC6P			BII7002PGDF Hydrophone, 10/50dB Gain, High Pass Filter: 10Hz, Free Hanging, 0.6m Shielded Cable, Connector: 6-pin Underwater Mateable Connector for Signals, Gain Selection, and DC Power Supply.			

**Wiring Information of BII7002FGDF 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	Black	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	N/A

#### Wiring Information of BII7002PGDF Hydrophones with One-Bit-Word Programmable Gain Preamps:

Differential Output:	Wire Leads	UMC6P/XLR6	DIN6	BNC + 9V BS	DIN3/XLR3 + 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, BNC Shield.	Battery Male Snap, DIN Pin 2 or XLR Pin 1.	Battery Male Snap, TRS Sleeve.
Output Signal+	White	Pin 2	Pin 3	"1" BNC Center Pin	DIN Pin 3	XLR Pin 2
Output Signal -	Green	Pin 4	Pin 2	"2" BNC Center Pin	DIN Pin 1	XLR Pin 3
Digital A0	Blue	Pin 6	Pin 5	Blue	Blue	Blue
Digital Common	Yellow or Brown	Pin 5	Pin 6	Yellow or Brown	Yellow or Brown	Yellow or Brown
Shielding	Shield	Metal Shell	Metal Shell	BNC Shield	Metal Shell	N/A

#### Selecting Sensitivity of One-bit Digitally Programmable

FFVS Selection Wire A0	Hydrophone Sensitivity FFVS at 1kHz.
0 (Logic Low)	-190.0 + 10 dB V/μPa.
1 (Logic High)	-190.0 + 50 dB V/μPa.

#### 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.

(1) The terminal of unused output **MUST** be insulated to avoid short circuit.

(2) Neither output+ nor output – of the hydrophone can be wired to common which is going to destroy the hydrophone by short circuit.

#### How do I use a programmable sensitivity hydrophone as a fixed sensitivity hydrophone?

When a **Gain Selection wire** is short to **Digital Common**, its digital logic is Low or "0". The gain of the built-in preamp is set to 20dB or low gain.

When a **Gain Selection wire** is floating or open, its digital logic is High or "1". The gain of the built-in preamp is set to 50dB or high gain.

**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.

#### How do I use Gain Selection wires 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.

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

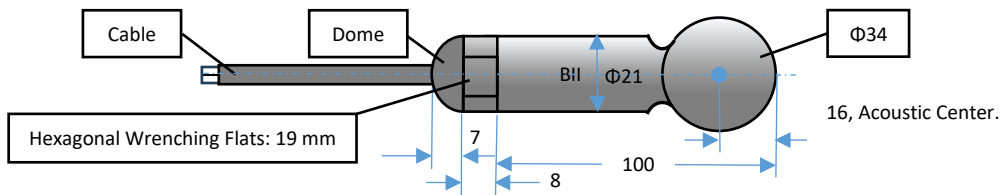
A low noise hydrophone + **PGA** amplifier with gain of 0/20/40/60 dB.

A low noise hydrophone + **VGA** amplifier with gain of 0 ~ 70 dB.

A low noise hydrophone + **AGC** amplifier with gain of -20 ~ 80dB.

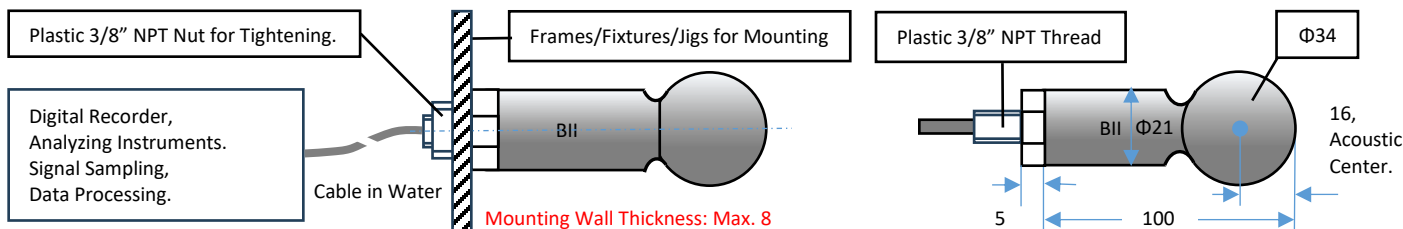
**Physical Size (Dimensional Unit: mm):** The overall length varies with the length of the built-in preamplifier and mounting parts.

**1. Free Hanging with Smooth Domes.**

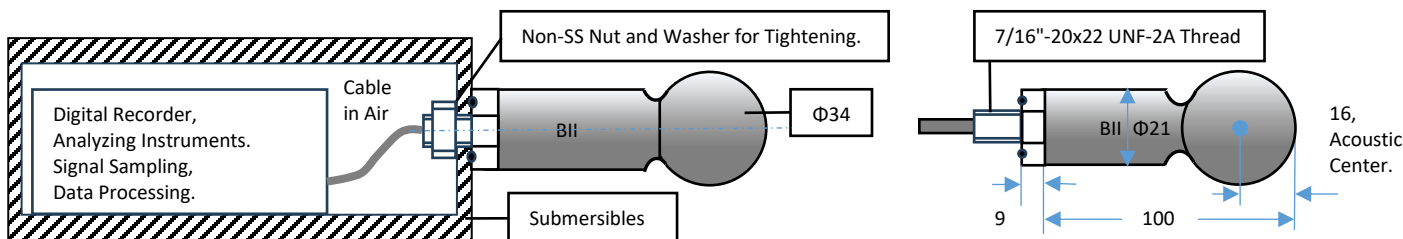


The hydrophone body has streamlined hemispherical domes which minimize the drag forces and the hydrodynamic noise caused by the hydrophone in motion or the flow past the hydrophone.

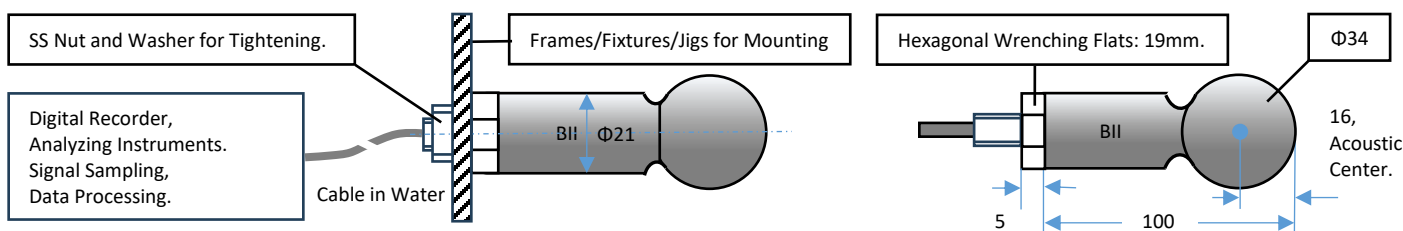
**2. Bolt-Fastening Mounting BFM-NPT3/8", 3/8" NPT Thread Length: 15mm. Nut Height: 5mm.**



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

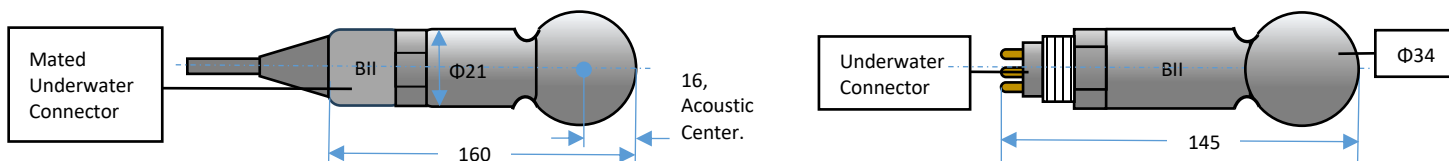


**4. Bolt-Fastening Mounting BFM-7/16" (7/16"-20x22 UNF-2A).**



**5. Free-hanging with Underwater Connector FHUWC-4P, 4 Pins (Fixed Sensitivity); FHUWC-6P, 6 Pins (Programmable Sensitivity).**

<b>Mating Connector and Cable</b>	<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.

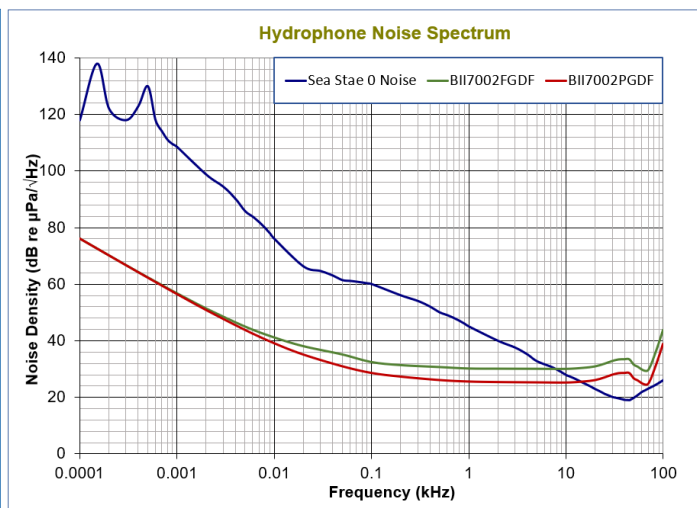
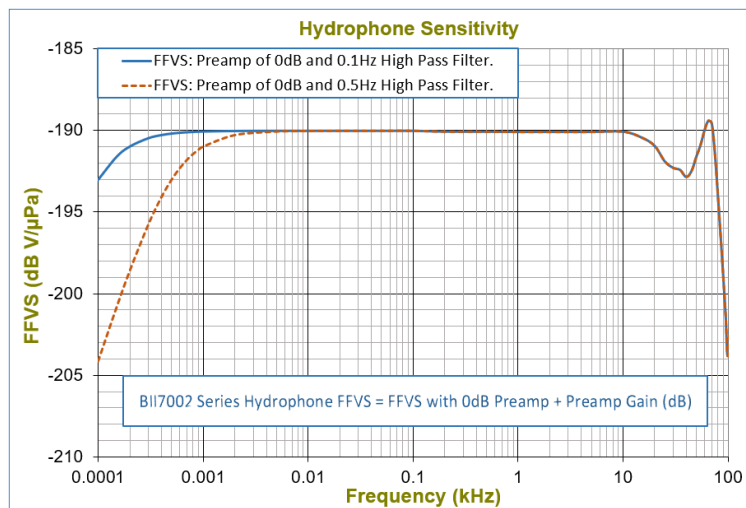


**6. More Mounting/Installation Options:** Please refer to online document [AcousticSystem.pdf](#) for a complete list of Mounting Options and details.

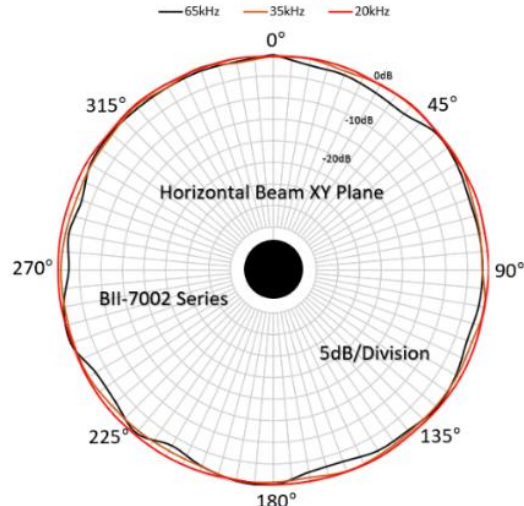
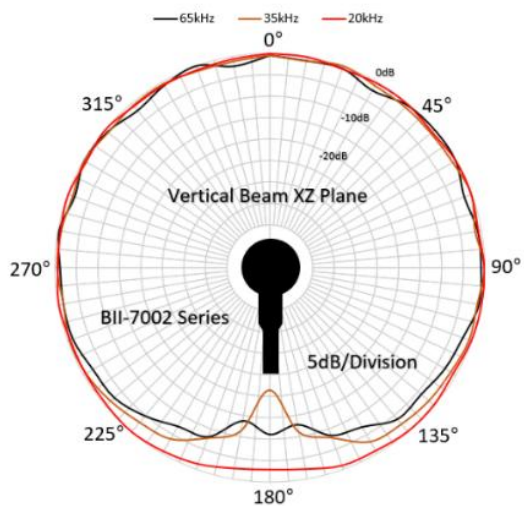


**Free-field Voltage Response (FFVS):**

**Pressure Noise Density (RTI, referred to the input):**



**Directivity Response Pattern**



**Simple Array Consisting of 2 or 3 Hydrophones.**  
"Figure 8" Pattern of a Dipole (Pressure-Gradient).

Cardioid Pattern= Pressure Hydrophone + Dipole.

