



### BII7010 Series Broadband Hydrophone: Low Power, Low Noise, 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 and its ringing is short. Custom-fit hydrophones with [low power preamplifiers](#) consume 40µA to 0.6mA which is a great merit for battery-powered portable acoustic system.

These hydrophones provide low-cost solutions for underwater recording, listening, and laboratory acoustics from 0.2Hz to 500kHz. They come with coax/shielded cables and underwater mateable/BNC/TRS/XLR/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 headphone.

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

BII7010 Hydrophones with integrated low power preamplifiers and filters are ideal gears to amplify the weak signals underwater and reject ambient noises. Its compact and small size avoid interferences to acoustic field under test. The [preamplifier](#) integrated in the hydrophone can drive cable up to 1000m without signal loss. These features allow them to be used in long line arrays (streamers) and large planar arrays.

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. they can measure the sound radiations and pressure changes in turbulent processes and flows.

BII7016 hydrophones is specialized to measures low frequency underwater sounds and pressure fluctuations down to 0.02 Hz: Surface Waves (Wave-height Sensor), Turbulences, seismic, ocean traffics, industrial noises, precipitations, biologics, ...

Sound Excitation by Turbulence:  $\frac{1}{c^2} \frac{\partial^2 p}{\partial t^2} - \Delta p = \rho \frac{\partial^2 v_k v_k}{\partial x_i \partial x_k}$  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, Communication. Parabolic Antennas Underwater. Reference Hydrophone, Noise Measurement. Signal detection in strong currents.	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. Studies of Ocean Turbulence and Flow, Marine Hydrodynamics.
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### 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:	BII7011FGDF	BII7011FGSE	BII7011PGDF	BII7011PGSE
Sensitivity @ 1 kHz:	-194.0 + Preamp Gain, ± 2 dB V/μPa.			
	-160.0 dB	-160.0 dB	-188.0, -148.0 dB	-174.0, -134.0 dB
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 μPa/VHz.			
Built-in Filters: at -3dB V/μPa.	Bespoke HPF .	Bespoke HPF .	Bespoke BPF .	Bespoke HPF .
	Minimum HPF: 0.2 Hz.	Minimum HPF: 2 Hz.	Minimum HPF: 1 Hz.	Minimum HPF: 0.2 Hz.
	in Water: 0.2 Hz ~ 60 kHz	2 Hz ~ 60 kHz	1 Hz ~ 60 kHz	0.2 Hz ~ 60 kHz
	in Air: 0.2 Hz ~ 5 kHz	2 Hz ~ 5 kHz	1 Hz ~ 5 kHz	0.2 Hz ~ 5 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):	<a href="#">Low Power Fixed Gain Preamp.</a>		<a href="#">Programmable Gain Preamp.</a>	
	34 dB.	34 dB.	6, 46 dB.	20, 60 dB.
	Note: If Digital Outputs or switches are used to select gains, Voltage Protection Rating or Absolute Maximum Voltage Ratings of these devices must be greater than V <sub>s</sub> Supply Voltage.			
Gain Selection Voltage: (Programmable Gain Preamp)	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 <sub>s</sub> .	
Directivity Pattern:	Omnidirectional and Toroidal. Refer to Graph of <a href="#">Directivity Response Pattern</a> .			
Side Lobe Level:	No side lobes.			
Signal Output Type:	Differential	Single Ended	Differential	Single Ended
	Differential signal has better capability to reduce and reject EMI noise, especially over long cable.			
Maximum Output V <sub>omax</sub> :	Supply Voltage V <sub>s</sub> - 4, in Vpp.	V <sub>s</sub> - 0.7, in Vpp.	V <sub>s</sub> - 4, in Vpp.	V <sub>s</sub> - 5, in Vpp.
Overload Pressure Level:	194 or (20*log(V <sub>omax</sub> /2.828) – Sensitivity) whichever is less. in dB μPa.			
Acceleration Sensitivity:	112.6 dBμPa/(m/s <sup>2</sup> ) at Acoustic Axis. ≤ 110 dBμPa/(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.			
Mounting Options:	1. Default: Free Hanging (FH).			
	2. Free-hanging with Male Underwater Connector (FHUWC-3P, FHUWC-4P, FHUWC-6P).			
	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-M12).			

	6. Bolt Fastening Mounting (Plastics) ( <b>BFMP-NPT3/8"</b> ). 7. Bolt Fastening Mounting (Stainless Steel) ( <b>BFM-7/16"</b> ). 8. Bolt Fastening Mounting (Stainless Steel) ( <b>BFM-5/8"</b> ). Please refer to online document <a href="#">AcousticSystem.pdf</a> for a complete list of Mounting Options and more details.			
Cable Options:	Four Conductor Shielded Cable ( <b>SC</b> )		Six Conductor Shielded Cable ( <b>SC</b> )	
Cable Length:	≤ 1000 m	≤ 60 m	≤ 1000 m	≤ 100 m
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 Φ14.3 mm), for SE ONLY. 3. 1/8" (3.5mm) TRS Plug ( <b>TRS</b> ) (Max. Diameter Φ10.5 mm), for SE or DF. 4. XLR Receptacle with 3 Male Pins ( <b>XLR3</b> ), (Max. Diameter Φ20.2 mm), for SE or DF. XLR Receptacle with 4 Male Pins ( <b>XLR4</b> ), (Max. Diameter Φ20.2 mm), for SE or DF. XLR Receptacle with 6 Male Pins ( <b>XLR6</b> ), (Max. Diameter Φ20.2 mm), for SE or DF. 5. Underwater Mateable Connector (4 pins) ( <b>UMC4P</b> ) (Max. Diameter Φ21.5 to Φ35 mm), for SE or DF. Underwater Mateable Connector (6 pins) ( <b>UMC6P</b> ) (Max. Diameter Φ21.5 to Φ35 mm), for SE or DF. <b>UMC</b> is from global manufacturers of underwater connectors. Its part number is listed in quote in detail. 6. +9VDC Battery Snap ( <b>BS</b> ), for +9VDC or +18VDC power supply. 7. 4mm Banana Plug Pair ( <b>Red</b> and Black Color) ( <b>BP</b> ), for DC power supply ONLY. Underwater Mateable Connectors are for underwater uses. Other connectors/wire leads are for dry uses and are not waterproofed.			
Supply Voltage $V_s$ :	+7.5 to +32 VDC	+3.4 to +32 VDC	+8.2 to +32 V	+9.5 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):	7.0 mA	1.55 mA	13 mA	3.0 mA
Size:	Free Hanging: ΦD = Φ25.4 mm, Overall Length = 67 mm. Other Mounting Types: actual length depends on Mounting Parts.			
Weight:	≥ 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; SE: Single Ended Output; BPF: Band Pass Filter; HPF: High Pass Filter; LPF: Low Pass Filter.					
Part Number	-Mounting	-Cable Length	-Connectors for Signal	/Gain Selection	/DC Supply
BII7011PGDF.	<a href="#">FH</a> : Free Hanging. <a href="#">BFMP-3/8"NPT</a> : Bolt-fastening Mounting.	20 m (65.6 ft)	WL, TRS, or XLR3, XLR4, XLR6, BS.		
Example of Part Number:	Description				
BII7011PGDF-FH-20m-WL	BII7011PGDF Hydrophone, Free Hanging, 20m Shielded Cable, Wire leads.				
BII7011PGDF-BFMP-3/8"NPT-20m-WL	BII7011PGDF Hydrophone, Bolt-fastening Mounting: BFMP-3/8"NPT, 20m Shielded Cable, Wire leads.				
BII7011PGDF-BFMP-3/8"NPT-20m-TRS/WL/BS	BII7011PGDF Hydrophone, Bolt-fastening Mounting: BFMP-3/8"NPT, 20m Shielded Cable, Connector: TRS for Signal, Wire Leads for Gain Selection, 9V Battery Snap for DC Supply.				
BII7011PGDF-FH-20m-XLR3/WL/BS	BII7011PGDF Hydrophone, Free Hanging, 20m Shielded Cable, Connector: XLR3 for Signal, Wire leads for Gain Selection, Battery Snaps for +9VDC Batteries.				
BII7011PGDF-FH-20m-XLR6	BII7011PGDF Hydrophone, Free Hanging, 20m Shielded Cable, Connector: XLR Receptacle with 6 Male Pins.				

**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	-3dB Filter Frequencies	-Mounting	-Shielded Cable Length	-Connectors for Signal	/Gain Selection	/DC Supply
BII7011FGDF	HPF	Mounting Options.	in meter. Up to 305m (1000 ft).	<a href="#">Connector Options</a> for Signals, Gain Selection (if any), and DC Supply.		
BII7011FGSE	HPF					
BII7011PGDF	BPF					
BII7011PGSE	HPF					
Example of Part Number:		Description				
BII7011FGSE-10Hz-FH-20m-BNC/BS		BII7011FGSE Hydrophone, High Pass Filter: 10Hz, Free Hanging, 20m Shielded Cable, Connector: Male BNC for Signals, Battery Snap for +9VDC Batteries.				
BII7011FGDF-10Hz-BFM-7/16"-100m-XLR3/BS		<a href="#">BII7011FGDF Hydrophone, High Pass Filter: 10Hz, Bolt Fastening Mounting BFM-7/16", 100m Shielded Cable, Connector: 3-pin XLR for Signals and Battery Snap for +9VDC Batteries.</a>				
BII7011FGDF-10Hz-FH-0.6m-UMC4P		BII7011FGDF Hydrophone, High Pass Filter: 10Hz, Free Hanging, 0.6m Shielded Cable, Connector: 4-pin Underwater Mateable Connector for Signals and DC Supply.				
<a href="#">BII7011PGDF-10Hz/60kHz-FH-100m-XLR3/WL/BS</a>		<a href="#">BII7011PGDF Hydrophone, Band Pass Filter: 10Hz to 60kHz, Free Hanging, 100m Shielded Cable, Connector: XLR3 for Signal, Wire leads for Gain Selection, Battery Snap for +9VDC Batteries.</a>				
BII7011PGDF-10Hz/60kHz-THM-7/16"-0.6m-WL		BII7011PGDF Hydrophone, Band Pass Filter: 10Hz to 60kHz, Thru-hole Mounting THM-7/16", 0.6m Shielded Cable, Wire leads for Signal, Gain Selection, and DC Supply.				
<a href="#">BII7011PGSE-0.2Hz-FH-50m-SC-XLR6</a>		<a href="#">BII7011PGSE Hydrophone, High Pass Filter: 0.2Hz, Free Hanging, 50m Shielded Cable, Connector: XLR Receptacle with 6 Male Pins for Signals, Gain Selections, and DC Supplies.</a>				

#### Wiring Information of Hydrophones with Fixed-gain Preamps:

Single Ended Output:	Wire Leads	BNC Male/SMA/SMC, 9V Battery Snap	UMC4P or XLR4 Connector	XLR3 and 9V Battery Snap	TRS Plug and 9V Battery Snap
+VDC	Red	Female Snap	Pin 3	Battery Female Snap	Battery Female Snap
Common	Black	Male Snap	Pin 1	Battery Male Snap	Battery Male Snap
Signal	White	Center Pin or Contact	Pin 2	XLR Pin 2	TRS Tip
Signal Common	Blue, Green, or Yellow	BNC/SMA/SMC Shield	Pin 4	XLR Pin 1 and Pin 3	TRS Ring and Sleeve
Shielding	Shield	N/A	N/A	XLR Metal Shell	N/A
<b>Differential Output:</b>	<b>Wire Leads</b>	<b>UMC4P or XLR4 Connector</b>		<b>XLR3 + 9V Battery Snap</b>	<b>TRS + 9V Battery Snap</b>
+VDC	Red	Pin 3		Battery Female Snap	Battery Female Snap
Common	Black	Pin 1		Battery Male Snap	Battery Male Snap
Signal+	White	Pin 2		XLR Pin 2	TRS Tip
Signal-	Blue, Green or Yellow	Pin 4		XLR Pin 3	TRS Ring
Signal Common	N/A	N/A		XLR Pin 1	TRS Sleeve
Shielding	Shield	N/A		XLR Metal Shell	N/A

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

Differential Output:	Wire Leads	UMC6P or XLR6 Connector		XLR3 + 9V Battery Snap		TRS + 9V Battery Snap
+VDC	Red	Pin 3		Battery Female Snap		Battery Female Snap
Common	Black	Pin 1		Battery Male Snap, XLR Pin 1.		Battery Male Snap, TRS Sleeve.
Digital Common	Yellow or Brown	Pin 5		Yellow or Brown		Yellow or Brown
Digital A0 (FFVS Selection)	Blue	Pin 6		Blue		Blue
Output Signal+	White	Pin 2		XLR Pin 2		TRS Tip
Output Signal -	Green	Pin 4		XLR Pin 3		TRS Ring
Shielding	Shield	N/A		XLR Metal Shell		N/A
Single-Ended Output:	Wire Leads	UMC6P or XLR6 Connector	9V Battery Snap and BNC Male/SMA/SMC	XLR3 + 9V Battery Snap		TRS + 9V Battery Snap
+VDC	Red	Pin 3	Battery Female Snap	Battery Female Snap		Battery Female Snap
Common	Black	Pin 1	Battery Male Snap	Battery Male Snap, XLR Pin 1.		Battery Male Snap, TRS Sleeve.
Digital Common	Yellow or Brown	Pin 5	Yellow or Brown	Yellow or Brown		Yellow or Brown
Digital A0 (FFVS Selection)	Blue	Pin 6	Blue	Blue		Blue
Output Signal	White	Pin 2	BNC/SMA/SMC Center	XLR Pin 2		TRS Tip
Output Signal Common	Green	Pin 4	BNC/SMA/SMC Shield	XLR Pin 3		TRS Ring
Shielding	Shield	N/A	Shield	XLR Metal Shell		N/A
4mm Banana Plug Pair: Red Plug for +VDC, Black Plug for Common of the DC power supply.						
Selecting Sensitivity of One-Bit-Word Digitally Programmable						
FFVS Selection Wire A0	BII7011PGDF Sensitivity FFVS at 1kHz.		BII7011PGSE Sensitivity FFVS at 1kHz.			
0 (Logic Low)	-194.0 + 6 dB V/μPa		-194.0 + 20 dB V/μPa			
1 (Logic High)	-194.0 + 46 dB V/μPa		-194.0 + 60 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.

**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 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.**

#### 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".

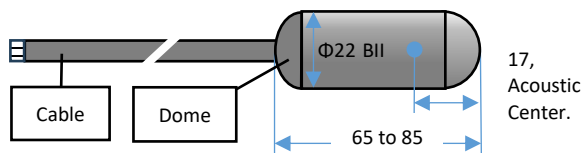
When a **Gain Selection wire** is short to **Digital Common**, its digital logic is Low or "0".

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.

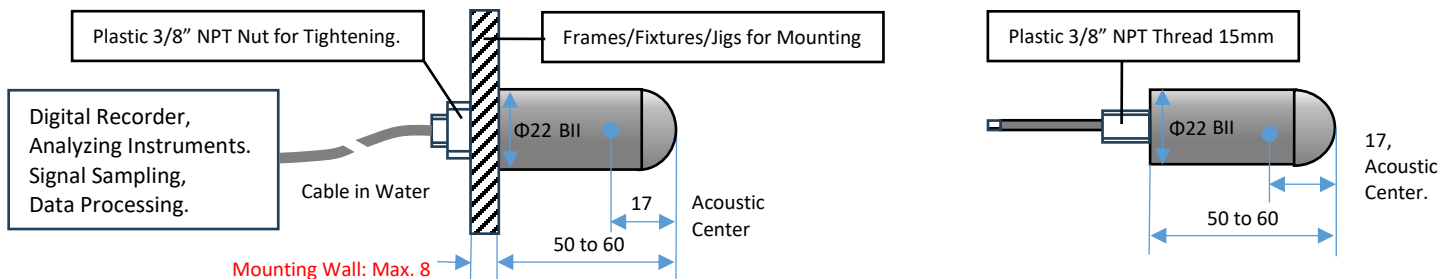
**Physical Size (Dimensional Unit: mm):** The overall length varies with the length of the built-in preamplifier and mounting parts.

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

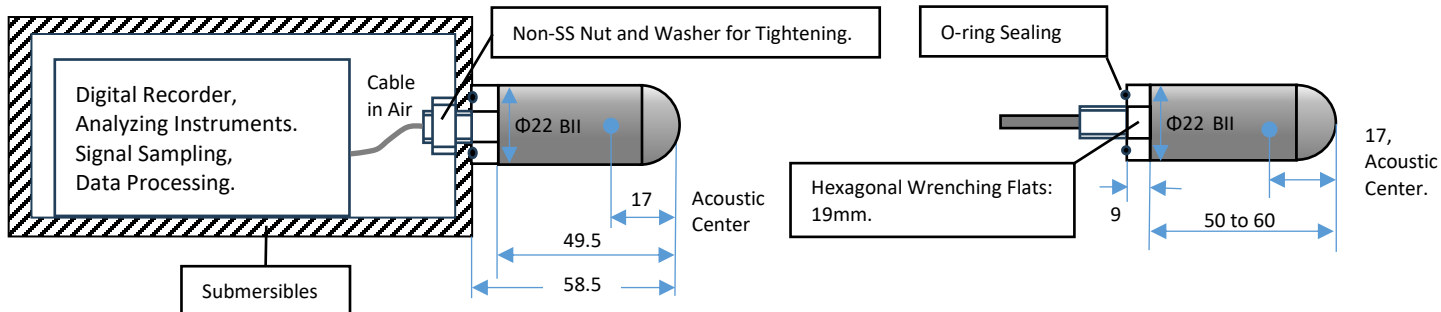


The hydrophone body has streamlined hemispherical domes which minimize the drag forces and the hydrodynamic noise caused by the hydrophone in motion or the flow past the hydrophone.

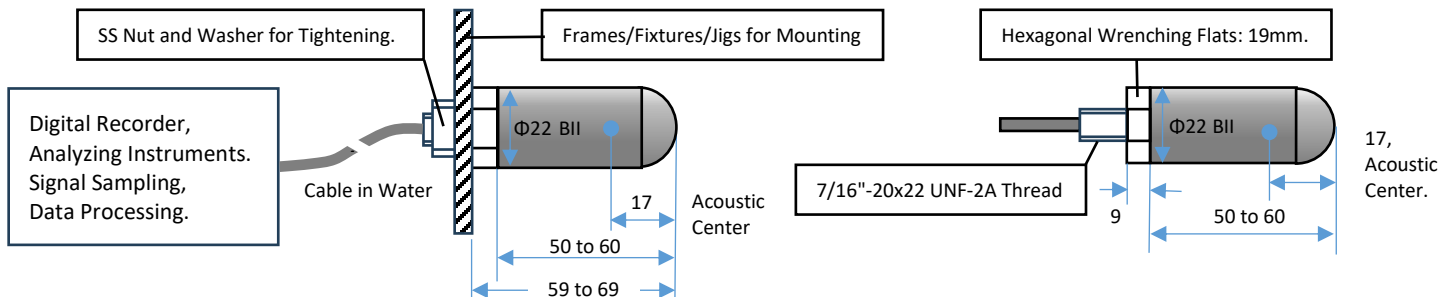
**2. Bolt-Fastening Mounting BFM-NPT3/8", 3/8" NPT Thread Length: 15mm. Nut Height: 5mm.**



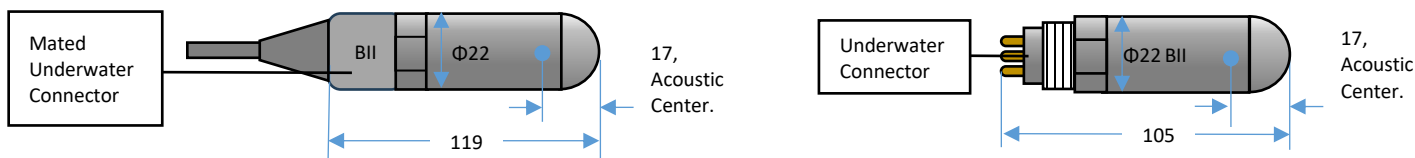
**3. Thru-hole Mounting (Inch Thread) with Single O-ring Sealing THM-7/16" (7/16"-20x22 UNF-2A).**



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



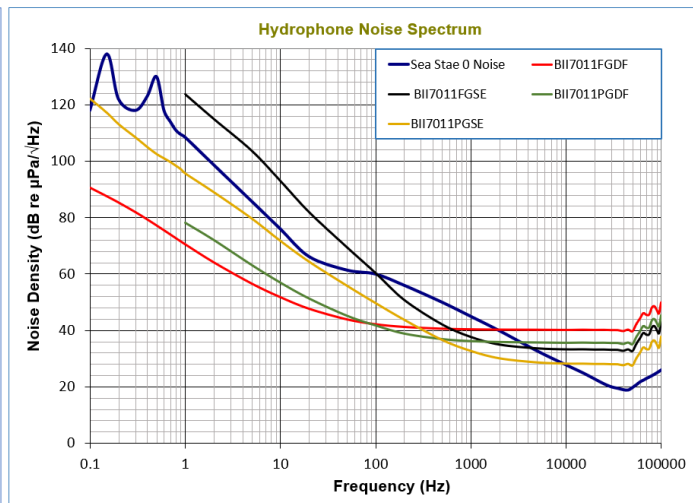
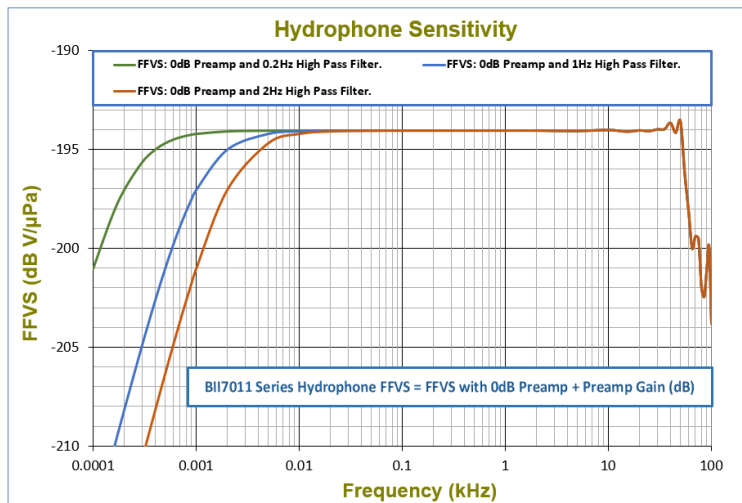
**5. Free-hanging with Underwater Connector FHUWC-4P, 4 Pins (Fixed Sensitivity); FHUWC-6P, 6 Pins (Programmable Sensitivity).**



**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:**

