# Benthowave Instrument Inc.

SE=SL-TL+AG-NL

Underwater Sound Solutions www.benthowave.com

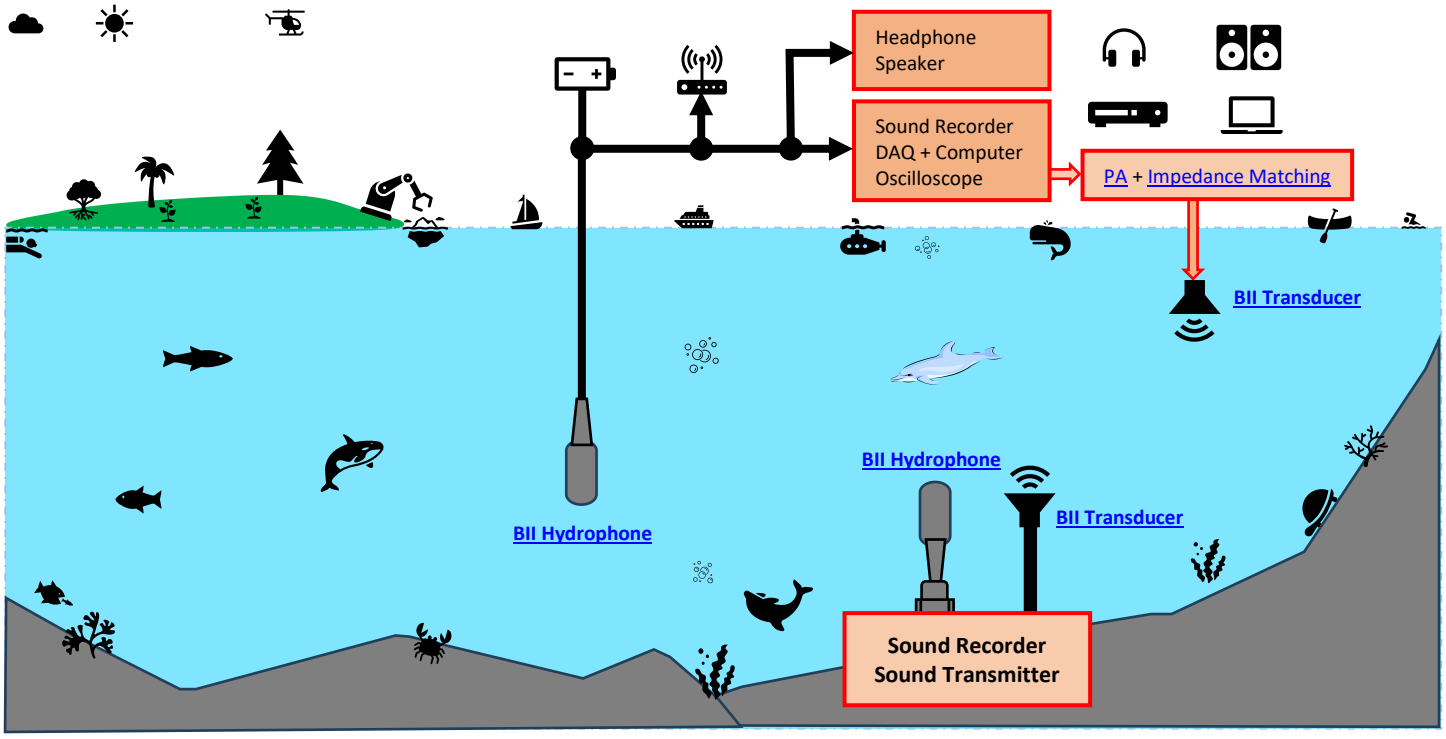
**BII7120 Series Low Noise, Low Power, and Low Frequency Hydrophone: Noise Level Below Sea State Zero**

BII's low noise hydrophones are optimized to possess self noise levels below sea-state zero with omnidirectional response in low frequency range and toroidal response in high frequency range. Its streamlined hemispherical dome minimizes drag force and hydrodynamic noise. The power consumption can be customized to be 600µA quiescent current at 5VDC for battery powered underwater instrumentation. A spatial array of multiple hydrophones can be set up for directional measurement system. The hydrophones can measure underwater sounds and pressure fluctuations down to 0.1Hz infrasonic sounds: Surface Waves (Wave-height Sensor), Turbulences, seismic, ocean traffics, industrial noises, precipitations, biologics, ...

With these low power hydrophones, battery and system lifetimes are extended, and lighter portable systems with lower-capacity batteries can be achieved. Its compact small size avoids interferences to acoustic field under test. The preamplifier integrated in the hydrophone can drive cable up to 200m without signal loss. Available cable terminals include audio connectors (TRS, XLR), BNC, and underwater mateable connectors.

The housing and mounting part are corrosion resistant plastics and/or stainless steels.

## Underwater Sound Listening, Recording, and Communication




**Typical Applications**

| | |
|---|---|
| Underwater Sounds Recording, Listening, and Communication, Marine Bioacoustics, Passive Acoustic Monitoring (PAM System). | Coastal/Offshore Processes, Engineering & Management, Wave-Structure Interaction, Wave-height Sensor, Wave and Tide Recorder/Logger. |
| Oceanic Ambient Noise Measurement, Surface Waves, Ocean Turbulences, Hydrodynamics, Marine Geophysics. | Battery-Powered Instruments: Sonobuoy, Recorder, Transponder, Acoustic Release... |

**Questions**

**How do I set up my professional sound recorders to work with BII Hydrophones?**

1. BII hydrophones have their own DC power supply to support **Line Input** of recorders, and **Do NOT** use phantom power 48V which may destroy the hydrophones.
2. **Maximum Input Level (Line Input)** of recorders should be large enough to avoid saturation or clipping during recording.
   **Equivalent Input Noise** of recorders should be low enough for the recorders to be sensitive to weak signal of the interest.
3. **Sampling Rate** of the recorder should be fast enough to avoid missing high frequency sound of the interest. Generally, the **Sampling Rate** should be at least two times greater than the maximum frequency of sound.
4. Calculate the **memory size of data storage** according to sampling rate, resolution, sampling channels, and recording time, and use suitable recording media.
5. Calculate **battery service life** according to battery power and consuming current.
6. When the cable is greater than 5m, **balanced signal or differential signal** is recommended to be in use over the cable.

**How do I playback the recorded sounds in water?**

System Setup: Recorder (Recorded Sounds) with **Line or Phone Output** -> Audio Power Amplifiers -> Impedance Matching Device -> Transducers (Projectors).

**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:** | **BII7126FGDF** | **BII7126FGSE** | **BII7126PGDF** | **BII7126PGSE** |
| Sensitivity @ 1 kHz: | -196.0 + Preamp Gain, ± 2 dB V/µPa. | | | |
| | -160.0 dB | -160.0 dB | -176.0, -146.0 dB | -176.0, -146.0 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. | | | |
| **Built-in Filters:** at -3dB V/µPa. | Bespoke BPF . | | | |
| | Minimum -3dB HPF = 15 Hz. | | | |
| | in Water: 15 Hz ~ 260 kHz | | | |
| | in Air: 15 Hz ~ 9 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.<br>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):** | Low Noise Fixed Gain Preamp. | | Programmable Gain Preamp. | |
| | 36 dB. | 36 dB. | 20, 50 dB. | 20, 50 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 $V_s$ Supply Voltage. | | | |
| Gain Selection Voltage: (Programmable Gain Preamp) | N/A | | CMOS/TTL Compatible<br>Logic Low 0: Gain Selection Wire to COM or 0 to +0.8 VDC.<br>Logic High 1: Gain Selection Wire Open or +2.4 VDC to $V_s$. | |
| Directivity Pattern: | Omnidirectional and Toroidal. Refer to Graph of Directivity Response Pattern. | | | |
| 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 $V_{omax}$: | Supply Voltage $V_s$ - 4, in Vpp. | | | |
| Overload Pressure Level: | 197 or (20*log($V_{omax}$/2.828) – Sensitivity) whichever is less. in dB µPa. | | | |
| Acceleration Sensitivity: | 101.5 dB re µPa/(m/s²) at Acoustic Axis; ≤ 101.5 dB µPa/(m/s²) 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**).<br>2. Free-hanging with Male Underwater Connector (**FHUWC-3P, FHUWC-4P, FHUWC-6P**).<br>3. Thru-hole Inch Mounting with Single O-ring Sealing (**THM-7/16”**).<br>4. Thru-hole Inch Mounting with Double O-ring Sealing (**THDO-7/16”**).<br>5. Bolt Fastening Mounting (Plastics) (**BFMP-M12**).<br>6. Bolt Fastening Mounting (Plastics) (**BFMP-NPT3/8”**).<br>7. Bolt Fastening Mounting (Stainless Steel) (**BFM-7/16”**).<br>8. Bolt Fastening Mounting (Stainless Steel) (**BFM-5/8”**). | | | |
| | Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details. | | | |
| **Cable Options:** | Four Conductor Shielded Cable (**SC**) | | Six Conductor Shielded Cable (**SC**) | |
| **Cable Length:** | ≤ 200 m | ≤ 200 m | ≤ 40 m | ≤ 40 m |
| **Connector:** | **SE**: Single ended Output, **DF**: Differential Output.<br>1. Default: Wire Leads (**WL**)<br>2. Male BNC (**BNC**) (Max. Diameter Φ14.3 mm), for SE ONLY.<br>3. 1/8" (3.5mm) TRS Plug (**TRS**) (Max. Diameter Φ10.5 mm), for SE or DF.<br>4. XLR Receptacle with 3 Male Pins (**XLR3**), (Max. Diameter Φ20.2 mm), for SE or DF.<br>XLR Receptacle with 4 Male Pins (**XLR4**), (Max. Diameter Φ20.2 mm), for SE or DF.<br>XLR Receptacle with 6 Male Pins (**XLR6**), (Max. Diameter Φ20.2 mm), for SE or DF.<br>5. Underwater Mateable Connector (4 pins) (**UMC4P**) (Max. Diameter Φ21.5 to Φ35 mm), for SE or DF.<br>Underwater Mateable Connector (6 pins) (**UMC6P**) (Max. Diameter Φ21.5 to Φ35 mm), for SE or DF.<br>**UMC** is from global manufacturers of underwater connectors. Its part number is listed in quote in detail. | | | |
| | 6. +9VDC Battery Snap (**BS**), for +9VDC or +18VDC power supply.<br>7. 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. | | | |
| Supply Voltage $V_s$: | +8 to +32 VDC | | | |
| Suggested DC Supply: | +9VDC Battery, Marine Battery, Automobile Battery, Fixed DC Linear Power Supply, Not Included.<br>DO NOT use variable power supply whose maximum supply voltage is higher than the rated voltage.<br>DO NOT use switching mode DC power supply. | | | |
| Current (Quiescent): | 16 mA | 13 mA | 16 mA | 13 mA |
| Size: | Free Hanging: ΦD = Φ21 mm, Overall Length = 90 to 100 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** |
| BII7126PGDF. | **FH**: Free Hanging.<br>**BFMP-3/8"NPT**: Bolt-fastening Mounting. | 20 m (65.6 ft) | WL, TRS, or XLR3, XLR4, XLR6, BS. | | |

| **Example of Part Number:** | **Description** |
|---|---|
| BII7126PGDF-FH-20m-WL | BII7126PGDF Hydrophone, Free Hanging, 20m Shielded Cable, Wire leads. |
| BII7126PGDF-BFMP-3/8"NPT-20m-WL | BII7126PGDF Hydrophone, Bolt-fastening Mounting: BFMP-3/8"NPT, 20m Shielded Cable, Wire leads. |
| BII7126PGDF-BFMP-3/8"NPT-20m-TRS/WL/BS | BII7126PGDF 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. |
| BII7126PGDF-FH-20m-XLR3/WL/BS | BII7126PGDF Hydrophone, Free Hanging, 20m Shielded Cable, Connector: XLR3 for Signal, Wire leads for Gain Selection, Battery Snaps for +9VDC Batteries. |
| BII7126PGDF-FH-20m-XLR6 | BII7126PGDF 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** | **-HPF/LPF** | **-Mounting** | **-Shielded Cable Length** | **-Connectors for Signal** | **/Gain Selection** | **/DC Supply** |
| BII7126FGDF | -3dB Filter Frequencies | Mounting Options. | ≤ 200 m | Connector Options for Signals, Gain Selection (if any), and DC Supply. | | |
| BII7126FGSE | | | ≤ 200 m | | | |
| BII7126PGDF | | | ≤ 40 m | | | |
| BII7126PGSE | | | ≤ 40 m | | | |

| Example of Part Number: | Description |
|---|---|
| BII7126FGSE-15Hz-FH-20m-BNC/BS | BII7126FGSE Hydrophone, High Pass Filter: 15Hz, Free Hanging, 20m Shielded Cable, Connector: Male BNC for Signals, Battery Snap for +9VDC Batteries. |
| BII7126FGDF-15Hz-BFM-7/16"-100m-XLR3/BS | BII7126FGDF Hydrophone, High Pass Filter: 15Hz, Bolt Fastening Mounting BFM-7/16", 100m Shielded Cable, Connector: 3-pin XLR for Signals and Battery Snap for +9VDC Batteries. |
| BII7126FGDF-15Hz-FH-0.6m-UMC4P | BII7126FGDF Hydrophone, High Pass Filter: 15Hz, Free Hanging, 0.6m Shielded Cable, Connector: 4-pin Underwater Mateable Connector for Signals and DC Supply. |
| BII7126PGDF-100Hz/150kHz-FH-40m-XLR3/WL/BS | BII7126PGDF Hydrophone, Band Pass Filter: 100Hz to 150kHz, Free Hanging, 40m Shielded Cable, Connector: XLR3 for Signal, Wire leads for Gain Selection, Battery Snap for +9VDC Batteries. |
| BII7126PGDF-100Hz/150kHz-THM-7/16"-0.6m-WL | BII7126PGDF Hydrophone, Band Pass Filter: 100Hz to 150kHz, Thru-hole Mounting THM-7/16", 0.6m Shielded Cable, Wire leads for Signal, Gain Selection, and DC Supply. |
| BII7126PGSE-100Hz/150kHz-FH-40m-SC-XLR6 | BII7126PGSE Hydrophone, Band Pass Filter: 100Hz to 150kHz, Free Hanging, 40m Shielded Cable, Connector: XLR Receptacle with 6 Male Pins for Signals, Gain Selections, and DC Supplies. |

**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 |
| **Differential Output:** | **Wire Leads** | **UMC4P or XLR4 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 | 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** | **BII7126PGDF Sensitivity FFVS at 1kHz.** | | **BII7126PGSE Sensitivity FFVS at 1kHz.** | | |
| 0 (Logic Low) | -196.0 + 20 dB V/µPa | | -196.0 + 20 dB V/µPa | | |
| 1 (Logic High) | -196.0 + 50 dB V/µPa | | -196.0 + 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.

**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.

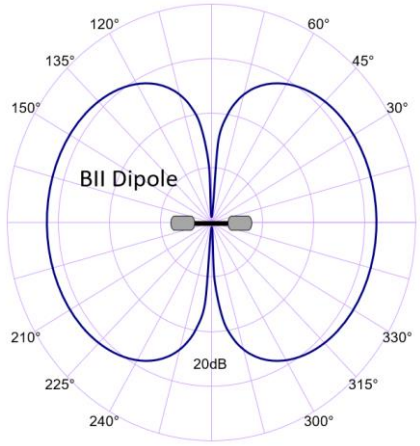
**Can the hydrophone with differential outputs be wired to single-ended inputs of a DAQ device (Data Acquisition Equipment) such as an Oscilloscope?** Yes, output+ and Common of a BII hydrophone can be used a single-ended signal, or Output- and Common of the hydrophone can be used a single-ended signal.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

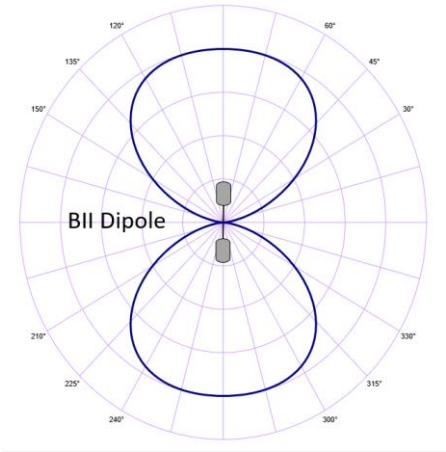
**How to increase hydrophone sensitivity for extremely weak sounds?**
BII low noise hydrophone with built-in preamp (Differential Output) -> Long Cable -> Standalone Preamp -> Analyzing Instrument or Recorder.

**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.

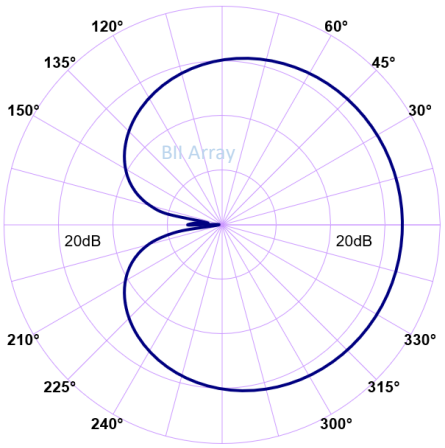
(2) **Gain Selection with Digital Outputs.** Digital Outputs of a DAQ (data acquisition device) select gains with TTL/CMOS logic levels.

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



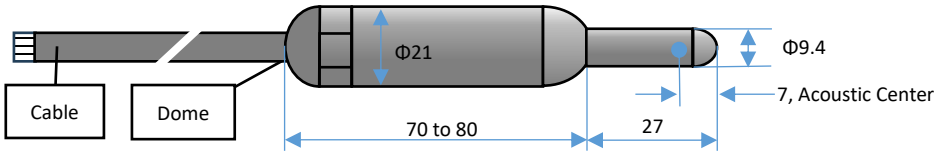




Cardioid Pattern= Presure Hydrophone + Dipole.



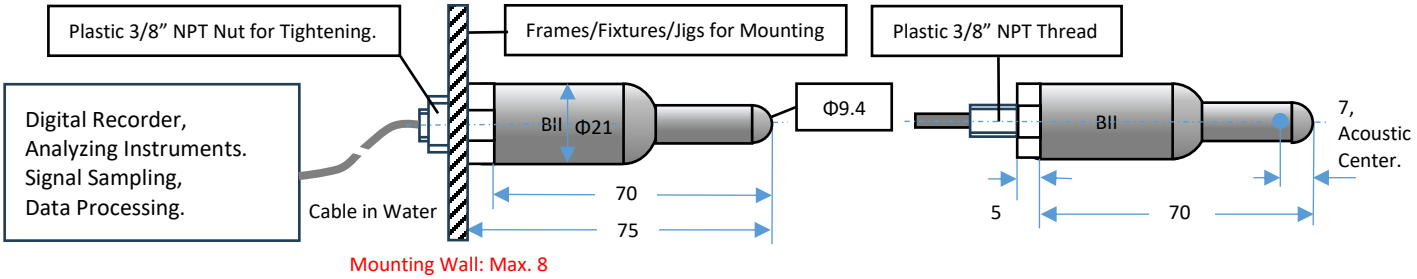
**Physical Size (Dimensional Unit: mm):** The overall length varies with the length of the built-in preamplifier and mounting parts.

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

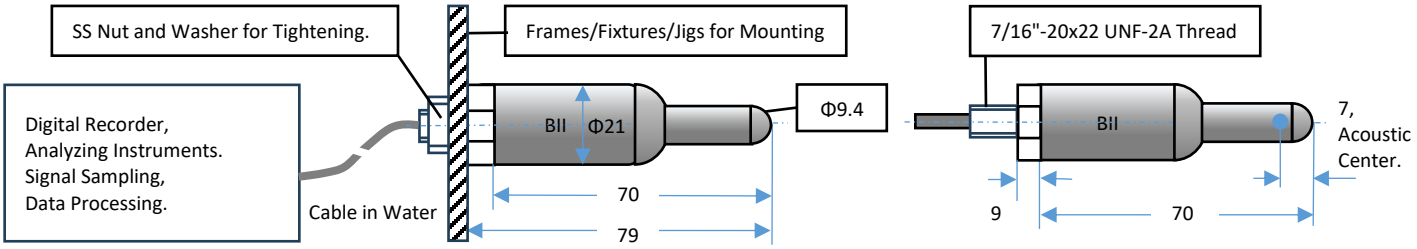



The hydrophone body has streamlined hemispherical domes which minimize the drag forces and the hydrodynamic noise caused by the hydrophone in motion or the flow past the hydrophone.

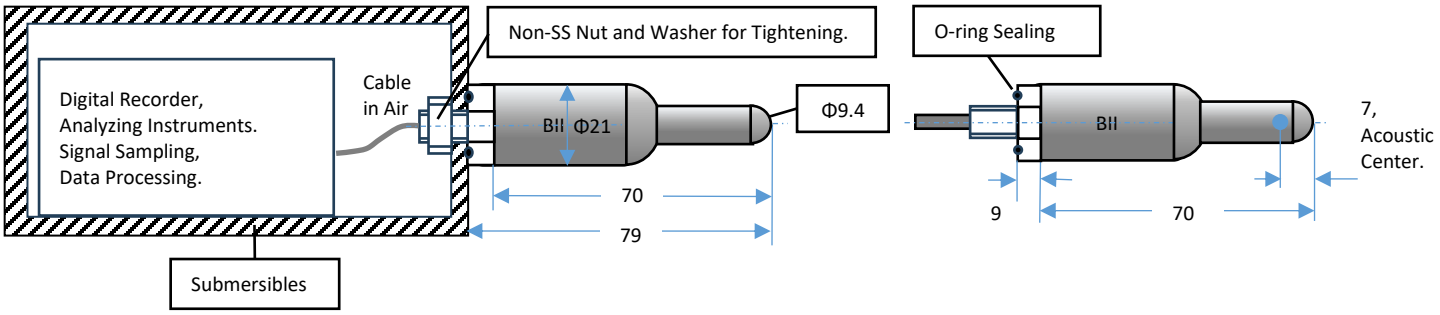
**2. Bolt-Fastening Mounting BFM-NPT3/8", 3/8" NPT Thread Length: 15mm. Nut Height: 5mm.**



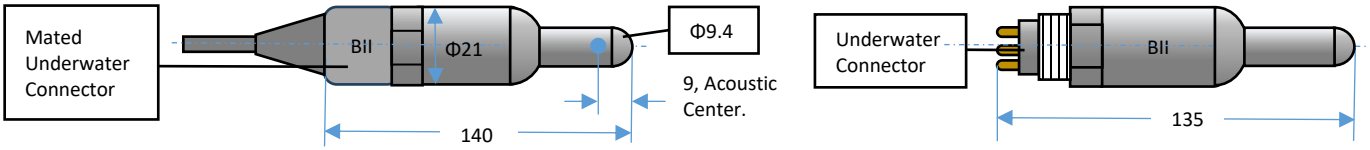

**3. Bolt-Fastening Mounting BFM-7/16" (7/16"-20x22 UNF-2A).**




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

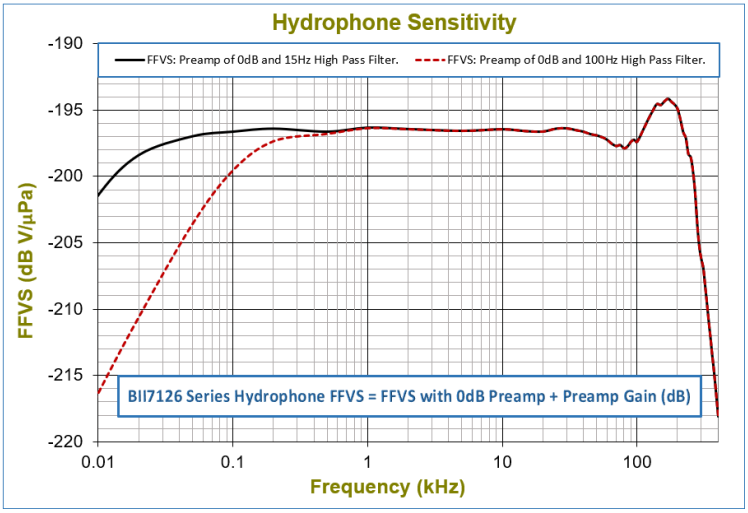



**5. Free-hanging with Underwater Connector FHUWC-4P, 4 Pins (Fixed Sensitivity); FHUWC-6P, 6 Pins (Programmable Sensitivity).**

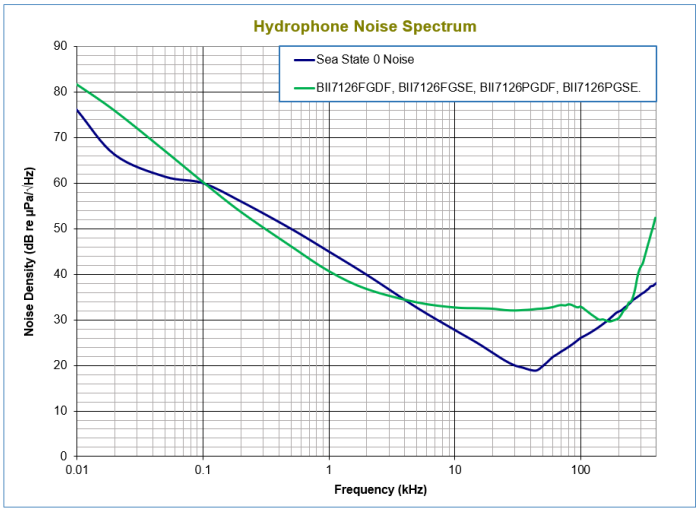


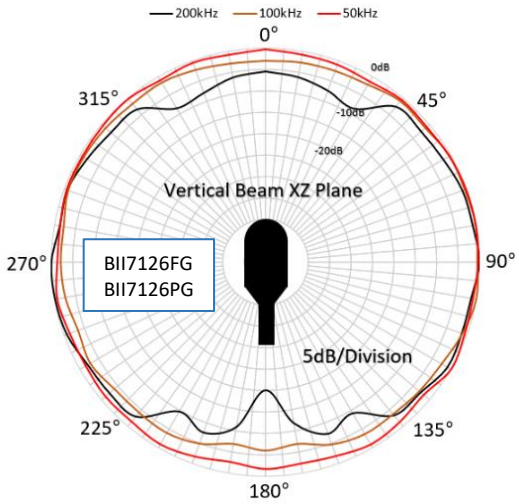
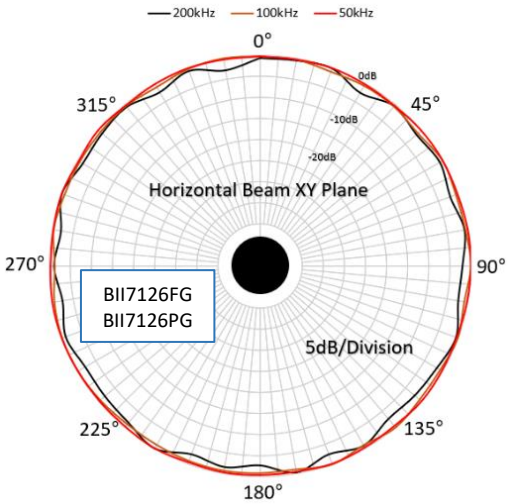

**6. More Mounting/Installation Options:** Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and details.

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




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




**Directivity Response Pattern:**