SE=SL-TL+AG-NL

Benthowave Instrument Inc.

Underwater Sound Solutions www.benthowave.com REVISED on 2025-7-10

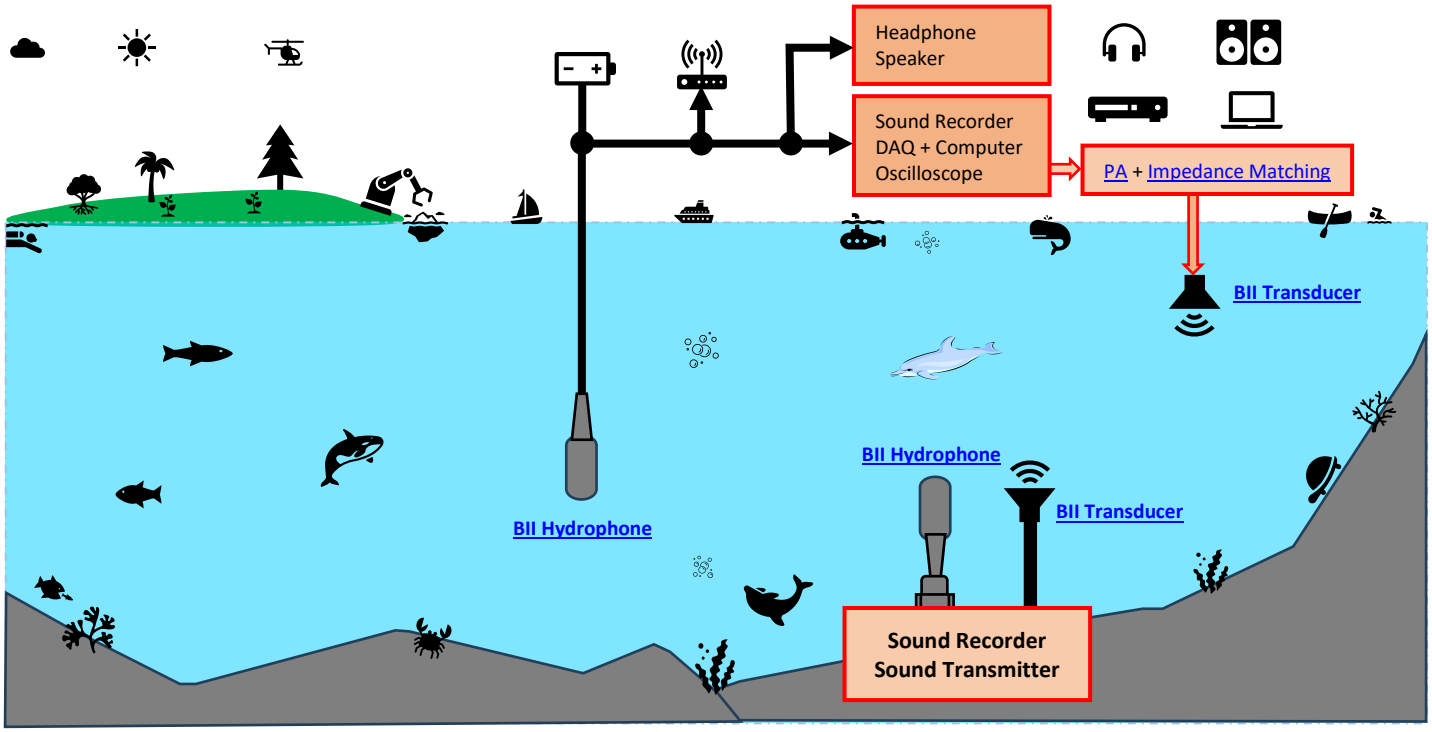
BII7000 Series Omnidirectional Spherical Hydrophone

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 noises, and avoid saturation.

Typical Applications

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

Underwater Sound Listening, Recording, and Communication



Typical Applications

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

Questions

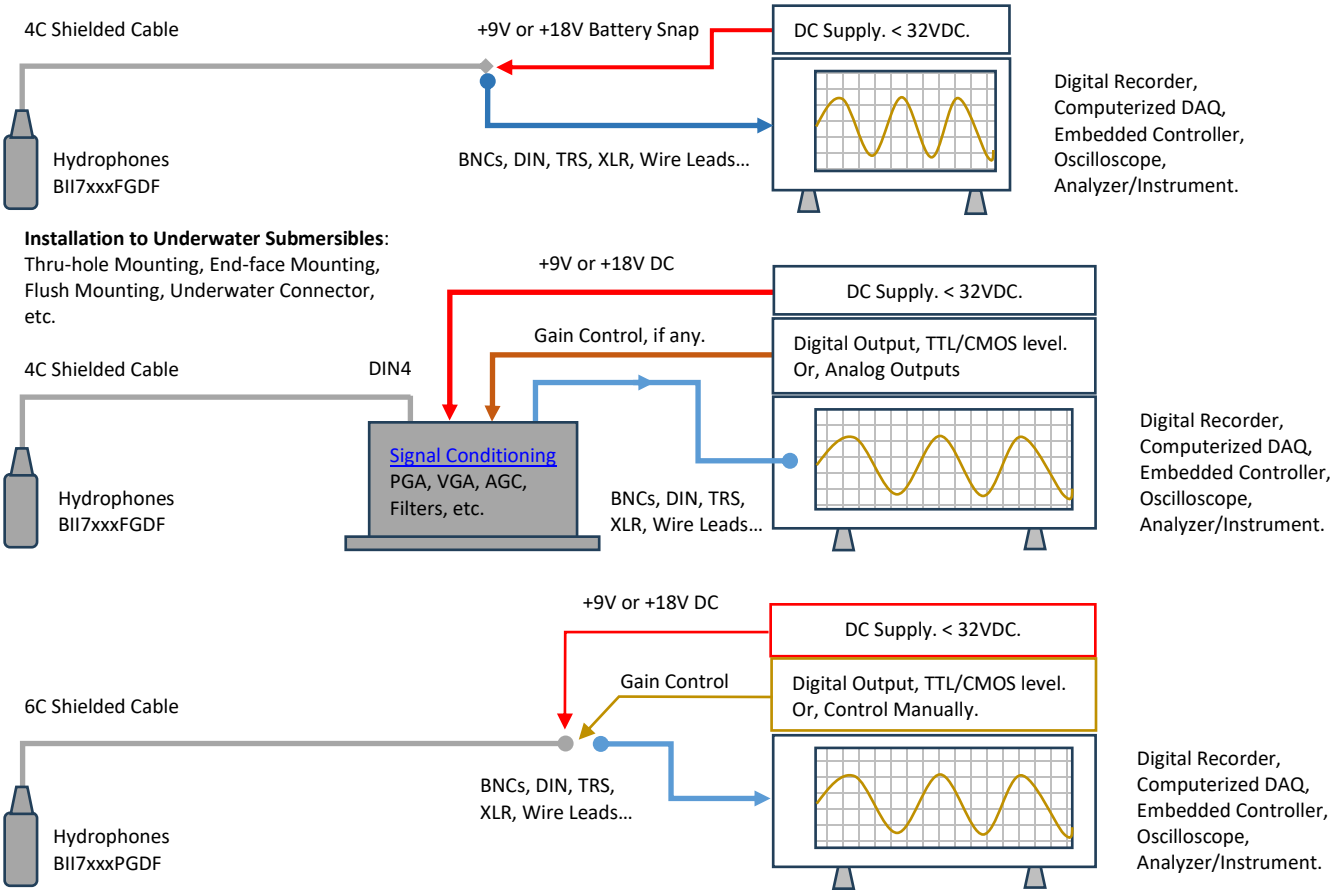
How do I set up my professional sound recorders to work with BII Hydrophones?

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).

System Configuration of Receiving Sounds and Waves.



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:	BII7003FGSE	BII7003PGSE
Sensitivity @ 1 kHz:	-211.0 + Preamp Gain, dB V/µPa. Variation: ± 2dB.	
	-171.0 dB V/µPa.	-181.0 and -151.0 dB V/µPa.
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 HPF, or BPF.	
	Minimum HPF: 5.0 Hz.	
	in Water: 5 Hz ~ 560 kHz.	
	in Air: 5 Hz ~ 20 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.	
Bespoke Preamp Gain (dB):	Fixed Gain Preamp: 40 dB.	Programmable Gain Preamp: 1. Default: 20, 60 dB. 2. Bespoke: 10, 50 dB, or 0, 40 dB.
Gain Selection Voltage:	N/A	CMOS/TTL Compatible **Logic Low 0**: Gain Selection Wire to COM or 0 to +0.8VDC. **Logic High 1**: Gain Selection Wire Open or +2.4 to Vs.
Directivity Pattern:	Omnidirectional. Refer to Graph of Directivity Response Pattern.	
Side Lobe Level:	No side lobes.	
Signal Output Type:	Single Ended	
Maximum Output V_{omax}:	V_{omax} = Supply Voltage Vs - 4, in Vpp.	Supply Voltage Vs – 1.0, in Vpp.
Overload Pressure Level:	20*log(Vomax/2.828) – Sensitivity, in dB µPa. Refer to the chart of Overload Pressure Level (OPL).	
Acceleration Sensitivity:	130.8 dB µPa/(m/s²)	
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-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-NPT3/8"**). 6. Bolt Fastening Mounting (Stainless Steel) (**BFM-7/16"**, **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 Sh ielded Cable (SC)
Cable Length:	1. Default: 20m (65.6ft) for Non-Underwater Connector; 0.6m (2ft) for Underwater Connectors. 2. Custom-fit Cable Length up to 305 m or 1000 ft, refer to Hydrophone Cable Length.	
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). DIN Receptacle with 6 Male Pins (**DIN6**), (Max. Diameter Φ17 mm). 4. 1/8" (3.5mm) TRS Plug (TRS) (Max. Diameter Φ9.5 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). XLR Receptacle with 6 Male Pins (**XLR6**), (Max. Diameter Φ20.2 mm). 6. Underwater Mateable Connector **UMC4P** and **UMC6P** 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): 4 pins (**UMC4P = MCIL4M + MCDLS-F, or MCOM4M + OMBMC + MCDLS-F.**), Maximum Diameter Φ21.5 to Φ35 mm. 6 pins (**UMC6P** = **MCIL6M + MCDLS-F, or MCOM6M + OMBMC + MCDLS-F**.), Maximum Diameter Φ21.5 to Φ35 mm.	
	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. 5. **MIL**: MIL-5015 Style Connectors, interconnection solution for high power signals. –55°C to +125°C, Fastening Type: Threaded. Dry Uses. 6. **UMC**: Underwater Mateable Connectors, interconnection solution for high power or weak signals. Fastening Type: Threaded. Underwater Uses.		
Supply Voltage Vs:	+9 to +30 VDC.	+14 to +35 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):	8 to 10.5 mA.	19 mA.
	Warning: The device will be destroyed with Vs ≥ +32VDC.	Warning: The device will be destroyed with Vs ≥ +36VDC.
Size:	Free Hanging: ΦD = Φ21 mm, Overall Length = 115 mm. Other Mounting Types: actual length depends on Mounting Parts.	
Weight:	≥ 0.9 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.	
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.	
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	-Preamp Gain	-HPF or BPF	-Mounting	-Cable Length	-Connectors for Signal/Gain Selection/DC Supply
BII7003FGSE	40 dB.	5 Hz.	FH	20m (65.6 ft)	WL, TRS, XLR3, DIN3, BNC, BS, BP; DIN4, XLR4.
		100 Hz.			
BII7003PGSE	20/60 dB.	5 Hz.			WL, TRS, XLR3, DIN3, BNC, BS, BP; DIN6, XLR6.
		100 Hz.			

In-Stock Examples:	**Description**
BII7003FGSE-40dB-100Hz-FH-20m-WL	BII7003FGSE Hydrophone, 40dB Gain, High Pass Filter: 100Hz, Free Hanging, 20m Shielded Cable, Connector: None, Wire leads.
BII7003FGSE-40dB-5Hz-FH-20m-BNC/BS	BII7003FGSE Hydrophone, 40dB Gain, High Pass Filter: 5Hz, Free Hanging, 20m Shielded Cable, Connector: Two BNC Male for Output+ and Output- Signals, 9V Battery Snaps for DC Supply.
BII7003FGSE-40dB-5Hz-FH-20m-XLR3/BS	BII7003FGSE Hydrophone, 40dB Gain, High Pass Filter: 5Hz, Free Hanging, 20m Shielded Cable, Connector: XLR3 for Signal, 9V Battery Snaps for DC Supply.
BII7003FGSE-40dB-5Hz-FH-20m-XLR4	BII7003FGSE Hydrophone, 40dB Gain, High Pass Filter: 5Hz, Free Hanging, 20m Shielded Cable, Connector: XLR4 for Signals and DC Power Supply.
BII7003PGSE-20/60dB-5Hz-FH-20m-WL	BII7003PGSE Hydrophone, 20/60dB Gain, High Pass Filter: 5Hz, Free Hanging, 20m Shielded Cable, Connector: None, Wire leads.
BII7003PGSE-20/60dB-5Hz-FH-20m-BNC/WL/BS	BII7003PGSE Hydrophone, 20/60dB Gain, High Pass Filter: 5Hz, Free Hanging, 20m Shielded Cable, Connector: BNC for Signal, Wire Leads for Gain Selection, 9V Battery Snaps for DC Supply.
BII7003PGSE-20/60dB-100Hz-FH-20m-XLR6	BII7003PGSE Hydrophone, 20/60dB Gain, High Pass Filter: 100Hz, Free Hanging, 20m Shielded Cable, Connector: XLR6 for Signals, Gain Selection, and DC Power Supply.
Non-stock Examples:	**Description**
BII7003FGSE-40dB-10Hz/300kHz-BFM-7/16"-100m-BNC/BS	BII7003FGSE Hydrophone, 40dB Gain, Band Pass Filter: 10Hz to 300kHz, Bolt Fastening Mounting BFM-7/16", 100m Shielded Cable, Connector: BNC for Signals and Battery Snap for +9VDC Batteries.

BII7003FGSE-40dB-10Hz-FH-0.6m-UMC4P	BII7003FGSE Hydrophone, 40dB Gain, High Pass Filter: 10Hz, Free Hanging, 0.6m Shielded Cable, Connector: 4-pin Underwater Mateable Connector for Signals and DC Power Supply.
BII7003FGSE-FHUWC-4P	BII7003FGSE Hydrophone, Free-hanging with Male Underwater Connector FHUWC-4P.
BII7003PGSE-20/60dB-10Hz/300kHz-BFM-7/16"-100m-BNC/WL/BS	BII7003PGSE Hydrophone, 20/60dB Gain, Band Pass Filter: 10Hz to 300kHz, Bolt Fastening Mounting BFM-7/16", 100m Shielded Cable, Connector: BNC for Signal, Wire Leads for Gain Selection, and Battery Snap for +9VDC Batteries.
BII7003PGSE-20/60dB-10Hz-FH-0.6m-UMC6P	BII7003PGSE Hydrophone, 20/60dB 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.
BII7003FGSE-FHUWC-6P	BII7003FGSE Hydrophone, Free-hanging with Male Underwater Connector FHUWC-6P.

Wiring Information of BII7003FGSE Hydrophones with Fixed-gain Preamps:

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

Wiring Information of BII7003PGSE Hydrophones with One-Bit-Word Programmable Gain Preamps:

Differential Output:	**Wire Leads**	**UMC6P/XLR6**	**DIN6**	**BNC + 9V BS**
+VDC	Red	Pin 3	Pin 4	Battery Female Snap
Common	Black	Pin 1	Pin 1	Battery Male Snap,
Output Signal	White	Pin 2	Pin 3	BNC Center Pin
Output Signal Common	Green	Pin 4	Pin 2	BNC Metal Shell
Digital A0	Blue	Pin 6	Pin 5	Blue
Digital Common	Yellow or Brown	Pin 5	Pin 6	Yellow or Brown
Shielding	Shield	Metal Shell	Metal Shell	BNC Shield
Selecting Sensitivity of One-bit Digitally Programmable				
FFVS Selection Wire A0		**Hydrophone Sensitivity FFVS at 1kHz.**		
0 (Logic Low)		-211.0 + 20 dB V/µPa.		
1 (Logic High)		-211.0 + 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.

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 = $j/(2\pi fC_h)$, 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 low gain such as 10dB.

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 high gain such as 50dB.

The unused terminals and bare splice wire leads MUST be insulated to avoid 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.

How do I use Gain Selection wires of a Programmable Sensitivity Hydrophone in field?

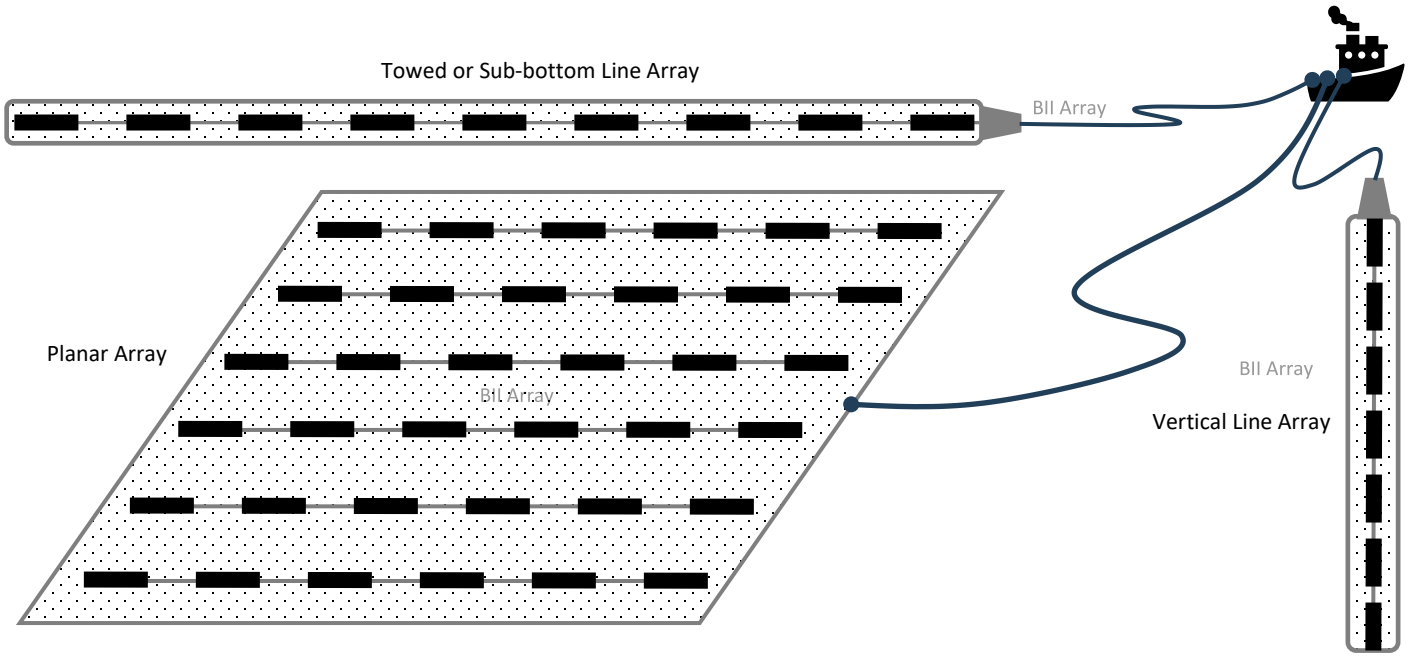
(1). Manual Gain Selection.

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.

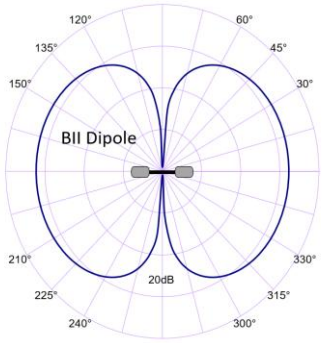
(2). Gain Selection with Digital Outputs. Digital Outputs of a DAQ (data acquisition device) select gains with TTL/CMOS logic levels.

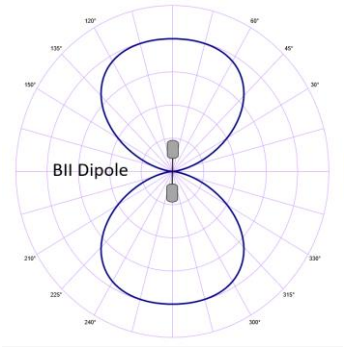
Array Elements for Underwater Linear and Planar Arrays



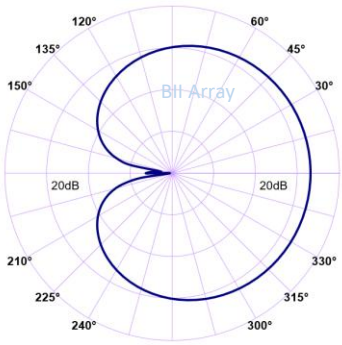
Simple Array Consisting of Hydrophones.

"Figure 8" Pattern of a Dipole (Pressure-Gradient).

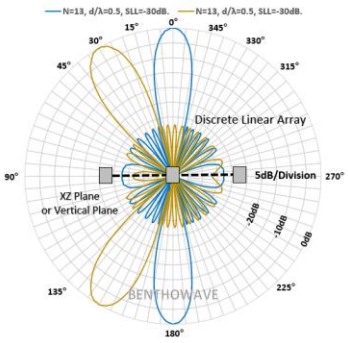




Cardioid Pattern

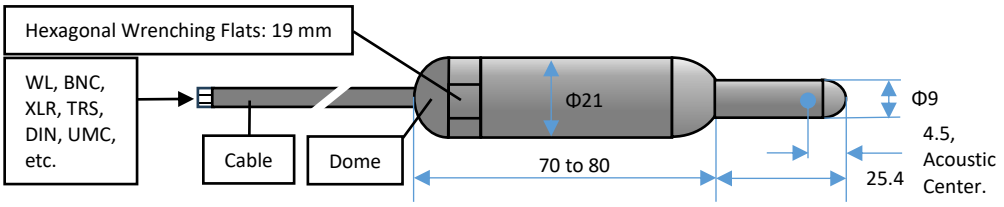


Linear Array with BII Discrete Hydrophones



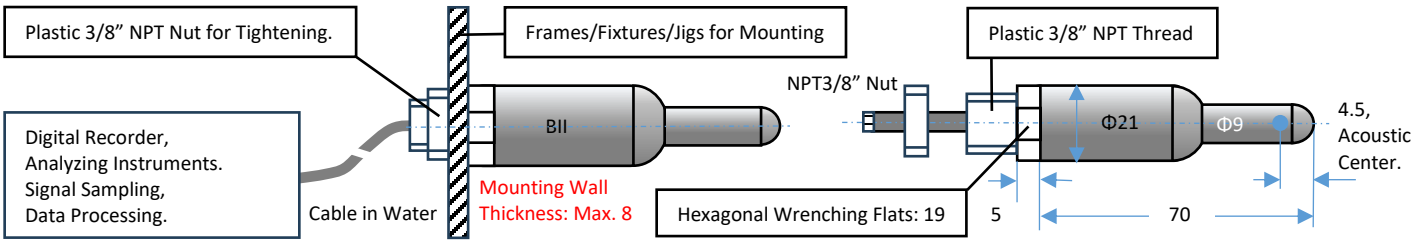
Physical Size (Dimensional Unit: mm): The overall length varies with the length of the built-in preamplifier and mounting parts.

1. Free Hanging with Smooth Domes.

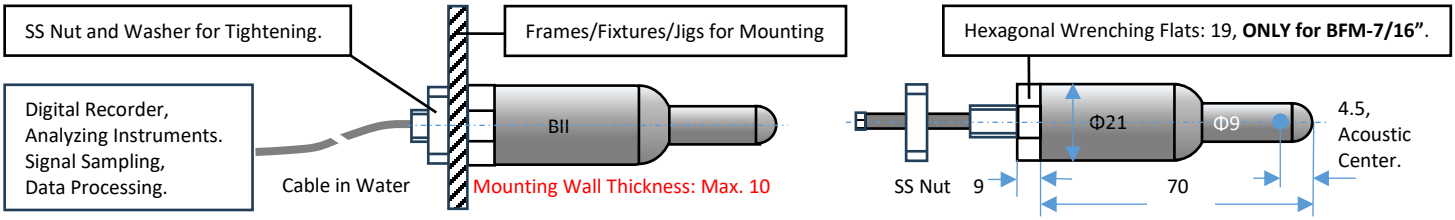


The hydrophone body has streamlined hemispherical domes which minimize the drag forces and the hydrodynamic noise caused by the hydrophone in motion or the flow past the hydrophone.

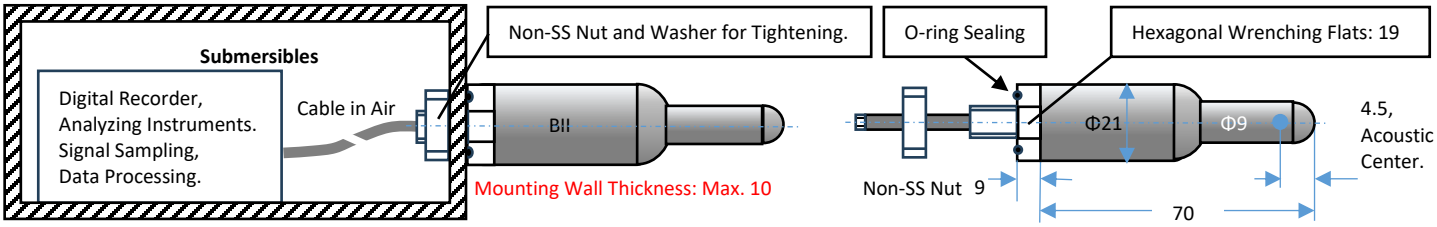
2. Bolt-Fastening Mounting BFM-NPT3/8", 3/8" NPT Thread Length: 15mm. Nut Height: 5mm. Tips: Plastic material has less sound reflection.



3. Bolt-Fastening Mounting BFM-7/16" (7/16"-20x22 UNF-2A), and BFM-5/8" (5/8"-18x22 UNF-2A, BFM-5/8" does NOT possess Hexagonal Wrenching Flats.).

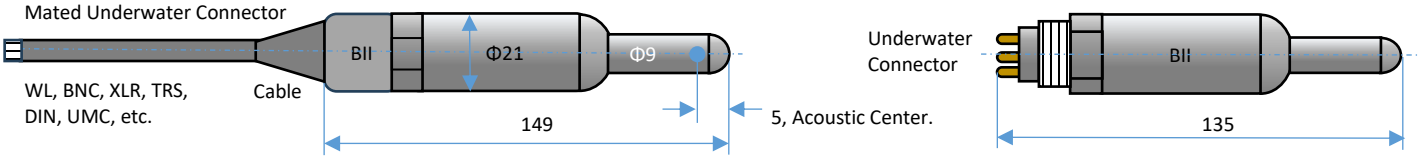


4. Thru-hole Mounting (Inch Thread) with Single O-ring Sealing THM-7/16" (7/16"-20x22 UNF-2A), and THM-5/8" (5/8"-18x22 UNF-2A, does NOT possess Hexagonal Wrenching Flats.).



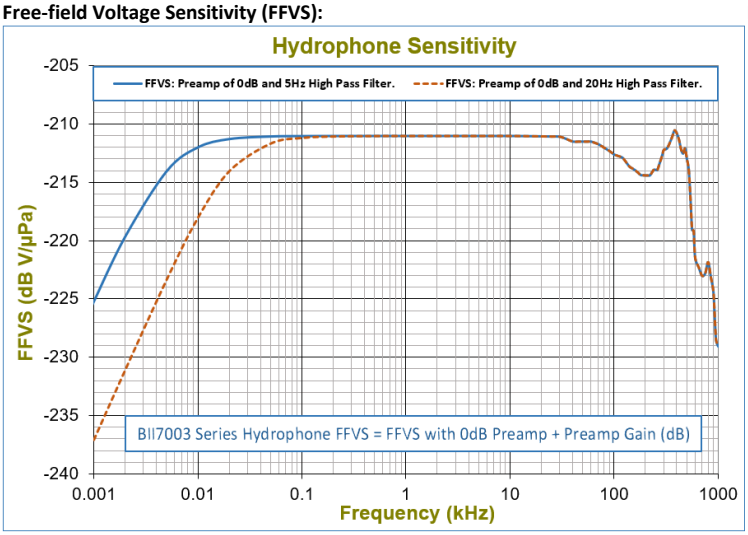
5. Free-hanging with Underwater Connector FHUWC-4P, 4 Pins (Fixed Sensitivity); FHUWC-6P, 6 Pins (Programmable Sensitivity).

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-BNC/BS**: 20 m cable with and Underwater Mateable Connector 4 Sockets (UMC4S) on one end, BNC Male and Two +9V Battery Snaps on other end.

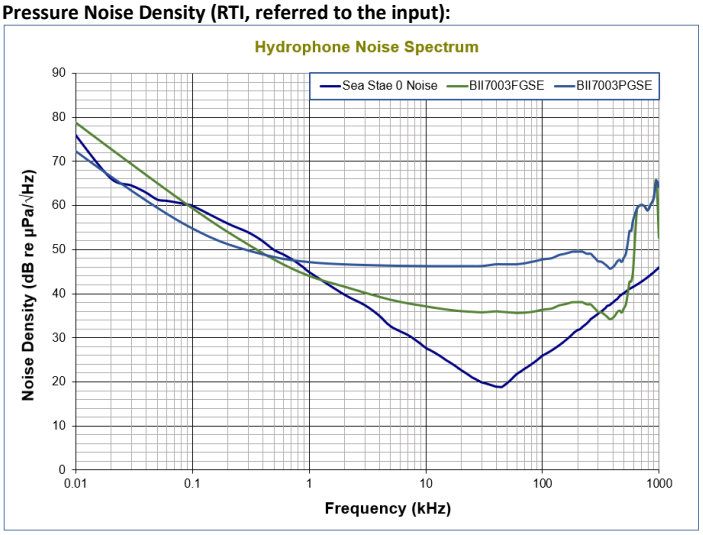


6. More Mounting/Installation Options: Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and details.

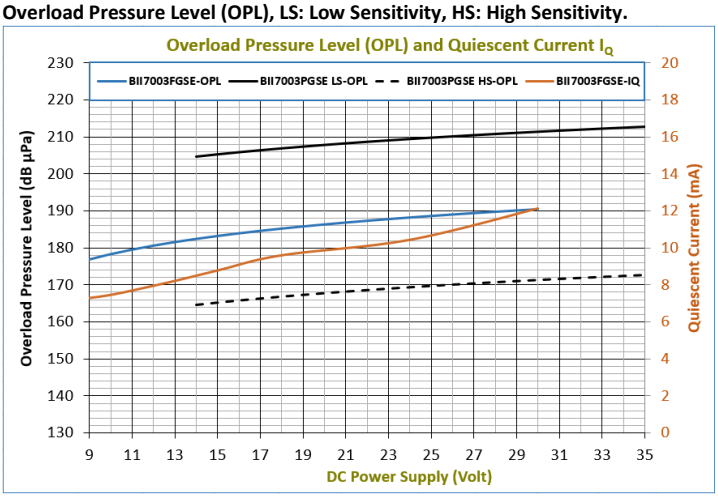
Free-field Voltage Sensitivity (FFVS):



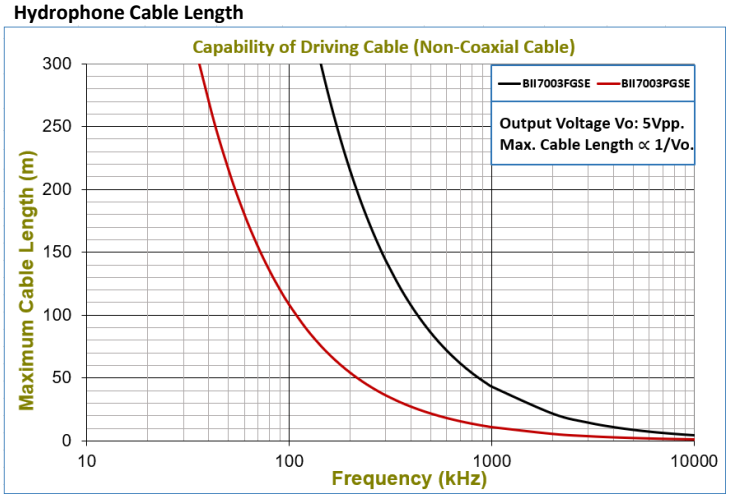
Pressure Noise Density (RTI, referred to the input):



Overload Pressure Level (OPL), LS: Low Sensitivity, HS: High Sensitivity.



Hydrophone Cable Length



Directivity Response Pattern: