

BII7020 Series Line Array Hydrophones: Toroidal Directivity Response.

A BII's line (linear) array hydrophone averages sound pressures along its length as a spatial filter, and utilize built-in amplitude shading/weighting to reduce side-lobes. Its toroidal directivity response makes it a great gear to detect and search underwater sound sources omnidirectionally with its main lobe and reject the noises in other directions. Smooth domes and housing reduce interferences to acoustic field under test.

Split-aperture correlators based on line arrays implement target angle estimation. The narrow beamwidth along the length provide direction information of the sound sources and reject the unwanted noises coming from other directions, the omnidirectional response cross the length covers large area to search. Two or four line arrays can be used to set up "T" or "+" type cross array functioning as a Target Angle Estimation System with Mills Cross techniques which provides accurate bearing information of sound sources.

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

For applications of beam steering (Digital or FFT Beamforming), please deploy multiple BII7021 arrays, [BII7010](#) hydrophones, or [BII7140](#) hydrophones to configure discrete linear or planar arrays.

Besides, Linear Planar Array hydrophones with side lobe suppression ($\leq -21\text{dB}$) is available from BII, please refer to [BII7570 sidescan transducer](#).

Typical Applications

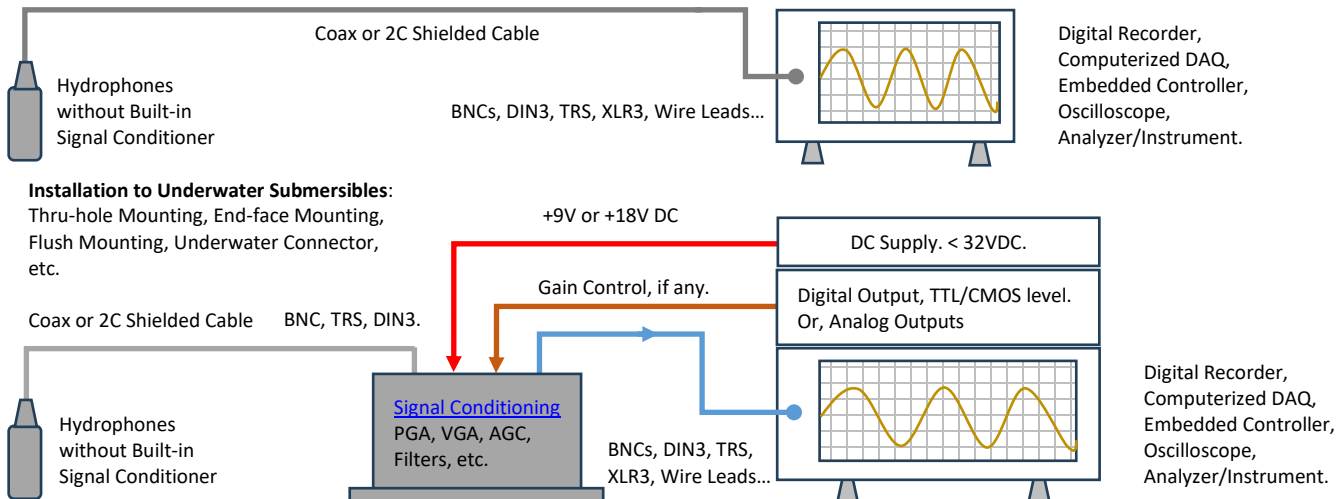
Array Elements, Towed Array, Sonobuoy, PAM System.	Tracking of Acoustic Tags, Locating Marker/Pinger/Beacon/Transponder.
Direction-finding Sonar System, Target Angle Estimation Systems.	Acoustic Pipeline Leak Detection, Directional Communication.

Related Products

[BII7010](#) hydrophone Low Noise Broadband Hydrophone

[BII7140](#) Hydrophone Acoustic Element for Array/Streamer/Beacon

System Configuration of Receiving Sounds and Waves.



Specification

The hydrophone is tested in water unless stated otherwise.		
S: Small; 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. DW: Deep Water, UMC: Underwater Mateable Connector, FFVS: Free-field Voltage Sensitivity, TVR: Transmitting Voltage Response.		
Line Array Hydrophone	BII7021	BII7022
Array Type:	Continuous Line	Continuous Line
Acoustic Aperture:	Φ12.7 x 300 mm	Φ12.7 x 1000 mm
Beam Steering:	Mechanical or Manual	
Sensitivity @ 1kHz:	-198.0 dB V/μPa ±2 dB	
	Sensitivity Loss over Extension Cable (dB) = 20*log[C _h /(C _h +C _c)]. Valid for hydrophone without preamplifier. C _h : Hydrophone Capacitance; C _c : Capacitance of Extension Cable. Cable is of 100 pF/meter roughly.	
FFVS:	Free-field Voltage Sensitivity, Refer to Graph of FFVS vs. Frequency .	
	0.1 Hz ~ 90 kHz at ±3 dB V/μPa.	
Usable Frequency: in Water, at ±3 dB V/μPa.	C _h and R _i constitute a high pass filter. -3dB high pass filter f _{-3dB} = 1/(2πR _i C _h). R _i : Input Resistance or Impedance of Preamp. C _h : Capacitance of hydrophone at 1 kHz. For example: A BII7021 and a BII preamp of R _i = 20 MΩ are used to detect sounds, -3dB high pass frequency of detection = 0.1 Hz. A BII7022 and a BII preamp of R _i = 10 MΩ are used to detect sounds, -3dB high pass frequency of detection = 0.06 Hz.	
Usable Frequency in Air:	0.1 Hz ~ 1 kHz at -3dB V/μPa.	
Capacitance C _h @ 1kHz:	75 nF ± 10%	250 nF ± 10%

SE=SL-TL+AG-NL

Acoustical Solutions: SONAR, NDT/AE, HIFU.

benthowave.com

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Dissipation @ 1kHz:	0.008
Noise Density at $f \ll f_s$: dB μ Pa/√Hz	$28.0 - 10 \cdot \log f$ 1. f in kHz; f_s: Resonance Frequency which is close to the frequency of maximum FFVS. 2. Noise densities in this datasheet are calculated values with transducer parameters being measured in water. 3. As hydrophones works with preamps or data acquisition modules, total noise density is determined by all noise sources. Generally, the total noise density is much higher than the ones stated in this datasheet.
Cable Length at (FFVS - 3dB):	220 m 732 m
Tips for Simple Array:	Both BII7021 and BII7022 can drive long shielded twisted-pair cable without significant sensitivity loss and EMI interference. A simple line (linear) array with multiple BII7021 (or BII7022) hydrophones can be configured quickly and easily which is being suspended by long cable bundles from the bottom of a buoy or a pontoon boat.
Directivity Pattern:	Toroidal.
Along-length Beam Width:	Refer to Graph of Directivity Pattern .
Cross-length Beam Width:	Omnidirectional
Side Lobe Level:	≤ -21.0 dB.
Signal Output Type:	Differential Output. Differential signal has better capability to reduce and reject EMI noise, especially over long cable.
Acceleration Sensitivity:	103.6 dB μ Pa/(m/s ²) at Acoustic Axis. ≤ 104 dB μ Pa/(m/s ²) at Acoustic Axis.
Transmitting Sound:	No, the hydrophone can NOT be used as sound projector.
Signal Conditioning:	None. Preamp and filter are available upon request.
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.
Operating Depth:	300 m, Maximum. 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). 3. Thru-hole Inch Mounting with Single O-ring Sealing (THM-5/8"). 4. 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:	1. Shielded Cable with Twisted Pair and PVC Jacket, $\Phi D=6.0$ mm (SC60). 2. Shielded Cable with Twisted Pair and Polyurethane Jacket, $\Phi D=4.7$ mm (SC47). 3. Shielded Cable with Rubber Jacket (Not Twisted Pair) $\Phi D=6.5$ mm (SC65). 4. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, $\Phi D=3.2$ mm (SC32). Non-waterproof, for aerial dry use ONLY. Differential/balanced signals over shielded twisted pair cable is recommended to reject Electromagnetic Interference (EMI).
Cable Length:	1. Default: 15 m. 2. Custom-fit Cable Length: Max. 150 m (492 ft).
Connector:	1. Default: Wire Leads (WL). 2. XLR Receptacle with 3 Male Pins (XLR3), Max. Diameter $\Phi 20.2$ mm. 3. DIN Receptacle with 3 Male Pins (DIN3), Max. Diameter $\Phi 17$ mm. 4. Underwater Mateable Connector UMC3P 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): 3 pin (UMC3P = MCIL3M + MCDLS-F.), Max. Diameter $\Phi 21.5$ to $\Phi 35$ mm. Depth Rating: 950 m. 3 pin (UMC3P = MCOM3M + OMBMC + MCDLS-F.), Max. Diameter $\Phi 21.5$ to $\Phi 35$ mm. Depth Rating: 300 m. Underwater Mateable Connectors are for underwater uses. Other connectors/wire leads are for dry aerial uses and are not waterproofed.
Physical Size:	Free Hanging: $\Phi D = \Phi 21.0$ mm, Length = 350 mm. Free Hanging: $\Phi D = \Phi 21.0$ mm, Length = 1050 mm. Other Mounting Types: Actual length depends on Mounting Parts.
Weight:	2.5 kg with 15m Shielded Cable (SC60). 3.9 kg with 15m Shielded Cable (SC60). 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.
For long line array, to avoid high pull force acting on the underwater connectors and the array cables, a reinforced rope with high pull strength shall be used along the array, and the array cables are tied on the reinforced rope with soft cotton rope (avoid scratching or damaging cable jacket). Make sure that ONLY reinforced rope withstands high pulling force during field operation. BII does not sell reinforced rope and soft cotton rope, which are usually available at buyer's local stores.	
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.	

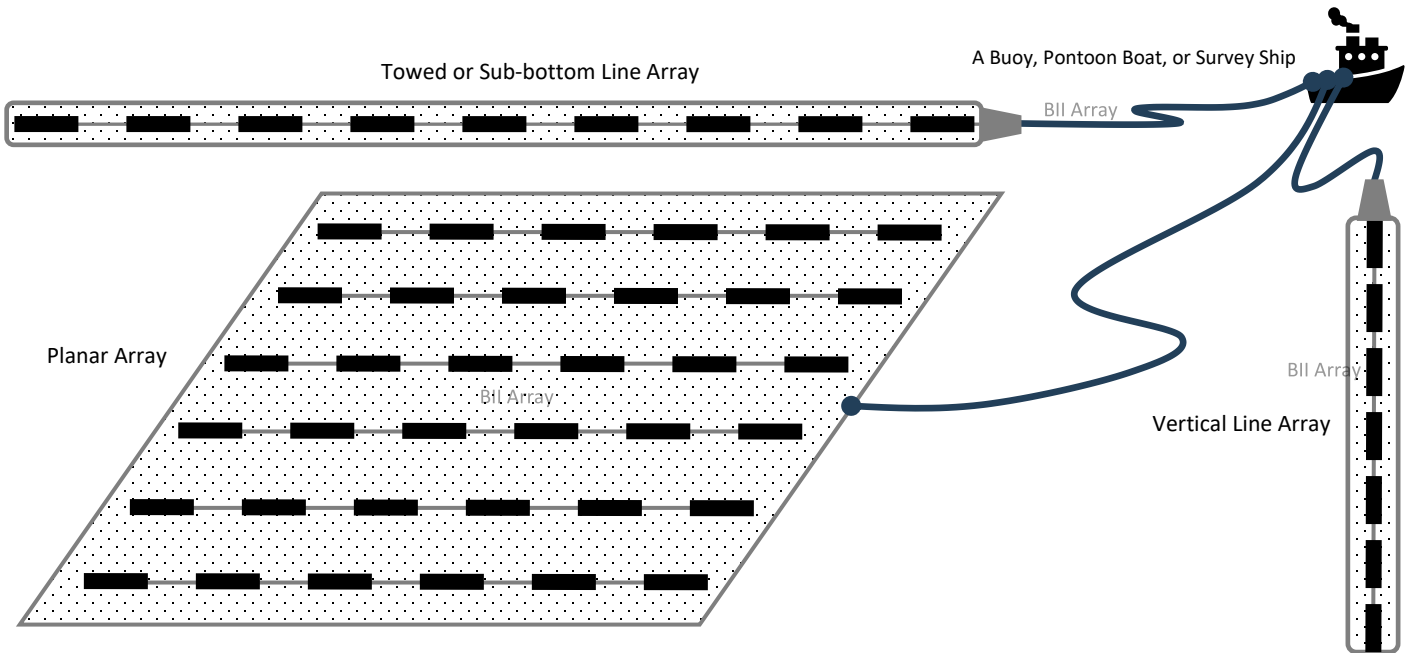
How to Order Standard Hydrophones. BII Keeps Standard Products in Stock.

Hydrophone Part Number	-Mounting Part	-Cable Length	-Cable Type	-Connector Type
BII7021, BII7022.	FH : Free Hanging. Bespoke.	Default: 20 m (65.6 ft). Bespoke, Max. 305m (1000 ft).	Default: SC60. Bespoke.	Default: WL. Bespoke: DIN3, XLR3, UMC3P.
Example:	Description			
BII7021-FH-20m-SC60-WL	BII7021 Hydrophone, Free Hanging, 20m SC60 Cable, Wire Leads.			
BII7021-BFM-5/8"-100m-SC60-XLR3	BII7021 Hydrophone, Mounting Parts: BFM-5/8", 100m SC60 Cable, Connector: XLR3.			
BII7021-THM-5/8"-0.15m-SC32-WL	BII7021 Hydrophone, Mounting Parts: THM-5/8", 0.15m SC32 Cable, Wire Leads.			
BII7021-FH-0.6m-SC60-UMC3P	BII7021 Hydrophone, Free Hanging, 0.6m SC60 Cable, Connector: UMC3P.			
BII7022-FH-20m-SC60-WL	BII7022 Hydrophone, Free Hanging, 20m SC60 Cable, Wire Leads.			

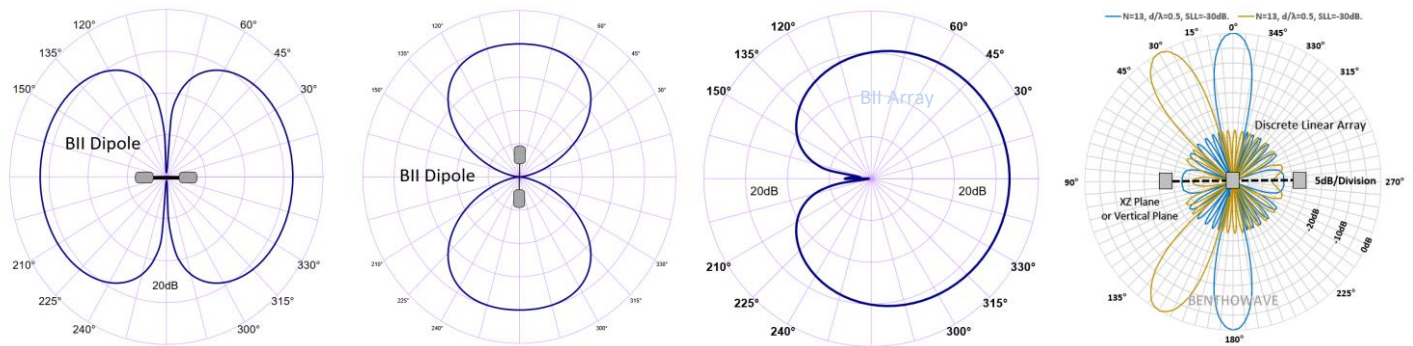
BII7022-FH-20m-SC60-UMC3P	BII7022 Hydrophone, Free Hanging, 20m SC60 Cable, Connector: UMC3P.
BII7021-FH-305m-SC60-XLR3	BII7021 Hydrophone, Free Hanging, 305m SC60 Cable, Connector: XLR3.

Wirings

Differential Output:	Wire Leads	UMC3P, UMC3S, FHUWC-3P.	DIN3	TRS	XLR3
Signal +	White or Red	Pin 2 or Socket 2	Pin 3	Tip, Positive/Hot	Pin 2, Positive/Hot.
Signal -	Black	Pin 1 or Socket 1	Pin 1	Ring, Negative/Cold	Pin 3, Negative/Cold.
Common & Shielding	Shield	Pin 3 or Socket 3	Pin 2	Sleeve, Ground/Common	Pin 1, Shield/Ground.

Array Elements for Underwater Linear and Planar Arrays**Simple Larger Array Consisting of Multiple Hydrophones.**

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

Cardioid Pattern**Linear Array with BII Discrete Hydrophones****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.

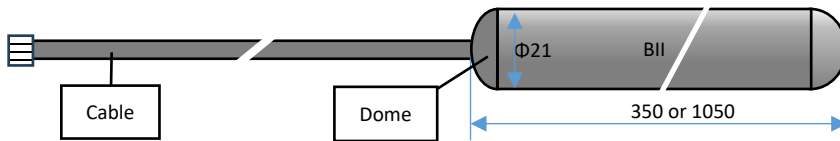
Can BII explain why the capacitance of my hydrophone/transducer affect high pass filtering? (1). Hydrophone/transducer is high impedance devices in low frequency range. Its simplified complex impedance = $j/(2\pi f C_h)$, C_h is the capacitance of hydrophone/transducer, f is frequency in Hz. This impedance 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 BII explain more on Single-ended (SE) and Differential (DF) measurement? (1). **SE hydrophone + coax + BNC/SMA/SMC** is compatible to most instruments such as oscilloscope, signal generators, and DAQ modules, etc.. Quick setup of SE measuring system and low cost with coax/BNC are the significant merits besides 50Ω matching in MHz range measurement. The shortcomings are weak rejection on common-mode noise and inductive coupling of EMI. (2). **DF hydrophone + Twisted-Pair Shielded Cable + WL/TRS/XLR/DIN** is compatible to most audio recording and analyzing instruments, etc.. Efficient rejection of common mode noises and inductive coupling noise

of EMI are the significant merits, especially over the long cable. The shortcomings are higher costs on hydrophones, cables, and differential signal processing circuits such as differential preamp and differential DAQ modules.

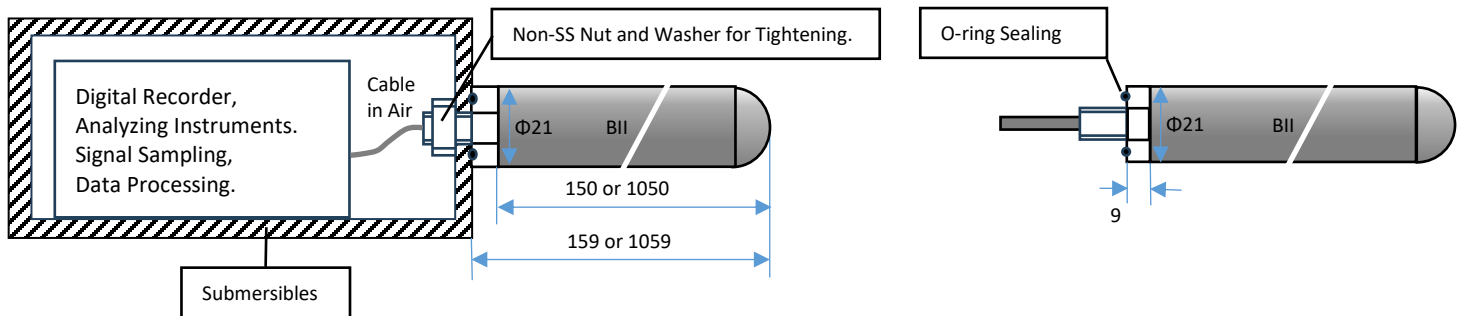
Physical Size (Dimensional Unit: mm): The overall length varies with the length of the mounting part.

1. Free Hanging with Smooth Domes.

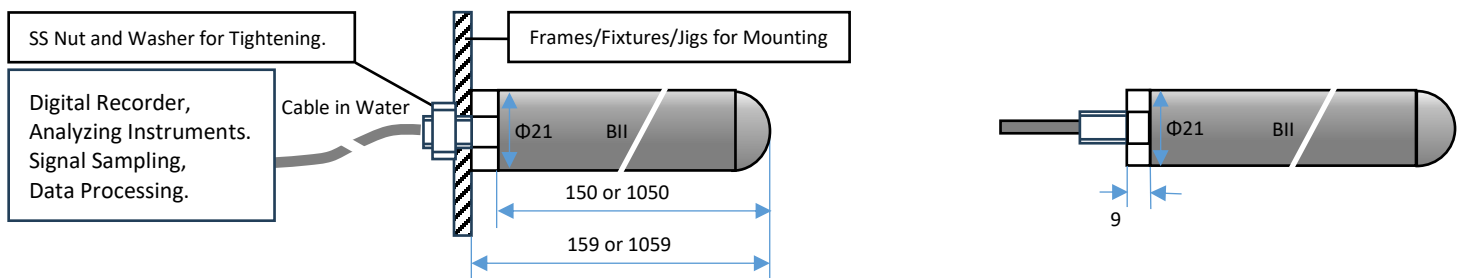


The hydrophone body has streamlined hemispherical domes which minimize the drag forces and the hydrodynamic noise caused by the hydrophone in motion or the flow past the hydrophone.

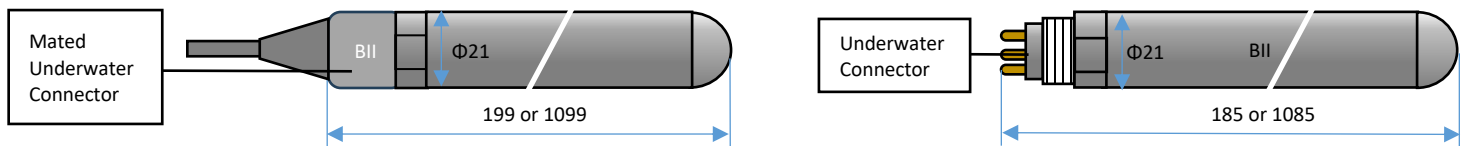
2. Thru-hole Mounting (Inch Thread) with Single O-ring Sealing THM-5/8" (5/8"-18x22 UNF).



3. Bolt-Fastening Mounting BFM-5/8" (5/8"-18x22 UNF).

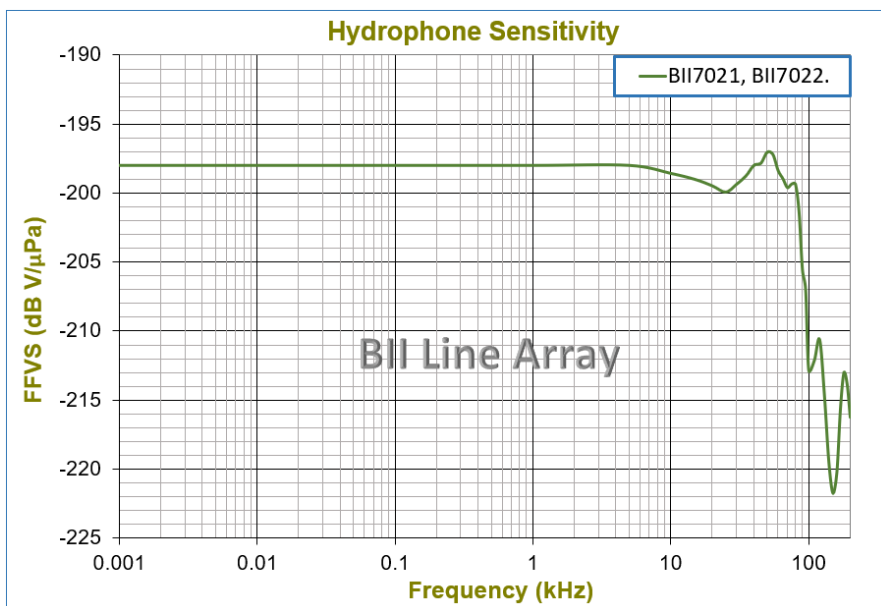


4. Free-hanging with Underwater Connector (FHUWC-3P), 3 Pins.



5. 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):



Directivity Pattern

