

BII7000 Series Omnidirectional Spherical Hydrophone

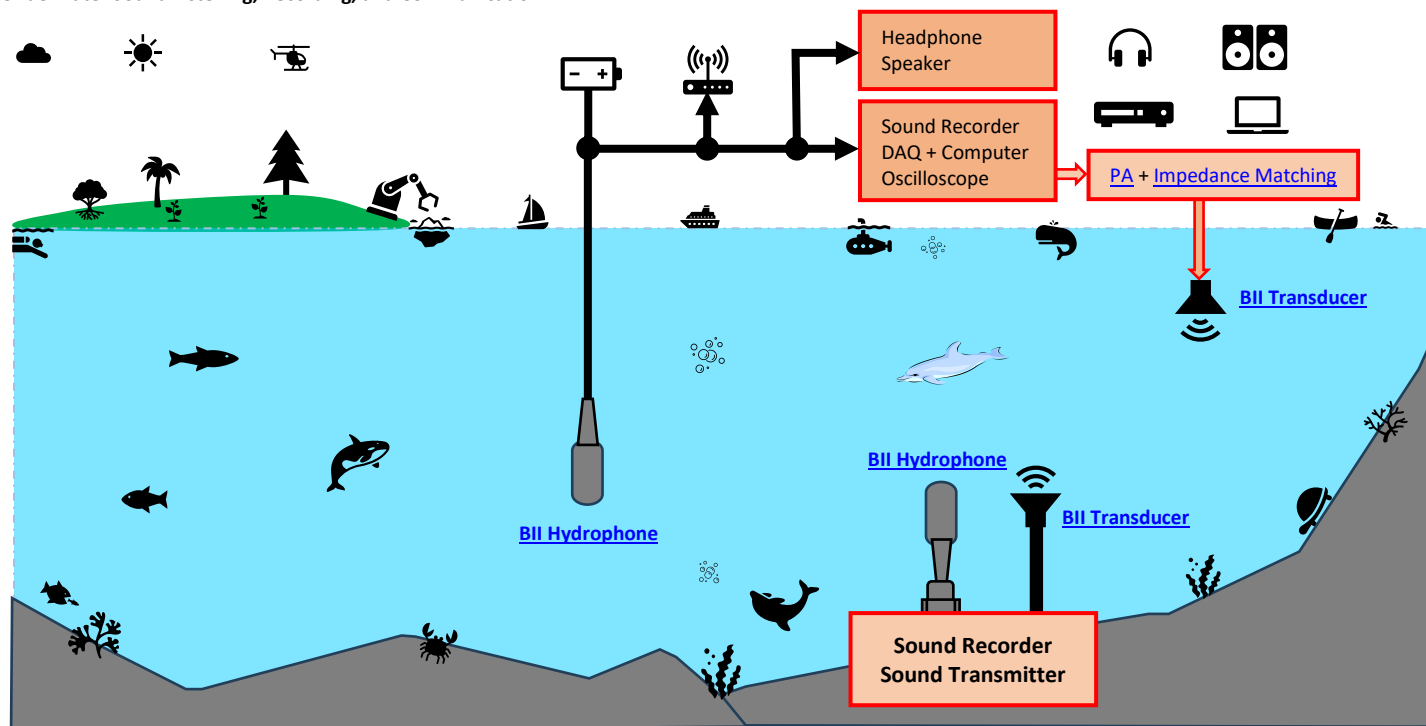
BII's spherical hydrophones provide omnidirectional responses up to 700kHz and offer excellent acoustic characteristics of low noise and durability, which make these hydrophones ideal for a wide range of oceanography applications. Bespoke built-in preamplifiers allow the hydrophones to be used with long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

Low Frequency Sounds in the Ocean at 1 Hz to 1 kHz. Low Frequency Sounds between 1Hz to 1kHz undergo little attenuation in ocean and lakes: 1.2×10^{-7} at 1Hz, 0.0002 at 10Hz, 0.0015 at 100Hz, 0.07 at 1kHz, in dB/km, proximately. The major propagation losses are Spreading Loss, Absorption and Scattering at boundaries such as seafloor sediments. The sounds being trapped in deep sound channel or SOFAR channel avoiding losses from both top and bottom boundaries can propagate very big area with very low loss. These low frequency sounds contain valuable information on their sources and propagation areas such as Weathers (Winds, Rains, Surface Waves, Ice, Storms, ...), Geological Process (Earthquakes, Tsunamis, Moving of Tectonic Plates and Crusts,...), Marine Animals (Whales, Dolphins, Fish, Invertebrates, ...), Anthropogenic Activities (Shipping, Harbor, Oil and Wind Energy Extraction, Air Guns, ...). Besides sounds detection or monitoring with deployment at 1000m depth, the distributed hydrophone network in shallow water (at a specific depth) can also be used to detect and monitor upward sounds being refracted from SOFAR channel.

Typical Applications

Sonobuoy, Dipping Hydrophone. LBL, SBL, USBL Positioning. 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.
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...	

Underwater Sound Listening, Recording, and Communication



Questions

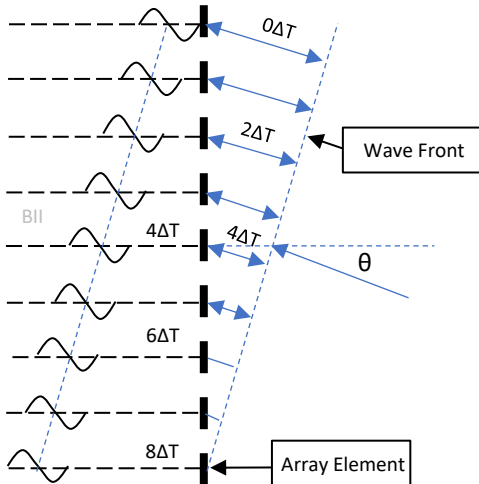
How do I set up my professional sound recorders to work with BII Hydrophones?

- 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.
- 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.
- 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.
- Calculate the memory size of data storage according to sampling rate, resolution, sampling channels, and recording time, and use suitable recording media.
- Calculate battery service life according to battery power and consuming current.
- When the cable is greater than 5m, balanced signal or differential signal is recommended to be in use over the cable.

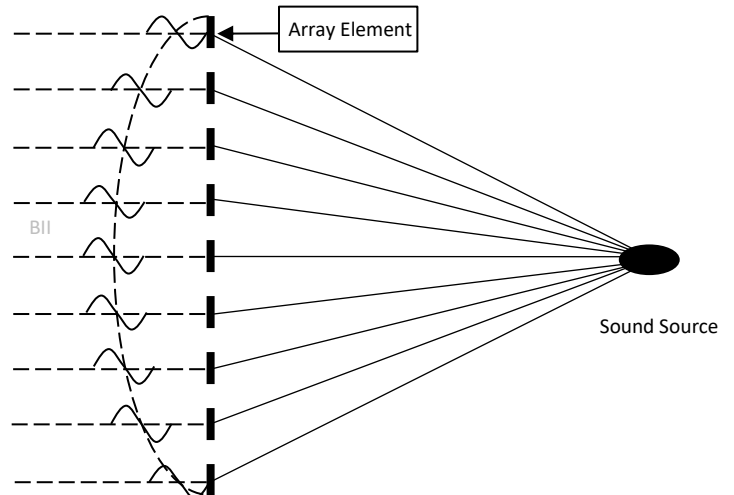
How do I playback the recorded sounds in water?

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

Linear (Rectangular) Array Beam Steering

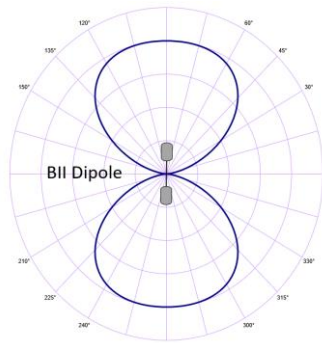
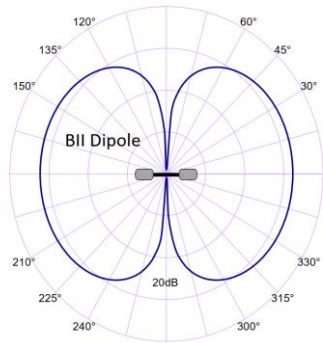


Linear, Annular, and Planar Array Beam Focusing

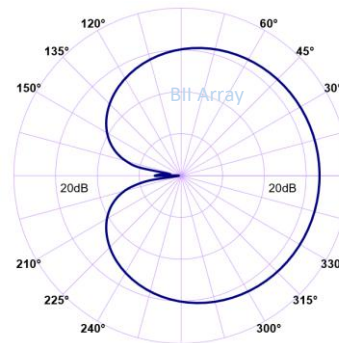


Simple Array Consisting of Hydrophones.

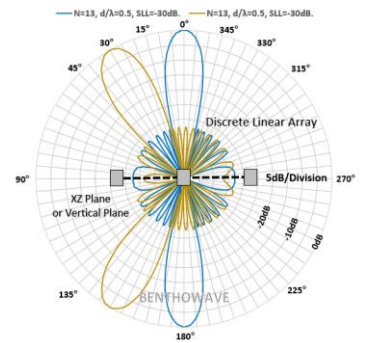
"Figure 8" Pattern of a Dipole (Pressure-Gradient).



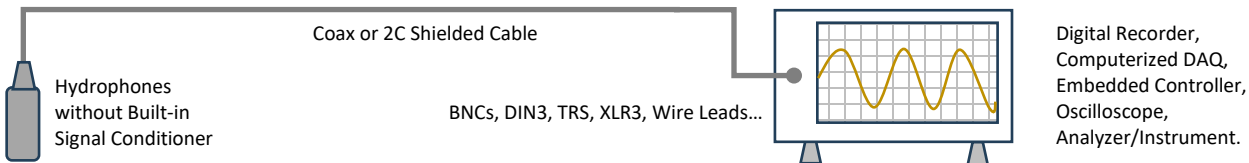
Cardioid Pattern



Linear Array with BII Discrete Hydrophones

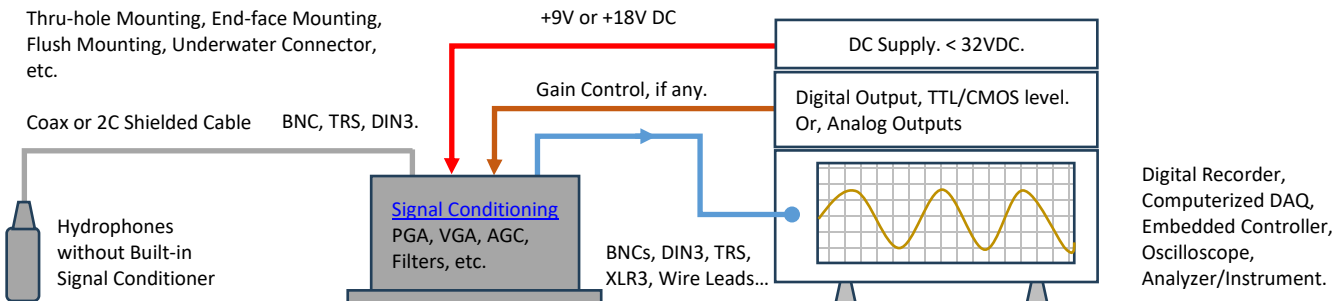


System Configuration of Receiving Sounds and Waves.



Installation to Underwater Submersibles:

Thru-hole Mounting, End-face Mounting, Flush Mounting, Underwater Connector, etc.



SPECIFICATION

Part Number:	BII7003		BII7003-HT200	
Sensitivity FFVS at 1 kHz:	-212.5 dB V/μPa + Sensitivity Loss over Cable, ± 2 dB.		-210.7 dB V/μPa + Sensitivity Loss over Cable, ± 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:	Refer to Graph of FFVS vs. Frequency . Free-field Voltage Sensitivity.			
Usable Frequency:	In Water: 1 Hz ~ 560 kHz at ±3dB V/μPa			
	In Air: 1 Hz ~ 12.6 kHz at -3dB V/μPa			
	Minimum Usable Frequency depends on -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.			
Capacitance C _h @ 1 kHz:	1.79 nF ± 10% without cable.		2.7 nF ± 10% without cable.	
Dissipation @ 1 kHz:	0.0044		0.015	
Noise Density at f << f _s : dB μPa/√Hz	39.9 – 10*log f		42.2 – 10*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.			
Directivity Pattern:	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.			
	Omnidirectional, Refer to Graph of Beam Pattern .			
-3dB Beam Width:	Refer to Graph of Beam Pattern .			
Side Lobe Level:	No side lobes			
Signal Output Type:	Single Ended			
Acceleration Sensitivity:	130.8 dB μPa/(m/s ²).		131.0 dB μPa/(m/s ²).	
Underwater Projector:	Yes. Do NOT use the hydrophone as a sound projector in the air otherwise the hydrophone will be damaged.			
Resonance f _s :	330 kHz ± 10%		293 kHz ± 10%	
TVR at f _s :	145 dB μPa/V at 1m.		149 dB μPa/V at 1m.	
Maximum Drive Voltage:	300 Vpp		200 Vpp	
Maximum Pulse Length:	100 mS at Maximum Drive Voltage		10 mS at Maximum Drive Voltage	
Duty Cycle in Water:	10% at Maximum Drive Voltage.		1% at Maximum Drive Voltage.	
	100% ≤ 30 Vpp or 10.6 Vrms.		Does NOT support continuous signals.	
Operating Depth:	400 m or 4 MPa, Maximum.		50 m or 0.5 MPa, 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. Thru-hole Mounting with Single O-ring (THM-M10, THM-7/16" .)			
	3. Thru-hole Mounting with Double O-ring (THDO-7/16")			
	4. Bolt Fastening Mounting (Stainless Steel) (BFM-7/16")			
	5. Bolt Fastening Mounting (Plastics) (BFMP-M12)			
	6. Free-hanging with Male Underwater Connector (FHUWC-2P, FHUWC-3P.)			
	Note: Mounting Option 1, 2, 3, 4 can be customized for BII7003-HT200, or -10°C to 200°C, or 14°F to 392°F.			
	Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.			
Cable Options:	1. Default: Coax RG174/U (RG174).		1. Default: Coax RG178/U (RG178).	
	2. Coax RG58/U (RG58).		2. Coax RG-316/U (RG316).	
Cable Length:	Default: 6 m (19.7 ft).			
	Custom-fit Cable Length.			
Connector:	1. Default: Wire Leads (WL).			
	2. Male BNC (BNC), Max. Diameter Φ14.3 mm, for SE ONLY. BNC with RG178 Coax: Service Temperature up to 165°C or 329°F.			
	3. Underwater Mateable Connector UMC2P and 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):			
	2 pin (UMC2P = MCIL2M + MCDLS-F.), Max. Diameter Φ21.5 to Φ35 mm.			
	3 pin (UMC3P = MCIL3M + MCDLS-F.), Max. Diameter Φ21.5 to Φ35 mm.			
	3 pin (UMC3P = MCOM3M + OMBMC + MCDLS-F.), Max. Diameter Φ21.5 to Φ35 mm.			
	Underwater Mateable Connector is for uses underwater. Other connectors and 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. UMC : Underwater Mateable Connectors, interconnection solution for high power or weak signals. Fastening Type: Threaded. Underwater Uses.				
Size:	ΦD x L = Φ9 x 30 mm for Free Hanging.		ΦD x L = Φ9.5 x 20 mm.	
	Actual length depends on Mounting Parts.			
Weight:	≥ 0.09 kg with 6m cable. Actual weight depends on Mounting Parts, Cable Types and Length.			
Operation Temperature:	-10°C to +60°C or 14°F to 140°F.		-10°C to 200°C, or 14°F to 392°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.			
Underwater Projector Application: for 50Ω BNC/SMA/SMC connector, it is buyer's sole responsibility to make sure that the BNC/SMA/SMC shield of the signal source is firmly grounded for operating safety before hooking up transducer/hydrophone to the signal source. Coax with BNC/SMA/SMC is not intended for hand-held use at voltages above 30Vac/60Vdc.				
Do NOT use the hydrophone as a sound projector in the air otherwise the hydrophone will be damaged.				
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 (**Green Color**), Non-stock Products are in **Black Color**.

Hydrophone Part Number	-Mounting Part	-Cable Length	-Cable Type	-Connector Type
BII7003	FH, BFMP-M12x1.5	6 m (19.7 ft)	RG174 Coax	WL, BNC.
BII7003-HT200	FH	6 m (19.7 ft)	RG178 Coax	BNC
In-Stock Examples:		Description		
BII7003-FH-6m-RG174-BNC		BII7003 Hydrophone, Free Hanging, 6m RG174 Coax , Male BNC.		
BII7003-BFMP-M12x1.5-10m-RG174-BNC		BII7003 Hydrophone, Bolt-fastening Mounting: BFMP-M12x1.5, 6m RG174 Coax, Male BNC.		
BII7003-HT200-FH-6m-RG178-BNC		BII7003-HT200 Hydrophone, Free Hanging, 6m RG178 Coax , Male BNC.		
Non-stock Examples:		Description		
BII7003-FHUWC-2P		BII7003 Hydrophone, Free-hanging with Male Underwater Connector: FHUWC-2P.		
BII7003-FH-0.6m-SC65-UMC3P		BII7003 Hydrophone, Free Hanging, 0.6m Shielded Cable SC65 , 3-pin Underwater Mateable Connector UMC3P.		
BII7003-BFM-7/16"-0.6m-SC65-UMC3P		BII7003 Hydrophone, Bolt-fastening Mounting BFM-7/16", 0.6m Shielded Cable SC65 , 3-pin Underwater Mateable Connector UMC3P.		

Wirings

Single Ended Output:	Wire Leads	UMC3P, UMC3S, FHUWC-3P.	UMC2P, FHUWC-2P.	DIN3	BNC/SMA/SMC	Coax with Wire Leads
Signal	White or Red	Pin 2 or Socket 2	Pin 2	Pin 3	Center Contact	Coax Center Contact
Signal Common	Black	Pin 1 or Socket 1	Pin 1	Pin 1	Shield	Coax Shield
Shielding	Shield	Pin 3 or Socket 3	N/A	Pin 2	Shield	Coax Shield

Typical Components of an Acoustic Receiving System. Depending on the system requirements, the signal conditioner is optional.



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.**

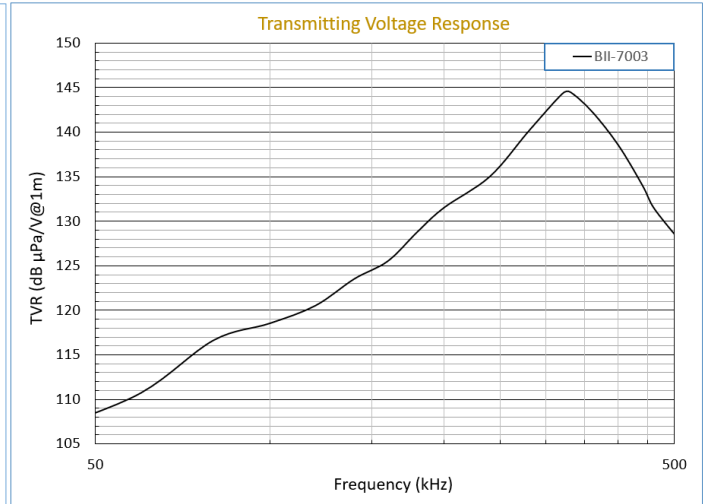
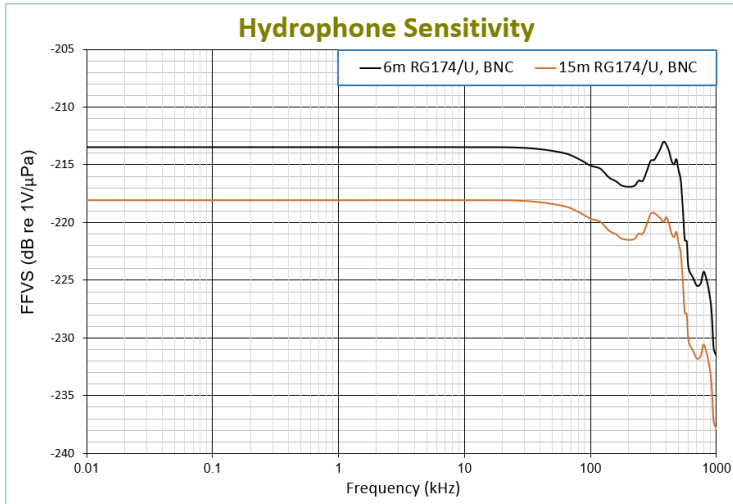
Is impedance matching necessary between hydrophones/sensors and preamplifiers/Recorders/Analyzers? it is NOT necessary to do impedance matching in low frequency range applications in which electromagnetic wave lengths are much greater than the cable length. High frequency transducers such as NDT pulsing 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.

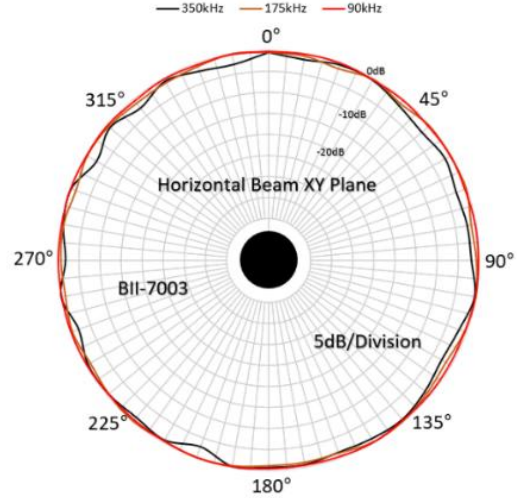
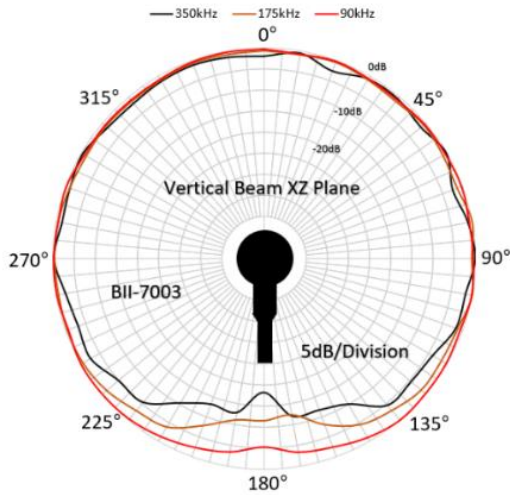
Can BII explain more on Single-ended (SE) and Differential (DF) measurement? (1). **SE hydrophone + coax + BNC/SMA/SMC** is compatible to most instruments such as oscilloscope, signal generators, and DAQ modules, etc.. Quick setup of SE measuring system and low cost with coax/BNC are the significant 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.

Free-field Voltage Sensitivity (FFVS):

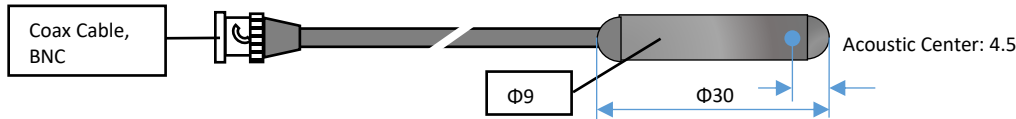
Transmitting Voltage Response (TVR):



Directivity Pattern

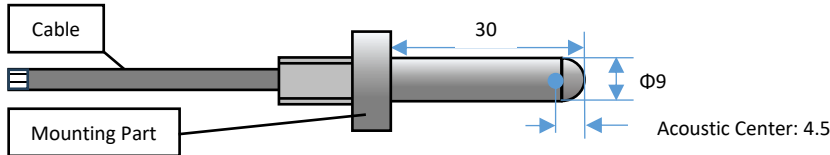


1. BII7003 Physical Size of Free Hanging, Dimensional Unit: mm.

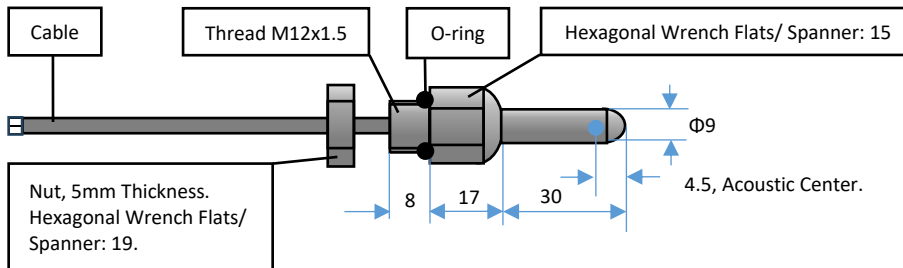


The streamlined hemispherical domes minimize drag forces and hydrodynamic noises caused by the hydrophone in motion or the flow past the hydrophone.

2. Physical Size (Dimensional Unit: mm) with Mounting Part:



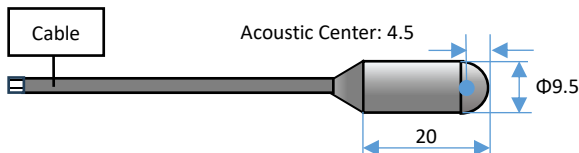
3. BII7003 Bolt-fastening Mounting (Plastics) BFMP (300m Depth or 3MPa Ratings) or Thread Mounting into a submersible enclosure (IP68, tighten with O-ring).



Bolt-Fastening Mount (Plastics) (BFMP-M12x1.5)
Thread: M12x1.5, Lock nut: included.
Maximum Depth: 300 m.
Mounting Hole: Φ12.1 to Φ13.0 mm.
Fastening Torque: ≤ 1.5 Nm.
Mounting Wall Thickness: ≤ 3 mm.

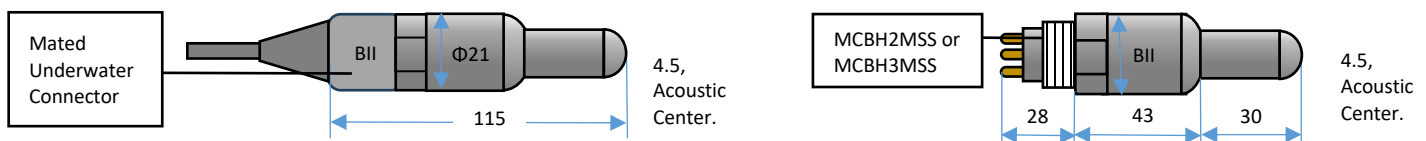


4. BII7003-HT200 Physical Size (Dimensional Unit: mm) of Free Hanging:



5. BII7003-FHUWC-2P and BII7003-FHUWC-3P: Free-hanging with Underwater Connector FHUWC-2P, 2 Pins or FHUWC-3P, 3 Pins.

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:
	UMC2S-20m-BNC: 20 m cable with Underwater Mateable Connector 2 Sockets (UMC2S) and BNC (BNC). UMC3S-20m-WL: 20 m cable with Underwater Mateable Connector 3 Sockets (UMC3S) on one end and wire leads (WL) on other end.



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