



BII7010 Series Broadband Hydrophone: Low Noise, Low Power, 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, biologies, ...

Sound Excitation by Turbulence: $\frac{1}{c^2} \frac{\partial^2 p}{\partial t^2} - \Delta p = \rho \frac{\partial^2 v_i v_k}{\partial x_i \partial x_k}$ 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. Reference Hydrophone, Noise Measurement. Signal Detection in Strong Currents. Parabolic Antennas Underwater. Passive Acoustic Monitoring (PAM System).	Detection of Ultrasonic Cavitation Noise, Thermoacoustics in Gas. Linear and Planar 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. SE: Single ended Output, DF: Differential Output, DW: Deep Water, UMC: Underwater Mateable Connector, FFVS: Free-field Voltage Sensitivity, TVR: Transmitting Voltage Response.	
Part Number:	BII7015
Sensitivity @ 1kHz:	-216.5 ± 2 dB V/μPa. 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.
Sensitivity Matching: (at 1 kHz)	When hydrophones are used as array elements, it is necessary for array elements to possess uniform sensitivities. Available Options of Sensitivity Tolerance: a. ±2.0 (Default); b. ±1.0; c. ±0.5; d. ±0.3; e. ±0.1; in dB V/μPa. 1. Sensitivity is tested at 1 kHz in water. 2. Hydrophones whose sensitivity variations are out of specified tolerance are rejected.
FFVS:	Refer to Graph of FFVS vs. Frequency .
Usable Frequency: in Water, at ±3 dB V/μPa.	1.2 Hz ~ 500 kHz. 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 BII7015 and a BII preamp of R _i = 100 MΩ are used to detect sounds, -3dB high pass frequency of detection = 1.2 Hz.
Usable Frequency in Air:	1.2 Hz ~ 15 kHz at -3dB V/μPa.
Capacitance C _h @ 1kHz:	1.35 nF ± 10%
Dissipation @ 1kHz:	0.005
Noise Density at f << fs: dB μPa/VHz	45.5 – 10*log f 1. f in kHz; fs: 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.
Directivity Pattern:	Omnidirectional and Toroidal. Refer to Graph of Directivity Pattern .
-3dB Beam Width:	Refer to Graph of Directivity Pattern .
Side Lobe Level:	No side lobes.
Signal Output Type:	Single Ended
Acceleration Sensitivity:	120.7 dBμPa/(m/s ²) at Acoustic Axis or XZ Direction. ≤ 118 dBμPa/(m/s ²) at Horizontal or XY Direction.
Underwater Projector:	Yes. Do NOT use the hydrophone as a sound projector in the air otherwise the hydrophone will be damaged.
Resonance fs:	300 kHz
TVR at fs:	145.0 dB μPa/V at 1m. Approximately, TVR drops 12dB/octave below fs and drops 6dB/octave above fs.
Maximum Drive Voltage:	250 Vpp
Maximum Pulse Length:	100 mS at Maximum Drive Voltage
Duty Cycle:	10% at Maximum Drive Voltage. 100% at 30 Vpp or 10.6 Vrms.
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:	<ol style="list-style-type: none"> 1. Default: Free Hanging (FH). 2. Free-hanging with Male Underwater Connector (FHUWC-2P). 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"). <p>Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.</p>
Cable Options:	<ol style="list-style-type: none"> 1. Default: Coax RG174/U, $\Phi D=2.8$ mm (RG174), (SE). 2. Coax RG58/U, $\Phi D=4.9$ mm (RG58), (SE). 3. Coax RG316/U, $\Phi D=2.5$ mm (RG316) up to 200°C, (SE). 4. Coax RG178/U, $\Phi D=1.8$ mm (RG178) up to 200°C, (SE).
Cable Length:	<ol style="list-style-type: none"> 1. Default: 2 m. 2. Custom-fit Cable Length.
Connector:	<ol style="list-style-type: none"> 1. Default: Wire Leads (WL). 2. Male BNC (BNC), Max. Diameter $\Phi 14.3$ mm. BNC with RG178 Coax: Service Temperature up to 165°C or 329°F. 3. SMA (Plug, Male Pin) (SMA), Voltage Rating: 335 V_{RMS} Continuous. 4. SMC (Plug, Female Socket) (SMC), Voltage Rating: 335 V_{RMS} Continuous. 5. Underwater Mateable Connector UMC2P 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 $\Phi 21.5$ to $\Phi 35$ mm, for SE. Depth Rating: 950 m. <p>Underwater Mateable Connectors are for underwater uses. Other connectors/wire leads are for dry uses and are not waterproofed.</p>
Size:	Free Hanging: $\Phi D = \Phi 7.4$ mm, Length = 28 mm.
Weight:	50 grams with 2m Coax/BNC Male. Actual weight depends on Mounting Parts, Cable Types and Length.
Operation Temperature:	<ol style="list-style-type: none"> 1. Default: -10°C to +60°C or 14°F to 140°F. 2. Bespoke High Temperature Hydrophone: -10°C to 120°C, or 14°F to 248°F. Append HT to part number. Maximum Operating Depth at 120°C or 248°F: 100 m.
Storage Temperature:	-20°C to +60°C or -4°F to 140°F.
for 50Ω BNC Male connector, it is buyer's sole responsibility to make sure that the (female) BNC shield of the signal source is firmly grounded for operating safety before hooking up transducer/hydrophone to the signal source. Coax with BNC is not intended for hand-held use at voltages above 30Vac/60Vdc.	
Sound Measurement in Air: The hydrophones can be used to detect sounds in air. Receiving 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	-Connector
BII7015	FH	2 m (6.56 ft)	RG174	BNC
In-Stock Examples:	Description			
BII7015-FH-2m-RG174-BNC	BII7015 Hydrophone, Free Hanging, 2m RG174 Coax, BNC Male.			
Non-stock Examples:	Description			
BII7015-FH-6m-RG174-BNC	BII7015 Hydrophone, Free Hanging, 6m RG174 Coax, BNC Male.			
BII7015-THM-7/16"-0.2m-RG174-WL	BII7015 Hydrophone, Thru-hole Mounting THM-7/16", 0.2m RG174 Coax, Wire Leads.			
BII7015-HT-FH-6m-RG178-BNC	BII7015 Hydrophone, Service Temperature: -10°C to 120°C (14°F to 248°F). Free Hanging, 6m RG178 Coax, BNC Male.			
BII7015-BFMP-NPT3/8"-10m-RG174-BNC	BII7015 Hydrophone, Bolt-fastening Mounting: BFMP-NPT3/8", 10m RG174 Coax, BNC Male.			

Wirings

Single Ended Output:	Wire Leads	UMC3P, UMC3S.	UMC2P	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

Components of an Acoustic Receiving System.



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.

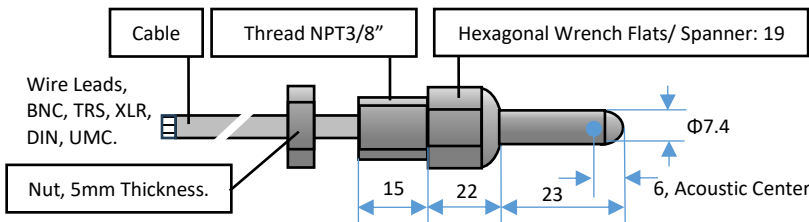
Can BII explain more on Single-ended (SE) and Differential (DF) measurement? (1). **SE hydrophone + coax + BNC/SMA/SMC** is compatible to most instruments such as oscilloscope, signal generators, and DAQ modules, etc.. Quick setup of SE measuring system and low cost with coax/BNC are the significant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

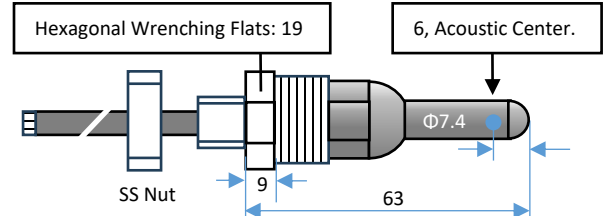
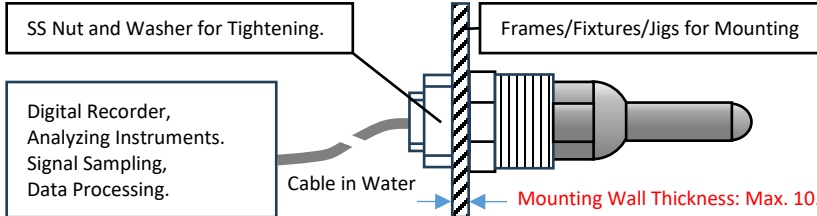
1. Free Hanging (Depth Rating limited by cable length).



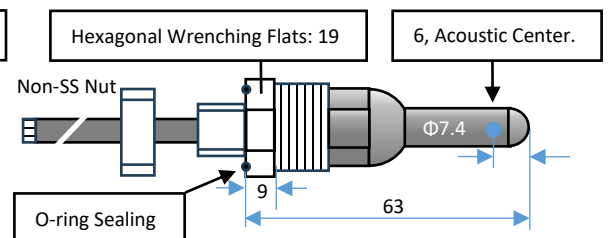
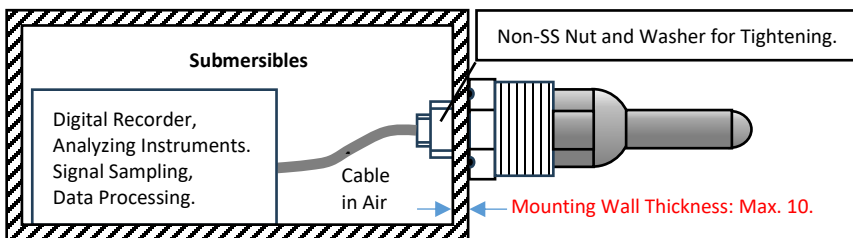
2. Bolt-fastening Mounting (Plastics) BFMP-NPT3/8". Tips: Plastic material has less sound reflection.



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

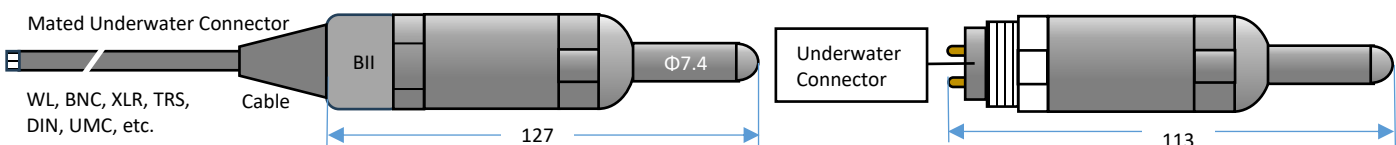


4. Thru-hole Mounting (Inch Thread) with Single O-ring Sealing THM-7/16" (7/16"-20x22 UNF-2A).



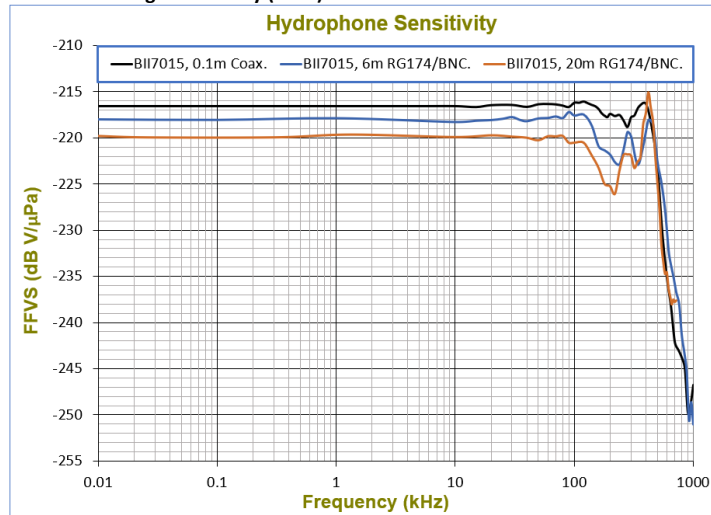
5. Free-hanging with Underwater Connector (FHUWC-2P), 2 Pins.

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

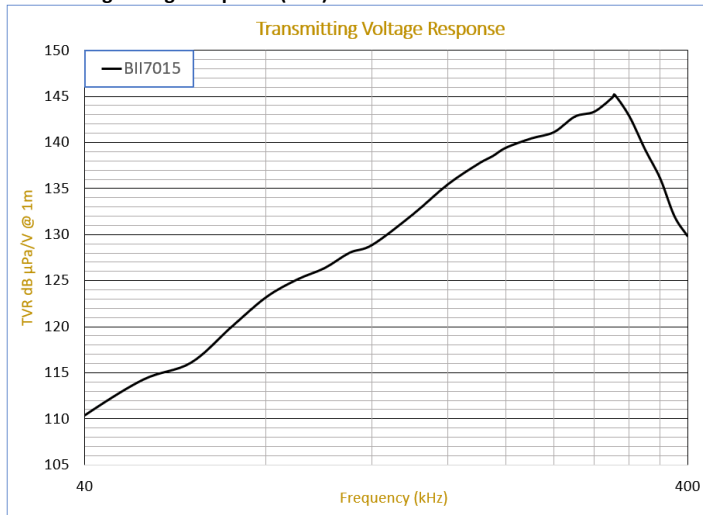


6. More Mounting/Installation Options: Please refer to online document [AcousticSystem.pdf](#) for a complete list of Mounting Options and details.

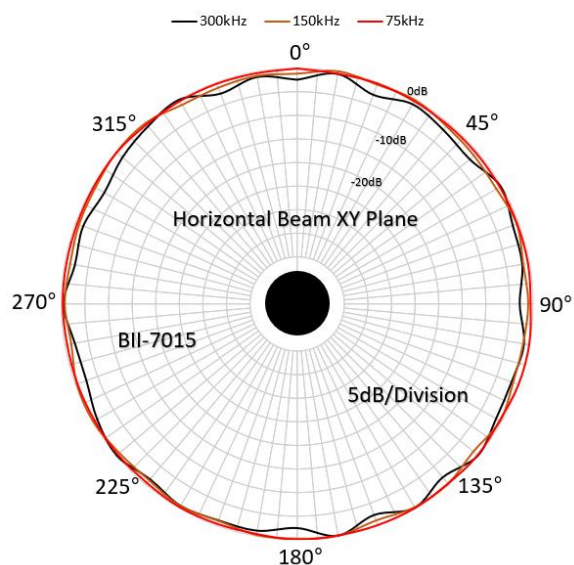
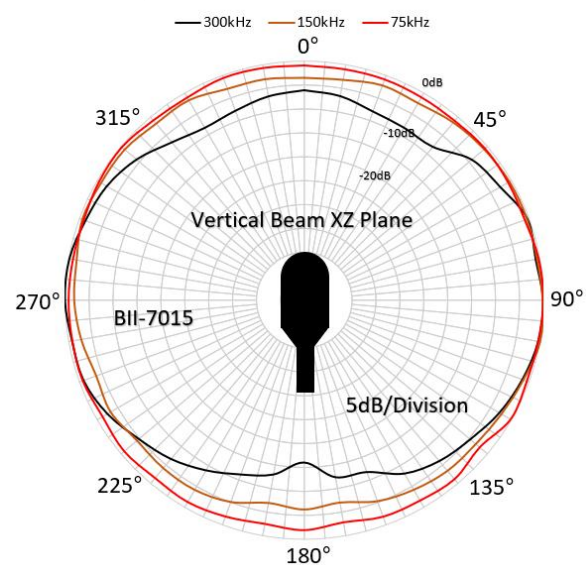
Free-field Voltage Sensitivity (FFVS):



Transmitting Voltage Response (TVR):



Directional Response Pattern:



Simple Array Consisting of 2 or 3 Hydrophones.

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

Cardioid Pattern= Pressure Hydrophone + Dipole.

