



### 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, biologics, ...

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. Parabolic Antennas Underwater. Reference Hydrophone, Noise Measurement. Signal detection in strong currents.	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. Studies of Ocean Turbulence and Flow, Marine Hydrodynamics.
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### Specification

<b>The hydrophone is tested in water unless stated otherwise.</b>	
<b>Part Number:</b>	<b>BII7014</b>
<b>Sensitivity @ 1kHz:</b>	-213.0 dB V/μPa ± 2 dB Sensitivity Loss over Extension Cable (dB) = 20*log[C <sub>h</sub> /(C <sub>h</sub> +C <sub>c</sub> )]. Valid for hydrophone without preamplifier. C <sub>h</sub> : Hydrophone Capacitance; C <sub>c</sub> : Capacitance of Extension Cable. Cable is of 100 pF/meter roughly.
<b>FFVS:</b>	Free-field Voltage Sensitivity, Refer to Graph of <a href="#">FFVS vs. Frequency</a> .
<b>Usable Frequency: in Water, at ±3 dB V/μPa.</b>	1 Hz ~ 300 kHz C <sub>h</sub> and R <sub>i</sub> constitute a high pass filter. -3dB high pass filter f <sub>-3dB</sub> = 1/(2πR <sub>i</sub> C <sub>h</sub> ). R <sub>i</sub> : Input Resistance or Impedance of Preamp. C <sub>h</sub> : Capacitance of hydrophone at 1 kHz. For example: A BII7014 and a <a href="#">BII preamp</a> of R <sub>i</sub> = 100 MΩ are used to detect sounds, -3dB high pass frequency of detection = 0.63 Hz.
<b>Usable Frequency in Air:</b>	1 Hz ~ 12 kHz at -3dB V/μPa.
<b>Capacitance C<sub>h</sub> @ 1kHz:</b>	2.53 nF ± 10%
<b>Dissipation @ 1kHz:</b>	0.005
<b>Noise Density at f &lt;&lt; fs: dB μPa/√Hz</b>	38.6 – 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.
<b>Directivity Pattern:</b>	Omnidirectional and Toroidal. Refer to Graph of <a href="#">Directivity Pattern</a> .
<b>-3dB Beam Width:</b>	Refer to Graph of <a href="#">Directivity Pattern</a> .
<b>Side Lobe Level:</b>	No side lobes.
<b>Signal Output Type:</b>	Single Ended
<b>Acceleration Sensitivity:</b>	116.7 dBμPa/(m/s <sup>2</sup> ) at Acoustic Axis; ≤ 115 dBμPa/(m/s <sup>2</sup> ) at other directions.
<b>Underwater Projector:</b>	Yes.
<b>Resonance fs:</b>	190 kHz
<b>TVR at fs:</b>	144.6 dB μPa/V at 1m. Approximately, TVR drops 12dB/octave below fs and drops 6dB/octave above fs.
<b>Maximum Drive Voltage:</b>	250 Vpp
<b>Maximum Pulse Length:</b>	100 mS at Maximum Drive Voltage
<b>Duty Cycle:</b>	10% at Maximum Drive Voltage. 100% at ≤ 30 Vpp or 10.6 Vrms.
<b>Operating Depth:</b>	Maximum: 300 m or 3 MPa pressure and limited by the cable length if the cable has wire leads or a non-waterproof connector.
<b>Mounting Options:</b>	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-7/16"). 4. Thru-hole Inch Mounting with Double O-ring Sealing (THDO-7/16"). 5. Bolt Fastening Mounting (Plastics) (BFMP-M12).

	6. Bolt Fastening Mounting (Plastics) ( <b>BFMP-NPT3/8"</b> ). 7. Bolt Fastening Mounting (Stainless Steel) ( <b>BFM-7/16"</b> ). Please refer to online document <a href="#">AcousticSystem.pdf</a> for a complete list of Mounting Options and more details.
<b>Cable Options:</b>	1. <b>Default:</b> Coax RG174/U, $\Phi D=2.8$ mm ( <b>RG174</b> ). 2. Coax RG178/U, $\Phi D=1.8$ mm ( <b>RG178</b> ) up to 200°C.
Cable Length:	1. Default: 6 m. 2. Custom-fit Cable Length.
<b>Connector:</b>	1. Default: Wire Leads ( <b>WL</b> ) 2. Male BNC ( <b>BNC</b> ), Max. Diameter $\Phi 14.3$ mm, for SE ONLY. <b>BNC with RG178 Coax: Service Temperature up to 165°C or 329°F.</b> 3. 1/8" (3.5mm) TRS Plug ( <b>TRS</b> ), Max. Diameter $\Phi 10.5$ mm, for SE or DF. 4. XLR Receptacle with 3 Male Pins ( <b>XLR3</b> ), Max. Diameter $\Phi 20.2$ mm, for SE or DF. 5. Underwater Mateable Connector (3 pin) ( <b>UMC3P</b> ), Max. Diameter $\Phi 21.5$ to $\Phi 35$ mm. <b>UMC3P</b> is from global manufacturers of underwater connectors. Its part number is listed in quote in detail. <b>Underwater Mateable Connectors are for underwater uses. Other connectors/wire leads are for dry uses and are not waterproofed.</b>
Size:	Free Hanging: $\Phi D = \Phi 9.4$ mm, Length = 28 mm. Other Mounting Types: Actual length depends on Mounting Parts.
Weight:	85 grams with 6 m Coax/BNC Male. Actual weight depends on Mounting Parts, Cable Types and Length.
Operation Temperature:	1. Default: -10°C to +60°C or 14°F to 140°F. 2. Bespoke: -10°C to 120°C, or 14°F to 248°F. Append <b>-HT</b> to part number. <b>Maximum Operating Depth at 120°C or 248°F: 100 m.</b>
Storage Temperature:	-20°C to +60°C or -4°F to 140°F.
<b>Underwater Projector Application:</b> for 50Q 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.	
<b>Do NOT use the hydrophone as a sound projector in the air otherwise the hydrophone will be damaged.</b>	
<b>Sound Measurement in Air:</b> 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
BII7014	<a href="#">FH</a> : Free Hanging. <a href="#">BFMP-3/8"NPT</a> : Bolt-fastening Mounting.	6 m (19.7ft)	<b>RG174</b> Coax	BNC
<b>Example:</b>	<b>Description</b>			
BII7014-FH-6m-RG174-BNC	BII7014 Hydrophone, Free Hanging, 6m RG174 Coax, BNC Male.			
BII7014-BFMP-NPT3/8"-6m-RG174-BNC	BII7014 Hydrophone, Bolt-fastening Mounting: BFMP-NPT3/8", 6m RG174 Coax, BNC Male.			

**How to Order Bespoke Hydrophones.** Non-stock.

Hydrophone Part Number	-Mounting Part	-Cable Length	-Cable Type	-Connector Type
BII7014	Mounting Options.	in meter.	Cable Options.	Connector Options.
<b>Example:</b>	<b>Description</b>			
BII7014-THM-7/16"-0.3m-RG174-WL	BII7014 Hydrophone, Thru-hole Mounting: THM-7/16", 0.3m RG174 Coax, Wire Leads.			
BII7014-HT-FH-6m-RG178-BNC	BII7014 Hydrophone, Service Temperature: -10 °C to 120 °C (14 °F to 248 °F). Free Hanging, 6m RG178 Coax, BNC Male.			

**Wirings**

Single Ended Output:	Underwater Connector UMC3P	BNC/SMA/SMC	Coax with Wire Leads	TRS Unbalanced mono
<b>Signal</b>	Pin 2	Center Contact	Coax Center Contact	Tip
<b>Signal Common</b>	Pin 1	Shield	Coax Shield	Ring & Sleeve
<b>Shielding</b>	Pin 3	Shield	Coax Shield	Ring & Sleeve

**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 50Q impedance matching among transducers, cables, and analyzers/digitizers.

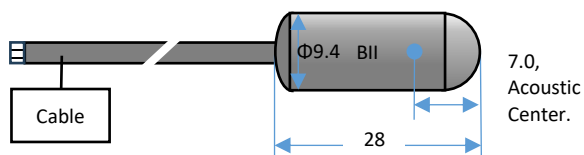
**My acoustic sensors generate differential signals in MHz range, are TRS connectors suitable for my applications?** BII's test shows TRS connectors (Plug and Jack) of BII preamps can be used up to 20 MHz. Test Conditions: TRS Jack with 0.2m cable and TRS plug with 1m cable. Oscilloscope: 1M $\Omega$  || 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 M $\Omega$  to hundreds M $\Omega$  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 M $\Omega$  to avoid bumping into saturation issue.

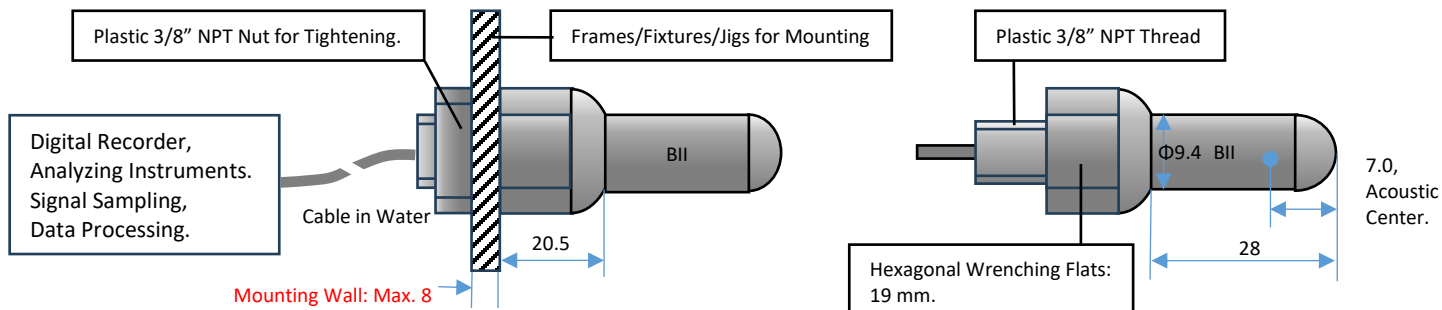
**Physical Size (Dimensional Unit: mm, Illustration ONLY, Scale is NOT 1:1):** The overall length varies with the length of the mounting part.

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

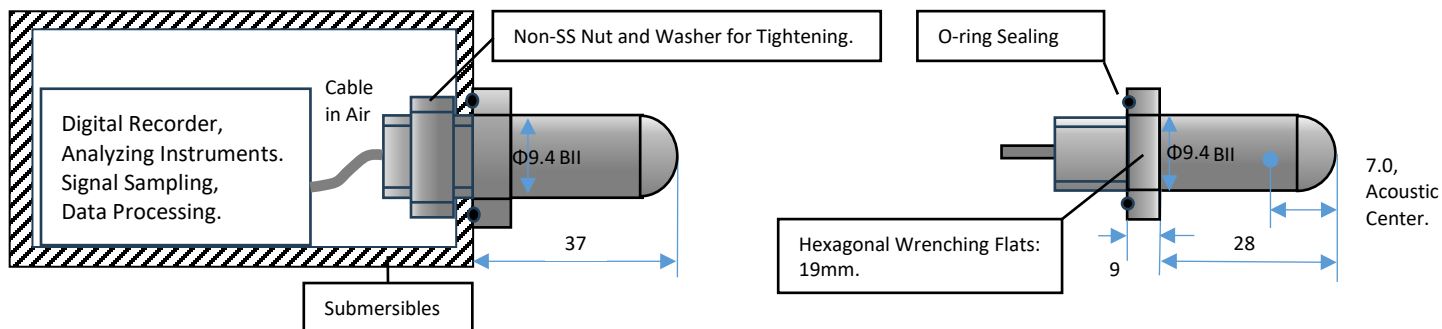


The hydrophone body has streamlined hemispherical domes which minimize the drag forces and the hydrodynamic noise caused by the hydrophone in motion or the flow past the hydrophone.

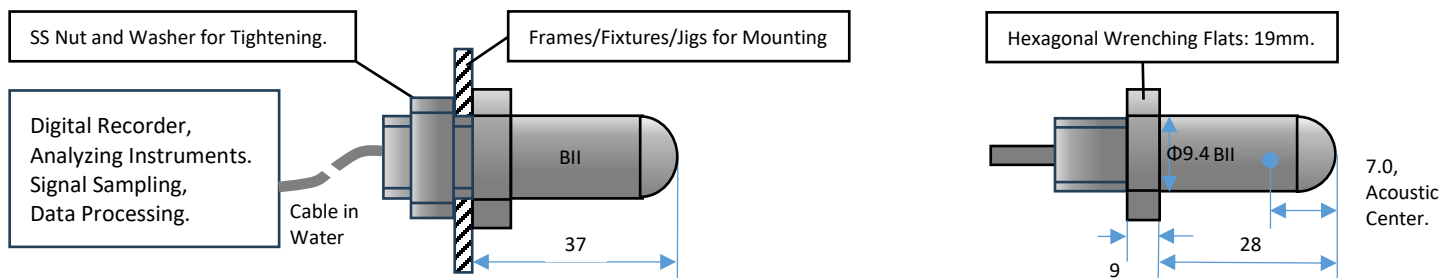
**2. Bolt-Fastening Mounting BFM-NPT3/8", 3/8" NPT Thread Length: 15mm. Nut Height: 5mm.**



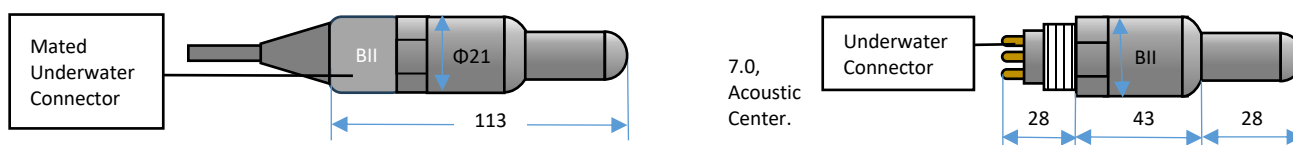
**3. Thru-hole Mounting (Inch Thread) with Single O-ring Sealing THM-7/16" (7/16"-20x22 UNF-2A).**



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



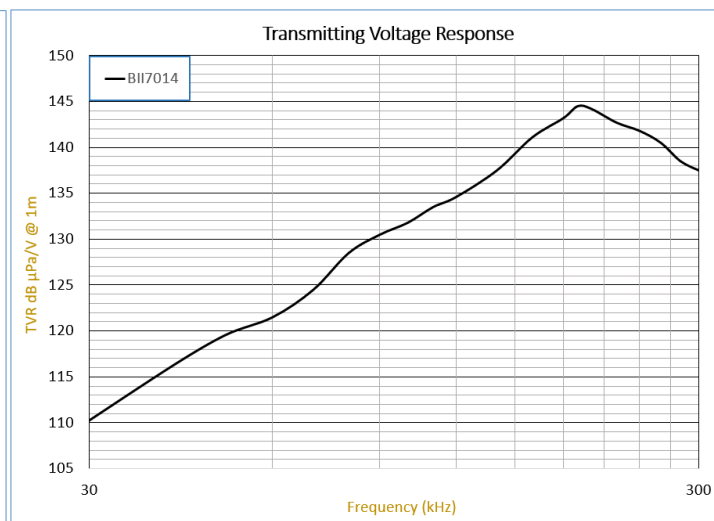
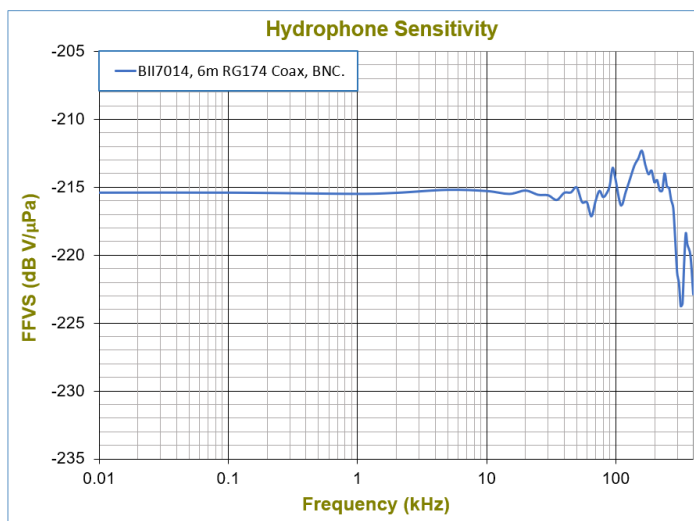
**5. Free-hanging with Underwater Connector (FHUWC-3P), 3 Pins.**



**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):**



**Directivity Pattern**

