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 0.02Hz 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.	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.
Signal detection in strong currents.	Studies of Ocean Turbulence and Flow, Marine Hydrodynamics.

Specification

The hydrophone is tested in water unless stated otherwise.	
Part Number:	BII7015
Sensitivity @ 1kHz:	-215.0 ± 2 dB V/µPa at 1 kHz.
	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 ~ 500 kHz at ±4 dB V/µPa.
	Minimum Usable Frequency depends on -3dB high pass filter $f_{-3dB} = 1/(2\pi R_i C_h)$. R_i: Input Resistance or Impedance of Preamp. C_h: Capacitance of hydrophone at 1 kHz.
Usable Frequency:	**In Water**: 1 Hz ~ 500 kHz at ±3 dB V/µPa.
	In Air: 1 Hz ~ 15 kHz at -3 dB V/µPa.
	Minimum Usable Frequency depends on -3dB high pass filter $f_{-3dB} = 1/(2\pi R_i C_h)$. R_i: Input Resistance or Impedance of Preamp. C_h: Capacitance of hydrophone at 1 kHz. when a BII7011 and a BII preamp of R_i = 200 MΩ are used to detect sounds, -3dB high pass frequency of detection = 0.59 Hz.
Capacitance C_h @ 1kHz:	1.35 nF ± 10%
Dissipation @ 1kHz:	0.005
Noise Density at f << fs: dB µPa/√Hz	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.**
Side Lobe Level:	No side lobes.
Signal Output Type:	Single Ended
Acceleration Sensitivity:	120.7 dBµPa/(m/s²) at Acoustic Axis.
	≤ 118 dBµPa/(m/s²) at other directions.
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:	1. Default: Free Hanging (**FH**) 2. Free-hanging with Male Underwater Connector (**FHUWC**)

	3. Thru-hole Mounting with Single O-ring (**THSO**) 4. Thru-hole Mounting with Double O-ring (**THDO**) 5. Bolt Fastening Mounting (Plastics) (**BFMP**) 6. Bolt Fastening Mounting (Stainless Steel) (**BFMSS**) 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**) (for Single Ended Output ONLY) 2. Coax RG178/U (**RG178**) (for Single Ended Output ONLY), up to 200°C. 3. Coax RG58/U (**RG58**) (for Single Ended Output ONLY)
Cable Length:	1. Default: 6 m. 2. Custom-fit Cable Length.
Connector:	1. Default: Wire Leads (WL) 2. Male BNC (BNC) 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. 1/8" (3.5mm) TRS Plug (TRS35) 6. XLR (pin) (XLR) 7. MIL-5015 Style (pin) (5015) 8. Underwater Mateable Connector (pin) (UMC)
	Underwater Mateable Connector is for uses underwater. Other connectors and wire leads are for dry uses and are not waterproofed.
Size:	**Free Hanging**: ΦD = Φ7.4 mm, Length = 28 mm.
	Other Mounting Types: Actual length depends on Mounting Parts.
Weight:	82 grams with 6m 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 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.

Wiring of Single Ended Output:	**Wire Leads**	**Underwater Connector**	**BNC/SMA/SMC**	**Coax with Wire Leads**	**TRS Unbalanced mono**
Signal	White or Red	Pin 2	Center Contact	Coax Center Contact	Tip
Signal Common	Black	Pin 1	Shield	Coax Shield	Ring & Sleeve
Shielding	Shield	Pin 3	Shield	Coax Shield	Ring & Sleeve

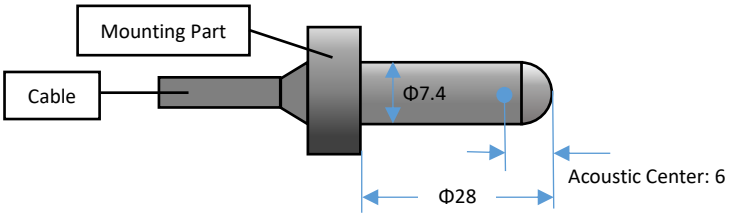
for 50Ω BNC Male connector, it is buyer's sole responsibility to make sure that the (female) BNC shield of the signal source is firmly grounded for operating safety before hooking up transducer/hydrophone to the signal source. Coax with BNC is not intended for hand-held use at voltages above 30Vac/60Vdc.

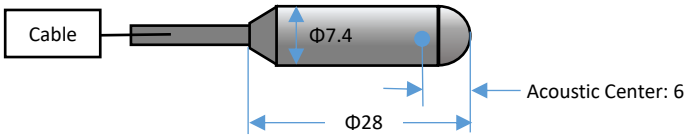
Sound Measurement in Air: The hydrophones can be used to detect sounds in air. Receiving sensitivity in air is same to the one in water in low frequency range.

How to Order Hydrophones

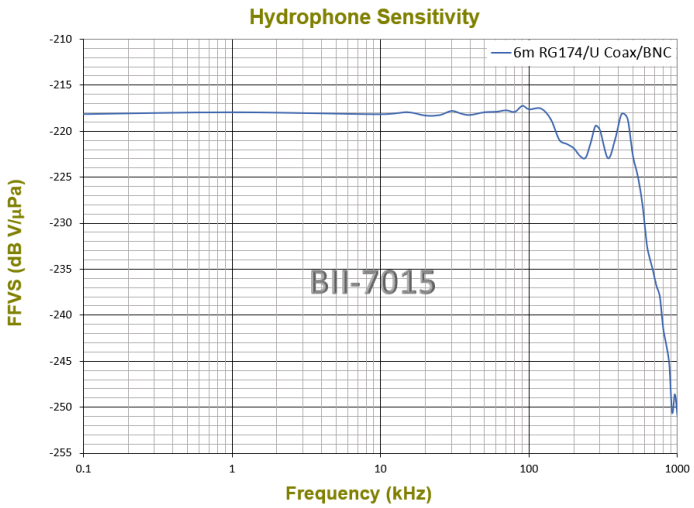
Part Number	**-Mounting Part**	**-Cable Length in Meter**	**-Cable Type**	**-Connector Type**
Example:	Description			
BII7015-FH-6m-RG174-BNC	BII7015 Hydrophone, Free Hanging, 6m RG174 Coax, Male BNC.			
BII7015-HT-FH-6m-RG178-SMC	BII7015 Hydrophone, Service Temperature: -10 °C to 120 °C, or 14 °F to 248 °F. Free Hanging, 6m RG178 Coax, SMC (Plug, Female Socket).			

Physical Size (Dimensional Unit: mm): Actual length depends on Mounting Parts. **Free Hanging**

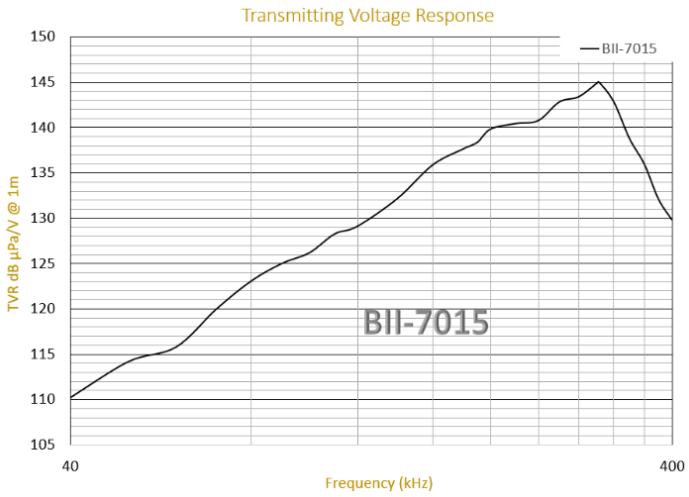




Free-field Voltage Sensitivity (FFVS):



Transmitting Voltage Response (TVR):



Directional Response Pattern: