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. 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.

Specification

The hydrophone is tested in water unless stated otherwise.		
Part Number:	BII7013	BII7013DF
Sensitivity FFVS at 1 kHz:	-207.5 dB V/μPa ± 2dB	-200.0 dB V/μPa ± 2dB
	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.	
Free-field Voltage Sensitivity:	Refer to Graph of **FFVS vs. Frequency**.	
Usable Frequency in Water:	0.1Hz ~ 160kHz at ±3dB V/μPa.	1Hz ~ 140kHz at ±3dB 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 Air:	1Hz ~ 9kHz at -3dB V/μPa.	
Capacitance C_h at 1 kHz:	6.6 nF ± 10%	1.8 nF ± 10%
Dissipation D at 1 kHz:	0.005	0.015
Noise Density at f << fs: dB μPa/√Hz	35.2 – 10*log f	33.0 – 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 **Beam Pattern.**	
-3dB Beam Width:	Refer to Graph of **Beam Pattern.**	
Side Lobe Level:	No side lobes	
Signal Output Type:	Single Ended	Differential Output
Acceleration Sensitivity:	112.5 dB μPa/(m/s²)	106.4 dB μPa/(m/s²)
Underwater Projector:	Yes.	No
Resonance fs:	110 kHz	N/A
TVR at fs:	144 dB μPa/V at 1m.	N/A
	Approximately, TVR drops 12dB/octave below fs and drops 6dB/octave above fs.	
Maximum Drive Voltage:	250 Vpp	N/A
Maximum Pulse Length:	100 mS at Maximum Drive Voltage	N/A
Duty Cycle in Water:	10% at Maximum Drive Voltage; 100% at ≤ 30 Vpp or 10.6 Vrms.	N/A
Maximum Operating Depth:	500 m, Maximum.	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**) 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) 4. Shielded Cable with Polyurethane Jacket, ΦD=2.6 mm (**SC26**) 5. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, ΦD=3.2 mm (**SC32**), up to 200°C. Not water-proof. 6. Shielded Cable with Twisted Pair and Polyurethane Jacket, ΦD=4.7 mm (**SC47**) 7. **Default**: Shielded Cable with Twisted Pair and PVC Jacket, ΦD=6.0 mm (**SC60**) (for Differential Output ONLY) 8. Shielded Cable with Rubber Jacket, ΦD=6.5 mm (**SC65**)
	Differential (balanced) output with shielded Twisted Pair Cable is recommended to reject Electromagnetic Interference (EMI) over long cable.
Cable Length:	1. Default: 6 m. 2. Custom-fit Cable Length.
Connector:	**SE**: Single ended Output, **DF**: Differential Output. 1. Default: Wire Leads (**WL**) 2. Male BNC (**BNC**), Max. Diameter Φ14.3 mm, for SE ONLY. 3. SMA (Plug, Male Pin) (**SMA**), Voltage Rating: 335 V_{RMS} Continuous. Max. Diameter Φ9.24 mm, for SE ONLY. 4. SMC (Plug, Female Socket) (**SMC**), Voltage Rating: 250 V_{RMS} Continuous. Max. Diameter Φ6.4 mm, for SE ONLY. SMA with RG178 Coax. Service Temperature: up to 155°C or 311°F. 5. 1/8" (3.5mm) TRS Plug (**TRS**), Max. Diameter Φ10.5 mm, for SE or DF. 6. XLR (pin) (**XLR**), Max. Diameter Φ20.2 mm, for SE or DF. 7. MIL-5015 Style (pin) (**MIL**), Max. Diameter Φ30 mm with 3 contacts, for SE or DF. 8. Underwater Mateable Connector (pin) (**UMC**), Max. Diameter Φ21.5 to Φ35 mm, for SE or DF. Note: Underwater Mateable Connector is for uses underwater. Other connectors and wire leads are for dry uses and are not waterproofed.
Size:	ΦD = Φ21.3 mm, Length ≥ 50.8 mm and actual length depends on Mounting Parts.
Weight:	85 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 Transducer: -10 °C to 120 °C, or 14 °F to 248 °F. Append HT to part number. Depth Rating at 120 °C, or 248 °F: 100 m.
Storage Temperature:	-20 °C to +60 °C or -4 °F to 140 °F.

Wiring of Differential Output:	**Wire Leads**	**Underwater Connector**	**TRS Plug (Balanced Mono)**	**XLR Plug (Balanced Audio)**
Signal +	White or Red	Pin 2	Tip, Positive/Hot	Pin 2, Positive/Hot.
Signal -	Black	Pin 1	Ring, Negative/Cold	Pin 3, Negative/Cold.
Common & Shielding	Shield	Pin 3	Sleeve, Ground/Common	Pin 1, Cable Shield/Chassis Ground.

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

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 Hydrophones

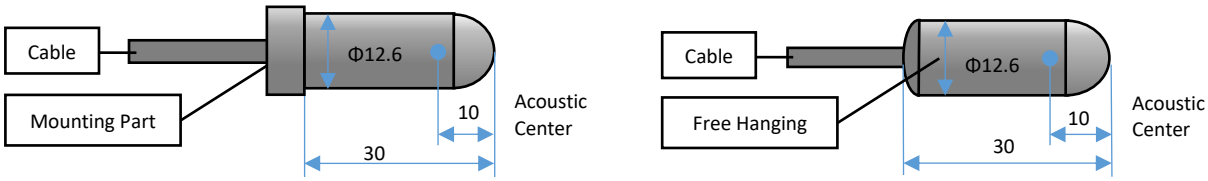
Part Number	**-Mounting Part**	**-Cable Length in Meter**	**-Cable Type**	**-Connector Type**
Example:	Description			
BII7013-FH-6m-RG174-BNC	BII7013 Hydrophone, Free Hanging, 6m RG174 Coax, Male BNC.			
BII7013-HT-FH-6m-RG178-SMC	BII7013 Hydrophone, Service Temperature: -10 °C to 120 °C, or 14 °F to 248 °F. Free Hanging, 6m RG178 Coax, SMC (Plug, Female Socket).			
BII7013DF-FH-10m-SC60-XLR	BII7013DF Hydrophone, Free Hanging, 10m Shielded Cable with Twisted Pair **SC60**, 3-pin XLR Plug.			
BII7013DF-FH-3m-SC60-UMC	BII7013DF Hydrophone, Free Hanging, 3m Shielded Cable with Twisted Pair **SC60**, 3-pin Underwater Mateable Connector.			

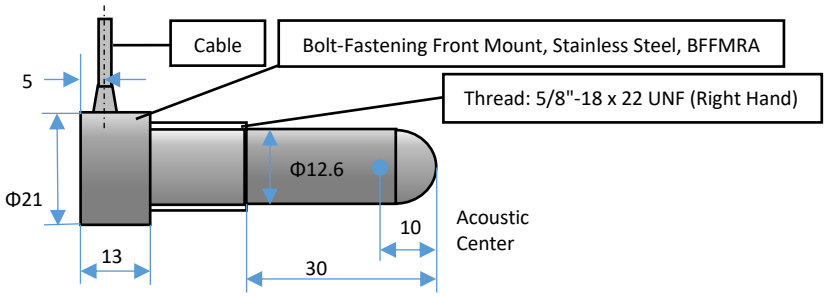
Question:

What if the mating connector of my DAQ module or recording device is NOT available from BII?

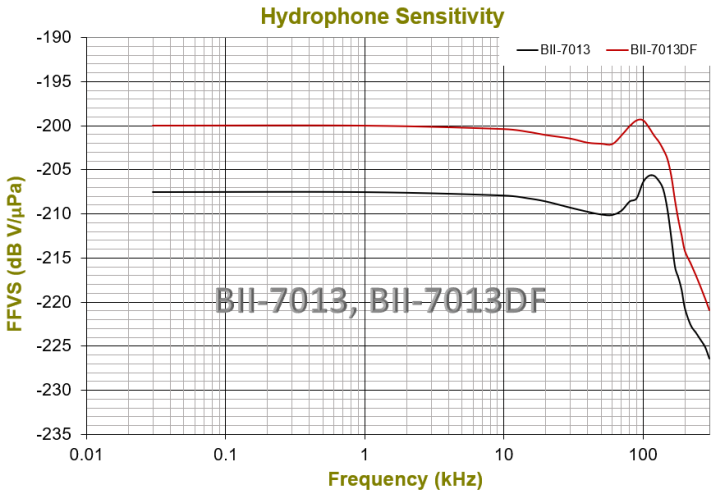
1. Buyer may order BII products with wire leads, and buyer assembles the mating connector to the cable end.
2. A connector adaptor might be assembled by BII by customization, and BII ships the adaptor to buyer as accessory of the device. Please contact BII for customizations.
3. Many adaptors for standard connectors are available in worldwide electronic suppliers such as BNC to SMA, BNC to SMC, XLR to TRS, etc. Check out your local suppliers.

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

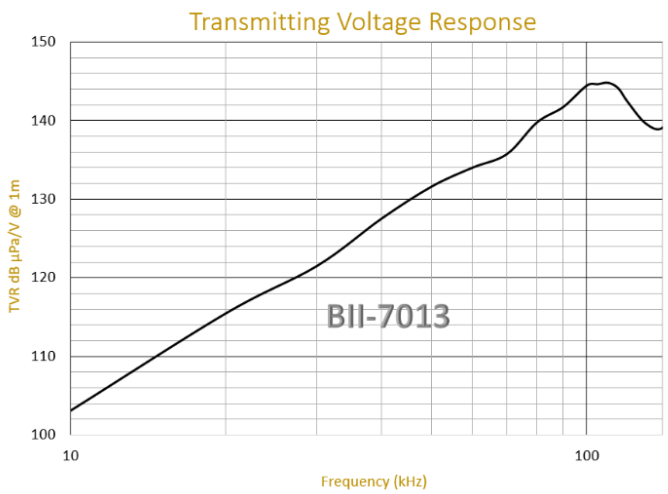




Free-field Voltage Sensitivity (FFVS):



Transmitting Voltage Response (TVR):



Directivity Pattern: