Communication & Miniature Transducer: Toroidal Beam

Low-Qm BII7510 series are broadband high power communication transducers with toroidal directivity pattern for uses in voice and message channels underwater especially in the horizontal plane, which is designed for analog and digital communication underwater. Sounds with carrier frequencies 3 to 360 kHz and sound levels up to 190 dB µPa support long range and short range communication underwater. The information can be exchanged over 10km away with low frequency sounds.
Medium-Qm BII7510 series are miniature transducers with toroidal directivity pattern for uses in underwater communication especially in the horizontal plane, and in material study and medical research as ultrasonic sources and sensors. Frequencies of 60 to 400 kHz and sound levels of 180 to 190 dB µPa support short to long range sound propagation in water, liquids, rubber-like material, and solids. Their miniature sizes make them be suitable to be embedded in materials.
Low Frequency Low Noise Receiver LNR is an add-on built-in programmable-sensitivity hydrophone of 1Hz to 60kHz, which is optimized to possess self noise levels below sea-state zero with omnidirectional response in low frequency range and toroidal response in high frequency range. Its streamlined hemispherical dome minimizes drag force and hydrodynamic noise.
Available Customization on LNR: 1. Low power consumption: around 1mA quiescent current at 5/9/12VDC for battery powered underwater instrumentation. 2. Fixed FFVS (Sensitivity) LNR with Fixed gain preamp. 3. Directivity Pattern: Omnidirectional with Spherical LNR, or Conical with Planar LNR.

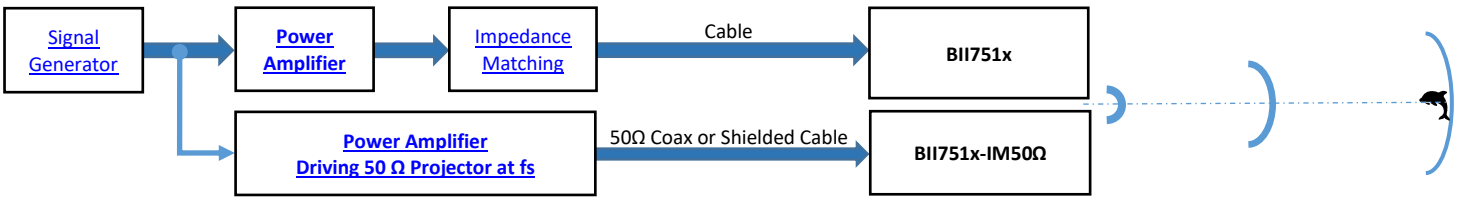
Low Frequency Sounds in the Ocean at 1 Hz to 1 kHz. Low Frequency Sounds between 1Hz to 1kHz undergo little attenuation in ocean and lakes: 1.2×10^{-7} at 1Hz, 0.0002 at 10Hz, 0.0015 at 100Hz, 0.07 at 1kHz, in dB/km, proximately. The major propagation losses are Spreading Loss, Absorption and Scattering 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.

Modulations: Pulsed FSK, Chirp-type FSK, Frequency Hopping, DSSS, PSK, CDMA/DSSS.

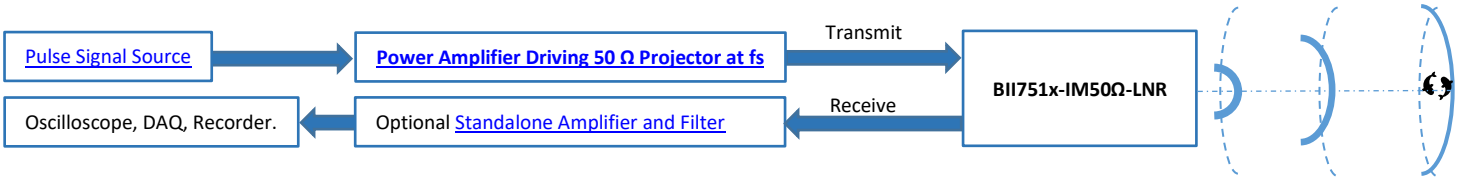
Typical Applications

Remote Control and Telemetry	Underwater Acoustic Network, Acoustic Elements for Arrays
Artificial Acoustic Target, Echo-Repeater	Diver Communication, Underwater Telephone
Acoustic Deterrent to Marine Animals	Pinger/Tag/Locator/Transponder/Beacon/Acoustic Release
Playback Marine Animal Voices/Calls/Whistles/Songs/Clicks	Marine Animal Behavior Research, Bioacoustic Stimuli
Material Study and Medical Research	Hydrophones, AE Sensors, Ultrasonic Sources

SYSTEM CONFIGURATION (Simplified Flow Charts: Control Signals, DC Power Supplies, etc. are NOT shown.)
(a) Generation of Underwater or Ultrasonic Sounds with BII751x and BII751x-IM50Ω.



(b) Transmitting and Receiving Underwater Sounds with BII751x-IM50Ω-LNR:



RELATED PRODUCTS

Power Amplifier for SONAR, NDT, and HIFU	Impedance Matching between Transducers and Amplifiers	Low Noise Low Power Preamplifiers

Specification

Transducers are tested in water at 20°C unless stated otherwise.

FG: Fixed Gain; **PG**: Programmable Gain; **DF**: Differential Output; **SE**: Single Ended Output; **BPF**: Band Pass Filter; **HPF**: High Pass Filter; **LPF**: Low Pass Filter.

f_s: Resonant Frequency; **IM**: Impedance Matching; **η_{ea}**: Electroacoustic Efficiency; **PF**: Power Factor; **TVR**: Transmitting Voltage Response; **SL**: Sound Level; **FFVS**: Free-field Voltage Response, Receiving Voltage Response (**RVR**), or Voltage Sensitivity; **DRP**: Directional Response Pattern; **HxV:** Horizontal x Vertical Beam Angles. **SLL**: Sidelobe Level; **SRD:** Sound Ranging Distance along Axis of Main Lobe; **Z**: Complex Impedance; **|Z|**: Impedance Amplitude; **θ**: Impedance Phase; **Y**: Admittance; **G**: Conductance of Admittance; **B**: Susceptance of Admittance; **Q_m**: Mechanical Quality Factor; **Q_e**: Electrical Quality Factor; **MIPP**: Maximum Input Pulse Power; **MPW**: Maximum Pulse Width at MIPP and at fs; **MCIP**: Maximum Continuous Input Power. **TR:** Transmit and Receive; **TRSW**: Transmit and Receive Switch with built-in low noise preamp and bandpass filter. **BW**: -3dB Bandwidth or Beamwidth; **PND**: Pressure Noise Density, **LNR**: Low Noise Receiver, **SC**: Signal Conditioning, **OPL**: Overload Pressure Level.

Transducer:	**BII7511**	**BII7511-IM50Ω**	**BII7511-IM50Ω-LNR**
Applications:	Emit & Receive Sounds	Emit Sounds	Emit & Receive Sounds
Communication:	Half-duplex or Semiduplex	Half-duplex or Semiduplex	Full-duplex and Half-duplex.
SRD:	Sound Ranging Distance: Pulse-Echo or Echo Sounding Ranging: refer to Echosounding Ranging vs Target Strength in Ocean.		
IM for Emit:	No Impedance Matching	Impedance matching to 50Ω	Impedance matching to 50Ω
SC for Receive:	Available as standalone.	Available as standalone.	Built-in PGA or Fixed Preamp and Filters.
Built-in LNR:	No	No	Built-in Low Noise Receiver
	LNR: Includes a low-noise high-sensitivity receiver separated from the transmitting element.		
f_s:	40 kHz ± 10%		
Operating Depth:	≤ 400 m or 4 MPa Pressure.	≤300 m or 3 MPa Pressure.	≤300 m or 3 MPa Pressure.
	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-7/16", or THM-5/8".)** 3. Thru-hole Mounting with Double O-ring (**THDO-7/16"**) 4. Bolt Fastening Mounting (Stainless Steel) (**BFM-7/16", or BFM-5/8".**) 5. Bolt-Fastening Mounting with Free Hanging (**BFM-FH-1/4", BFM-FH-3/8".)** 6. Free-hanging with Male Underwater Connector (**FHUWC-2P, FHUWC-3P, FHUWC-4P, FHUWC-6P.**) 7. End-face Mounting (**EFMS.**)		
	Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.		
Cable Options:	**Transmit Signals:** 1. Shielded Cable (**SC**), Rubber Jacket. Two Conductors (AWG20, 600V, 4A.). 2. Unshielded Cable (**USC),** Rubber Jacket. Two Conductors (AWG18, 600V, 10A.). 3. 50 Ω RG58 Coax (**RG58**). 4. 50 Ω RG174/U Coax (**RG174**). 5. 50 Ω Coax RG316/U (**RG316**) (Operating Temperature Range: -50°C To +200°C or -58°F to 392°F). 6. 50 Ω RG178/U Coax (**RG178**) (Operating Temperature Range: -70°C To +200°C or -94°F to 392°F). 7. Shielded Cable, Twisted Pair, Teflon (PTFE) Jacket, ΦD=3.2 mm (**SC32**), up to 200°C, 600V, 0.8A, Not Water-proofed. 8. Shielded Cable, Twisted Pair, Teflon (PTFE) Jacket, ΦD=4.0 mm (**SC40**), up to 200°C, 600V, 4A, Not Water-proofed.		
	Receive Signals: ONLY for BII7511-IM50Ω-LNR. 1. **Programmable FFVS**: Shielded Cable (**SC**), Rubber or PVC Jacket. Six Conductors (AWG24 or AWG26/28), 2. **Programmable FFVS**: Cable Bundles (**CB**), Rubber or PVC Jacket. 4C SC (AWG24 or AWG26/28) + 2C SC (AWG24). 3. **Programmable FFVS**: Cable Bundles (**CB**), Rubber or PVC Jacket. 4C SC (AWG24 or AWG26/28) + RG58 or RG174 Coax.		
	Handling: Do not use the cable to support transducer weight in air and water if the transducer has a mounting part. Do not bend the cable.		
Connector Options:	**Transmit Signals:** 1. Default: Wire Leads (**WL**). 2. Underwater Mateable Connector (2 pins) (**UMC2P**) (Max. Diameter Φ35.5 mm). Locking Sleeve: DLSA-M. Underwater Mateable Connector (3 pins) (**UMC3P**) (Max. Diameter Φ35.5 mm). Locking Sleeve: DLSA-M. Underwater Mateable Connectors (**UMC**) is from well-known global manufacturers. Its part number is listed in quote in detail. 3. MIL-5015 Style (3 pin) (**MIL3P**) (Max. Diameter Φ19 to Φ30 mm). 4. XLR Receptacle with 3 Male Pins (**XLR3P**), (Max. Diameter Φ20.2 mm). 5. DIN Receptacle with 3 Male Pins (**DIN3P**), (Max. Diameter Φ17 mm). 6. Male BNC (**BNC**) (Max. Diameter Φ14.3 mm), for Transmit or Receive Grounded Signal. **BNC with RG178 or RG316 Coax**: Service Temperature up to 165°C or 329°F.		
	Receive Signals: ONLY for BII7511-IM50Ω-LNR. **Signal Connectors for Programmable FFVS**: (1). Default: Wire Leads (**WL**). (2). Underwater Mateable Connector (6 pins) (**UMC6P**) (Max. Diameter Φ22 mm). Locking Sleeve: MCDLS-F. (3). XLR Receptacle with 6 Male Pins (**XLR6P**), (Max. Diameter Φ20.2 mm). (4). DIN Receptacle with 6 Male Pins (**DIN6P**), (Max. Diameter Φ17 mm). (5). XLR Receptacle with 3 Male Pins (**XLR3P**) for Signals, (Max. Diameter Φ20.2 mm). (6). DIN Receptacle with 3 Male Pins (**DIN3P**), (Max. Diameter Φ17 mm). (7). 1/8" (3.5mm) TRS Plug (**TRS**) (Max. Diameter Φ10.5 mm). **Gain Selection (or FFVS Selection) Connectors for Programmable FFVS**: (1). Default: Wire Leads (**WL**). (2). Male BNC (**BNC**). (3). DIN Receptacle with 3 Male Pins (DIN3P), (Max. Diameter Φ17 mm). **Connectors for DC Power Supply**: (1). Wire Leads (**WL**) (2). +9VDC Battery Snap (**BS**). (3). 4mm Banana Plug Pair (Red and Black Color) (**BP**).		
	Note: 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. **XLR**: Employed for balanced audio and DC or AC power signal interconnections, 3 to 7 contacts. **Fastening Type: Latch Lock**.
3. **MIL**: MIL-5015 Style Connectors, interconnection solution for high power signals. –55°C to +125°C, **Fastening Type: Threaded. Dry Uses**.
4. **UMC**: Underwater Mateable Connectors, interconnection solution for high power or weak signals. **Fastening Type: Threaded. Underwater Uses**.
5. **DIN**: Electrical cylindrical connectors, 3 to 14 contacts, Φ20mm diameter, used for audio, RF, digital, and DC or AC power signals. **Fastening Type: Threaded**.
6. **3.5mm (1/8") TRS** stand for Tip, Ring, and Sleeve, miniature, quick connect/disconnect, audio frequency connector for shielded cable. **Fastening Type: None**.

Physical Size:	Free Hanging: Φ28.5 x 60 mm	Free Hanging: Φ48 x 150 mm.	Free Hanging: Φ48 x 850 mm.
	Actual length depends on Mounting Parts and/or Add-on Parts such as -TR, -IM, -HT, etc.		
Weight in Air:	≥ 0.95 kg with 15 m cable.	≥ 1.5 kg with 15 m cable.	≥ 2.0 kg with 2x15 m cable.
	Generally, cable weight: 1. **Transmit**: 41 g/m (RG58 Coax), 66 g/m (2C SC Cable), 78 g/m (2C USC Cable). 2. **Receive**: 70 g/m for 6C SC Cable, 38 g/m for 4C SC Cable.		
	Actual weight depends on Mounting Parts, Cable Types and Length, and/or Add-on Parts such as -TR, -IM, -HT, etc.		
Operation Temperature:	1. Default: -10 °C to +60 °C or 14 °F to 140 °F. 2. **BII7511 ONLY:** Bespoke Temperature -10 °C to 120 °C, or 14 °F to 248 °F. Append **-HT120** to part number.		
Storage Temperature:	-20 °C to +60 °C or -4 °F to 140 °F.		
IM at f_s:	1. Default 50Ω Impedance Matching: **-IM50Ω**. BIIxxxx-IM50Ω: BIIxxxx transducer with built-in Impedance Matching Network as 50Ω load at fs. 2. Bespoke BII6000 Impedance Matching between transducers and power amplifiers. Order Separately as standalone devices or append **-IMxxΩ** to the part number for integrating BII6000 into the transducer and specify impedance in Ω at fs. For example, BIIxxxx-IM5Ω: BIIxxxx transducer with built-in Impedance Matching Network as 5Ω load at fs.		
	Phase Angle |θ| of Complex Impedance ≤ 20° at fs.		
Amplifier:	BII5000 Power Amplifiers for SONAR, NDT, HIFU. Order Separately as standalone devices.		
WARNING: DANGER — HIGH VOLTAGE on wires. Wires shall be insulated for safety. DO NOT TOUCH THE WIRES BEFORE THE DRIVING SIGNAL IS SHUT DOWN. Cable shield must be grounded firmly for safety.			
for 50Ω BNC connector, it is buyer's sole responsibility to make sure that the 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.			

Transmitting Specs

Transmit Frequency:	f_s ± 20%*f_s	f_s ± 25%*f_s	f_s ± 25%*f_s
	Minimum: None.	**Sinusoidal Signals**: Minimum 8 kHz. **Square Signals**: Minimum 10 kHz.	
	Operating Frequency < Minimum Transmitting Frequency: transducer impedance is very low which causes over-current issue to power amplifier, and results in overheat issue (damage) to power amplifier and the transducer.		
Signal Type:	SONAR/Communication/Pulsing Signals: SINE Pulses, Bell-shaped Sine Pulses, Ricker Pulses, Chirp/FM Pulses, PSK/FSK, Burst Pulse Train.		
	Continuous Signals, Arbitrary Signals, Aquatic/Marine Animal Sounds, etc.		
DRP:	Refer to Graph of Directional Response Pattern. Toroidal Beam at fs; Omnidirectional at f ≤ 17 kHz.		
-3dB BW:	Horizontal x Vertical = Omnidirectional x 70° at fs.		
SLL:	**Side Lobe Level**: No side lobes.		
Q_m at f_s:	1.5	≤ 2	≤ 2
	-3dB bandwidth $\Delta f = f_s/Q_m$. **Quality Factor** Q_m determines the transient response or the rise and fall rings of steady-state response.		
η_{ea} at f_s:	0.86 in Water, Electroacoustic Efficiency.		
η_{ea} at f << f_s:	$\eta_{ea} / \eta_{ea\ at\ fs} \approx (k*\Phi D)^2$. Wave Number $k = 2\pi/\lambda$; ΦD = Diameter of Radiation Face = Φ28.5 mm.		
	1. Driving Transducer with Continuous Signals: (1). Electroacoustic Efficiency η_{ea} is quite low at f << f_s and drops gradually at f > f_s. It is NOT recommended to apply high voltage to transducers to emit high power sounds at frequencies far from f_s. Otherwise, transducer may be damaged by over-voltage and/or overheating. (2). Transducer can emit low power sounds at frequencies far from f_s. For example, input power $P_i \le \eta_{ea}$*MIPP at f ≤ 0.8*f_s and $P_i \le 0.2$*MIPP at f ≥ 1.3*f_s. **2. Driving Transducer with Pulsing Signals such as SINE Pulses:** Electroacoustic Efficiency η_{ea} is quite low at f << f_s and drops gradually at f > f_s, so it is recommended for transducers to emit high pulsing power sounds at frequencies far from f_s with **Pulsing Signals with Duty Cycle ≤ 10%, Pulse Length ≤ 10mS**. The applied voltage must be less than the rated safe voltage of the transducer. Otherwise, transducer will be damaged by overvoltage and/or overheating.		
PF at f_s:	0.2	≥ 0.94	≥ 0.94
TVR at f_s:	Refer to TVR Chart, Transmitting Voltage Response. Tolerance: ±2 dB.		
Radiation SL:	SL = 20*log V_D + TVR, dB µPa@1m. Driving Voltage V_D is in unit of V_{rms}.		
	Maximum SL = 188.0 ± 2 dB µPa@1m from 35 kHz to 50 kHz.		
Y or Z:	Refer to G-B Chart.	~~Refer to Z θ Chart.~~	~~Refer to Z θ Chart.~~
Driving Voltage V_D:	Max. $V_D = \sqrt{(MIPP/G_{max})}$ or **300**, whichever is less, in V_{rms}.	Max. $V_D = \sqrt{(MIPP * \|Z\|)}$, in V_{rms}. Max. V_D = 72.8 V_{rms} at Z = 50Ω. Z is impedance at fs.	Max. $V_D = \sqrt{(MIPP * \|Z\|)}$, in V_{rms}. Max. V_D = 72.8 Vrms at Z = 50Ω. Z is impedance at fs.
	To achieve higher sound level, built-in impedance matching is recommended to step up Driving voltage inside the transducer.		
Input Power P_i:	$P_i = V_D^2 * G$. G is conductance.	$P_i = V_D^2 / Z$ at f_s. Z is impedance at f_s.	$P_i = V_D^2 / Z$ at f_s. Z is impedance at f_s.
	Refer to G-B Graph.	~~Refer to Z θ Graph.~~	~~Refer to Z θ Graph.~~
MIPP at f_s:	Maximum Input Pulse Power at f_s: $P_i = V_D^2 * G_{max}$ or 91 Watts, whichever is less.		
MPW at MIPP and f_s:	100 Seconds, Maximum Pulse Width at MIPP, at f_s, and Duty Cycle D ≤ 50%.		
Cable Type:	1. Two Conductor Shielded Cable (**2C SC**). 2. Two Conductor Unshielded Cable (**2C USC**). 3. Coax.		
	Refer to Cable Options.		
Cable Orientation:	1. Default: Perpendicular to end face of the housing. 2. Customization: Perpendicular to side wall of the housing to reduce the overall length. Appending SW to the part number.		

Cable Length:	1. Default: (a) 15 m. (b) 0.6m with Underwater Mateable Connector (2 pins) (**UMC2P**) and (3 pins) (**UMC3P**). 2. Custom-fit.		
Connector:	2 or 3-contact Connectors: BNC, XLR, UMC, MIL-5015, etc.		
	Refer to Connector Options.		
Receiving Specs			
DRP:	Refer to Graph of Directional Response Pattern. Toroidal Beam at fs. Omnidirectional at f ≤ 17kHz.		
-3dB BW:	Horizontal x Vertical = Omnidirectional x 100° at fs.		
SLL:	**Side Lobe Level**: No side lobes.		
Capacitance C_f:	13.2 nF ± 10% @ 1 kHz	N/A	N/A
	For BII7511 ONLY: C_f increases if there is extension Cable, C_f ≈ Cable Length * 0.1nF/meter.		
Dissipation:	0.004 @ 1 kHz	N/A	N/A
FFVS:	Refer to Graph of FFVS vs. Frequency. Free-field Voltage Sensitivity.		
FFVS at f_s: ± 2 dB V/µPa.	-202.0 ± 2 dB V/µPa	-209 ± 2 dB V/µPa	-185.0 + Receive Gain
	For BII7511 ONLY: $Sensitivity\ Loss\ over\ extension\ cable\ at\ f_s\ (dB) = 20 * \log\{(1 + 2\pi f_s C_c/B)/\sqrt{[G^2 + (B + 2\pi f_s C_c)^2]/(G^2 + B^2)}\}$ **G**: Conductance at f_s; **B**: Susceptance at f_s; $\mathbf{C_c}$: Capacitance of Extension Cable. Cable is of 100 pF/meter roughly. **FFVS**: Free-field Voltage Sensitivity. Please refer to online document AcousticSystem.pdf for conversion between G-B and Z-θ, if necessary.		
FFVS at f << f_s: ± 2 dB V/µPa.	-200.0 ± 2 dB V/µPa.	Not Recommended.	-181.0 + Receive Gain
	For BII7511 ONLY: Sensitivity Loss over Extension Cable (dB) = 20*log[C_f/(C_f+C_c)]. C_f: Hydrophone Capacitance; C_c: Capacitance of Extension Cable. Cable is of 100 pF/meter roughly.		
Receiving SL:	SL = 20*logV_o - FFVS, dB µPa. Receiving Voltage V_o is in unit of V_{rms}.		
PND:	41.1 dB µPa/√Hz at fs.	29.0 dB µPa/√Hz at fs.	Refer to Pressure Noise Density.
	21.3 dB µPa/√Hz at 1 kHz.		
Filters:	Band Pass Filter	Band Pass Filter	Band Pass Filter
	1st order, 20 dB/Decade Roll-off.	2nd order, 40 dB/Decade Roll-off.	2nd order, 40 dB/Decade Roll-off.
	0.1 Hz to 1.5*f_s.	f_s ± 25%*f_s	1. Default: 10 Hz to 50 kHz. 2. Bespoke: 0.5 Hz to 50 kHz.
	A High Pass Filter is formed with C_f of transducers and R_i of Preamps. -3dB High Pass Frequency: $f_{-3dBH} = 1/(2\pi R_i C_f)$. R_i: Input Resistance or Impedance of Preamp. C_f: Capacitance of transducer at 1 kHz (non-resonance measurement) or fs (resonance measurement such as NDT pulsing system). For example: A transducer 10nF at 1kHz and preamp Ri 100MΩ constitute high pass filter with -3dB frequency at 0.159Hz.		
	1. **Reduce Noise**. Both ocean ambient noises and the self-noises of electronic devices decrease when frequency increases. It is recommended to choose a built-in high pass filter to reject noises in low frequency range. For example, if you are interested in the signals greater than 1 kHz, you may specify a high pass filter with -3dB cut-off frequency at 100 Hz to improve signal to noise ratio of the signals of the interest. 2. **Avoid Saturation**. When there are strong low frequency noises, disturbances, and/or vibrations, resulting from rough surface waves and/or mechanical movements of the platform, it is recommended to specify a high pass filter to avoid hydrophone saturation in these low frequency ranges.		
Receive Gain:	N/A	N/A	10/40 dB.
Gain Selection:	N/A	N/A	One-bit.
	Logic Low "0": 0 to +0.8 VDC from digital outputs, or Gain Selection Wire is short to Digital COM. Logic High "1": +2.4 VDC to +Vs from digital outputs, or Gain Selection Wire Opens. Vs: Power Supply Voltage.		
	Warning: Logic Voltage is greater than maximum voltage rating or less than -0.8V will damage the device.		
	Warning: digital outputs, switches, relays, optocouplers etc. can be used for gain selection and the voltage protection rating of these devices must be greater than power supply voltage level.		
Signal Conditioning:	Additional Signal Conditioning is available such as PGA/AGC/VGA preamps with filters, which compensate the loss of sound propagation and spreading up to 90dB dynamic range depending on specific configuration. Order separately.		
IDR:	**Input Dynamic Range**: ≥ 90 dB at 100 kHz Bandwidth.		
Output Type:	Single-ended	Single-ended	Differential
V_{omax} (Vpp):	N/A	N/A	Maximum Output $V_{omax} = V_s - 3.4$.
OPL (dB µPa):	Overload Pressure Level ≤ 220	Overload Pressure Level ≤ 220	20*log(V_{omax}/2.828) – Sensitivity. Refer to Overload Pressure Level.
Acceleration Sensitivity: dB µPa/(m/s²)	126.0 at Acoustic Axis.	133.0 at Acoustic Axis.	109.5 at Acoustic Axis.
	≤ 123.0 at other directions.	≤ 130.0 at other directions.	≤ 105.0 at other directions.
Output Z:	Z ≈ -j/(2*π*f*C_f)	Z = 50Ω ± 10% at fs.	20 Ω
Cable Drive Capability:	≤ 50 m.	50Ω Coax Cable.	Refer to Receive-Cable Length.
Cable Type:	Two C Shielded Cable or Coax.	50Ω Coax or Two C Shielded Cable.	6C Shielded Cable or Cable Bundles.
	Refer to Cable Options. Cable type being used is determined by frequency range and cable length.		
Cable Orientation:	1. Default: Perpendicular to end face of hydrophone. 2. Customization: Perpendicular to side wall of hydrophone (Generally, this is used to reduce the overall length of hydrophone). Appending SW to the part number.		
Cable Length:	1. Default: 15m (49.2ft) for Non-Underwater Connector; 0.6m (2ft) for Underwater Connectors.		
	2. Custom-fit Cable Length up to 305 m or 1000 ft.		
Connector:	2 or 3 contact Connector	2 or 3 contact Connector	3 and/or 6 contact Connector
	Refer to Connector Options.		
V_s:	N/A	N/A	Supply Voltage V_s: +9 to +32 VDC.

I_q:	N/A	N/A	18 mA
Suggested DC Supply:	+9VDC Battery, Marine Battery, Automobile Battery, Fixed DC Linear Power Supply, Not Included. DO NOT use variable power supply whose maximum supply voltage is higher than the above rated voltage. DO NOT use switching mode DC power supply.		

Transmit Wiring Information

Transducer Wiring:	**Shielded Cable**	**Coax, BNC.**	**UMC3P, Locking Sleeve: DLSA-M.**	**MIL3P**	**DIN3P**	**XLR3P**
Signal:	White or Red	Center Contact	Pin 2	Pin C or G	Pin 3	Pin 2
Signal Common:	Black	Shield	Pin 1	Pin B	Pin 1	Pin 3
Shielding and Grounding	Shield	Shield	Pin 3	Pin A	Pin 2	Pin 1
Please contact us for bespoke wirings of differential transducers such as dipole, quadrupole, multimode rings, and flextensional sources.						
Wiring of Unshielded Cable:	**Wire Leads WL**	**UMC2P** (0.6m USC Cable originally coming from manufacturer of the connector, Fixed.). Locking Sleeve: DLSA-M.				
Signal	White	Contact 2				
Signal Common	Black	Contact 1				

Receive Wiring Information of BII7511-IM50Ω-LNR.

Differential Output:	**Wire Leads**	**UMC6P/XLR6**	**DIN6**	**BNC + 9V BS**	**DIN3/XLR3 + 9V BS**		**TRS + 9V BS**
+VDC	Red	Pin 3	Pin 4	Battery Female Snap	Battery Female Snap		Battery Female Snap
Common	Black	Pin 1	Pin 1	Battery Male Snap, BNC Shield.	Battery Male Snap, DIN Pin 2 or XLR Pin 1.		Battery Male Snap, TRS Sleeve.
Output Signal+	White	Pin 2	Pin 3	"1" BNC Center Pin	DIN Pin 3	XLR Pin 2	TRS Tip
Output Signal -	Green	Pin 4	Pin 2	"2" BNC Center Pin	DIN Pin 1	XLR Pin 3	TRS Ring
Digital A0	Blue	Pin 6	Pin 5	Blue	Blue		Blue
Digital Common	Yellow or Brown	Pin 5	Pin 6	Yellow or Brown	Yellow or Brown		Yellow or Brown
Shielding	Shield	Metal Shell	Metal Shell	N/A	Metal Shell		N/A
Selecting Sensitivity of One-bit Digitally Programmable							
FFVS Selection Wire A0		**Hydrophone Sensitivity FFVS at 1kHz.**					
0 (Logic Low)		FFVS + 10 dB V/μPa					
1 (Logic High)		FFVS + 40 dB V/μPa					

How to Order Transducers BII7511 and BII7511-IM50Ω. The default options are for stock items which are regularly available.

FH: Free Hanging. **SC for Transmit**: Shielded Cable (Rubber Jacket, 600V) with 2 conductors. **Coax**: 50 Ω Coaxial Cable. **WL**: Wire Leads.				
Undewater Mateable Connector UMC2P is fixed with 0.6m unshielded cable.				
Part Number	**-Mounting**	**-Cable Length**	**-Cable Type**	**-Connector for signals of Transmit**
BII7511 BII7511-IM50Ω	Default: **BFM-FH**.	Default: **15m**.	**SC or Coax**	Default: **WL**.

Example:	**Description**
BII7511-BFM-FH-15m-SC-WL	**BII7511 Transducer, Bolt-Fastening Mounting with Free Hanging: BFM-FH, 15m Shielded Cable, Wire Leads.**
BII7511-BFM-5/8"-0.6m-UMC2P	BII7511 Transducer, Bolt Fastening Mounting BFM-5/8", 0.6m Cable, Male Underwater Mateable Connector.
BII7511-HT-FH-6m-RG178-BNC	BII7511 Transducer, Service Temperature: -10 °C to 120 °C, or 14 °F to 248 °F. Free Hanging, 6m RG178 Coax, BNC Male.
BII7511-IM50Ω-FH-20m-RG58-BNC	BII7511 Transducer, Built-in Impedance Matching Network as 50Ω load at fs, Free Hanging, 20m RG58 Coax, Male BNC.
BII7511-IM8Ω-FH-10m-SC-XLR3P	BII7511 Transducer, Built-in Impedance Matching Network as 8Ω load at fs, Free Hanging, 10m Shielded Cable, XLR Plug.
BII7511-IM8Ω-FH-10m-SC-WL	BII7511 Transducer, Built-in Impedance Matching Network to 8Ω load at fs, Free Hanging, 10m Shielded Cable, Wire Leads.

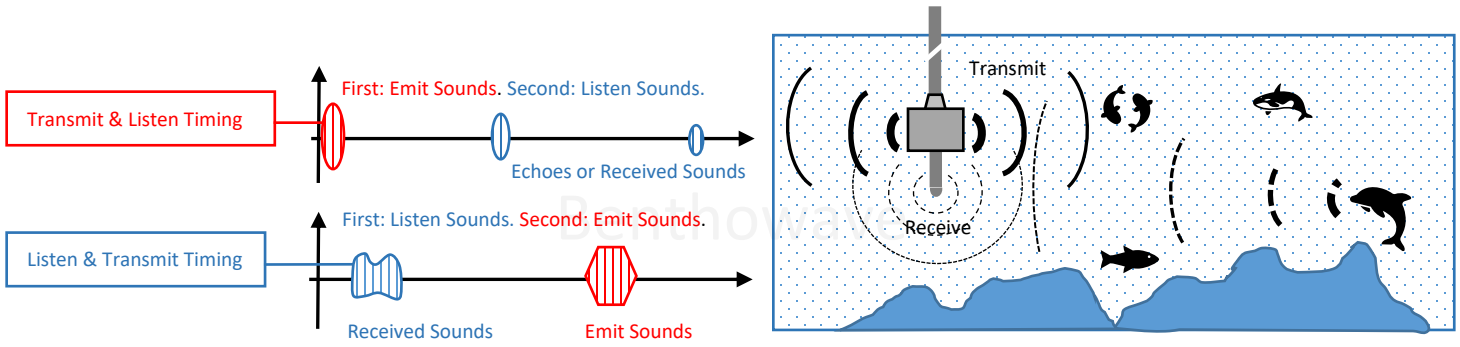
How to Order BII7511-IM50Ω-LNR. The default options are for stock items which are regularly available.

Transmitting cable is coax (RG58, RG316, RG174, or RG178) or two-conductor shielded cable (PUR, EPDM, Rubber, or PVC Jacket).					
Receiving cable is a six-conductor shielded cable, or cable bundles of two shielded cables for signals, sensitivity selection, and DC power supply.					
Length of Transmitting and receiving cables are same in default.					
Undewater Mateable Connector UMC2P and UMC4P are fixed with 0.6m unshielded cables.					
Buyer should specify buyer's special specs on cables, if any, when ordering, BII will choose suitable cable to meet buyer's special specs on cables. Without buyer's special specs on cables, BII will choose suitable default cables for the order at BII's discretion.					
Part Number	**-Receive Gain**	**-HPF/LPF**	**-Mounting**	**-Cable Length**	**-Connectors for Transmit Signals/ Receive Signal/FFVS Selection/DC Supply**
BII7511-IM50Ω-LNR	Default: **10/40dB**	-3dB Receive bandpass Frequencies. Default: **10Hz to 50kHz.**	Default: **BFM-FH-1/4", or, BFM-FH-3/8".**	Default: **15m.**	Default: **WL**.

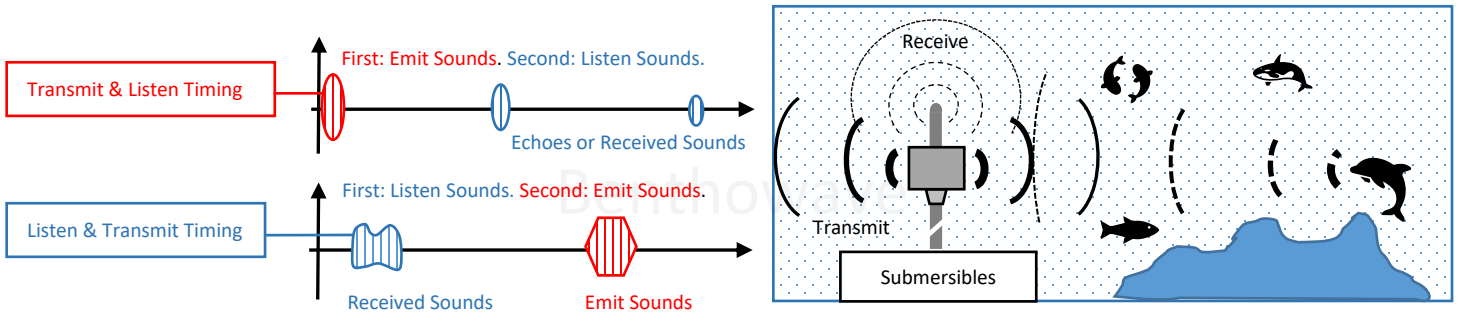
Example:	**Description**
BII7511-IM50Ω-LNR-10/40dB-10Hz/50kHz-BFM-FH-3/8"-15m-WL	BII7511 Transducer, Built-in Impedance Matching Network as 50Ω load at fs, Built-in Low Noise Receiver. Receive Gain: 10/40dB, Receive Bandpass Filter: 10Hz to 50kHz. Bolt-Fastening Mounting with Free Hanging: BFM-FH-3/8", 15m cables, Wire Leads.
BII7511-IM50Ω-LNR-10/40dB-1Hz/50kHz-FH-15m-BNC/WL/BS	BII7511 Transducer, Built-in Impedance Matching Network as 50Ω load at fs, Built-in Low Noise Receiver. Receive Gain: 10/40dB, Receive Bandpass Filter: 1Hz to 50kHz. Free Hanging, 15m cables, BNC Male Connector for Transmit Signal, Wire Leads for Receive Signal, 9V Battery Snap for DC Supply.
BII7511-IM50Ω-LNR-10/40dB-100Hz/50kHz-BFM-FH-3/8"-50m-BNC/XLR4P/BS/TRS	BII7511 Transducer, Built-in Impedance Matching Network as 50Ω load at fs, Built-in Low Noise Receiver. Receive Gain: 10/40dB, Receive Bandpass Filter: 100Hz to 50kHz. Bolt-Fastening Mounting with Free Hanging: BFM-FH-3/8", 50m cables, BNC Male Connector for Transmit Signal, 4 Pin XLR for Receive Signal, 9V Battery Snap for DC Supply, TRS for Temperature Signal.

Typical Applications on Underwater Communications

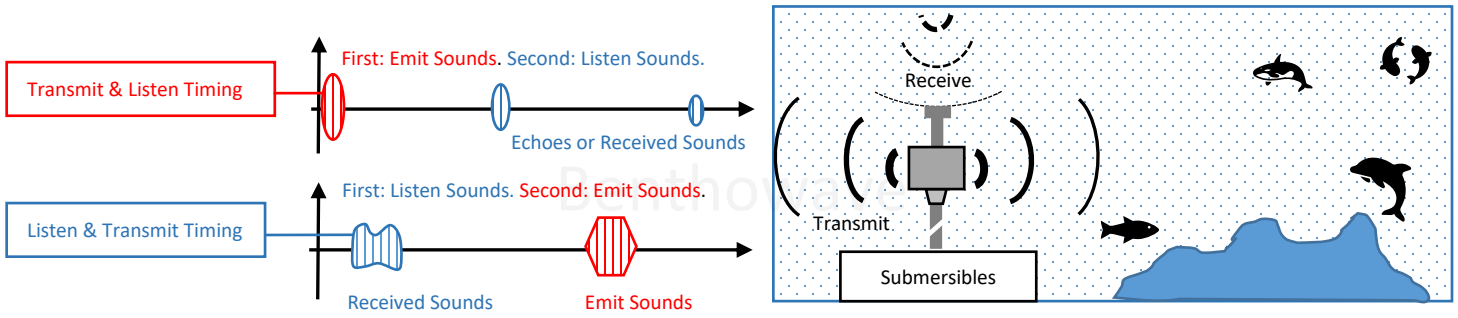
1. Communication System: Transmitting Omnidirectional Sounds Horizontally and Receiving Omnidirectional Sounds in Horizontal and/or Vertical Planes.



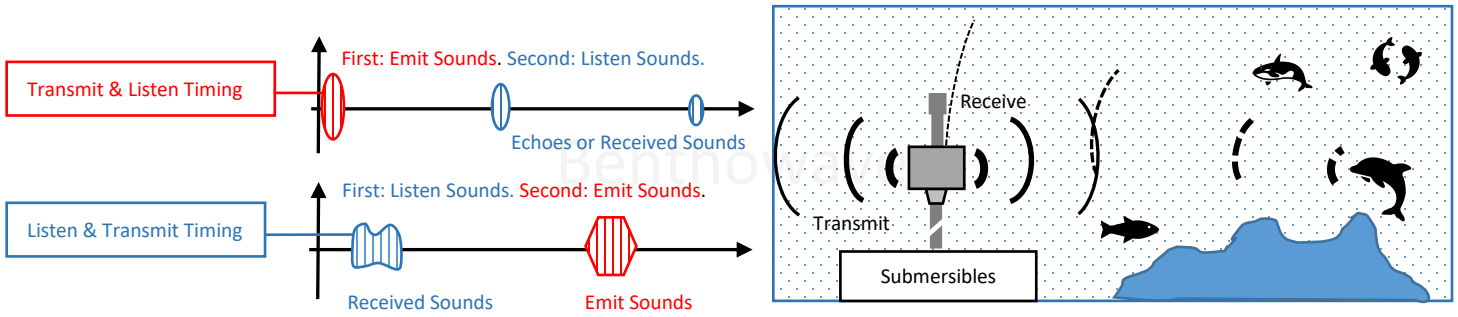
2. Communication System: Transmitting Omnidirectional Sounds Horizontally and Receiving Omnidirectional Sounds in Horizontal and/or Vertical Planes.



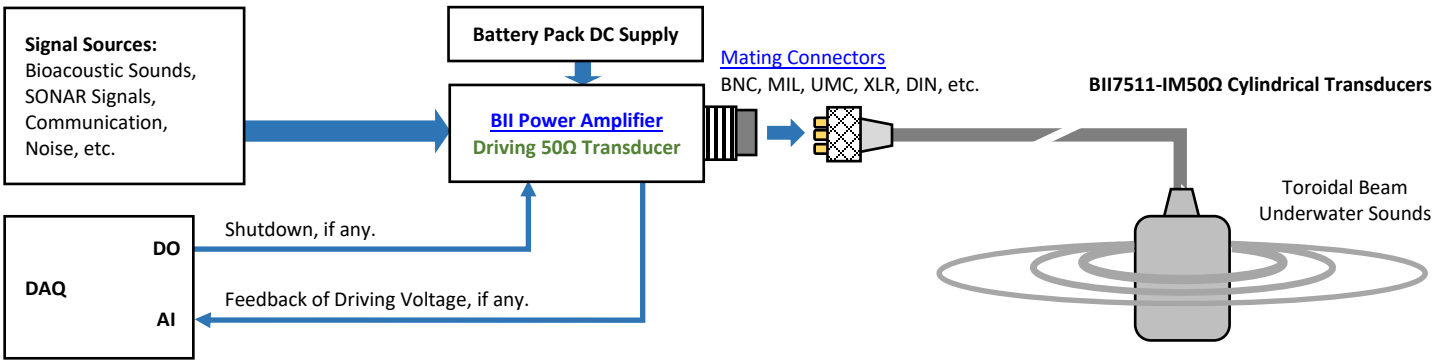
3. Communication System: Transmitting Omnidirectional Sounds Horizontally and Receiving Directional Sounds in Vertical Plane.

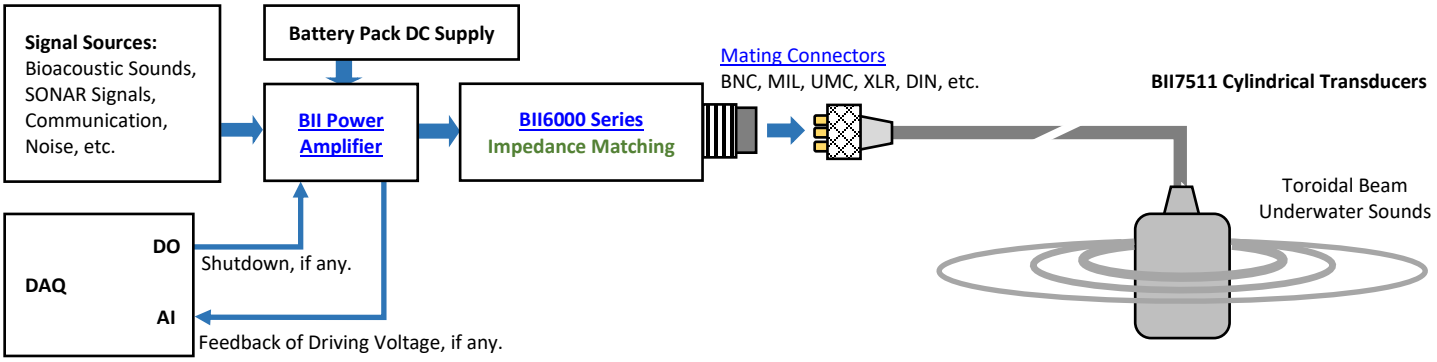


4. Communication System: Transmitting Omnidirectional Sounds Horizontally and Receiving Directional Sounds in Horizontal Plane.

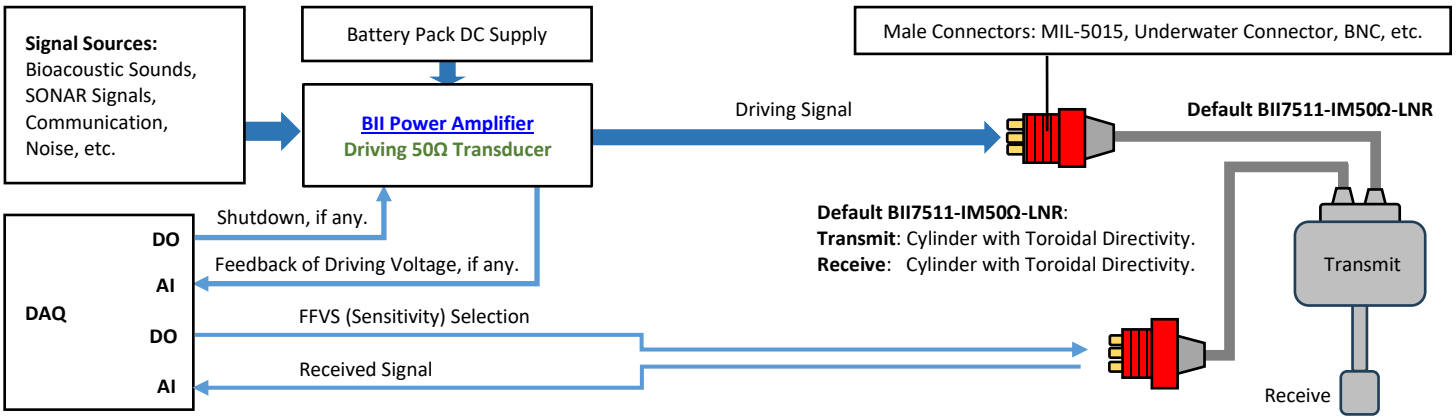


System Block Diagram of Generate Sounds





System Setup of Transmitting and Receiving Sounds.



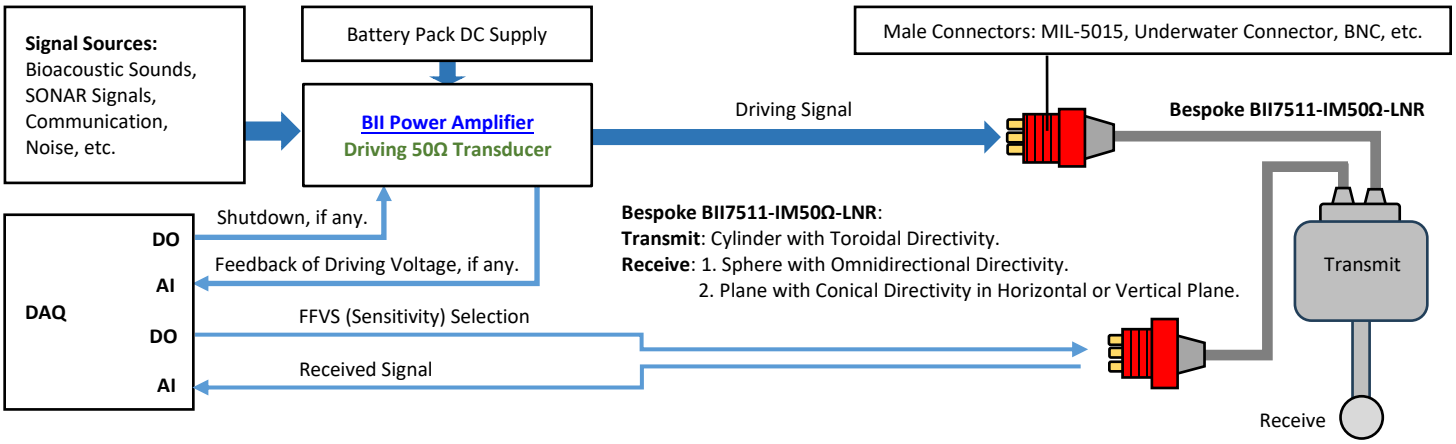
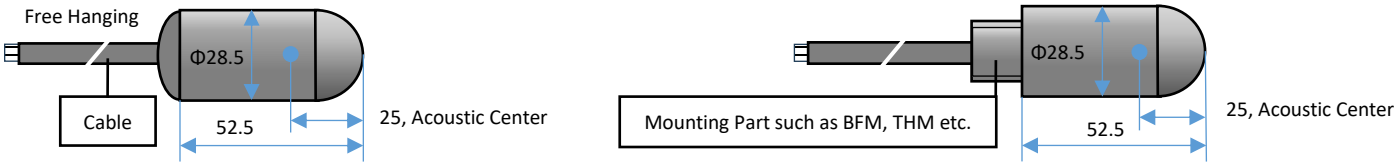
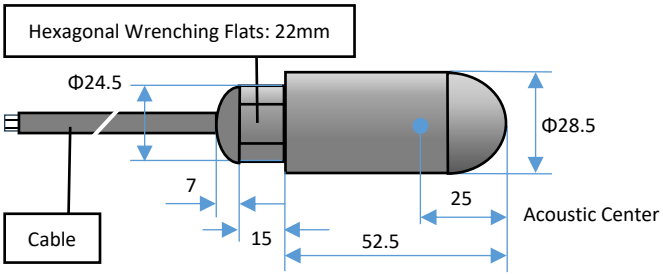


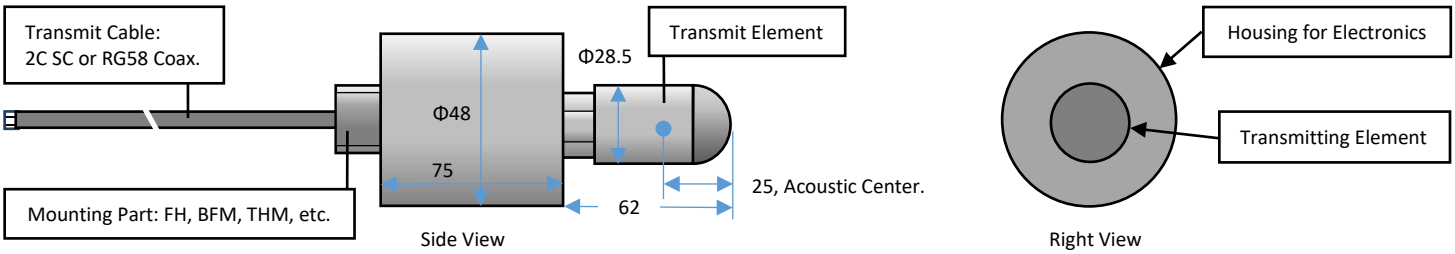
Illustration Only, Scale is NOT 1:1. The overall length varies with the length of mounting parts. Please refer to online information of mounting options.
BII7511 Physical Size, Dimensional Unit: mm.
a. General Size information.



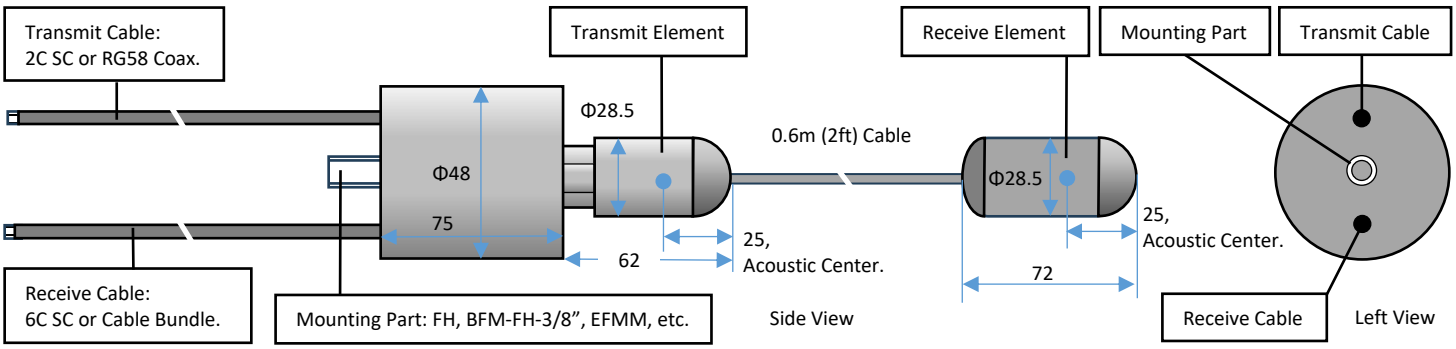
b. Size information of Free Hanging with Cable Gland.



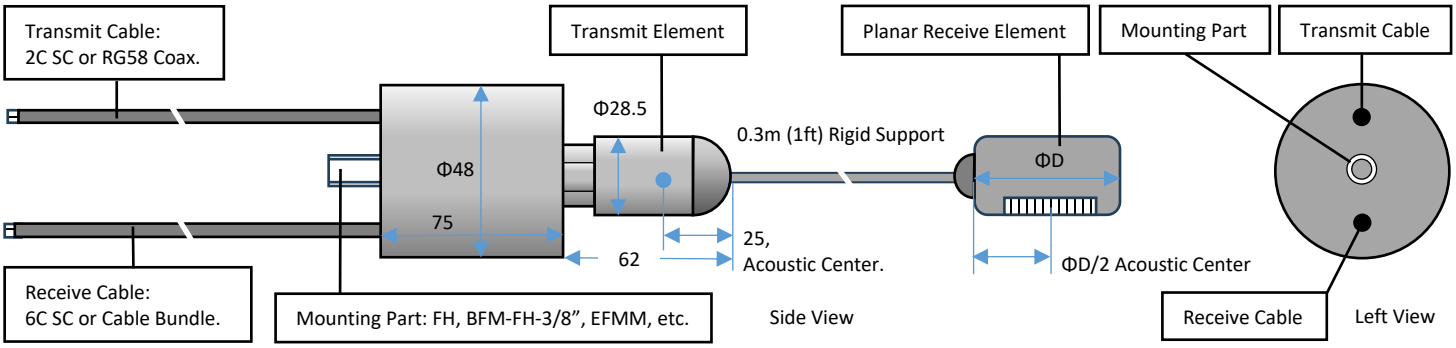
BII7511-IM50Ω, BII7511-IM5Ω, etc. Physical Size, Dimensional Unit: mm.



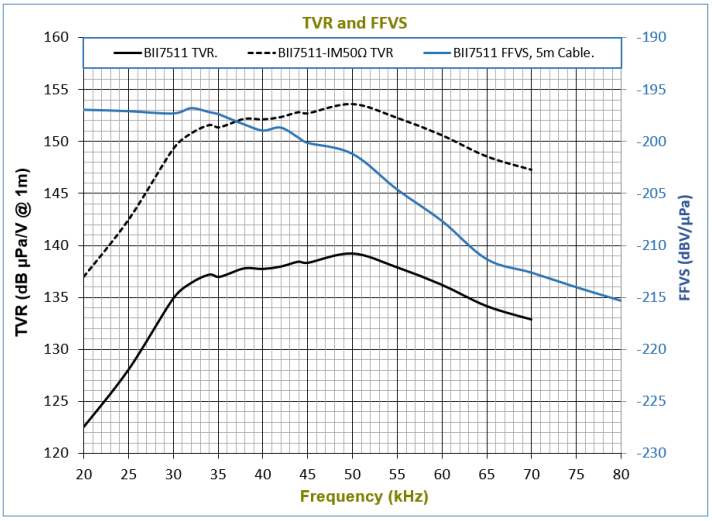
BII7511-IM50Ω-LNR, BII7511-IM5Ω-LNR, etc. Dimensional Unit: mm.

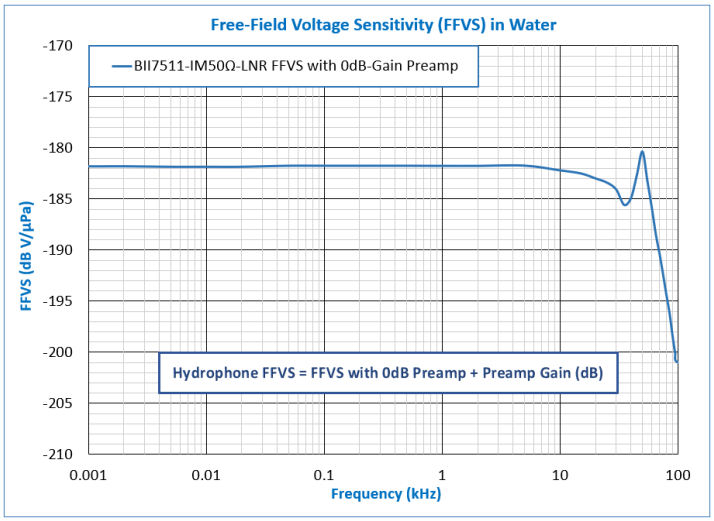


Omnidirectional Projector and Directional Receiver: Transmit Omnidirectional Sounds in Horizontal Plane, Receive Sounds in Vertical or Horizontal Plane. The specification is NOT listed in this datasheet, contact BII for customization.

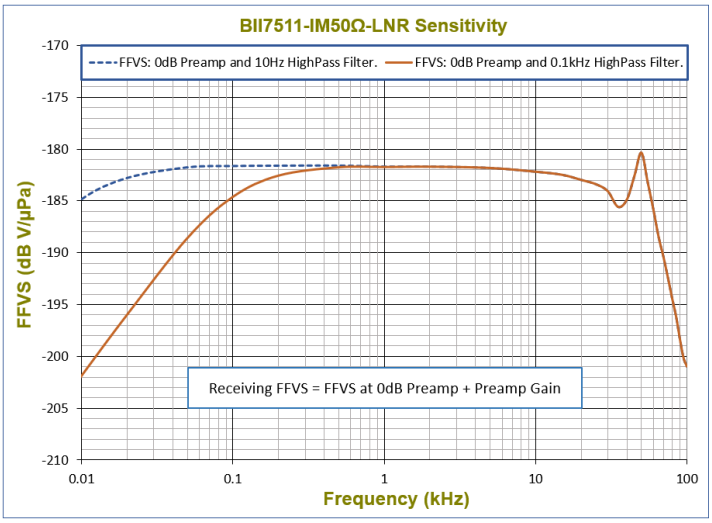


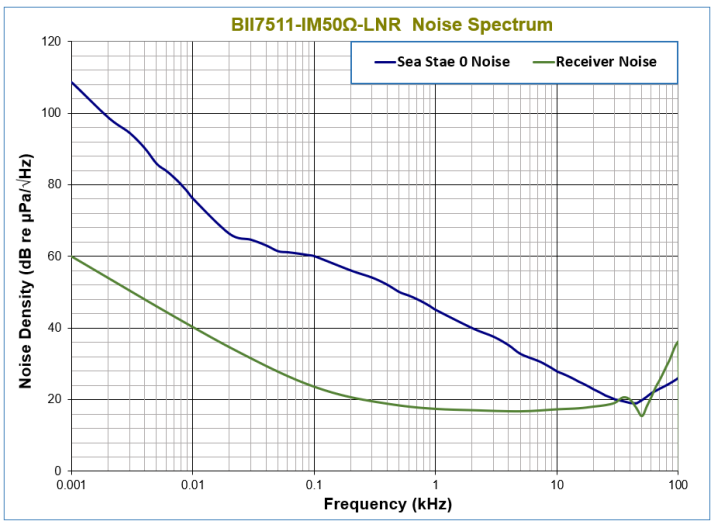
TVR (Transmitting Voltage Response) and FFVS (Free-filed Voltage Response)



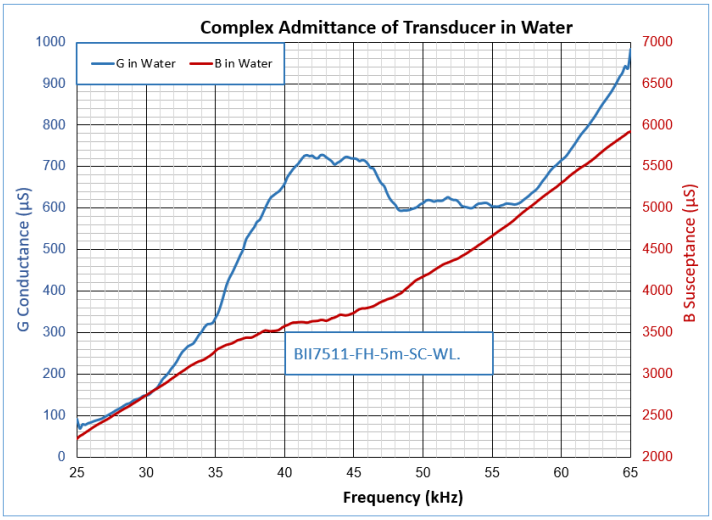


FFVS, Filter and Noise Density

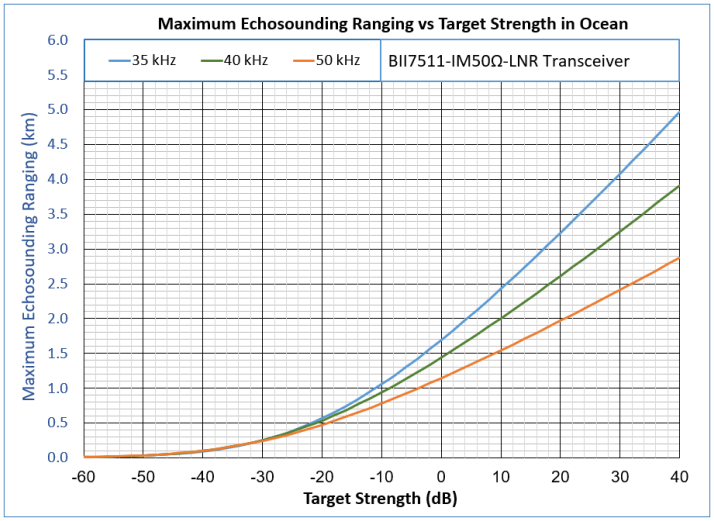




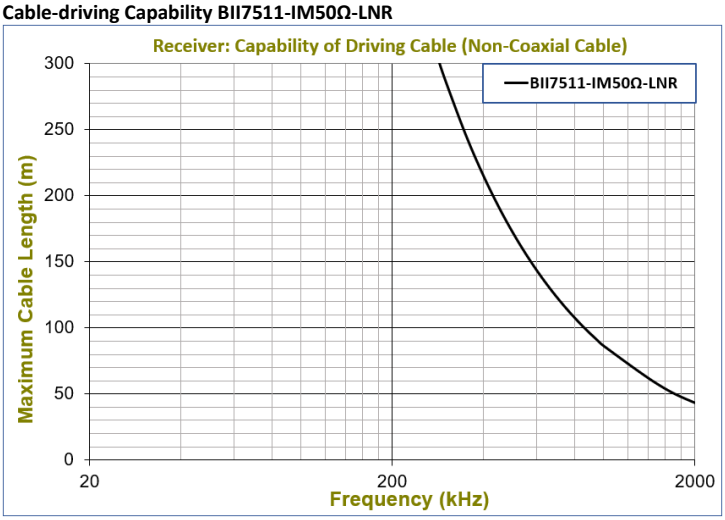
Admittance in Water



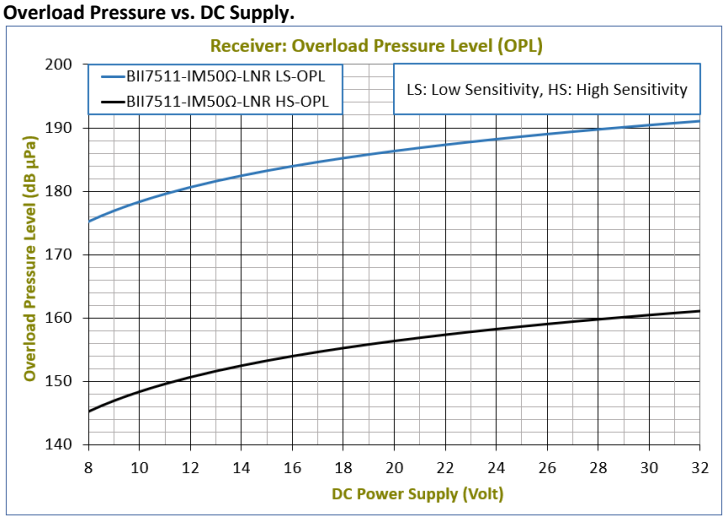
Echosounding Ranging vs Target Strength



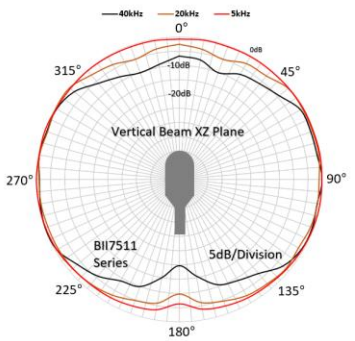
Cable-driving Capability BII7511-IM50Ω-LNR

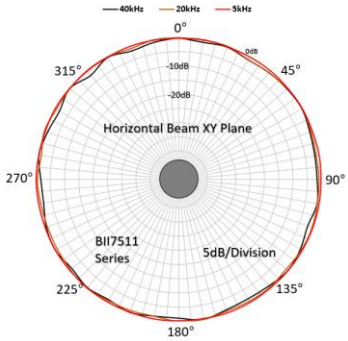


Overload Pressure vs. DC Supply.

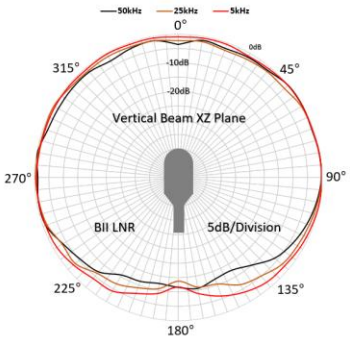


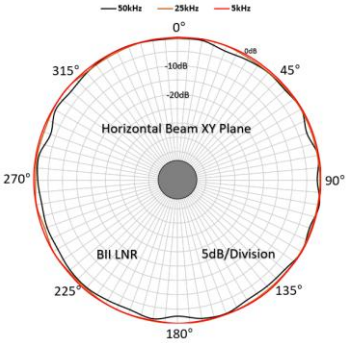
Directional Response Pattern of Transmitting Sounds





Directivity Response Pattern of Receive Sounds





Question:

Can the receiver with differential outputs be wired to single-ended inputs of a DAQ device (Data Acquisition Equipment) such as an Oscilloscope?

Yes, output+ and Common of a BII hydrophone can be used a single-ended signal, or Output- and Common of the hydrophone can be used a single-ended signal.

(1) Unused output terminal MUST be insulated to avoid short circuit.

(2) Neither "output +" nor "output –" can be wired to common which is going to destroy the device by short circuit.

How do I use Gain Selection wires in field?

1. **Manual Gain Selection.**
   When a **Gain Selection wire** is floating or open, its digital logic is High or "1".
   When a **Gain Selection wire** is short to **Digital Common**, its digital logic is Low or "0".
   Sensitivity of a Hydrophone is fixed when its Gain Selection wires are fixed to **Digital Common** or open (floating) during operation.
2. **Gain Selection with Digital Outputs.** Digital Outputs of a DAQ (data acquisition device) select gains with TTL/CMOS logic levels.

Where is the TVR graph of the transceiver of BII751x-IM50Ω-LNR?

TVR graph of a transceiver of BII751x-IM50Ω-LNR is same to the one of BII751x-IM50Ω.

Any crosstalk or interference between transmitter and receiver of a BII751x-IM50Ω-LNR?

Although the crosstalk or interference is minimized by BII's design and manufacturing, the sidelobes and vibrations of the transmitter (projector) will induce false sounds of the receiver though the cable or rigid support. Therefore, it is recommended to use the device in Half-duplex or Semiduplex mode.