Benthowave Instrument Inc.

Acoustical Solutions: SONAR, NDT/AE, HIFU. benthowave.com Revised on 2025/01/12

Hydrophone and Ultrasonic Preamplifier

BII's low noise low power preamplifiers (amplifiers) have built-in filters and their gains are fixed or programmable with digital and analog control. These preamplifiers (amplifiers) are custom-fit for use in broadband (wideband) underwater SONAR, ultrasonic (Ultrasound, NDT, AE) system and material study.

Typical Applications

Hydrophone, SONAR, Underwater Communication, Navigation. Seafloor-mapping, Sub-bottom/Sediment Profiler, Acoustic Image. Streamer/Towed Array, Sonobuoy, Target Strength Testing.	Ultrasonic (Ultrasound, AE, NDT) Testing, Material Characterization. Low Noise Ultrasonic Preamplifier, Ultrasonic Instrumentation, Pulse Amplifier. Sonic Cavitation Noise.

BII1050 Series Low Noise Ultrasonic Preamplifier: 0.02 Hz to 10 MHz, 1 nV/√Hz, 0.8 fA/√Hz.

Specification

e_n: Input Referred Voltage Noise at 1kHz; **i_n**: Input Referred Current Noise at 1kHz; **Vs**: Supply Voltage VDC; **I_Q**: Quiescent Supply Current; **BPF**: Band Pass Filter; **HPF**: High Pass Filter; **SE**: Single-ended; **DF**: Differential. **Rectangular PCB Size**: LxWxH. **BNC Jack**: for Single Ended Signal. 3.5 mm **TRS Jack**: for Differential Signal.

Preamplifier:	**BII1051**	**BII1053**	**BII1052**	**BII1054**	**BII1055**	**BII1056**
Input Type:	Both single ended input signals and differential input signals are acceptable.					
Input Referred Noise: (f ≥ 1 kHz).	e_n: 1 nV/√Hz	e_n: 1 nV/√Hz	e_n: 10.0 nV/√Hz	e_n: 10.0 nV/√Hz	e_n: 1 nV/√Hz	e_n: 10.0 nV/√Hz
	i_n: 1.6 pA/√Hz	i_n: 1.6 pA/√Hz	i_n: 0.8 fA/√Hz	i_n: 0.8 fA/√Hz	i_n: 1.6 pA/√Hz	i_n: 0.8 fA/√Hz
	Roughly, electronic noise density at input, RTI, $V_n^2 = e_n^2 + [\, i_n$ * impedance of the transducer (or hydrophone)$]^2$.					
Input Impedance:	1 MΩ	1 MΩ	200 MΩ	200 MΩ	1 MΩ	100 MΩ
	Specify when ordering to set up -3dB high pass filter frequency with Capacitance C_h of a piezoelectric sensor.					
	Ri 50Ω matches 50Ω coax cable impedance and damps down NDT transducer to achieve good transient or pulse response or reduce decaying time (or ringing) of the transducer.					
	End user may set input impedance to be 50Ω with a T type BNC adaptor and a 50Ω BNC Terminator.					
Maximum Input:	2.4 Vpp or (Maximum Output)/Gain, whichever is less.					
Gain of Pass Band:	40 dB	40 dB or 60 dB.	40 dB or 60 dB.	40 dB or 60 dB.	40 dB	40 dB
Built-in Filter:	BPF	BPF	BPF	BPF	HPF	HPF
	HPF: Second Order, **LPF:** First Order.				**HPF:** First Order.	
	Specify -3dB cut-off frequencies when ordering. White noise level is proportional to the square root of bandwidth.					
	Filters of Preamps. Both oceanic 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 of a preamp with -3dB cut-off frequency 100 Hz to improve signal to noise ratio of the signals of the interest.					
	System Filters Consisting of Standalone Piezoelectric Hydrophones and Standalone Preamps. -3dB High Pass Frequency: $f_{-3dBH} = 1/(2\pi R_i C_h)$. that is, $R_i = 1/(2\pi\, f_{-3dBH} * C_h)$. R_i: Input Resistance or Impedance of Preamp. C_h: Capacitance of piezoelectric hydrophone/sensor/transducer at 1 kHz (non-resonance measurement) or f_s (resonance measurement such as NDT pulsing system). For example: (1) A Hydrophone 10nF at 1kHz and preamp R_i 200MΩ constitute high pass filter with -3dB frequency 0.08Hz. (2) A Hydrophone (or NDT/AE Transducer) 0.1nF at f_s and preamp R_i 25kΩ constitute high pass filter with -3dB frequency 63.662kHz. (3) A Hydrophone (or NDT/AE Transducer) 10nF at f_s and preamp R_i 50Ω constitute high pass filter with -3dB frequency 318.3kHz.					
-3dB Bandwidth Range:	0.1kHz ~ 10MHz	10Hz ~ 2MHz	0.02Hz ~ 1.5MHz	0.02Hz ~ 1.5MHz	0.1kHz ~ 8MHz	0.02Hz ~ 500kHz
Settling Time, 0.01%:	0.4 µS	0.4 µS	4 µS	4 µS	0.4 µS	4 µS
Output Type:	SE	DF	SE	DF	SE	SE
Output Impedance:	50 Ω	10 Ω	10 Ω	10 Ω	50 Ω	10 Ω
Maximum Output V_{omax}:	(Supply Voltage Vs - 4), in Vpp.					
Cable Driving Capability:	1. 50Ω-Impedance Matching Coaxial Cable System: ≥ 300m. 2. Non-Coaxial Shielded Cable: Refer to Chart of Cable-Drive Capacity.					
Power Supply Vs:	+7.5 to +32 VDC	+7.5 to +32 VDC	+8.5 to +32 VDC	+8.5 to +32 VDC	+7.5 to +32 VDC	+9 to +32 VDC
Quiescent Current:	11.0 mA	13.5 mA	8.3 mA	9.8 mA	7.7 mA	3.5 mA
Suggested DC Supply Vs:	1.2 V to 12.6 V Batteries (AA, AAA, C, and D, 9V, Coin Cell, Marine and Automobile). Fixed DC Linear Power Supplies, Not Included. DO NOT use variable power supplies whose maximum supply voltage are higher than the above rated voltage. DO NOT use switching mode DC power supplies whose noise levels and harmonics are high.					
Operating Temperature:	-40 to 70 °C or -40 to 158 °F					
Storage Temperature:	-40 to 70 °C or -40 to 158 °F					

Available Packages:

Metal or Plastic Housing with Four Mounting Holes.

1. **BNC**: "Bayonet Neill–Concelman", miniature quick connect/disconnect radio/audio frequency connector used for coaxial cable. **Fastening Type**: Bayonet Lock.
2. **XLR**: Employed for balanced audio interconnections, 3 to 7 contacts. **Fastening Type**: Latch Lock. NOT supported by BII metal housing because of its large size.
3. **3.5mm TRS** stand for Tip, Ring, and Sleeve, miniature, quick connect/disconnect audio frequency connector used for shielded cable. **Fastening Type**: None.
4. **DIN**: Electrical cylindrical connectors, 3 to 14 contacts, Φ20mm diameter, used for audio, RF, digital, and DC or AC power signals. **Fastening Type**: Threaded.
5. **DC Power Connector**: Supply DC voltage and current to devices, miniature, quick connect/disconnect, used for shielded cable. **Fastening Type**: None.

Packages:	**Signal Type**	**Small Metal Housing with Four Mounting Holes**	**Large Metal or Plastic Housing with Four Mounting Holes**
Input Connector:	Single Ended	BNC Jack (**BNC**)	BNC Jack (**BNC**)
	Differential	3.5 mm (1/8") TRS Jack (**TRS35**)	XLR Plug with with 3 Sockets (**XLR**)
Output Connector:	Single Ended	BNC Jack (**BNC**)	BNC Jack (**BNC**)
	Differential	3.5 mm (1/8") TRS Jack (**TRS35**)	XLR Plug with with 3 Sockets (**XLR**)
Power Supply:	DC Power Connector Jack on Housing.		
	Options of Power Supply Cable: DCBP24, DCBS9V, DCBS18V.		
Size LxWxH (mm):	77x50.6x33 (No BNC Jacks) or 77x50.6x43 (with BNC Jacks)		109.45x83.4x65 (No BNC Jacks) or 109.45x83.4x67 (with BNC Jacks)
Weight:	115 grams ± 10%		150 grams ± 10%

Standard Preamps, Plastic or Metal Housing. BII keeps standard parts in stock.

Part Number	**-Gain**	**-R_i** Input Impedance, Refer to R_iC_h Filter.	**-Input/Output Connector**	**-DC Supply Type**
BII1052	40dB	200 MΩ (Differential Input). 20 MΩ (Differential Input). 2 MΩ (Differential Input).	**XLR/BNC** Jacks.	DCBP24, DCBS18V.
BII1054			**XLR/XLR** Jacks.	

Example:	**Description:**
BII1052-40dB-20MΩ-XLR/BNC-DCBP24:	BII1054, Preamp, 40dB Gain, Input Impedance: 20MΩ, Input Connector: XLR Jack, Output Connector: BNC Jack. DC Supply Cable: DCBP24.
BII1054-40dB-200MΩ-XLR/XLR-DCBS18:	BII1054, Preamp, 40dB Gain, Input Impedance: 200MΩ, Input and Output Connectors: XLR Jacks. DC Supply Cable: DCBP24.

How to Order Bespoke Preamplifiers with Plastic or Metal Housing. Non-stock.

Part Number	**-Gain**	**-R_i** Input Impedance.	**-HPF or HPF/LPF**	**-Input/Output Connector**	**-Accessory Cable Length**	**-Type**
BII1051, BII1052, BII1053, BII1054, BII1055, BII1056.	40dB, 60dB.	Refer to R_iC_h Filter.	-3dB High Pass or Bandpass Frequency, in Hz, kHz, MHz.	BNC: BNC Jack. TRS: 3.5mm TRS Jack. XLR: Plug with 3 Jacks.	Blank or Default: No Accessories. A1 to A7. DCBP24, DCBS18V.	

High Pass Filter of the preamp is the combination of R_iC_h High Pass Filter and **HPF** High Pass Filter. R_iC_h High Pass Filter is determined by C_h.

To avoid adverse effects of parasitic components of a resistor, input impedance ≤ 5 kΩ is recommended for 5 MHz to 10 MHz applications.

Example:	**Description:**
BII1051-40dB-50Ω-0.1MHz/10MHz-BNC/BNC-DCBP24:	BII1051, Preamp, 40dB Gain, Input Impedance: 50Ω, -3dB Band Pass Filter: 0.1MHz to 10MHz; Input and Output: BNC Jacks. DC Supply Cable: DCBP24.
BII1051-40dB-25kΩ-1kHz/1MHz-XLR/BNC-DCBP24:	BII1051, Preamp, 40dB Gain, Input Impedance: 25kΩ, -3dB Band Pass Filter: 1kHz to 1MHz; Input/Output: XLR/BNC Jack. DC Supply Cable: DCBP24.
BII1052-60dB-1MΩ-1Hz/200kHz-TRS/BNC-30m-A4-DCBS18V:	BII1052, Preamp, 60dB Gain, Input Impedance: 1MΩ, -3dB Band Pass Filter: 1Hz to 200kHz; Input/Output: TRS/BNC Jack. Accessory: 30m A4. DC Supply Cable: DCBS18V.
BII1054-60dB-1MΩ-1Hz/200kHz-XLR/XLR-30m-A4-DCBS18V:	BII1054, Preamp, 60dB Gain, Input Impedance: 1MΩ, -3dB Band Pass Filter: 1Hz to 200kHz; Input/Output: XLR Jack. Accessory: 30m A4. DC Supply Cable: DCBS18V.

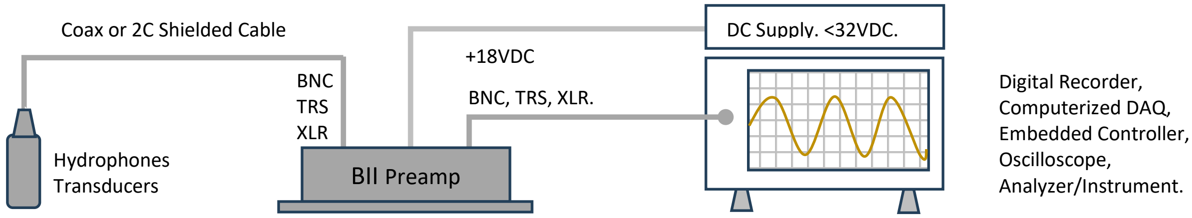
Signals and Wiring of Panel-Mount Connectors

Input or Output Signals			**Power Supply**
Single Ended (SE)	**Differential/Balanced (DF):**		**Single DC Supply**
BNC Jack	**3.5mm TRS Jack**	**XLR (Balanced Audio)**	**Power Jack**
Center: Signal Shield: Common	Tip: Signal +, Positive or Hot. Ring: Signal -, Negative or Cold. Sleeve: Common/Ground.	Pin 2, Positive/Hot. Pin 3, Negative/Cold. Pin 1, Shield/Ground.	Center Contact: +VDC. Shell: Common.
Metal Case is for shielding and grounding.			

Signals and Wiring of Accessory Cables

Input or Output Signals			**DC Supply Cable**
Single Ended (SE)	**Differential/Balanced Signal (DF)**		**Single DC Supply**
BNC and Coax	**3.5mm TRS and Cable**	**XLR (Balanced Audio)**	**Power Plug**
Center: Signal Shield: Common	Tip, White Wire: Signal +. Ring, Black Wire: Signal -. Sleeve, Shield: Common.	Pin 2, Positive/Hot. Pin 3, Negative/Cold. Pin 1, Shield/Ground.	Red Banana Plug: +VDC. Black Banana Plug: Common. Cable Shield, if any: Shielding.
Warning: "Signal –" is the reverse (180° phase difference) of "Signal +", and "Signal –" MUST NOT be connected to Common or Ground.			

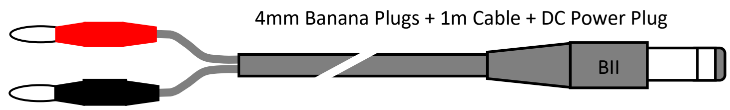
System Wirings of Standalone Preamp.



Accessories:

Part Number: DCBP24. One 1m DC supply cable with Red and Black Banana Plugs, and DC Power Plug.

To Terminals of DC Supply:
a. One Red 4mm Banana Plug.
b. One Black 4mm Banana Plug.

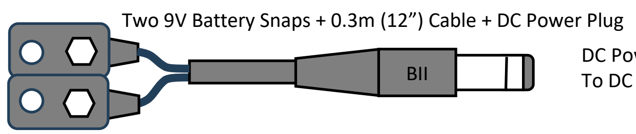


DC Power Plug.
To DC Power Jack of the Device.

Red Banana Plug or Red Wire Lead: +VDC.	**Black Banana Plug or Black Wire Lead:** Common.	**Cable Shield, if any**: Shielding.

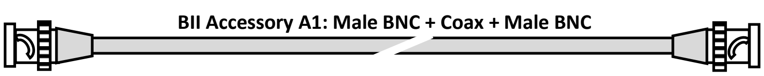
Part Number: DCBS18V. 0.3m (12") DC supply cable with two 9V Battery Snaps which supplies +18VDC to amplifiers and one DC Power Plug.

To Two 9V Batteries.

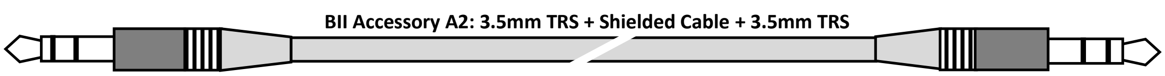


DC Power Plug.
To DC Power Jack of the Device.

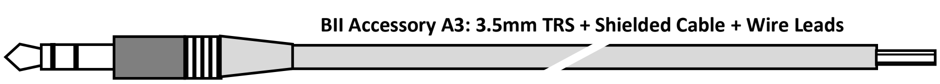
A1: Bespoke length RG58, RG174, or RG178 Coax with BNC Male to BNC Male. Default: 0.6m.



A2: Bespoke length cable with 3.5mm TRS Plug to 3.5mm TRS Plug. Default: 1.828m.

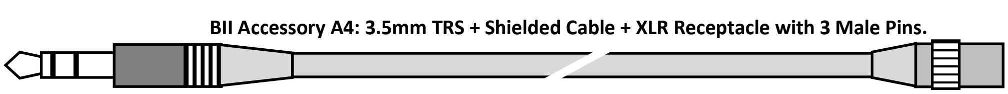


A3: Bespoke length cable with 3.5mm TRS Plug to Wire Leads. Default: 0.9m.



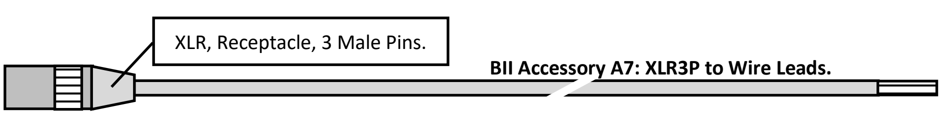
Wire Leads

A4: Bespoke length cable with 3.5mm TRS Plug to XLR Receptacle with 3 Male Pins. Default: 0.9m.



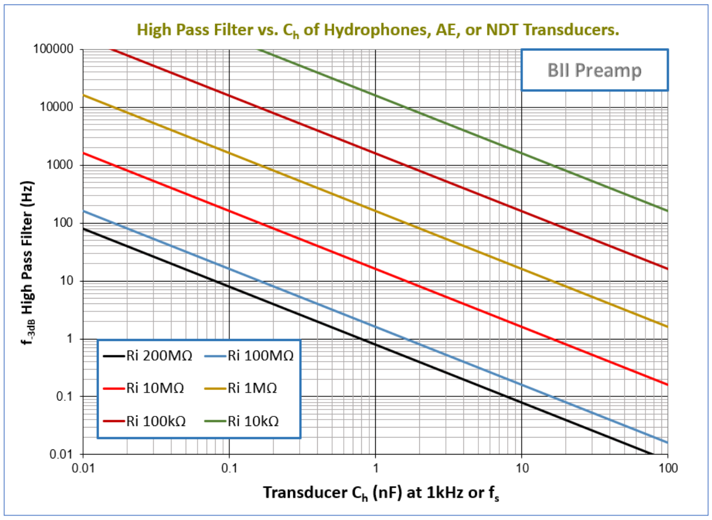
XLR Receptacle with 3 Male Pins.

A7 Receiving Signal Cable. Part Number: XLR-P-WL-1m, Bespoke length cable with XLR Receptacle Male Pin to Wire Leads. Default: 1m.

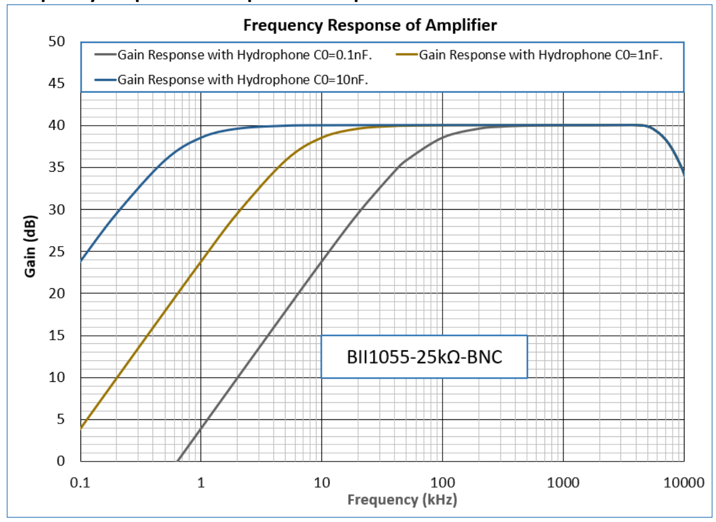


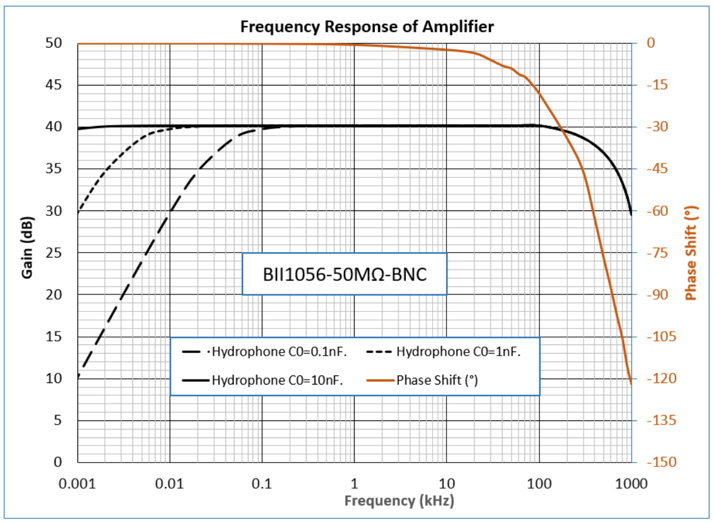
Wire Leads, or bespoke TRS, XLR, Male or Female, etc.

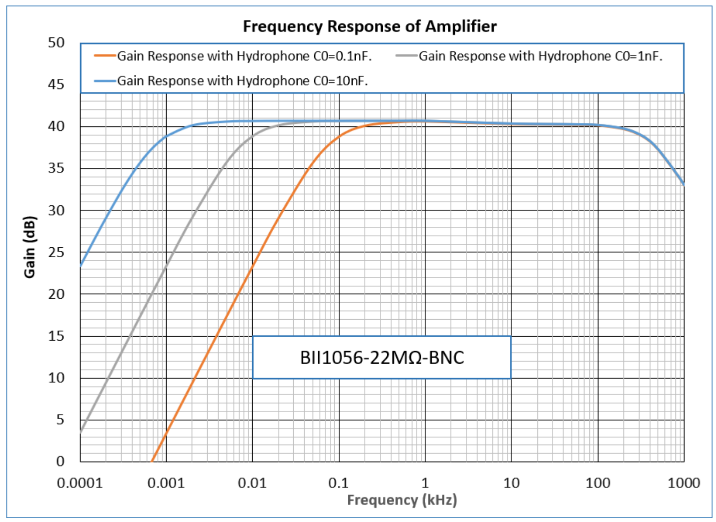
High Pass Filter vs. Ch of Hydrophone, AE, or NDT Transducer.



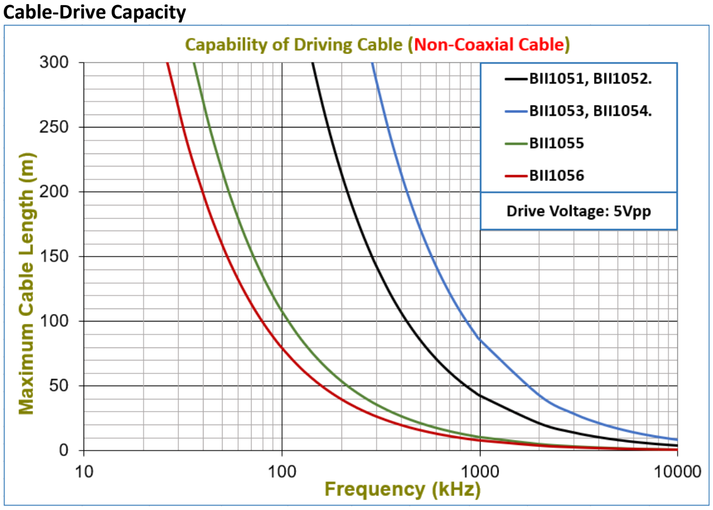
Frequency Response of Bespoke Preamps.



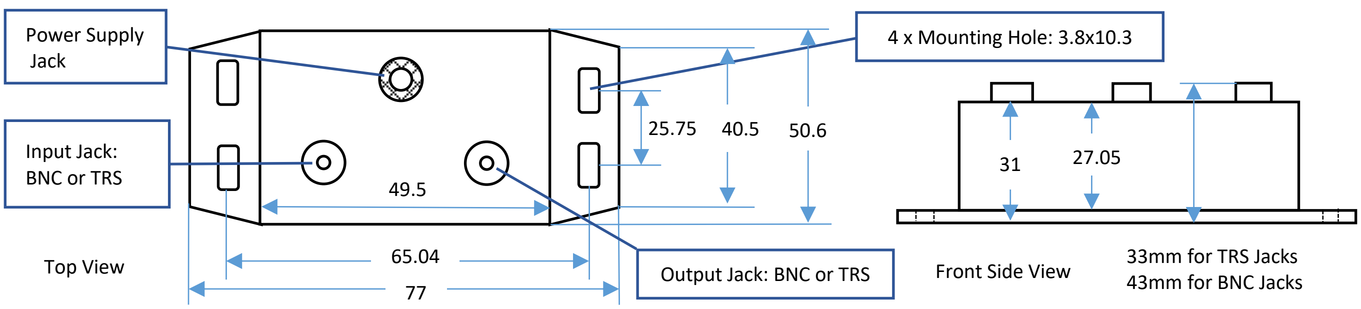




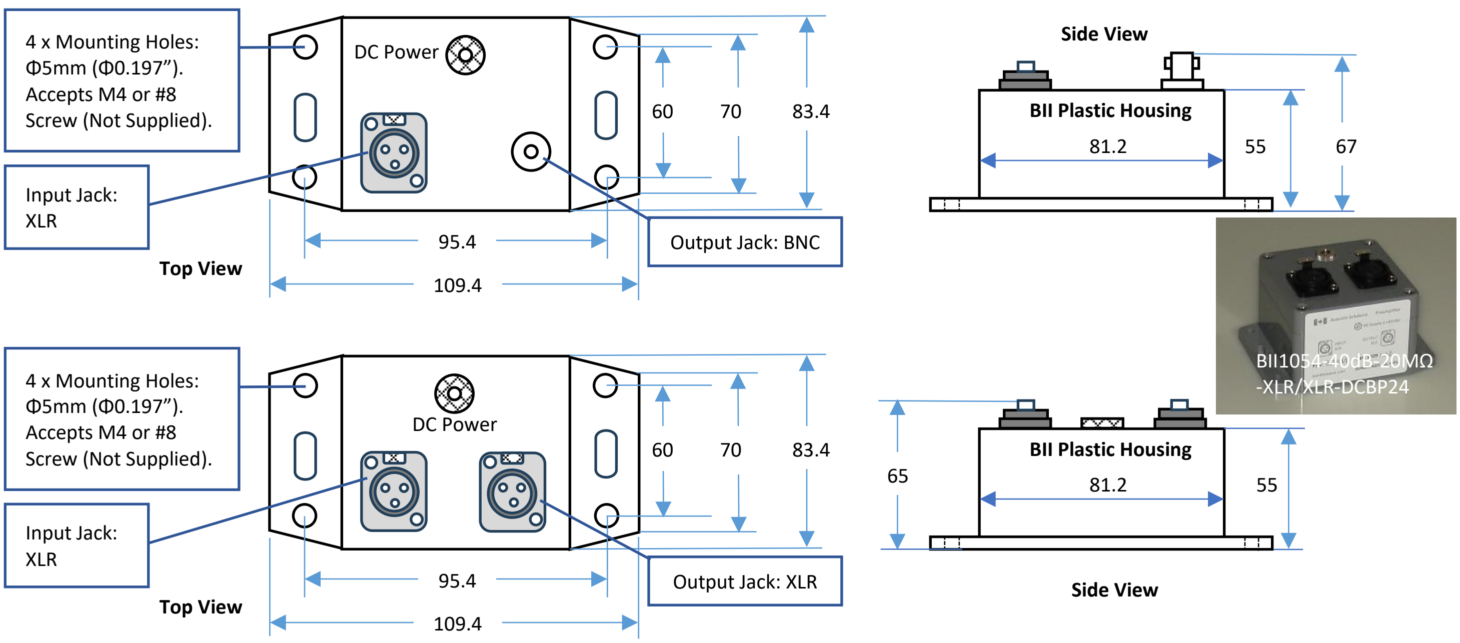
Cable-Drive Capacity



Metal Housing, Outline Dimensions (mm), Illustration only, the scale is not 1:1.

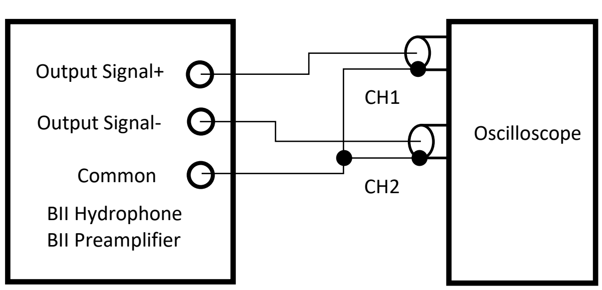


Plastic Housing, Outline Dimensions (mm), Illustration only, the scale is not 1:1.

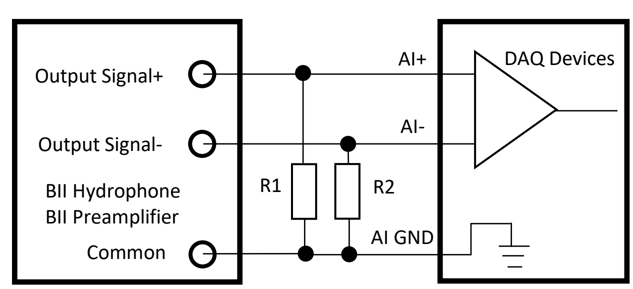


Preamplifier Wirings to DAQ (Data Acquisition): DAQ: Data Acquisition Hardware; AI: Analog Input; CH: Channel; GND: Ground.
R1 and R2 resistors are NOT necessary for most applications. If DAQ saturation occurs, use R1 = R2 = 10kΩ to 1MΩ resistors.

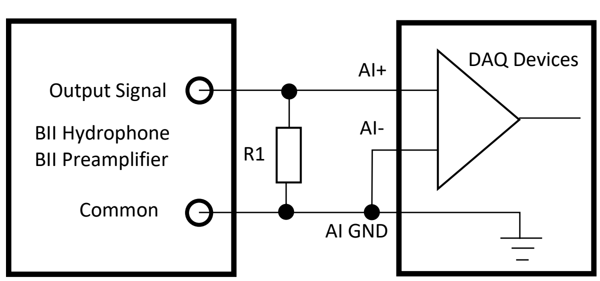
BII’s Differential Output to BNC Input of an Oscilloscope



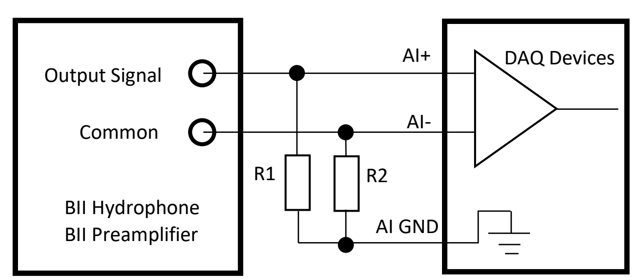
BII’s Differential Output to Differential Input of a DAQ



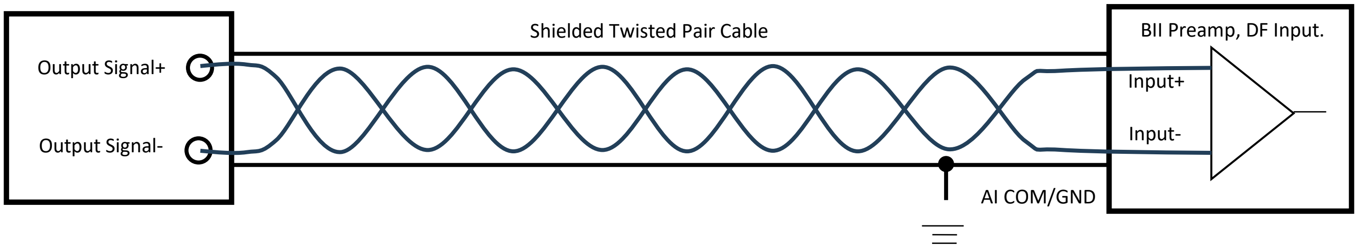
BII’s Single-Ended Output to Single-Ended Input of a DAQ



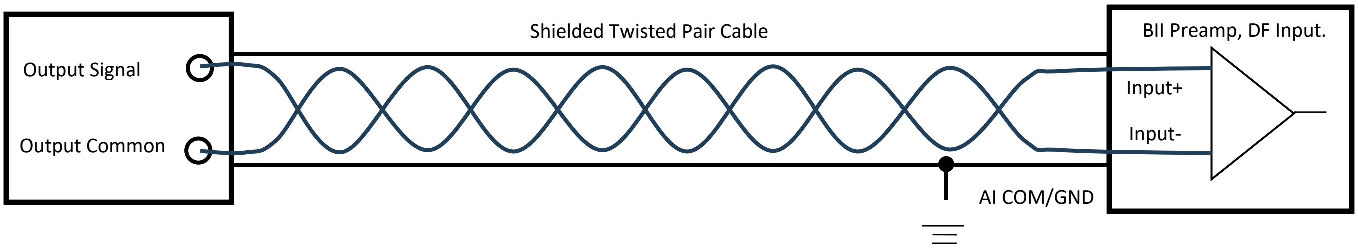
BII’s Single-Ended Output to Differential Input of a DAQ



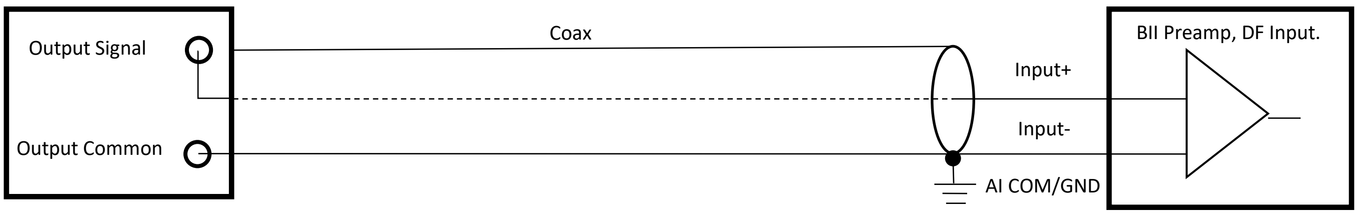
BII's Differential Sound Receiver to Differential Input of a BII Preamp (Signal Conditioner)



BII's Single-ended Receiver to Differential Input of a BII Preamp



BII's Single-ended Receiver to Differential Input of a BII Preamp



Questions

What if the connector of my transducer/sensor is SMA or SMC Connector? SMA (or SMC) to BNC (Male) adaptors are available from many electronic distributors. BII may sell the adaptor as an accessory of the device upon request. **By default, BII does NOT supply the adaptor as accessories.**

How do I wire 50Ω transducer/sensor to preamplifiers in high frequency applications? Many BII preamplifiers have non-50Ω input resistances which does NOT match 50Ω in high frequency applications. Therefore, one T type BNC adaptor and one 50Ω BNC terminal are necessary between 50Ω transducer/sensor and the preamplifier to change the impedance of the preamp to be 50Ω. BII may ship T type BNC adaptor and one 50Ω BNC terminal as accessories of the device. Please specify this request when ordering. **By default, BII does NOT supply these two parts as accessories**. By the way it is NOT necessary to do 50Ω matching in low frequency range applications in which electromagnetic wave lengths are much greater than the cable length.

How do I wire BII preamplifiers to audio connectors XLR Plug with 3 Female Sockets (Differential Signal) of my recording devices? BII Preamplifiers have panel mount TRS Jacks as output connectors. Please order accessory A4 with preamplifiers. **By default, BII does NOT supply the cable assembly as accessories**.

My acoustic sensors generate differential signals in MHz range, are TRS connectors of BII preamps suitable for my applications? Our test shows the 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||30pF, 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.

My recorder (or signal processing device) is about 100m away from the hydrophone (or AE Sensor), which type of preamplifiers should I choose? Choose differential-output preamps to drive the 100m cable and ensure that your data acquisition device can accept differential signals.

Can the hydrophone 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. But, neither output+ nor output – of the hydrophone can be wired to common which is going to destroy the hydrophone by short circuit.

Driving 100Ω Balanced Twisted Pair Cable/Wires and 50 or 75 Ω Coax.

(1) Impedance of most Balanced Twisted Pair Cable/Wire is from 100Ω to 150Ω.
BII preamp has 100Ω output impedance or bespoke impedance to match the impedance of Balanced Twisted Pair Cable/Wires.

(2) Impedance of most Coax is 50Ω or 75Ω.
BII preamp has 50Ω output impedance or bespoke 75Ω impedance to match the impedance of coaxes.