BII

SE=SL-TL+AG-NL

Benthowave Instrument Inc.

Acoustical Solutions: SONAR, NDT/AE, HIFU. benthowave.com Revised on 2025/3/4

Hydrophone and Ultrasonic Preamplifier

BII's low power low noise 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. Streamer/Towed Array, Sonobuoy, Infrasonic and noise measurement.	Ultrasonic (Ultrasound, AE, NDT) Testing, Material Characterization. Portable Battery-powered Acoustic System, Bioacoustics, Sound Recording.

BII1010 Series and BII1060 Series Low Power Low Noise Preamplifier: Hand-held, Portable, Battery-operated Systems.

Low Power Low Noise Preamplifiers for acoustical instruments: Hydrophones, Air Transducers, Acoustic Emission Sensors, and Ultrasonic Transducers (Non-destructive Testing). Uses in underwater sound (oceanography and hydrography), sonic and ultrasonic engineering, electroacoustics, communication, bioacoustics, exploration seismology and seismic wave, physical acoustics, acoustical Imaging, and material study.

Specification

HPF: High Pass Filter; **BPF**: Band Pass Filter; **LPF**: Low Pass Filter. **SE**: Single-ended, **DF**: Differential. **RTI**: Referred to the input of the preamp. R_i: Input Impedance. V_s: Supply Voltage. I_Q: Quiescent Current; V_{omax}: Output Voltage Swing; Z_0: Output Impedance. **TRS:** 3.5 mm TRS Jack.

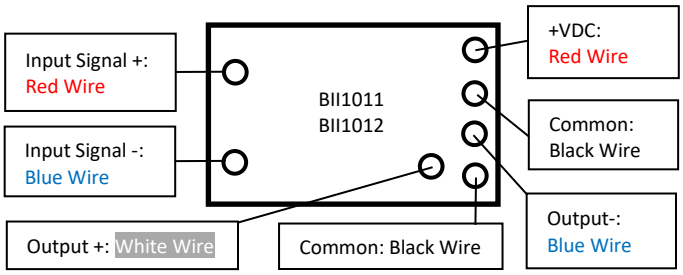
Low Power Preamp:	**BII1011**	**BII1012**	**BII1018**	**BII1064**	**BII1066**	**BII1067**	**BII1069**
Input Type:	Differential, either single ended (SE) or differential (DF) input signals are accepted.						
Input Referred Noise: e_n, i_n. RTI, f ≥ 1 kHz.	14 nV/√Hz. 0.5 fA/√Hz.	5 nV/√Hz. 85 fA/√Hz.	7 nV/√Hz. 0.4 fA/√Hz.	12 nV/√Hz 170 fA/√Hz	12 nV/√Hz. 170 fA/√Hz.	21 nV/√Hz. 160 fA/√Hz.	7 nV/√Hz. 170 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 R_i:	**200 MΩ**	20 MΩ	**200 MΩ**	44 MΩ	44 MΩ	20 MΩ	20 MΩ
	Bespoke R_i: specify when ordering to set up -3dB high pass filter frequency with Capacitance C_h of a piezoelectric sensor.						
Maximum Input:	2.4 Vpp or (Maximum Output V_{omax})/Gain, whichever is less.						
Built-in Filter:	HPF	HPF	HPF	BPF	BPF	BPF	HPF
	HPF: First Order.			**HPF:** Second Order; **LPF:** First Order.			**HPF:** 2nd Order.
	Customized high pass filter and/or Low pass filter, 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) hydrophone 10nF at 1kHz and preamp R_i 200MΩ constitute high pass filter with -3dB frequency 0.079Hz. (2) hydrophone 10nF at 1kHz and preamp R_i 100MΩ constitute high pass filter with -3dB frequency 0.159Hz. (3) hydrophone 10nF at 1kHz and preamp R_i 20MΩ constitute high pass filter with -3dB frequency 0.795Hz. (4) hydrophone 10nF at 1kHz and preamp R_i 2MΩ constitute high pass filter with -3dB frequency 7.950Hz. (5) hydrophone 10nF at 1kHz and preamp R_i 200kΩ constitute high pass filter with -3dB frequency 79.50Hz.						
Gain of Pass Band:	40dB	40dB.	40dB	40dB	40dB	40dB	40dB
	The gain is fixed and set at BII factory. Each preamp has ONLY one gain.						
-3dB Bandwidth:	0.1Hz ~ 100kHz	1Hz ~ 350kHz	0.1Hz ~ 800kHz	**1Hz ~ 640kHz**	1Hz ~ 640kHz	1Hz ~ 350kHz	1Hz ~ 500kHz
Settling Time, 0.01%:	35 µS	6 µS	4 µS	6 µS	6 µS	12 µS	6 µS
Output Type:	DF	DF	DF	**SE**	DF	**SE**	DF
Output Impedance:	20 Ω	20 Ω	20 Ω	10 Ω	20 Ω	10 Ω	100 Ω
Maximum Output V_{omax}:	Vs-3.4, Vpp.	Vs - 2.0, Vpp.	Vs - 4.0, Vpp.	Vs - 5.0, Vpp.	Vs - 5.0, Vpp.	Vs - 0.7, Vpp.	Vs - 4.0, Vpp.
Cable Driving Capability:	Refer to Chart of Cable-Drive Capacity.						
Power Supply V_s (VDC):	+4.5 to +32	+4.5 to +32	+9 to +32	+6 to +32	+6 to +32	+3.4 to +32.	+7.5 to +32
Quiescent Current I_Q:	**1.05 mA**	**1.45 mA**	6.8 mA	3.1 mA	5.4 mA	**1.55 mA**	7.0 mA
Suggested DC Supply:	1.2 V to 12.6 V Batteries (AA, AAA, C, and D, 9V, Coin Cell, Marine and Automobile). 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.						
Operating Temperature:	-40 to 70 °C or -40 to 158 °F						
Storage Temperature:	-40 to 70 °C or -40 to 158 °F						
Package	Metal Housing with four mounting holes						
Input Connector:	1. BNC Jack (**BNC**): for Single Ended Signal. 2. 3.5 mm TRS Jack (**TRS**) 3. XLR Plug with 3 Sockets (**XLR**): for Differential Signal.						
Output Connector:	1. TRS Jack 2. XLR Jack	1. TRS Jack 2. XLR Jack	1. TRS Jack 2. XLR Jack	BNC Jack	1. TRS Jack 2. XLR Jack	BNC Jack	1. TRS Jack 2. XLR Jack
Power Supply:	Power Connector Jack on Housing. Power Supply Cable: DCBP24, DCBS18V, DCBS9V.						

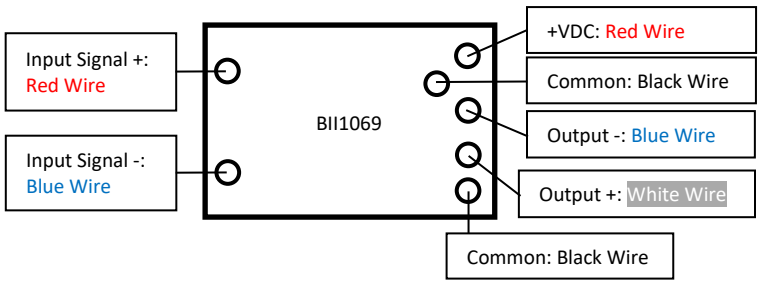
Size LxWxH:	77x50.6x33 mm (TRS Jacks) or 77x50.6x43 mm (BNC Jacks).						
Weight:	75 grams						
Accessories:	A1: Bespoke length RG58, RG174, or RG178 Coax with BNC Male to BNC Male. A2: Bespoke length cable with 3.5mm TRS Plug to 3.5mm TRS Plug. A3: Bespoke length cable with 3.5mm TRS Plug to Wire Leads. A4: Bespoke length cable with 3.5mm TRS Plug to XLR Receptacle with 3 Male Pins. A7: Bespoke length cable with XLR Receptacle Male Pin to Wire Leads. Default: 1m.						
PCB Package	**Coated PCB with Wires and Wire Leads**						
Input Wiring:	5cm wires, twisted.						
	Differential Input Wiring: Red: Input Signal +, Blue: Input Signal -, and Use Power Supply Common as input signal common.						
	Single-ended Input Wiring: Red: Input Signal, Blue: Input Common and wire Blue Wire to Power Supply Common.						
Output Wiring:	5cm wires, twisted.						
	Differential Output Wiring: White: Output Signal +, Blue: Output Signal -, Black: Output Common.						
	Single-ended Output Wiring: White: Output Signal, Black: Output Common.						
Power Supply Wiring:	5cm wires, twisted. Red: +VDC, Black: Common. Common of DC Power Supply is the commons of input and output.						
Size (LxWxH) (mm):	33x8.9x5	33x8.9x5	32x12x5	30x11.5x5	38x11.5x5	29.2x11.43x5	30x8.9x5
Weight:	≤ 4 grams						

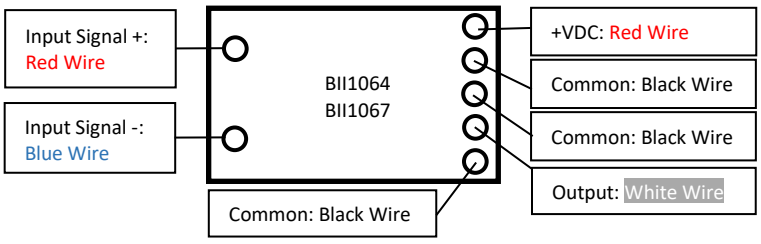
Standard Coated PCB. BII keeps standard parts in stock.

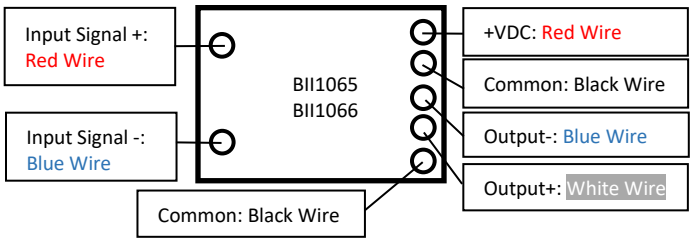
Part Number	**-R_i** Input Impedance.	**-PCB**
BII1011	200 MΩ.	Cotaed PCB. 5cm Wires.
BII1012	20 MΩ.	
BII1018	200 MΩ.	
BII1067	20 MΩ.	
BII1069	20 MΩ.	
-3dB High Pass Frequency: $f_{-3dBH} = 1/(2\pi R_i C_h)$. Refer to Built-in Filter, R_iC_h Filter and -3dB Bandwidth.		
Example:	**Description:**	
BII1011-200MΩ-PCB:	BII1011, Preamp, Input Impedance: 200MΩ, Coated PCB with 5cm Wires.	
BII1012-20MΩ-PCB:	BII1012, Preamp, Input Impedance: 20MΩ, Coated PCB with 5cm Wires.	
BII1018-200MΩ-PCB:	BII1018, Preamp, Input Impedance: 200MΩ, Coated PCB with 5cm Wires.	
BII1067-20MΩ-PCB:	BII1067, Preamp, Input Impedance: 20MΩ, Coated PCB with 5cm Wires.	
BII1069-20MΩ-PCB:	BII1069, Preamp, Input Impedance: 20MΩ, Coated PCB with 5cm Wires.	

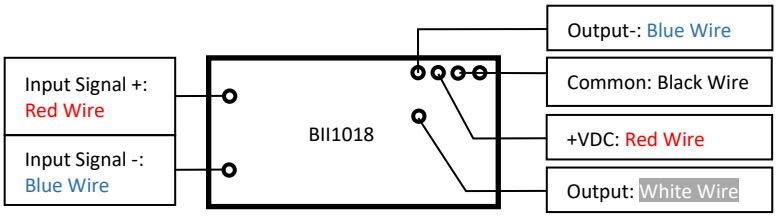
Coated PCB Wiring: "Output –" is the reverse (180° phase difference) of "Output +". "Output –" MUST NOT be connected to Common or Ground.
Signal Input Type of Coated PCB: Differential, either single ended (**SE**) or differential (**DF**) input signals are accepted. Refer to Input Wiring.











Enclosure Package: 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 Metal Housing. BII keeps standard parts in stock.

Part Number	**-R_i**	**-Input/Output Connector**	**-Accessory Cable Length**	**-Accessory Type**
BII1011	200 MΩ.	TRS/TRS, BNC/TRS, or XLR/XLR.	0.6m, 0.9m, 1.8m, 10m, 20m, 50m, 100m, 200m, 305m.	A1 to A7. DCBP24, DCBS18V.
BII1018	200 MΩ.	TRS/TRS, BNC/TRS, or XLR/XLR.		
BII1067	20 MΩ.	TRS/BNC, BNC/BNC, or XLR/BNC.		
BII1069	20 MΩ.	TRS/TRS, BNC/TRS, or XLR/XLR.		

-3dB High Pass Frequency: $f_{-3dBH} = 1/(2\pi R_i C_h)$. Refer to Built-in Filter, R_iC_h Filter and -3dB Bandwidth.

Example:	**Description:**
BII1011-200MΩ-TRS/TRS-50m-A3- DCBS18V:	BII1011, Preamp, Input Impedance: 200MΩ, Input/Output: TRS/TRS Jacks. 50m A3 Cable Accessories. DC Supply Cable: DC-DCBS18V.
BII1011-200MΩ-BNC/TRS-50m-A4- DCBS18V:	BII1011, Preamp, Input Impedance: 200MΩ, Input/Output: BNC/TRS Jacks. 50m A4 Cable Accessories. DC Supply Cable: DC-DCBS18V.
BII1018-200MΩ-TRS/TRS-50m-A3- DCBS18V:	BII1018, Preamp, Input Impedance: 200MΩ, Input/Output: TRS/TRS Jacks, 50m A3 Cable Accessories. DC Supply Cable: DC-DCBS18V.
BII1018-200MΩ-BNC/TRS-50m-A4- DCBS18V:	BII1018, Preamp, Input Impedance: 200MΩ, Input/Output: BNC/TRS Jacks, 50m A4 Cable Accessories. DC Supply Cable: DC-DCBS18V.
BII1067-20MΩ-TRS/BNC-DCBS18V:	BII1067, Preamp, Input Impedance: 20MΩ, Input/Output: TRS/BNC Jacks. DC Supply Cable: DC-DCBS18V.
BII1067-20MΩ-BNC/BNC-DCBS18V:	BII1067, Preamp, Input Impedance: 20MΩ, Input/Output: BNC/BNC Jacks. DC Supply Cable: DC-DCBS18V.
BII1069-20MΩ-TRS/TRS-100m-A3-DCBS18V:	BII1069, Preamp, Input Impedance: 20MΩ, Input/Output: TRS/TRS Jacks, 100m A3 Cable Accessories. DC Supply Cable: DCBS18V.
BII1069-20MΩ-BNC/TRS-100m-A4-DCBS18V:	BII1069, Preamp, Input Impedance: 20MΩ, Input/Output: BNC/TRS Jacks, 100m A4 Cable Accessories. DC Supply Cable: DCBS18V.

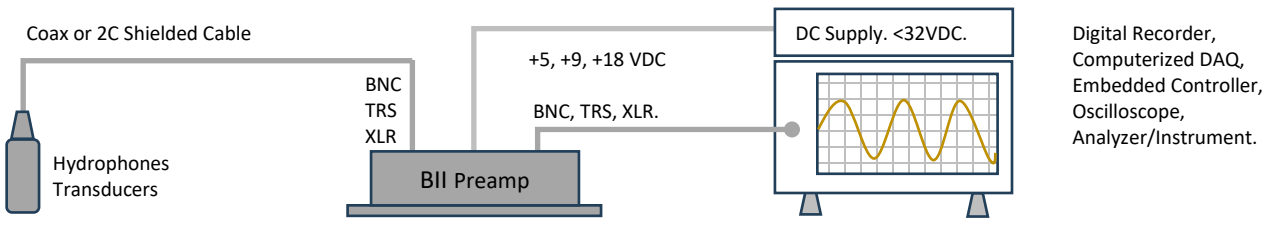
Signals and Wiring of Panel-Mount Connectors

Input or Output Signals			**Power Supply**
Single Ended (SE)	**Differential/Balanced (DF):**		**Single DC Supply**
BNC Jack	**3.5mm (1/8") 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.			

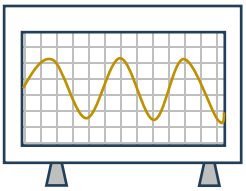
Signals and Wiring of Accessory Cables

Input or Output Signals			**DC Supply Cable**
Single Ended (SE)	**Differential/Balanced Signal (DF)**		**Single DC Supply**
BNC and Coax	**3.5mm (1/8") 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.



Components of an Acoustic Receiving System.



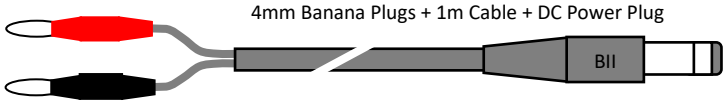
Digital Recorder,
Computerized DAQ,
Embedded Controller,
Oscilloscope,
Analyzer/Instrument.

Accessories:

Part Number: DCBP24.

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

4mm Banana Plugs + 1m Cable + DC Power Plug



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

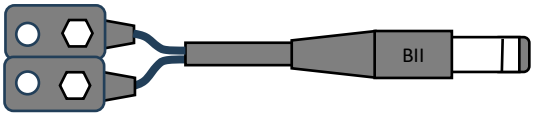
Red Banana Plug or Red Wire Lead: +VDC.	**Black Banana Plug or Black Wire Lead:** Common.	**Cable Shield, if any**: Shielding.

One 1m DC supply cable. One end is with Red and Black Banana Plugs, another end of the cable is with DC Power Plug. Depending on output terminals of buyer's DC Supply, buyer may assemble other type of connectors to DC supply cable at buyer's cost.

Part Number: DCBS18V.

Two 9V Battery Snaps + 0.3m (12") Cable + DC Power Plug

To Two 9V Batteries.



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

One 0.3m (12") DC supply cable. One end is two 9V Battery Snaps which supplies +18VDC to amplifiers, another end of the cable is with DC Power Plug.

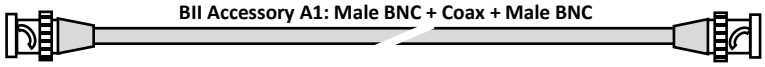
Part Number: DCBS9V. One 0.3m (12") DC supply cable with one 9V Battery Snaps which supplies +9VDC to amplifiers, and one DC Power Plug.

One 9V Battery Snap + 0.3m (12") Cable + DC Power Plug

To One 9V Battery.

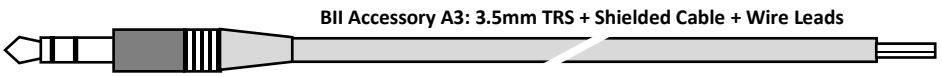
DC Power Plug.
To DC Power Jack of the Device.

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



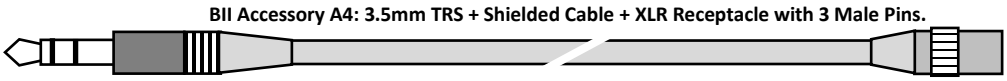
A2: Bespoke length cable with 3.5mm TRS Plug to 3.5mm TRS Plug. Default: 1.828m.

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.



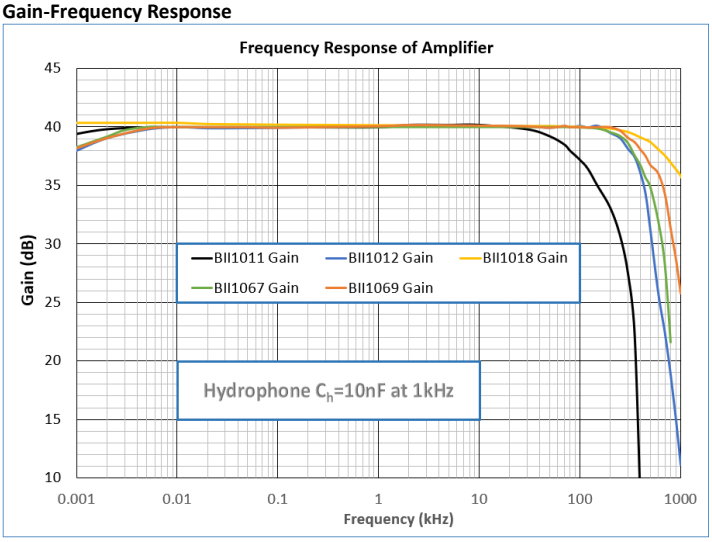
XLR Receptacle with 3 Male Pins.

Most recorders and analyzers use **XLR Plug with 3 Female Sockets** on front panel as differential/balance input connector and BII's XLR of A4 is compatible to it.

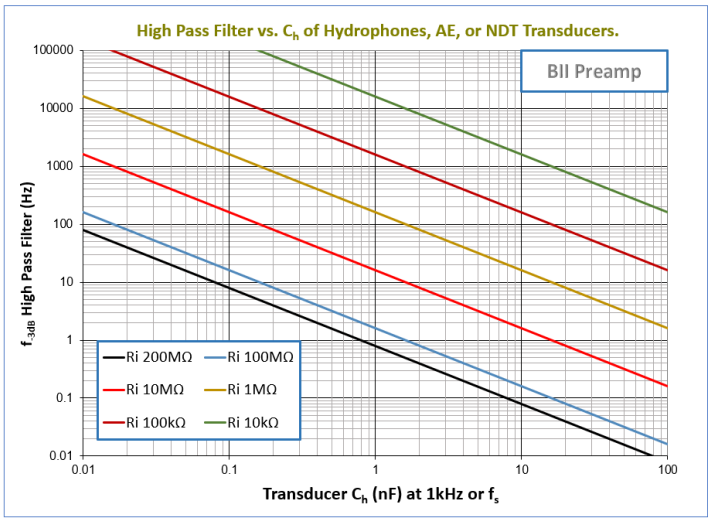
A7 Receiving Signal Cable. Part Number: XLR-P-WL-1m, Bespoke length cable with XLR Receptacle Male Pin to Wire Leads. Default: 1m.

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

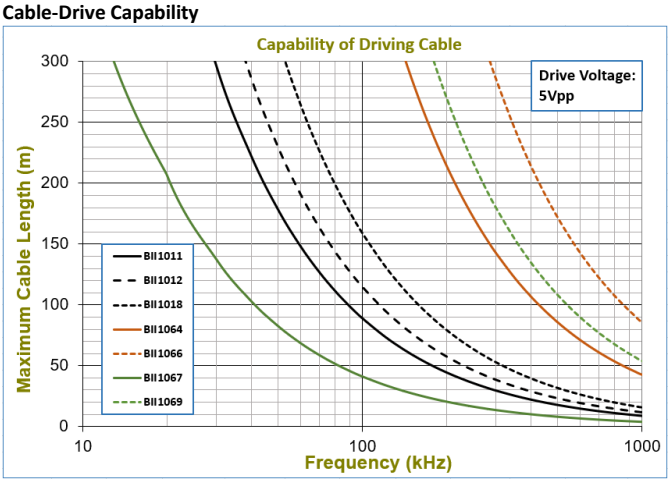
Gain-Frequency Response



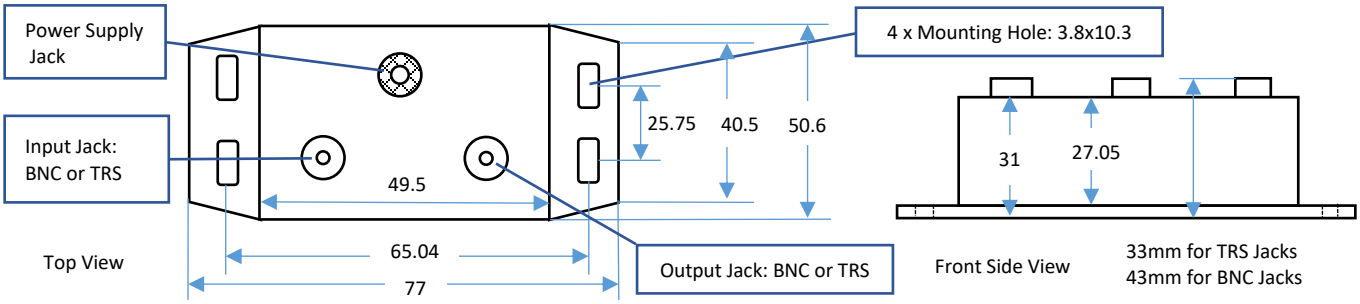
High Pass Filter vs. C_h of Hydrophone, AE, or NDT Transducer.



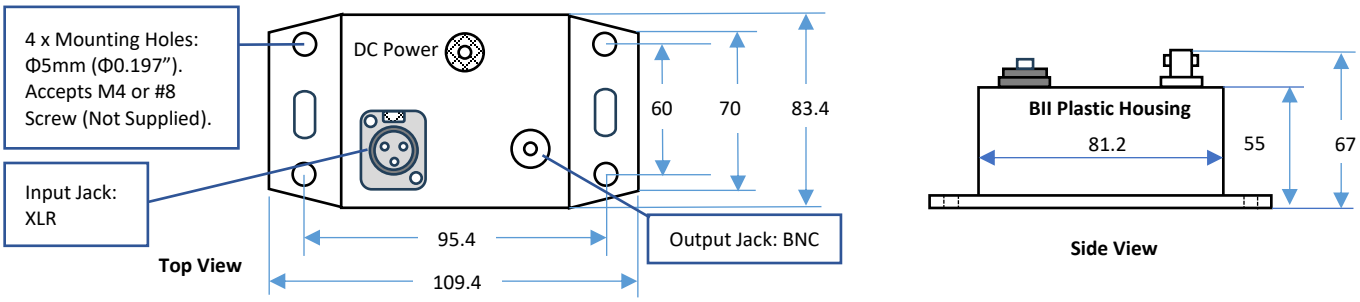
Cable-Drive Capability

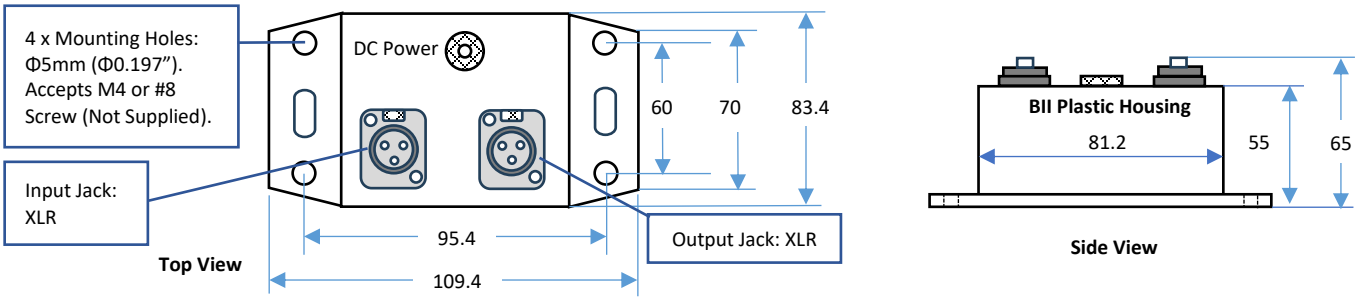


Metal Housing, Outline Dimensions (mm), Illustration only, the scale is not 1:1.



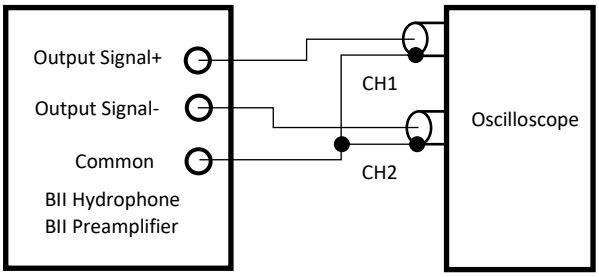
Plastic Housing, Outline Dimensions (mm), Illustration only, the scale is not 1:1.



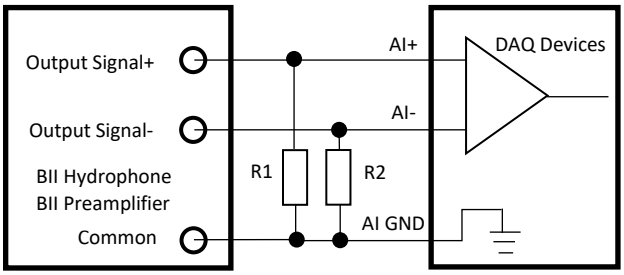


Preamplifier Wirings to DAQ (Data Acquisition): DAQ: Data Acquisition Hardware; AI: Analog Input; CH: Channel; GND: Ground.
R1 and R2 resistors are NOT necessary for most applications. If DAQ saturation occurs, use R1 = R2 = 10kΩ to 1MΩ resistors.

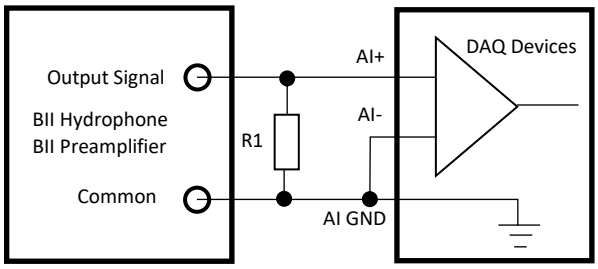
BII’s Differential Output to BNC Input of an Oscilloscope



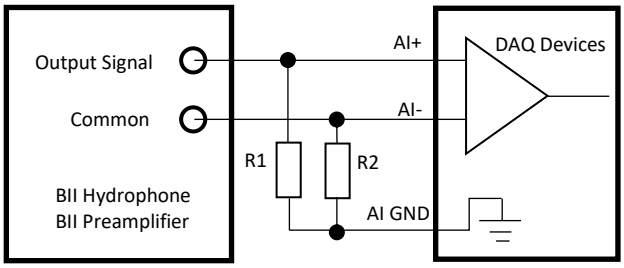
BII’s Differential Output to Differential Input of a DAQ



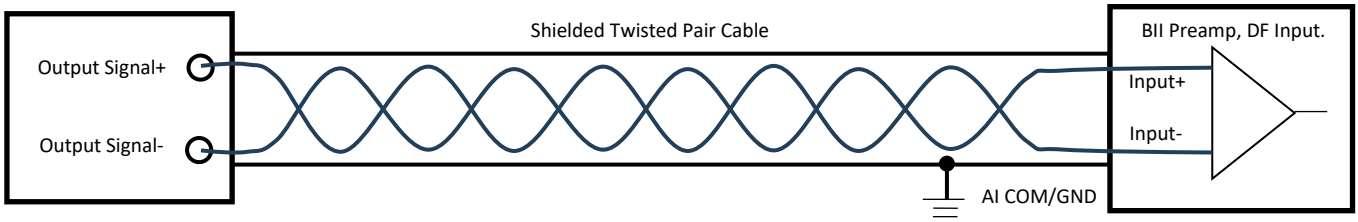
BII’s Single-Ended Output to Single-Ended Input of a DAQ



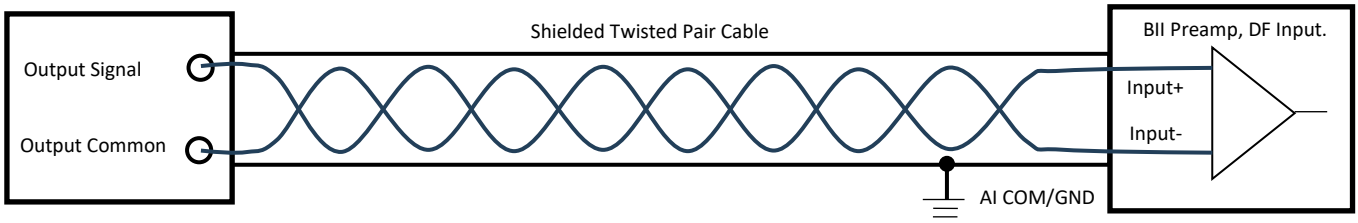
BII’s Single-Ended Output to Differential Input of a DAQ



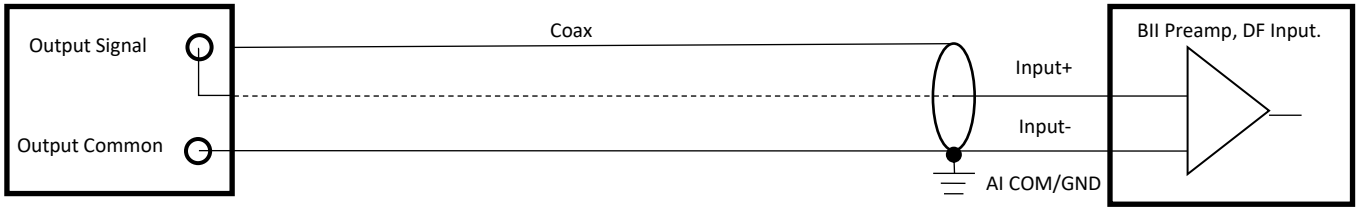
BII’s Differential Sound Receiver to Differential Input of a BII Preamp (Signal Conditioner)



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 20MHz. 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 capacitances of hydrophones/transducers 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.