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. Target Strength Testing, Towed Array, Sonobuoy, Bottom Moored Systems.	Ultrasonic (Ultrasound, AE, NDT) Testing, Material Characterization. Low Noise Ultrasonic Preamplifier, Instrumentation, Pulse Amplifier. Sonic Cavitation Noise, Hand-held, Portable, Battery-operated Systems.

BII1090 Series Low Noise Programmable Gain Preamplifier: 0.02Hz to 8MHz, 1.0nV/√Hz, 0.8fA/√Hz, 80dB Gain Variation, 1000m Cable Capacity.

Digitally programmable-gain amplifiers are invaluable components in SONAR (Underwater and Air) and ultrasound systems which detect a variety of sources with varying signal levels. Gain-selection is accomplished by a two-bit (or one-bit) digital word (TTL/CMOS level compatible), or manual setup.

Specification

SE: Single-ended, **DF**: Differential, **V_{omax}**: Maximum Output, **HPF**: Highpass Filter, **BPF**: Bandpass Filter, **LPF**: Lowpass Filter. BNC Jack (**BNC**): for Single Ended Signal. 3.5 mm TRS Jack (**TRS35**): for Differential Signal.

Preamplifier	**BII1091SE**	**BII1091DF**	**BII1092SE**	**BII1092DF**	**BII1093**	**BII1094**	**BII1098**
Input Type:	Differential, either single ended (**SE**) or differential (**DF**) input signals are accepted.						
Input Coupling:	AC						
Input Referred Noise: (f ≥ 1 kHz)	e_n: 5.8 nV/√Hz i_n: 3.1 fA/√Hz		e_n: 12 nV/√Hz i_n: 1.0 fA/√Hz		e_n: 5.2 nV/√Hz i_n: 3.1 fA/√Hz	e_n: 20 nV/√Hz i_n: 1.0 fA/√Hz	e_n: 1.0 nV/√Hz i_n: 1.6 pA/√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:	≤44MΩ||4pF (10/40dB Gain)		≤5MΩ||4pF (0/20/40/60dB)		≤2MΩ||4pF (20/40/60/80dB)	≤ 0.2GΩ||5pF	≤ 0.5MΩ||7pF or 50Ω||7pF.
	≤44MΩ||4pF (20/50dB Gain)		≤44MΩ||4pF (20/60dB)		≤2MΩ||4pF (40/80dB)		
	≤10MΩ||4pF (30/60dB Gain)		≤44MΩ||4pF (0/40dB)		≤10MΩ||4pF (20/60dB)		
	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.						
	To avoid adverse effects of parasitic components of a resistor, input impedance ≤ 5kΩ is recommended for MHz applications.						
Maximum Input:	2.4 Vpp or Maximum Output V_{omax}/Gain, whichever is less.						
Built-in Filter:	BPF		BPF		BPF	HPF	HPF
	Customized high pass or bandpass filters, 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 10MΩ constitute high pass filter with -3dB frequency 1.59Hz. (2) hydrophone 10nF at 1kHz and preamp R_i 200MΩ constitute high pass filter with -3dB frequency 0.08Hz.						
Gain of Pass Band:	10, 40 dB.		0, 20, 40, 60 dB.		20, 40, 60, 80 dB.	20, 60 dB.	30, 70 dB.
	20, 50 dB.		20, 60 dB.		40, 80 dB.		
	30, 60 dB.		0, 40 dB.		20, 60 dB.		
-3dB Bandwidth:	1Hz to 2.2MHz.		1Hz to 1MHz/350kHz.		1Hz to 1MHz/350kHz.	0.02Hz to 250kHz	1Hz to 8MHz
Settling Time, 0.01%:	0.12 µS		2 µS at Gain < 60dB. 10 µS at Gain = 60dB.		2 µS at Gain < 80dB. 10 µS at Gain = 80dB.	20 µS	0.4 µS
Output Type:	SE	DF	SE	DF	DF	SE	SE
Output Coupling:	AC						
Output Impedance:	10 Ω	10 Ω	10 Ω	50 Ω	50 Ω	10 Ω	50 Ω
V_{omax} (Vpp):	Vs – 3.4	Vs – 3.4	Vs – 3.4	Vs – 4.0	Vs – 4.0	Vs – 5.0	Vs – 1.0
Cable Driving Capability:	≤40 m ≤ 200 m at 20, 50 dB Gain. This option is bespoke order.		≤ 200 m	≤ 1000 m	≤ 1000 m	≤ 160 m	≤ 100 m
Gain Selection:	Digitally (CMOS/TTL Compatible, controlled by Digital Outputs) and/or Manually. **One-bit Wire**: A0 and Digital Common for Two Gain Selections. **Two-bit Wires**: A1, A0 and Digital Common for Four Gain Selections.						
	One-bit Wire		**One-bit or Two-bit Wires**		**One-bit or Two-bit Wires**	**One-bit Wire**	**One-bit Wire**
	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.						

Supply Voltage Vs:	+8 to +32 V	+8 to +32 V	+8 to +32 V	+8 to +32 V	+8 to +32 V	+9.5 to +32 V	+8 to +32 V
Quiescent Current:	13/14 mA	17/19 mA	9 mA	13 mA	22 mA	3.0 mA	15 mA
Suggested DC Supply V_s:	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.						
Service 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 (**TRS35**): for Differential Signal.						
Output Connector:	BNC Jack	TRS Jack	BNC Jack	TRS Jack	TRS Jack	BNC Jack	BNC Jack
Gain Selection:	BNC Jack	BNC Jack	TRS Jack	TRS Jack	TRS Jack	BNC Jack	BNC Jack
	1. 3.5 mm TRS Jack on Housing for tow-bit digital signal. **Accessories:** A3 with 0.9m Cable**.** 2. BNC Jack on Housing for one-bit digital signal. Gain Selection Cable: Buy uses buyer's own BNC and coax.						
Power Supply:	Power Connector Jack on Housing. Power Supply Cable: DCBP24, DCBS18V.						
Size:	77x50.6x33 mm (TRS Jacks) or 77x50.6x43 mm (BNC Jacks), or 95x59x37 mm (TRS Jacks) or 95x59x47 mm (BNC Jacks).						
Weight:	70 to 80.0 gram						
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: Cable with 3.5mm TRS Plug to XLR Receptacle with 3 Male Pins.						

Gain Selection Table with One-bit

A0	**BII1091SE, BII1091DF.**			**BII1092SE, BII1092DF.**		**BII1093**		**BII1094**	**BII1098**
0	10 dB	20 dB	30 dB	0 dB	20 dB	20 dB	40 dB	20 dB	30 dB
1	40 dB	50 dB	60 dB	40 dB	60 dB	60 dB	80 dB	60 dB	70 dB

Gain Selection Table with Two-bit

A1	**A0**	**BII1092SE, BII1092DF.**	**BII1093**
0	0	0 dB	20 dB
0	1	20 dB	40 dB
1	0	40 dB	60 dB
1	1	60 dB	80 dB

Standard Preamp, Metal Housing. BII keeps standard parts in stock.

Part Number	**-Gain**	**-R_i,** Refer to R_iC_h Filter.	**-Input Connector**	**-Accessory Cable Length**	**-Type**
BII1091DF, BII1091SE.	10/40dB	44 MΩ, 5 MΩ, 500 kΩ.	BNC or TRS.	Blank: No Accessories. 0.6m, 0.9m, 1.8m, 10m, 20m.	A1, A2, A3, or A4. DCBP24, DCBS18V.
	20/50dB	44 MΩ, 5 MΩ, 500 kΩ.			
	30/60dB	10 MΩ, 1 MΩ, 100 kΩ.			

Example:	**Description:**
BII1091DF-10/40dB-44MΩ-BNC-20m-A4-DCBS18V:	BII1091DF, Preamp, Gain: 10/40dB, Input Impedance: 44MΩ, Input: BNC Jack, Accessory: 20m A4. DC Supply Cable: DCBS18V.
BII1091DF-10/40dB-44MΩ-TRS-20m-A4-DCBS18V:	BII1091DF, Preamp, Gain: 10/40dB, Input Impedance: 44MΩ, Input: TRS Jack, Accessory: 20m A4. DC Supply Cable: DCBS18V.
BII1091DF-20/50dB-44MΩ-BNC-20m-A4-DCBS18V:	BII1091DF, Preamp, Gain: 20/50dB, Input Impedance: 44MΩ, Input: BNC Jack, Accessory: 20m A4. DC Supply Cable: DCBS18V.
BII1091DF-30/60dB-10MΩ-BNC-DCBP24:	BII1091DF, Preamp, Gain: 30/60dB, Input Impedance: 44MΩ, Input: BNC Jack, DC Supply Cable: DCBP24.

How to Order Bespoke Preamplifiers (Metal Housing). Non-stock.

Part Number	**-Gain**	**-HPF/LPF or HPF**	**-Input Connector**	**-Accessory Cable Length**	**-Type**
BII1092SE, BII1092DF, BII1093.	Gain Options.	-3dB Bandpass or Highpass Frequency, in Hz, kHz, MHz.	BNC or TRS.	Blank: No Accessories. in meter.	A1, A2, A3, or A4. DCBP24, DCBS18V.
BII1094, BII1098.		Not Supported.			

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

Example:	**Description:**
BII1092SE-20/60dB-10Hz-BNC-DCBS18V:	BII1092DF, Preamp, Gain: 20/60dB, -3dB Highpass Filter: 10Hz, Input: BNC Jack, DC Supply Cable: DCBS18V.
BII1092DF-20/60dB-10Hz/200kHz-BNC-DCBS18V:	BII1092DF, Preamp, Gain: 20/60dB, -3dB Bandpass Filter: 10Hz to 200kHz, Input: BNC Jack, DC Supply Cable: DCBS18V.
BII1092SE-20/60dB-10Hz-TRS-DCBS18V:	BII1092SE, Preamp, Gain: 20/60dB, -3dB Highpass Filter: 10Hz, Input: TRS Jack, DC Supply Cable: DCBS18V.
BII1092DF-20/60dB-10Hz/200kHz-TRS-100m-A4-DCBS18V:	BII1092DF, Preamp, Gain: 20/60dB, -3dB Bandpass Filter: 10Hz to 200kHz, Input: TRS Jack, Accessory: 100m A4. DC Supply Cable: DCBS18V.

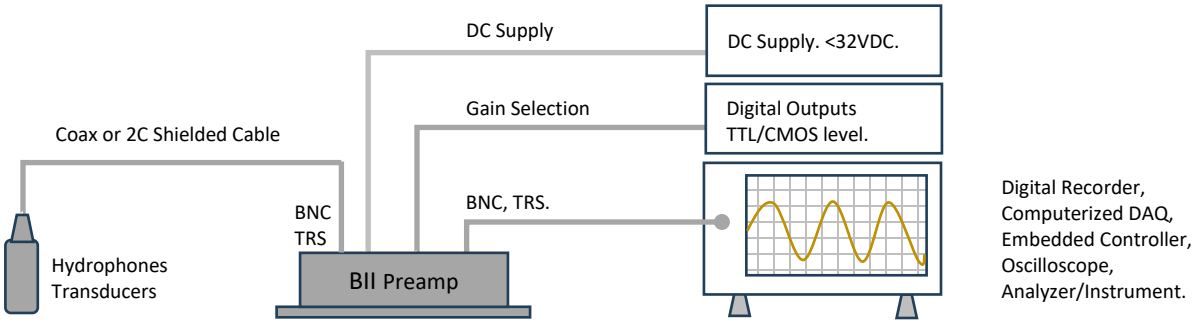
Signals and Wiring of Panel-Mount Connectors

Input or Output Signals		Gain Selection (BII1090 Series)		Power Supply
Single Ended (SE)	Differential/Balanced (DF)	Digital Signals, Logic "0" and "1".		Single DC Supply.
BNC Jack	3.5mm TRS and Cable	3.5mm TRS Jack	BNC Jack	Power Jack,
Center: Signal Shield: Common	Tip, Signal +. Ring, Signal -. Sleeve: Shield and Common.	Tip: A1. Ring: A0. Sleeve: Digital COM.	Conductor: A0. Shield: Digital COM.	Center Contact: +VDC. Shell: Common.
Metal Case is for shielding and grounding.				

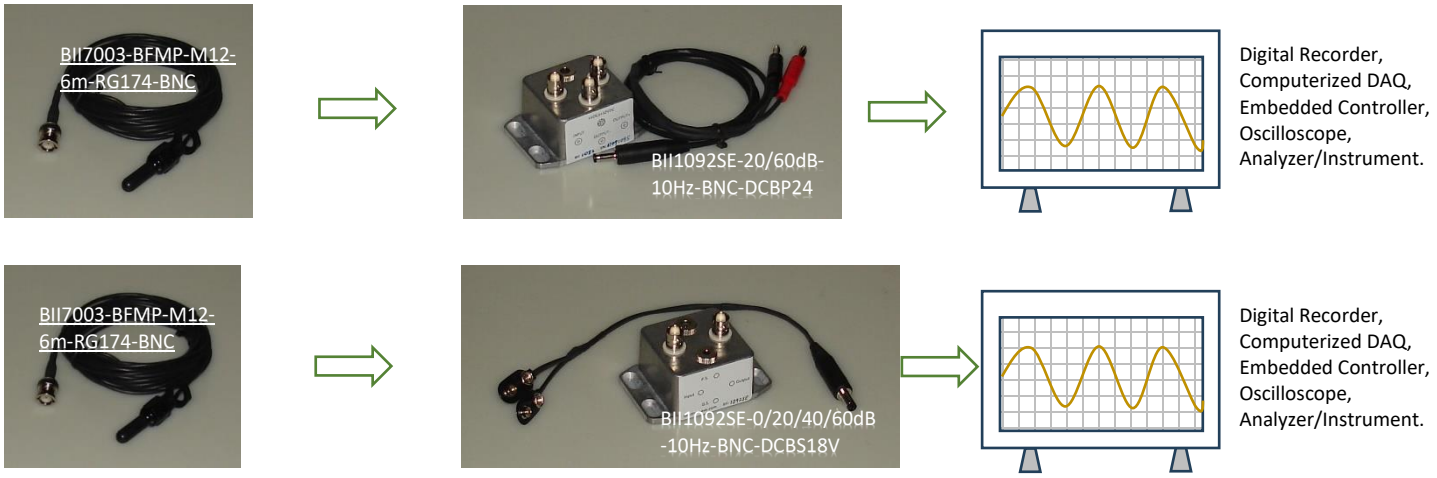
Signals and Wiring of Accessory Cables

Input and Output Signals			Gain Selection (BII1090 Series)		DC Supply Cable
Single Ended (SE)	Differential/Balanced (DF)		Digital Signals Logic "0" and "1"		Single DC Supply.
BNC and Coax	1/8" TRS and Cable	XLR and Cable	3.5mm TRS and Cable	BNC and Coax	Power Plug
Center: Signal Shield: Common	**Signal+**:White, TRS Tip, XLR Pin 2. **Signal-**: Black or Red, TRS Ring, XLR Pin 3. **Common:** Shield, TRS Sleeve, XLR Pin 1.		Tip, White Wire: A1. Ring, Black or Red Wire: A0. Sleeve, Black Wire: Digital COM.	Conductor: A0. Shield: Digital COM.	Red Banana Plug: +VDC. Black Banana Plug: Common. Cable Shield: Shielding.
Warning: "Signal –" is the reverse (180° phase difference) of "Signal +", and "Signal –" can NOT be connected to Common or Ground.					

System Wirings of Standalone Preamp.



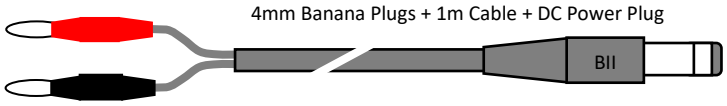
Components of an Acoustic Receiving System.



Accessories:

Part Number: DCBP24.

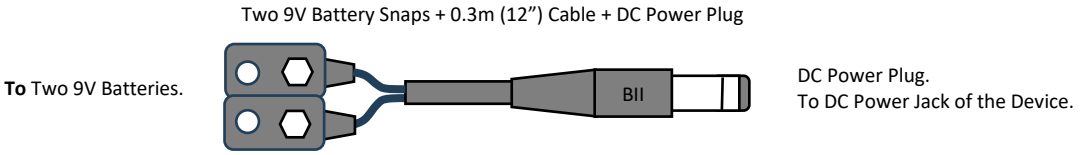
To Terminals of DC Supply:
a. One Red 4mm Banana Plug.
b. One Black 4mm Banana Plug.



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

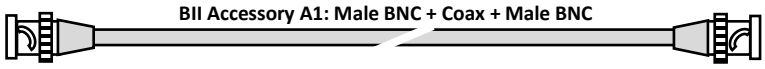
One 1m DC supply cable. One end is with Red and Black Banana Plugs, another end of the cable is with DC Power Plug. Depending on output terminals of buyer's DC Supply, buyer may assemble other type of connectors to DC supply cable at buyer's cost.

Part Number: DCBS18V.



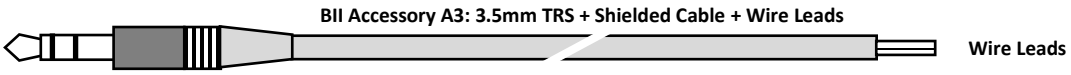
One 0.3m (12") DC supply cable. One end is two 9V Battery Snaps which supplies +18VDC to amplifiers, another end of the cable is with DC Power Plug.

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

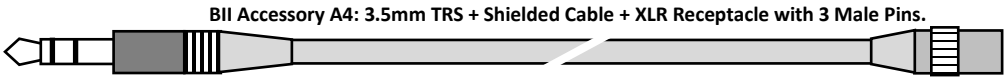


A2: Bespoke length cable with 3.5mm TRS Plug to 3.5mm TRS Plug. Default: 1.828m.

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



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



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.

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.

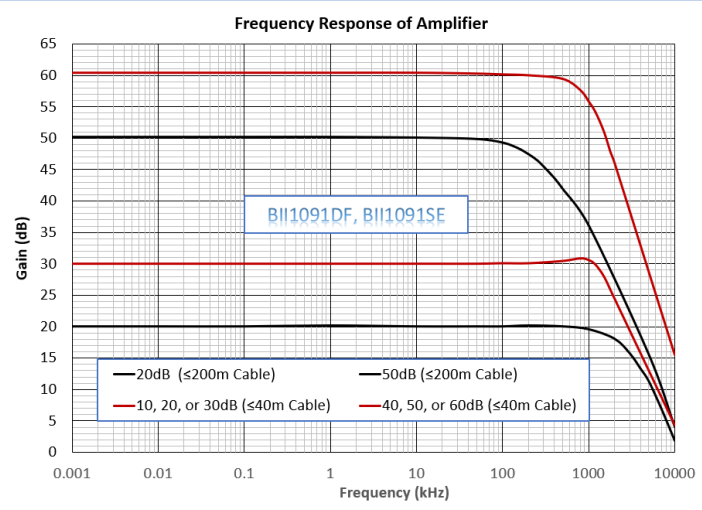
Can 3.5mm (1/8") TRS be configured for single-ended signal of a hydrophone/transducer which does not have built-in preamplifier? Yes, the preamp with differential-input TRS can accept single-ended signals from hydrophones/transducers whose TRS wiring should be like followings: **TRS Tip**: Signal. **TRS Ring and Sleeve:** Both terminals are soldered together for Signal Common and Shielding. Common and shielding should be "one-point" contact.

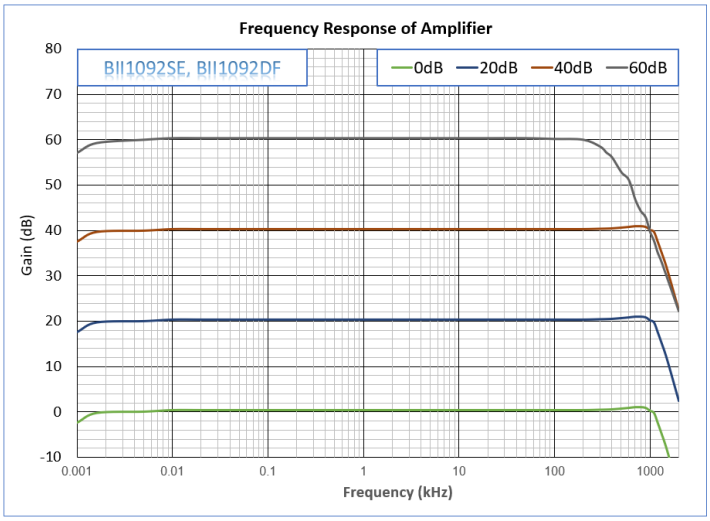
Can BII explain why the capacitance of my hydrophone/transducer affect high pass filtering? (1). Hydrophone/transducer is high impedance devices in low frequency range. Its simplified complex impedance = $j/(2\pi f C_h)$, C_h is the capacitance of hydrophone/transducer, f is frequency in Hz. This impedance 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.

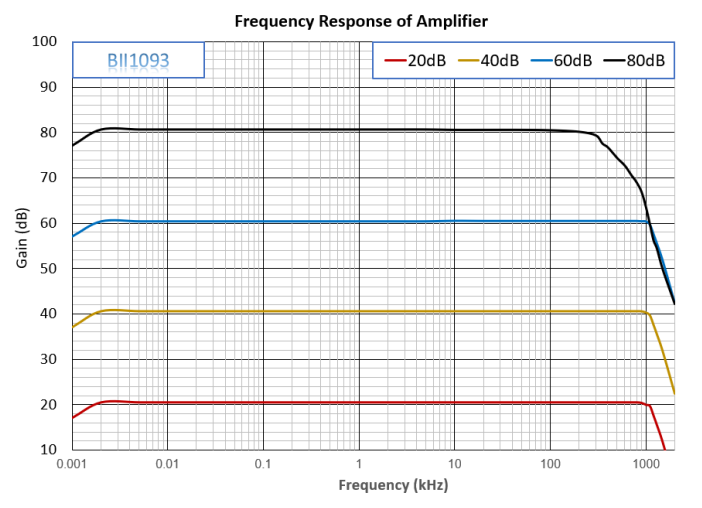
My recorder (or signal processing device) is about 100m away from the hydrophone (or AE Sensor), which type of preamplifiers should I choose? Choose differential-output preamps to drive the 100m cable and ensure that your data acquisition device can accept differential signals.

I need a low noise preamp, How do I choose the BII preamps? Generally, choose low i_n preamp if useful signal consists of low frequency components less than 10 kHz; choose low e_n preamp if frequency components of useful signal are greater than 10 kHz.

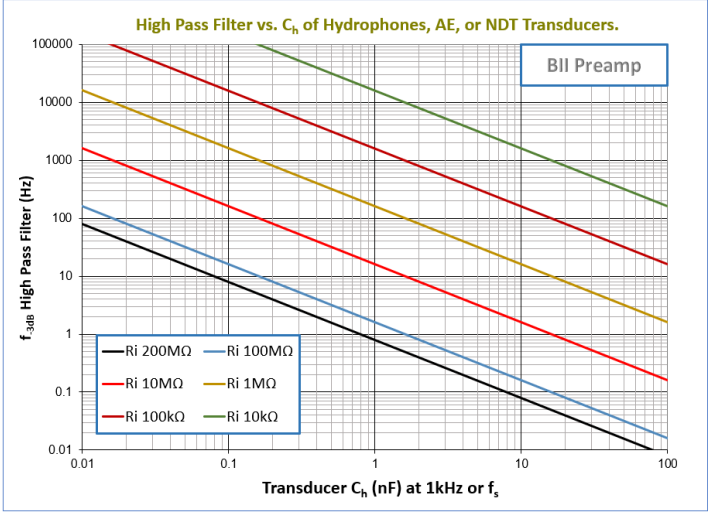
Frequency Response



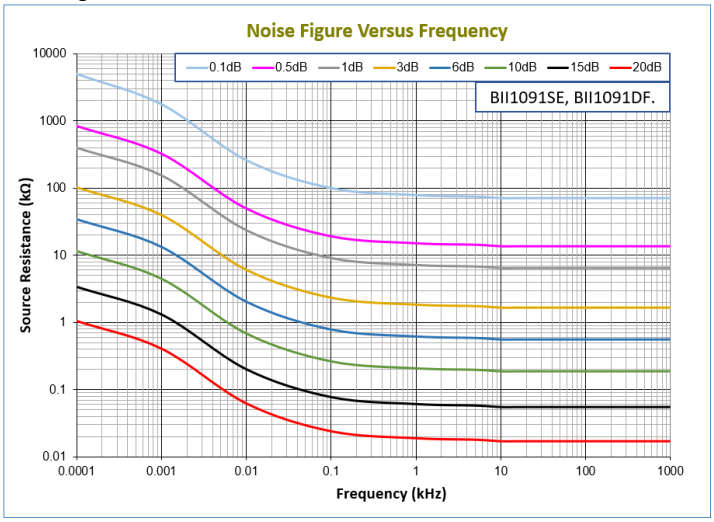




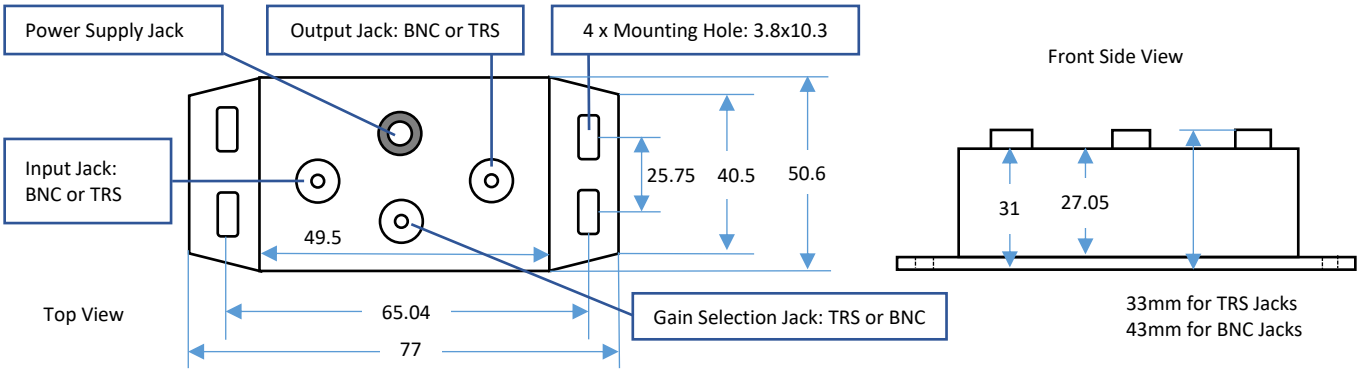
High Pass Filter vs. Ch of Hydrophone, AE, or NDT Transducer.



Noise Figure

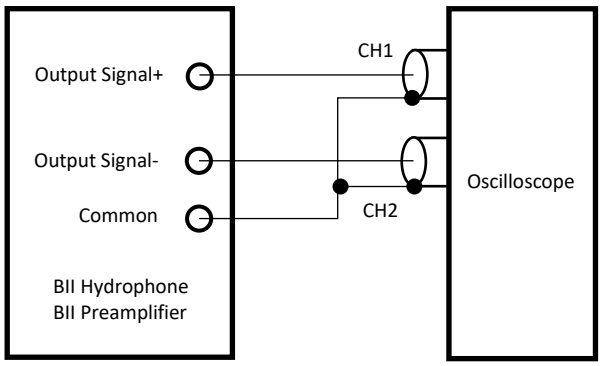


Programmable Gain Preamplifiers BII1090 Series with Metal Housing LxWxH = 77x50.6x31, Outline Dimensions (mm).



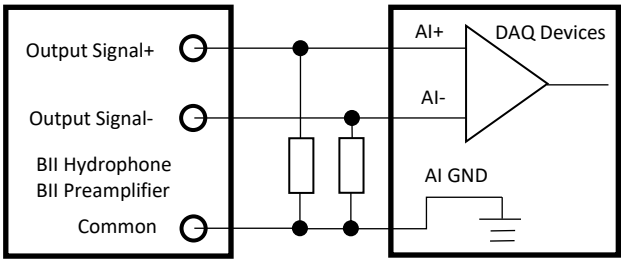
Preamplifier Wirings to DAQ (Data Acquisition) BII: Benthowave Instrument Inc.; DAQ: Data Acquisition Hardware; AI: Analog Input; CH: Channel; GND: Ground.

BII's Differential Output to BNC Input of an Oscilloscope



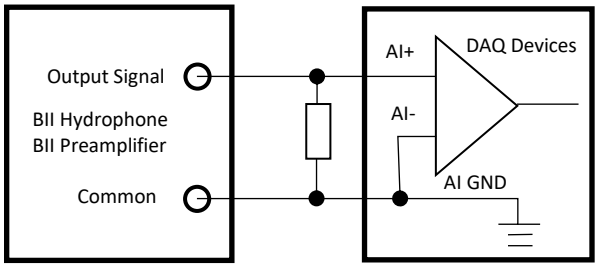
BII's Differential Output to Differential Input of a DAQ

If input impedance of a DAQ device is greater than 100MΩ, use following wiring with one 100kΩ to 1MΩ resistor.



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

If input impedance of a DAQ device is greater than 100MΩ, use following wiring with one 100kΩ to 1MΩ resistor.



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