



Transducer Specification

Part Number:	BII7524	BII7524-IM50Ω
Resonant Frequency f_s :	50 kHz \pm 5%	50 kHz \pm 10%
Transmitting Frequency:	$f_s \pm 20\% * f_s$	$f_s \pm 25\% * f_s$ and MUST greater than 10 kHz.
Impedance Matching:	No	Built-in, Impedance matching to 50Ω by default.
	TVR and FFVS variation of a transducer with built-in Impedance Matching Network: 1. When $R_{IM} < 1/G$, TVR increases, FFVS decreases. Generally, this is true for low frequency transducers. 2. When $R_{IM} > 1/G$, TVR decreases, FFVS increases. Generally, this is true for high frequency transducers. R_{IM} : Impedance-Matched Resistance such as 50 Ω. G: Transducer Conductance at Operating Frequency.	
Signal Type:	Pulsed SINE, Chirp, PSK, FSK, Pulsed Square Waveform, etc.	
Directivity Pattern:	Omnidirectional Beam at f_s . Refer to Graph of Directivity Pattern .	
Free Capacitance C_f :	24.0 nF \pm 10% @ 1kHz, 1m cable.	N/A
Dissipation D:	0.004 @ 1kHz, 1m cable.	N/A
Quality Factor Q_m at f_s :	3.85	2.8
	-3dB bandwidth $\Delta f = f_s/Q_m$. Q_m determines the transient response or the rise and fall rings of steady-state response.	
η_{ea} at f_s at f_s :	0.86 in Water, Electroacoustic Efficiency, Load Medium Dependent.	
η_{ea} at $f \ll f_s$:	at $f \ll f_s$, $\eta_{ea} / \eta_{ea \text{ at } f_s} \approx 0.25 * (k * \Phi D)^2$. Wave Number $k = 2\pi/\lambda$; ΦD = Transducer Diameter.	
	1. Electroacoustic Efficiency η_{ea} is quite low at $f \ll f_s$ and drops gradually at $f > f_s$, so it is NOT recommended for transducers to emit high power sounds at frequencies far from f_s. Otherwise, transducer may be damaged by overheating. 2. Transducer can emit low power sounds at frequencies far from f_s. For example, input power $P_i \leq \eta_{ea} * MIPP$ at $f \leq 0.8 * f_s$ and $P_i \leq 0.2 * MIPP$ at $f \geq 1.3 * f_s$.	
Power Factor at f_s :	0.84	≥ 0.94
TVR at f_s :	150.0 \pm 2 dB $\mu Pa/V@1m$, Transmitting Voltage Response.	152.5 \pm 2 dB $\mu Pa/V@1m$ for BII7524-IM50Ω. 155.0 \pm 2 dB $\mu Pa/V@1m$ for BII7524-IM30Ω. 159.0 \pm 2 dB $\mu Pa/V@1m$ for BII7524-IM5Ω.
Radiation Sound Level SL:	SL = 20*log V_i + TVR, dB $\mu Pa@1m$. Driving Voltage V_i is in unit of V_{rms} .	
Admittance or Impedance:	Refer to G-B Graph .	1. Default: Z = 50* $e^{j\theta}$, in Ω , and Phase Angle $ \theta \leq 20^\circ$ at fs. 2. Customization: refer to Impedance Matching at f_s . Refer to Z-θ Graph .
Driving Voltage V_i at f_s :	Pulsed Driving Signal and Duty Cycle D < 100%: $V_{imax} = \sqrt{(MIPP/G_{max})}$ or 230 , whichever is less, in V_{rms} .	Pulsed Driving Signal and Duty Cycle D < 100%: $V_{imax} = \sqrt{(MIPP * Z)}$, in V_{rms} . Z is impedance at f_s .
	Continuous Operation at 100% Duty Cycle: $V_{imax} = \sqrt{(MCIP/G_{max})}$, in V_{rms} .	Continuous Operation at 100% Duty Cycle: $V_{imax} = \sqrt{(MCIP * Z)}$, in V_{rms} .
	To achieve higher sound level, built-in impedance matching is recommended to step up driving voltage inside the transducer.	
Input Power P_i :	$P_i = V_i^2 * G$. Refer to G-B Graph : G is conductance.	$P_i = V_i^2 / Z$ at f_s . Z is impedance at f_s .
MIPP at f_s :	460 Watts, Maximum Input Pulse Power.	
MPW at MIPP and f_s :	24 Seconds, Maximum Pulse Width.	
MCIP at f_s :	130 Watts, Maximum Continuous Input Power.	
How to determine pulse width, duty cycle and off-time with input pulse power (peak power) at f_s:		
1. Determine the input pulse power (IPP, peak power) with sound intensity required by the project. IPP MUST be less than MIPP.		
2. Pulse Width $\leq (MIPP * MPW * (120^\circ C - T) / 103^\circ C) / IPP$. T: Water Temperature in $^\circ C$.		
3. Duty Cycle $D \leq MCIP * (120^\circ C - T) / 103^\circ C / IPP$.		
4. Off-time $\geq PW * (1 - D) / D$.		
FFVS at f_s :	-198.0 \pm 2 dB V/ μPa , Free-field Voltage Response.	-201.0 \pm 2 dB V/ μPa for BII7524-IM50Ω. -203.0 \pm 2 dB V/ μPa for BII7524-IM30Ω. -211.0 \pm 2 dB V/ μPa for BII7524-IM5Ω.
	<i>Sensitivity Loss over extension cable at f_s (dB) = 20 * log {(1 + 2$\pi f_s C_e / B$) / $\sqrt{[G^2 + (B + 2\pi f_s C_e)^2] / (G^2 + B^2)}}$ G: Conductance at f_s; B: Susceptance at f_s; C_e: Capacitance of Extension Cable. Cable is of 100 pF/meter roughly. Please refer to online document AcousticSystem.pdf for conversion between G-B and Z-θ, if necessary.</i>	
Receiving Sound Level SL:	SL = 20*log V_o - FFVS, dB μPa . Receiving Voltage V_o is in unit of V_{rms} .	
Operating Depth:	Maximum, 460 m or 4.6 MPa Pressure.	Maximum, 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 (THSO) 3. Thru-hole Mounting with Double O-ring (THDO) 4. Bolt Fastening Mounting (Stainless Steel) (BFMSS) 5. End-face Mounting (EFM) Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.	
Cable Options:	1. Two Conductor Shielded Cable (SC), Rubber or PVC Jacket. SC with Two Conductors for transmit signal; SC with 4 conductors for receive signal. 2. 50 Ω RG58 Coax (RG58)	

	<p>3. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, $\Phi D=3.2$ mm (SC32), up to 200°C, AWG26 Conductors (Not Waterproofed, ONLY for Dry Air Use).</p> <p>4. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, $\Phi D=4.0$ mm (SC40), up to 200°C, AWG20 Conductors (Not Waterproofed, ONLY for Dry Air Use).</p> <p>5. Two Conductor Unshielded Cable (USC)</p> <p>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.</p>	
Cable Length:	<p>1. Default: 1 m.</p> <p>2. Custom-fit.</p>	
Connector Options:	<p>1. Default: Wire Leads (WL), for Transmit, Receive Signal, and DC Power Supply.</p> <p>2. Underwater Mateable Connector (pin) (UMC) (Max. Diameter $\Phi 21.5$ to $\Phi 35$ mm), for Transmit or Receive Signal.</p> <p>3. MIL-5015 Style (pin) (MIL) (Max. Diameter $\Phi 19$ to $\Phi 30$ mm), for Transmit or Receive Signal.</p> <p>4. XLR Plug (pin) (XLR). (Max. Diameter $\Phi 20.2$ mm), for Transmit or Receive Signal.</p> <p>5. Male BNC (BNC) (Max. Diameter $\Phi 14.3$ mm), for Transmit or Receive Grounded Signal.</p> <p style="color: blue;">BNC with RG178 Coax: Service Temperature up to 165°C or 329°F.</p> <p>6. 1/8" (3.5mm) TRS Plug (TRS) (Max. Diameter $\Phi 10.5$ mm), for Receive Signal ONLY.</p> <p>7. +9VDC Battery Snap (BS), +9VDC or +18VDC power supply for Built-in T/R Switch Module.</p> <p>8. 4mm Banana Plug Pair (Red and Black Color) (BP), DC power supply for Built-in T/R Switch Module.</p> <p>Note: Underwater Mateable Connector is for uses underwater. Other connectors and wire leads are for dry uses and are not waterproofed.</p>	
Size:	$\Phi D = \Phi 41.3$ mm, Length ≥ 50.8 mm.	$\Phi D = \Phi 48$ mm, Length ≥ 105 mm.
	Actual length depends on Mounting Parts and/or Add-on Parts such as -TR, -IM, -HT, etc.	
Weight in Air:	0.37 kg, 1m cable.	0.6 to 1.0 kg, 1m cable.
	Actual weight depends on Mounting Parts, Cable Types and Length, and/or Add-on Parts such as -TR, -IM, -HT, etc.	
Operation Temperature:	<p>1. Default: -10 °C to +60 °C or 14 °F to 140 °F.</p> <p>2. Bespoke High Temperature Transducer: -10 °C to 120 °C, or 14 °F to 248 °F. Append HT to part number.</p>	
Storage Temperature:	-20 °C to +60 °C or -4 °F to 140 °F.	
Impedance Matching at fs:	<p>BII6000 Bespoke Impedance Matching between transducers and power amplifiers. Order Separately as standalone devices or append -IMxxxΩ to the part number for integrating BII6000 into the transducer and specify impedance in Ω at fs. For example, BIIxxxx-IM8Ω: BIIxxxx transducer with built-in Impedance Matching unit as 8Ω load at fs.</p>	
TR Switch Module:	<p>BII2100 Transmitting & Receiving Switch Module with built-in Preamp and Bandpass Filter. Order Separately as standalone devices or append -TR to the part number for integrating BII2100 into the transducer. For example, BIIxxxx-TR: BIIxxxx transducer with built-in T/R Switch Module.</p>	
Temperature Sensor:	<p>1. Default: No built-in temperature sensor.</p> <p>2. Built-in temperature sensor. Append -TS to part number (BIIxxxx-TS) for integrating a temperature sensor in the transducer.</p>	
Power Amplifier:	BII5000 Power Amplifiers for SONAR, NDT, HIFU. Order Separately as standalone devices.	
Potable Transmitter:	BII8030 series portable acoustic transmitters.	
Portable T/R System:	BII8080 series portable transmit and receive systems.	
<p>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.</p> <p>for 50Ω BNC/SMA/SMC connector, it is buyer's sole responsibility to make sure that the BNC/SMA/SMC shield of the signal source is firmly grounded for operating safety before hooking up transducer/hydrophone to the signal source. Coax with BNC/SMA/SMC is not intended for hand-held use at voltages above 30Vac/60Vdc.</p>		

Wiring Information of a Transducer without T/R Switch.

Transducer Wiring:	Shielded Cable	Coax, BNC.	Underwater Connector	MIL-5015 Connector	XLR Plug
Signal:	White or Red	Center Contact	Contact 2	Contact C	Pin 2
Signal Common:	Black	Shield	Contact 1	Contact B	Pin 3
Shielding and Grounding	Shield	Shield	Contact 3	Contact A	Pin 1

Wiring Information of Temperature Signal.

Temperature Sensor Wiring:	Shielded Cable	Coax, BNC, SMC, SMA	Underwater Connector	XLR Plug	TRS Plug
Signal:	White or Red	Center Contact	Contact 2	Pin 2	Tip
Signal Common:	Black	Shield	Contact 1	Pin 3	Ring
Shielding and Grounding	Shield	Shield	Contact 3	Pin 1	Sleeve

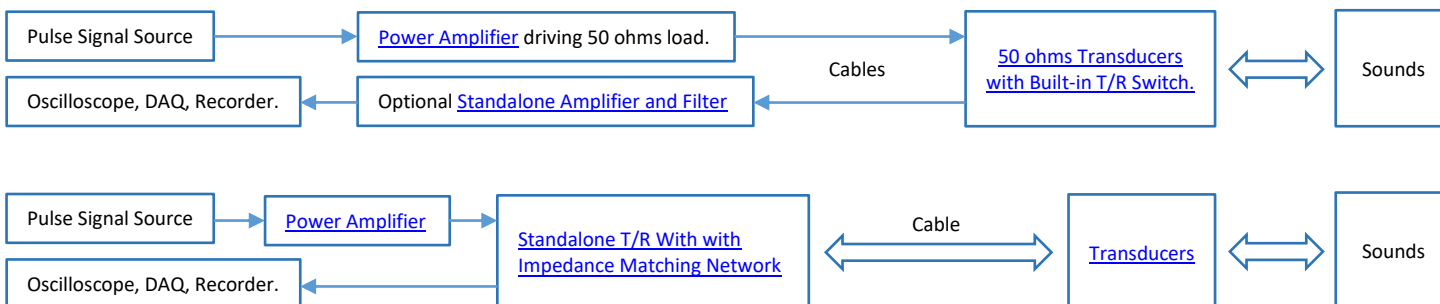
How to Order Transducers without T/R Switches. The default options are for stock items which are regularly available.

<p>FH: Free Hanging. SC for Transmit: Shielded Cable (Rubber Jacket, 600V) with 2 conductors. Coax: 50 Ω Coaxial Cable. WL: Wire Leads.</p>					
Part Number	-Appendage	-Mounting	-Cable Length	-Cable Type	-Connector for signals of Transmit and Temperature Sensor
BII7524	Default: None.	Default: FH.	Default: 10m.	SC for low frequency signal. Coax for high frequency signal.	Default: WL.
Example:	Description				
BII7524-BFMSS-0.3m-SC-UMC	BII7524 Transducer, Bolt Fastening Mounting (Stainless Steel) (BFMSS), 0.3m Shielded Cable, Male Underwater Mateable Connector.				
BII7524-HT-FH-6m-RG178-BNC	BII7524 Transducer, Service Temperature: -10 °C to 120 °C, or 14 °F to 248 °F. Free Hanging, 6m RG178 Coax, BNC Male.				
BII7524-IM50 Ω -FH-20m-RG58-BNC	BII7524 Transducer, Built-in Impedance Matching Network as 50 Ω load at fs, Free Hanging, 20m RG58 Coax, Male BNC.				
BII7524-IM8 Ω -FH-10m-SC-XLR	BII7524 Transducer, Built-in Impedance Matching Network as 8 Ω load at fs, Free Hanging, 10m Shielded Cable, XLR Plug.				
BII7524-TS-IM8 Ω -FH-10m-SC-WL/TRS	BII7524 Transducer, Built-in Temperature Sensor, Built-in Impedance Matching Network to 8 Ω at fs, Free Hanging, 10m Shielded Cable, Wire Leads for Transmit Signal, TRS for Temperature Signal.				

Specifications of Built-in T/R Switch for Sound Receiving with Transducer BII77524-TR or BII77524-TR-IMxxΩ.

Receiving Preamp and Filter:	Yes, Fixed Gain Preamp and Bandpass Filter are built inside transducer housing to receive sounds. 1. Avoid saturation caused by strong sounds levels in low frequency range. 2. Avoid signal loss over cable. 3. Avoid signal loss caused by impedance matching network which is built inside transducers.
Receiving Gain:	1. Default: 40 dB. 2. Bespoke: 20 dB to 60 dB.
-3dB Receiving Bandwidth:	1. Default: 2 to 200 kHz. 2. Customized, Specify when ordering.
	Minimum -3dB cut-off frequency of high pass filter: 2 kHz. Band Pass Filter: 1 st order, 20/Decade Roll-off.
Voltage Noise RTI e_n :	7.0 nV/√Hz at default gain.
Current Noise RTI i_n :	0.56 fA/√Hz.
Input Dynamic Range:	≥ 100 dB at 100 kHz Bandwidth.
Output Signal Type:	Differential
Output Impedance:	10 Ω
Cable Drive Capability:	200 m
Cable:	Four Conductor Shielded Cable
Connector:	Refer to Connector Options .
Signal Conditioning:	Standalone Programmable Gain Amplifier and Filters to compensate the loss of sound propagation and spreading. Order separately.
Power Supply of Receiving Circuit	
Supply Voltage V_s :	+8.5 to +32 VDC
Current (Quiescent):	6.8 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.
DC Supply Cable:	Two Conductor Shielded Cable if the cable of Receiving Signal is Coax.
DC Supply Connector:	Refer to Connector Options .

System Setup of Transmitting and Receiving Sounds.



Wiring Information of Transmitting Sounds of a Transducer with T/R Switch.

Single Ended Signal:	Shielded Cable	Coax, BNC.	Underwater Connector	MIL-5015 Connector	XLR Plug
Signal:	White or Red	Center Contact	Contact 2	Contact C	Pin 2
Signal Common:	Black	Shield	Contact 1	Contact B	Pin 3
Shielding and Grounding	Shield	Shield	Contact 3	Contact A	Pin 1

Please contact us for bespoke wirings of differential transducers such as dipole, quadrupole, multimode rings, and flexensional sources.

Wiring Information of Receiving Sounds of a Transducer with T/R Switch.

Differential Output:	Wire Leads	Underwater/XLR Connector	XLR + 9V Battery Snap	TRS + 9V Battery Snap
+VDC	Red	Pin 3	Battery Female Snap	Battery Female Snap
Common	Black	Pin 1	Battery Male Snap	Battery Male Snap
Signal+	White	Pin 2	XLR Pin 2	TRS Tip
Signal-	Blue, Green, or Yellow	Pin 4	XLR Pin 3	TRS Ring
Signal Common	N/A	N/A	XLR Pin 1	TRS Sleeve
Shielding	Shield	N/A	XLR Metal Shell	N/A

4mm Banana Plug Pair: Red Plug for +VDC, Black Plug for Common of the DC power supply.

How to Order Transducers with T/R Switches.

The default options are for stock items which are regularly available.

FH: Free Hanging. **SC for Low Frequency Transmit:** Shielded Cable (Rubber Jacket, 600V) with 2 conductors. **Coax for High Frequency Transmit:** 50 Ω Coaxial Cable. **SC for Low Frequency Receive:** Shielded Cable with 4 conductors. **Coax for High Frequency Receive:** 50 Ω Coaxial Cable. **WL:** Wire Leads. **HPF:** -3dB High Pass Filter Frequency. **LPF:** -3dB Low Pass Filter Frequency. **Cable of Temperature sensor** is two-conductor shielded cable. **Cable of DC Supply** is two-conductor shielded cable in case that receive cable is coax.

Part Number	-Appendage	-Receive Gain	-HPF/LPF	-Mounting	-Cable Length	-Cable Type	-Connector for signals of Transmit/Receive/DC Supply/Temperature
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BII7524	Default: TRIM50Ω	Default: 40 dB	-3dB Receiving bandpass Frequencies. Default: 2 to 200 kHz.	Default: FH.	Default: 10m.	Default: SC or Coax	Default: WL.
Example:			Description				
BII7524-TR-IM50Ω-40dB-2kHz/200kHz-BFMSS-10m-SC-MIL/XLR/BS			BII7524 Transducer, Built-in T/R Switch, Built-in Impedance Matching Network as 50Ω load at fs, Receiving Gain: 40dB, Receiving Bandpass Filter: 2kHz to 200kHz. Bolt-fastening Mounting (Stainless Steel), 10m Shielded Cable, MIL-5015 Connector for Transmit Signal, XLR for Receive Signal, 9V Battery Snap for DC Supply.				
BII7524-TS-TR-IM50Ω-40dB-2kHz/200kHz-BFMSS-10m-SC-MIL/XLR/BS/TRS			BII7524 Transducer, Built-in Temperature Sensor, Built-in T/R Switch, Built-in Impedance Matching Network as 50Ω load at fs, Receiving Gain: 40dB, Receiving Bandpass Filter: 2kHz to 200kHz. Bolt-fastening Mounting (Stainless Steel), 10m Shielded Cable, MIL-5015 Connector for Transmit Signal, XLR for Receive Signal, 9V Battery Snap for DC Supply, TRS for Temperature Signal.				

Question:

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

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

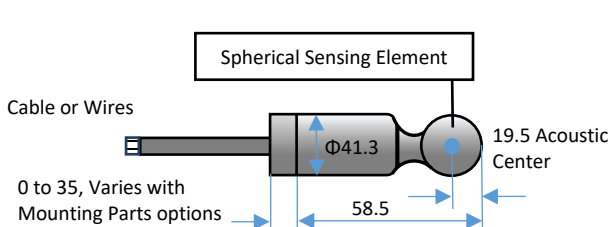
What are the advantage and disadvantage of a built-in T/R Switch Module comparing to a standalone T/R Switch Module?

A built-in T/R Switch Module amplifies the received signal of the sensing element before the signal is polluted by EMI noises and system ground loop noises, and before it is attenuated by capacitance, inductance, and resistance of cables. But its price is a little bit higher than standalone T/R Switch Module.

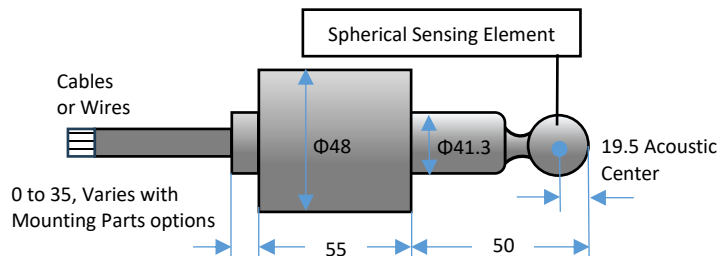
Cable and Connector Information for High Power Signals (from Power Amplifier and to Transducers). Non-UL Uses.

Cable:	Wire and Cable Types	Ratings of Voltage, Current or Power, and Temperature.
		AWG18 Wires (WR)
	Two Conductor Shielded Cable (SC)	600 Vrms, 5 Arms.
	High Temperature Shielded Cable (HTSC199)	600 Vrms, 6 Arms, up to +199°C or 390 °F, Non-waterproof.
	Coax RG58 (50Ω) (RG58)	1400 Vrms, 4 Arms.
	Coax RG174/U (50Ω) (RG174)	1100 Vrms, 1.6 Arms.
	Coax RG178B/U (50Ω) (RG178).	750 Vrms, 0.86 Arms, up to +200°C or 390°F.
Connector:	Connector Type	Ratings of Voltage, Current or Power, and Temperature.
	1. Wire Leads (WL)	Used for Cables or Wires.
	2. 50Ω BNC (BNC), Bayonet Lock. Panel Mount or In-line. In-line BNC: Input uses Pin, output uses Socket. Panel Mount BNC: Both Input and Output use BNC Jacks.	500Vrms, 316W. -65°C to 165°C, or -53.9°F to 329°F. Used for Grounded Signal with Metal Enclosures or Coax Cables.
	3. MIL-5015 Type Connector (MIL), Thread Fastening. Panel Mount or In-line. Input uses Pin, output uses Socket.	500Vrms, 13 A; Up to +125°C or 257°F, or, 900Vrms, 13 A; Up to +125°C or 257°F. Used for Metal Enclosures or Shielded Cables.
	4. XLR Connector (XLR), Positive Latchlock. Panel Mount or In-line. Input uses Pin, output uses Socket.	133Vrms, 15 A; -25°C to +75°C or -13°F to +167°F. Used for Metal Enclosures or Shielded Cables.
5. Underwater Mateable Connector (UMC), Thread Fastening. Panel Mount or In-line. Input uses Pin, output uses Socket.	600Vrms, 10A. Waterproof, IP68. Used for Metal Enclosures or Shielded Cables.	
How to choose cable and connector for BII devices: Driving Voltage $V_{drive} (V_{rms}) = \sqrt{Power * R_L} = \sqrt{Power/G}$. R_L : Resistance of a transducer in load medium at f_s . G : conductance at f_s ; $R_L = 1/G$ at f_s . BII lists G-B data at f_s and/or the graph of G-B vs Frequency in online datasheet.		
Case 1. Deliver 1000 Wrms to 3 kΩ transducer at f_s . Note: the 3 kΩ is the resistance of the transducer in load medium at f_s . Driving voltage to transducer $V_{drive} = \sqrt{1000 * 3000} = 1732 V_{rms}$. The current to 3 kΩ transducer $I_{drive} = V_{drive}/R_L = 1732Vrms/3000Ω = 0.57733 A_{rms}$. Therefore, AWG18 Wire and Wire leads are suitable.		
Case 2. Deliver 500 Wrms to 300 Ω transducer at f_s . Note: the 300 Ω is the resistance of the transducer in load medium at f_s . Driving voltage to transducer $V_{drive} = \sqrt{500 * 300} = 387.3 V_{rms}$. The current to 300 Ω transducer $I_{drive} = V_{drive}/R_L = 387.3Vrms/300Ω = 1.291 A_{rms}$. Therefore, Two Conductor Shielded Cable and MIL-5015 Type Connector or Underwater Mateable Connector (UMC) are suitable.		
Case 3. Deliver 300 Wrms to 50 Ω transducer at f_s . Driving voltage to transducer $V_{drive} = \sqrt{300 * 50} = 122.5 V_{rms}$. The current to 50 Ω transducer $I_{drive} = V_{drive}/R_L = 122.5Vrms/50Ω = 2.45A_{rms}$. Therefore, 50Ω RG58 Coax and BNC are suitable.		

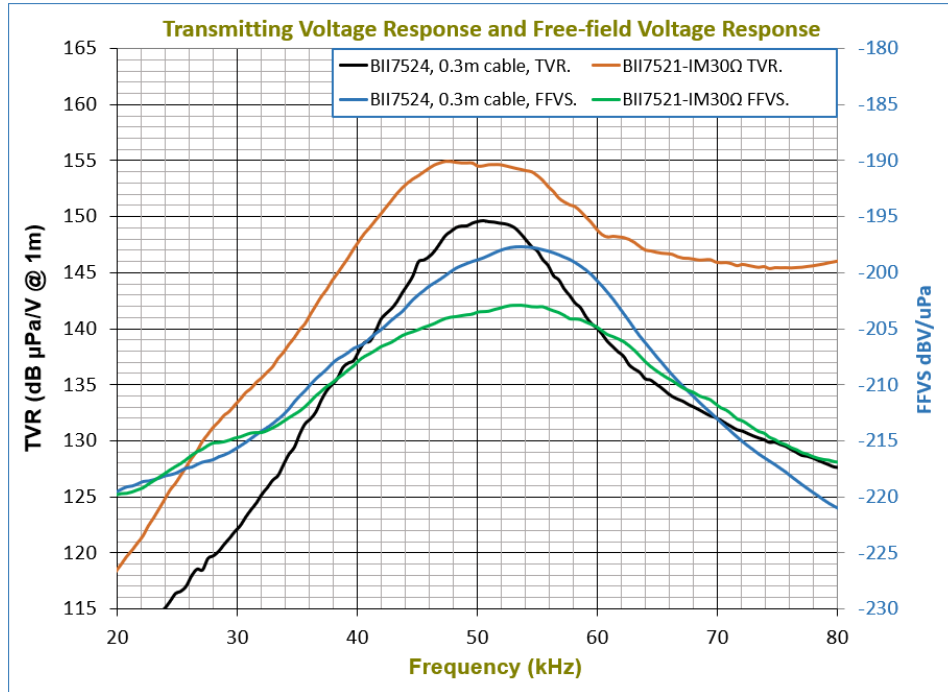
Physical Size without IM, TR, or TRIM (unit: mm):



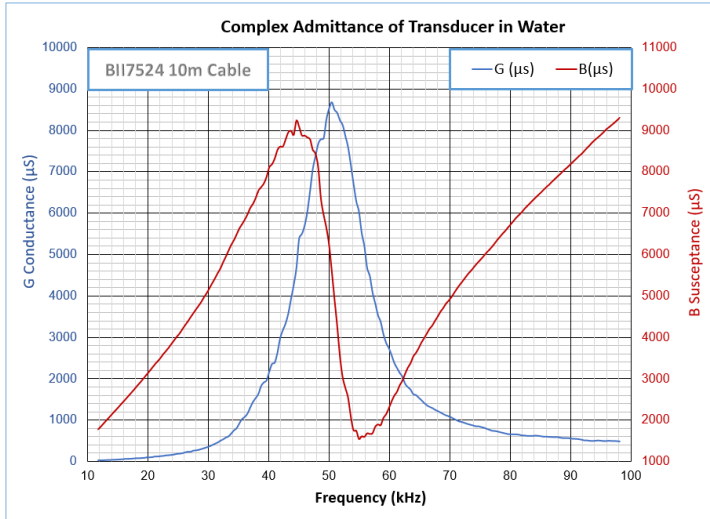
Physical Size with IM, TR, or TRIM (unit: mm):



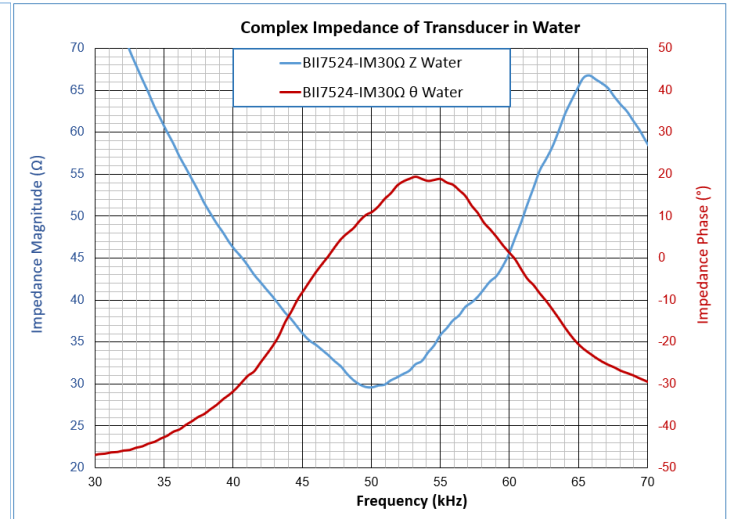
TVR (Transmitting Voltage Response) and FFVS (Free-field Voltage Response):



Admittance



Bespoke Admittance of BII7524-IM30 Ω



Directivity Pattern:

