BII7732 Series Broadband Transducer: Low Q_m, Bespoke Dual-Beam or Dual-Frequency Transducers

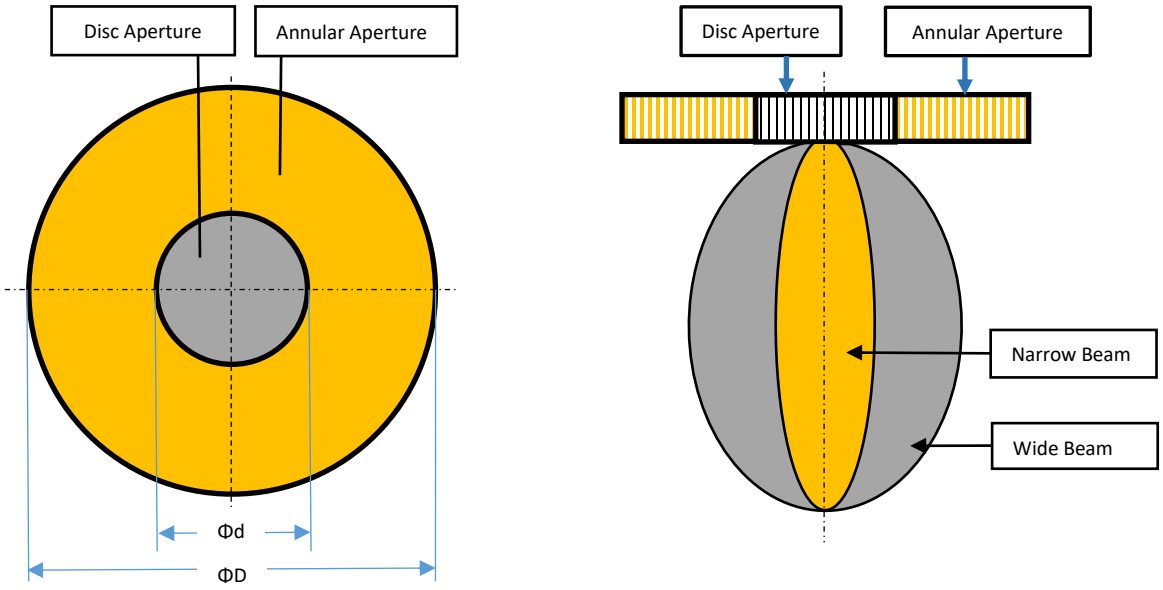
BII's broadband (low Q_m) transducers are customized with conical beamwidth and operating frequency, and offer flexible, custom-fit solutions to wide bandwidth requirements of underwater and ultrasonic acoustic systems (SONAR, NDT, AE). The transducer consists of two concentric elements which support with dual frequencies and dual beams for transmitting and/or receiving.

When the transducer is used to detect acoustic emission (AE) and NDT ultrasonic waves, the couplant (water, gel, grease, oils and commercial couplant) is a necessary material to provide efficient acoustic coupling between the transducer face and the piece under test.

Custom-fit Applications	
Underwater Communication and Telephone	NDT, AE, Process Control, Diagnostics, Material Research, and Air Acoustics
Artificial Acoustic Target, Echo-Repeater Target, Active-Acoustic Target	Synthetic Aperture Imaging and Synthetic Aperture Sequential Imaging
High Resolution Sonar, Chirp/FM Sonar	Pinger/Locator/Transponder/Acoustic Positioning/Tracking
Direction-finding Sonar, Navigation, Obstacle Avoidance	Fishery Sonar, Bioacoustics, Marine Animal Behavior Research

Available Operating Modes:

1. **Dual Frequencies, Dual Beams**: Annular Ring: Transmit Sounds; Disc: Transmit Sounds.
2. **Single Beam with Separated Transmitting and Receiving**: Annular Ring: Transmit Sounds, Disc: Receive Sounds; vice versa.
3. **Single Beam and Single Frequency**: Annular Ring and Disc are in Parallel as one Disc.



Specification

Broadband Transducer	BII7732	BII7732-IM50Ω
Resonant Frequency f_s:	Available from 30 to 500 kHz, Custom-fit. In-stock elements: 30, 40, 50, 60, 70, 100, 120, 150, 200, 250, 300, 400, and 500 kHz, ± 2% to ± 10%.	
Transmitting Frequency:	f_s ± 20%*f_s	f_s ± 25%*f_s
	Minimum Operating Frequency: None.	Minimum Operating Frequency: TBD, to be determined.
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:	Spike (Negative or Positive), Pulsed SINE, Chirp, PSK, FSK, Pulsed Square Waveform, CW, etc.	
Aperture:	Two Concentric Elements: Annular Ring and Disc, Isolated Acoustically.	
Operation Modes:	1. **Dual Frequencies, Dual Beams**. 2. **Single Beam with Separated Transmitting and Receiving.** 3. **Single Beam and Single Frequency.** Large Annular Ring and Small Disc are in Parallel as one Disc.	
Directivity Pattern:	Dual Concentric Conical Beams	
-3dB Beam Width θ_{-3dB}:	Custom-fit. λ: Sounds Wavelength in Load Medium. D: Large Disc Diameter, d: Small Disc Diameter.	
	Annular Ring: **Main Lobe $\theta_{-3dB} \approx 42.1*\lambda/D$, in °.** Disc: **Main Lobe $\theta_{-3dB} = 58.9*\lambda/d$, in °.**	
Side Lobe Level:	Default: ≤-17.8 dB when θ_{-3dB} < 49°; No side lobe when $\theta_{-3dB} \geq 49°$.	
Free Capacitance C_f:	TBD, to be determined.	N/A
Dissipation D:	TBD, to be determined.	N/A

Quality Factor Q_m at f_s:	Typical 3. Varies from 2.5 to 5.	Typical 3. Varies from 2 to 5.
	-3dB bandwidth $\Delta f = f_s/Q_m$. Qm determines the transient response or the rise and fall rings of steady-state response.	
$\eta_{ea\ at\ fs}$ at f_s:	0.3 to 0.8 in Water, Electroacoustic Efficiency, Load Medium Dependent.	
η_{ea} at $f << f_s$:	at $f << fs$, $\eta_{ea} / \eta_{ea\ at\ fs} \approx 0.1225*(k*\Phi D)^2$. Wave Number $k = 2\pi/\lambda$; ΦD = Transducer Diameter.	
	1. Electroacoustic Efficiency η_{ea} is quite low at $f << f_s$ 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 $P_i \le \eta_{ea}$*MIPP at $f \le 0.8*f_s$ and $P_i \le 0.2$*MIPP at $f \ge 1.3*f_s$.**	
Power Factor at f_s:	0.4 to 0.9.	≥ 0.94
TVR at f_s:	140 to 190 ± 2 dB µPa/V@1m. Transmitting Voltage Response.	140 to 190 ± 2 dB µPa/V@1m for BII7732-IM50Ω. 140 to 190 ± 2 dB µPa/V@1m for BII7732-IM8Ω. 140 to 190 ± 2 dB µPa/V@1m for BII7732-IM5Ω.
Radiation Sound Level SL:	SL = 20*logV_i + TVR, dB µPa@1m. Driving Voltage V_i is in unit of V_{rms}.	
Admittance or Impedance:	TBD, to be determined, or refer to **G-B Graph**.	1. Default: $Z = 50*e^{j\theta}$, in Ω, and Phase Angle $\lvert\theta\rvert \le 20°$ at fs. 2. Customization.
Driving Voltage V_i at f_s: (V_{imax}: Maximum V_i.)	**Pulsed Driving Signal and Duty Cycle D < 100%:** $V_{imax} = \sqrt{(MIPP/G_{max})}$ or **300 or 600**, whichever is less, in V_{rms}.	**Pulsed Driving Signal and Duty Cycle D < 100%:** $V_{imax} = \sqrt{(MIPP * \lvert Z\rvert)}$, in V_{rms}. Z is impedance at fs.
	Continuous Operation at 100% Duty Cycle: $V_{imax} = \sqrt{(MCIP/G_{max})}$, in V_{rms}.	**Continuous Operation at 100% Duty Cycle:** $V_{imax} = \sqrt{(MCIP * \lvert Z\rvert)}$, 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.	
MIPP at f_s:	Maximum Input Pulse Power at f_s: $P_i = V_i^2 * G_{max}$ or up to 5000 Watts, whichever is less. TBD, to be determined.	
MPW at MIPP and f_s:	Maximum Pulse Width at MIPP and at f_s. TBD, to be determined.	
MCIP at f_s:	Up to 200 Watts, Maximum Continuous Input Power at f_s. TBD, to be determined.	
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 ≤ (MIPP * MPW*(120°c-T)/103°c)/IPP. T: Water Temperature in °c. 3. Duty Cycle D ≤ MCIP*(120°c-T)/103°c)/IPP. 4. Off-time ≥ PW*(1-D)/D.		
FFVS at f_s:	-195.0 to -170.0, ± 2 dB V/µPa. TBD, to be determined. Free-field Voltage Sensitivity.	-195.0 to -170.0 ± 2 dB V/µPa for BII7732-IM50Ω. -195.0 to -170.0 ± 2 dB V/µPa for BII7732-IM8Ω. -195.0 to -170.0 ± 2 dB V/µPa for BII7732-IM5Ω.
	$Sensitivity\ Loss\ over\ extension\ cable\ at\ f_s\ (dB) = 20 * \log\{(1 + 2\pi f_s C_c/B)/\sqrt{[G^2 + (B + 2\pi f_s C_c)^2]/(G^2 + B^2)}\}$ G: Conductance at f_s; B: Susceptance at f_s; C_c: 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.	
Receiving Sound Level SL:	SL = 20*logV_o - FFVS, dB µPa. Receiving Voltage V_o is in unit of V_{rms}.	
Operating Depth:	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**) 6. Flange Mounting (**FGM**) 7. Flush Mounting (**FSM**)	
	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**). 3. 50 Ω RG174/U Coax (**RG174**). 4. 50 Ω RG178/U Coax (RG178) (Operating Temperature Range: -70°C To +200°C). 5. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, ΦD=3.2 mm (**SC32**), up to 200°C, AWG26 Conductors (Not Water-proofed, ONLY for Dry Air Use). 6. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, ΦD=4.0 mm (**SC40**), up to 200°C, AWG20 Conductors (Not Water-proofed, ONLY for Dry Air Use). 7. Two Conductor Unshielded Cable (**USC**).	
	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.	
Cable Length:	1. Default: 1 m. 2. Custom-fit.	
Wiring:	Two separate cables: Cable with label 1 for small center aperture, Cable with label 0 for big outer Aperture.	
Connector Options:	1. Default: Wire Leads (**WL**), for Transmit, Receive Signal, and DC Power Supply. 2. Underwater Mateable Connector (pin) (**UMC**) (Max. Diameter Φ21.5 to Φ35 mm), for Transmit or Receive Signal. 3. MIL-5015 Style (pin) (**MIL**) (Max. Diameter Φ19 to Φ30 mm), for Transmit or Receive Signal. 4. XLR Plug (pin) (**XLR**). (Max. Diameter Φ20.2 mm), for Transmit or Receive Signal. 5. Male BNC (**BNC**) (Max. Diameter Φ14.3 mm), for Transmit or Receive Grounded Signal. **BNC with RG178 Coax**: Service Temperature up to 165°C or 329°F.	
	Note: Underwater Mateable Connector is for uses underwater. Other connectors and wire leads are for dry uses and are not waterproofed.	
Physical Size:	Maximum Housing Diameter: ΦD ≤ 168 mm, Height: TBD, to be Determined.	
	Actual length depends on Mounting Parts and/or Add-on Parts such as -IM, etc.	
Weight in Air:	≥ 1.0 kg with 2x10 m cables.	

	Actual weight depends on Mounting Parts, Cable Types and Length, and/or Add-on Parts such as -IM, etc.
Operation Temperature:	-10 °C to +60 °C or 14 °F to 140 °F.
Storage Temperature:	-20 °C to +60 °C or -4 °F to 140 °F.
Impedance Matching at f_s:	BII6000 Bespoke 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-IM8Ω: BIIxxxx transducer with built-in Impedance Matching unit as 8Ω load at fs.
	Phase Angle |θ| of Complex Impedance ≤ 20° at fs.
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.
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/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.	

Wiring Information of a Transducer.

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

Order Custom-fit Transducers (Projectors). A specific option which is not necessary can be ignored.

FH: Free Hanging. **SC**: Shielded Cable (Rubber Jacket, 600V) with 2 conductors. **Coax**: 50 Ω Coaxial Cable. **WL**: Wire Leads.

P/N	**-Annular fs**	**-Annular IMxxΩ**	**-Annular BW**	**-Disk fs**	**-Disk IMxxΩ**	**-Disc BW**	**-Mounting**	**-Cable Length**	**-Cable Type**	**-Connectors** for Annular Ring/Disk
BII7732	Frequency, in kHz.	Default: **None**.	-3dB Conical Beam Width, in°.	Frequency, in kHz.	Default: **None**.	-3dB Conical Beam Width, in°.	Default: **FH**.	Default: **10m**.	**SC or Coax**	Default: **WL**.

Example of Part Number:	Description
BII7732-70kHz-30°-100kHz-30°-BFMSS-0.6m-SC-UMC/UMC	BII7732 Transducer, Annular Ring fs: 70kHz; Conical Beam Angle: 30°; Disk fs: 100kHz; Conical Beam Angle: 30°; Bolt Fastening Mounting (Stainless Steel); 2x0.6m Shielded Cable; Two Underwater Mateable Connectors for Annular Ring and Disc Apertures.
BII7732-70kHz-IM50Ω-30°-200kHz-15°-BFMSS-30m-SC-WL/WL	BII7732 Transducer, Annular Ring fs: 70kHz, Built-in Impedance Matching as 50Ω Load at fs, Conical Beam Angle: 30°. Disk fs: 200kHz, Conical Beam Angle: 15°; Bolt Fastening Mounting (Stainless Steel); 2x30m Shielded Cable; Wire Leads for Annular Ring and Disc Apertures.
BII7732-70kHz-IM50Ω-30°-100kHz-IM50Ω-30°-BFMSS-30m-SC-WL/WL	BII7732 Transducer, Annular Ring fs: 70kHz, Built-in Impedance Matching as 50Ω Load at fs, Conical Beam Angle: 30°. Disk fs: 100kHz, Built-in Impedance Matching as 50Ω Load at fs, Conical Beam Angle: 30°; Bolt Fastening Mounting (Stainless Steel); 2x30m Shielded Cable; Wire Leads for Annular Ring and Disc Apertures.

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.

	Wire and Cable Types	**Ratings of Voltage, Current or Power, and Temperature.**
Cable:	AWG18 Wires (**WR**)	3000 Vrms, 10 Arms.
	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.	600Vrms, 10A. Waterproof, IP68.

	Panel Mount or In-line. Input uses Pin, output uses Socket.	Used for Metal Enclosures or Shielded Cables.
	~~6. SMA (Plug, Male Pin) (**SMA**). Thread Fastening. In-line.~~	~~Voltage Rating: 335 VRMS Continuous. (Max. Diameter Φ9.24 mm). Up to 155°C or 311°F.~~
	~~7. SMC (Plug, Female Socket) (**SMC**). Thread Fastening. In-line.~~	~~Voltage Rating: 335 VRMS Continuous. (Max. Diameter Φ6.4 mm). Up to 155°C or 311°F.~~
	~~8. LEMO (Plug Male Pins) (**LEMO**). Push-Pull Fastening. Panel Mount or In-line.~~	~~900 V (AC), 1270 V (DC), 8A, (Max. Diameter Φ9.5 mm with 3 contacts). Temp (min / max) -55°C / +250°C.~~

How to choose cable and connector for BII devices: Driving Voltage V_{drive} (V_{rms}) = $\sqrt{RMS\ Power * \frac{G}{G^2+B^2}}$.

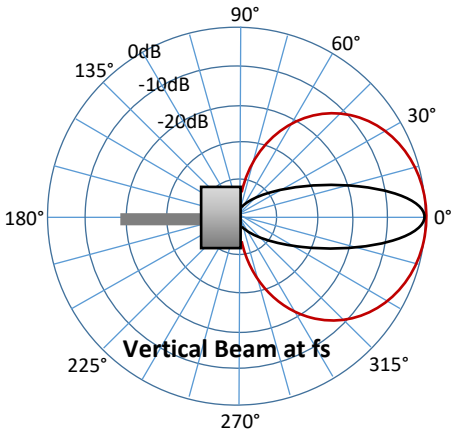
BII lists G-B data at fs and/or the graph of G-B vs Frequency in online datasheet.

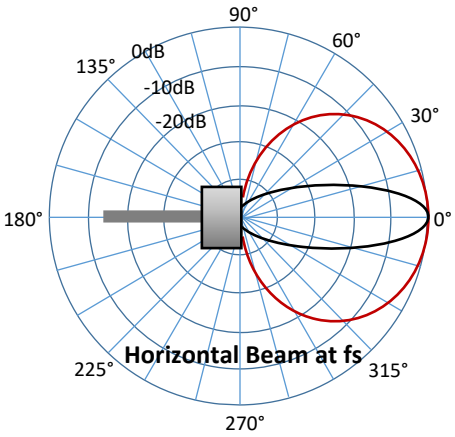
Case 1. Deliver 1000 Wrms to 3 kΩ transducer at f_s. Note: $G/(G^2+B^2)$=3 kΩ is the resistive load of the transducer in load medium at f_s.
Driving voltage to transducer $V_{drive} = \sqrt{1000 * 3000}$ = 1732 V_{rms}. The current to 3 kΩ transducer $I_{drive} = V_{drive}/R_L$ = 1732Vrms/3000Ω = 0.57733 A_{rms}.
Therefore, AWG18 Wire and Wire leads are suitable.

Case 2. Deliver 500 Wrms to 300 Ω transducer at f_s. Note: $G/(G^2+B^2)$=300 Ω is the resistive load 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.

Directivity Pattern of Dual Beam Transducer BII7732: illustration ONLY. Please refer to -3 dB beam width of a specific transducer.





Physical Size (Dimensional Unit: mm)