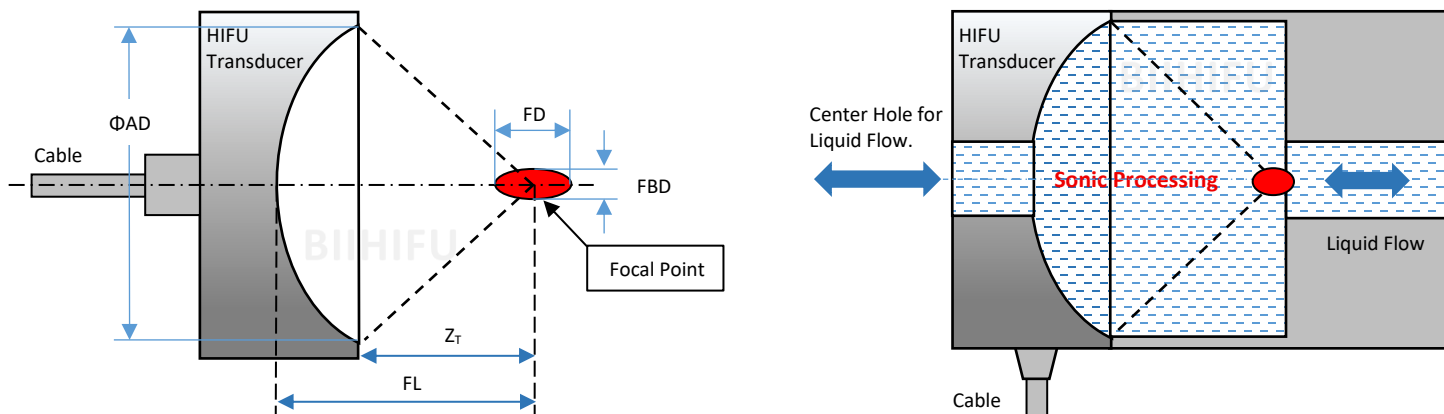


High Intensity Focused Ultrasound (HIFU) Transducer

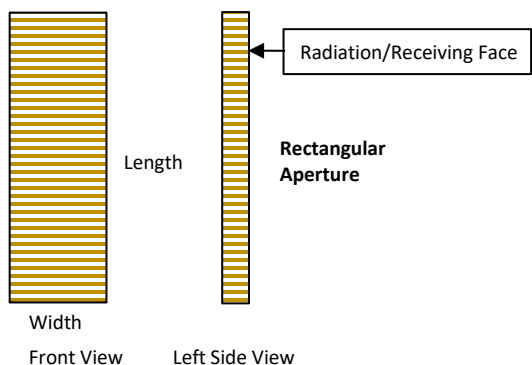
BII's HIFU transducers consist of apertures: bowl (concave, with or without a center hole), Linear (rectangular) and Annular Array. The energy at focal point or focal line is for physical, chemical, biological, thermal and high-stress uses in nonlinear underwater acoustics: cavitation, streaming, sonic processes and HIFU R&D. The focus of linear array and annular array can be manipulated with technology of array beamforming (beam steering and focusing). The bowl aperture transducers provide the best lateral and axial resolutions. For information on MRI compatibility or safety, please contact BII. To support HIFU R&D, BII provides customized designs on frequency, geometric focus, Fresnel number, focal diameter/length/intensity.

Concave Spherical Sector (Bowl) Aperture with or without Center Hole

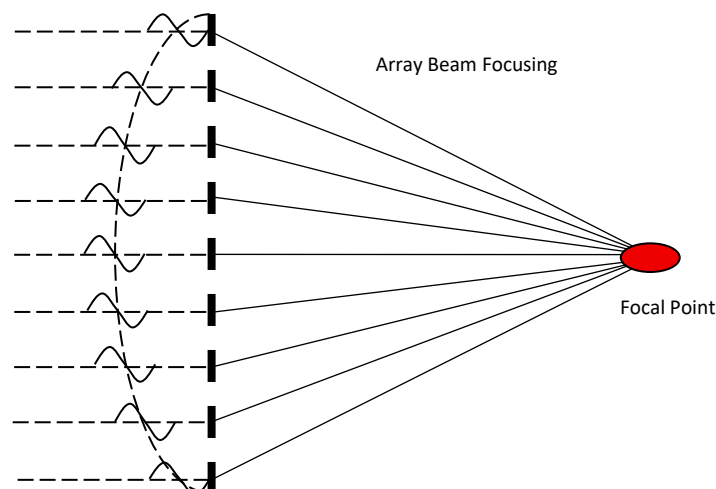
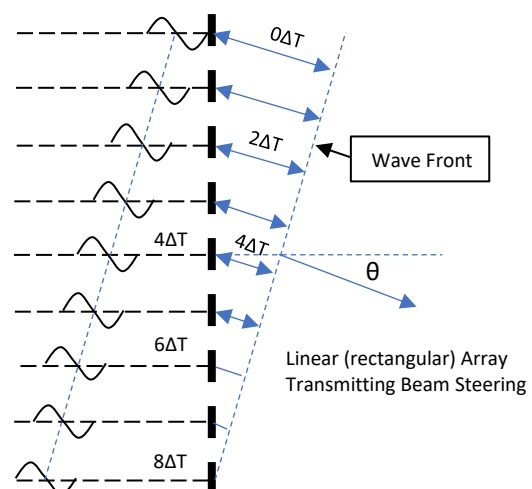


Line Array (Rectangular Aperture, Beam Steering and Focusing)

Refer to [BII7630 Series Phased Array Transducer](#).



Annular Array (Array Focusing, Refer to [BII7740 Series Transducer](#).)



Quality Factor Q_m :	≥ 6 . Note: -3dB bandwidth $\Delta f = f_s/Q_m$. Q_m determines the transient response or the rise and fall rings of steady-state response.
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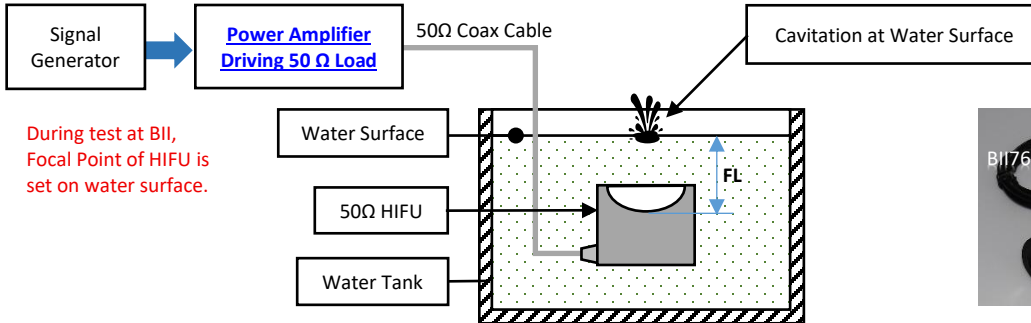
Efficiency η_{ea} at $f < f_s$:	1. Electroacoustic Efficiency η_{ea} is quite low at $f < f_s$ and drops gradually at $f > f_s$, so it is NOT recommended for transducers to emit high power sounds at frequencies far from f_s . Otherwise, transducer may be damaged by overheating. 2. Transducer can emit low power sounds at frequencies far from f_s . For example, input power $P_i \leq \eta_{ea} * MIPP$ 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 :	≥ 0.94	
SPL at f_s :	$Sound\ Pressure\ Level\ SPL = \sqrt{Focal\ Intensity * \rho C}$, ρC = Characteristic Impedance of loading medium. Greater than cavitation threshold at water surface. Cavitation at water surface is guaranteed.	
Impedance at f_s :	$Z = 50 * e^{j\theta}$, in Ω , and Phase Angle $ \theta \leq 20^\circ$ at f_s .	
Driving Voltage V_i : (at f_s)	Pulsed Driving Signal and Duty Cycle $D < 100\%$: $V_{imax} = \sqrt{(MIPP * Z)}$, in V_{rms} . Z is impedance at f_s . V_{imax} : Maximum V_i .	Continuous Operation at 100% Duty Cycle: $V_{imax} = \sqrt{(MCIP * Z)}$, in V_{rms} .
Input Power P_i :	$P_i = V_i^2 / Z$ at f_s . Z is impedance at f_s .	
Operating Depth:	Maximum 20m and 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 (THM-M10, THM-7/16", or THM-5/8".) 3. Thru-hole Mounting with Double O-ring (THDO-7/16") 4. Bolt Fastening Mounting (Stainless Steel) (BFM-M6, BFM-7/16", or BFM-5/8".) 5. Bolt Fastening Mounting (Plastics) (BFMP-NPT3/8", or BFMP-NPT1/2".) 6. Bolt-Fastening Mounting with Free Hanging (BFM-FH-1/4", BFM-FH-3/8".) 7. Free-hanging with Male Underwater Connector (FHUWC-2P, FHUWC-3P.) 8. End-face Mounting (EFMS or EFMM.) 9. Flange Mounting (FGM-Φ220, FGM-Φ190, FGM-Φ165, FGM-Φ140, or FGM-Φ110.) Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.	
Cable-Out:	1. By default , the cable goes out of the device from the end face. 2. Customization : To save space or have the device shorter, cable can go out of a device from the side wall. Specify when ordering.	
Cable Options:	1. 50 Ω RG58 Coax (RG58). 2. 50 Ω RG174/U Coax (RG174). 3. 50 Ω RG178/U Coax (RG178). 4. Two Conductor Shielded Cable (SC) or Unshielded Cable (USC), Rubber or PVC Jacket. 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 50 Ω Coax (RG58, RG174, or RG178), or 1m Shielded Cable. 2. 0.6m unshielded cable with Underwater Mateable Connector (2 pins) (UMC2P). 3. Custom-fit.	
Connector Options:	1. Default: Male BNC (BNC) (Max. Diameter $\Phi 14.3$ mm), for Power $\leq 319W$. 2. Wire Leads (WL). 3. Underwater Mateable Connector (2 pins) (UMC2P) (Max. Diameter $\Phi 21.5$ to $\Phi 35$ mm). Locking Sleeve: DLSA-M . Underwater Mateable Connector (3 pins) (UMC3P) (Max. Diameter $\Phi 21.5$ to $\Phi 35$ mm). Locking Sleeve: DLSA-M . Underwater Mateable Connectors are fixed with 0.6m unshielded cable. UMC is from global manufacturers of underwater connectors. Its part number is listed in quote in detail. 4. MIL-5015 Style (3 pin) (MIL3P) (Max. Diameter $\Phi 19$ to $\Phi 30$ mm), for Power $> 319W$. 5. XLR Receptacle with 3 Male Pins (XLR3P), (Max. Diameter $\Phi 20.2$ mm), for Power $> 319W$. Underwater Mateable Connector is for uses underwater. Other connectors and wire leads are for dry uses and are not Waterproofed.	
Physical Size:	Refer to the table . Actual length depends on Mounting Parts and/or Add-on Parts such as-TS, etc.	
Weight:	0.1 kg to 3 kg with 1 m cable. Actual weight depends on Mounting Parts, Cable Types and Length, etc.	
Operation Temp.:	-10 $^\circ C$ to +60 $^\circ C$ or 14 $^\circ F$ to 140 $^\circ F$.	
Storage Temp.:	-20 $^\circ C$ to +60 $^\circ C$ or -4 $^\circ F$ to 140 $^\circ F$.	
Power Amplifier:	BII5000 Series Power Amplifier, Order Separately, or Third-party's power amplifiers such as 50 Ω RF power amplifiers.	
Warning: the loading medium which the transducer is immersed in MUST be non-corrosive and non-flammable.		
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 Male connector, it is buyer's sole responsibility to make sure that the (female) BNC shield of the signal source is firmly grounded for operating safety before hooking up transducer/hydrophone to the signal source. Coax with BNC is not intended for hand-held use at voltages above 30Vac/60Vdc.		

How to Order HIFU Transducer. The default options are for stock items which are regularly available.

FH: Free Hanging. SC: Shielded Cable (Rubber Jacket, 600V) with 2 conductors. Coax: 50 Ω Coaxial Cable. WL: Wire Leads. Underwater Mateable Connector UMC2P is fixed with 0.6m unshielded cable (USC).				
Part Number	-Mounting	-Cable Length	-Cable Type	-Connector
BII765x-xxxxIM	Default: FH, BFM-FH-1/4", or BFM-FH-3/8".	Default: 1m, or 0.6m.	RG58, RG174, RG178 Coax for high frequency signal. SC for low frequency signal. USC for UMC2P Connector.	Default: BNC, WL, UMC.
Example:		Description		
BII7651Q-1000IM-BFM-5/8"(Side-Wall)-1m-RG58-BNC		BII7651Q-1000IM, HIFU Transducer , Impedance Matching to 50 Ω , Bolt Fastening Mount: BFM-5/8" on side wall of Housing, 1m RG58 50 Ω Coax, BNC Male.		
BII7652-2000IM-CH-FGM-110-1m-RG58 (Side-Wall)-BNC.		BII7652-2000IM-CH, HIFU Transducer with Center Hole, Impedance Matching to 50 Ω , Flange Mount FGM-110, 1m RG58 50 Ω Coax on side wall of Housing, BNC Male.		

Wiring Information

Transducer Wiring:	Shielded Cable	Coax, BNC.	UMC3P, Locking Sleeve: DLSA-M.	MIL3P	XLR3P
Signal:	White or Red	Center Contact	Contact 2	Contact C or G	Pin 2
Signal Common:	Black	Shield	Contact 1	Contact B	Pin 3
Shielding and Grounding	Shield	Shield	Contact 3	Contact A	Pin 1

Cavitation Test on Water Surface at BII: Focal Point of HIFU is Set on Water Surface.**HIFU Operating Configuration and Cavitation Test**

To produce cavitation in liquids, please choose carefully the liquid (surface tension, viscosity, temperature), hydrostatic pressure, pulse length, operating frequency and driving voltage level or driving power. As a general guide, cavitation threshold of a liquid increases as the operating frequency increases.

Focal Point of HIFU is Set on Water Surface, or Distance from water surface to the center of concave face of the transducer equals to Focal Length FL.

To avoid damage transducer:

(1) for Continuous SINE, the RMS power delivered to transducer must be less than or equal to MCIP.

(2) for Pulse Signal, the pulse power delivered to transducer must be less than MIPP with Pulse Duration (or pulse width) less than MPW.

P/N#	Operating Configuration
BII7651Q-1000IM	System Setup: Signal Generator -> BII5121BNC -> BII7651Q-1000IM, Focal Point of HIFU is Set on Water Surface -> Cavitation.
	Continuous SINE, 1MHz, 14W RMS Power delivered to Transducer: Cavitation starts on water surface.
	Continuous SINE, 1MHz, 34W RMS Power delivered to Transducer: Very Strong Mist, Fog and Fountains on water surface.
BII7652/2000	SINE Pulse, 1MHz, Pulse Duration: 0.5mS, Duty Cycle: 50%. 64W pulse power or 32W Average Power delivered to Transducer: Very Strong Mist, Fog and Fountains on water surface.
	System Setup: Pulse Signal Generator -> BII5111BNC -> BII7652/2000, Focal Point of HIFU is Set on Water Surface -> Cavitation.
BII7653/1000	Signal: Pulsed/Burst Pulse Train, 2MHz, Pulse Width = 10mS, Duty Cycle = 10%. Pulse Power delivered to Transducer: 1.5 W.
	Phenomenon on Water Surface at Room Temperature: Mist, Fog and Tiny Fountain with height of 8 cm.
	System Setup: Pulse Signal Generator -> BII5121BNC -> BII7653/1000, Focal Point of HIFU is Set on Water Surface -> Cavitation.
BII7653/1000	Signal: SINE Pulse, 1MHz, Pulse Width=0.1mS, Duty Cycle=10%. Pulse Power delivered to Transducer: 5W.
	Phenomenon on Water Surface at Room Temperature: Mist, Fog and Tiny Fountain with height of 8 to 10 mm.

Maintenance and Operations of BII HIFU Transducers

Cooling Transducer:	To avoid overheating HIFU transducers during high power applications, pulse signal MUST be used to allow HIFU transducers to cool down in water or liquid. Effective cooling is necessary by liquid circulation and keep water/liquid in specified temperature range. Refer to How to determine pulse width, duty cycle and off-time with input pulse power (peak power) .
Remove Air Bubbles on Radiation Surface:	To increase power efficiency, air bubbles on transducer radiation face developed during operation must be removed with soft cloth before driving the transducer. An flashlight is a useful aid to check the situation of the transducer surface underwater. It is a good routine to rub the transducer radiation surface lightly with soft cloth before driving the transducer each time. Warning: Do NOT touch the water/liquid and transducer when the system is powered.
Testing before shipment: BII carries out the cavitation test on fresh water surface at room temperature).	
Disclaimer: Focal Intensity, Focal Diameter, and Focal Length in the specs are tested with low intensity sound level at BII or are calculated with electrical and physical parameters of transducers. BII DOES NOT GUARANTEE THEIR ACCURACY. To get accurate data of these parameters, the end user shall have the transducer calibrated at the buyer's cost by National Metrology Institutes or other organizations who provide calibration services in end user's country.	

Cavitation Threshold vs. Frequency.

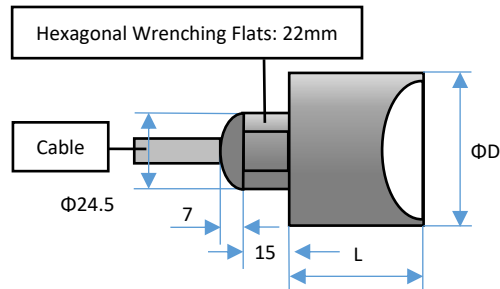
Frequency	Aerated (tap) Water: Cavitation Threshold.	RMS Pressure MPa	Degassed Water: Cavitation Threshold.	RMS Pressure MPa
70 kHz	0.8 W/cm ²	0.035	8 W/cm ²	0.110
100 kHz	1 W/cm ²	0.039	9 W/cm ²	0.116
150 kHz	1.6 W/cm ²	0.049	11 W/cm ²	0.128
200 kHz	2 W/cm ²	0.055	13 W/cm ²	0.140
300 kHz	7 W/cm ²	0.102	25 W/cm ²	0.194
400 kHz	8 W/cm ²	0.110	40 W/cm ²	0.245
500 kHz	10 W/cm ²	0.122	60 W/cm ²	0.300
1 MHz	600 W/cm ²	0.949	600 W/cm ²	0.949
2 MHz	1000 W/cm ²	1.225	1000 W/cm ²	1.225
3 MHz	5000 W/cm ²	2.739	5000 W/cm ²	2.739
4 MHz	10000 W/cm ²	3.873	10000 W/cm ²	3.873
5 MHz	80000 W/cm ²	10.954	80000 W/cm ²	10.954

Outline Drawings of HIFU Transducers

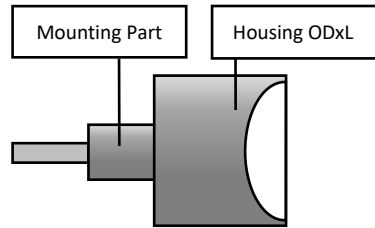
Physical Size of Bowl or Concave Spherical Sector without Center Hole (Dimensional Unit: mm): The overall length varies with the length of mounting parts. Please refer to online information of mounting options.

1. Cable goes out of the device from the end face.

a. Size information of Free Hanging.

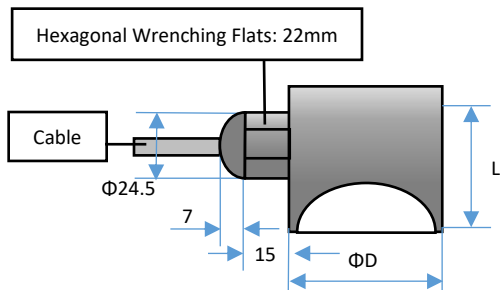


b. General Size information.

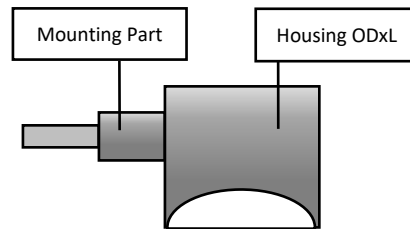


2. Cable goes out of the device from the side wall.

a. Size information of Free Hanging.



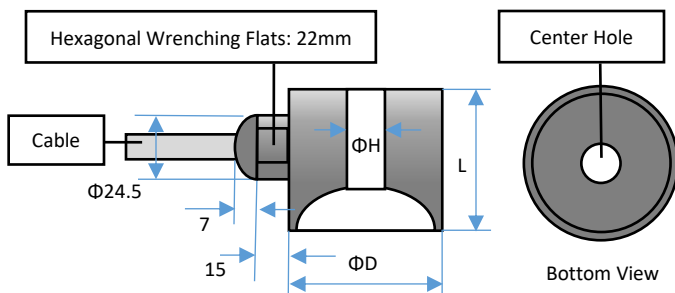
b. General Size information.



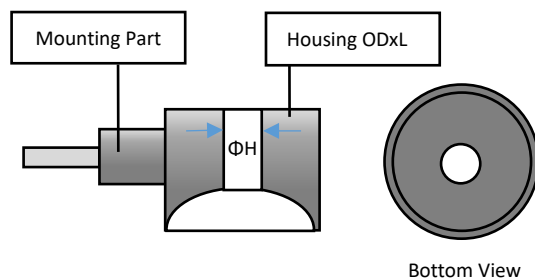
Physical Size of Bowl or Concave Spherical Sector with Center Hole (Dimensional Unit: mm):

The overall length varies with the length of mounting parts. Please refer to online information of mounting options. **Cable goes out of the device from the end face.**

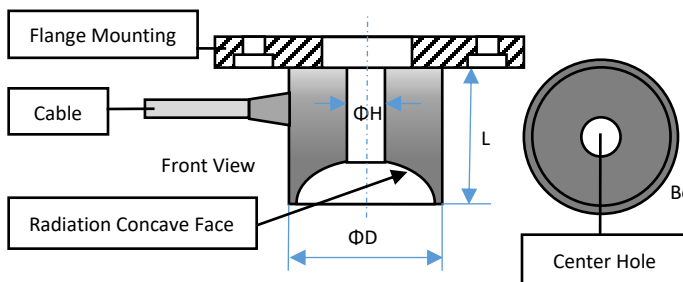
a. Size information of Free Hanging.



b. General Size information.



c. Size information of Flange Mounting.



D. Size information of End-face Mounting.

