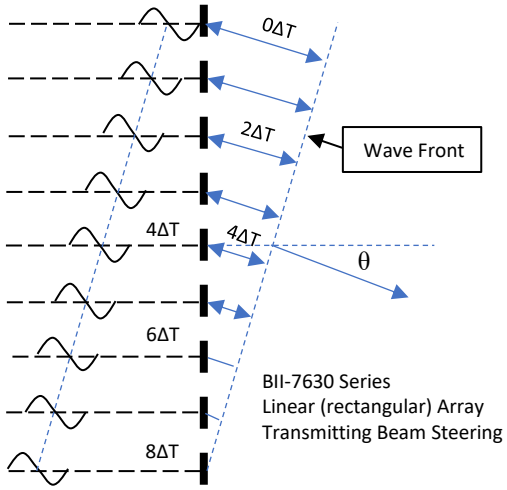
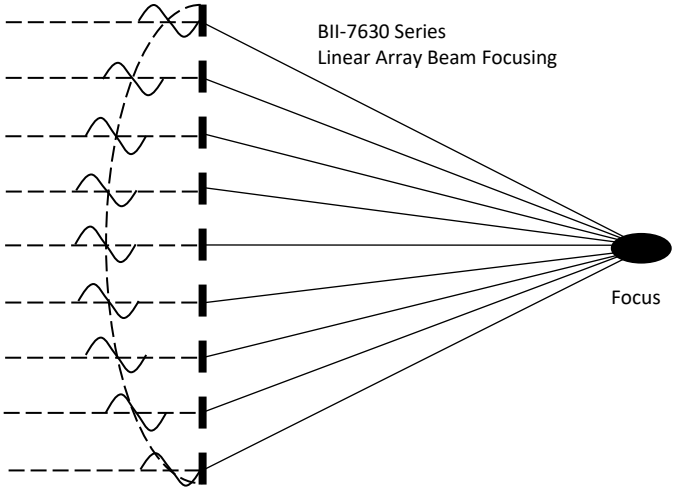
BII-7630 Series Phased Array Transducer

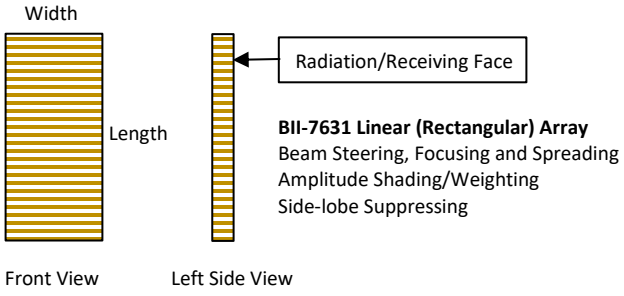
BII-7630 Series Phased Array Transducer: Beamforming

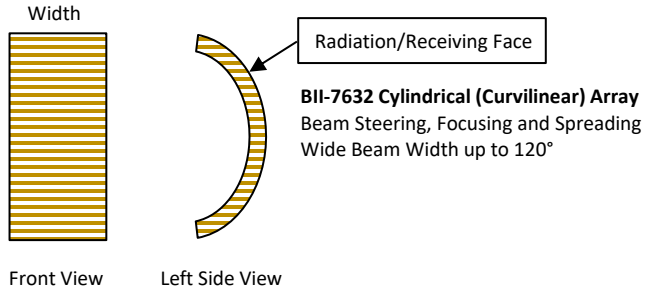
The phased array transducers are rectangular (linear) or Curvilinear (Cylindrical Segment) array with custom-fit along-length (or along-curve) beamwidth and cross-length (or cross-curve) beamwidth for use in location, search of sound sources underwater in in tens or hundreds meter range, and acoustical imaging in biomedical, oceanography, NDT & AE, and material study. Along-length (or along-curve) beam can be steered and focused in ±90° range with array beamforming technology. Multiple beams at different directions can also be formed simultaneously with digital beamforming technology. The side lobes along length can be suppressed with amplitude shading or weighting.

Two or four array hydrophones can be used to set up "T" or "+" type cross array functioning as **Target Angle Estimation System** with Mills Cross technique. High resolution image can be formed with the technology of **Synthetic Aperture Sequential Imaging**. A phased line array transducer (projector) and a phased array hydrophone can work as a multibeam SONAR with Mills Cross technique. Multiple transducers can be wired in parallel electrically to set up a longer line array for reducing along-length beam width in low frequency range.









Typical Applications

Acoustical Imaging: B-mode (2D) and Mechanical 3D, Diagnostic Ultrasound.	Underwater Floor/Bottom Mapping, Sector Scanning
Acoustic Pipeline Leak Detection, AE (NDT) and Material Study	Target Angle Estimation Systems, Direction-finding Sonar
Search & Tracking of Acoustic Tag, Pinger, Beacon/Transponder...	Navigation, Target Tracking, Obstacle Avoidance, Positioning, Object Detection

Specification

Phased Array	**BII-7631**	**BII-7632**
Array Aperture:	Linear Array (Rectangular)	Curvilinear Array (Cylindrical Sector/Segment)
Major Features:	Narrow Beam along the length. Wide beam along the width.	Wide Beam along the curved face. Wide beam along the width.
Array Element Number N:	Custom-fit, N is determined by fs, d and -3dB along-Length or along-curve beamwidth. N = 76200/(fs*d*Along-Length Beamwidth)+1.	Custom-fit, N is determined by fs, d and -3dB along-Length or along-curve beamwidth. BII will work out N with along-curve beamwidth and Element spacing d.
Signal Type:	Pulsed SINE, Chirp, PSK, FSK, Pulsed Square Waveform, CW, etc.	
Resonant Frequency fs:	50 kHz to 2 MHz, Custom-fit. **fs in stock**: 50, 60, 70, 100, 120, 150, 200, 250, 300, 350, 400, 500 kHz.	
	1. Efficiency is low in the frequency range far from f_s, so it is NOT recommended to operate transducer at frequency far from f_s. **2. Transducer can operate in low power at frequency far from fs, the input power P_i should be much less than 1% MCIP at f_s.**	
Third Harmonic:	2.9fs ~ 3.2fs; Transducers can operate at 3fs.	
Quality Factor Q_m:	≈ 3 to 5. -3dB bandwidth = fs/Q_m.	
Element Spacing d:	The distance among the center lines of two neighboring elements. Along Length or Curve. Default: λ/2 or Custom-fit, in mm.	
TVR:	> 160 dB µPa/V@1m @ fs. Transmitting Voltage Response.	
Radiation Sound Level SL:	SL = 20*logV_i + TVR, dB µPa@1m. Driving Voltage V_i is in unit of V_{rms}.	
Admittance (G and B):	TBD, to be determined.	
-3dB Beam Width at fs:	Horizontal (Along-length) Plane: 0.1° to 50°	Horizontal (Along-curve) Plane: 30° to 120°

	Vertical (Cross-length) Plane: 1° to 50°	Vertical (Cross-curve) Plane: 1° to 50°
	Specify with H°xV° when ordering. For example, 5°x50° at fs, horizontal beam width 5°, vertical beam width 50°.	
Directivity Pattern:	Fan-shaped beam	
Steering Beam:	**Along-Length**: ±90°	**Along-curve**: ±90°
	Cross-length: No.	**Cross-curve**: No.
Beamforming:	Electronic beam steering and focusing in the scan plane.	
Side Lobe Level:	≤ -15 (dB)	≤ -20 to -30 (dB) depends on frequency and curvature.
Driving Voltage:	1. Default: Maximum 600 Vrms. 2. TBD. To be determined with customization.	
Transducer without Impedance Matching Unit		
Driving Voltage V_i at f_s:	**Pulsed Driving Signal and Duty Cycle D < 100%:** Maximum V_i, $V_{imax} = \sqrt{(MIPP/G_{max})}$ or 600, whichever is less, in V_{rms}.	
	Continuous Operation at 100% Duty Cycle: Maximum V_i, $V_{imax} = \sqrt{(MCIP/G_{max})}$, in V_{rms}.	
	To achieve higher sound level, built-in impedance matching is recommended to step up driving voltage inside the transducer.	
Transducer with Impedance Matching Unit		
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 with Impedance Matching Unit at fs.	
	Continuous Operation at 100% Duty Cycle: Maximum V_i, $V_{imax} = \sqrt{(MCIP * \|Z\|)}$, in V_{rms}.	
Input Power P_I:	$P_i = V_i^2 * G$. Refer to **G-B Graph:** G is conductance, G_{max} is maximum G at f_s.	
MIPP at f_s:	Maximum Input Pulse Power at f_s: $P_i = V_i^2 * G_{max}$ or TBD Watts, whichever is less. TBD, to be determined.	
MPW at MIPP and f_s:	TBD Seconds, Maximum Pulse Width at MIPP and at f_s. TBD, to be determined.	
MCIP at f_s:	TBD 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:	-181 to -195 dB V/µPa @ fs. Free-field Voltage Sensitivity.	
	$Sensitivity\ Loss\ over\ extension\ cable\ at\ f_s\ (dB) = 20 * \log\{(1 + 2\pi f_s C_c/B)/\sqrt{[G^2 + (B + 2\pi f_s C_c)^2]/(G^2 + B^2)}\}$ G: Conductance at f_s; B: Susceptance at f_s; C_c: Capacitance of Extension Cable. Cable is of 100 pF/meter roughly.	
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. 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 for Multi-Element: (EFMM) Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.	
Cable-Out:	By default, the cable goes out of the device from the end face. To save space and have the device shorter, the cable can go out of the device from the side wall for uses in air or shallow water (< 50m). Specify when ordering.	
Cable:	1. Two Conductor Shielded Cable (SC), Rubber or PVC Jacket. 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. 6. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, ΦD=4.0 mm (SC40), up to 200°C, AWG20 Conductors.	
	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: 1m. 2. Custom	
Connector:	1. Default: Wire Leads (WL) 2. Male BNC (BNC) (Max. Diameter Φ14.3 mm) 3. SMA (Plug, Male Pin) (SMA), Voltage Rating: 335 VRMS Continuous. (Max. Diameter Φ9.24 mm) 4. SMC (Plug, Female Socket) (SMC), Voltage Rating: 335 VRMS Continuous. (SMC) (Max. Diameter Φ6.4 mm) 5. MIL-5015 Style (pin) (5015) (Max. Diameter Φ30 mm with 3 contacts) 6. LEMO (Plug Male Pins) (LEMO) (Max. Diameter Φ9.5 mm with 3 contacts) 7. Underwater Mateable Connector (pin) (UMC) (Max. Diameter Φ21.5 to Φ35 mm) 8. Customized, buyer specifies the connector. (Custom) Note: Underwater Mateable Connector is for uses underwater. Other connectors and wire leads are for dry uses and are not waterproofed.	
Size:	TBD. To be determined with customization.	
Weight:	TBD. To be determined with customization.	
Operation Temperature:	1. Default: -10 to +60 °C, or 14 to 140 °F. 2. Customized High Temperature Transducer: -15°C to 120°C or 5°F to 248°F.	
Storage Temperature:	-20 °C to +60 °C or -4 °F to 140 °F.	
Impedance Matching:	BII-6000 Bespoke Impedance Matching between transducers and power amplifiers. Order Separately. Append **IM** to the part number for integrating BII-6000 in the transducer, and specify impedance in Ω. For example, BII-xxxxIM50Ω: BII-xxxx transducer with built-in Impedance Matching unit as a 50 Ω load.	
TR Switch:	BII-2100 Transmitting & Receiving Switch. Not Included. Order Separately, Append TR to part number (BII-xxxxTR).	
Temperature Sensor:	1. Default: No built-in temperature sensor.	

	2. Built-in temperature sensor. Append **TS** to part number (BII-xxxxTS) for integrating a temperature sensor in the transducer.
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.	

Transducer Wiring:	**Shielded Cable**	**Coax/BNC/SMA/SMC**	**Coax/Wire Leads**	**Underwater Connector**	**MIL-5015 Connector**
Driving Signal	White or Red	Center Contact	Coax Center Conductor	Contact 2	Contact C
Signal Common	Black	Shield	Coax Shield	Contact 1	Contact B
Shielding & Grounding	Shield	Shield	Coax Shield	Contact 3	Contact A

How to Order

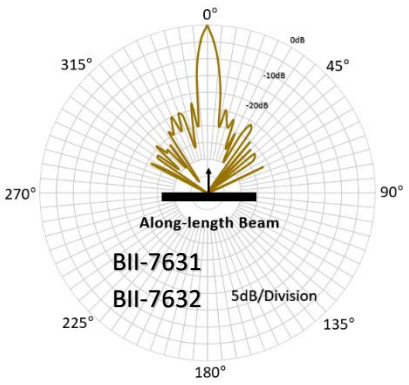
Array Spacing d: the distance among the center lines of two neighboring elements.
Beam Width: The angle of main lobe at -3dB when driving signals to all array elements are identical (f, phase and amplitude are same.).

Transducer	**/fs**	**-N**	**-d**	**-Beam Width**	**-Mounting**	**-Cable Length**	**-Cable**	**-Connector**
BII-7631 BII-7632	in kHz	Number of elements	Spacing of Elements, in mm	H°xV° at fs	Refer to specs.	of Each Element, in meter	Refer to specs.	

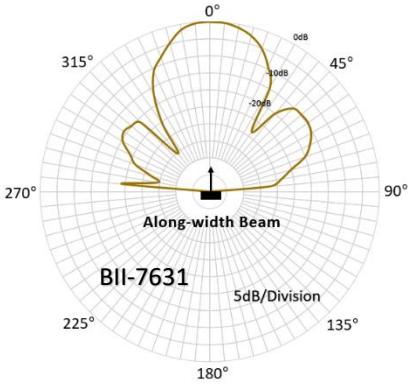
Example of Part Number:	Description
BII-7631/100kHz-9-7.5mm-3°x30°-FH-10m-SC-WL	BII-7631 transducer, fs: 100kHz; Array Elements: 9; Array Element Spacing: 7.5mm; -3dB Beamwidth at fs: 3°x30°; Free Hanging, 9x10m Shielded Cable, Wire leads.

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

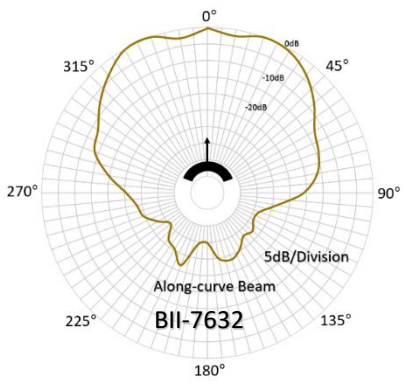
Along-length or Cross-curve



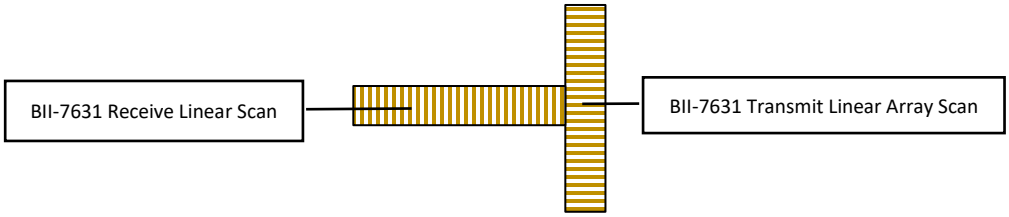
Along-width or Cross-length



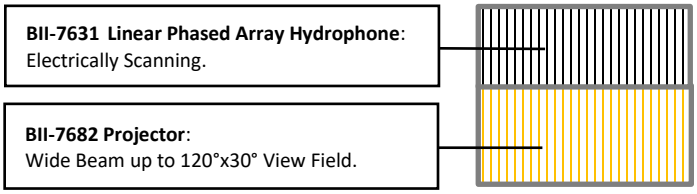
Along-curve



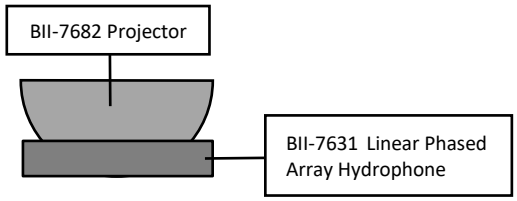
3D "T" Type Imaging Multibeam Transducer: Two BII-7631 Linear Phased Array (Rectangular Aperture).



2D Imaging Multibeam Transducer: one BII-7631 Linear Phased Array (Rectangular Aperture) and one BII-7682 (Curvilinear or Cylindrical Sector Aperture).



Front View: Acoustic Window



Top View