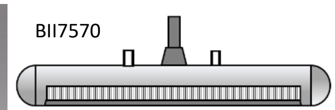
SE=SL-TL+AG-NL

Benthowave Instrument Inc.

Underwater Sound Solutions www.benthowave.com



Side-scan Transducer Specification

BII-7570 Series Side Scan, Interferometric (Phase-measuring) and Parametric Transducers: Sea-floor Mapping and Sub-bottom Profiling.

Conventional Side Scan: BII's side scan transducers with fan-shaped beam are designed for use in underwater imaging, sea/river/lake-floor mapping, target location, mine hunting, fisheries... The beam covers wide across-track swath and provides high along-track spatial resolution in tens or hundreds meter range. Acoustic image of underwater bottom is achieved at grazing angles of incidence. High resolution image can be formed with the technique of **Synthetic Aperture Imaging**. Multiple frequencies are available in one transducer.

Interferometric (Phase-measuring) Side Scan: The phase differences of received signals are detected by multiple linear receive arrays paralleling to the linear transmit array. After ambiguity is removed with proper techniques, the direction of arrival (DOA) and location of the scatterer can be accurately determined.

Parametric Side Scan: When two underwater sound waves of different primary frequencies f_{p1} and f_{p2} ($f_{p1}>f_{p2}$) propagate in the same direction, they interact with each other to create low frequency sound wave of secondary frequency $f_{sec.}$ ($f_{sec.}=f_{p1}-f_{p2}$). The directivity of secondary frequency is close to the ones of primary frequencies. This difference frequency sound is useful for practical applications in sediment profiling, depth sounding and communication. Parametric array gain or efficiency (generally ≤ 1%) is better as primary sound powers are higher, secondary frequency $f_{sec.}$ is higher, down shift ratio $(f_{p1}+f_{p2})/(2f_{sec.})$ is lower, and ($\alpha p*R_r$) is lower (αp: mean primary sound attenuation coefficient; R_r: rayleigh distance). Attenuation/absorption coefficient of sediments is frequency dependent around 0.06f to 0.6f (dB/(m*kHz)).

Typical Applications

Sea/River/Lake-floor Mapping	Target Location Underwater	Fisheries	Direction of Arrival	Mine Hunting

Specifications

Side Scan Transducer	BII-7571	BII-7572	BII-757N (N=3, 4, 5, ….)
Line Array Number:	One Line Array	Two Line Arrays in Parallel	N Line Arrays on Parallel
Frequency f_s Options:	Operation frequency f_s: 45 kHz to 1 MHz, Bespoke. In-stock Array Elements: 45, 50, 60, 70, 100, 120, 150, 200, 250, 300 kHz. < 45 kHz, please consider **Parametric Side Scan Transducer.** For example: a BII-7572 with one 45 kHz line array and one 50 kHz line array to achieve 5 kHz side scan sounds. **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.**		
Survey Range:	≤ 500 m, determined by source level, propagation loss, target strength, etc… 50 kHz: 400 m; 70 kHz: 380 m; 100 kHz: 350 m; 120 kHz: 320 m; 200 kHz: 200 m; 250 kHz: 160 m; 300 kHz: 135 m; 500 kHz: 100 m; 600 kHz: 70 m		
Pulsed Driving Signal:	Spike (Negative or Positive), pulse and burst SINE/Square/Chirp excitation.		
Directivity Pattern:	Fan-shaped Beam		
Beamwidth (-3dB):	Customized: Along-track: ≤ 2.0°. Across-track: ≤ 50°. Specify when ordering.		
Side Lobe Level:	≤ -13.3 dB (One-Way).		
Quality Factor Q_m:	3 ~ 4, -3 dB bandwidth = fs/Q_m.		
TVR at f_s:	≥ 160 dB µPa/V@1m at f_s, 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, or refer to **G-B Graph**.		
Transducer without Impedance Matching Unit			
Driving Voltage V_i at f_s:	**Pulsed Driving Signal and Duty Cycle D ≤ 1%:** Maximum V_i, V_{imax} = √(MIPP/G_{max}) or 600, whichever is less, in V_{rms}.		
Transducer with Impedance Matching Unit			
Driving Voltage V_i at f_s:	**Pulsed Driving Signal and Duty Cycle D ≤ 1%:** V_{imax} = √(MIPP * |Z|), in V_{rms}. Z is impedance with Impedance Matching Unit at f_s.		
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 500 to 2000 Watts Watts, whichever is less. TBD, to be determined.		
MPW at MIPP and f_s:	0.02 Seconds, Maximum Pulse Width at MIPP and at f_s. TBD, to be determined.		
MCIP at f_s:	10 to 50 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): 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 PW ≤ (MIPP * MPW*(120°c-T)/103°c)/IPP, or PW ≤ 20 mS, whichever is less. T: Water Temperature in °c. 3. Duty Cycle D ≤ MCIP*(120°c-T)/103°c)/IPP, or D ≤ 1%, Whichever is less. 4. Off-time ≥ PW*(1-D)/D.			
FFVS at f_s:	-195 to -170 dB V/µPa at f_s, 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:	300 m, maximum, and Limited by the cable length if the cable has wire leads or a non-waterproof connector.		
Mounting:	Two 3/8"-16 x 1.25" 316 SS Screw. Hex Nut and Split Lock Washer are included.		
Cable:	1. Two Conductor Shielded Cable (SC). 2. 50 Ω RG58 Coax (RG58).		
Cable Length:	1. Default: 1 m. 2. Custom.		
Connector:	1. Default: Wire Leads (WL). 2. 50 Ω BNC Male (BNC). 3. Underwater Mateable Connector (UMC). 4. MIL-5015 Style (5015). 5. Custom (custom). Note: Underwater Mateable Connector is for underwater uses. Other connectors and wire leads are for dry uses and are non-waterproof.		
Size (LxWxH):	TBD. Determined by beam angles.		
Weight in Air:	≥ 0.5 kg with 1 m cable. Actual weight depends on Mounting Parts, Cable Types and Length.		
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:	BII-6000 Bespoke standalone impedance matching between transducers and power amplifiers. Order Separately.
TR Switch:	BII-2100 Standalone transmitting & receiving Switch.
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**	**Underwater Connector**	**MIL-5015 Connector**
Signal	White or Red	Center Contact	Contact 2	Contact C
Signal Common	Black	Shield	Contact 1	Contact B
Shielding and System Grounding	Shield	Shield	Contact 3	Contact A

Note: The cables will be labelled with #1, #2, #3, #4, #5 .... for multiple linear arrays inside the transducers.

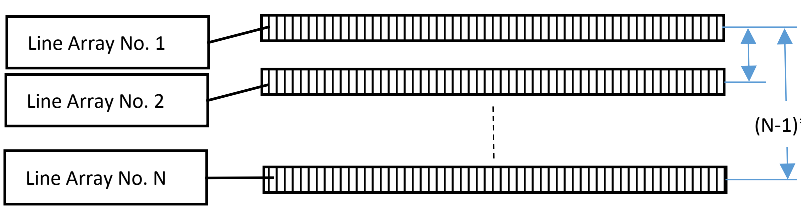
How to Order:

BII-757	**N**	**-fs x d**	**-Beamwidth**	**-Cable type**	**-Cable Length**	**-Connector**
	Number of Linear Arrays	fs, in kHz. d: Array Spacing in mm.	HxV in ° of Each Array	Refer to options.		

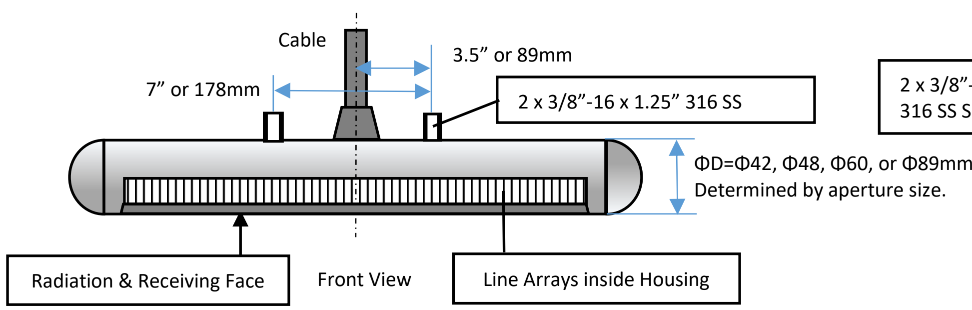
For examples:

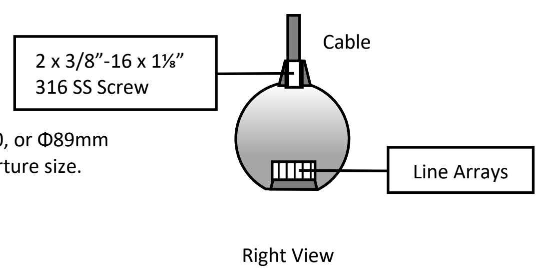
BII-7571-100kHz-1°x50°-SC-1m-WL	BII-7571 Transducer, Number of Linear Arrays: 1; One 100kHz Linear Array; Beamwidth: 1°x50°; Default Mounting: Two SS Screws; Shielded Cable; 1m, Wire Leads.
BII-7572-45kHzx50kHzx35mm-1°x50°-SC-1m-WL	BII-7572 Transducer, Number of Linear Arrays: 2; 45kHz and 50kHz Linear Arrays in Parallel with spacing 35mm; Beamwidth of Each Array: 1°x50°; Default Mounting: Two SS Screws; Shielded Cable; 1m, Wire Leads.
BII-7575-100kHzx18mm-1°x50°-SC-1m-WL	BII-7575 Transducer, Number of Linear Arrays: 5; Five 100kHz Linear Arrays in Parallel with evenly spacing 18mm; Beamwidth of Each Array: 1°x50°; Default Mounting: Two SS Screws; Shielded Cable; 1m, Wire Leads.

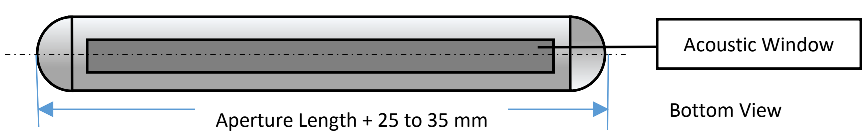
N Line Arrays in Parallel



Physical Size (Dimensional Unit: mm). following transducer structures are for illustration ONLY.







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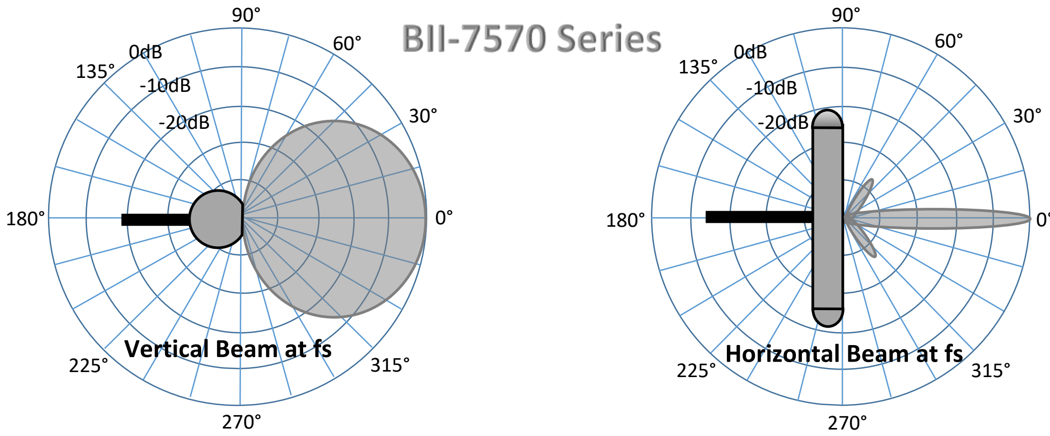
Directivity Pattern: illustration ONLY. Please refer to -3 dB beam width of a specific transducer.



Admittance