



Multibeam (Scanning) Transducer: 2D Imaging Sonar

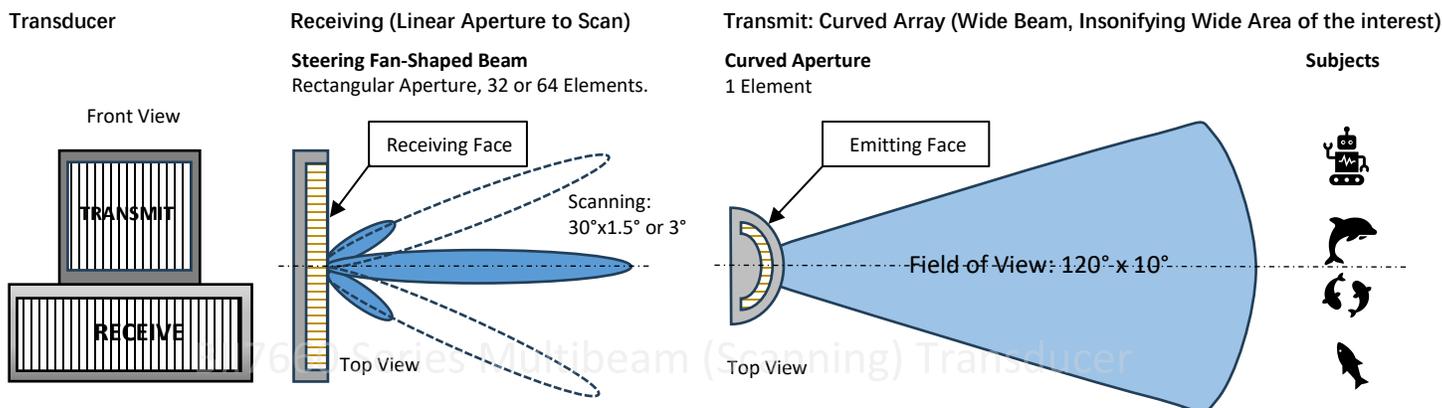
BII7660 series multibeam (scanning) transducers are designed for uses in long range 2D image Sonar, underwater floor/bottom mapping, sector scanning, navigation, object detection, target tracking, obstacle avoidance in hundreds and thousands meter range.

Transmitting aperture (one element) and receiving aperture (32 or 64 elements) operate independently. The curved transmitting element transmits a broad fan-shape beam to insonify a large sector of interest (field of view around 120°), the linear receiving array has fan-shape beam perpendicular to the emit-beam and can be steered electrically to scan the area of interest with 3° or 1.5° resolution. Both emit and receive array are broadband to support broadband SONAR signals (such as SINE Pulses, FM/Chirp Pulses, Ricker Pulses, etc.). Acoustic sweeping (2D scanning) of the horizon or vertical can be achieved with digital beamforming technology.

Typical applications are long range acoustic positioning, tracking, echo locating, navigation, communication, and artificial acoustic target in horizontal or vertical plane in the ocean, rivers, and lakes.

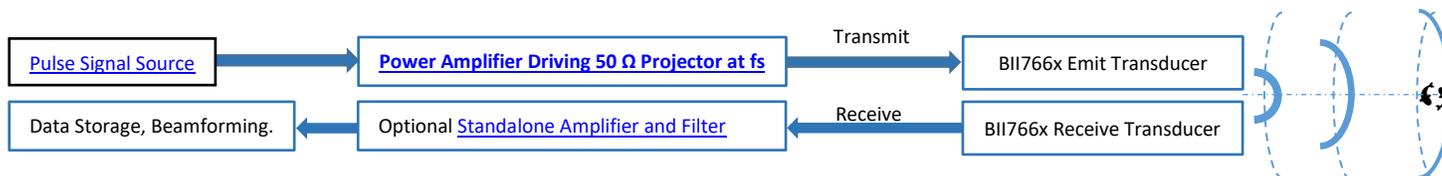
BII7660 series multibeam transducer consists of one [BII7682](#) (curvilinear aperture) and one [BII7631](#) (linear phased array).

Manual or mechanical scanning SONAR: [BII7770 Series](#) Underwater Mechanical Scanning Transducer.



SYSTEM CONFIGURATION (Simplified Flow Charts: Control Signals, DC Power Supplies, etc. are NOT shown.):

Transmitting and Receiving Underwater Sounds:



TYPICAL APPLICATIONS

Forward-looking Sonar, Scanning Sonar, Underwater Floor Mapping. Object/Target Detection, Navigation, Obstacle Avoidance, Target Tracking.	Underwater Robotic and Vehicle (ROV, AUV, UUV). Fish Finding, Underwater Acoustic Positioning: Transponder, Responder.
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RELATED PRODUCTS

Power Amplifier for SONAR, NDT, and HIFU.	Impedance Matching between Transducers and Amplifiers.
BII7630 Series Phased Array Transducer: Beamforming, Dynamic Focusing.	BII7680 Series Transducer: Wide Beam Directional Transducer.
BII7710 Scanning SONAR Transducer: 360° Search.	BII7770 Series Underwater Mechanical Scanning Transducer.

Specification

Transducers are tested in water at 20°C unless stated otherwise.			
FG: Fixed Gain; PG: Programmable Gain; DF: Differential Output; SE: Single Ended Output; BPF: Band Pass Filter; HPF: High Pass Filter; LPF: Low Pass Filter.			
f_s: Resonant Frequency; IM: Impedance Matching; η_{ea}: Electroacoustic Efficiency; PF: Power Factor; TVR: Transmitting Voltage Response; SL: Sound Level; FFVS: Free-field Voltage Response, Receiving Voltage Response (RVR), or Voltage Sensitivity; DRP: Directional Response Pattern; SLL: Sidelobe Level; SRD: Sound Ranging Distance along Axis of Main Lobe; Z: Complex Impedance; Z : Impedance Amplitude; θ: Impedance Phase; Y: Admittance; G: Conductance of Admittance; B: Susceptance of Admittance; Q_m: Mechanical Quality Factor; Q_e: Electrical Quality Factor; MIPP: Maximum Input Pulse Power; MPW: Maximum Pulse Width at MIPP and at f _s ; MCIP: Maximum Continuous Input Power. TR: Transmit and Receive; TRSW: Transmit and Receive Switch with built-in low noise preamp and bandpass filter. BW: -3dB Bandwidth or Beamwidth; PND: Pressure Noise Density, LNR: Low Noise Receiver. SC: Signal Conditioning. OPL: Overload Pressure Level.			
Transducer:	BII7661	BII7662	BII7663
Applications:	Long Range Multibeam Transducers for 2D Imaging SONAR.		
Acoustic Apertures:	Transmit: Cylindrical Segment. One transmit transducer with only one element. Receive: 32- or 64-element Linear Array. One receive linear array transducer with 32 or 64 elements.		

Operation Mode:	Full-duplex and Half-duplex.		
Scanning Mode:	Scanning in horizontal plane of linear array (along Length) with beam-steering electronically in end user's digital beamformer.		
	If all elements of the linear array are in parallel as one element whose output signal is fed to a signal conditioner (not necessary), scanning along array Length mechanically or manually.		
Sound Ranging SRD :	Pulse-Echo or Echo Sounding Ranging: refer to Maximum Echosounding Ranging vs Target Strength in Ocean .		
	Passive Listening Range with Half-duplex mode is much greater than Echo Sounding Range and depends on the levels of sound sources.		
Transmit (Projector) Module			
Array Geometry:	Curved Face of Cylindrical Segment.		
Transmit Element:	One		
Digital Beamformer:	Not Necessary.		
f _s :	35 kHz ± 10%	50 kHz ± 10%	60 kHz ± 10%
	Minimum: 3.5 kHz.	Minimum: 5 kHz.	Minimum: 5 kHz.
	Operating Frequency < Minimum Transmit Frequency: transducer impedance is very low which causes over-current issue to power amplifier, and results in overheat issue (damage) to power amplifier and the transducer.		
IM at f _s :	built-in Impedance matching to 50Ω , Phase Angle θ of Complex Impedance ≤ 20° at f _s .		
	Impedance Z = 50*e ^{iθ} , in Ω, Phase Angle θ ≤ 20° at f _s .		
Signal Type:	SONAR Pulsing Signals: SINE Pulses, Bell-shaped Sine Pulses, Ricker Pulses, Chirp/FM Pulses, PSK/FSK, Burst Pulse Train.		
Beam Width θ _{-3dB} (°):	Horizontal x Vertical = 128°x10°	Horizontal x Vertical = 114°x10°	Horizontal x Vertical = 118°x8.3°
	Horizontal: Along-curve Beamwidth (-3dB); Vertical: Along-Height Beamwidth (-3dB).		
DRP:	Fan-shaped Directivity, refer to Directivity Pattern .		
Side lobes SLL:	Refer to Graph of Directional Response Pattern .		
	No side lobes in Horizontal Plane or XY Plane; -14dB side lobes in Vertical Plane or XZ Plane.		
Sidelobe Suppression:	No Sidelobe Suppression is applied to transmit element.		
Q _m at f _s :	3.6 ± 0.5	3.5 ± 0.5	3.8 ± 0.5
	-3dB bandwidth Δf = f _s /Q _m . Quality Factor Q _m determines the transient response or the rise and fall rings of steady-state response.		
η _{ea} at f _s :	0.65 ± 0.5. in Water, Electroacoustic Efficiency.		
η _{ea} at f << f _s :	Electroacoustic Efficiency η _{ea} is quite low at f << f _s and drops gradually at f > f _s . It is NOT recommended to apply high voltage to transducers to transmit high power sounds at frequencies far from f_s. Otherwise, transducer may be damaged by over-voltage and/or overheating.		
PF at f _s :	≥ 0.96		
TVR at f _s :	160.0 ± 2 dB μPa/V@1m.	165.0 ± 2 dB μPa/V@1m.	170.0 ± 2 dB μPa/V@1m.
	Refer to TVR Chart , Transmitting Voltage Response. Tolerance: ±2 dB.		
Radiation SL:	SL = 20*log V _D + TVR, dB μPa@1m. Driving Voltage V _D is in unit of V _{rms} .		
Driving Voltage V_D:	Pulsing Signal: Duty Cycle D ≤ 1%, Pulse Duration (Pulse Width) ≤ 100mS. Max. V _D = √(MIPP * Z) = 316 V _{rms} . Z is impedance at f _s .		
Input Power P _i :	P _i = V _D ² / Z at f _s . Z is impedance at f _s or 50Ω.		
MIPP at f _s :	Maximum Input Pulse Power at f _s : P _i = V _D ² * Z or 2000 Watts .		
MPW at MIPP and f _s :	≤ 100 mS at Maximum Pulse Width at MIPP, at f _s and Duty Cycle D ≤ 1% .		
MCIP at f _s :	100 Watts, Maximum Continuous Input Power at f _s .		
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.			
Operating Depth:	300 m maximum and limited by the cable length if the cable has wire leads or a non-waterproof connector.		
Mounting Options:	Bolt-Fastening Mounting with Free Hanging (BFM-FH-3/8").		
	Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.		
	Mounting part and cable are at rear face of the transducer for easy operation.		
	End user installs transducers on end user's positioning jigs for field deployment.		
Transmit Cable:	1. Two Conductor Unshielded Cable (USC), Rubber, AWG18 Conductor, 600Vrms, 10A.		
	2. Two Conductor Shielded Cable (SC), Rubber or PVC Jacket, AWG20 Conductor, 600Vrms, 4A		
	3. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, ΦD=4.0 mm (SC40), 600V, 4A, up to 200°C, AWG20 Conductors. Not Waterproofed.		
	Handling: (1) Do not use the cable to support transducer weight in air and water if the transducer has a mounting part. (2) Do not bend the cable.		
Cable Orientation:	1. Default: Perpendicular to end face of the housing.		
	2. Customization: Perpendicular to side wall of the housing to reduce the overall length. Appending SW to the part number.		
Cable Length:	1. Default: (a) 15 m. (b) 0.6m with Underwater Mateable Connector (2 pins) (UMC2P) or (3 pins) (UMC3P).		
	2. Custom up to 50 m.		
Connector Options:	1. Default: Wire Leads (WL).		
	2. Underwater Mateable Connector (2 pins) (UMC2P) (Max. Diameter Φ35 mm). Locking Sleeve: DLSA-M.		
	Underwater Mateable Connector (3 pins) (UMC3P) (Max. Diameter Φ35 mm). Locking Sleeve: DLSA-M.		
	Underwater Mateable Connectors (UMC) are fixed with 0.6m unshielded cable. UMC is from global manufacturers of underwater connectors. Its part number is listed in quote in detail.		
	3. MIL-5015 Style (3 pin) (MIL3P) (Max. Diameter Φ19 to Φ30 mm).		
	Note: Underwater Mateable Connector is for uses underwater. Other connectors and wire leads are for dry aerial uses and are not waterproofed.		
1. MIL: MIL-5015 Style Connectors, interconnection solution for high power signals. -55°C to +125°C, Fastening Type: Threaded . Dry Aerial Uses.			

2. UMC: Underwater Mateable Connectors, interconnection solution for high power signals. Fastening Type: Threaded. Underwater Uses.			
Physical Size:	LxWxH = 168 x 84 x 220 mm	LxWxH = 168 x 84 x 220 mm	LxWxH = 168 x 84 x 180 mm
	Refer to outline drawings .		
Weight in Air:	≥ 10 kg with 15 m cable.	≥ 10 kg with 15 m cable.	≥ 9 kg with 15 m cable.
	Generally, cable weight: 66g/m (2C SC Cable), 78g/m (2C USC Cable).		
	Actual weight depends on Mounting Parts, Cable Types and Length, 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.		
Amplifier:	BI5000 Power Amplifiers for SONAR, NDT, HIFU. Order Separately as standalone devices.		
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.			
Receive Module			
Array Geometry:	Linear Array	Linear Array	Linear Array
Digital Beamformer:	Necessary to achieve 2D underwater field view, Not included. End users develop Digital Beamformer at end users' cost.		
Receiving Element:	32	32	64
	Bespoke transducers are available on receiving element quantities.		
Element Spacing:	Fixed, Half Wavelength.	Fixed, Half Wavelength.	Fixed, Half Wavelength.
Side lobes SLL:	refer to Directivity Pattern .		
Sidelobe Suppression:	No Sidelobe Suppression in Horizontal Plane or XY Plane. End user should do digital beamforming in buyers' application software.		
	Sidelobe Suppression to -21 dB in Vertical Plane or XZ Plane.		
Beam Width θ_{-3dB} (°):	Horizontal x Vertical = 3.0°x30°	Horizontal x Vertical = 3.0°x30°	Horizontal x Vertical = 1.5°x30°
	Horizontal: Along-length Beamwidth (-3dB); Vertical: Along-width Beamwidth (-3dB).		
Beam Steering Range:	±60°	±60°	±60°
Q _m at f _s :	3.5 ± 0.5	3.5 ± 0.5	3.5 ± 0.5
	-3dB bandwidth $\Delta f = f_s/Q_m$. Quality Factor Q _m determines the transient response or the rise and fall rings of steady-state response.		
FFVS at f _s :	-184.0 + Preamp Gain ± 2dB, in dB V/μPa, at operating frequency f _s .		
	Refer to Graph of FFVS vs. Frequency . 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. FFVS: Free-field Voltage Sensitivity. Please refer to online document AcousticSystem.pdf for conversion between G-B and Z-0, if necessary.		
FFVS at f << f _s :	Not Recommended.		
Frequency Range:	Available: 10 Hz to 100 kHz		
Receiving SL:	SL = 20*logV _o - FFVS, dB μPa. Receiving Voltage V _o is in unit of V _{rms} .		
Capacitance C _r :	2.0 nF ± 10% @ 1 kHz.	1.0 nF ± 10% @ 1 kHz.	0.6 nF ± 10% @ 1 kHz.
Each Array Element.	C _r increases if there is extension Cable, Cable C ≈ Cable Length * 0.1nF/meter.		
Dissipation:	0.01 @ 1 kHz	0.01 @ 1 kHz	0.01 @ 1 kHz
Input Noise Density:	Refer to Pressure Noise Density (RTI, referred to the input).		
Filters:	A High Pass Filter is formed with C _r of transducers and R _i of Preamps. -3dB High Pass Frequency: $f_{-3dBH} = 1/(2\pi R_i C_r)$. R _i : Input Resistance or Impedance of Preamp. C _r : Capacitance of transducer at 1 kHz (non-resonance measurement) or f _s (resonance measurement such as NDT pulsing system). For example: 2nF of an array element at 1kHz and preamp R _i 1MΩ constitute high pass filter with -3dB frequency at 80 Hz.		
	1. Reduce Noise. Both ocean ambient noises and the self-noises of electronic devices decrease when frequency increases. It is recommended to choose a built-in high pass filter to reject noises in low frequency range. For example, if you are interested in the signals greater than 35 kHz, you may specify a high pass filter with -3dB cut-off frequency at 3.5 kHz to improve signal to noise ratio of the signals of the interest.		
	2. Avoid Saturation. When there are strong low frequency noises, disturbances, and/or vibrations, resulting from rough surface waves and/or mechanical movements of the platform, it is recommended to specify a high pass filter to avoid hydrophone saturation in these low frequency ranges.		
Signal Conditioning:	Additional Low Noise Signal Conditioning is available such as PGA/AGC/VGA preamps with filters, which compensate the loss of sound propagation and spreading up to 90dB dynamic range depending on specific configuration. Order separately.		
	Signal Conditioning of Receive for Each Element: (1) Standalone PCB with wire bundles to be installed in end user's submersibles. (2) standalone devices with BNC connectors for dry aerial uses.		
V _{omax} (Vpp):	N/A		
OPL (dB μPa):	≤ 220 dB μPa. Overload Pressure Level.		
Acceleration Sensitivity:	≤ 103 dB μPa/(m/s ²)	≤ 100 dB μPa/(m/s ²).	≤ 110 dB μPa/(m/s ²).
Output Type:	Each Element outputs Single-ended Signal.		
Output Z:	$Z \approx -j/(2*\pi*f*C_r)$		
Operating Depth:	300 m maximum and limited by the cable length if the cable has wire leads or a non-waterproof connector.		
Mounting Options:	1. Bolt-Fastening Mounting with Free Hanging (BFM-FH-3/8") for portable applications on boats or shore.		
	2. Bolt-Fastening Mounting with Free Hanging (BFM-FH-3/8") and End-face Mounting (EFMM) for installation on submersibles.		
	Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details. Mounting part and cable are at rear face of the transducer for easy rotation. End user installs both transducers on end user's positioning jigs for field deployment.		
Receive Cable Bundle:	1. Default: 50 Ω Coax RG174/U, ΦD=2.8 mm (RG174).		
	2. 50 Ω Coax RG316/U, ΦD=2.5 mm (RG316).		
	3. Shielded Cable with Twisted Pair and PVC Jacket, ΦD=3.6 mm (SC36).		
	32 Cables	32 Cables	64 Cables

	Handling: (1) Do not use the cable to support transducer weight in air and water if the transducer has a mounting part. (2) Do not bend the cable.		
Cable Orientation:	Perpendicular to rear face of receiving units.		
Orientation of Receiving Array:	1. in default: First Element is located at the most right position of the array with Front View or Receiving Face View Last Element (32 nd or 64 th) is located at the most left position of the array in Front View or Receiving Face View 2. If the orientation of the linear array is not in default, BII shall specify the orientation in data sheet.		
Cable Length:	Default: 0.3 m (1 ft) for each array element.		
	≤ 15 m.	≤ 10 m.	≤ 5 m.
	Preamp close to the receiving element is necessary to avoid signal loss over the cable.		
Connector Options:	1. Wire Leads (WL).		
	2. Male BNC (BNC) (Max. Diameter Φ14.3 mm). Note: wire leads and BNC are for dry aerial uses and are not waterproofed.		
Physical Size:	LxWxH = 720 x 89 x 35 mm	LxWxH = 520 x 89 x 35 mm	LxWxH = 830 x 89 x 35 mm
	Refer to outline drawings .		
Weight in Air:	≥ 10 kg with 15 m cable.	≥ 8 kg with 10 m cable.	≥ 6 kg with 5 m cable.
	Actual weight depends on Mounting Parts, Cable Types and Length, 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.		

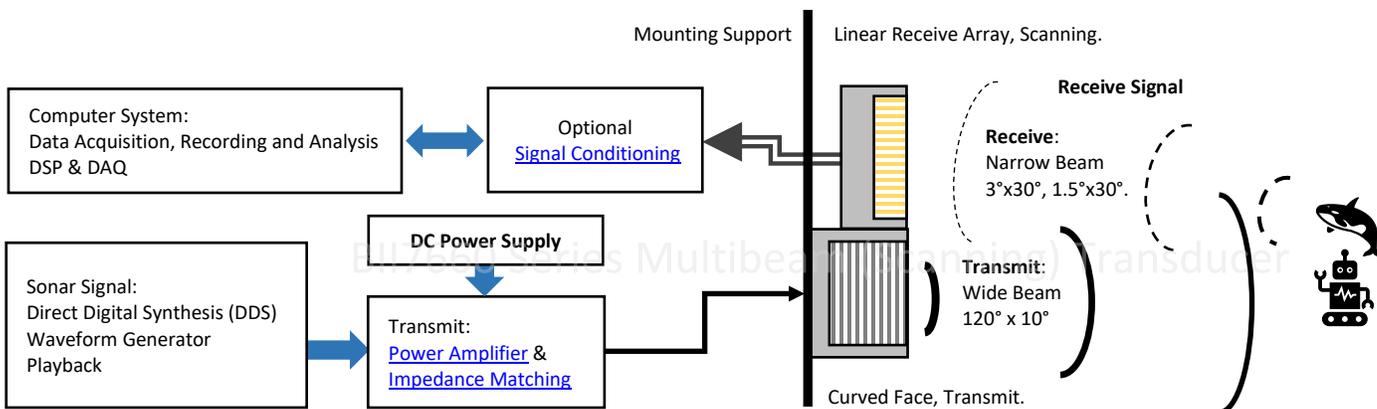
Wiring Information.

Transducer Wiring:	Shielded Cable	Coax, BNC.	UMC3P, Locking Sleeve: DLSA-M.	MIL3P
Signal:	White or Red	Center Contact	Pin 2	Pin C or G
Signal Common:	Black	Shield	Pin 1	Pin B
Shielding and Grounding	Shield	Shield	Pin 3	Pin A
Wiring of Unshielded Cable:	Wire Leads WL	UMC2P (0.6m USC Cable originally coming from manufacturer of the connector, Fixed.). Locking Sleeve: DLSA-M.		
Signal	White	Pin 2		
Signal Common	Black	Pin 1		

How to Order. Note: Please remember to purchase Transmit and Receive units.

Transducer	-Transmit or Receive	-Mounting	-Cable Length	-Cable Type	-Connector
BII7661, BII7662, BII7663.	Transmit or Receive Module	Refer to Options.			
Example of Part Number:	Description				
BII7661-Transmit-BFM-FH-3/8"-15m-USC-WL	BII7661 transducer, Transmit Module, Bolt-Fastening Mounting with Free Hanging (BFM-FH-3/8"), 15m Two Conductor Unshielded Cable (USC), Wire Leads.				
BII7661-Transmit-BFM-FH-3/8"-0.3m-USC-UMC3P	BII7661 transducer, Transmit Module, Bolt-Fastening Mounting with Free Hanging (BFM-FH-3/8"), 0.3m Two Conductor Unshielded Cable (USC), Underwater Mateable Connector (2 pins) (UMC2P) with Locking Sleeve: DLSA-M.				
BII7661-Receive-BFM-FH-3/8"-15m-RG174-BNC	BII7661 transducer, Receive Module, Bolt-Fastening Mounting with Free Hanging (BFM-FH-3/8"), 15m RG174 Coax Cable (RG174) for each array element, BNC Male.				
BII7661-Receive-BFM-FH-3/8"-EFMM-1m-RG174-WL	BII7661 transducer, Receive Module, Bolt-Fastening Mounting with Free Hanging (BFM-FH-3/8") and End-face Mounting EFMM, 1m RG174 Coax Cable (RG174) for each array element, Wire Leads.				

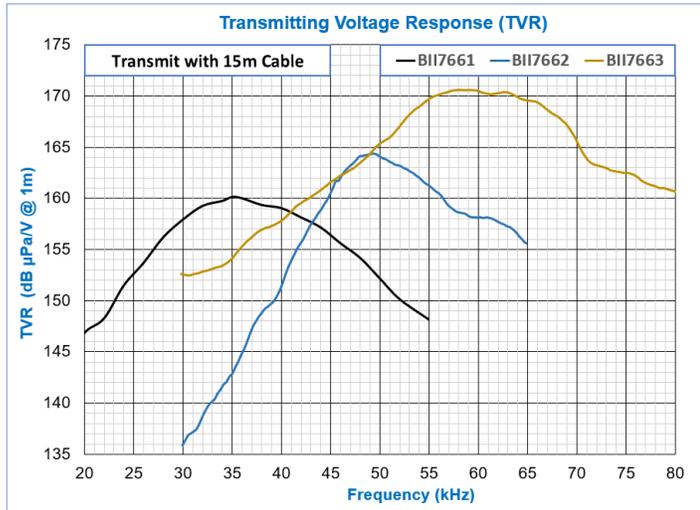
Tracking, Locating, Navigation, Communication, and Artificial Acoustic Target:



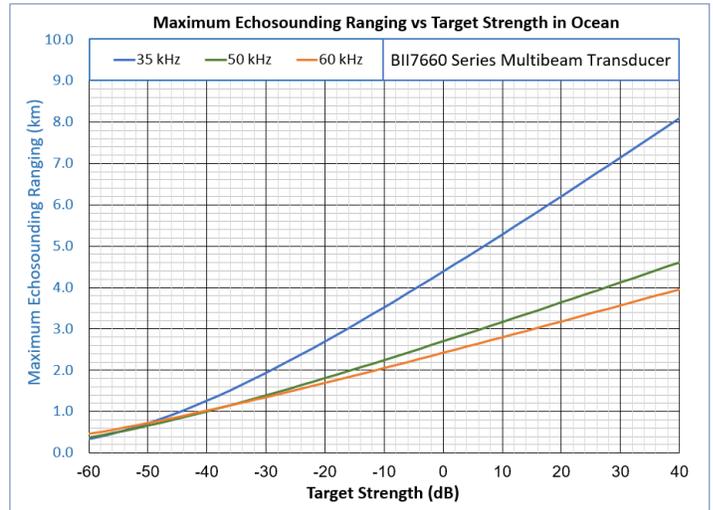
Application Notes:

Target strength of a 10"-length (0.25m) fish is about -35 dB. Target Strength of a Fish Shoal with 1000 fish is about -5 dB. Target strength of a dolphin is about -20 dB. Target strength of a whale is about 0 dB. Target strength of seamounts is from +30 to +60 dB. Refer to [Maximum Echo-Sounding Ranging vs Target Strength](#) in Ocean for sounding ranges.

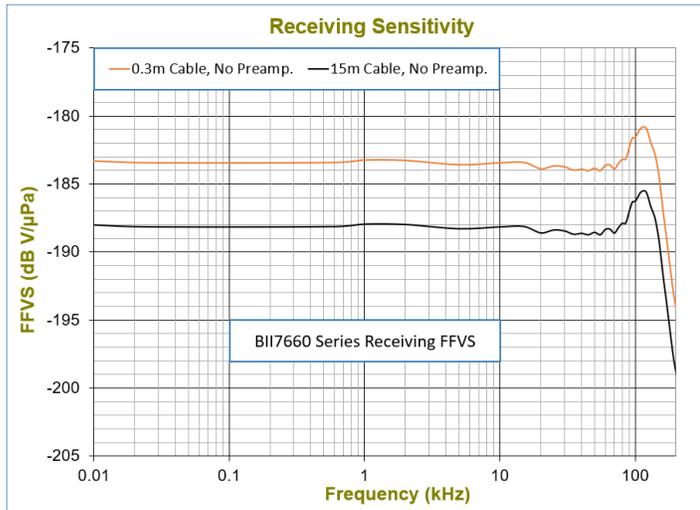
TVR Transmitting Voltage Response.



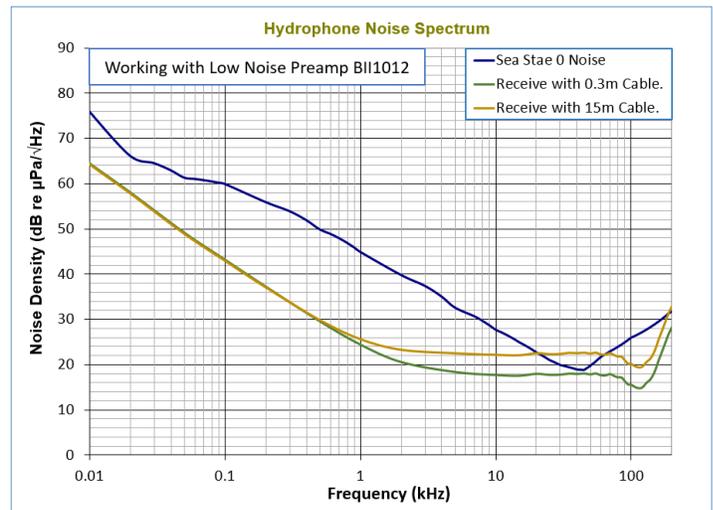
Maximum Echo-Sounding Ranging vs Target Strength in Ocean



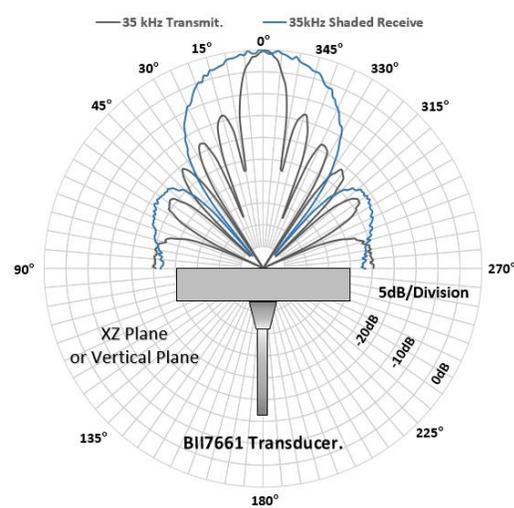
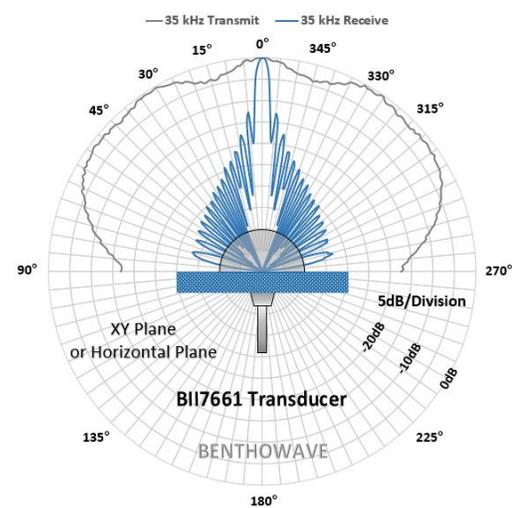
Free-field Voltage Sensitivity (FFVS):

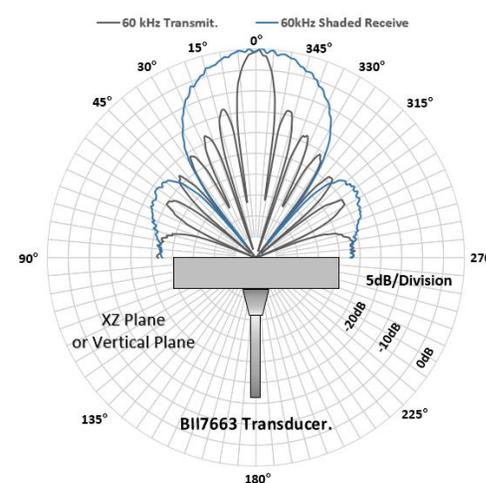
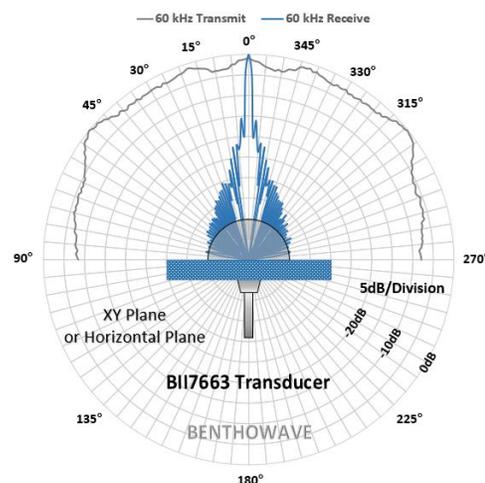
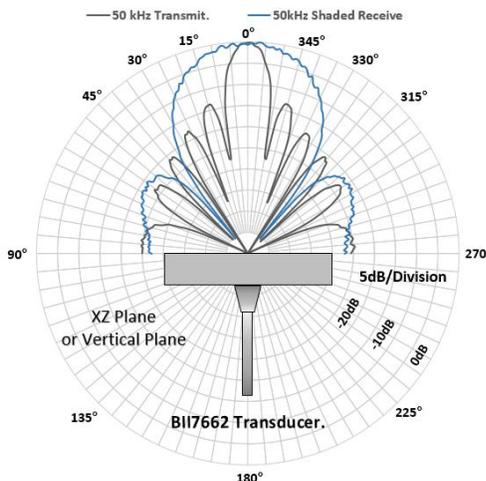
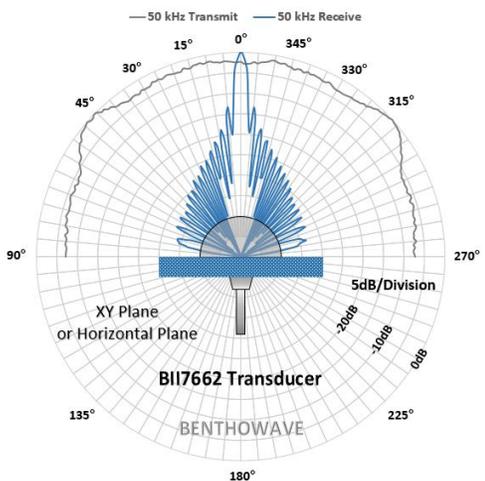


Pressure Noise Density of Receive (RTI, referred to the input):



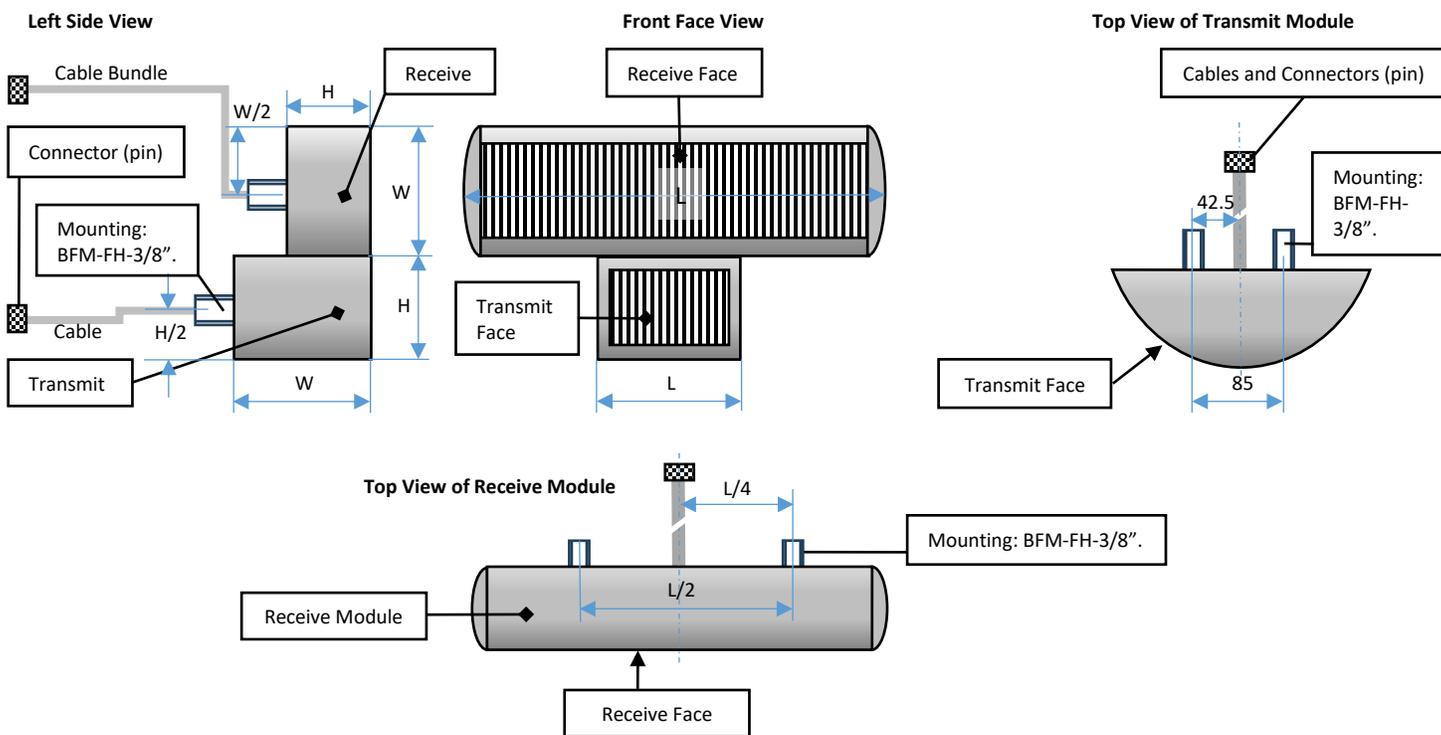
Directivity Pattern





Physical Size (Dimensional Unit: mm), Illustration only, scale is not 1:1.

1. Installation with BFM-FH-3/8" on portable fixtures for application on boats and shore: Two 3/8"-16 bolts are on the rear face of the transducer and two nuts are included. End user needs to prepare mounting jigs to position the transducer securely for locating, obstacle avoidance, navigation, and/or tracking targets.



2. How to extend cable into submersibles (underwater vehicles) such as UUVs (ROVs, AUVs.)?

1. Ordering transducer with Mounting Parts of BFM-FH-3/8" and EFMM.
2. Besides two mounting parts BFM-FH-3/8", a End-face Mounting Part (EFMM with O-ring Sealing, refer to [Acoustic System](#) for more info.) is on the rear face for cable bundles going through. End users should prepare mounting holes on submersibles to install EFMM and its O-ring.

