

BII7640 Series Underwater Dual-Element Transceiver: Omnidirectional and/or Directional Directivity Patterns.

Bll underwater acoustic transceivers are dual-element transducers which integrate (1) a broadband omnidirectional projector in horizontal plane and an omnidirectional low noise receiver in horizontal and vertical planes, (2) a broadband omnidirectional projector in horizontal plane and a directional low noise receiver in vertical plane, or, (3) a broadband omnidirectional projector in vertical plane and a broadband directional projector in vertical plane.

Typical applications include artificial acoustic target which is able to simulate quantitatively the noise, Doppler effect, echo or characteristic sounds of the subjects such as ships, torpedoes, submarines, fish, marine animals, seabed, sub-bottom, etc.

SYSTEM CONFIGURATION

Transmitting and Receiving Sounds.

		Transmit Cable		а (́		$-\lambda$
Pulse Signal Source	Power Amplifier Driving 50 Ω Projector at fs		Dual-Element Transceiver: 50Ω Proiector and	5		
Oscilloscope, DAQ, Recorder.	- Optional <u>Standalone Amplifier and Filter</u>	Receive Cable	Low Noise Receiver.		Y	
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Typical Applications				
Artificial Acoustic Target: Echo-Repeater Target, Active-Acoustic Target.	Underwater Telephone, Long Range Sound Transmission.			
Underwater Communication and Modem, Acoustic Release.	Acoustic Deterrent to Marine Animals Marine.			
Underwater Acoustic Positioning: Transponder, Responder.	Animal Behavior Research, Bioacoustic Stimuli & Playback.			
Related Products				
Power Amplifier for SONAR, NDT, and HIFU	Impedance Matching between Transducers and Amplifiers			

1. Omnidirectional Transceiver: Transmit Omnidirectional Sounds in Horizontal Plane, Receive Omnidirectional Sounds in Horizontal and Vertical Planes.



2. Omnidirectional Projector and Directional Receiver: Transmit Omnidirectional Sounds in Horizontal Plane, Receive Sounds in Vertical Plane (-3dB Beam Angle: 50° at fs.). The specification is NOT listed in this datasheet, contact BII for customization.





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3. Omnidirectional Projector and Directional Projector: Transmit Omnidirectional Sounds in Horizontal Plane and Transmit directional Sounds in Vertical Plane with -3dB Beam Angle of 50° at fs. Specification is NOT listed in this datasheet, contact BII for customization.



Typical Applications on Underwater Communications

1. Communication System: Transmitting Omnidirectional Sounds Horizontally and Receiving Omnidirectional Sounds in Horizontal and Vertical Planes.



2. Communication System: Transmitting Omnidirectional Sounds Horizontally and Receiving Omnidirectional Sounds in Horizontal and Vertical Planes.



3. Communication System: Transmitting Omnidirectional Sounds Horizontally and Receiving Directional Sounds in Vertical Plane.





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Specification

Acoustic Transceiver	BII7641QIM	BII7642IM	BII7643IM	BII7644IM	BII7645IM	BII7646IM			
Operating Depth:	500m	300m	300m	300m	300m	100m			
Operating Depth:	Limited by the cable len	gth if the cable has wire	leads or a non-waterp	proof connector.					
Operation Mode:	Half-duplex	Half-duplex							
	1. Default: Free Hanging	(FH)							
	2. Bolt-Fastening Mount	ing with Free Hanging (E	SFM-FH-M6, BFM-FH-	M8, BFM-FH-M10, BFM	FH-3/8".)				
Mounting Options:	3. Free-hanging with Ma	le Underwater Connecto	or (FHUWC-2P, FHUW	C-3P, FHUWC-4P, FHUV	/C-6P.)				
	4. End-face Mounting (E	4. End-face Mounting (EFMS or EFMM)							
	Please refer to online do	Please refer to online document AcousticSystem.pdf for a complete list of Mounting Options and more details.							
	Φ42x95mm	Ф60x100mm	Ф89x90mm	Ф114x90mm	Φ141x100mm	Ф168x100mm			
Physical Size (WDXH):	Actual length depends on Mounting Parts and/or Add-on Parts such as -HT, etc.								
	≥ 2.5 kg with two x 15m cable bundles:								
Maight in Aire	One Transmit Cable: RG58 or 2-conductor Shielded Cable.								
weight in Air.	One Receive Cable: 6-conductor Shielded 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.								
Power Amplifier:	BII5000 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.									
for 50Ω BNC connector, it is buyer's sole responsibility to make sure that the BNC shield of the signal source is firmly grounded for operating safety before hooking									
up transducer/hydrophon	up transducer/hydrophone to the signal source. Coax with BNC is not intended for hand-held use at voltages above 30Vac/60Vdc.								

Omnidirectional Projector: Transmit Omnidirectional Sounds in Horizontal Plane

Resonant Frequency f _s :	40 kHz	30 kHz	14 kHz	8 kHz	6kHz	4.5kHz		
	$f_{s} \pm 25\% * f_{s}$							
Transmitting Frequency:	Operating Frequency < Minimum Transmitting 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.							
	Built-in, Impedance m	atching to 50Ω by defau	ilt.					
Impodance Matching	Customization: Bespo	oke Impedance Matchi	ng between transduce	rs and power amplifier	s. Append IM to t	he part number for		
impedance Matching.	integrating BII6000 ir	1 the transducer, and	specify impedance in G	Ω. For example, Bllxxxx	IM8Ω: BIIxxxx tran	sducer with built-in		
	Impedance Matching	unit as a 8 Ω load.						
Signal Type:	SINE Pulses, Chirp, PSK, FSK, Pulsed Square Waveform, Continuous Signals, Arbitrary Signals, etc.							
Signal Type.	SONAR/Communication	on/Pulsing Signals, Aqua	tic/Marine Animal Soun	ds, Ambient and Ship/Ve	hicle Noises, etc.			
Transmitting Face:	Cylinder							
Directivity Pattern:	Toroidal Beam at fs; O	mnidirectional at f << fs						
Beam Width:	$\theta_{H-3dB} x \theta_{V-3dB}$ (°) = Omni	x 80°, Horizontal x Vert	tical at fs.					
Side Lobe Level:	No side lobes.	-			-			
Quality Factor Q., at f.:	1.5	1.3	1.5	1.2	3	3		
	-3dB bandwidth $\Delta f = f_s$	s/Qm. Qm determines th	e transient response or	the rise and fall rings of s	steady-state respon	se.		
η _{ea} at f _s :	≥ 0.8 in Water, Electro	acoustic Efficiency, Load	d Medium Dependent.					
	at f << fs, η_{ea} / $\eta_{ea at fs} \approx$	- (k*ΦD) ² . Wave Numbe	er k = 2π/λ; ΦD = Transdu	ucer Diameter.				
	1. Driving Transducer with Continuous Signals:							
	(1). Electroacoustic Eff	liciency η _{ea} is quite low	at f << f _s and drops grad	ually at f > f _s , so it is NO	T recommended for	r transducers to emit		
	high power sounds at	frequencies far from fs.	Otherwise, transducer n	nay be damaged by over	heating.			
$p \rightarrow f < f$	(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 $P_i \le 0.8*f_s$ and P_i							
IJea at I << Is.	$0.2*MIPP \text{ at } f \ge 1.3*f_s.$							
	2. Driving Transducer with Pulsing Signals such as SINE Pulses:							
	Electroacoustic Efficiency η_{ea} is quite low at f << fs and drops gradually at f > fs, so it is recommended for transducers to emit high power							
	sounds at frequencies far from f_s with Pulsing Signals with Duty Cycle \leq 10%, Pulse Length \leq 100mS. Otherwise, transducer may be							
	damaged by overheati	ing.						
Power Factor at f _s :	≥ 0.94							
TVR at fs:	Refer to TVR Chart, Tra	ansmitting Voltage Resp	onse. Tolerance: ±2 dB.					
Radiation Sound Level:	SL = 20*logV _i + TVR, dl	B μPa@1m. Driving Volt	age V_i is in unit of V_{rms} .					
Impedance at fs:	1. Default: Z = 50*e ^{iθ} , in Ω , and Phase Angle $ \theta \le 20^{\circ}$ at fs.							
impedance at is.	2. Customization.							
Driving Voltage V _i at f _s :	Pulsed Driving Signal a	nd Duty Cycle D < 100%	5: V _{imax} = V(MIPP * Z), i	n V _{rms} . Z is impedance at	fs.			
(V _{imax:} Maximum V _{i.})	Continuous Operation	at 100% Duty Cycle: Vin	$_{nax} = V(MCIP * Z), in V_{rr}$	ns.				
Input Power P _i :	$P_i = V_i^2 / Z$ at f_s . Z is implicitly a set of the set of t	pedance at f _s . Z = 50Ω b	y default.			-		
MIPP at fs:	250W	400W	300W	240W	240W	200W		
MPW at MIPP and fs:	25s	60s	70s	120s	130s	200s		
MCIP at f _s :	60W 95W 100W 130W 150W 150W							
MIPP: Maximum Input Pul	se Power; MCIP: Maxim	um Continuous Input Po	ower, MPW : Maximum F	Pulse Width at MIPP.				
How to determine pulse w	vidth, duty cycle and off	-time with input pulse	power (peak power) at	fs:				
1. Determine the input pul	se power (IPP, peak pow	ver) with sound intensity	y required by the projec	t. IPP MUST be less than	MIPP.			

2. Pulse Width \leq (MIPP * MPW*(120°c-T)/103°c)/IPP. T: Water Temperature in °c.

3. Duty Cycle D \leq MCIP*(120°c-T)/103°c)/IPP.

4. Off-time \geq PW*(1-D)/D.



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	1. 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 (R	G58).							
Cable Options:	3. Shielded Cable with	Twisted Pair and	Teflon (PTFE) Jacket, ΦD=4.0 mm (SC40)), up to 200°C, AW	G20 Conductors (Not Water-proofed,			
cable options.	ONLY for Dry Air Use).								
	4. Two Conductor Uns	shielded Cable (US	SC) for Underwater Connector 2 pins.						
	Handling: Do not use	the cable to supp	ort transducer weight in air and water	if the transducer h	as a mounting pa	rt. Do not bend the			
	cable.								
Cable Longth:	1. Default: (a) 15 m. (k	o) 0.6m with Unde	erwater Mateable Connector (2 pins) (U	MC2P) and (3 pins)	(UMC3P).				
Cable Length.	2. Custom-fit.								
	1. Default: Wire Leads (WL), for Transmit, Receive Signal, and DC Power Supply.								
	2. Underwater Mateable Connector (2 pins) (UMC2P) (Max. Diameter Ф21.5 to Ф35 mm). Locking Sleeve: DLSA-M.								
	Underwater Mateable Connector (3 pins) (UMC3P) (Max. Diameter Ф21.5 to Ф35 mm). Locking Sleeve: DLSA-M.								
	Undewater 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.								
Transmit Connector:	3. MIL-5015 Style (3 pin) (MIL3P) (Max. Diameter Φ19 to Φ30 mm).								
	4. XLR Receptacle with 3 Male Pins (XLR3P), (Max. Diameter Φ20.2 mm), for SE or DF.								
	5. DIN Receptacle with 3 Male Pins (DIN3P), (Max. Diameter Φ 17 mm), for SE or DF.								
	6. Male BNC (BNC) (Max. Diameter Ф14.3 mm), for Transmit Grounded Signal.								
	Note: Underwater Ma	teable Connector	r is for uses underwater. Other connected	ors and wire leads a	are for dry uses a	nd are not			
	waterproofed.								
Transducer Wiring:	: Shielded Cable Coax, BNC. UMC3P, Locking Sleeve: DLSA-M. MIL3P DIN3P								
Signal:	White or Red	Center	Contact 2	Contact C or G	Din 2	Din 2			
	White of Red	Contact		Contact C of G	FIII 3	FIIIZ			
Signal Common:	Black	ack Shield Contact 1 Contact B Pin 1 Pin 3							
Shielding and Grounding	Shield	Shield Shield Contact 3 Contact A Pin 2 Pin 1							

Omnidirectional Low Noise Receiver: Receive Omnidirectional Sounds in Horizontal and Vertical Planes

Sensitivity FFVS @ 1 kHz:	-185 + Preamp Gain, $\pm 2 \text{ dB V/}\mu\text{Pa}$.				
FFVS:	Bespoke, Refer to Graph of FFVS vs. Frequency. Free-field Voltage Sensitivity.				
Pressure Noise Density:	Refer to Graph of Pressure Noise Density, Referred to Input (RTI), in μ Pa/VHz.				
Hackle Freewood and	In Water: 1 Hz \sim 50 kHz at ±2dB V/ μ Pa.				
Usable Frequency:	In Air: $1 \text{ Hz} \sim 4 \text{ kHz}$ at -3dB V/µPa.				
Preamp Gain:	Programmable Gain Preamp: 20, 50 dB.				
Cain Selection Voltage:	CMOS/TTL Compatible.				
Gain Selection Voltage:	Logic Low 0: Gain Selection Wire to COM or 0 to +0.8 VDC. Logic High 1: Gain Selection Wire Open or +2.4 VDC to V_s .				
	1. Default: -3dB Bandpass Pass Filter: 0.4 Hz to 50 kHz.				
	2. Bespoke High Pass or Band Pass filter. Specify when ordering. Note: Minimum high pass filter f-ade: 0.4 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				
Built-in Filter:	signals greater than 1 kHz, you may specify a high pass filter with -3dB cut-off frequency at 100 Hz 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.				
-3dB Beam Width:	Omnidirectional and Toroidal. Refer to Graph of Directivity Pattern.				
	Differential. Differential (balanced) outputs reject Electromagnetic Interference (EMI) over long cable.				
Output Type:	How to use differential output as single-ended output?				
	Output+ and COM constitute a single-ended output. The terminal of unused output- must be insulated to avoid short circuit.				
Maximum Output Vomax:	(Supply Voltage Vs – 3.4) Vpp.				
Overload Pressure Level:	185 or $[20*log(V_{omax}/2.828) - Sensitivity]$, whichever is less. in dB μ Pa.				
Acceleration Sensitivity:	104.3 dB re μPa/(m/s ²) at Acoustic Axis; ≤ 103.0 dBμPa/(m/s ²) at other directions.				
Operating Depth:	Maximum 300 m or 3 MPa pressure and limited by the cable length if the cable has wire leads or a non-waterproof connector.				
Cable:	Six Conductor Shielded Cable (SC)				
Cable Length:	1. Default: 15m. 2. Custom-fit Cable Length up to 200m.				
	1. Default: Wire Leads (WL)				
	2. Two Male BNC (BNCs) (Max. Diameter Φ14.3 mm), One BNC for Output+ and COM, another for Output- and COM.				
	3. 1/8" (3.5mm) TRS Plug (TRS) (Max. Diameter Φ10.5 mm).				
	4. DIN Receptacle with 3 Male Pins (DIN3), (Max. Diameter Φ17 mm).				
	DIN Receptacle with 4 Male Pins (DIN4), (Max. Diameter Φ 17 mm).				
	DIN Receptacle with 6 Male Pins (DIN6), (Max. Diameter Φ 17 mm).				
	5. XLR Receptacle with 3 Male Pins (XLR3), (Max. Diameter Φ 20.2 mm).				
	XLR Receptacle with 4 Male Pins (XLR4), (Max. Diameter Φ 20.2 mm).				
Receive Connector:	XLR Receptacle with 6 Male Pins (XLR6), (Max. Diameter Φ20.2 mm).				
	6. Underwater Mateable Connector (4 pins) (UMC4P) (Max. Diameter Φ21.5 to Φ35 mm).				
	Underwater Mateable Connector (6 pins) (UMC6P) (Max. Diameter Φ21.5 to Φ35 mm).				
	UMC is from global manufacturers of underwater connectors. Its part number is listed in quote in detail.				
	7. +9VDC Battery Snap (BS), for +9VDC or +18VDC power supply.				
	8. 4mm Banana Plug Pair (Red and Black Color) (BP), for DC power supply ONLY.				
	Gain Selection Wires are of wire leads. Buyer may assemble connector to wires of Gain Selection.				
	Underwater Mateable Connectors are for underwater uses. Other connectors/wire leads are for dry uses and are not waterproofed.				



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Current (Quiescent):	18 mA
Supply Voltage Vs:	+9 to +32 VDC.
	+9 VDC Battery, Marine Battery, Automobile Battery, Fixed DC Linear Power Supply, Not Included.
Suggested DC Supply:	DO NOT use variable power supply whose maximum supply voltage is higher than the rated voltage.
	DO NOT use switching mode DC power supply.
Physical Size:	$\Phi D = \Phi 28.5 \text{ mm}$, Length $\ge 60 \text{ mm}$, and actual length depends on Mounting Parts.

Wiring Information of Receiver with One-Bit-Word Programmable Gain Preamps:

Differential Output:	Wire Leads	UMC6P/XLR6	DIN6	BNC + 9V BS	DIN3/XLR3 +	9V BS	TRS + 9V BS
+VDC	Red	Pin 3	Pin 4	Battery Female Snap	Battery Fema	male Snap Battery Female Sna	
Common	Plack	Din 1	Din 1	Battery Male Snap,	Battery Male Snap,		Battery Male Snap,
Common	DIACK		PIILI	BNC Shield.	DIN Pin 2 or 2	KLR Pin 1.	TRS Sleeve.
Output Signal+	White	Pin 2	Pin 3	"1" BNC Center Pin	XLR Pin 3	XLR Pin 2	TRS Tip
Output Signal -	Green	Pin 4	Pin 2	"2" BNC Center Pin	XLR Pin 1	XLR Pin 3	TRS Ring
Digital A0	Blue	Pin 6	Pin 5	Blue	Blue		Blue
Digital Common	Yellow or Brown	Pin 5	Pin 6	Yellow or Brown	Yellow or Bro	own	Yellow or Brown
Shielding	Shield	Metal Shell	Metal Shell	BNC Shield	Metal Shell N/A		N/A
Selecting Sensitivity of One-bit Digitally Programmable							
FFVS Selection Wire A0 Hydrophone Sensitivity FFVS at 1kHz.							
0 (Logic Low)		$-165 = -185 + 20 \text{ dB V/}\mu\text{Pa}$					
1 (Logic High)		-135 = -185 + 50 dB V/μPa					

How to Order BII7640 Series Transducers (if a parameter is not used, please leave it in blank)

When Transmit Connector is BNC, the transmit cable is 50Ω RG58 coax. When Transmit Connector is wire leads or other types of connectors (MIL-5015, UMC, XLR, DIN, TRS, etc.), the transmit cable is 2-conductor shielded cable. Transducer -Receiver HP/LP -Mounting -Cable Length -Transmit Connector -Receive Connectors **Receiving Bandpass Filter** T/R Cable Bundle. DC Supply/Received Signal/Gain Selection. Refer to specs. BII764xIM Default: Wire Leads. in Hz, kHz. in meter. Default: Free Hanging. Default: Wire Leads. Default: 0.4 Hz to 50 kHz. Default: 2x15 m. **Example of Part Number:** Description BII7642IM, 50Ω Transducer at fs; Receiving Band Pass Filter: 100Hz to 50kHz; Free Hanging; 2x15m Cable Bundles; BII7642IM-100Hz/50kHz-FH-15m-WL-WL Wire Leads. BII7642IM, 500 Transducer at fs; Receiving Band Pass Filter: Default; End-face Mounting EFMM; 2x0.3m Cable BII7642IM-EFMM-0.3m-WL-WL Bundles; Wire Leads. BII7642IM, 500 Transducer at fs; Receiving Band Pass Filter: Default; Bolt-Fastening Mounting with Free Hanging: BII7642IM-BFM-FH-3/8"-20m-BNC-BFM-FH-3/8"; 2x20m Cable Bundles; Transmit Connector: BNC Male; Receiver Connectors: 9V Batteries for DC Supply, BS/XLR3/WL XLR3 for received Signal, Wire Leads for Gain Selection.

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.

Can the receiver with differential outputs be wired to single-ended inputs of a DAQ device (Data Acquisition Equipment) such as an Oscilloscope? Yes, output+ and Common of a BII hydrophone can be used a single-ended signal, or Output- and Common of the hydrophone can be used a single-ended signal. (1) The terminal of unused output MUST be insulated to avoid short circuit.

(2) Neither output+ nor output - of the hydrophone can be wired to common which is going to destroy the hydrophone by short circuit.

How do I use Gain Selection wires in field?

1. Manual Gain Selection.

When a Gain Selection wire is floating or open, its digital logic is High or "1".

When a Gain Selection wire is short to Digital Common, its digital logic is Low or "0".

- Sensitivity of a Hydrophone is fixed when its Gain Selection wires are fixed to Digital Common or open (floating) during operation.
- 2. Gain Selection with Digital Outputs. Digital Outputs of a DAQ (data acquisition device) select gains with TTL/CMOS logic levels.

How do I use a programmable sensitivity receiver as a fixed sensitivity receiver?

When a Gain Selection wire is short to Digital Common, its digital logic is Low or "0. The gain of the built-in preamp is set to 20dB or low gain. When a Gain Selection wire is floating or open, its digital logic is High or "1". The gain of the built-in preamp is set to 50dB or high gain. The unused terminals and bare splice wire leads MUST be insulated to avoid short circuit.



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Physical Size (Dimensional Unit: mm)

1. Omnidirectional Transceiver: Transmit Omnidirectional Sounds in Horizontal Plane, Receive Omnidirectional Sounds in Horizontal and Vertical Planes. The specification is listed in this datasheet.



2. Omnidirectional Projector and Directional Receiver: Transmit Omnidirectional Sounds in Horizontal Plane, Receive Sounds in Vertical Plane (-3dB Beam Angle: 50° at fs.). The specification is NOT listed in this datasheet, contact BII for customization.



3. Omnidirectional Projector and Directional Projector: Transmit Omnidirectional Sounds in Horizontal Plane and Transmit directional Sounds in Vertical Plane with -3dB Beam Angle of 50° at fs. Specification is NOT listed in this datasheet, contact BII for customization.





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Transmitting Voltage Response (TVR):













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Noise Density (Referred to Input):

Free-field Voltage Sensitivity:

Hydrophone Sensitivity Hydrophone Noise Spectrum -180 110 FFVS: Preamp of OdB and 0.4Hz High Pass Filter. - - FFVS: Preamp of 0dB and 10Hz High Pass Filter. Sea State 0 Noise -BII7640 Series Receiver 100 -185 90 Noise Density (dB re µPa/VHz) 80 -190 FFVS (dB V/µPa) 70 60 -195 50 40 -200 30 -205 20 BII7640 Series Receiver FFVS = FFVS with 0dB Preamp + Preamp Gain (dB) 10 -210 0 0.1 1 Frequency (kHz) 0.001 0.01 100 0.1 Frequency (kHz) 10 0.001 0.01 10 100

Directivity Pattern:



