Parametric Array Transducer

Parametric Array Transducer: Sediment Profiling

The underwater parametric array transducers are designed for uses in sub-bottom profiling and are optimized to explore the first layers of sediment below the sea floor. These parametric array features narrow directivity pattern at the low frequency and seafloor penetration of tens of meters. To achieve a specific deference frequency, transducers need two signal sources as inputs: **Low primary frequency (LPF)** signal source and **high primary frequency (HPF)** signal source.

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} ($f_{sec} = f_{p1}-f_{p2}$). This difference frequency sound is useful for practical applications in sediment profiling, depth sounding and communication. The directivity of secondary frequency is close to the ones of primary frequencies. Parametric array gain or efficiency is better as primary sound powers are higher, secondary frequency fs is higher, down shift ratio $(f_{p1}+f_{p2})/(2f_{sec})$ is lower, and (α_p*R_r) is lower (αp: mean primary sound attenuation coefficient; Rr: rayleigh distance). **Attenuation/absorption coefficient of sediments is frequency dependent around 0.06f to 0.6f (dB/(m*kHz)).**

Typical Applications

Sub-Bottom Investigation/Assessment/Profiler	Sediment Profiling/Sediment Penetrating	Detection of Buried Objects, Search Pipeline/Cable Survey
Synthetic Aperture Imaging and Sequential Imaging	R & D on Nonlinear Underwater Acoustics	Construction of Harbor, Coast, Estuary…

Specifications

Parametric Transducer		**BII7546-40**	**BII7546-50**	**BII7546-60**	**BII7546-110**	**BII7544**
Primary Sources f_p:		35 to 55 kHz	45 to 65 kHz	55 to 75 kHz	100 to 120 kHz	185 to 205 kHz
		When two primary f_p = two resonance f_s, maximum secondary source level **SL**$_{sec}$ is achieved. **f_s:** Resonance Frequency of Primary Sources.				
Primary Source Signal:		Pulsed SINE, Chirp, PSK, FSK, Pulsed Square Waveform, etc.				
Radiation Face:		Circular Plane				
Quality Factor Q_m:		4.0 to 5.5, -3dB bandwidth $\Delta f = fs/Q_m$.				
Primary TVR at f_s:	HPF	162.0	167.0	170.6	172.0	169.3
	LPF	156.0	163.0	160.0	168.0	165.7
	Primary **TVR**: Transmitting Voltage Response of two primary sound sources, dB µPa/V@1m.					
Radiation Sound Level SL_p:		Primary Source Level at f_p: $SL_p = 20*\log V_i$ + TVR, dB µPa@1m. Driving Voltage V_i is in unit of V_{rms}.				
Admittance (G and B):		refer to **G-B Graph**.				
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:	HPF:	2600 Watts	2600 Watts	2400 Watts	3000 Watts	1150 Watts
	LPF:	2200 Watts	2200 Watts	2400 Watts	1700 Watts	770 Watts
	Maximum Input Pulse Power at f_s: $P_i = V_i^2 * G_{max}$ or MIPP Watts, whichever is less.					
MPW at MIPP and f_s:		44 Seconds	40 Seconds	26 Seconds	17 Seconds	10 Seconds
		Maximum Pulse Width at MIPP and at f_s. **MPW of HPF = MPW of LPF.**				
MCIP at f_s:	HPF:	55 Watts	60 Watts	76 Watts	80 Watts	35 Watts
	LPF:	30 Watts	30 Watts	30 Watts	40 Watts	25 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.						
Directivity Pattern at f_{sec}:		Conical Beam				
Secondary frequency f_{sec}:		$f_{sec} \le 15$ kHz. **f_{sec}:** Secondary Frequency, $f_{sec} = |f_{p1} - f_{p2}|$.				
Maximum SL_{sec} at f_s:		≥ 200 dB µPa, **SL**$_{sec}$**:** Source Level at f_{sec} secondary frequency.				
-3dB Beamwidth at f_{sec}:		15°	15°	10°	8°	6°
Side Lobe Level:		≤ -17.7 dB				
Penetration Capability:		**≥ 40 m at Secondary frequency f_{sec}.**				
FFVS at f_s:	HPF	-174.0	-174.6	-174.3	-180.0	-187.2
	LPF	-172.0	-173.0	-171.7	-180.5	-187.5
	$FFVS\ Sensitivity\ Loss\ over\ extension\ cable\ at\ f_s\ (dB) = 20 * \log\{\left(1+\frac{2\pi f_s C_c}{B}\right)/\sqrt{[G^2+(B+2\pi f_s C_c)^2]/(G^2+B^2)}\}$ 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, in dB V/µPa.
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 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. Bolt Fastening Mounting (Stainless Steel) with Free Hanging Cables (**BFMFH**) 3. End-face Mounting for Multi-Channel (**EFMM**) 4. Flange Mounting (**FGM**) Please refer to online document **AcousticSystem.pdf** for a complete list of Mounting Options and more details.
Cable:	1. Two Conductor Shielded Cable (**SC**), Rubber or PVC Jacket. 2. 50 Ω RG58 Coax (**RG58**) 3. Shielded Cable with Twisted Pair and Teflon (PTFE) Jacket, ΦD=4.0 mm (**SC40**), up to 200°C, AWG20 Conductors (Not Water-proofed, ONLY for Dry Air Use).
	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: Two x 10 m. 2. Custom.
Connector:	1. Default: Wire Leads (**WL**) 2. Male BNC (**BNC**) (Max. Diameter Φ14.3 mm) 3. MIL-5015 Style (pin) (**MIL**) (Max. Diameter Φ30 mm with 3 contacts) 4. Underwater Mateable Connector (pin) (**UMC**) (Max. Diameter Φ21.5 to Φ35 mm) Note: Underwater Mateable Connector is for uses underwater. Other connectors and wire leads are for dry uses and are not waterproofed.
Size ΦDxH (mm):	168 x 55 | 168 x 50 | 168 x 40 | 168 x 40 | 114 x 40
	Actual length depends on Mounting Parts.
Weight in Air:	8 kg | 7 kg | 5 kg | 5 kg | 2 kg
	Weight is with 10 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 at f_s:	BII6000 Bespoke Impedance Matching between transducers and power amplifiers. Order Separately as standalone devices or append **-IMxxΩ** to the part number for integrating BII6000 into the transducer and specify impedance in Ω at fs. For example, BIIxxxx-IM8Ω: BIIxxxx transducer with built-in Impedance Matching unit as 8Ω load at fs.
	Phase Angle |θ| of Complex Impedance ≤ 20° at fs.
TR Switch Module:	BII2100 Transmitting & Receiving Switch Module with Built-in Preamp and Bandpass Filter. Order Separately as standalone devices or append **-TR** to the part number for integrating BII2100 into the transducer. For example, BIIxxxx-TR: BIIxxxx transducer with built-in T/R Switch Module.
Temperature Sensor:	1. Default: No built-in temperature sensor. 2. Built-in temperature sensor. Append **-TS** to part number (BIIxxxx-TS) for integrating a temperature sensor in the transducer.
Power Amplifier:	BII5000 Power Amplifiers for SONAR, NDT, HIFU. Order Separately as standalone devices.
Potable Transmitter:	BII8030 series portable acoustic transmitters.
Portable T/R System:	BII8080 series portable transmit and receive systems.
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/hydrophone to the signal source. Coax with BNC is not intended for hand-held use at voltages above 30Vac/60Vdc.	

Wiring Information

Transducer Wiring:	**Shielded Cable**	**Coax, BNC.**	**Underwater Connector**	**MIL-5015 Connector**	**XLR Plug**
Signal:	White or Red	Center Contact	Contact 2	Contact C	Pin 2
Signal Common:	Black	Shield	Contact 1	Contact B	Pin 3
Shielding and Grounding	Shield	Shield	Contact 3	Contact A	Pin 1
Transducer Wiring. LPF: Low Primary Frequency, Cable Label "1"; **HPF:** High Primary Frequency, Cable Label "0".					

Wiring Information of Temperature Signal.

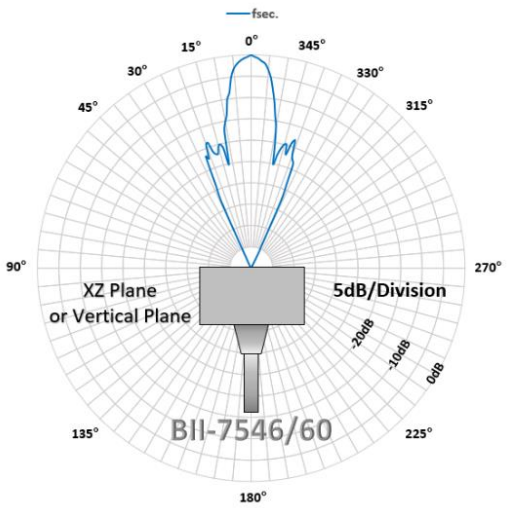
Temperature Sensor Wiring:	**Shielded Cable**	**Coax, BNC, SMC, SMA**	**Underwater Connector**	**XLR Plug**	**TRS Plug**
Signal:	White or Red	Center Contact	Contact 2	Pin 2	Tip
Signal Common:	Black	Shield	Contact 1	Pin 3	Ring
Shielding and Grounding	Shield	Shield	Contact 3	Pin 1	Sleeve

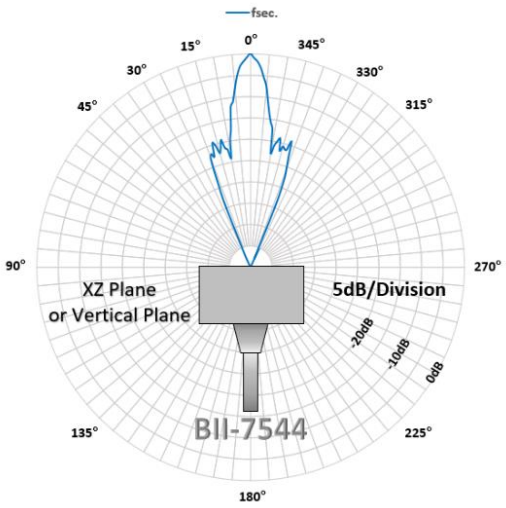
How to Order

Part Number	**-TS**	**-IM**	**-Mounting**	**-Cable Length**	**-Cable**	**-Connector**
Transducer	Temperature Sensor	Impedance Matching	Refer to specs.	in meter x Two	Refer to specs.	

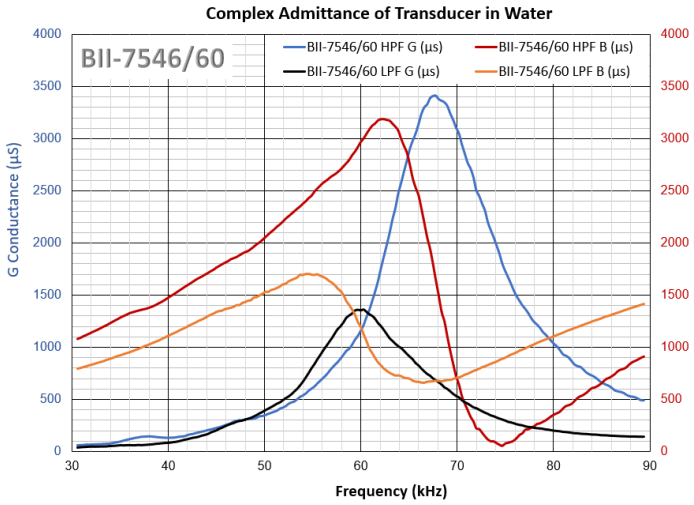
Example of Part Number:	**Description**
BII7546-60-BFMFH-20m-SC-WL	BII7546-60 transducer, Bolt Fastening Mounting (Stainless Steel) with Free Hanging Cables (BFMFH), 2x20m Shielded Cables, Wire Leads.
BII7546-60-IM50Ω-FH-20m-SC-WL	BII7546-60 transducer, built-in Impedance Matching unit as 50Ω load, Free Hanging, 2x20m Shielded Cable, Wire Leads.
BII7546-60-TS-IM50Ω-FH-20m-SC-WL	BII7546-60 transducer, built-in temperature Sensor, built-in Impedance Matching unit as 50Ω load, Free Hanging, 2x20m Shielded Cable, Wire Leads.

Directivity Pattern of Secondary Frequency Signal:

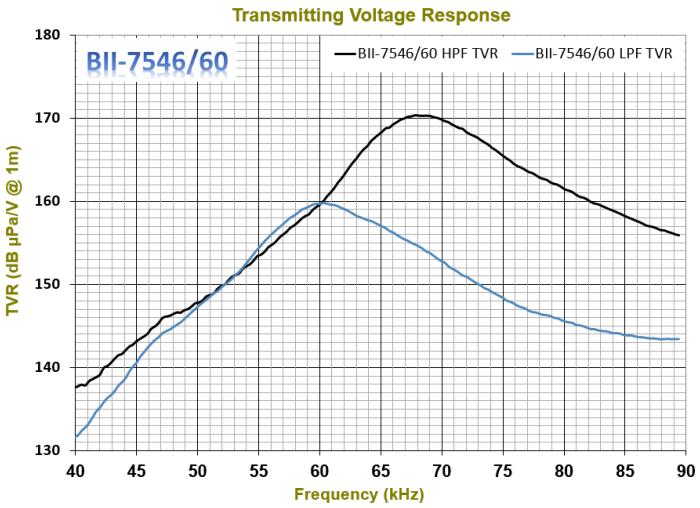


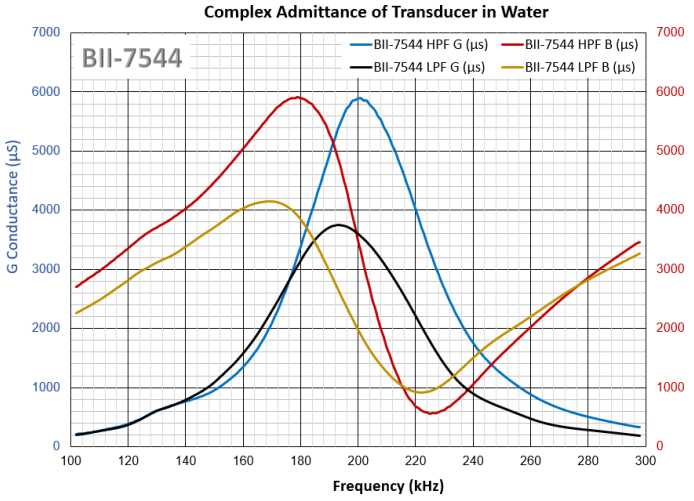


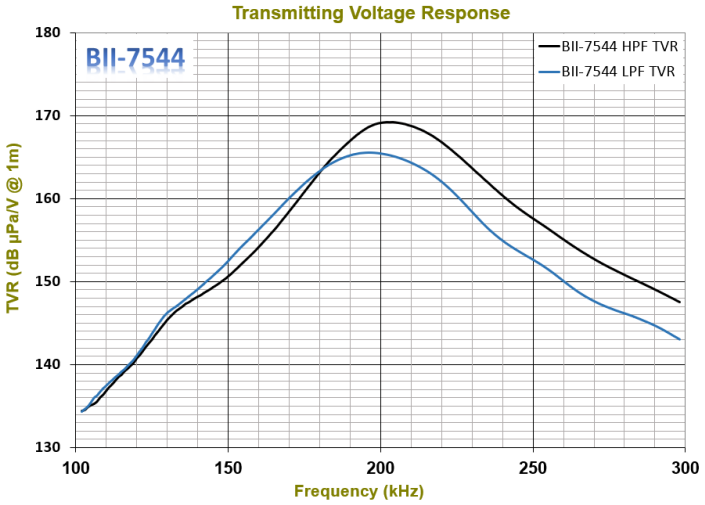
TVR Transmitting Voltage Response



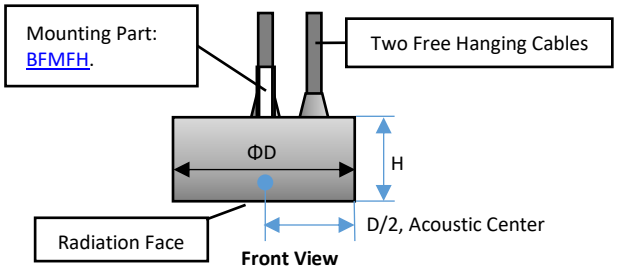
Admittance



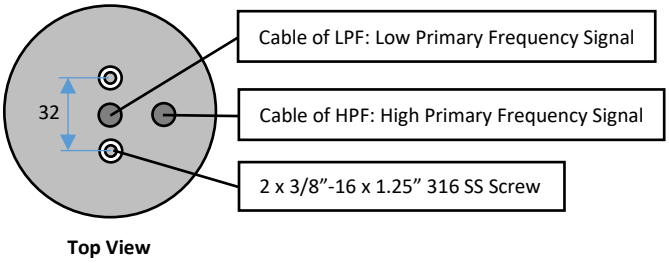




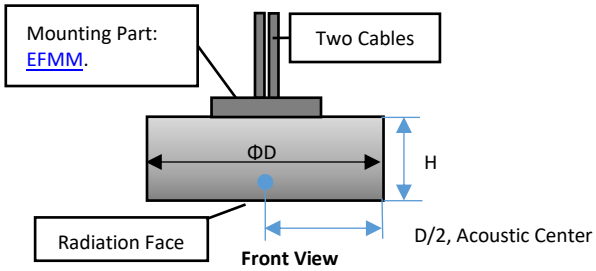
Physical Size (Dimensional Unit: mm)



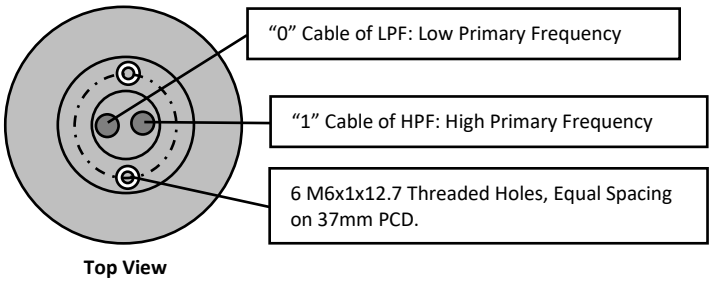
Cable-out Layout for Bolt Fastening Mount with Free Hanging Cable (BFMFH).



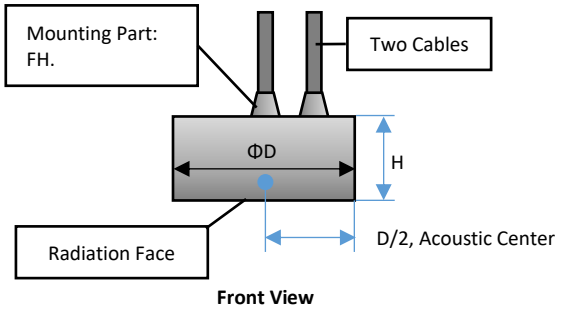
Physical Size (Dimensional Unit: mm)



Cable-out Layout for End-face Mounting for Multi-Channel (EFMM)



Physical Size (Dimensional Unit: mm)



Cable-out Layout for Free Hanging.