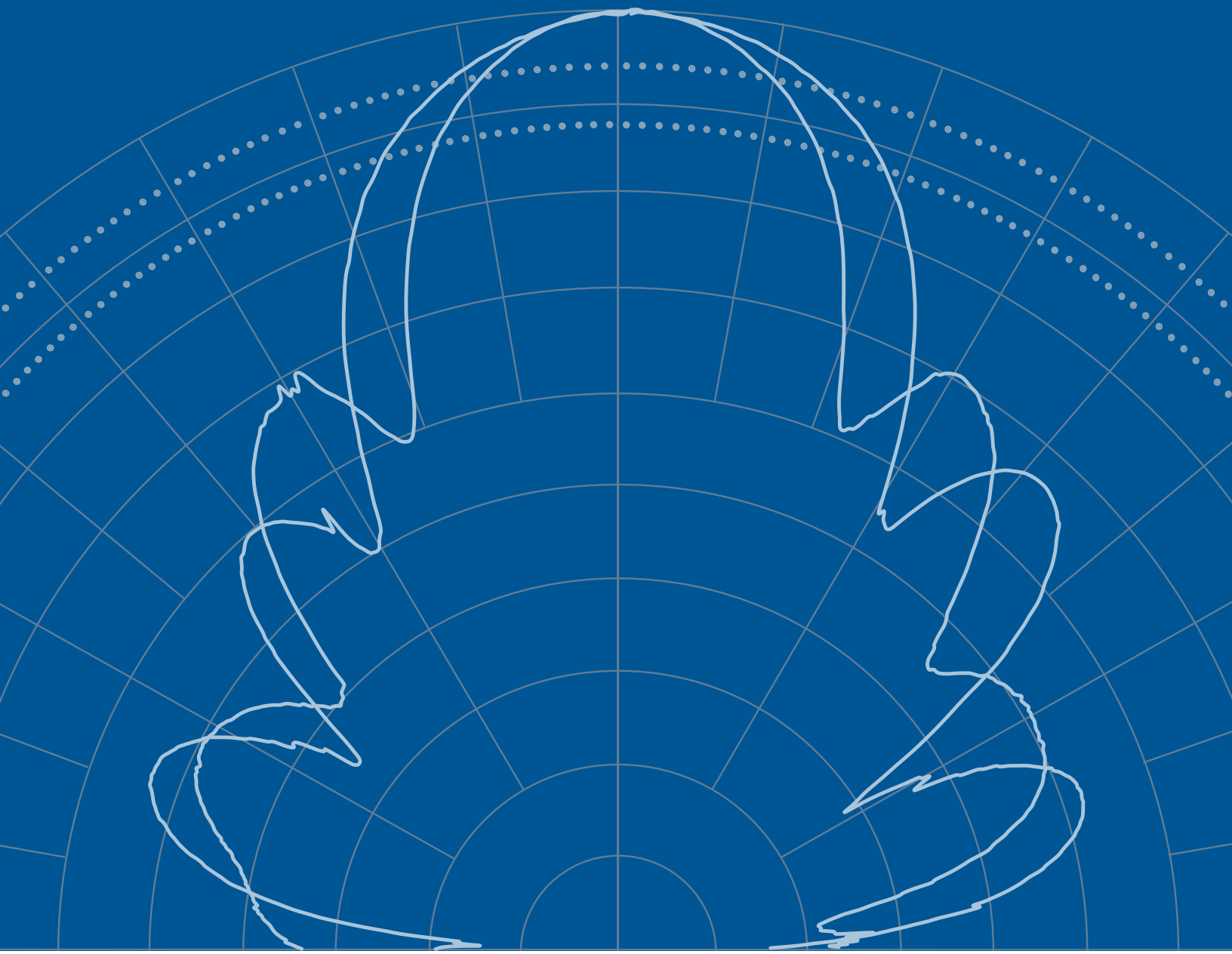
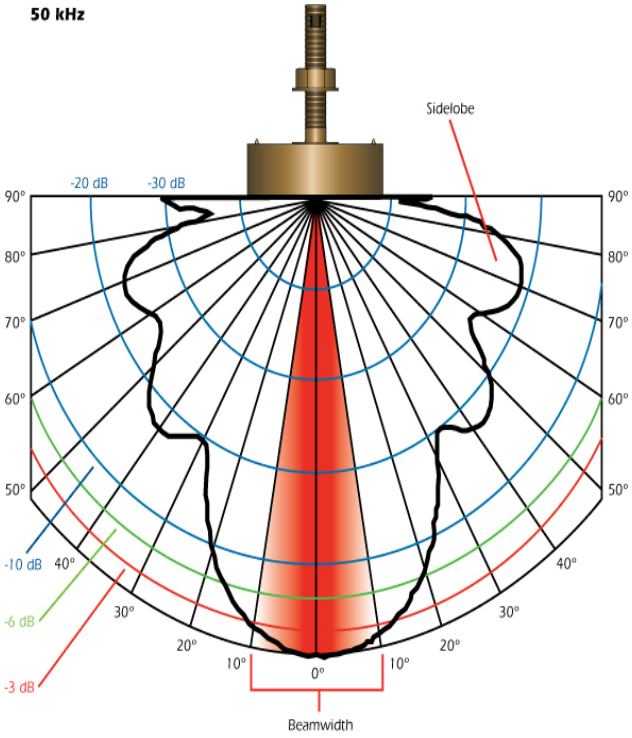
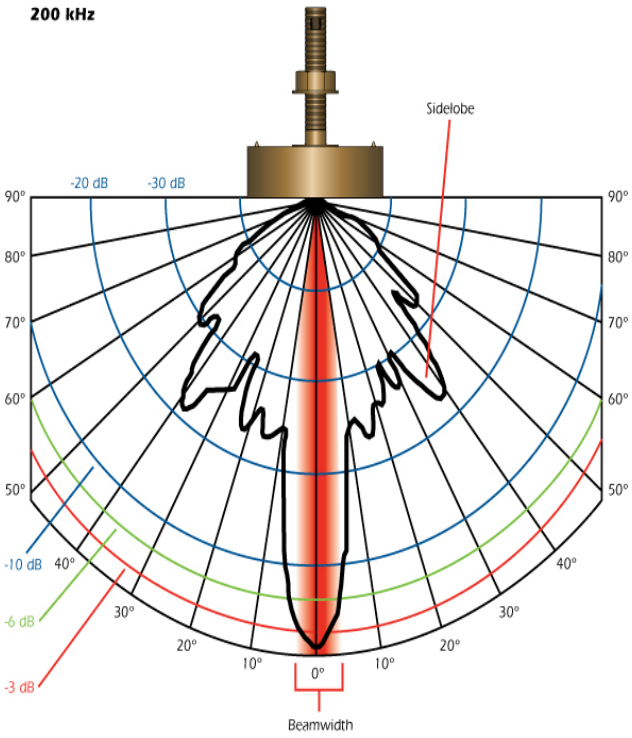
TECHNICAL DATA CATALOG



AIRMAR®
TECHNOLOGY CORPORATION

Airmar Technology Corporation
Technical Data Catalog





Acoustic Data

Airmar's Technical Data Catalog provides detailed performance information for piezoceramic elements and arrays incorporated in Airmar transducers. This catalog, however, is not intended to be used alone, but in conjunction with the Airmar Product Catalog. The technical data provided includes transducer sensitivity (as a function of frequency), bandwith, radiation patterns, and impedance data. With such information, an echosounder system designer can determine the effect of frequency and impedance tolerance on system performance.

The transducer data presented herein was measured in Airmar's test tanks. Unless otherwise specified Receiving Voltage Response (RVR) is measured using self-reciprocity. Transmitting Voltage Response (TVR) is calculated using RVR and impedance, and radiation patterns are measured during transmit using a small hydrophone. Impedance (Z and phase angle), is measured either using a Hewlett Packard / Agilent impedance analyzer or by simultaneous measurement of voltage and current wave forms using National Instruments 5102 or 5112 oscilloscope cards, and transducers are measured untuned. Airmar's power amplifiers have an operating frequency range from 10Hz to 5MHz. Airmar's test systems are computer controlled via IEEE-488 bus using National Instruments LabVIEW ® object language software. The computer calculates peak TVR; peak RVR; transmit Q; and -3 dB, -6 dB, and -10 dB beamwidths. It also computes other forms of impedance such as z, ϕ, Rp, Cp, R-jX, admittance and susceptance. The data is then plotted and stored. Directivity Index (DI) is calculated from geometry dimensions and wavelength at frequency of operation.

Transmitting Voltage Response (TVR) and Q

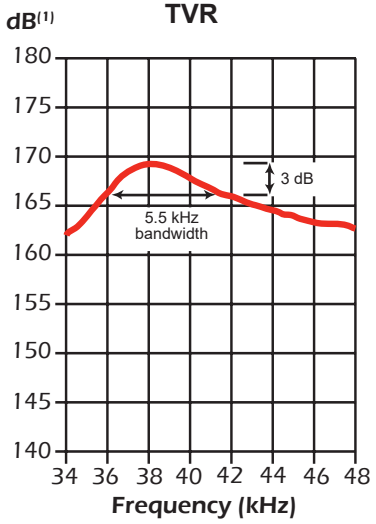
Transmitting Voltage Response is computed using Receiving Voltage Response and Impedance. Q is calculated by dividing frequency(for peak TVR) by the transducer bandwidth at -3 dB. Lower Q provides a shorter pulse rise time and less ringing. The unit of measure for TVR is dB relative to 1 micro Pascal per Vrms at a reference distance of 1 meter. (These units can be converted to dB relative to microbars by subtracting 100 dB.) Since the units of measure are relative to 1 volt, a transducer with a low impedance obtained using a transformer or different transducer construction, will have a higher TVR than a transducer with a higher impedance. Keep this in mind when comparing various transducers.

Receiving Voltage Response (RVR)

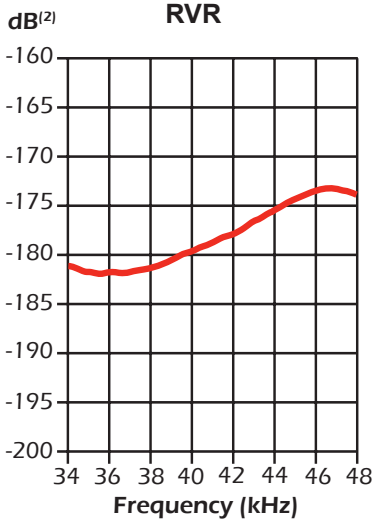
Receiving Voltage Response (RVR) is usually measured by applying (nominal) 200V peak-to-peak to the transducer under test, pointing it at a nearly perfect reflector, and measuring the echo amplitude as a function of frequency. The unit of measure is dB relative to 1 Vrms per micro Pascal. (This measurement can be converted to dB relative to microbars by adding 100 dB.) Transducers with longer and/or higher capacity cables will have a numerically smaller RVR than similar transducers with a shorter or lower capacity cable. Note the cable length and type when comparing RVR and Figure of Merit. For best results, compare transducers with equivalent cable capacitance. With transducers incorporating matching transformers, the capacitance is normally tuned out thereby improving TVR, RVR, and Figure of Merit.

Figure of Merit (Insertion Loss)

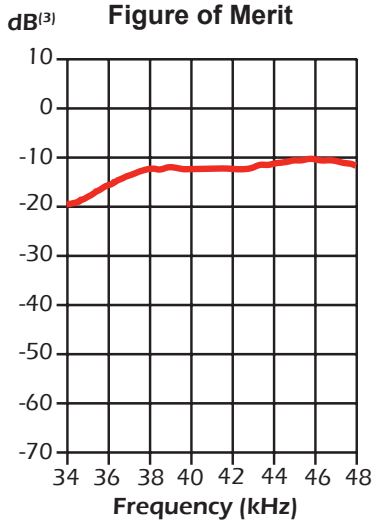
This graph is a numerical summation of TVR and RVR and provides a measure of two-way performance. It is analogous to Insertion Loss, which is often used to describe antenna and filter performance. A transducer whose Figure of Merit response has a wide bandwidth is generally preferred over a transducer with a narrow bandwidth. The former usually rings less and offers most consistent performance over the transducer's range of frequency tolerance.



dB re. 1µPa per V@1m



dB re. 1Vrms per µPa



Sum of TVR & RVR

Beam (Directivity) Pattern

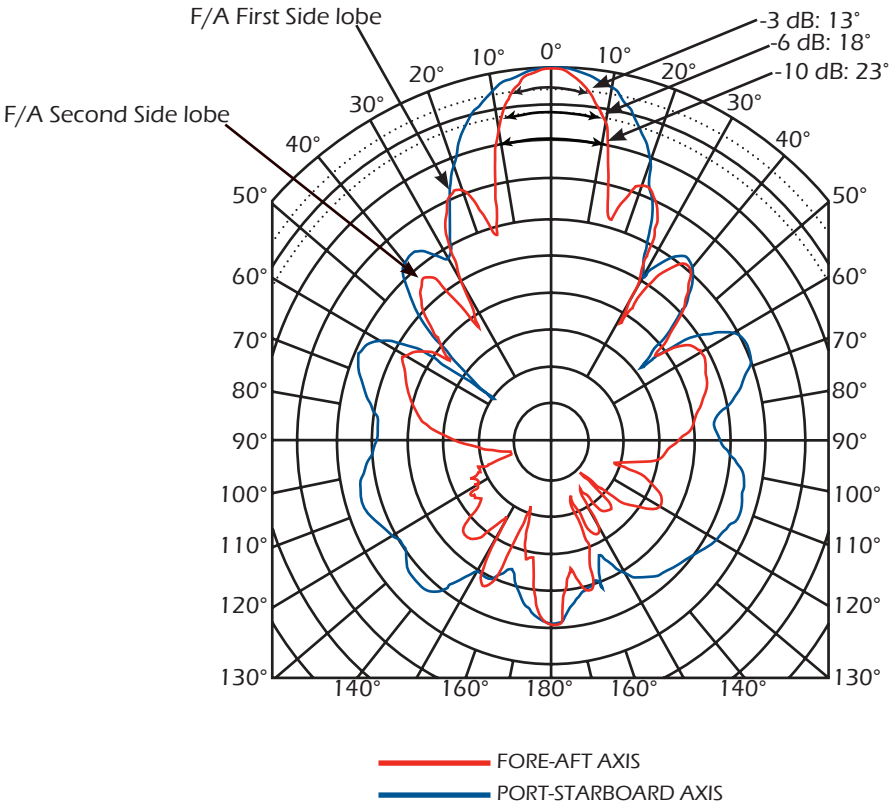
Beam patterns are a graphical representation of a transducer's ability to direct sound transmitted or to selectively receive (listen directionally). Beam patterns are usually plotted in polar format.

When the transducer or array radiation (or receive) aperture is not symmetrical, beam patterns are given for both the fore-aft and port-starboard axes. The legend is provided beneath the pattern. Sometimes there is a difference in side lobe levels due to asymmetry in the housing design. In most cases, the radiation pattern of the main lobe is not significantly influenced by the housing.

Beam patterns can be measured during transmit (a radiation pattern) or during acoustic reception (a receive pattern). Reciprocity-based acoustic calibration assumes that the transmit and receive beam patterns are the same. In practice this is a reasonable assumption especially for the transducer's main lobe. Airmar beam patterns are almost always measured in transmit (unless otherwise noted).

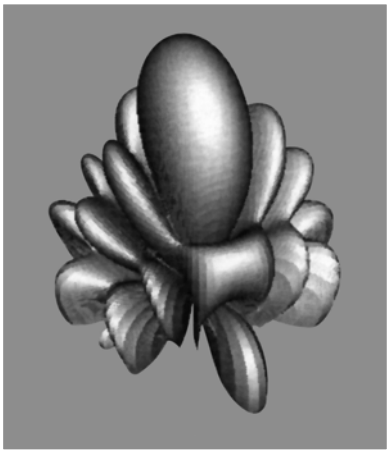
Sound is actually radiated in three dimensions. For the 38kHz–D array, the three-dimensional radiation pattern was computed and is represented in polar coordinates. Two-dimensional patterns are usually provided because they are easy to understand and can be measured in a reasonable amount of time. Three-dimensional patterns take hours to measure.

Transmit Radiation Pattern



Two-Dimensional Representation of Directivity Pattern

Normalized Beam major divisions:
5 dB steps starting at 0 dB outer ring.
50 dB total dynamic range shown.

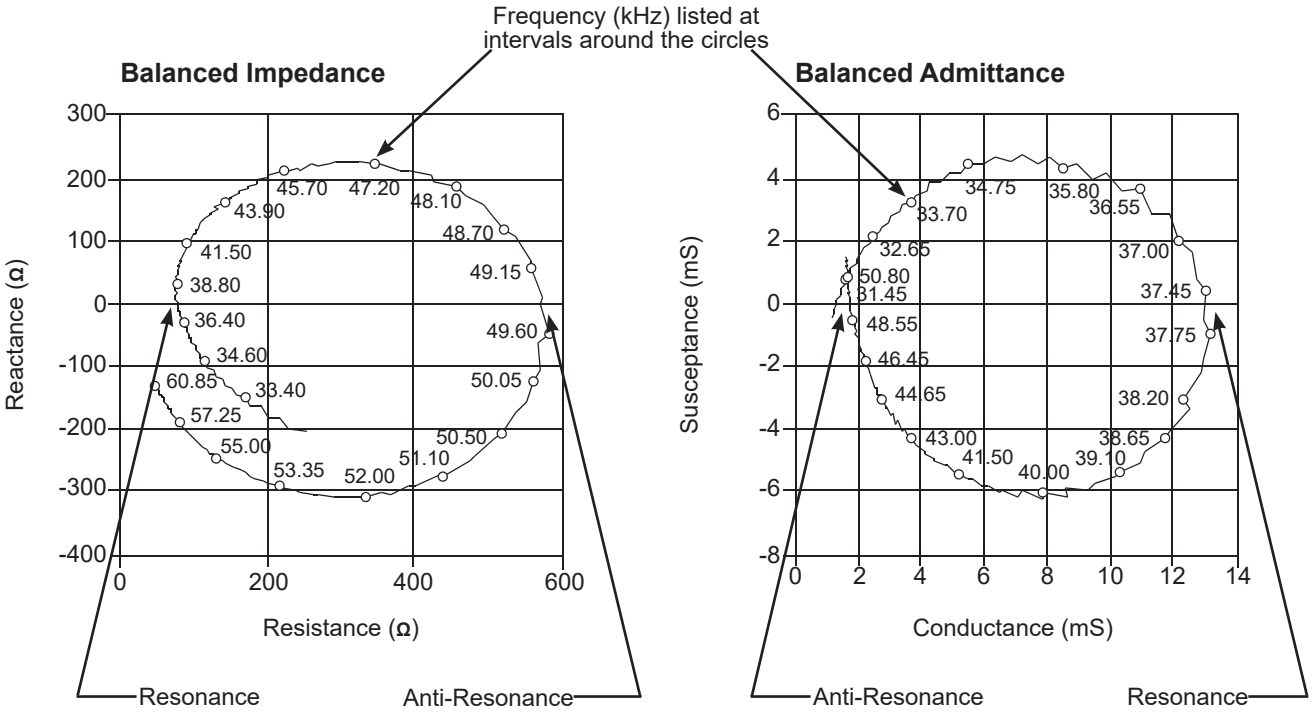


Three-Dimensional Representation of Directivity Pattern

Impedance and Admittance Circles

The impedance data presented is measured by an HP4194 impedance analyzer or derived from simultaneous voltage and current waveforms as measured by National Instruments 5102 or 5112 oscilloscope cards. At lower frequencies, the walls of the test tank have some effect (they cause fine-scale oscillations in the data due to multipath interference). Impedance and Admittance circles usually are provided in both balanced and unbalanced format.

Typically, commercial echosounders use balanced transmission lines and balanced impedance data is of primary interest. Since many recreational echosounders typically utilize unbalanced transmission lines, we usually provide unbalanced data also. In some cases, only balanced or unbalanced data is available due to the cable type and/or wiring format used.



Impedance Tables

For some piezoceramic transducers Airmar provides an Impedance table that includes all of the impedance related values.

For broadband ceramics transducers, impedance circles are not as useful as an impedance table.

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
12.00	364.10	-77.69	77.60	-355.73	0.5854	2.6834	1708.29	35590.08
12.20	339.50	-78.57	67.31	-332.76	0.5840	2.8871	1712.47	37663.00
12.40	305.29	-75.82	74.79	-295.99	0.8024	3.1758	1246.26	40761.29
12.60	268.88	-76.73	61.73	-261.69	0.8539	3.6198	1171.11	45723.40
12.80	256.28	-75.48	64.24	-248.10	0.9780	3.7774	1022.48	46967.86

Cable

Note the cable length and type used in the transducer.
For details on the cable types, please contact Airmar's Customer Support team.

Example:
Cable Type: C44-02
Cable Length: 10.1m (33.0')

Directivity Index

Directivity Index (DI) is used in sonar to indicate how acoustic power is concentrated in a beam relative to the same power if it were uniformly propagated in all directions (omnidirectional). DI is the ratio in dB of acoustic intensity along the main beam relative to the same power transmitted in all directions. For example, an omnidirectional transducer has a DI of zero (0 dB) -- in other words, it gives no preference to direction. Whereas a transducer with DI of 10 dB, say, concentrates its power in a narrower beam and hence creates an even narrower and more intense beam.
The DI is useful in sonar systems calculations because it can help establish the useful operation range (or depth) based on transducer size, power, and frequency.

For a simple piston transducer (with $\pi d > \lambda$)

$$DI = 10 \log \left(\frac{\pi d}{\lambda}\right)^2 \quad \text{(in dB)}$$

d = diameter of ceramic (piston)

λ = wavelength in water at specific frequency

For a 65 mm (2.56") diameter ceramic at 200kHz (200kHz-BH), and assuming 1500 m/s sound speed in water.
DI is calculated as follows:

$$\lambda = \frac{1{,}500{,}000 \text{ mm/sec}}{200{,}000 \text{ cycles/sec}} = 7.5 \text{ mm}$$

$$DI = 10 \log \left(\frac{3.14 \times 65}{7.5}\right)^2 = 28.7 \text{ dB}$$

Impedance Table Cross Reference

Code	Impedance[1]
0	No Transformer
1	50 ohms
2	60 ohms
3	90 ohms
4	125 ohms
5	250-300 ohms
6	Other [request specific data]
7	100 ohms
Code	**Impedance[2]**
B1	100-250 ohms
B2	100-400 ohms
B3	50-200 ohms
B4	650 ohms
B5	10-25 ohms

1. Impedance is stated in equivalent parallel resistance. Transducers without transformers will also have an equivalent parallel capacitance. These values are given for each transducer. Space permitting, transformers can be added to most transducers to achive desired impedance. Minimum impedance in the frequency band at 25°C.

2. This is the expected impedance range over the frequency band of a broadband transducer.

Piezoceramic System Designation Chart

Airmar Technology's Piezoceramic System Designation Chart is the key to understanding the specifications in the Product Catalog and the Technical Data Catalog . These piezoceramic system designators are arranged in alpha-numeric order by frequency. The notes below are necessary for interpreting the data.

1. When "lq" or "lQ" is listed with a designation, it indicates a low "Q" design with $4 < Q \leq 10$. "Broadband" designator indicates a ceramic system with a "Q" of 4 or less.

2. Airmar's new line of low Q ceramics are shaded in the Ceramic Designation Chart. Data pages for "Broadband" system are found in the Broadband Section of the Technical Data Catalog.

3. Ceramic Element Material
   - BT =Barium Titanate
   - L =Langevin or Tonpilz type laminated assembly
   - PZT =Lead Zirconate Titanate

4. Dimensions of Radiating Elements

   - Example of an array with circular elements: 15 x 35 (1.38)
     15 = quantity of elements
     35 = diameter of each element in millimeters
     (1.38) = diameter of each element in inches

   - Example of a array with rectangular element array: 8 x 36 x 3.3 = 36 x 29
     8 = quantity of elements
     36 = length of each elements in millimeters
     3.3 = width of each elements in millimeters
     36 = length of the complete array in millimeters
     29 = width of the complete array in millimeters

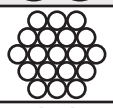
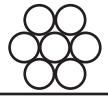
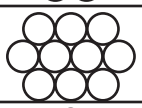
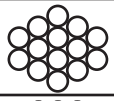
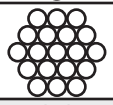
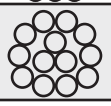
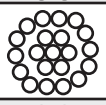
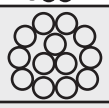
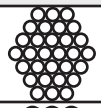
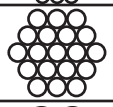
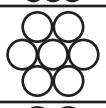
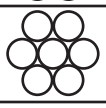
5.

Acoustic Window Material	Radiating Suface Material
• E = Epoxy	• U = Urethane
• E/U = Epoxy Urethane	• CR = Cast Resin
• HPC = Plastic Composite Material	• TP = Thermoplastic
• LPE = Layered Plastic Epoxy	• SS = Stainless Steel
• LPU = Layered Plastic Urethane	
• LSOU = Layered Stainless Steel, Oil and Urethane	
• U = Urethane	

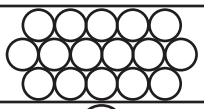
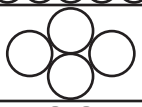
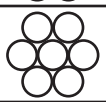
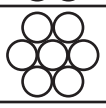
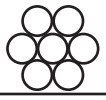
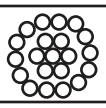
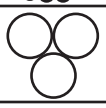
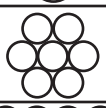
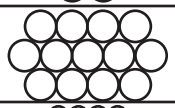
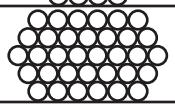
6. Typical Housing Models Used
   To identify the acoustic window material used with a particular housing model, consult the product page in the Airmar Product Catalog.

7. For conventional tone burst operation, power rating is in watts operating at 1 % duty cycle in water. For long duty cycle/CHIRP/FM operation, power rating for broadband ceramics is given both in watts @ 1% duty cycle and in continous watts (CW) in water.

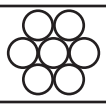
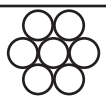
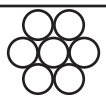
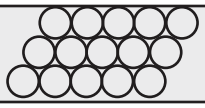
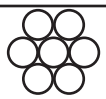
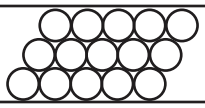
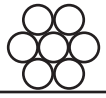
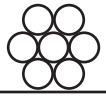
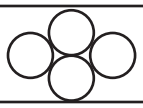
Piezoceramic System Designation Chart

Frequency-Piezoceramic Designator	Piezoceramic Material-Radiating Surface	Dimensions of Radiating Elements mm (in)	Configuration (Not to Scale)	Beam Width @ -3dB	Max Power (Watts) Duty Cycle1%	Typical Housing Models Used
10 kHz-D Broadband	PZT/L-U	3 x 102 (4.02)		39°	1,000	
10 kHz-H	PZT/L-U	19 x 102 (4.02)		16°	6,000	
12 kHz-B	PZT/L-U	7 x 60 (2.36)		42°	2,100	CS234/229, CS271
12 kHz-C	PZT/L-U	10 x 60 (2.36)		26° x 38°	3,000	M162, M175
12 kHz-D	PZT/L-U	14 x 60 (2.36)		25° x 32°	4,200	M176
12 kHz-E	PZT/L-U	19 x 60 (2.36)		24°	5,700	M190
12 kHz-J Broadband	PZT/L-U	13 x 63 (2.48)		19°	4,000	M74
15 kHz-B	PZT/L-U	22 x 76 (3.00)		11°	8,000	M187
15 kHz-C Broadband	PZT/L-U	13 x 64 (2.52)		17°	4,000	M74
15 kHz-E Broadband	PZT/L	3 x 64 (2.5)		12 kHz: 54° 15 kHz: 50° 18 kHz: 40°	925	M192
24 kHz-AB	PZT/L-U	30 x 51 (2.01)		11°	7,000	
24 kHz-R	PZT/L-U	19 x 37 (1.46)		20°	1,200	M42, M175
24 kHz-W	PZT/L-U	7 x 51 (2.01)		24°	1,500	M108, M192
28 kHz-E	PZT/L-U	7 x 36.5 (1.44)		29°	1,000	M177

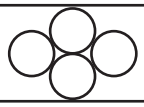
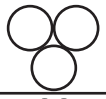
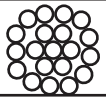
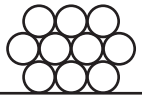
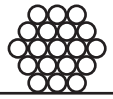
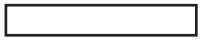
Piezoceramic System Designation Chart

Frequency-Piezoceramic Designator	Piezoceramic Material-Radiating Surface	Dimensions of Radiating Elements mm (in)	Configuration (Not to Scale)	Beam Width @ -3dB	Max Power (Watts) Duty Cycle1%	Typical Housing Models Used
28 kHz-F	PZT/L-U	16 x 36.5 (1.44)		12° x 27°	2,200	M177
28 kHz-G	PZT/L-U	4 x 44 (1.75)		23° x 32°	1,000	SS561, M155
28 kHz-N	PZT/L-U	7 x 44 (1.75)		24°	1,500	M175, M192
28 kHz-R	PZT/L-U	7 x 51 (2.01)		18°	2,000	M192
30 kHz-D	PZT/L-U	7 x 35 (1.38)		26°	600	M163
33 kHz-D	PZT/L-U	7 x 44 (1.75)		19°	1,000	M163, M192
33 kHz-E	PZT/L-U	7 x 35 (1.38)		23°	700	M177, M191
33 kHz-Glq	PZT/L-U	48 (1.89)		62°	100	P329
33 kHz-H	PZT/L-U	21 x 44 (1.75)		10°	3,000	
33 kHz-M	PZT/L-U	3 x 51 (2.01)		24°	1,000	M149, M449
38 kHz-B	PZT/L-U	7 x 38 (1.50)		20°	1,000	M159, M192
38 kHz-D	PZT/L-U	13 x 35 (1.38)		13° x 22°	1,200	M155
38 kHz-E	PZT/L-U	24 x 35 (1.38)		10° x 12°	2,200	M42
38 kHz-F	PZT/L-U	34 x 35 (1.38)		8° x 13°	3,000	M42

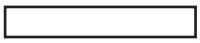
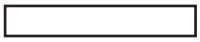
Piezoceramic System Designation Chart

Frequency-Piezoceramic Designator	Piezoceramic Material-Radiating Surface	Dimensions of Radiating Elements mm (in)	Configuration (Not to Scale)	Beam Width @ -3dB	Max Power (Watts) Duty Cycle1%	Typical Housing Models Used
38 kHz-J	PZT/L-U	7 x 51 (2.01)		15°	1,000	M192
38 kHz-N	PZT/L-U	51 (2.01)		53°	350	M157
40 kHz-H	PZT/L-U	7 x 38 (1.50)		19°	1,000	M42, SS216
50 kHz-AE	PZT/L-U	7 x 28 (1.10)		19°	1,000	B260, CM260, M260, R199, SS260
50 kHz-AFlq Broadband	PZT/L-CR	15 x 35 (1.38)		8° x 17°	2,000	R99, R199
50 kHz-AN	PZT/L-U/TP	51 (2.01)		44°/46°	600	M153
50 kHz-AWlq	PZT-U	7 x 20 (0.80)		25°	1,000	SS264, SS270, TM270
50 kHz-AZ	PZT-U	15 x 28.7 (1.13)		9° x 19°	2,000	CM488
50 kHz-BB	PZT-HPC/U	7 x 38 (1.50)		14°	2,500	CM444
50 kHz-T	PZT/L-U	7 x 35 (1.38)		15°	1,000	M159, M177, M191, SS241
50 kHz-W	PZT/L-U	35 (1.38)		45°	150	P19
50/200 kHz-A	PZT-TP	44 (1.75)		50 kHz: 50° 200 kHz: 12°	600	B44V, B45, B60, B117, B619, B744, P52, P58, P65, P66, P74, P79, P319, SS619
50/200 kHz-Alq	PZT-TP	44 (1.75)		50 kHz: 38° 200 kHz: 12°	600	P66, SS582
50/200 kHz-B	PZT-U	4 x 44 (1.75)		50 kHz: 14° x 23° 200 kHz: 3° x 5°	1,200	B256, B258, M256, SS258, TM258

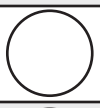
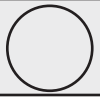
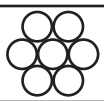
Piezoceramic System Designation Chart

Frequency-Piezoceramic Designator	Piezoceramic Material-Radiating Surface	Dimensions of Radiating Elements mm (in)	Configuration (Not to Scale)	Beam Width @ -3dB	Max Power (Watts) Duty Cycle1%	Typical Housing Models Used
50/200 kHz-Blq	PZT/L-U	4 x 44 (1.75)		50 kHz: 15° x 21° 200 kHz: 3° x 5°	1,000	B258, SS258, TM258
50/200 kHz-Glq	PZT-U	3 x 35 (1.38)		50 kHz: 22° 200 kHz: 6°	1,000	B164, SS164
50/200 kHz-L	PZT-U	3 x 42.4 (1.67)		50 kHz: 18° 200 kHz: 5°	1,500	CM422, SS422
70 kHz-A	BT/L-U	20 x 38 (1.50)		6°	3,000	P79, M176
75 kHz-F	PZT/L-U	10 x 25 (0.98)		9° x 13°	1,000	M155
75 kHz-L	PZT/L-U	19 x 25 (0.98)		10°	1,500	M163
77/200 kHz-A	PZT-U	27 (1.07)		77 kHz: 43°/46° 200 kHz:14°/13°	300	B619, P32, P72, P619
83/200 kHz-A	PZT-TP or PZT-U	24 (0.95)		83 kHz: 38°/ 44° 200 kHz: 21°/ 18°	300	SS70,SS141
100 kHz-A	PZT-U	51 (2.01)		15°	300	M194
100 kHz-B	PZT/L-U	19 x 19 (0.75)		9°	1,000	SS216
100 kHz-Nlq	PZT5-U	20 (0.79)		42°	100	M419
120 kHz-A	PZT/L-TP/U	19 (0.75)		37°/38°	100	P5, P19, P23, M419
120 kHz-H	PZT-TP/U	10 x 57 (2.24)		11° x 52°/ 57°	200	P338, M42
120 kHz-T	PZT-TP/HPC	19 (0.75)		90°	85	SS523

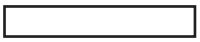
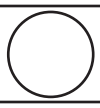
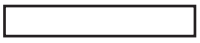
Piezoceramic System Designation Chart

Frequency-Piezoceramic Designator	Piezoceramic Material-Radiating Surface	Dimensions of Radiating Elements mm (in)	Configuration (Not to Scale)	Beam Width @ -3dB	Max Power (Watts) Duty Cycle1%	Typical Housing Models Used
120 kHz-Ylq	PZT-U	33 (1.30)		23°	300	P7
120 kHz-AAlq Split Beam	PZT-U	88 (3.46)		8°	2,000	M172
150 kHz-A	PZT-TP/U	27 (1.08)		19°/ 20°	200	P5, P17, P19, P72, P76
165 kHz-A	PZT-U	73.7 x 31.3 (2.90 x 1.23)		12° / 6°	960	B54
170 kHz-A	PZT-TP/U	51 (2.01)		11° / 12°	500	P66, P79
170 kHz-C	PZT-TP/U	28 (1.10)		13° / 19°	200	B17, B122, P19, P617V, P619, P624, M72, M107
170 kHz-D	PZT-U	8 x 29 (0.31 x 1.14)		14° x 56°	100	P17
200 kHz-A	PZT-TP	27 (1.08)		13°/ 14° / 15°	300	P8, P17, P23, P32, P37, P72
200 kHz-AW	PZT-U	67.3 (2.65)		7°	1,000	CM444
200 kHz-AWlq	PZT-U	67.3 (2.65)		7°	1,000	B260, M191, M260, SS260, TM260
200 kHz-BA	PZT-U	6.6 x 29 (0.26 x 1.14)		13° x 50°	100	P17, P617
200 kHz-BAlQ	PZT-U	6.6 x 29 (0.26 x 1.14)		12° x 39°	100	P48
200 kHz-BB	BT-TP/U	28 (1.10)		14°	250	B619, P5, P7, P19, P219, P436
200 kHz-BC	PZT-U	51 (2.01)		9°	500	SS510

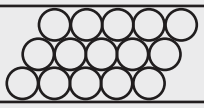
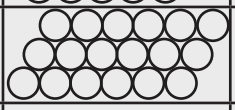
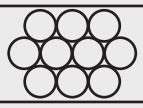
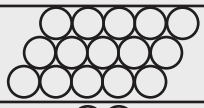
Piezoceramic System Designation Chart

Frequency-Piezoceramic Designator	Piezoceramic Material-Radiating Surface	Dimensions of Radiating Elements mm (in)	Configuration (Not to Scale)	Beam Width @ -3dB	Max Power (Watts) Duty Cycle1%	Typical Housing Models Used
200 kHz-BCIq Broadband	PZT-U	51 (2.01)		8°	500	M162, M163, M175, M176, M192, M194, SS510
200 kHz-BF	PZT-U	88 (3.46)		5°	2,000	B238, R99, R199, SS538
200 kHz-BFIq Broadband	PZT-CR/U	88 (3.46)		5°	2,000	M42, M108, M177, SS538
200 kHz-BH	PZT-U	65 (2.56)		6°/ 7°	1,000	B260, CM260, M260, SS264, TM260
200 kHz-BL	PZT-U	7 x 51 (2.01)		3°	3,000	SS549, M192
200 kHz-BM	PZT-U	65 (2.56)		25°	1,000	CM270, SS264, SS270, TM270
200 kHz-C	PZT-TP/U	16 (0.63)		22°	80	M55
200 kHz-HIq	PZT-U	51 (2.01)		8°	600	M163, SS505, SS510
200 kHz-U	BT-TP/U	38 (1.50)		11°	375	B45, B744, P7, P19, P39, P269, P619
210 kHz-F	PZT-SS	27 (1.08)		13° / 14°	300	SS534
225 kHz-B	PZT-U	3 x 68.02 x 5.84 (2.68 x 0.23)		2° / 41°	100	SS904
235 kHz-A	PZT-TP	51 (2.01)		6°	600	P66, P79, SS510
235 kHz-B	PZT-TP/U	36 (1.42)		11°	350	P7, P37, P39, P66, P74, P78, P79
235 kHz-D	BT-TP/U	51 (2.01)		6° / 7°	600	P79

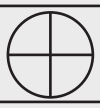
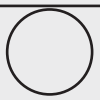
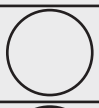
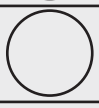
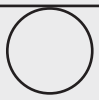
Piezoceramic System Designation Chart

Frequency-Piezoceramic Designator	Piezoceramic Material-Radiating Surface	Dimensions of Radiating Elements mm (in)	Configuration (Not to Scale)	Beam Width @ -3dB	Max Power (Watts) Duty Cycle1%	Typical Housing Models Used
235 kHz-F	PZT-U	5.6 x 32 (0.22 x 1.26)		10° x 44°	100	B17, B617V, P17, P617V
235 kHz-G	PZT-TP	23 (0.90)		14°	200	B17, B122, P6, P17, P23, P6, P692
235 kHz-J	PZT-U	33 (1.30)		11°	250	DT800
235 kHz-Jlq	PZT-U	33 (1.30)		11°	250	B617V, P617V, P651-P650, B744
235 kHz-K	PZT-U	33 (1.30)		12°	250	B122, P617V
240 kHz-Dlq	PZT-CR	77 (3.03)		6°	1,000	M48, M71
270 kHz-Blq	PZT-U	32 (1.26)		10°	300	M193
270 kHz-Clq Broadband	PZT-U	37 (1.46)		9°	500	M91, M467
300 kHz-Blq	PZT-CR	30 (1.18)		11°	250	P415
360 kHz-Alq	PZT-U	19 (0.75)		13°	80	M417
455 kHz-A	PZT-TP	27 (1.06)		7°	300	P5
455/800 kHz-D	PZT-D	60 x 3.07 (2.36 x 0.121)		455 kHz: 4°/40° 800 kHz: 1°/19°	25	SS422
500 kHz-A	PZT-U	30 (1.18)		7°	200	P182, P400
500 kHz-Dlq	PZT-CPVC	42 (1.65)		4°	150	N500

Piezoceramic System Designation Chart

Frequency-Piezoceramic Designator	Piezoceramic Material-Radiating Surface	Dimensions of Radiating Elements mm (in)	Configuration (Not to Scale)	Beam Width @ -3dB	Max Power (Watts) Duty Cycle1%	Typical Housing Models Used
545 kHz-Blq	PZT-U	25 (0.98)		6°	300	P193
22 to 40 kHz-A Broadband	PZT-U	52 x 42 x 42 (1.65 x 1.65)		32 kHz: 9° 38 kHz: 8°	2,000	M438
25 to 45 kHz-A Broadband	PZT-CR	15 x 44.4 (1.75)		28 kHz: 10°x17° 38 kHz: 8°x16° 45 kHz: 7°x13°	3,000	R309, R399
25 to 45 kHz-B Broadband	PZT-U	7 x 44.4 (1.75)		25 kHz: 24° 35 kHz: 19° 45 kHz: 14°	1,000	M563
25 to 50 kHz-A Broadband	PZT-CR	15 x 44.4 (1.75)		28 kHz: 10°x17° 38 kHz: 8°x16° 50 kHz: 7°x13°	3,000	CM510
28 to 60 kHz-A Broadband	PZT-CR	24 x 35 (1.38)		28 kHz: 11°x23° 45 kHz: 7°x13° 60 kHz: 5°x9°	3,000	R209, R299
30 to 60 kHz-A Broadband	PZT-U	15 x 35 (1.38)		30 kHz: 13°x25° 45 kHz: 10°x18° 60 kHz: 7°x12°	2,000	M188
33 to 60 kHz-A Broadband	PZT-CR	24 x 35 (1.38)		38 kHz: 7°x13° 50 kHz: 9°x16° 60 kHz: 6°x10°	3,000	R209, R299
33 to 60 kHz-Blq Broadband	PZT-U	35 (1.38)		35 kHz: 46° 50 kHz: 40° 60 kHz: 30°	150	M73, M417, M418, M419
35 to 65 kHz-A Broadband	PZT-U	10 x 35 (1.38)		35 kHz: 17°x22° 50 kHz: 12°x15° 65 kHz: 9°x12°	1,000	CM365
38 to 58 kHz-A Broadband	PZT-U	35 (1.38)		40 kHz: 46° 44 kHz: 37° 50 kHz: 33°	150	M450
38 to 75 kHz-A Broadband	PZT-U	15 x 35 (1.38)		40 kHz: 10°x19° 60 kHz: 8°x14° 75 kHz: 5°x10°	2,000	CM199, R109
40 to 60 kHz-A Broadband	PZT-U	7 x 20 (0.80)		40 kHz: 31° 50 kHz: 23° 60 kHz: 21°	1,000	B175, CM270, TM270
40 to 60 kHz-B Broadband	PZT-E/U	14 x 20 (0.80)		40 kHz: 25°x75° 50 kHz: 29°x50° 60 kHz: 35°x34°	2,000	PM411

Piezoceramic System Designation Chart

Frequency-Piezoceramic Designator	Piezoceramic Material-Radiating Surface	Dimensions of Radiating Elements mm (in)	Configuration (Not to Scale)	Beam Width @ -3dB	Max Power (Watts) Duty Cycle1%	Typical Housing Models Used
40 to 75 kHz-A Broadband	PZT-U	35 (1.38)		50 kHz: 32° 65 kHz: 28° 75 kHz: 21°	300	B75, B765
42 to 65 kHz-A Broadband	PZT-U	7 x 29 (1.13)		42 kHz: 25° 50 kHz: 20° 65 kHz: 16°	1,000	B265, CM265, M265, TM265
58 to 110 kHz-A Broadband	PZT-U	171 (6.75)		60 kHz: 10° 80 kHz: 8° 110 kHz: 5°	1,000	M475
60 to 100 kHz-A Broadband	PZT-U	5 x 61 x 6.3 2 x 30 x 6 (5 x 2.42" X 0.247" 2x 1.18" X 0.247")		60 kHz: 20°/60° 80 kHz: 15°/60° 100 kHz: 12°/65°	1,000	B175
80 to 130 kHz-A Broadband	PZT-U	43 (1.70)		85 kHz: 23° 100 kHz: 20° 135 kHz: 16°	600	B765, B785
80 to 130 kHz-B Broadband	PZT-CR/U	88 (3.46)		80 kHz: 13° 100 kHz: 10° 135 kHz: 8°	2,000	CM199, CM599, PM111, R109, R111, R509, R599, R609
85 to 135 kHz-B Broadband	PZT-U	65 (2.56)		85 kHz: 16° 105 kHz: 13° 135 kHz: 11°	1,000	B175, B265, B285, CM265, M265, TM185, TM265
95 to 155 kHz-A Broadband	PZT-HPC/U	33 (1.30)		100 kHz: 26° 130 kHz: 20° 160 kHz: 17°	300	TM150
120 to 220 kHz-A Broadband	PZT-U	21 (0.83)		125 kHz: 25° 160 kHz: 23° 220 kHz: 19°	250	M419, M428, M449
130 to 210 kHz-B Broadband	PZT-CR/U	88 (3.46)		130 kHz: 8° 170 kHz: 5° 210 kHz: 4°	2,500	R209, R299, R309, R399
130 to 210 kHz-BRlq Broadband	PZT-CR	88 (3.46)		140 kHz: 7° 160 kHz: 6° 200 kHz: 5°	2,000	R209, R299, R309, R399
130 to 210 kHz-C Broadband	PZT-U	65 (2.56)		130 kHz: 11° 160 kHz: 8° 210 kHz: 6°	1,000	B175, B265, CM265, M265, TM265
130 to 210 kHz-D Broadband	PZT-U	43 (1.70)		130 kHz: 15° 170 kHz: 12° 210 kHz: 9°	600	B75, B765
130 to 210 kHz-E Broadband	PZT-E or PZT-U	80 (3.15)		130 kHz: 8°/ 9° 160 kHz: 7°/ 7° 210 kHz: 5°/ 6°	1,500	P836

Piezoceramic System Designation Chart

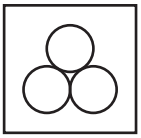
Frequency-Piezoceramic Designator	Piezoceramic Material-Radiating Surface	Dimensions of Radiating Elements mm (in)	Configuration (Not to Scale)	Beam Width @ -3dB	Max Power (Watts) Duty Cycle1%	Typical Housing Models Used
150 to 250 kHz-A Broadband	PZT-HPC/U	65 (2.56)		160 kHz: 24° 200 kHz: 30° 235 kHz: 26°	1,000	B175, B275, B285, CM275, CM599, PM111, PM275, R109, R509, TM185, TM275
150 to 250 kHz-B Broadband	PZT-U	51 (2.01)		160 kHz: 24° 200 kHz: 30° 235 kHz: 26°	600	TM165
400 to 600 kHz-A Broadband	PZT-U	51 (2.01)		400 kHz: 5° 500 kHz: 3° 600 kHz: 3°	500	SS510

10 kHz-D

Transformed to 200 ohms

Power Rating: 1 kW rms @ 2% duty cycle
3 x 102 mm (4.0") PZT/L
Active Area: 243 cm²
Urethane Window

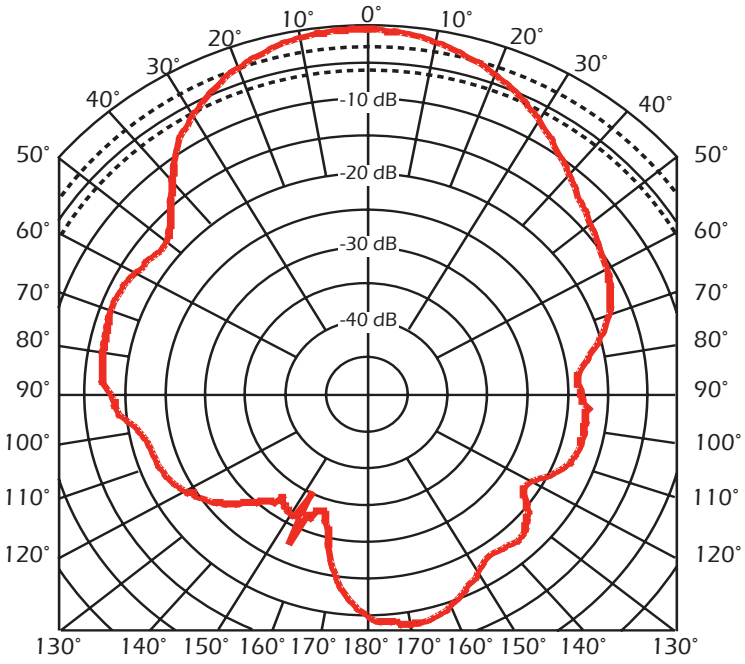
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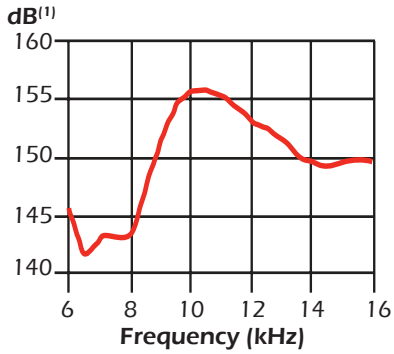
Beamwidth:
-3 dB: 39°
-6 dB: 56°
-10 dB: 73°

Directivity Index:	12.8
Frequency Tolerance:	± 1 kHz
Peak TVR(1), nominal:	155 dB
Peak TVR(1), minimum:	153 dB
Q (transmit):	3
Peak Source Level(4):	208 dB
Peak RVR(2), nominal:	-164 dB
Peak Figure of Merit(3):	-15 dB

Transmit Radiation Pattern



TVR



RVR

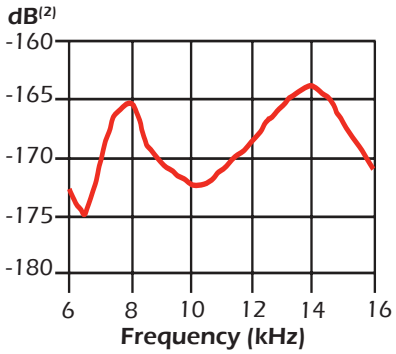
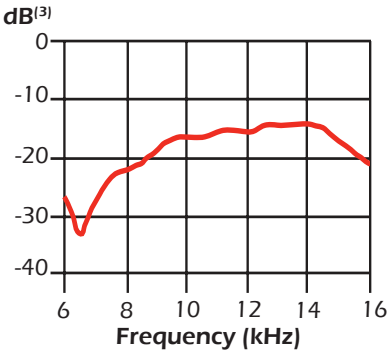


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

10 kHz-D

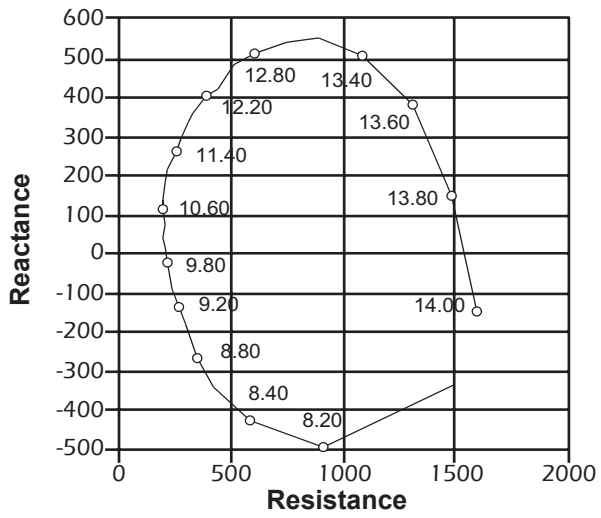
3 x 102 mm (4.0”) PZT/L

Cable Type: C41
Cable Length: 61.0 m (200’)

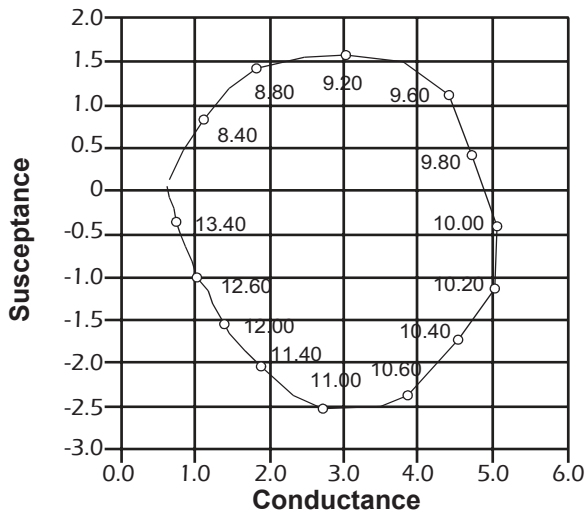
Note:
Impedance data includes cable

Impedance Data w/ transformer	
	Balanced
Parallel: Rp.	200 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF
Series [R - jX]: (nominal)	200 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a

Balanced Impedance



Balanced Admittance



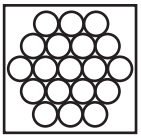
10 kHz-H

Transformed to 50 ohms
Power Rating: 6 kW rms @ 2% duty cycle
19 x 102 mm (4.0") PZT/L
Active Area: 1540 cm²
Urethane Window

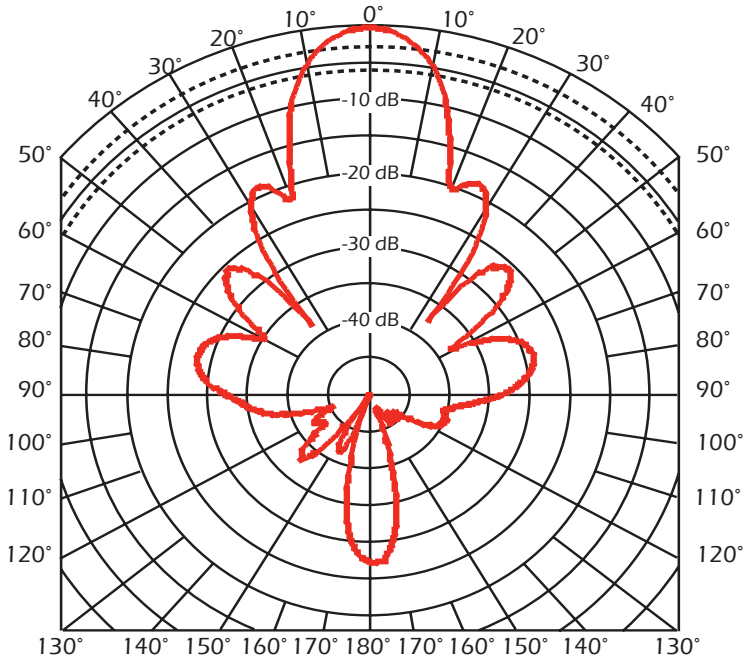
Beamwidth:
-3 dB: 16°
-6 dB: 22°
-10 dB: 28°

Directivity Index:	20.3
Frequency Tolerance:	± 1 kHz
Peak TVR(1), nominal:	167 dB
Peak TVR(1), minimum:	165 dB
Q (transmit):	4
Peak Source Level(4):	222 dB
Peak RVR(2), nominal:	-162 dB
Peak Figure of Merit(3):	-2 dB

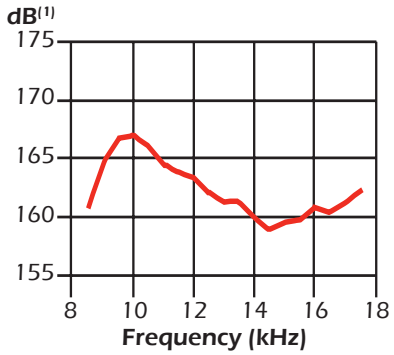
Array



Transmit Radiation Pattern



TVR



RVR

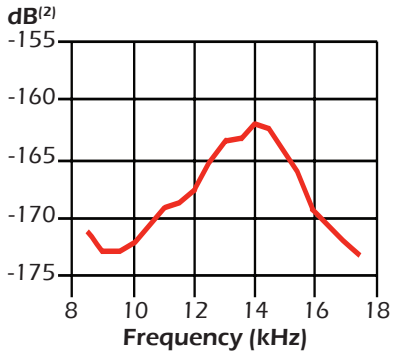
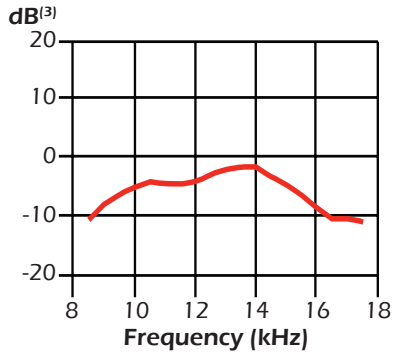


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

10 kHz-H

19 x 102 mm (4.0”) PZT/L

Cable Type: Custom
Cable Length: 0.9 m (3’)

Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	50 Ω: -20%, +40%	50 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	50 Ω - j0 Ω	50 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
6.00	120.36	87.70	4.84	120.27	0.3341	-8.3014	2993.11	-220201.78
6.20	133.07	87.41	6.01	132.94	0.3392	-7.5070	2948.25	-192706.18
6.40	148.09	86.09	10.11	147.74	0.4610	-6.7370	2169.21	-167536.27
6.60	169.70	84.49	16.29	168.92	0.5657	-5.8655	1767.65	-141442.89
6.80	196.28	83.87	20.98	195.15	0.5445	-5.0657	1836.60	-118562.53
7.00	223.81	80.63	36.43	220.83	0.7272	-4.4084	1375.13	-100231.21
7.20	277.57	72.62	82.93	264.89	1.0764	-3.4381	929.05	-75998.83
7.40	378.78	66.65	150.11	347.77	1.0463	-2.4239	955.78	-52131.51
7.60	443.28	59.03	228.12	380.07	1.1609	-1.9343	861.37	-40506.51
7.80	460.09	29.06	402.17	223.47	1.8999	-1.0557	526.34	-21541.02
8.00	449.77	-11.06	441.42	-86.26	2.1821	0.4264	458.28	8483.68
8.20	419.12	-26.95	373.61	-189.93	2.1269	1.0813	470.16	20986.18
8.40	266.31	-27.62	235.96	-123.49	3.3269	1.7411	300.58	32988.66
8.60	171.52	-39.65	132.07	-109.45	4.4890	3.7202	222.77	68846.74
8.80	147.41	-43.60	106.75	-101.66	4.9127	4.6781	203.55	84607.25
9.00	115.06	-31.72	97.88	-60.49	7.3929	4.5689	135.26	80796.69
9.20	80.79	-30.54	69.59	-41.06	10.6607	6.2891	93.80	108797.38
9.40	75.69	-28.64	66.43	-36.27	11.5962	6.3319	86.24	107207.64
9.60	66.01	-9.67	65.07	-11.09	14.9337	2.5458	66.96	42206.23
9.80	48.18	-0.96	48.18	-0.81	20.7507	0.3479	48.19	5649.90
10.00	56.69	4.81	56.49	4.75	17.5774	-1.4792	56.89	-23541.91
10.20	55.30	30.40	47.70	27.98	15.5962	-9.1496	64.12	-142765.77
10.40	49.20	31.92	41.76	26.01	17.2532	-10.7461	57.96	-164451.25
10.60	67.14	33.86	55.75	37.41	12.3670	-8.2991	80.86	-124608.25
10.80	79.25	53.81	46.80	63.96	7.4509	-10.1836	134.21	-150071.07
11.00	72.11	54.76	41.60	58.90	8.0013	-11.3276	124.98	-163894.17
11.20	91.04	48.17	60.72	67.83	7.3259	-8.1838	136.50	-116293.41
11.40	116.43	61.84	54.95	102.65	4.0536	-7.5720	246.70	-105711.81
11.60	105.25	62.72	48.24	96.54	4.3551	-8.4444	229.61	-115858.77
11.80	125.23	51.75	77.54	98.34	4.9441	-6.2707	202.26	-84576.71
12.00	170.97	58.79	88.61	146.22	3.0312	-5.0022	329.90	-66344.00
12.20	152.12	66.27	61.22	139.26	2.6453	-6.0178	378.03	-78505.63
12.40	161.89	53.15	97.09	129.54	3.7047	-4.9428	269.93	-63441.02

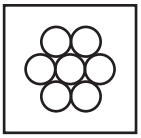
12 kHz-B

Transformed to 185 ohms
Power Rating: 2.1 kW rms @ 2% duty cycle
7 x 60 mm (2.38") PZT/L
Active Area: 200 cm²
Stainless Steel Window

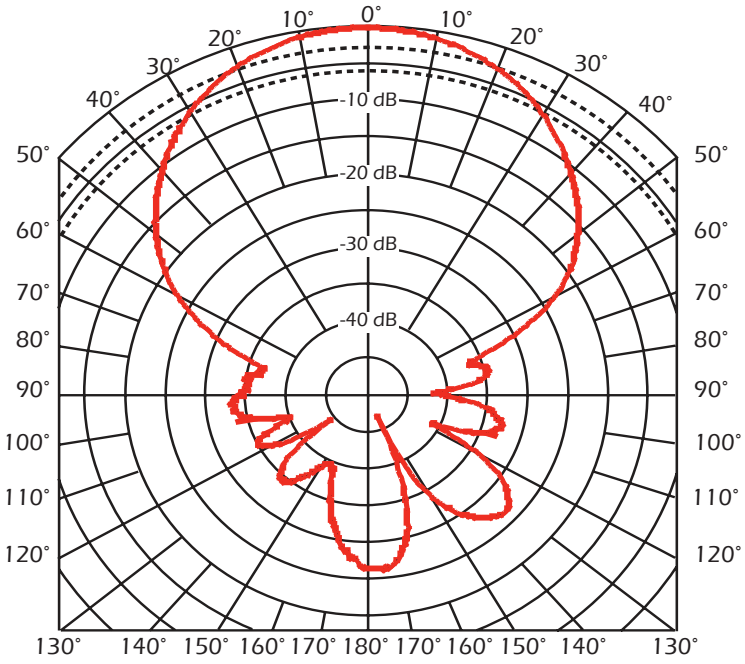
Beamwidth:
-3 dB: 42°
-6 dB: 59°
-10 dB: 77°

Directivity Index:	13.7
Frequency Tolerance:	± 1 kHz
Peak TVR(1), nominal:	158 dB
Peak TVR(1), minimum:	156 dB
Q (transmit):	7
Peak Source Level(4):	214 dB
Peak RVR(2), nominal:	-160 dB
Peak Figure of Merit(3):	-14 dB

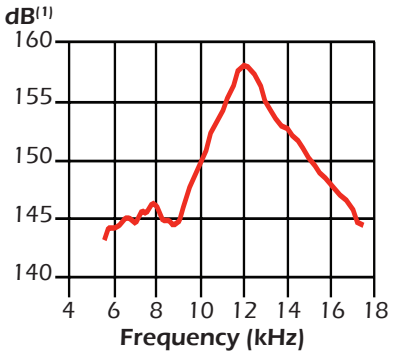
Array



Transmit Radiation Pattern



TVR



RVR

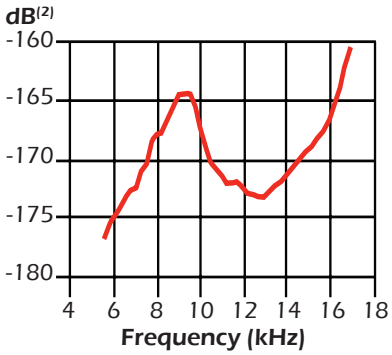
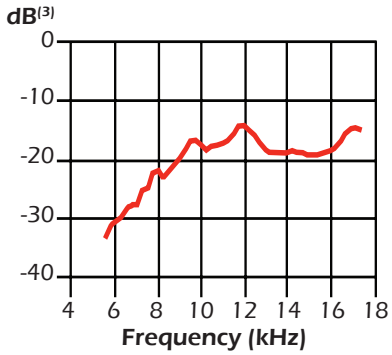


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

12 kHz-B

7 x 60 mm (2.38”) PZT/L

Cable Type: C43
Cable Length: 9.1 m (30’)

Note:
Impedance data includes cable

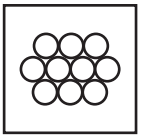
Impedance Data w/transformer	
	Balanced
Parallel: Rp.	185 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF
Series [R - jX]: (nominal)	185 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
7.00	417.80	85.88	29.99	416.72	0.1718	-2.3873	5821.27	-54279.44
7.25	458.55	84.60	43.14	456.52	0.2052	-2.1711	4873.60	-47660.84
7.50	503.26	83.33	58.42	499.86	0.2307	-1.9736	4335.00	-41881.45
7.75	553.78	81.62	80.73	547.86	0.2633	-1.7865	3798.59	-36687.28
8.00	619.50	79.53	112.53	609.20	0.2932	-1.5873	3410.47	-31579.24
8.25	711.17	77.10	158.72	693.23	0.3138	-1.3707	3186.46	-26442.36
8.50	816.73	74.52	217.98	787.10	0.3268	-1.1800	3060.09	-22094.10
8.75	955.27	70.41	320.24	899.99	0.3509	-0.9862	2849.52	-17939.00
9.00	1124.75	62.05	527.16	993.56	0.4167	-0.7854	2399.77	-13888.66
9.25	1377.92	49.89	887.70	1053.88	0.4675	-0.5551	2138.86	-9550.37
9.50	1557.20	29.88	1350.20	775.78	0.5568	-0.3199	1795.94	-5359.78
9.75	1436.26	7.59	1423.68	189.69	0.6902	-0.0920	1448.95	-1501.02
10.00	1255.62	-14.11	1217.73	-306.12	0.7724	0.1942	1294.69	3090.24
10.25	983.48	-25.25	889.49	-419.56	0.9196	0.4338	1087.39	6735.37
10.50	747.66	-30.13	646.67	-375.26	1.1568	0.6713	864.43	10175.51
10.75	535.36	-34.16	442.97	-300.63	1.5456	1.0489	647.01	15529.73
11.00	410.61	-31.67	349.45	-215.61	2.0726	1.2788	482.48	18502.71
11.25	343.24	-26.50	307.18	-153.13	2.6074	1.2998	383.52	18388.35
11.50	290.93	-20.62	272.28	-102.47	3.2170	1.2107	310.85	16755.60
11.75	246.99	-13.12	240.54	-56.08	3.9431	0.9192	253.61	12451.31
12.00	224.87	-5.48	223.84	-21.48	4.4268	0.4248	225.90	5634.04
12.25	199.99	4.99	199.23	17.39	4.9814	-0.4349	200.75	-5649.94
12.50	178.12	18.49	168.92	56.49	5.3244	-1.7805	187.81	-22670.51
12.75	177.17	33.67	147.44	98.23	4.6973	-3.1297	212.89	-39066.75
13.00	195.16	41.30	146.61	128.82	3.8493	-3.3821	259.79	-41406.34
13.25	216.54	51.14	135.86	168.62	2.8973	-3.5960	345.15	-43194.04
13.50	252.40	58.78	130.81	215.85	2.0534	-3.3883	486.99	-39946.06
13.75	293.69	63.63	130.45	263.13	1.5124	-3.0507	661.21	-35311.43
14.00	344.98	67.30	133.15	318.25	1.1188	-2.6741	893.82	-30400.18
14.25	398.60	70.19	135.07	375.02	0.8502	-2.3603	1176.26	-26362.19
14.50	442.36	72.81	130.71	422.60	0.6680	-2.1597	1497.01	-23704.96
14.75	503.69	72.87	148.34	481.35	0.5847	-1.8973	1710.26	-20472.16
15.00	568.42	73.91	157.50	546.17	0.4874	-1.6904	2051.50	-17935.36

12 kHz-C

Array

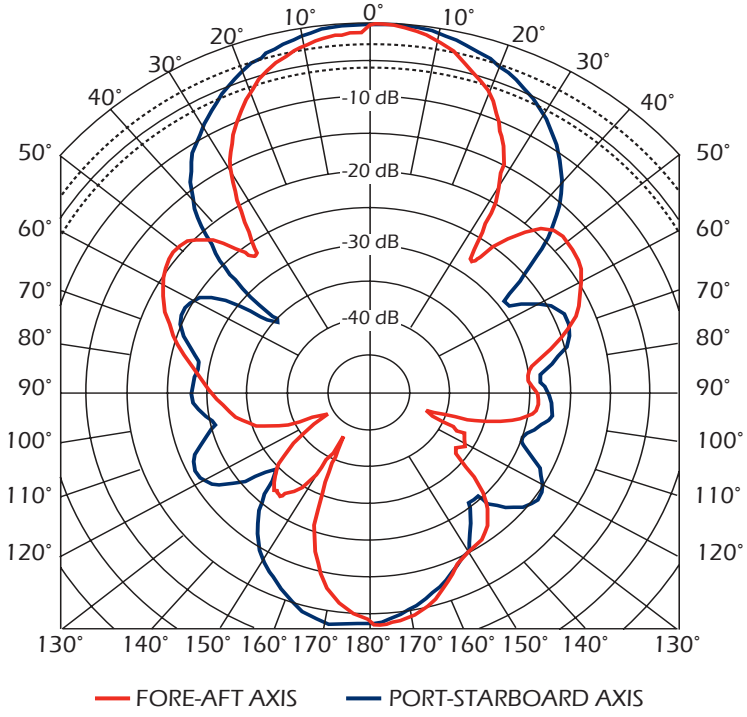


Transformed to 60 ohms
Power Rating: 3 kW rms @ 2% duty cycle
10 x 60 mm (2.38") PZT/L
Active Area: 285 cm²
Urethane Window

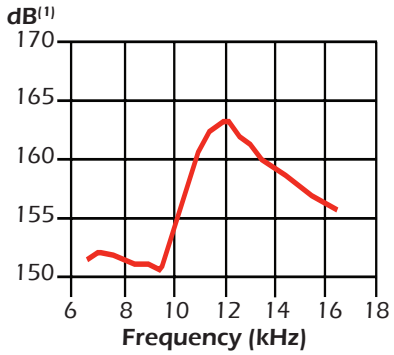
Beamwidth:
-3 dB: 26° x 38°
-6 dB: 38° x 54°
-10 dB: 48° x 69°

Directivity Index:	15.0
Frequency Tolerance:	± 1 kHz
Peak TVR(1), nominal:	162 dB
Peak TVR(1), minimum:	160 dB
Q (transmit):	8
Peak Source Level(4):	215 dB
Peak RVR(2), nominal:	-168 dB
Peak Figure of Merit(3):	-8 dB

Transmit Radiation Pattern



TVR



RVR

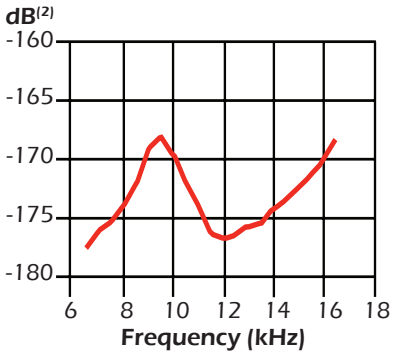
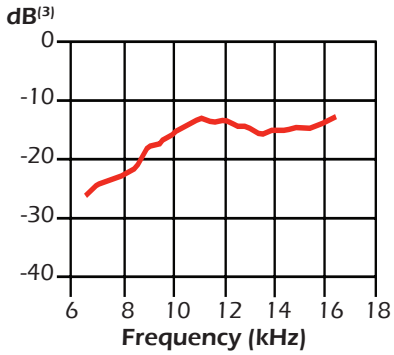


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

12 kHz-C

10 x 60 mm (2.38”) PZT/L

Cable Type: C44
Cable Length: 15.2 m (50’)

Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	60 Ω - j0 Ω	60 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
6.00	110.89	87.50	4.84	110.78	0.3933	-9.0094	2542.42	-238980.80
6.50	132.11	86.77	7.43	131.90	0.4259	-7.5573	2347.70	-185044.33
7.00	161.37	85.37	13.01	160.85	0.4997	-6.1766	2001.19	-140433.88
7.50	207.00	82.17	28.22	205.07	0.6585	-4.7858	1518.53	-101558.82
8.00	284.32	76.71	65.36	276.70	0.8086	-3.4230	1236.74	-68098.36
8.50	426.10	60.38	210.57	370.43	1.1598	-2.0403	862.23	-38202.24
9.00	555.72	9.68	547.80	93.48	1.7738	-0.3027	563.75	-5352.80
9.50	332.19	-27.99	293.33	-155.91	2.6582	1.4129	376.20	23669.82
10.00	171.68	-37.04	137.03	-103.42	4.6495	3.5089	215.08	55846.28
10.50	100.80	-31.35	86.08	-52.44	8.4725	5.1614	118.03	78235.15
11.00	64.40	-9.25	63.56	-10.36	15.3255	2.4972	65.25	36130.75
11.50	58.83	21.58	54.71	21.63	15.8070	-6.2512	63.26	-86513.99
12.00	71.09	44.82	50.43	50.11	9.9774	-9.9150	100.23	-131501.30
12.50	90.84	53.14	54.50	72.67	6.6044	-8.8076	151.41	-112141.38
13.00	110.43	61.31	53.02	96.87	4.3475	-7.9433	230.02	-97247.00
13.50	141.45	67.27	54.65	130.47	2.7316	-6.5206	366.09	-76872.45
14.00	172.59	68.33	63.72	160.40	2.1391	-5.3847	467.49	-61214.64
14.50	220.24	68.01	82.46	204.22	1.6999	-4.2103	588.25	-46212.97
15.00	276.06	67.78	104.38	255.57	1.3697	-3.3535	730.09	-35581.22
15.50	349.96	64.48	150.77	315.82	1.2310	-2.5787	812.32	-26477.79
16.00	482.54	60.31	238.99	419.19	1.0264	-1.8003	974.25	-17908.36

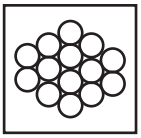
12 kHz-D

Transformed to 60 ohms
Power Rating: 4.2 kW rms @ 2% duty cycle
14 x 60 mm (2.38") PZT/L
Active Area: 400 cm²
Urethane Window

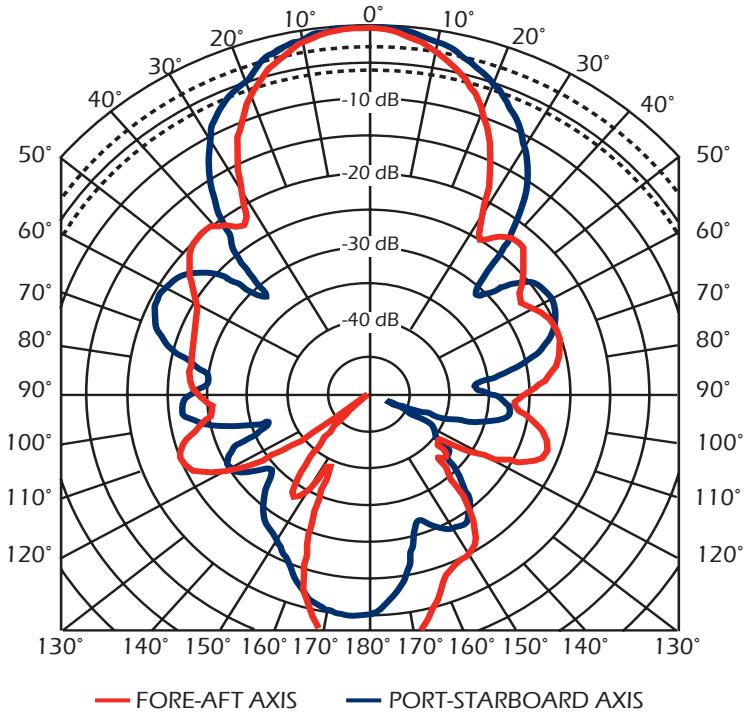
Beamwidth:
-3 dB: 25° x 32°
-6 dB: 35° x 44°
-10 dB: 44° x 57°

Directivity Index:	16.3
Frequency Tolerance:	± 1 kHz
Peak TVR(1), nominal:	163 dB
Peak TVR(1), minimum:	161 dB
Q (transmit):	7
Peak Source Level(4):	217 dB
Peak RVR(2), nominal:	-164 dB
Peak Figure of Merit(3):	-10 dB

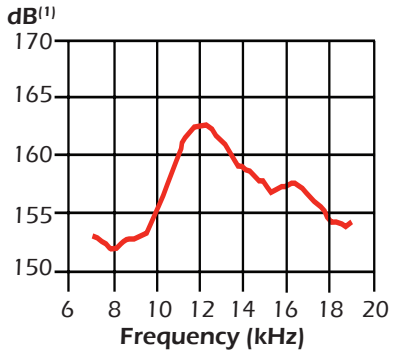
Array



Transmit Radiation Pattern



TVR



RVR

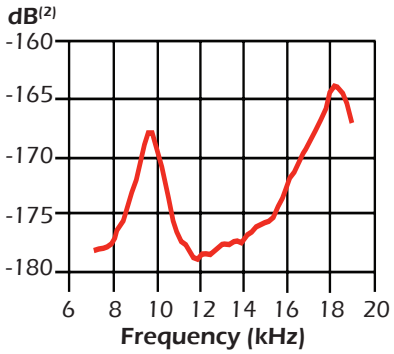
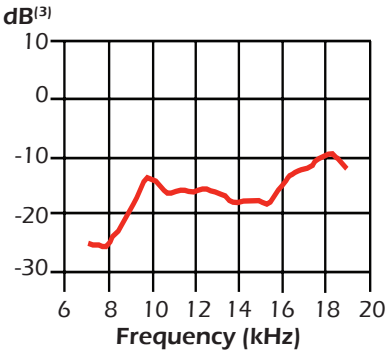


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

12 kHz-D

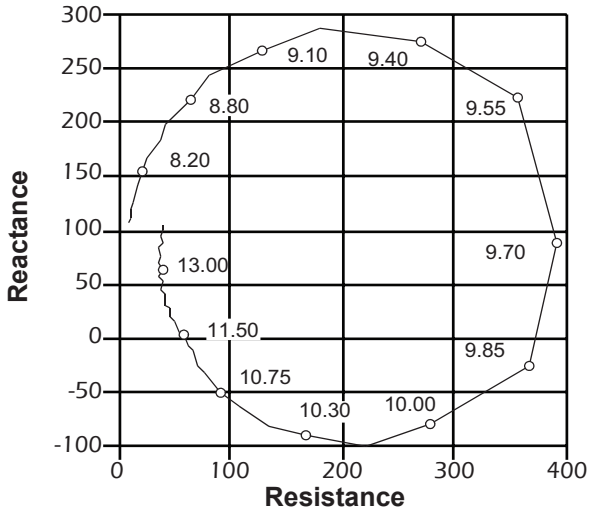
14 x 60 mm (2.38”) PZT/L

Cable Type: C44
Cable Length: 10.1 m (33’)

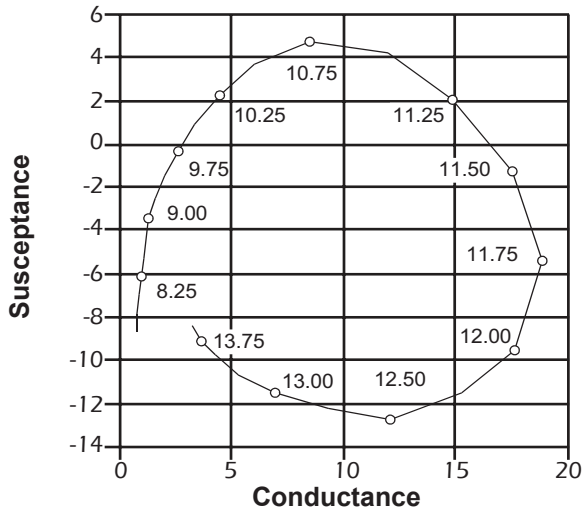
Note:
Impedance data includes cable

Impedance Data w/ transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	60 Ω - j0 Ω	60 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

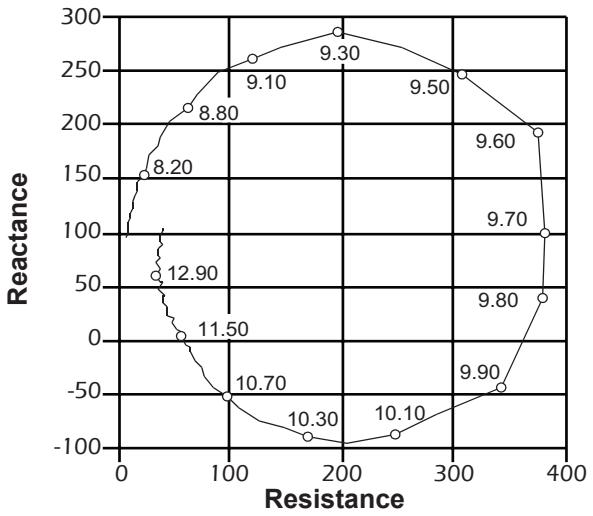
Unbalanced Impedance



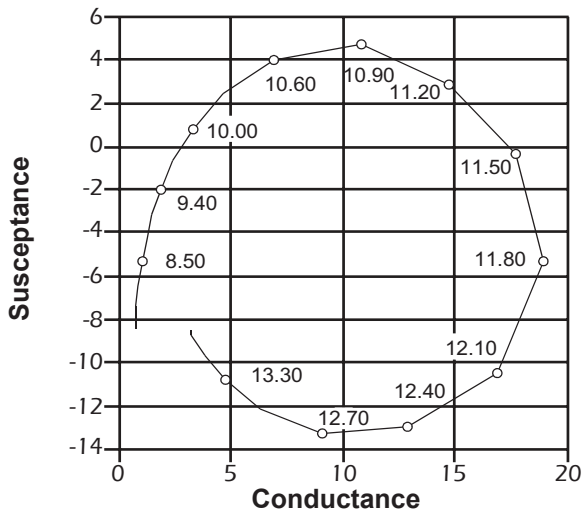
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



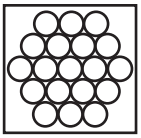
12 kHz-E

Transformed to 60 ohms
Power Rating: 5.7 kW rms @ 2% duty cycle
19 x 60 mm (2.38") PZT/L
Active Area: 540 cm²
Urethane Window

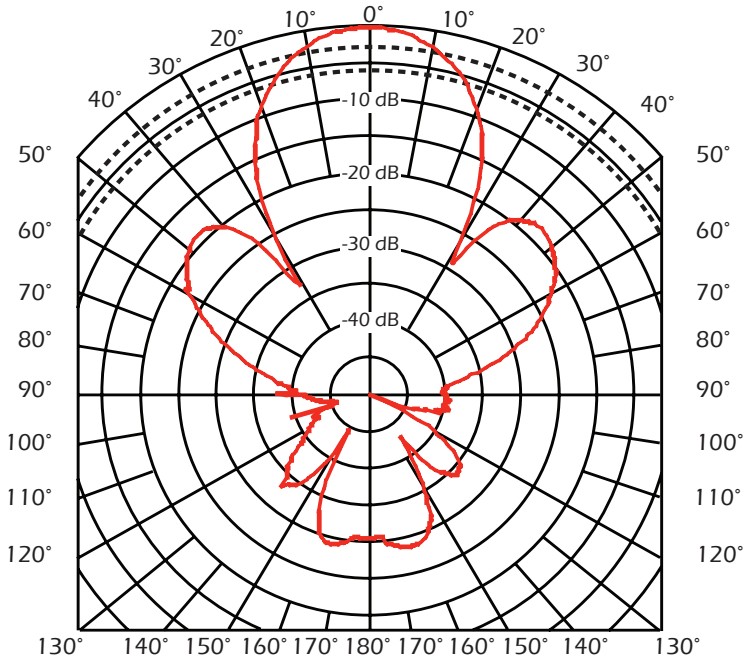
Beamwidth:
-3 dB: 24°
-6 dB: 34°
-10 dB: 42°

Directivity Index:	17.6
Frequency Tolerance:	± 1 kHz
Peak TVR(1), nominal:	166 dB
Peak TVR(1), minimum:	164 dB
Q (transmit):	7
Peak Source Level(4):	221 dB
Peak RVR(2), nominal:	-166 dB
Peak Figure of Merit(3):	-6.5 dB

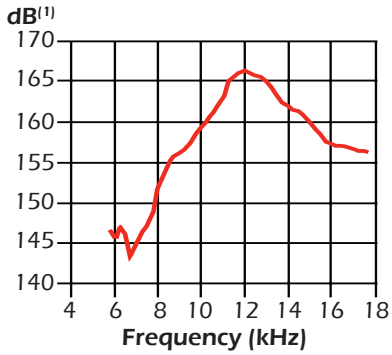
Array



Transmit Radiation Pattern



TVR



RVR

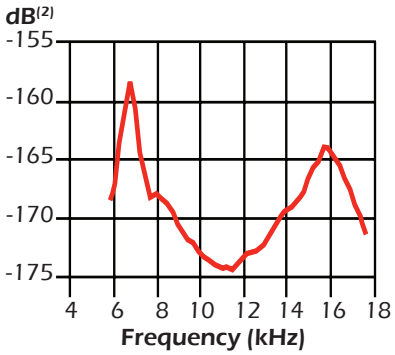
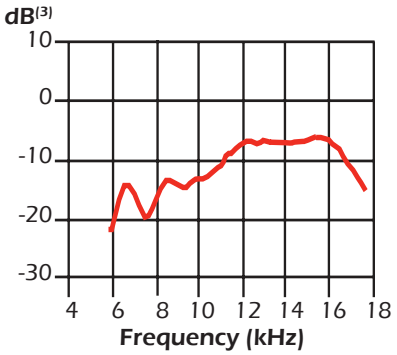


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

12 kHz-E

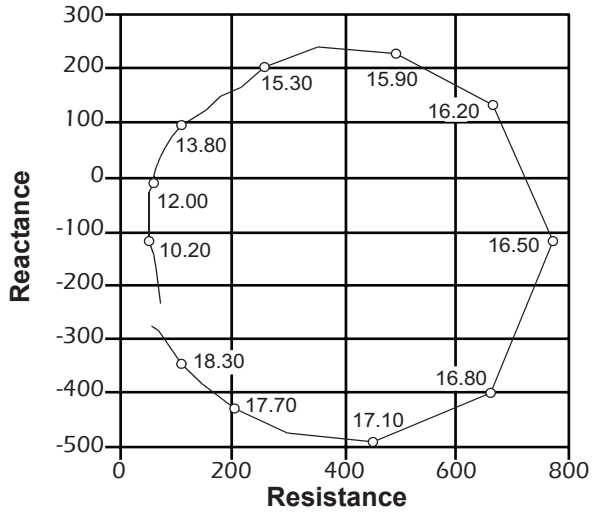
19 x 60 mm (2.38”) PZT/L

Cable Type: C43
Cable Length: 15.2 m (50’)

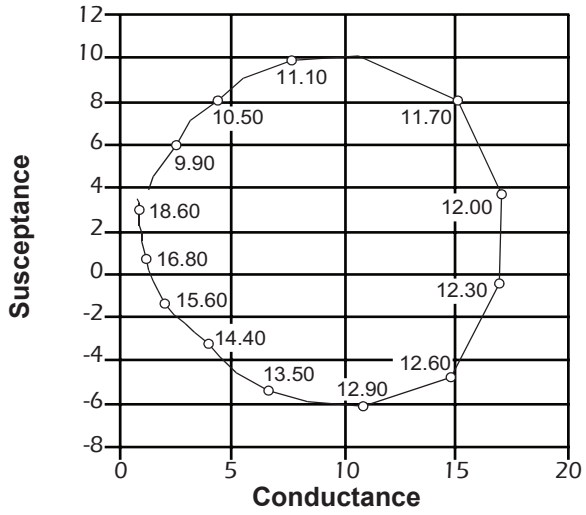
Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	60 Ω - j0 Ω	60 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

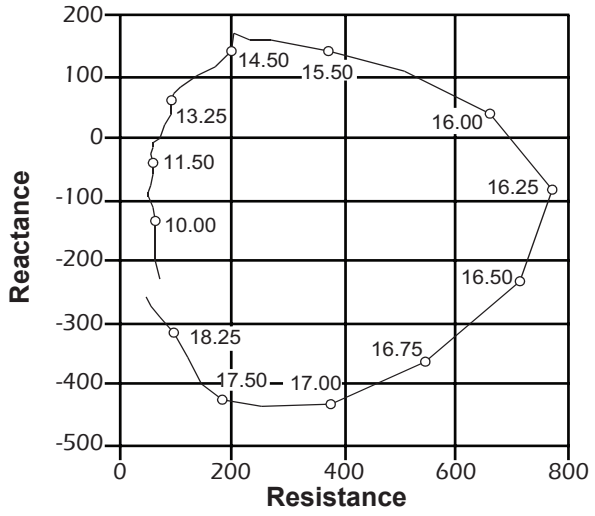
Unbalanced Impedance



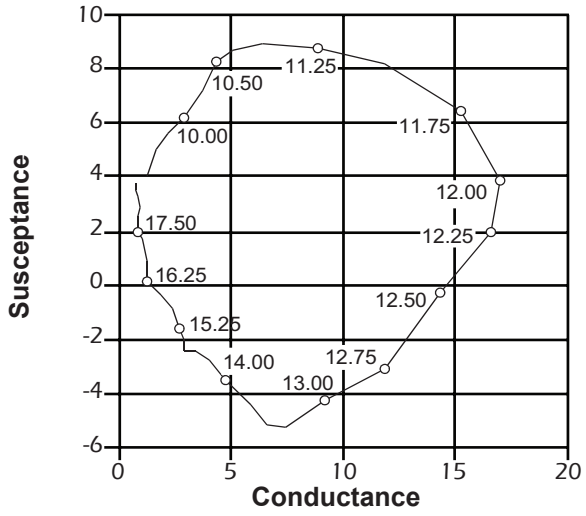
Unbalanced Admittance



Balanced Impedance

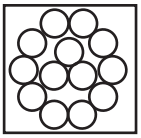


Balanced Admittance



12 kHz-J

Array

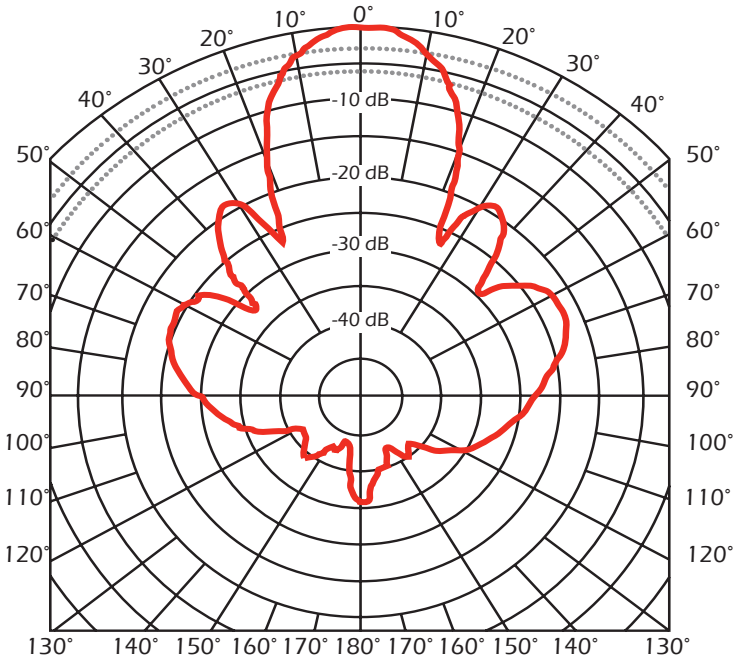


Transformed to 60 ohms
Power Rating: 4 kW rms @ 2% duty cycle
13 x 63 mm (2.5") PZT/L
Active Area: 412 cm²
Urethane Window

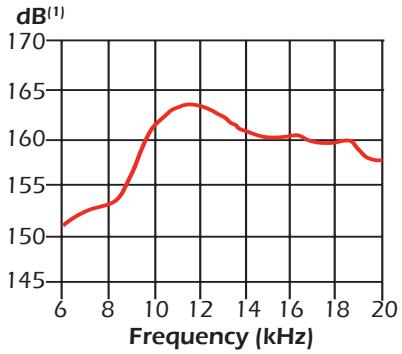
Beamwidth:
-3 dB: 19°
-6 dB: 27°
-10 dB: 34°

Directivity Index:	18.0
Frequency Tolerance:	± 1 kHz
Peak TVR(1), nominal:	165 dB
Peak TVR(1), minimum:	163 dB
Q (transmit):	2.7
Peak Source Level(4):	218.7 dB
Peak RVR(2), nominal:	-170.4 dB
Peak Figure of Merit(3):	-9.7 dB

Transmit Radiation Pattern



TVR



RVR

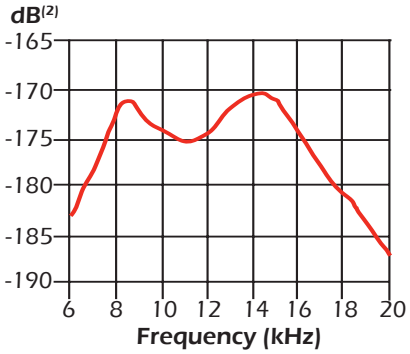
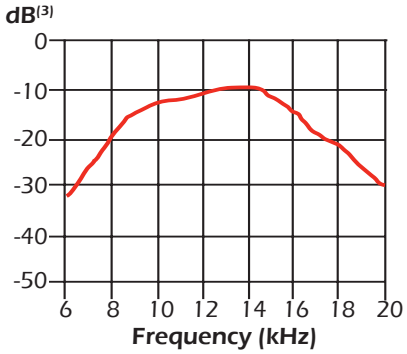


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

12 kHz-J

13 x 63 mm (2.5”) PZT/L

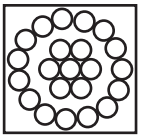
Cable Type: C43
Cable Length: 15.2 m (50’)

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	n/a	n/a
Series [R - jX]: (nominal)	60 - j0 Ω	60 - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
6.00	59.25	87.57	2.51	59.20	0.72	-16.86	1398.55	-447289.01
6.50	73.28	86.15	4.92	73.12	0.92	-13.61	1091.94	-333365.68
7.00	94.54	83.24	11.12	93.89	1.24	-10.50	803.70	-238817.14
7.50	127.62	77.54	27.53	124.62	1.69	-7.65	591.59	-162362.21
8.00	184.60	59.76	92.98	159.48	2.73	-4.68	366.50	-93100.16
8.50	221.52	22.71	204.34	85.54	4.16	-1.74	240.15	-32639.50
9.00	159.54	0.11	159.54	0.30	6.27	-0.01	159.54	-211.60
9.50	111.39	-4.99	110.97	-9.70	8.94	0.78	111.81	13093.18
10.00	92.08	-8.66	91.03	-13.87	10.74	1.64	93.14	26027.25
10.50	74.31	-2.40	74.24	-3.12	13.45	0.56	74.37	8558.45
11.00	63.96	4.76	63.74	5.30	15.58	-1.30	64.18	-18759.70
11.50	69.30	17.32	66.16	20.64	13.77	-4.30	72.60	-59460.11
12.00	79.69	28.73	69.87	38.31	11.00	-6.03	90.88	-80013.33
12.50	92.81	28.84	81.30	44.76	9.44	-5.20	105.95	-66171.63
13.00	124.88	24.09	114.00	50.98	7.31	-3.27	136.80	-40020.60
13.50	166.87	21.99	154.73	62.49	5.56	-2.24	179.97	-26455.83
14.00	189.49	8.25	187.53	27.20	5.22	-0.76	191.47	-8611.07
14.50	211.52	-13.80	205.41	-50.46	4.59	1.13	217.81	12380.54
15.00	217.07	-29.34	189.22	-106.37	4.02	2.26	249.02	23952.10
15.50	181.60	-43.76	131.16	-125.61	3.98	3.81	251.45	39108.21
16.00	149.09	-56.66	81.94	-124.55	3.69	5.60	271.27	55740.30
16.50	129.69	-63.03	58.82	-115.58	3.50	6.87	285.95	66287.82
17.00	110.60	-66.16	44.71	-101.16	3.65	8.27	273.61	77421.46
17.50	95.21	-69.26	33.72	-89.04	3.72	9.82	268.84	89327.56
18.00	85.33	-71.05	27.71	-80.71	3.81	11.08	262.76	98003.34
18.50	77.29	-72.25	23.57	-73.61	3.95	12.32	253.46	106002.76
19.00	70.82	-74.64	18.75	-68.29	3.74	13.62	267.45	114054.32
19.50	64.53	-78.86	12.46	-63.32	2.99	15.20	334.13	124096.39
20.00	55.61	-83.10	6.68	-55.20	2.16	17.85	463.17	142071.84

15 kHz-B

Array

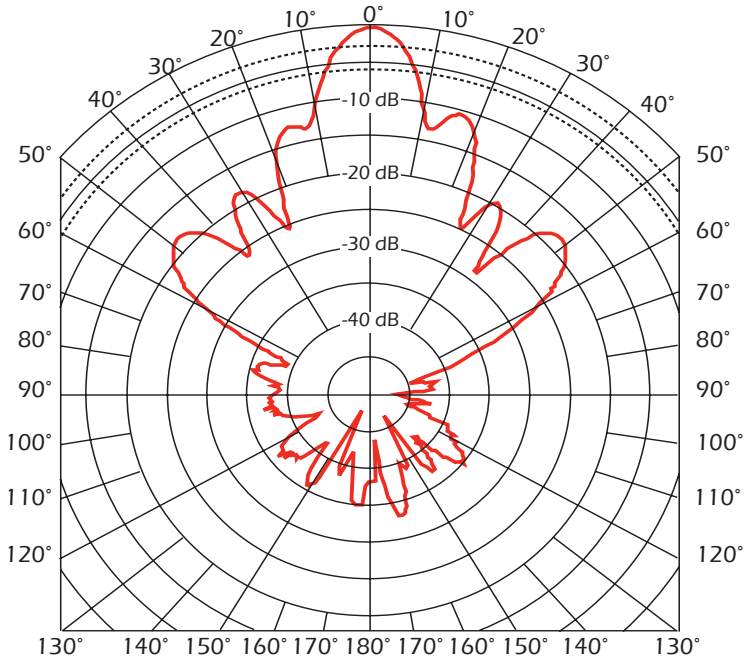


Transformed to 100 ohms
Power Rating: 8 kW rms @ 2% duty cycle
22 x 76 mm (3.0") PZT/L
Active Area: 957 cm²
Urethane Window

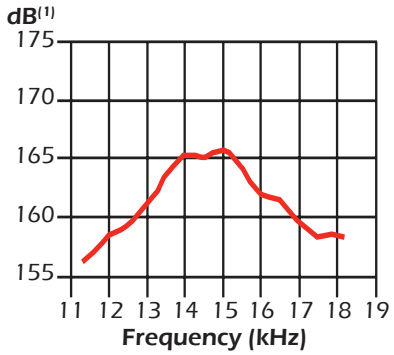
Beamwidth:
-3 dB: 11°
-6 dB: 15°
-10 dB: 19°

Directivity Index:	22.2
Frequency Tolerance:	± 1.2 kHz
Peak TVR(1), nominal:	165 dB
Peak TVR(1), minimum:	163 dB
Q (transmit):	10
Peak Source Level(4):	224 dB
Peak RVR(2), nominal:	-164 dB
Peak Figure of Merit(3):	-2 dB

Transmit Radiation Pattern



TVR



RVR

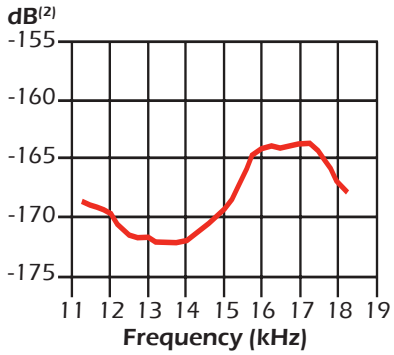
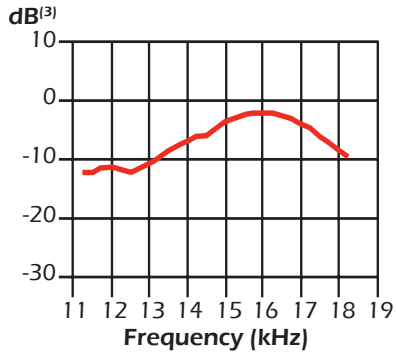


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

15 kHz-B

22 x 76 mm (3.0”) PZT/L

Cable Type: C43
Cable Length: 15.2 m (50’)

Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	100 Ω: -20%, +40%	100 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	100 Ω - j0 Ω	100 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
12.00	364.10	-77.69	77.60	-355.73	0.5854	2.6834	1708.29	35590.08
12.20	339.50	-78.57	67.31	-332.76	0.5840	2.8871	1712.47	37663.00
12.40	305.29	-75.82	74.79	-295.99	0.8024	3.1758	1246.26	40761.29
12.60	268.88	-76.73	61.73	-261.69	0.8539	3.6198	1171.11	45723.40
12.80	256.28	-75.48	64.24	-248.10	0.9780	3.7774	1022.48	46967.86
13.00	225.93	-71.61	71.29	-214.39	1.3966	4.2000	716.02	51419.47
13.20	200.21	-73.00	58.53	-191.46	1.4602	4.7765	684.82	57591.59
13.40	191.44	-69.37	67.45	-179.17	1.8404	4.8886	543.36	58062.58
13.60	165.90	-64.87	70.44	-150.20	2.5594	5.4574	390.72	63865.08
13.80	151.00	-64.79	64.31	-136.62	2.8205	5.9917	354.55	69102.01
14.00	140.16	-57.02	76.29	-117.58	3.8833	5.9852	257.51	68041.35
14.20	120.99	-51.63	75.11	-94.86	5.1305	6.4797	194.91	72624.76
14.40	118.48	-47.11	80.64	-86.80	5.7446	6.1838	174.08	68346.18
14.60	107.93	-32.76	90.76	-58.40	7.7916	5.0136	128.34	54653.86
14.80	95.32	-28.34	83.90	-45.24	9.2338	4.9794	108.30	53546.69
15.00	111.83	-19.01	105.73	-36.43	8.4545	2.9129	118.28	30907.11
15.20	111.80	5.44	111.30	10.60	8.9043	-0.8481	112.30	-8880.39
15.40	106.86	3.59	106.64	6.70	9.3401	-0.5867	107.07	-6062.93
15.60	158.94	4.99	158.34	13.82	6.2679	-0.5470	159.54	-5580.83
15.80	175.05	27.67	155.03	81.28	5.0595	-2.6527	197.65	-26721.13
16.00	167.91	20.54	157.23	58.92	5.5768	-2.0899	179.32	-20788.47
16.20	245.71	13.92	238.49	59.10	3.9504	-0.9789	253.14	-9617.46
16.40	284.75	32.74	239.51	154.02	2.9538	-1.8995	338.55	-18433.53
16.60	271.51	21.73	252.23	100.51	3.4214	-1.3634	292.28	-13071.72
16.80	401.48	13.60	390.23	94.38	2.4210	-0.5855	413.06	-5546.73
17.00	427.89	24.80	388.42	179.49	2.1215	-0.9804	471.37	-9178.17
17.20	414.87	8.09	410.74	58.40	2.3864	-0.3393	419.04	-3139.63
17.40	515.08	-3.44	514.15	-30.92	1.9379	0.1165	516.01	1065.86
17.60	598.78	5.16	596.35	53.88	1.6633	-0.1503	601.22	-1358.81
17.80	556.49	-14.46	538.86	-138.98	1.7400	0.4488	574.70	4012.66
18.00	729.45	-26.90	650.52	-330.03	1.2226	0.6202	817.95	5484.13
18.20	697.68	-22.46	644.78	-266.49	1.3246	0.5475	754.92	4787.64
18.40	582.70	-38.74	454.52	-364.62	1.3386	1.0739	747.02	9288.84

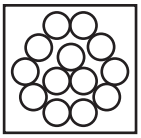
15 kHz-C

Transformed to 70 ohms
Power Rating: 4 kW rms @ 2% duty cycle
13 x 64 mm (2.5") PZT/L
Active Area: 412 cm²
Urethane Window

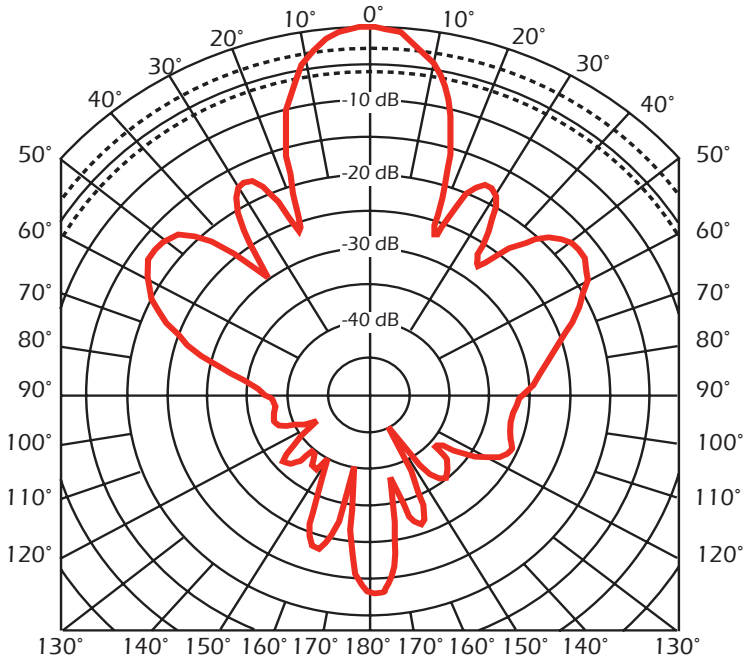
Beamwidth:
-3 dB: 17°
-6 dB: 24°
-10 dB: 29°

Directivity Index:	21.0
Frequency Tolerance:	± 0.3 kHz
Peak TVR(1), nominal:	165 dB
Peak TVR(1), minimum:	163 dB
Q (transmit):	2
Peak Source Level(4):	218 dB
Peak RVR(2), nominal:	-171 dB
Peak Figure of Merit(3):	-10 dB

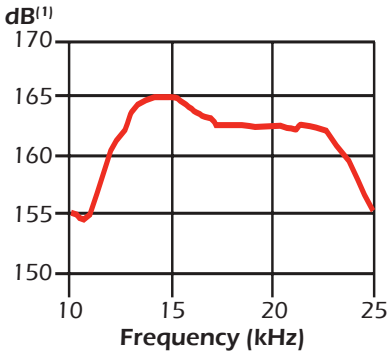
Array



Transmit Radiation Pattern



TVR



RVR

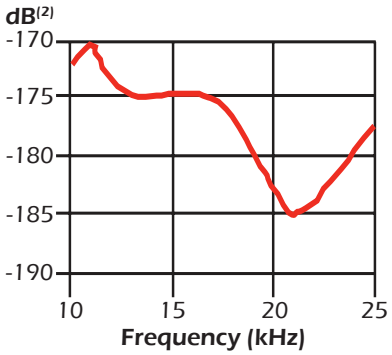
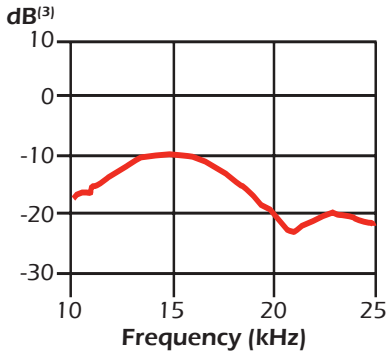


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

15 kHz-C

22 x 76 mm (3.0”) PZT/L

Cable Type: C43
Cable Length: 15.2 m (50’)

Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70 Ω: -20%, +40%	70 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	70 Ω - j0 Ω	70 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
12.00	139.21	-29.29	121.41	-68.11	6.2650	3.5147	159.62	46615.49
12.50	95.79	-24.46	87.20	-39.66	9.5023	4.3225	105.24	55035.76
13.00	75.90	-17.93	72.21	-23.36	12.5354	4.0557	79.77	49652.78
13.50	74.03	-8.82	73.15	-11.35	13.3487	2.0711	74.91	24416.95
14.00	78.66	-0.80	78.65	-1.11	12.7118	0.1786	78.67	2030.33
14.50	77.69	1.40	77.66	1.89	12.8684	-0.3140	77.71	-3446.31
15.00	82.42	1.42	82.40	2.04	12.1290	-0.3006	82.45	-3189.28
15.50	88.97	3.77	88.78	5.86	11.2151	-0.7398	89.17	-7596.71
16.00	89.45	2.12	89.39	3.30	11.1719	-0.4128	89.51	-4105.81
16.50	94.03	-3.13	93.89	-5.13	10.6190	0.5805	94.17	5599.64
17.00	102.12	-7.12	101.33	-12.66	9.7168	1.2140	102.91	11365.42
17.50	101.46	-11.24	99.52	-19.77	9.6669	1.9206	103.45	17466.84
18.00	94.56	-20.13	88.79	-32.54	9.9289	3.6392	100.72	32177.75
18.50	87.33	-26.21	78.36	-38.57	10.2731	5.0567	97.34	43502.54
19.00	76.31	-27.82	67.49	-35.62	11.5898	6.1166	86.28	51235.85
19.50	64.58	-28.21	56.91	-30.53	13.6450	7.3192	73.29	59738.17
20.00	56.19	-24.77	51.02	-23.54	16.1602	7.4573	61.88	59343.55
20.50	48.88	-16.22	46.93	-13.65	17.6454	5.7157	50.90	44375.06
21.00	45.29	-4.84	45.13	-3.82	22.0028	1.8624	45.45	14114.58
21.50	47.39	8.70	46.84	7.17	20.8589	-3.1922	47.94	-23630.40
22.00	53.79	21.59	50.02	19.79	19.2851	-6.8397	57.85	-49480.76
22.50	65.57	30.15	56.70	32.94	13.1867	-7.6597	75.83	-54181.42
23.00	84.79	35.62	68.93	49.38	9.5878	-6.8684	104.30	-47527.98
23.50	112.93	37.65	89.41	68.98	7.0111	-5.4092	142.63	-36634.32
24.00	154.56	34.85	126.83	88.33	5.3093	-3.6976	188.35	-24520.53

15 kHz-E (Broadband)

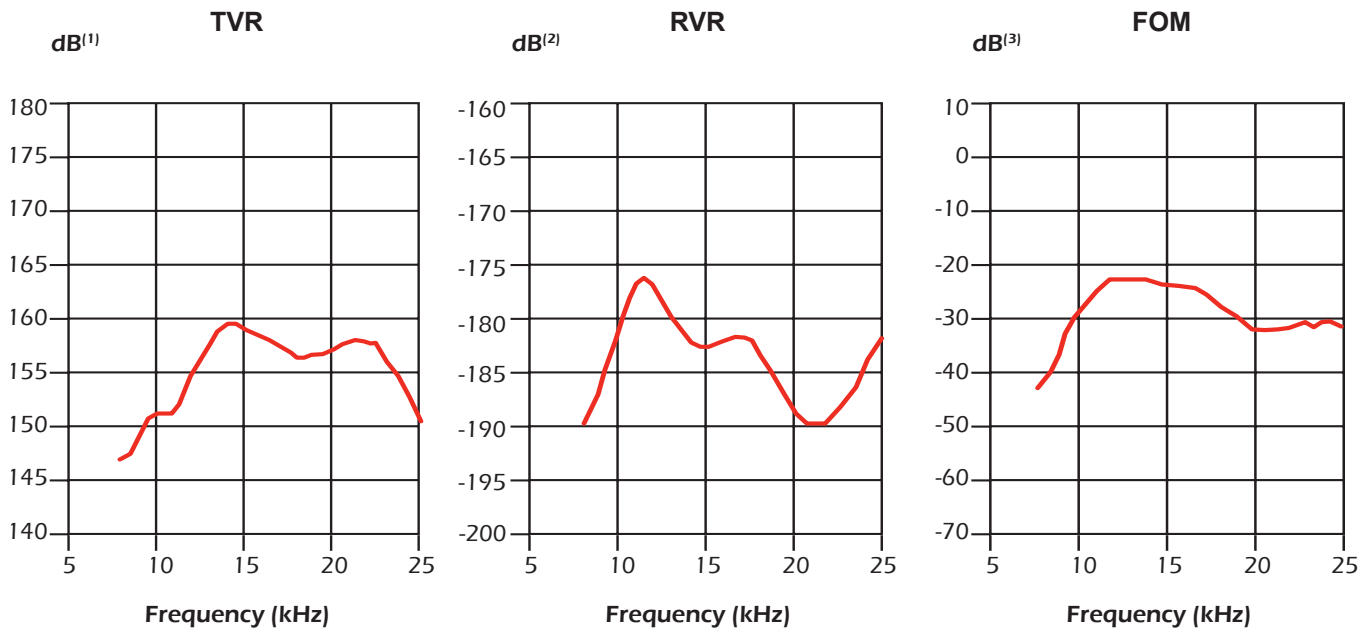
Transformed to 60 ohms
Wired in parallel

Power Rating:
- 925 W @ 2% duty cycle

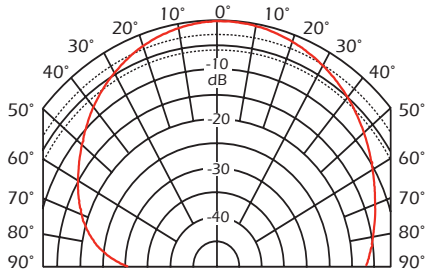
3 x 64 mm (2.5”) PZT/L
Active Area: 95 cm² (14.7 in²)
Radiating Surface: Urethane

Q ≈ 2
Cable Type: C44-02
Cable Length: 10 m (33 ft)

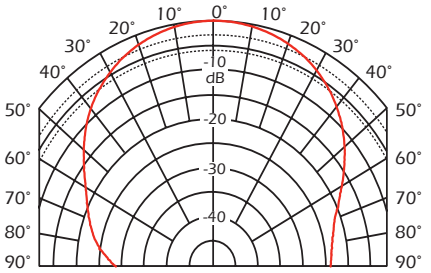
Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response



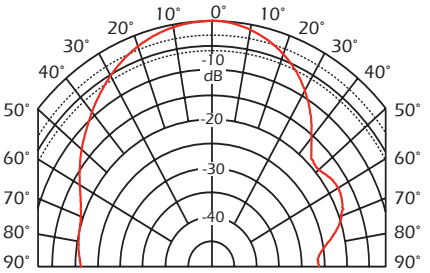
Transmit Radiation Pattern



Beamwidth	@ 12 kHz
-3 dB	54°
-6 dB	79°
-10 dB	105°



Beamwidth	@ 15 kHz
-3 dB	50°
-6 dB	70°
-10 dB	90°



Beamwidth	@ 18 kHz
-3 dB	40°
-6 dB	57°
-10 dB	75°

15 kHz-E (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
8.00	57.05	87.33	2.66	56.98	0.82	-17.51	1222.59	-348361.49
8.50	66.94	85.67	5.06	66.75	1.13	-14.90	886.35	-278909.27
9.00	79.95	83.36	9.25	79.42	1.45	-12.42	690.99	-219692.04
9.50	96.31	79.94	16.82	94.82	1.81	-10.22	551.27	-171284.23
10.00	122.45	75.94	29.74	118.79	1.98	-7.92	504.11	-126079.48
10.50	168.03	64.58	72.14	151.76	2.55	-5.37	391.40	-81470.96
11.00	213.80	40.66	162.20	139.29	3.55	-3.05	281.82	-44090.00
11.50	208.80	10.88	205.04	39.41	4.70	-0.90	212.62	-12510.81
12.00	159.95	-10.31	157.36	-28.63	6.15	1.12	162.57	14842.68
12.50	117.58	-20.06	110.45	-40.32	7.99	2.92	125.17	37138.35
13.00	86.89	-21.78	80.69	-32.24	10.69	4.27	93.57	52278.29
13.50	68.32	-17.80	65.05	-20.88	13.94	4.47	71.75	52748.86
14.00	59.01	-9.85	58.14	-10.10	16.70	2.90	59.90	32957.25
14.50	56.43	-0.26	56.43	-0.25	17.72	0.08	56.43	875.64
15.00	58.70	7.05	58.25	7.20	16.91	-2.09	59.14	-22187.91
15.50	64.91	12.11	63.47	13.62	15.06	-3.23	66.39	-33177.81
16.00	75.06	13.32	73.04	17.30	12.96	-3.07	77.14	-30533.20
16.50	85.07	9.77	83.84	14.44	11.58	-2.00	86.33	-19243.92
17.00	94.63	2.57	94.53	4.24	10.56	-0.47	94.72	-4431.27
17.50	98.22	-7.40	97.41	-12.64	10.10	1.31	99.05	11919.28
18.00	92.50	-17.84	88.06	-28.33	10.29	3.31	97.17	29276.66
18.50	80.53	-24.23	73.43	-33.05	11.32	5.10	88.31	43852.08
19.00	69.79	-27.74	61.77	-32.48	12.68	6.67	78.85	55870.28
19.50	58.89	-28.02	51.98	-27.66	14.99	7.98	66.70	65108.31
20.00	50.16	-24.11	45.79	-20.49	18.20	8.14	54.96	64791.65
20.50	44.00	-16.24	42.24	-12.30	21.82	6.35	45.82	49336.86
21.00	41.64	-5.15	41.47	-3.74	23.92	2.15	41.81	16330.71
21.50	42.62	6.42	42.35	4.77	23.32	-2.62	42.89	-19427.76
22.00	46.56	17.61	44.38	14.09	20.47	-6.50	48.85	-47010.60
22.50	54.85	27.72	48.55	25.52	16.14	-8.48	61.96	-59997.58
23.00	69.13	34.92	56.69	39.57	11.86	-8.28	84.31	-57293.76
23.50	92.54	38.75	72.18	57.92	8.43	-6.76	118.66	-45804.26
24.00	131.74	37.81	104.08	80.77	6.00	-4.65	166.75	-30861.09
24.50	194.75	29.36	169.73	95.50	4.48	-2.52	223.46	-16356.94
25.00	285.25	8.77	281.92	43.48	3.46	-0.53	288.63	-3402.11

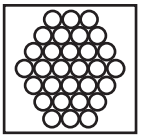
24 kHz-AB

Transformed to 50 ohms
Power Rating: 7 kW rms @ 2% duty cycle
30 x 51 mm (2.0") PZT/L
Active Area: 600 cm²
Urethane Window

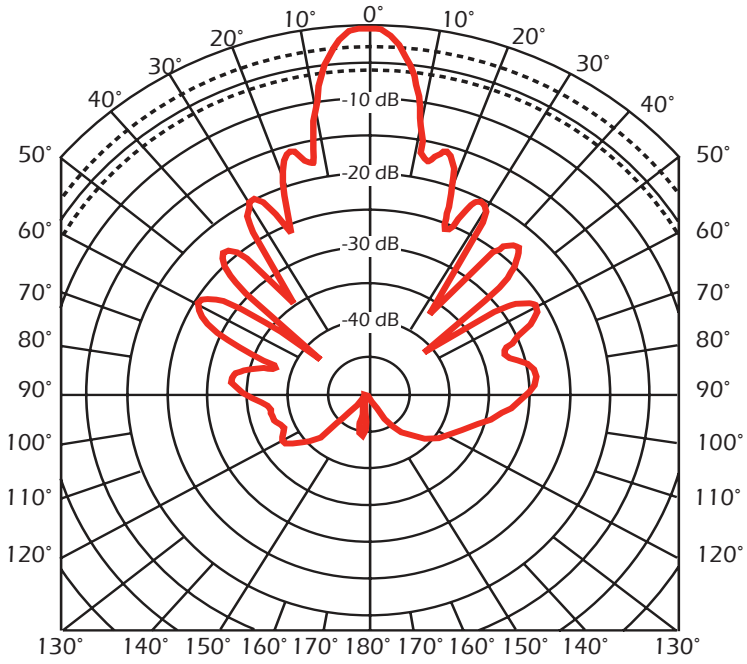
Beamwidth:
-3 dB: 11°
-6 dB: 15°
-10 dB: 18°

Directivity Index:	23.9
Frequency Tolerance:	± 1.2 kHz
Peak TVR(1), nominal:	171 dB
Peak TVR(1), minimum:	169 dB
Q (transmit):	8
Peak Source Level(4):	226 dB
Peak RVR(2), nominal:	-168 dB
Peak Figure of Merit(3):	-1 dB

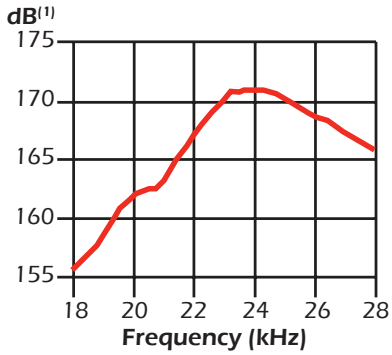
Array



Transmit Radiation Pattern



TVR



RVR

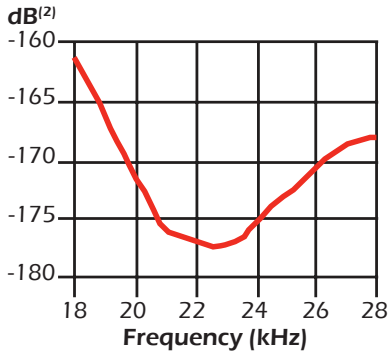
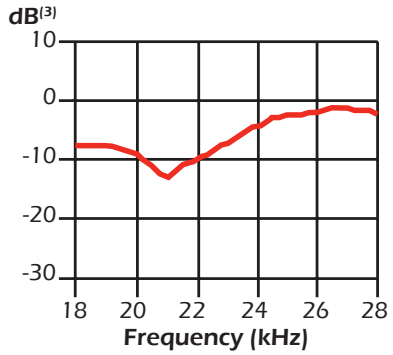


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

24 kHz-AB

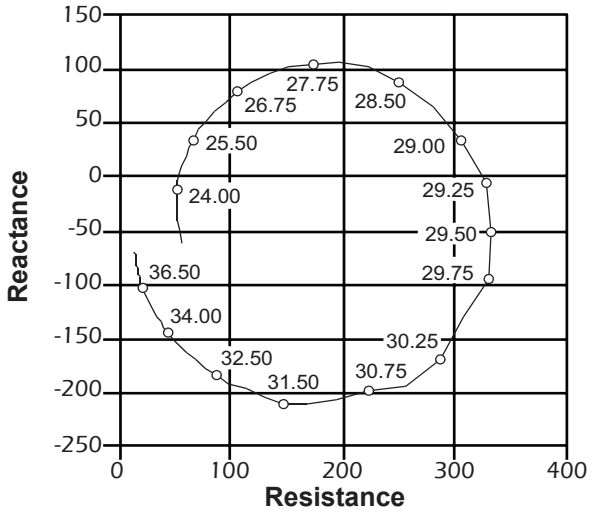
30 x 51 mm (2.0”) PZT/L

Cable Type: C43
Cable Length: 15.2 m (50’)

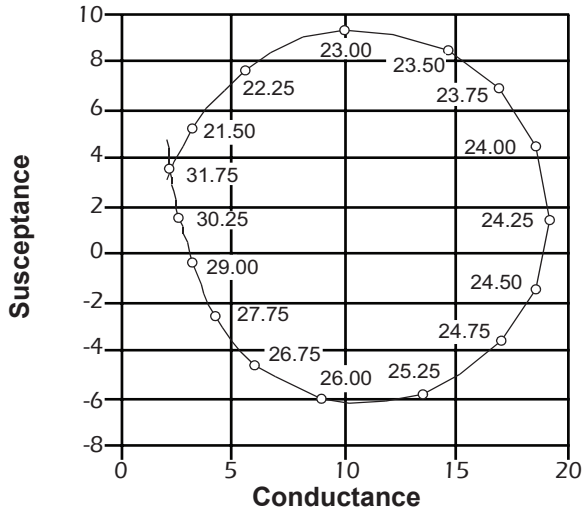
Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	50 Ω: -20%, +40%	50 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	50 Ω - j0 Ω	50 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

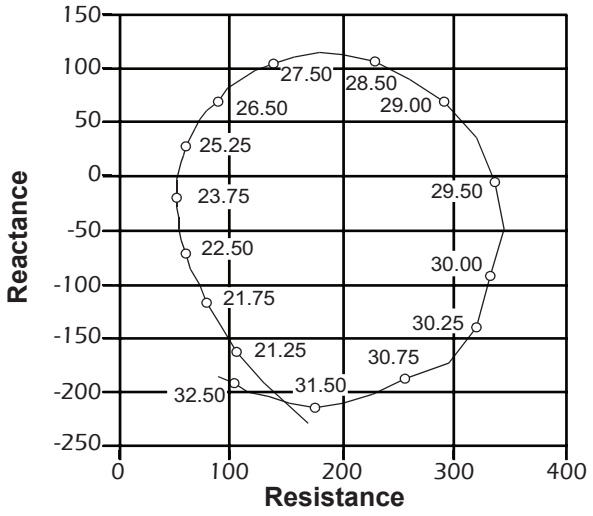
Unbalanced Impedance



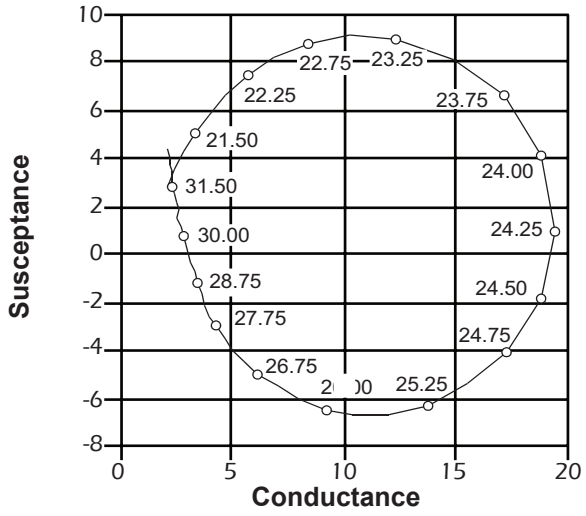
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



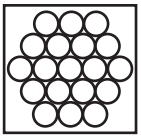
24 kHz-R

Transformed to 60 ohms
Power Rating: 1.2 kW rms @ 2% duty cycle
19 x 37 mm (1.45") PZT/L
Active Area: 205 cm²
Urethane Window

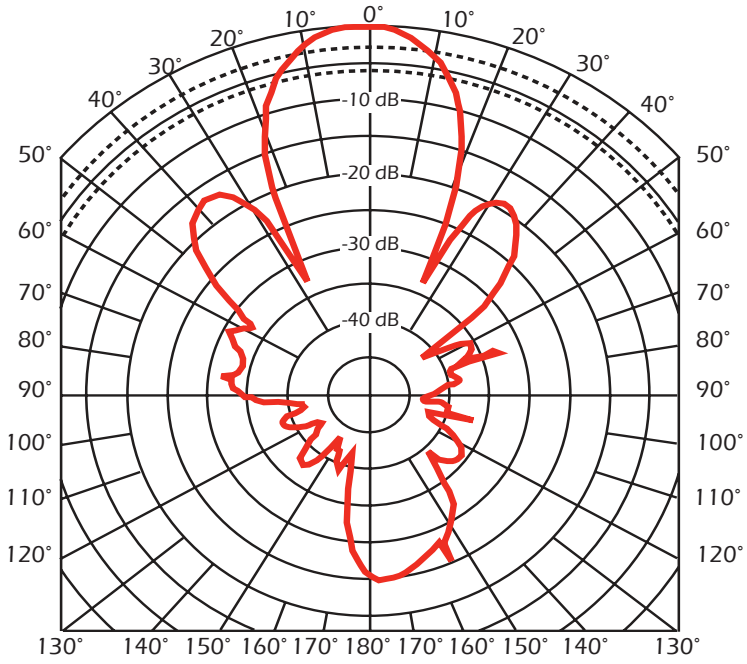
Beamwidth:
-3 dB: 20°
-6 dB: 28°
-10 dB: 35°

Directivity Index:	17.0
Frequency Tolerance:	± 1.2 kHz
Peak TVR(1), nominal:	166 dB
Peak TVR(1), minimum:	164 dB
Q (transmit):	8
Peak Source Level(4):	215 dB
Peak RVR(2), nominal:	-166 dB
Peak Figure of Merit(3):	-11 dB

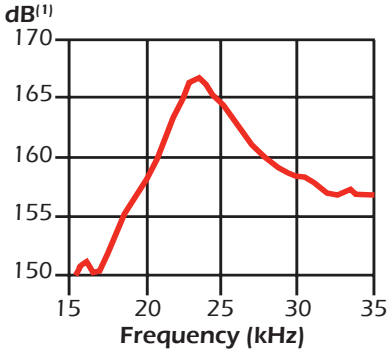
Array



Transmit Radiation Pattern



TVR



RVR

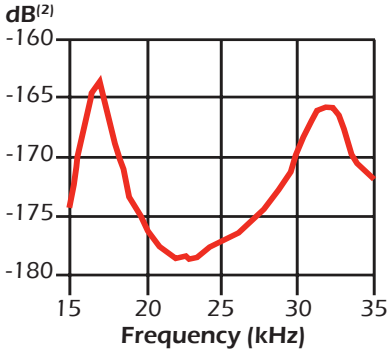
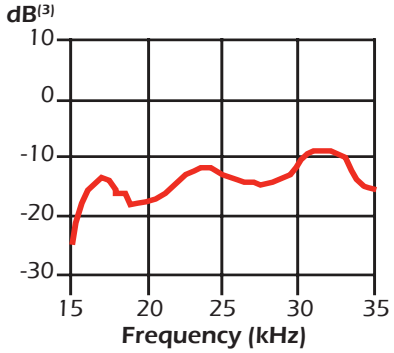


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

24 kHz-R

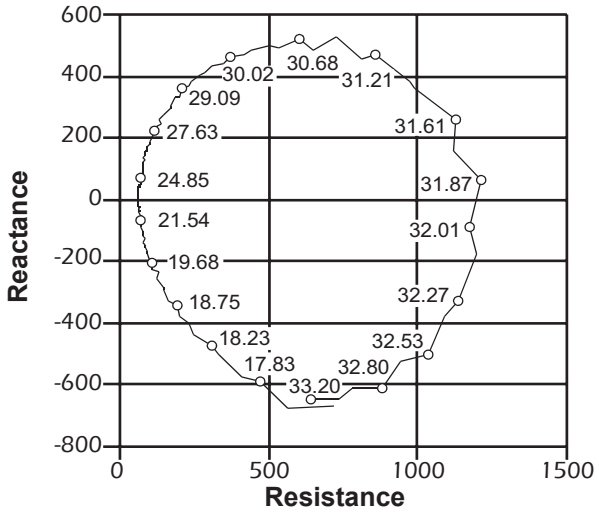
19 x 27 mm (1.08”) PZT/L

Cable Type: C44
Cable Length: 10.1 m (33’)

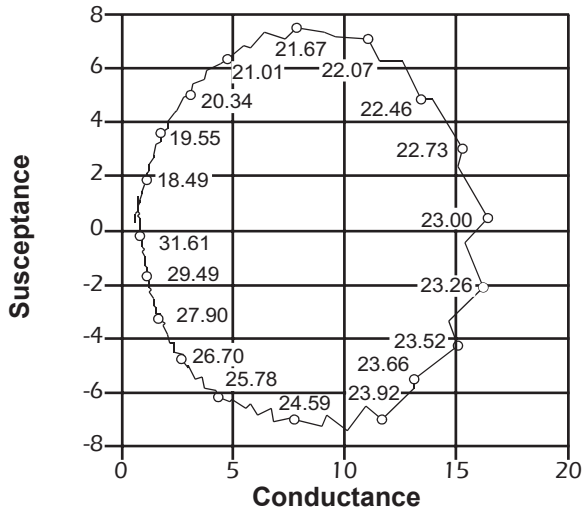
Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	60 Ω - j0 Ω	60 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balanced Impedance

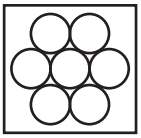


Balanced Admittance



24 kHz-W

Array

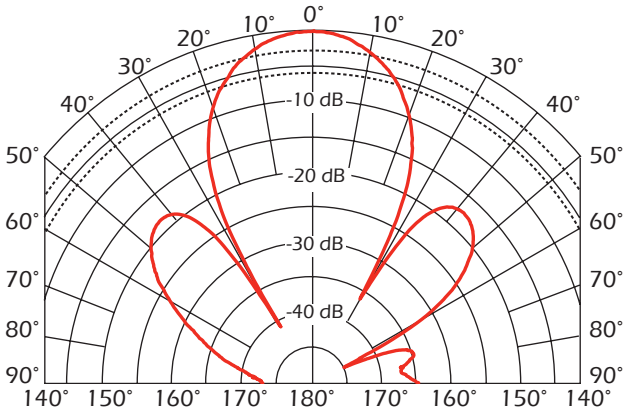


Transformed to 60 ohms
Power Rating: 1500 W rms @ 2% duty cycle
7 x 51 mm (2.0") PZT/L
Active Area: 60 cm²
Urethane Window

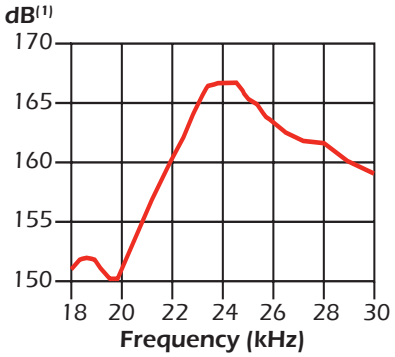
Beamwidth:
-3 dB: 24°
-6 dB: 33°
-10 dB: 42°

Directivity Index:	19
Frequency Tolerance:	± 1.2 kHz
Peak TVR(1), nominal:	167 dB
Peak TVR(1), minimum:	164 dB
Q (transmit):	8
Peak Source Level(4):	214 dB
Peak RVR(2), nominal:	-170 dB
Peak Figure of Merit(3):	-11 dB

Transmit Radiation Pattern



TVR



RVR

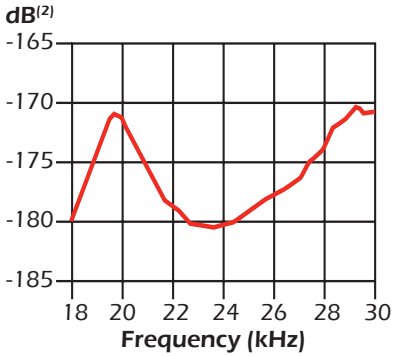
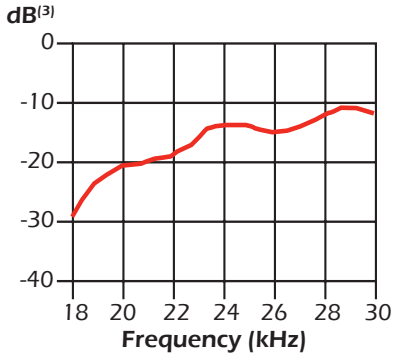


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

24 kHz-W

7 x 51 mm (2.0”) PZT/L

Cable Type: C43
Cable Length: 10.1 m (33’)

Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	60 + j8 Ω	60 + j8 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
18.00	256.02	81.68	37.04	253.33	0.57	-3.86	1769.82	-34172.19
18.50	331.05	77.58	71.20	323.30	0.65	-2.95	1539.25	-25378.77
19.00	482.43	69.05	172.50	450.54	0.74	-1.94	1349.24	-16215.36
19.50	769.31	41.62	575.07	511.01	0.97	-0.86	1029.15	-7047.11
20.00	799.86	-11.04	785.05	-153.18	1.23	0.24	814.94	1905.29
20.50	441.38	-45.23	310.84	-313.36	1.60	1.61	626.74	12487.94
21.00	260.16	-52.52	158.29	-206.46	2.34	3.05	427.59	23118.53
21.50	179.73	-54.99	103.11	-147.20	3.19	4.56	313.26	33734.68
22.00	118.09	-51.39	73.70	-92.28	5.28	6.62	189.24	47866.59
22.50	89.39	-43.27	65.08	-61.27	8.15	7.67	122.77	54243.64
23.00	66.98	-32.93	56.22	-36.41	12.53	8.12	79.80	56166.63
23.50	52.90	-12.20	51.71	-11.18	18.48	3.99	54.12	27044.79
24.00	57.90	8.53	57.26	8.59	17.08	-2.56	58.55	-16986.60
24.50	56.98	21.21	53.12	20.62	16.36	-6.35	61.12	-41250.72
25.00	76.89	39.02	59.74	48.40	10.11	-8.19	98.96	-52122.77
25.50	87.68	38.90	68.24	55.06	8.88	-7.16	112.67	-44702.09
26.00	106.32	50.69	67.35	82.27	5.96	-7.28	167.85	-44548.39
26.50	142.90	45.22	100.66	101.43	4.93	-4.97	202.86	-29830.95
27.00	154.11	49.90	99.26	117.88	4.18	-4.96	239.26	-29258.83
27.50	231.56	47.35	156.90	170.30	2.93	-3.18	341.74	-18381.53
28.00	253.08	38.45	198.19	157.39	3.09	-2.46	323.18	-13967.69
28.50	338.37	36.94	270.44	203.36	2.36	-1.78	423.36	-9918.77
29.00	428.70	14.51	415.02	107.42	2.26	-0.58	442.83	-3207.81
29.50	434.18	4.90	432.59	37.10	2.29	-0.20	435.77	-1061.65
30.00	505.40	-22.47	467.04	-193.13	1.83	0.76	546.90	4011.19

28 kHz-E

Transformed to 70 ohms

Power rating: 1 kWrms @ 2% duty cycle
7 x 36.5 mm (1.44") PZT/L
Active Area: 74 cm²
Urethane Window

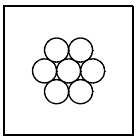
Beamwidth:

-3 dB:	29°
-6 dB:	42°
-10 dB:	52°

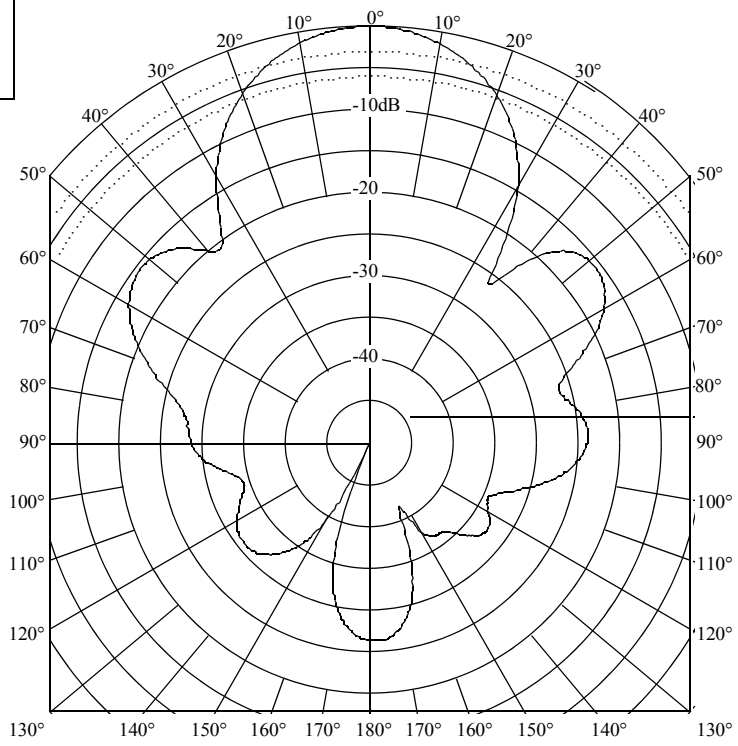
Directivity Index:	16.4
Frequency Tolerance:	±1.4 kHz
Peak TVR(1), nominal:	164 dB
Peak TVR(1), minimum:	162 dB
Q (transmit):	11
Peak Source Level(4):	213 dB
Peak RVR(2), nominal:	-170 dB
Peak Figure of Merit(3):	-14 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

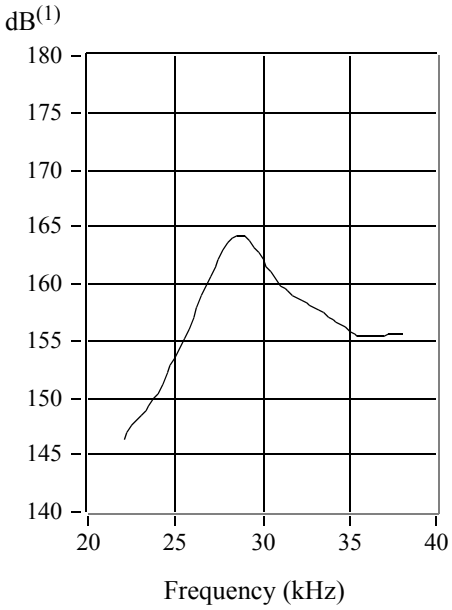
Array:



Transmit Radiation Pattern



TVR



RVR

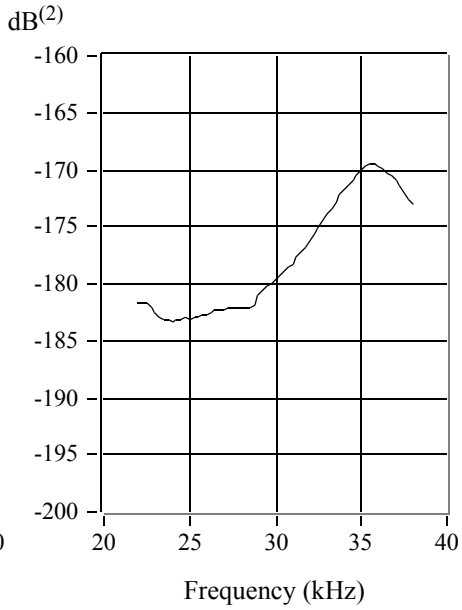
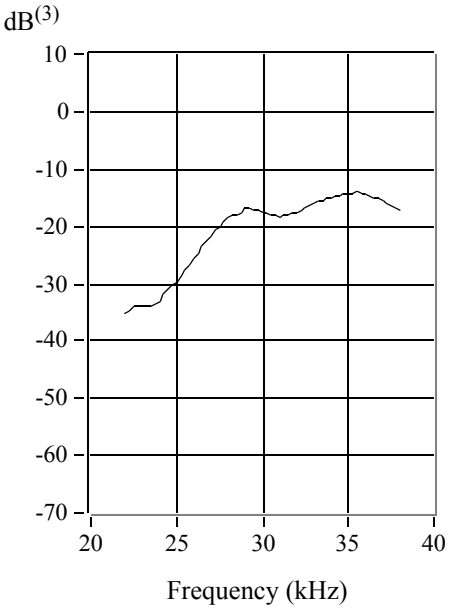


Figure of Merit



28 kHz-E

7x36.5mm (1.44") PZT/L

Cable Type: C44
Cable Length: 15.2m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70ohms -20%,+40%	70ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	70 – j0ohms	70 – j0ohms
1 kHz Capacitance	n/a	n/a

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (ohms)	Phase Angle (°)	Series Resistance (ohms)	Series Reactance (ohms)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (ohms)	Parallel Capacitance (pF)
22.00	540.35	-78.25	110.02	-529.03	0.3768	1.8119	2653.90	13107.66
22.25	492.62	-78.06	101.91	-481.96	0.4200	1.9861	2381.20	14206.38
22.50	450.06	-77.89	94.40	-440.04	0.4661	2.1725	2145.66	15367.45
22.75	412.52	-77.59	88.66	-402.88	0.5210	2.3675	1919.49	16562.35
23.00	379.21	-77.10	84.64	-369.64	0.5886	2.5705	1698.94	17787.47
23.25	348.64	-77.16	77.49	-339.92	0.6375	2.7965	1568.51	19143.39
23.50	323.44	-76.57	75.11	-314.60	0.7179	3.0072	1392.93	20366.54
23.75	298.40	-75.72	73.60	-289.18	0.8266	3.2477	1209.85	21763.44
24.00	275.90	-75.04	71.23	-266.55	0.9358	3.5016	1068.61	23220.62
24.25	254.23	-74.28	68.86	-244.72	1.0654	3.7865	938.61	24850.87
24.50	235.15	-73.41	67.14	-225.36	1.2142	4.0757	823.56	26476.00
24.75	217.43	-72.30	66.10	-207.14	1.3981	4.3816	715.25	28175.69
25.00	201.59	-71.13	65.20	-190.76	1.6044	4.6938	623.28	29881.72
25.25	185.71	-69.38	65.41	-173.81	1.8966	5.0396	527.27	31765.57
25.50	170.33	-67.75	64.50	-157.64	2.2234	5.4338	449.76	33914.16
25.75	156.56	-65.77	64.25	-142.77	2.6212	5.8248	381.50	36002.06
26.00	144.37	-63.40	64.64	-129.09	3.1014	6.1934	322.44	37911.80
26.25	132.90	-60.87	64.69	-116.10	3.6623	6.5730	273.05	39852.36
26.50	121.81	-57.44	65.55	-102.66	4.4184	6.9195	226.33	41557.53
26.75	110.97	-53.51	65.99	-89.21	5.3593	7.2449	186.59	43104.84
27.00	101.20	-49.13	66.22	-76.52	6.4665	7.4720	154.64	44044.87
27.25	92.80	-44.37	66.34	-64.89	7.7036	7.5352	129.81	44009.45
27.50	85.33	-38.24	67.02	-52.82	9.2045	7.2539	108.64	41981.44
27.75	79.19	-30.93	67.93	-40.70	10.8331	6.4906	92.31	37225.58
28.00	74.25	-22.31	68.70	-28.19	12.4592	5.1122	80.26	29058.39
28.25	70.43	-12.43	68.78	-15.16	13.8667	3.0556	72.12	17214.55
28.50	68.54	-1.96	68.50	-2.34	14.5807	0.4984	68.58	2783.21
28.75	70.65	8.64	69.85	10.61	13.9929	-2.1260	71.46	-11769.17
29.00	77.72	18.19	73.84	24.26	12.2234	-4.0169	81.81	-22044.94
29.25	86.19	26.31	77.26	38.21	10.4000	-5.1428	96.15	-27982.85
29.50	95.54	33.21	79.94	52.33	8.7568	-5.7330	114.20	-30929.89
29.75	106.10	38.24	83.33	65.68	7.4024	-5.8343	135.09	-31211.80
30.00	117.91	42.16	87.41	79.13	6.2875	-5.6923	159.05	-30198.34
30.25	128.96	44.94	91.29	91.09	5.4892	-5.4773	182.18	-28817.71
30.50	143.75	47.36	97.37	105.75	4.7119	-5.1177	212.23	-26705.20
30.75	161.46	49.72	104.39	123.18	4.0041	-4.7250	249.74	-24455.40
31.00	176.65	51.63	109.67	138.49	3.5142	-4.4379	284.56	-22784.16
31.25	193.34	53.07	116.17	154.55	3.1077	-4.1344	321.79	-21056.39
31.50	210.09	53.76	124.20	169.45	2.8138	-3.8390	355.39	-19396.76
31.75	230.50	53.95	135.65	186.35	2.5533	-3.5076	391.66	-17582.83
32.00	252.83	54.30	147.52	205.33	2.3078	-3.2122	433.31	-15975.98
32.25	276.94	54.68	160.10	225.98	2.0874	-2.9463	479.07	-14540.31
32.50	299.42	55.35	170.25	246.30	1.8991	-2.7473	526.58	-13453.98

28 kHz-F

Transformed to 60 ohms

Power rating: 2.2 kW$_{rms}$ @ 2% duty cycle

16 x 36.5 mm (1.44") PZT/L

Active Area: 168 cm^2

Urethane Window

Beamwidth:

-3 dB: 12° x 27°

-6 dB: 17° x 37°

-10 dB: 21° x 47°

Directivity Index:	19.9
Frequency Tolerance:	±1.4 kHz
Peak TVR[1], nominal:	167 dB
Peak TVR[1], minimum:	164 dB
Q (transmit):	10
Peak Source Level[4]:	218 dB
Peak RVR[2], nominal:	-168 dB
Peak Figure of Merit[3]:	-9 dB

Notes:

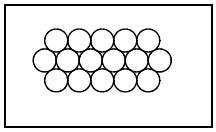
(1) dB re 1 µPa per volt at 1 meter

(2) dB re 1 volt per µPa

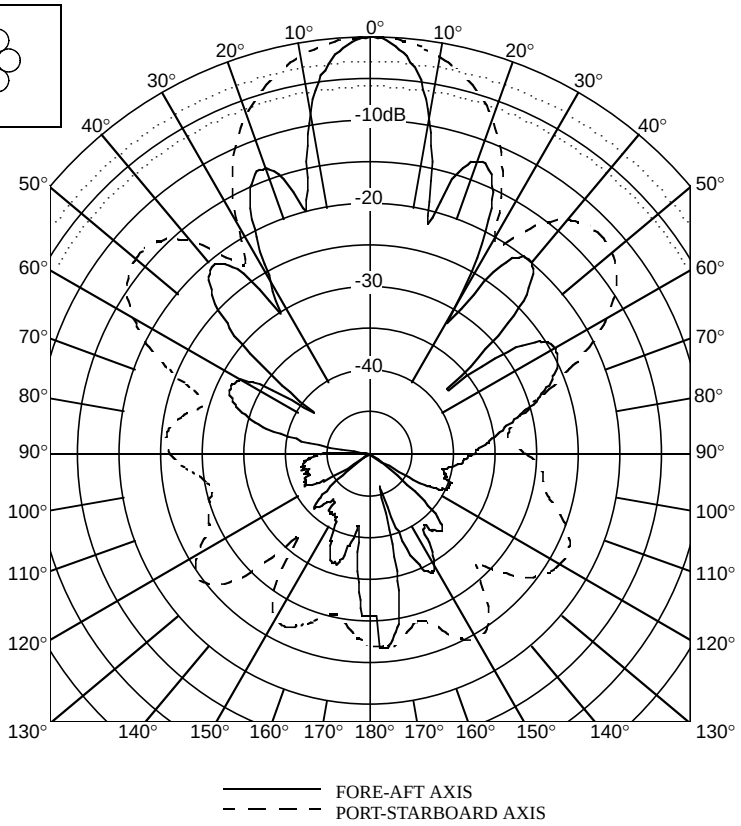
(3) sum of transmitting voltage response and receiving voltage response

(4) Nominal peak TVR, rated power, and no cavitation

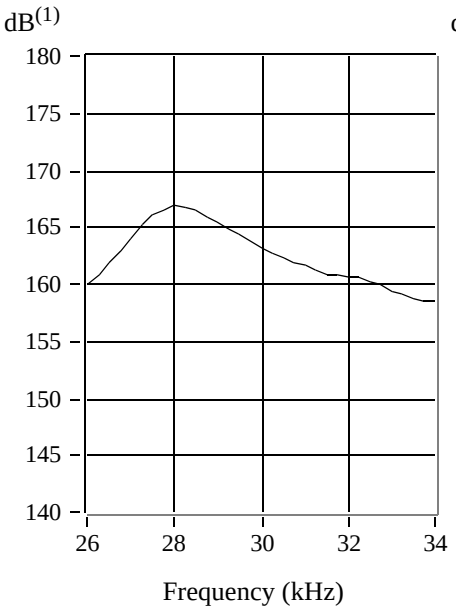
Array:



Transmit Radiation Pattern



TVR



RVR

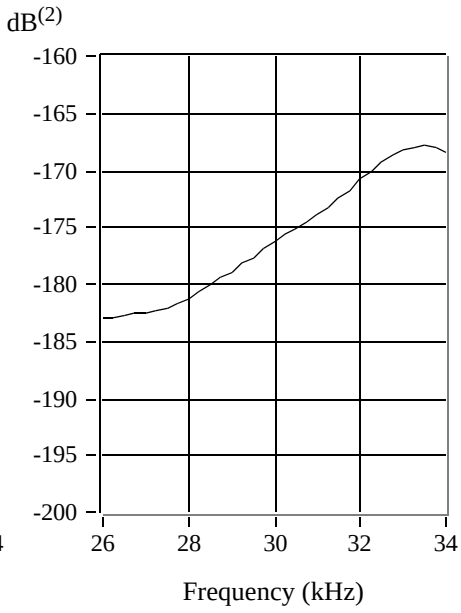
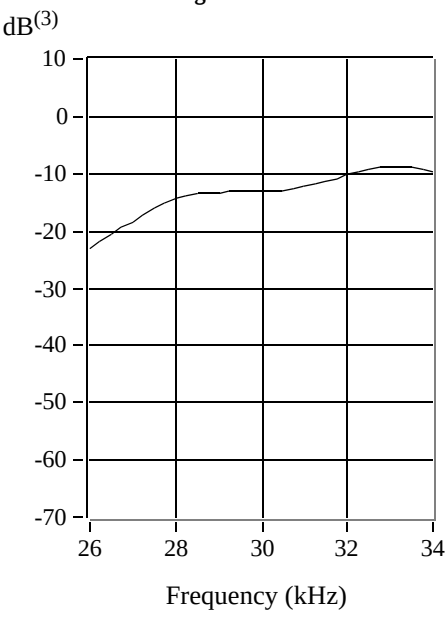


Figure of Merit

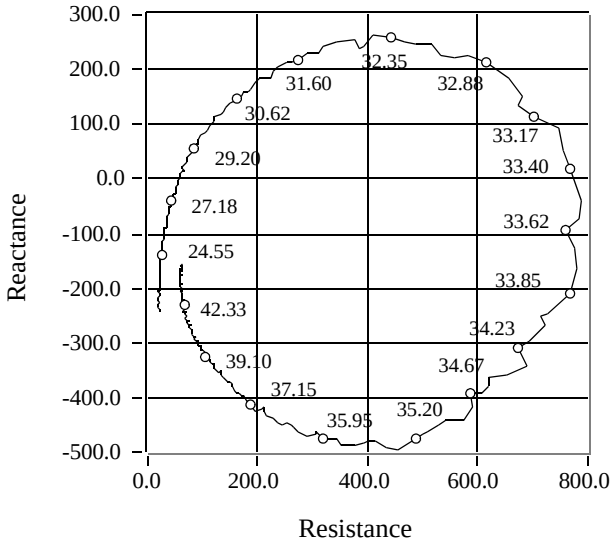


28 kHz-F

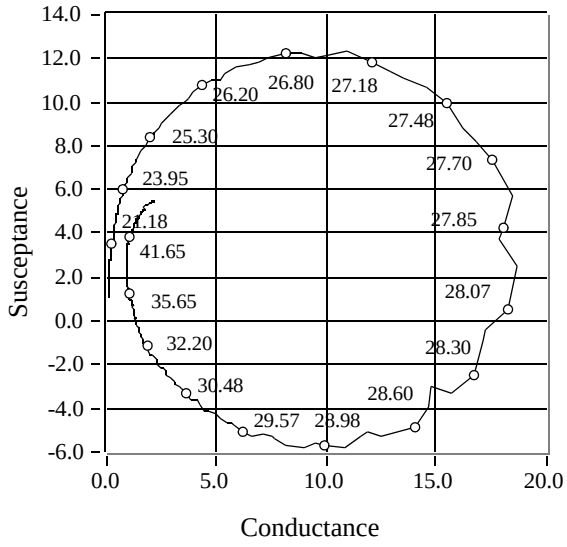
6x36.5mm (1.44") PZT/L
Cable Type: C43
Cable Length: 15.2m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 ohms -20%, +40%	60 ohms -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	60 – j0 ohms	60 – j0 ohms
1 kHz Capacitance	n/a	n/a

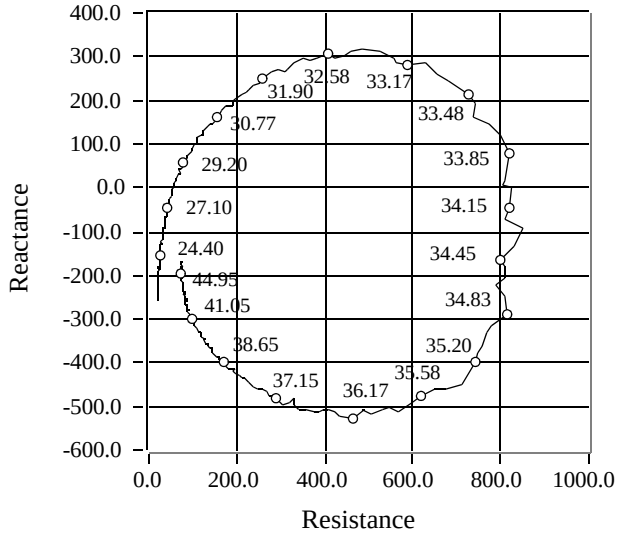
Unbalanced Impedance



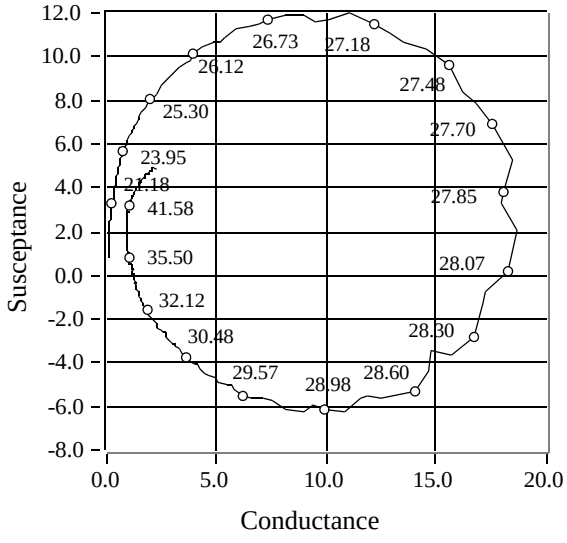
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



28 kHz-F

Transformed to 250 ohms

Power rating: 2.2 kWrms @ 2% duty cycle

16 x 36.5 mm (1.44") PZT/L

Active Area: 168 cm^2

Urethane Window

Beamwidth:

-3 dB: 12° x 27°

-6 dB: 17° x 37°

-10 dB: 21° x 47°

Directivity Index:	19.9
Frequency Tolerance:	±1.4 kHz
Peak TVR (1), nominal:	161 dB
Peak TVR (1), minimum:	159 dB
Q (transmit):	10
Peak Source Level (4):	218 dB
RVR (2), nominal:	-161 dB
Peak Figure of Merit (3):	-10 dB

Notes:

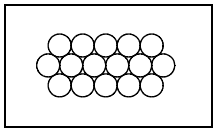
(1) dB re 1 µPa per volt at 1 meter

(2) dB re 1 volt per µPa

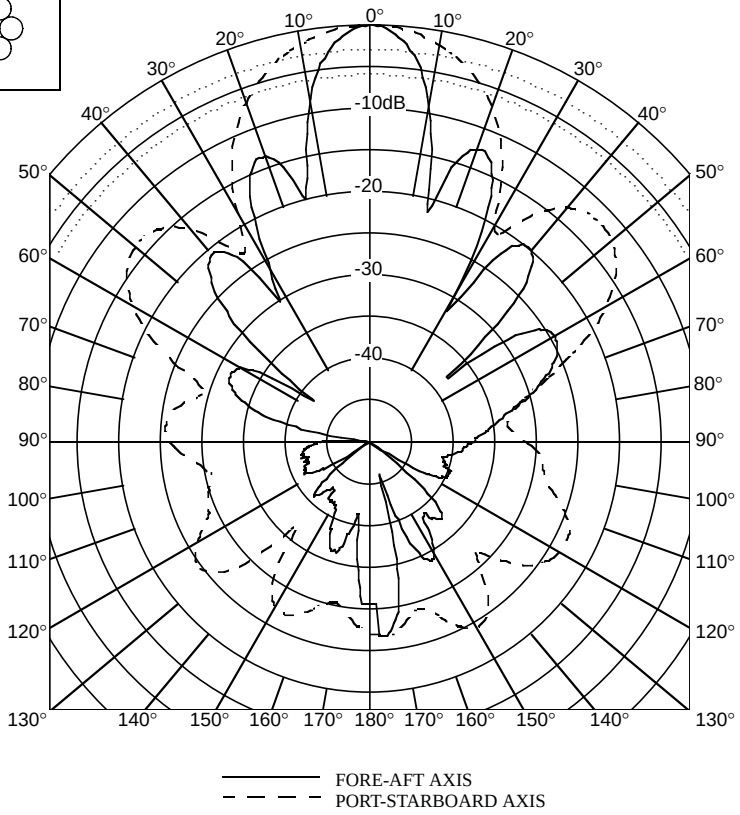
(3) sum of transmitting voltage response and receiving voltage response

(4) Nominal peak TVR, rated power, and no cavitation

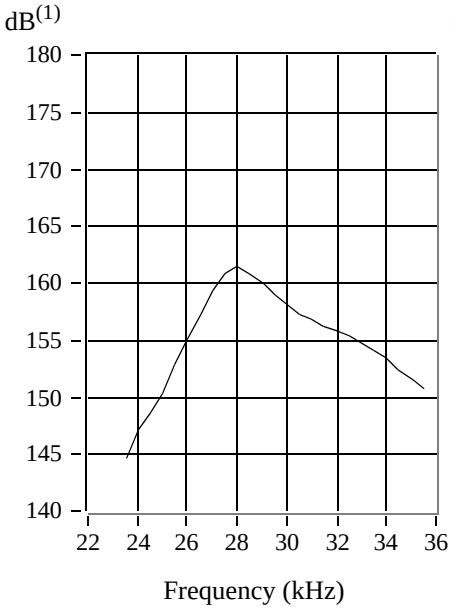
Array:



Transmit Radiation Pattern



TVR



RVR

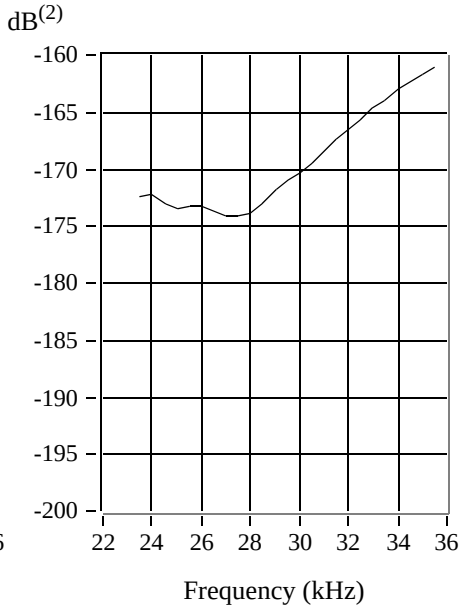
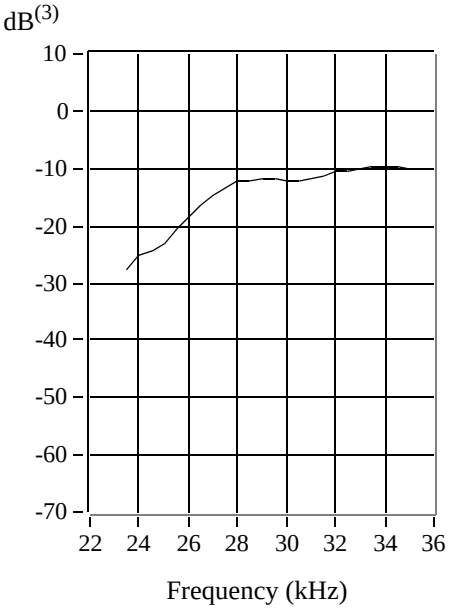


Figure of Merit



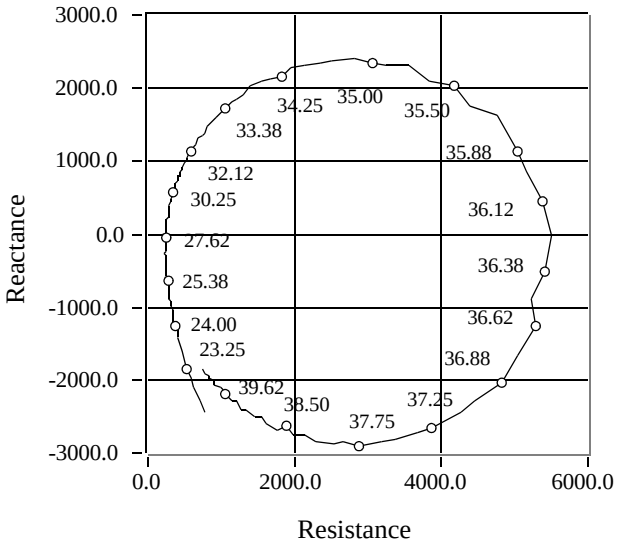
28 kHz-F

16x36.5mm (1.44") PZT/L

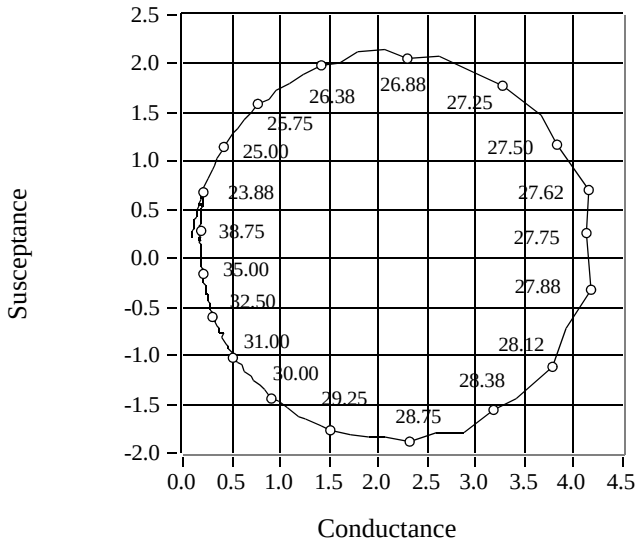
Cable Type: C43
Cable Length: 15.2 m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	250 ohms -20%, +40%	250 ohms -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	250 – j0 ohms	250 – j0 ohms
1 kHz Capacitance	n/a	n/a

Balanced Impedance

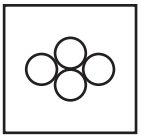


Balanced Admittance



28 kHz-G

Array

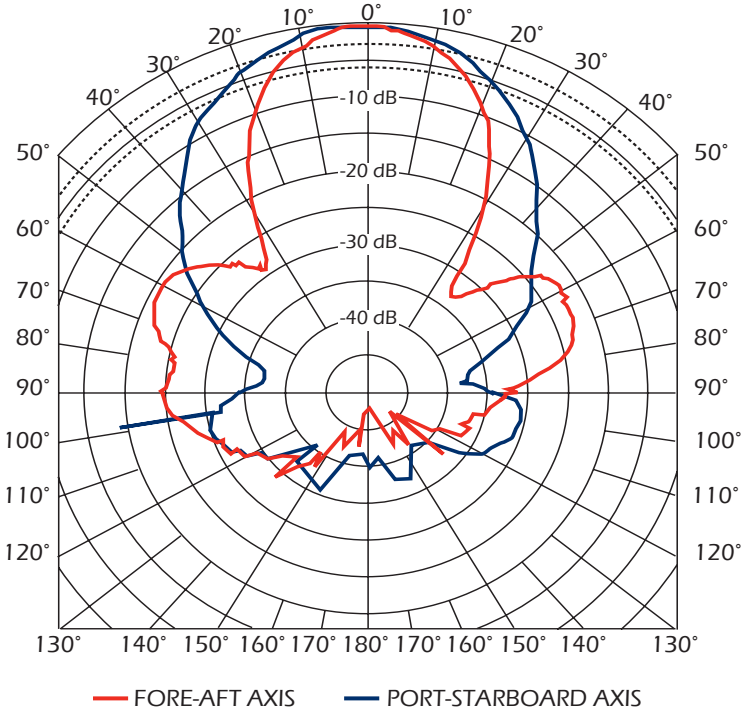


Transformed to 60 ohms
Power Rating: 1 kW rms @ 2% duty cycle
4 x 44 mm (1.75") PZT/L
Active Area: 62 cm²
Urethane Window

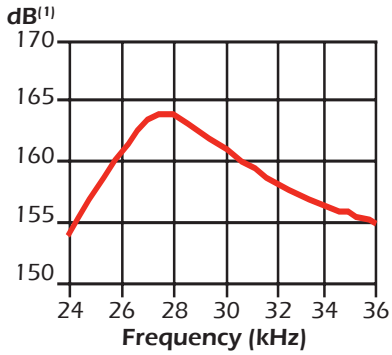
Beamwidth:
-3 dB: 23° x 32°
-6 dB: 33° x 47°
-10 dB: 42° x 62°

Directivity Index:	15.4
Frequency Tolerance:	± 1.4 kHz
Peak TVR(1), nominal:	164 dB
Peak TVR(1), minimum:	162 dB
Q (transmit):	8
Peak Source Level(4):	212 dB
Peak RVR(2), nominal:	-180 dB
Peak Figure of Merit(3):	-20 dB

Transmit Radiation Pattern



TVR



RVR

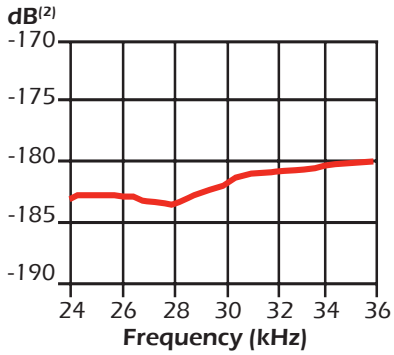
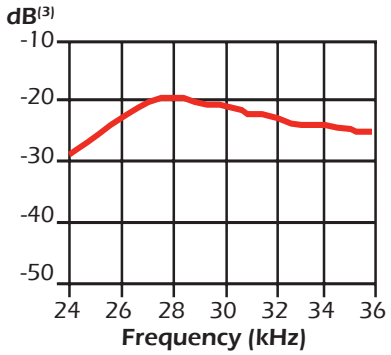


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

28 kHz-G

4 x 44 mm (1.75”) PZT/L

Cable Type: C37
Cable Length: 10.1 m (33’)

Note:
Impedance data includes cable

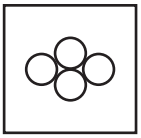
Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	60 Ω - j0 Ω	60 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
24.00	172.92	-47.55	116.71	-127.59	3.9032	4.2671	256.20	28297.12
24.50	143.96	-47.92	96.47	-106.85	4.6550	5.1558	214.82	33492.71
25.00	119.57	-45.77	83.41	-85.68	5.8336	5.9926	171.42	38150.25
25.50	99.46	-41.66	74.31	-66.11	7.5117	6.6825	133.12	41707.82
26.00	84.75	-35.24	69.22	-48.90	9.6368	6.8080	103.77	41674.26
26.50	74.20	-27.18	66.01	-33.89	11.9893	6.1555	83.41	36969.11
27.00	64.27	-18.31	61.01	-20.19	14.7721	4.8885	67.70	28815.86
27.50	57.65	-4.09	57.50	-4.11	17.3027	1.2373	57.59	7160.82
28.00	58.21	12.81	56.76	12.91	16.7519	-3.8101	59.69	-21657.26
28.50	66.55	26.36	59.63	29.55	13.4642	-6.6725	74.27	-37261.76
29.00	78.02	35.09	63.84	44.85	10.4880	-7.3673	95.35	-40432.47
29.50	90.55	39.99	69.38	58.19	8.4611	-7.0972	118.19	-38289.72
30.00	105.70	42.45	77.99	71.35	6.9804	-6.3859	143.26	-33878.16
30.50	119.35	44.55	85.05	83.74	5.9703	-5.8782	167.49	-30673.62
31.00	134.54	45.14	94.91	95.36	5.2434	-5.2682	190.72	-27047.16
31.50	152.16	45.33	106.96	108.22	4.6201	-4.6743	216.45	-23617.11
32.00	167.41	44.42	119.58	117.16	4.2667	-4.1805	234.37	-20791.93
32.50	184.62	43.08	134.86	126.10	3.9563	-3.6993	252.76	-18115.78
33.00	202.53	41.35	152.05	133.79	3.7067	-3.2617	269.78	-15730.67
33.50	218.78	39.08	169.84	137.91	3.5484	-2.8813	281.81	-13688.53
34.00	237.16	37.10	189.15	143.07	3.3629	-2.5437	297.37	-11907.03
34.50	253.35	34.49	208.83	143.45	3.2534	-2.2349	307.37	-10310.01
35.00	270.01	31.48	230.27	141.02	3.1583	-1.9342	316.63	-8795.24
35.50	287.62	28.66	252.39	137.93	3.0509	-1.6674	327.77	-7475.33
36.00	301.82	25.16	273.19	128.32	2.9988	-1.4086	333.46	-6227.54

28 kHz-G

Array

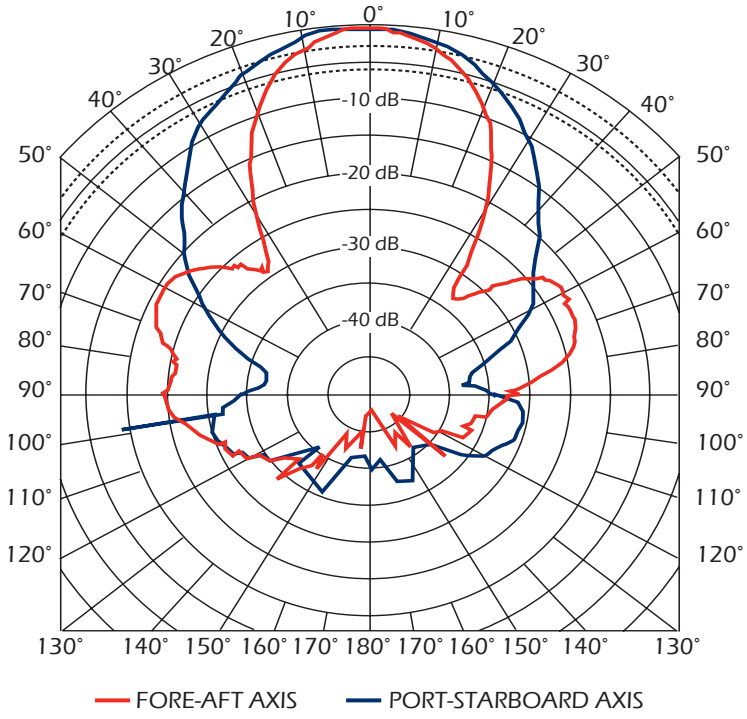


Transformed to 150 ohms
Power Rating: 1 kW rms @ 2% duty cycle
4 x 44 mm (1.75") PZT/L
Active Area: 62 cm²
Urethane Window

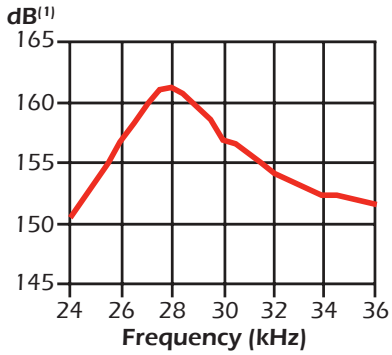
Beamwidth:
-3 dB: 23° x 32°
-6 dB: 33° x 47°
-10 dB: 42° x 62°

Directivity Index:	15.4
Frequency Tolerance:	± 1.4 kHz
Peak TVR(1), nominal:	161 dB
Peak TVR(1), minimum:	159 dB
Q (transmit):	10
Peak Source Level(4):	213 dB
Peak RVR(2), nominal:	-175 dB
Peak Figure of Merit(3):	-17 dB

Transmit Radiation Pattern



TVR



RVR

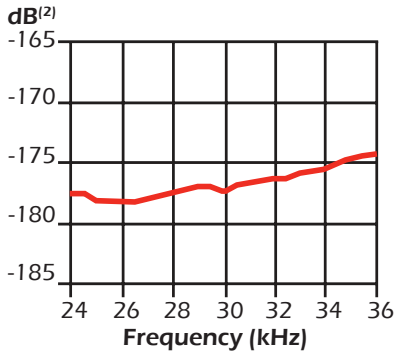
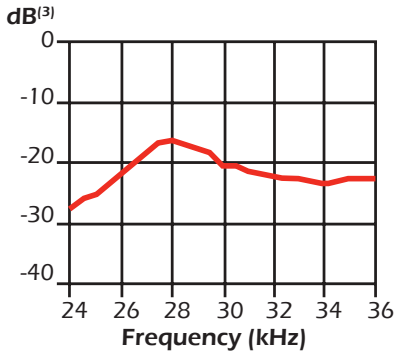


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

28 kHz-G

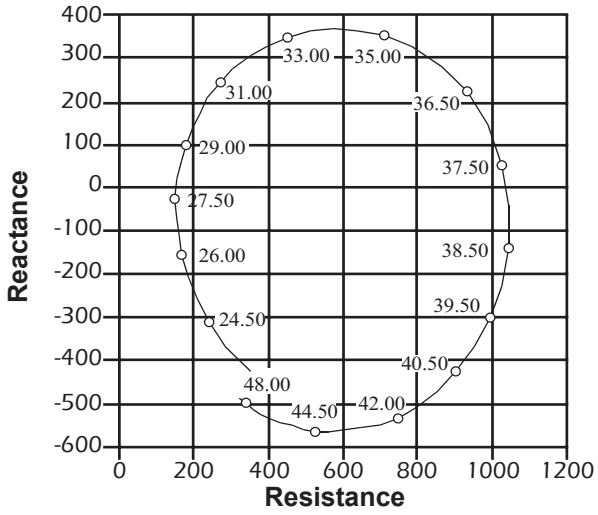
4 x 44 mm (1.75”) PZT/L

Cable Type: C37
Cable Length: 10.4 m (34’)

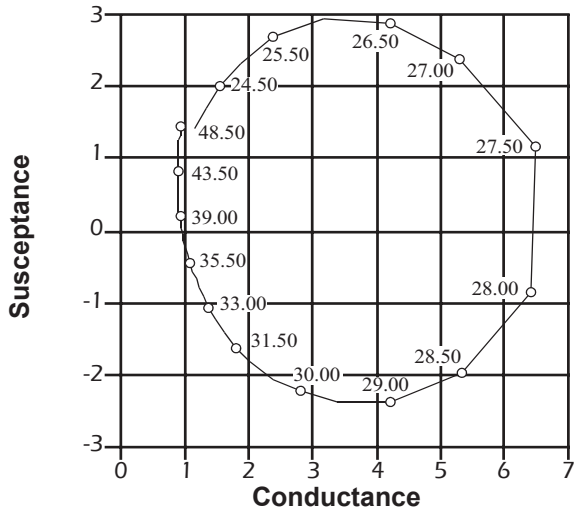
Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	150 Ω: -20%, +40%	150 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	150 Ω - j0 Ω	150 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

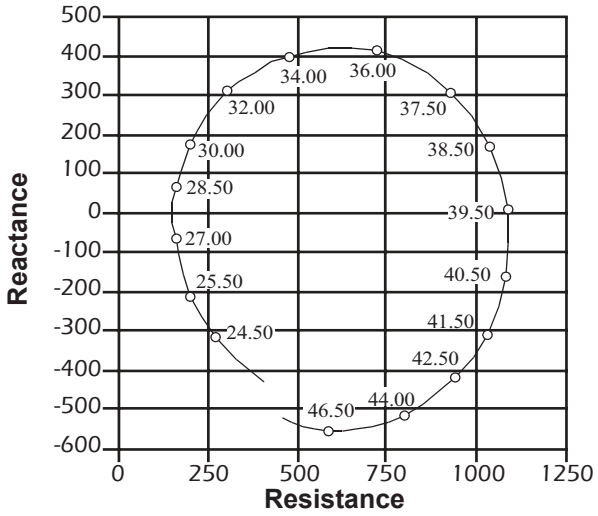
Unbalanced Impedance



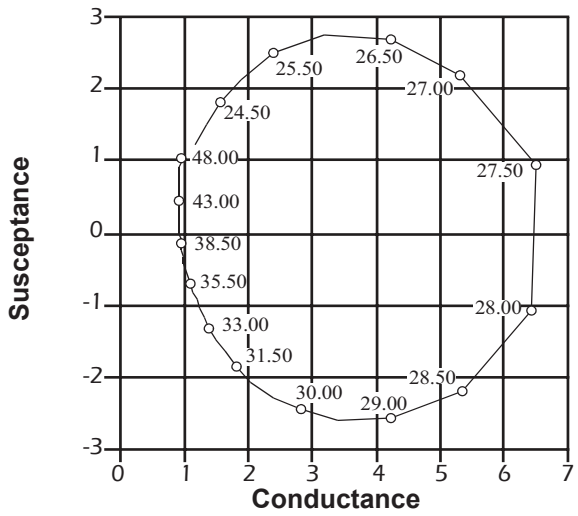
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



28 kHz-N

Transformed to 120 ohms

Power rating: 1.5 kWrms @ 2% duty cycle

7x44mm (1.75") PZT/L

Active Area: 109cm²

Urethane Window

Beamwidth:

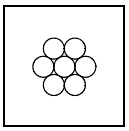
-3dB: 24°
-6dB: 33°
-10dB: 42°

Directivity Index:	17.9
Frequency Tolerance:	±1.4kHz
Peak TVR(1), nominal:	162dB
Peak TVR(1), minimum:	160dB
Q (transmit):	9
Peak Source Level(4):	215dB
Peak RVR(2), nominal:	-167dB
Peak Figure of Merit(3):	-13dB

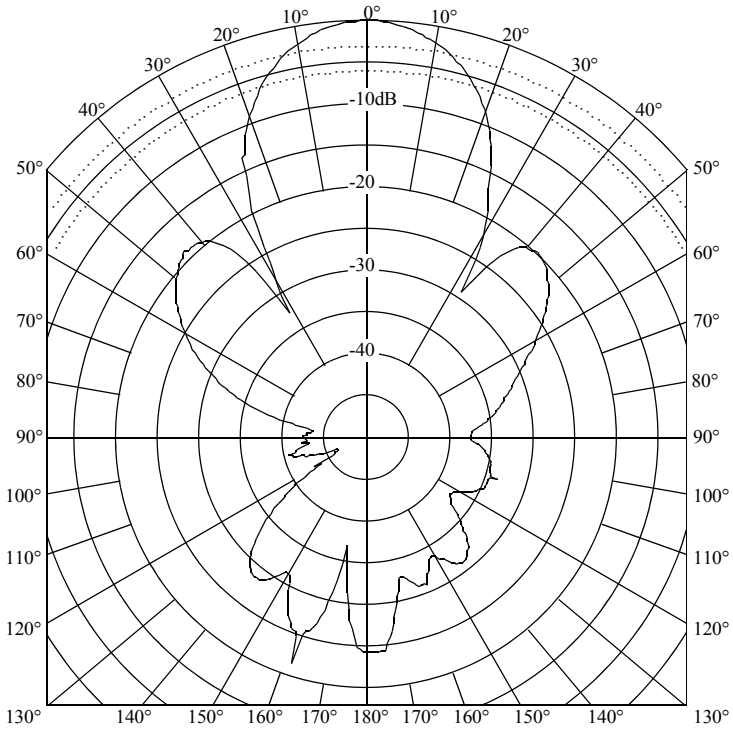
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

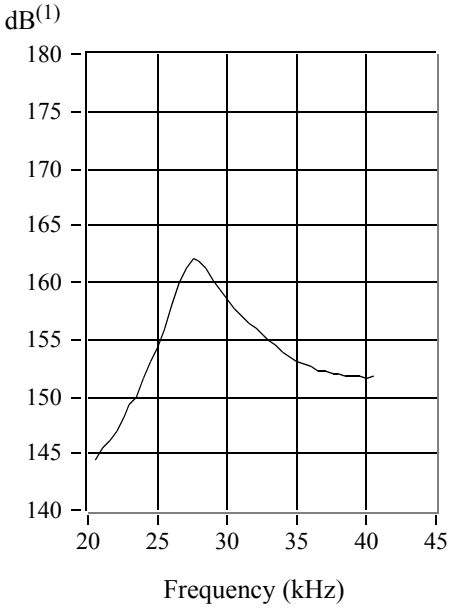
Array:



Transmit Radiation Pattern



TVR



RVR

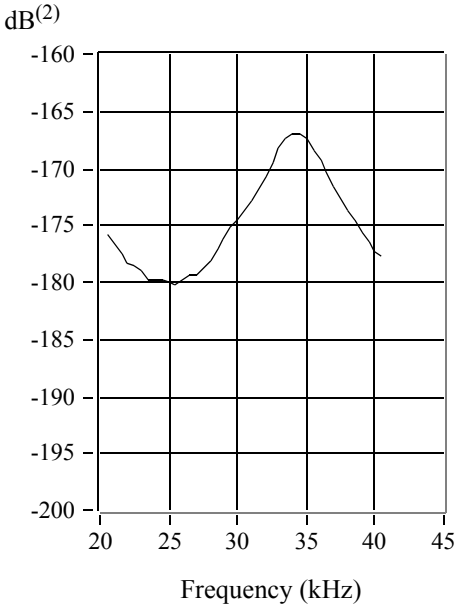
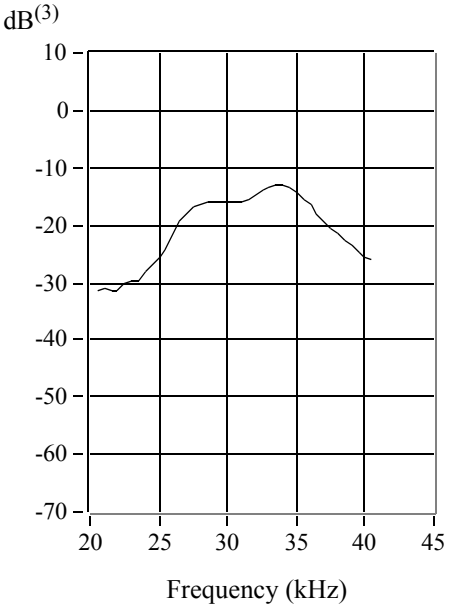


Figure of Merit



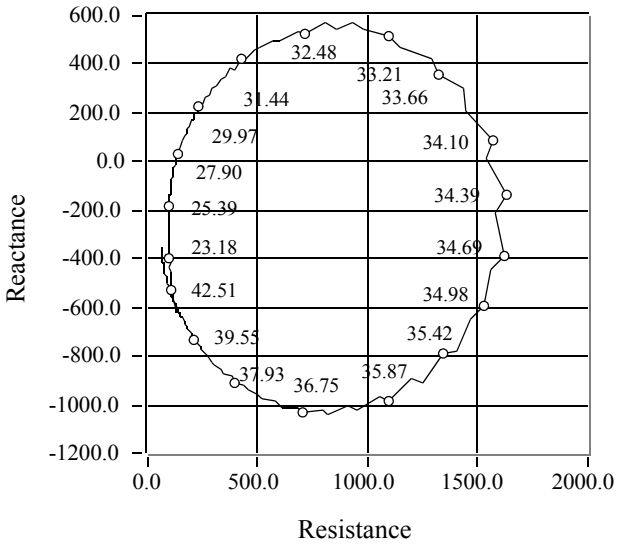
28 kHz-N

7x44mm (1.75") PZT/L

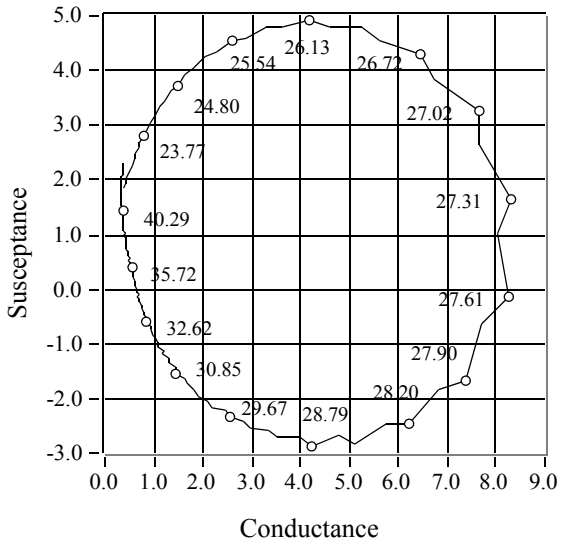
Cable Type: C43
Cable Length: 25.3 m (83.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	120 ohms -20%, +40%	120 ohms -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	120 – j0 ohms	120 – j0 ohms
1 kHz Capacitance	n/a	n/a

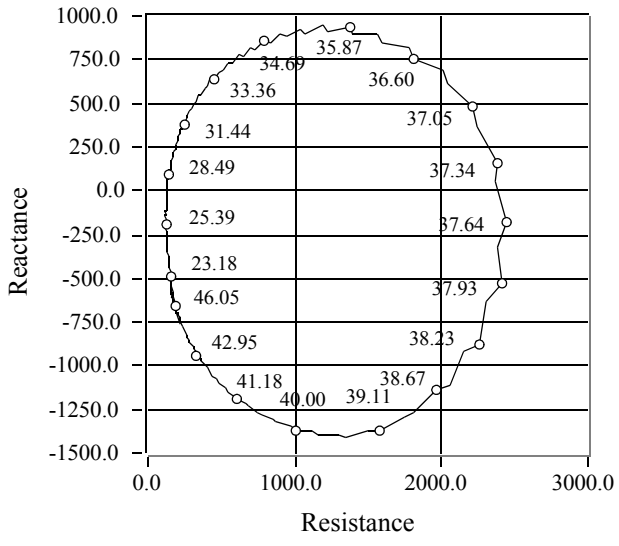
Unbalanced Impedance



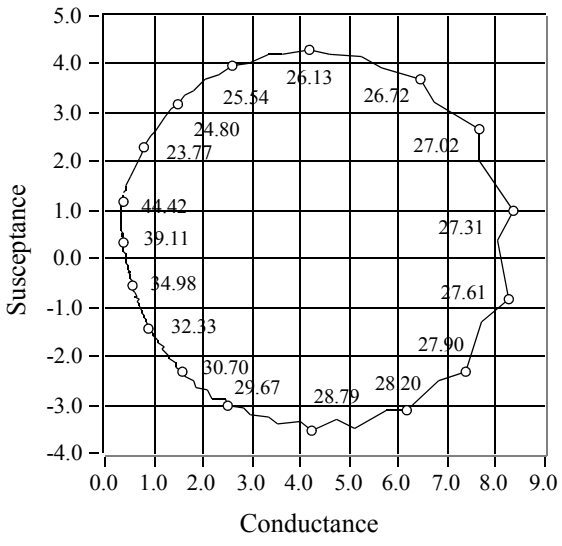
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



28 kHz-R

Transformed to 60 ohms

Power rating: 2 kWrms @ 2% duty cycle
7x51mm (2.0") PZT/L
Active Area: 140cm²
Urethane Window

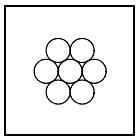
Beamwidth:

-3dB:	18°
-6dB:	26°
-10dB:	33°

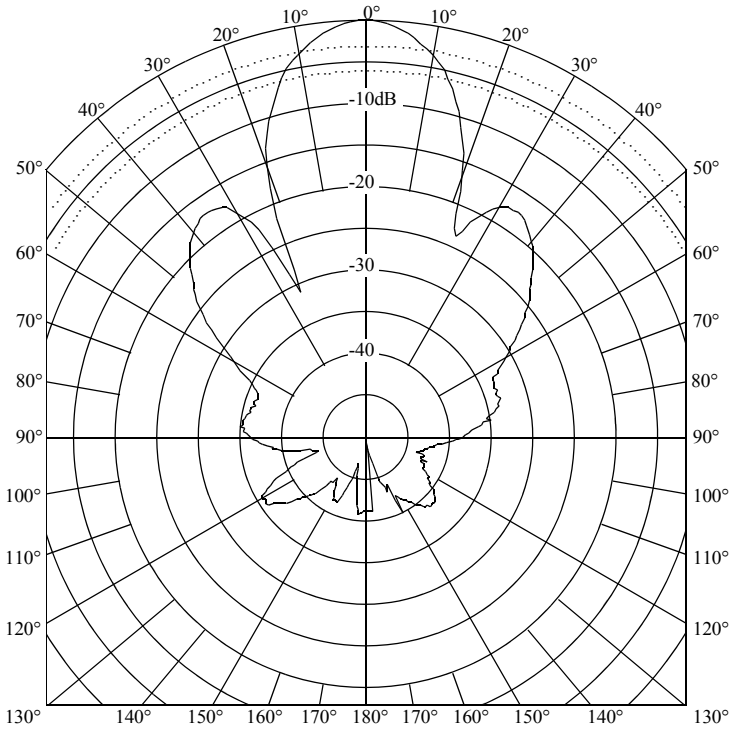
Directivity Index:	18.8
Frequency Tolerance:	±1.4kHz
Peak TVR (1), nominal:	167dB
Peak TVR (1), minimum:	165dB
Q (transmit):	7
Peak Source Level (4):	218dB
Peak RVR (2), nominal:	-170dB
Peak Figure of Merit (3):	-10dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

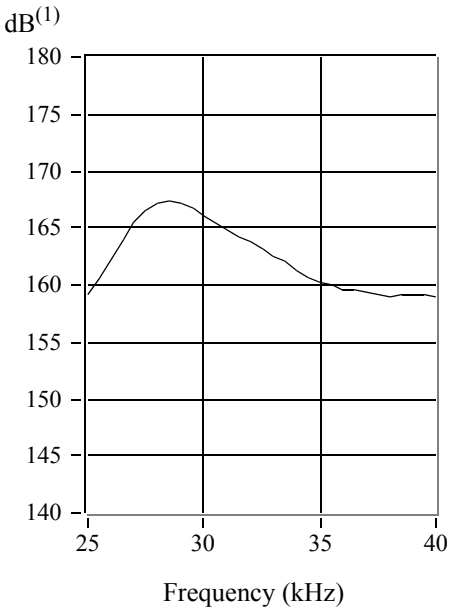
Array:



Transmit Radiation Pattern



TVR



RVR

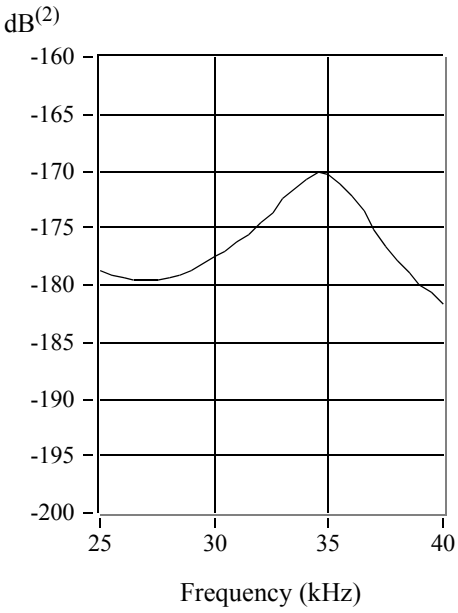
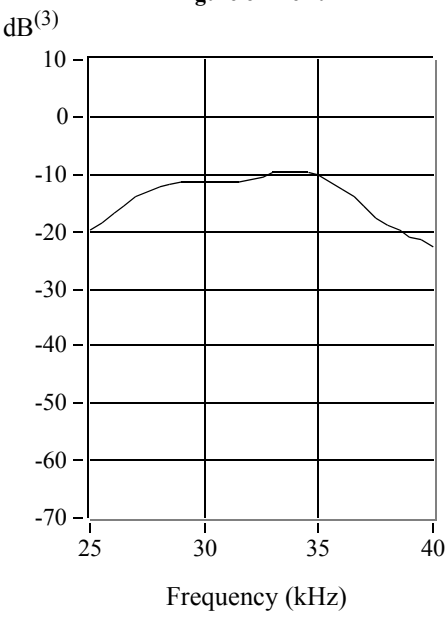


Figure of Merit



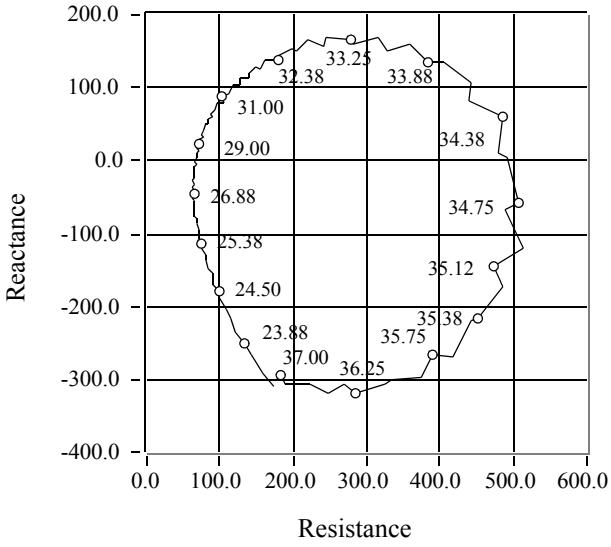
28 kHz-R

7x51mm (2.0") PZT/L

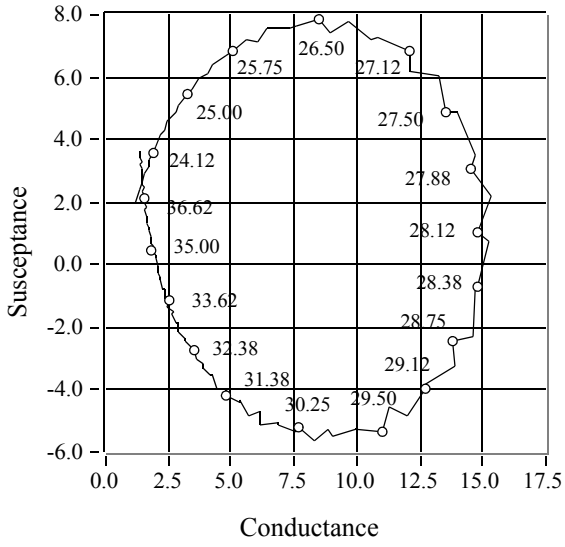
Cable Type: C43
Cable Length: 25.3m (83.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60ohms -20%,+40%	60ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	60 – j0ohms	60 – j0ohms
1 kHz Capacitance	n/a	n/a

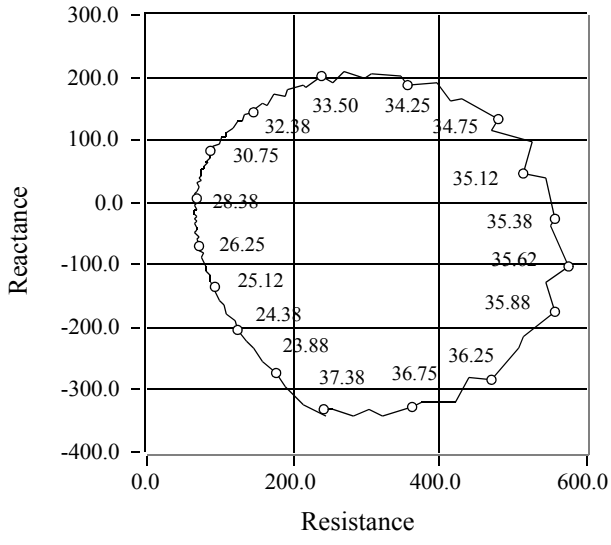
Unbalanced Impedance



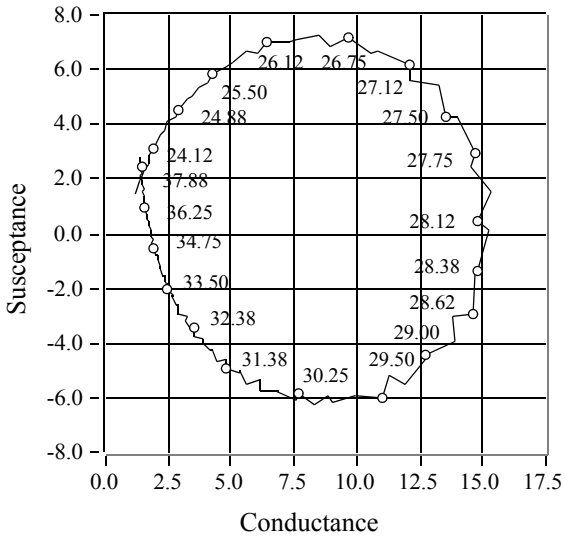
Unbalanced Admittance



Balanced Impedance

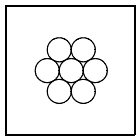


Balanced Admittance



28 kHz-R

Array:



Transformed to 120 ohms

Power rating: 2 kW rms @ 2% duty cycle

7 x 51 mm (2.0") PZT/L

Active Area: 140 cm²

Urethane Window

Beamwidth:

-3 dB:	18°
-6 dB:	26°
-10 dB:	33°

Directivity Index:	18.8
Frequency Tolerance:	±1.4 kHz
Peak TVR (1), nominal:	165 dB
Peak TVR (1), minimum:	163 dB
Q (transmit):	7
Peak Source Level (4):	219 dB
Peak RVR (2), nominal:	-168 dB
Peak Figure of Merit (3):	-9 dB

Notes:

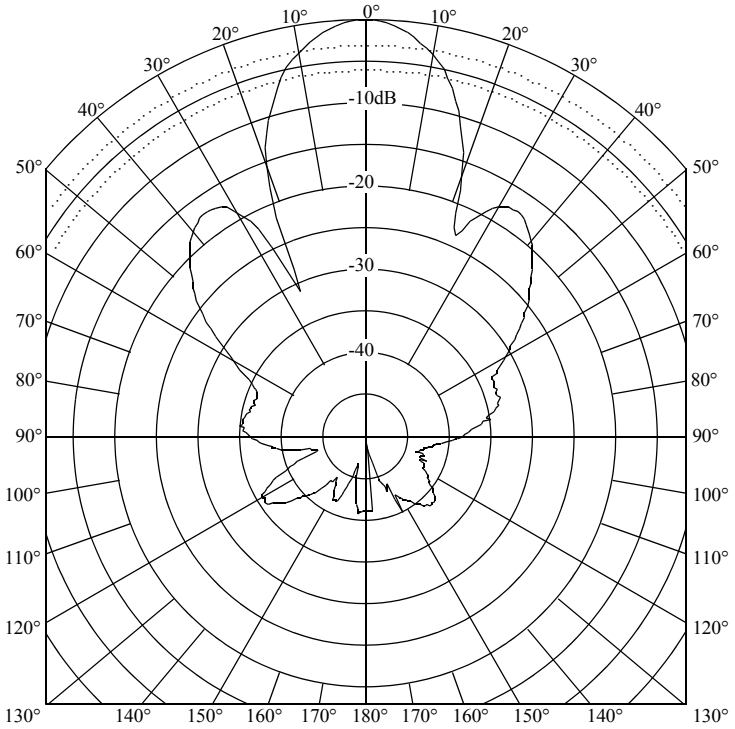
(1) dB re 1 µPa per volt at 1 meter

(2) dB re 1 volt per µPa

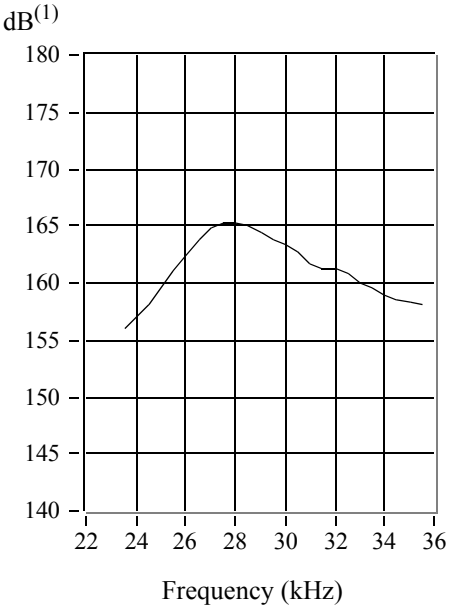
(3) sum of transmitting voltage response and receiving voltage response

(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

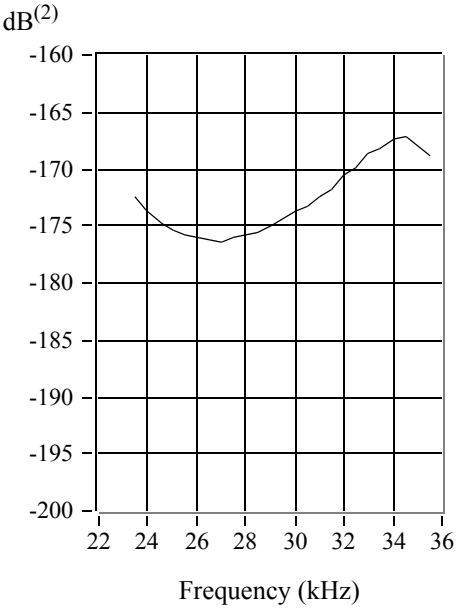
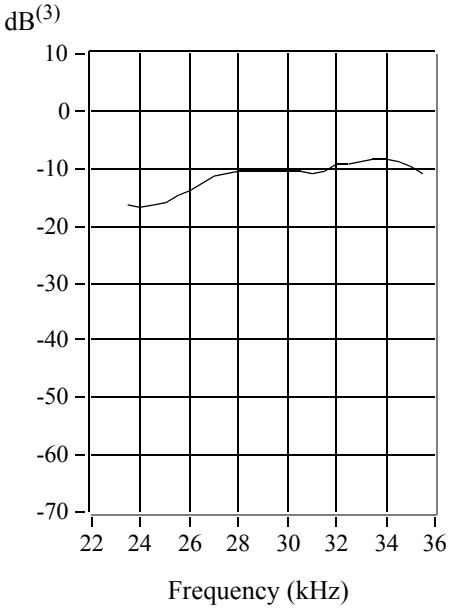


Figure of Merit



28 kHz-R

7x51mm (2.0") PZT/L

Cable Type: C44
Cable Length: 15.2m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	120ohms-20%,+40%	120ohms-20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	120 – j0ohms	120 – j0ohms
1 kHz Capacitance	n/a	n/a

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (ohms)	Phase Angle (°)	Series Resistance (ohms)	Series Reactance (ohms)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (ohms)	Parallel Capacitance (pF)
24.00	554.76	-47.16	377.24	-406.76	1.2258	1.3217	815.82	8764.50
24.50	411.01	-49.13	268.95	-310.79	1.5921	1.8398	628.09	11951.57
25.00	312.32	-48.47	207.06	-233.81	2.1228	2.3970	471.07	15259.87
25.50	254.09	-44.45	181.37	-177.95	2.8093	2.7563	355.97	17203.04
26.00	199.07	-40.86	150.56	-130.23	3.7994	3.2863	263.20	20116.85
26.50	166.43	-35.32	135.79	-96.23	4.9022	3.4741	203.99	20865.20
27.00	141.57	-24.27	129.06	-58.18	6.4396	2.9032	155.29	17113.02
27.50	122.89	-12.28	120.08	-26.13	7.9510	1.7305	125.77	10014.98
28.00	120.67	0.45	120.67	0.94	8.2865	-0.0645	120.68	-366.87
28.50	126.19	14.94	121.92	32.53	7.6570	-2.0428	130.60	-11407.89
29.00	132.18	25.57	119.23	57.05	6.8246	-3.2655	146.53	-17921.62
29.50	150.63	31.58	128.31	78.89	5.6555	-3.4771	176.82	-18759.45
30.00	173.88	37.64	137.69	106.18	4.5544	-3.5121	219.57	-18632.18
30.50	195.27	43.93	140.63	135.48	3.6881	-3.5530	271.15	-18540.02
31.00	224.35	45.04	158.53	158.75	3.1496	-3.1539	317.50	-16192.21
31.50	268.10	47.69	180.46	198.28	2.5106	-2.7585	398.31	-13937.18
32.00	302.20	49.83	194.95	230.91	2.1347	-2.5284	468.46	-12575.20
32.50	345.83	47.72	232.67	255.85	1.9455	-2.1393	514.02	-10476.45
33.00	418.33	47.08	284.90	306.32	1.6280	-1.7504	614.25	-8442.02
33.50	487.96	43.80	352.17	337.77	1.4790	-1.4185	676.12	-6739.34
34.00	552.89	41.38	414.85	365.49	1.3571	-1.1956	736.85	-5596.79
34.50	679.22	35.10	555.69	390.57	1.2045	-0.8466	830.20	-3905.55
35.00	795.83	28.99	696.11	385.71	1.0991	-0.6090	909.83	-2769.35
35.50	888.12	15.81	854.53	241.94	1.0834	-0.3067	923.03	-1375.16
36.00	1010.80	0.67	1010.73	11.81	0.9892	-0.0116	1010.87	-51.12

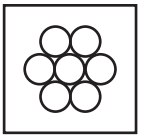
30 kHz-D

Transformed to 70 ohms
Power Rating: 600 W rms @ 2% duty cycle
7 x 35 mm (1.38") PZT/L
Active Area: 67 cm²
Urethane Window

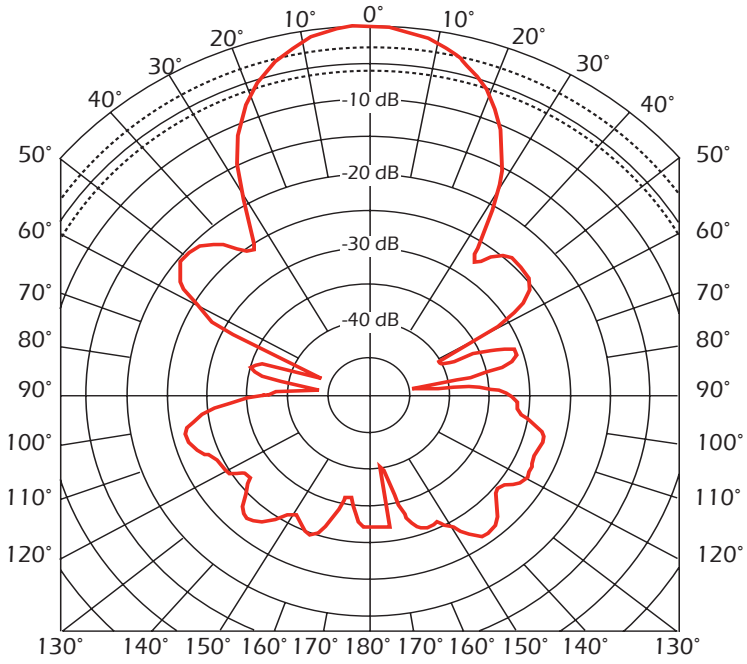
Beamwidth:
-3 dB: 26°
-6 dB: 37°
-10 dB: 46°

Directivity Index:	16.6
Frequency Tolerance:	± 1.5 kHz
Peak TVR(1), nominal:	164 dB
Peak TVR(1), minimum:	162 dB
Q (transmit):	7
Peak Source Level(4):	210 dB
Peak RVR(2), nominal:	-172 dB
Peak Figure of Merit(3):	-15 dB

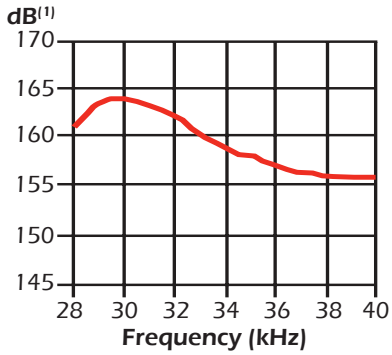
Array



Transmit Radiation Pattern



TVR



RVR

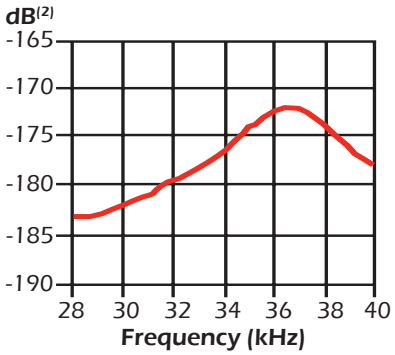
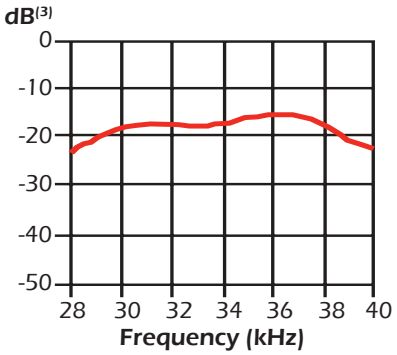


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

30 kHz-D

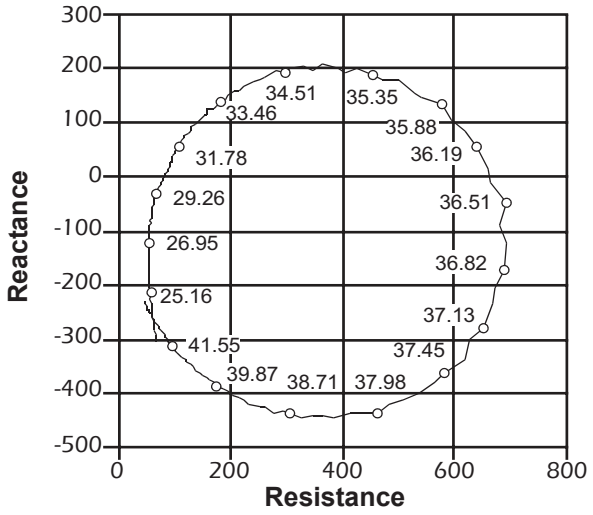
7 x 35 mm (1.38”) PZT/L

Cable Type: C44
Cable Length: 10.4 m (34’)

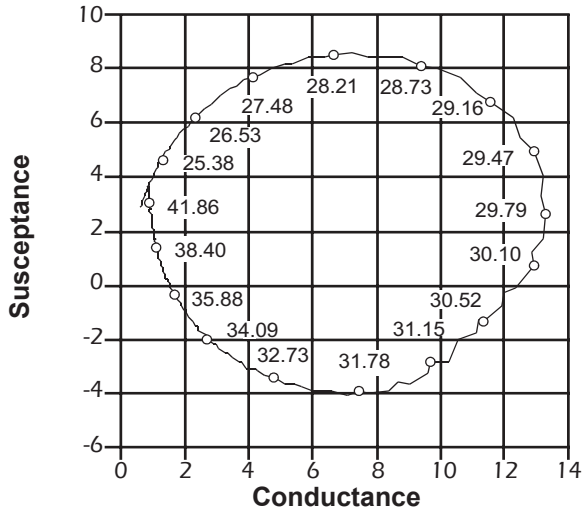
Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70 Ω: -20%, +40%	70 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	70 Ω - j0 Ω	70 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

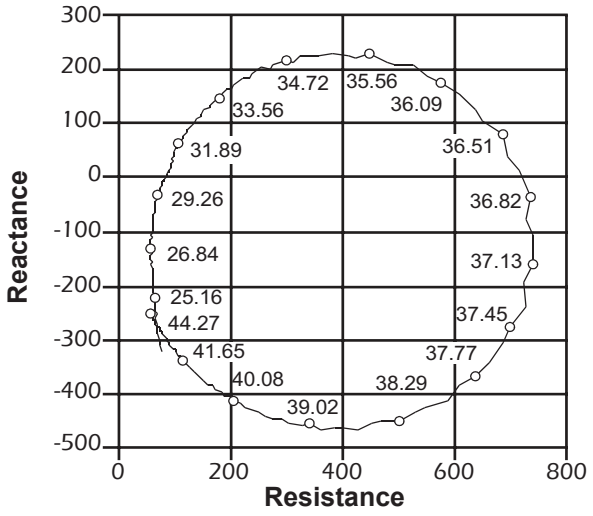
Unbalanced Impedance



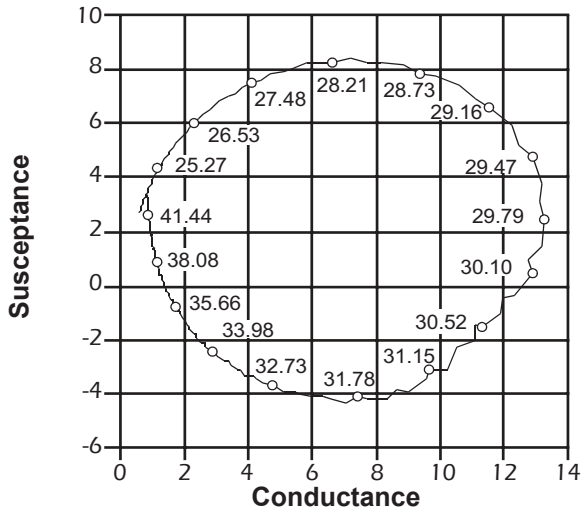
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



33 kHz-D

Transformed to 70 ohms

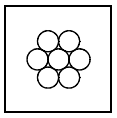
Power rating: 1 kWrms @ 2% duty cycle
7x44mm (1.75") PZT/L
Active Area: 109cm²
Urethane Window

Beamwidth:
-3dB: 19°
-6dB: 26°
-10dB: 32°

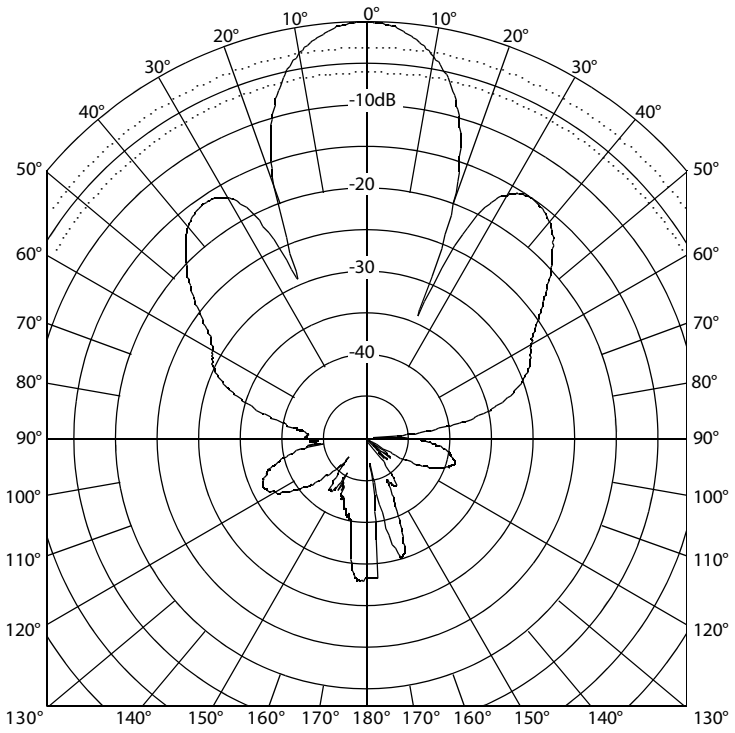
Directivity Index:	19.0
Frequency Tolerance:	±1.7kHz
Peak TVR(1), nominal:	167dB
Peak TVR(1), minimum:	164dB
Q (transmit):	7
Peak Source Level(4):	216dB
Peak RVR(2), nominal:	-173dB
Peak Figure of Merit(3):	-13dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

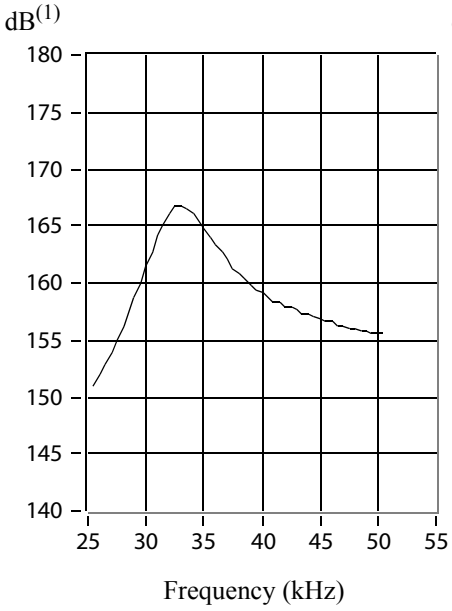
Array:



Transmit Radiation Pattern



TVR



RVR

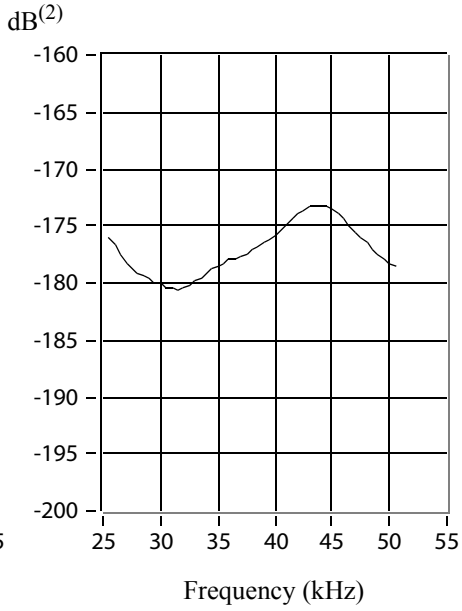
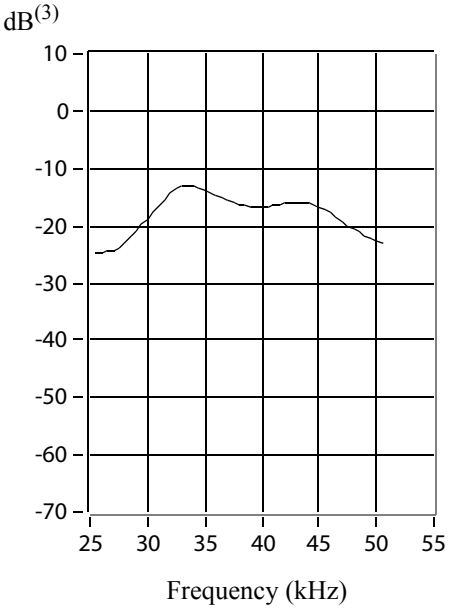


Figure of Merit



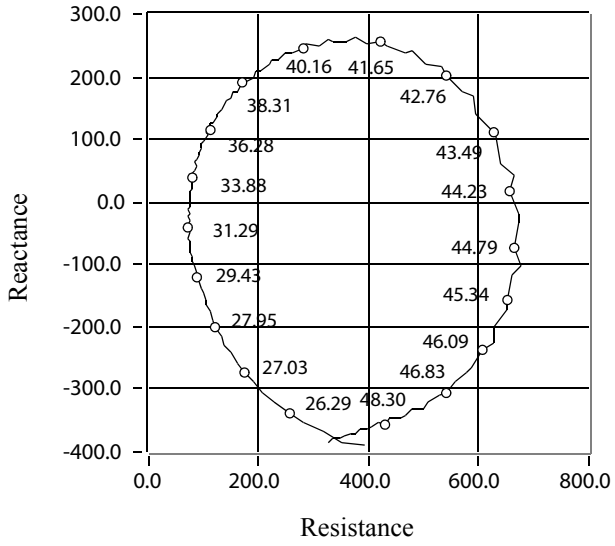
33 kHz-D

7x44mm (1.75") PZT/L

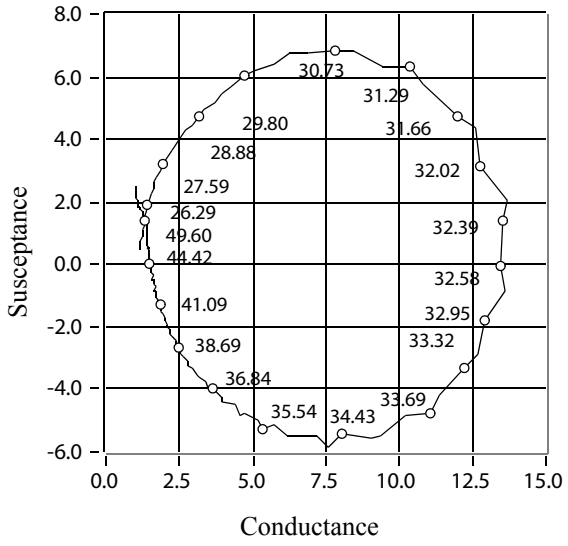
Cable Type: C44
Cable Length: 25.6m (84.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70ohms -20%,+40%	70ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	70 – j0 ohms	70 – j0 ohms
1 kHz Capacitance	n/a	n/a

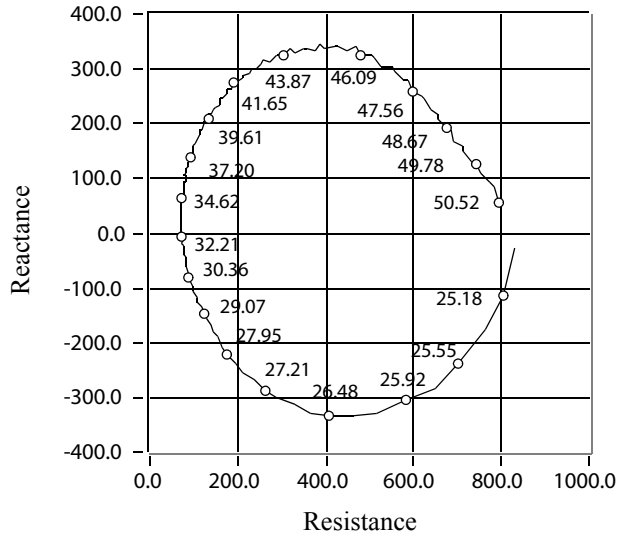
Unbalanced Impedance



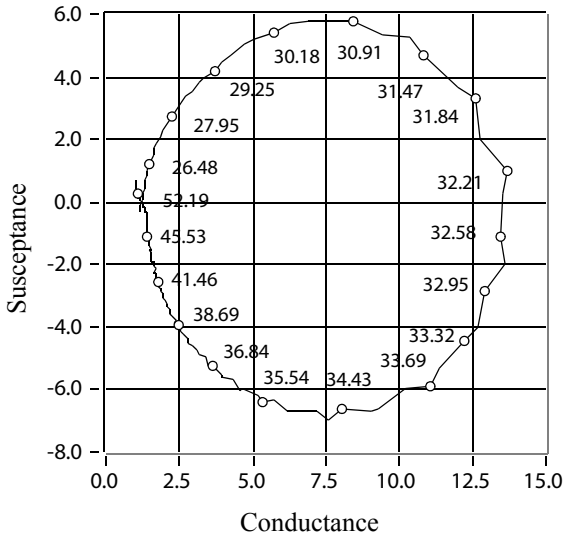
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



33 kHz-D

Array:

Transformed to 125 ohms

Power rating: 1 kWrms @ 2% duty cycle
7x44mm (1.75") PZT/L
Active Area: 109cm²
Urethane Window

Beamwidth:

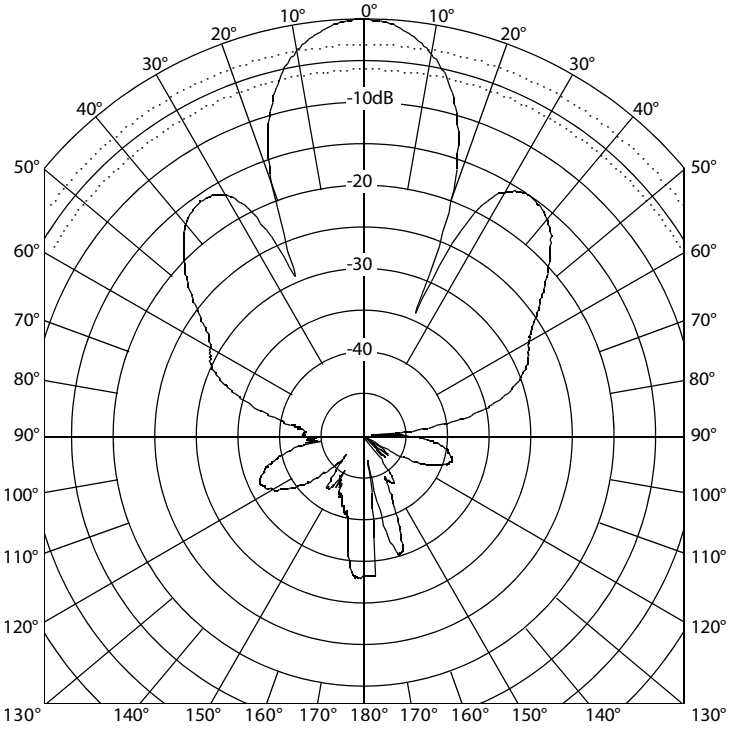
-3dB: 19°
-6dB: 26°
-10dB: 32°

Directivity Index:	19.0
Frequency Tolerance:	±1.7kHz
Peak TVR(1), nominal:	164dB
Peak TVR(1), minimum:	162dB
Q (transmit):	7
Peak Source Level(4):	215dB
RVR(2), nominal:	-173dB
Peak Figure of Merit(3):	-13dB

Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

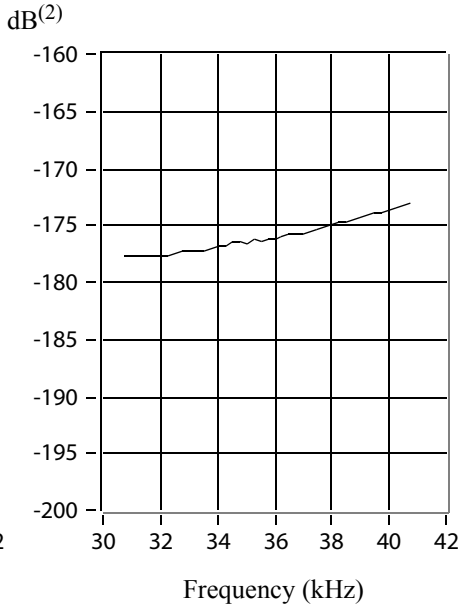
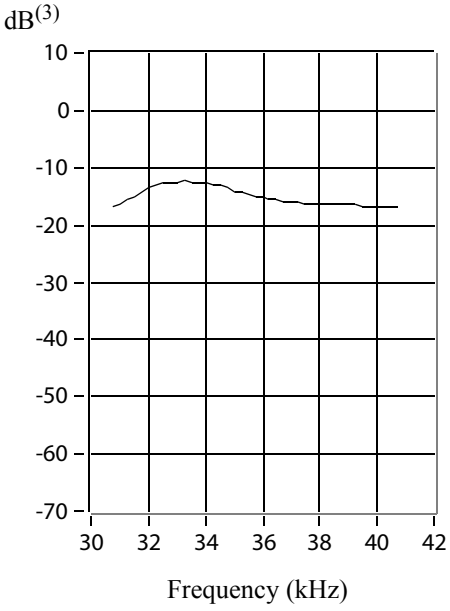


Figure of Merit



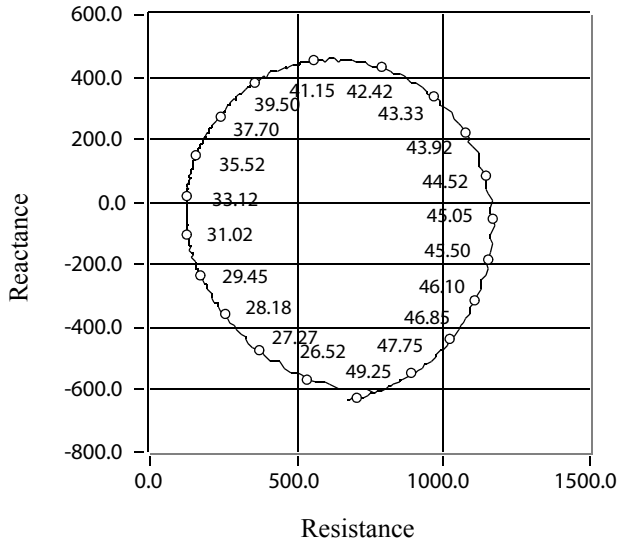
33 kHz-D

7x44mm (1.75") PZT/L

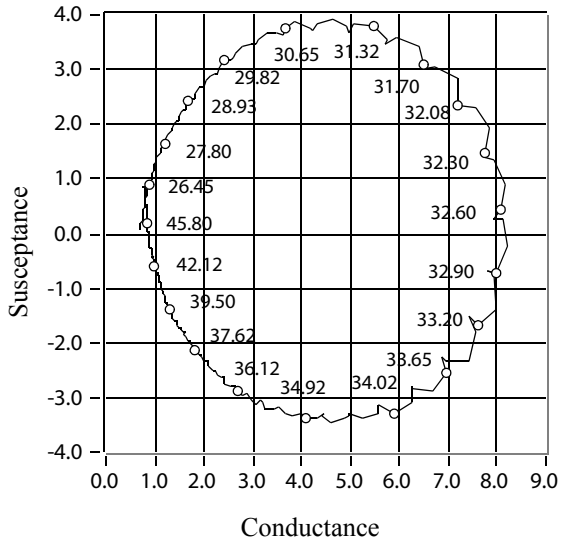
Cable Type: C44
Cable Length: 15.2m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	125ohms -20%,+40%	125ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	125 – j0ohms	125 – j0ohms
1 kHz Capacitance	n/a	n/a

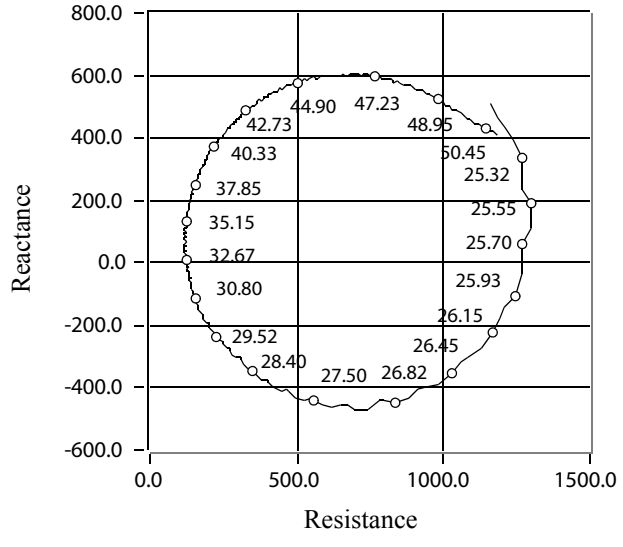
Unbalanced Impedance



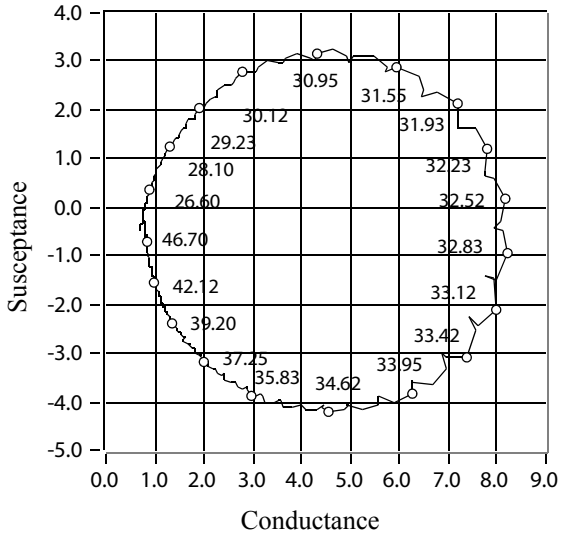
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



33 kHz-E

Transformed to 70 ohms

Power rating: 700 W

7x35mm (1.38") PZT/L

Active Area: 67cm^2

Urethane Window

Beamwidth:

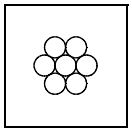
-3dB: 23°
-6dB: 32°
-10dB: 40°

Directivity Index:	17.4
Frequency Tolerance:	±1.7kHz
Peak TVR(1), nominal:	164dB
Peak TVR(1), minimum:	162dB
Q (transmit):	7
Peak Source Level(4):	211dB
Peak RVR(2), nominal:	-169dB
Peak Figure of Merit(3):	-17 dB

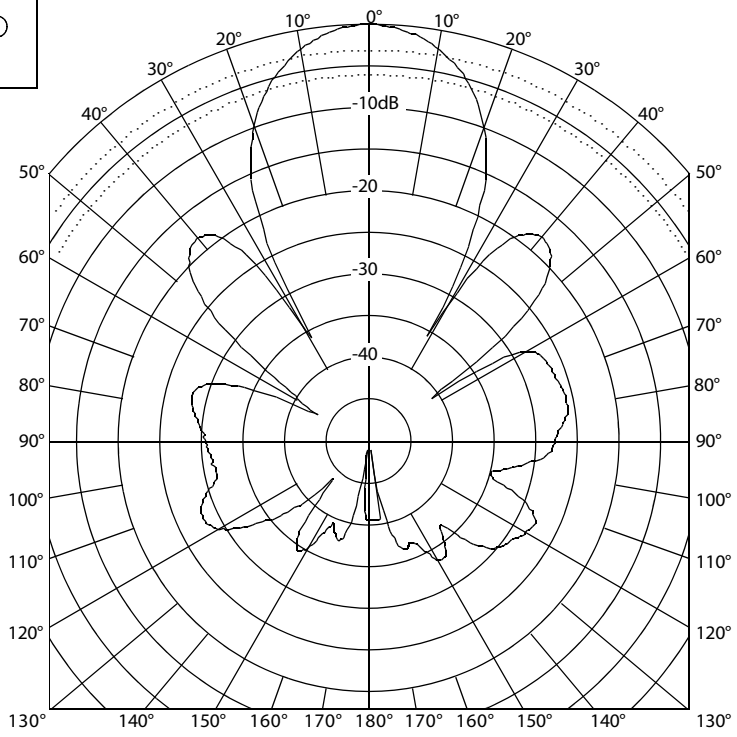
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

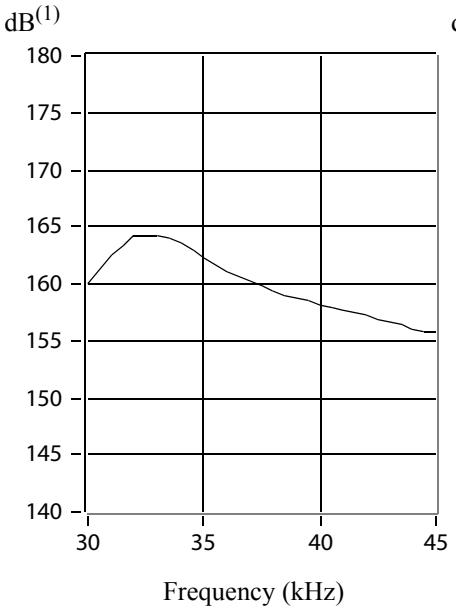
Array:



Transmit Radiation Pattern



TVR



RVR

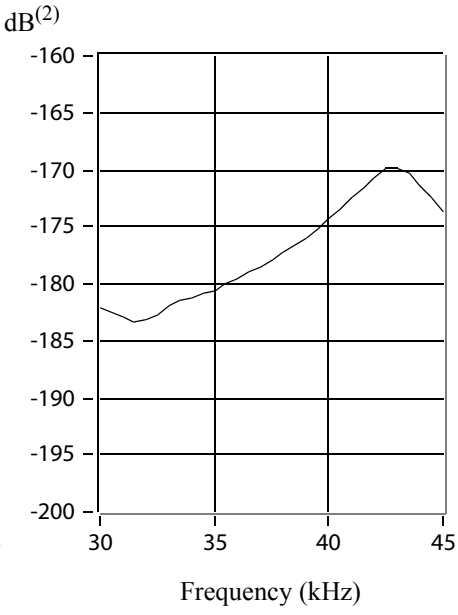
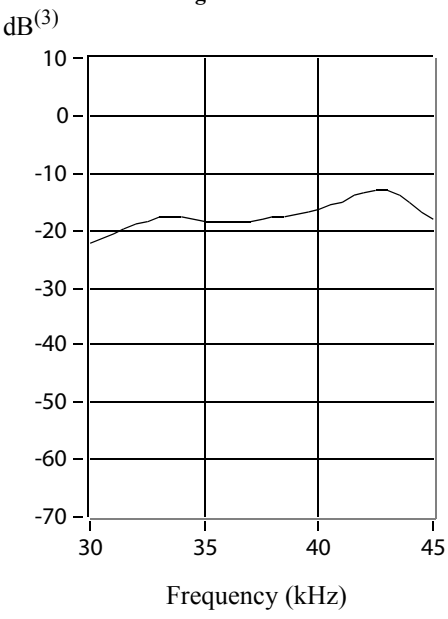


Figure of Merit



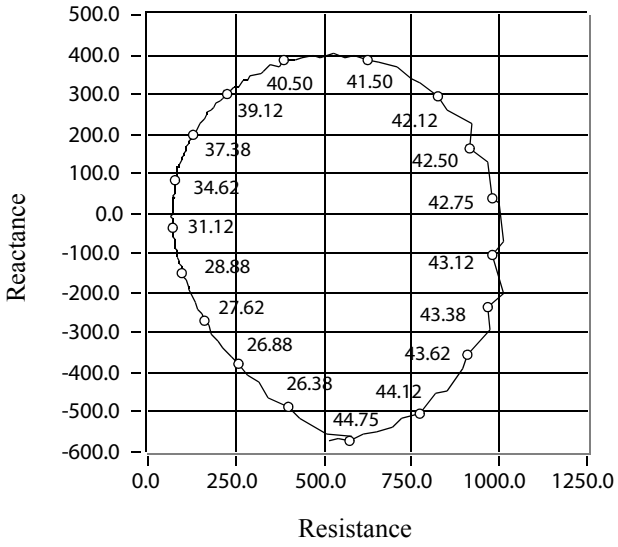
33 kHz-E

7x35mm (1.38") PZT/L

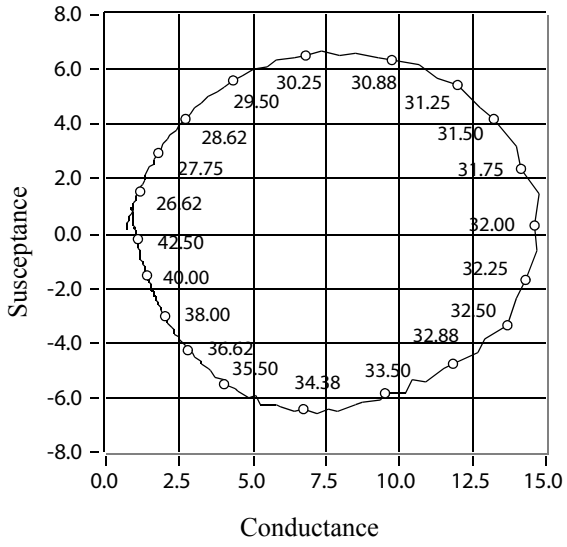
Cable Type: C44
Cable Length: 10.4m (34.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70ohms -20%,+40%	70ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	70 – j0 ohms	70 – j0 ohms
1 kHz Capacitance	n/a	n/a

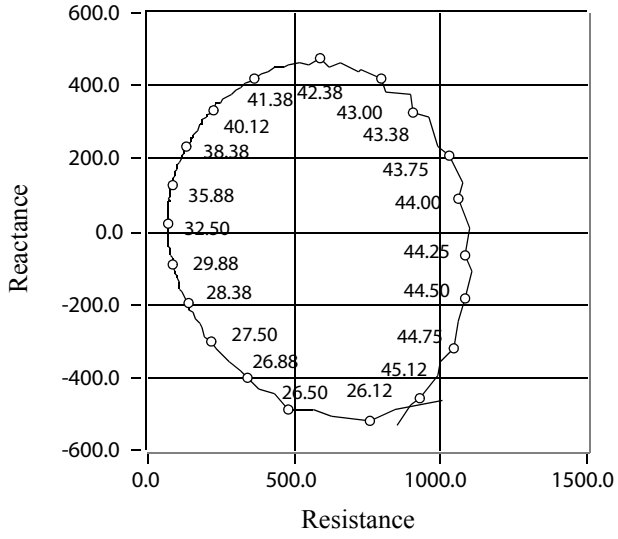
Unbalanced Impedance



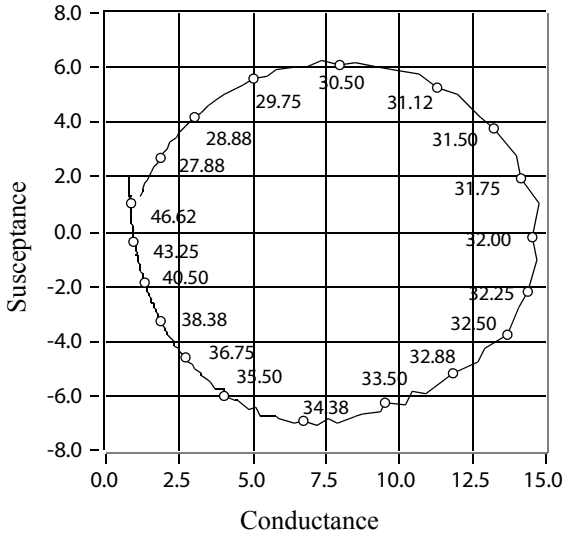
Unbalanced Admittance



Balanced Impedance

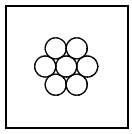


Balanced Admittance



33 kHz-E

Array:



Transformed to 110 ohms

Power rating: 700 Wrms @ 2% duty cycle

7 x 35 mm (1.38") PZT/L

Active Area: 67 cm²

Urethane Window

Beamwidth:

-3 dB: 23°

-6 dB: 32°

-10 dB: 40°

Directivity Index:	17.4
Frequency Tolerance:	±1.7 kHz
Peak TVR (1), nominal:	163 dB
Peak TVR (1), minimum:	161 dB
Q (transmit):	8
Peak Source Level (4):	212 dB
Peak RVR (2), nominal:	-169 dB
Peak Figure of Merit (3):	-16 dB

Notes:

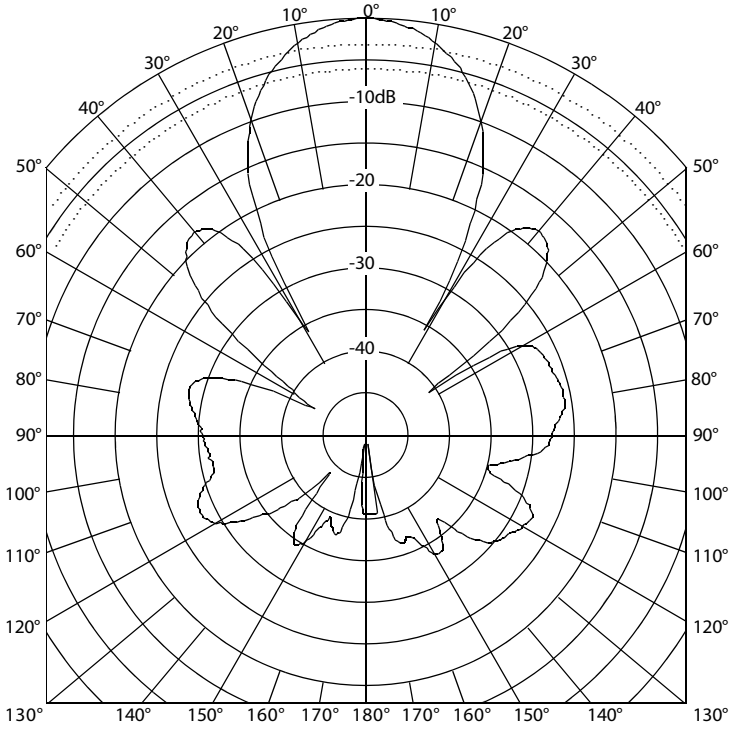
(1) dB re 1 µPa per volt at 1 meter

(2) dB re 1 volt per µPa

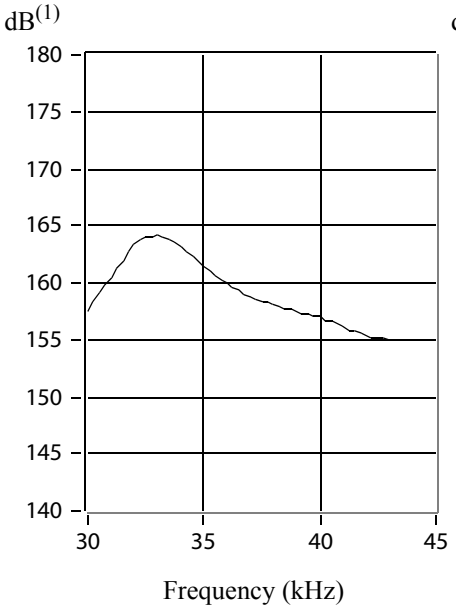
(3) sum of transmitting voltage response and receiving voltage response

(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

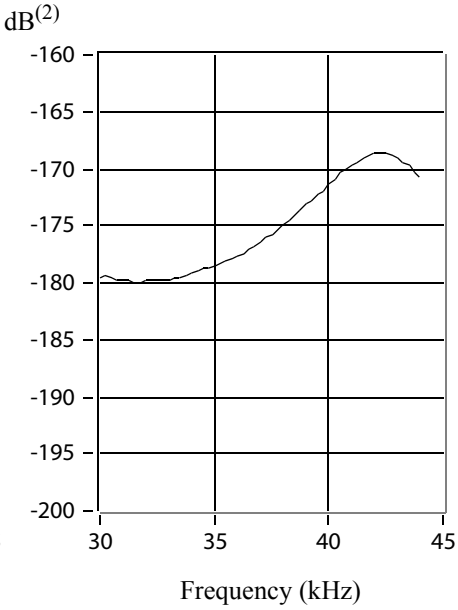
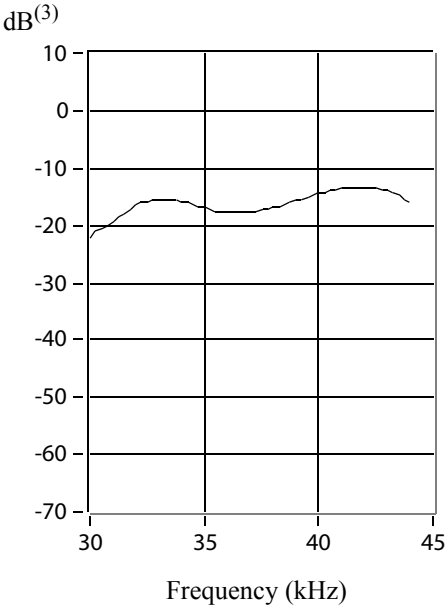


Figure of Merit



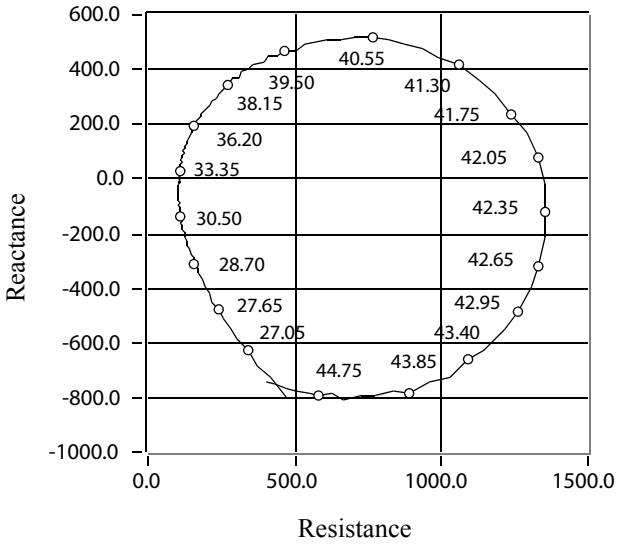
33 kHz-E

7x35mm (1.38") PZT/L

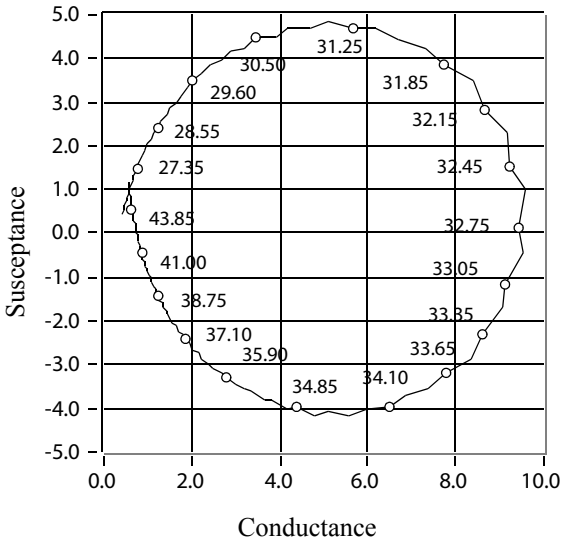
Cable Type: C44
Cable Length: 10.1m (33.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	110ohms -20%,+40%	110ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	110– j0 ohms	110– j0 ohms
1 kHz Capacitance	n/a	n/a

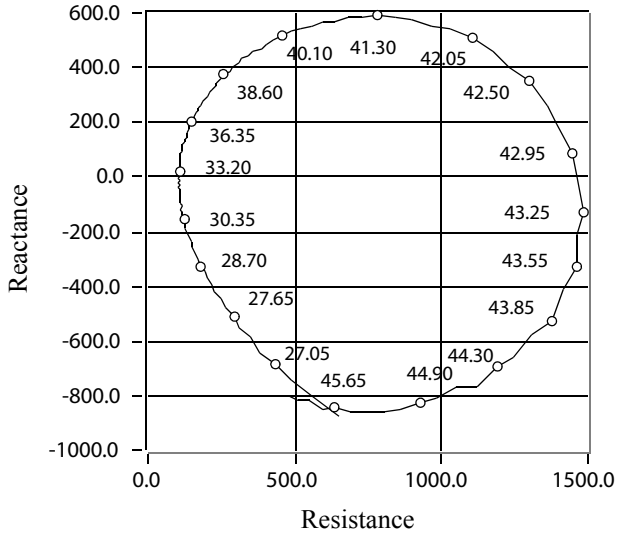
Unbalanced Impedance



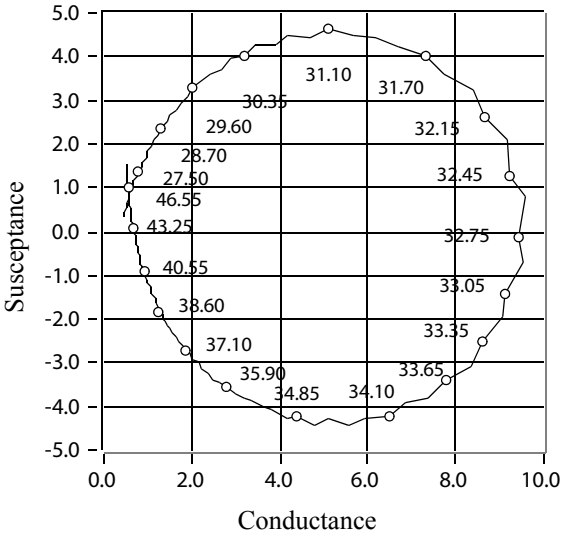
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



33 kHz-Glq

Power rating: 100 Wrms @ 2% duty cycle
48 mm (1.88") PZT/L
Active Area: 18 cm²
Urethane Window

Beamwidth:

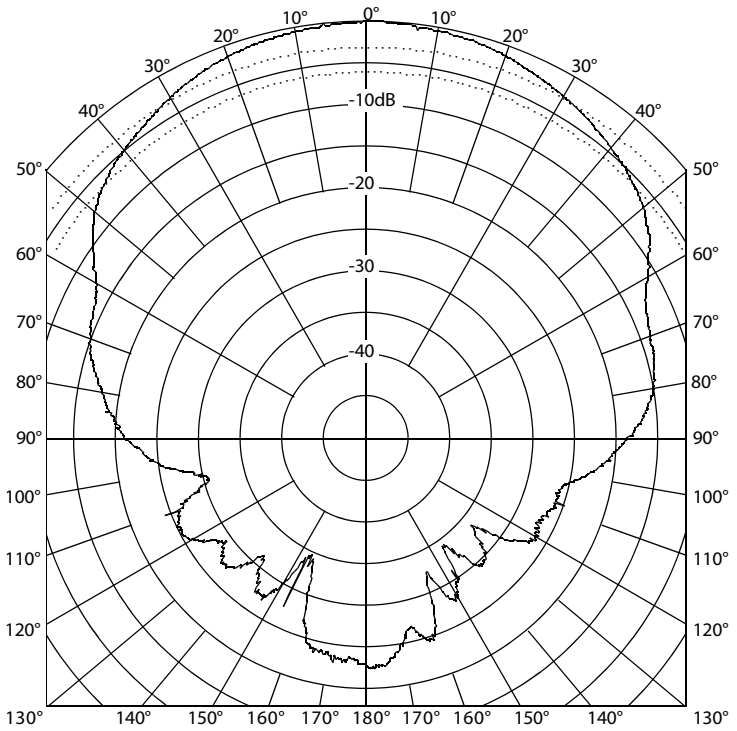
-3 dB:	62°
-6 dB:	91°
-10 dB:	112°

Directivity Index:	10.6
Frequency Tolerance:	±2 kHz
Peak TVR(1), nominal:	143 dB
Peak TVR(1), minimum:	141 dB
Q (transmit):	5
Peak Source Level(4):	194 dB
Peak RVR(2), nominal:	-177 dB
Peak Figure of Merit(3):	-36 dB

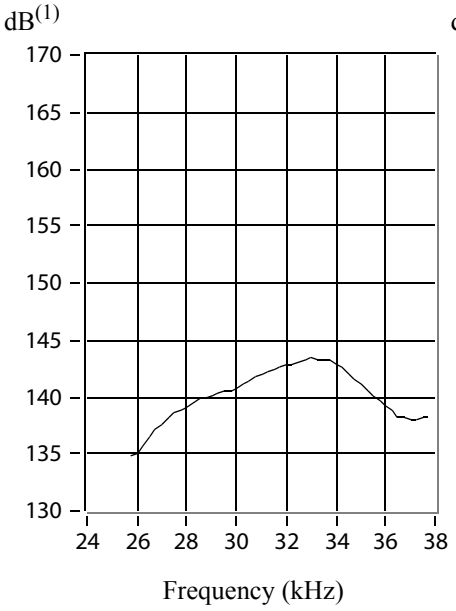
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

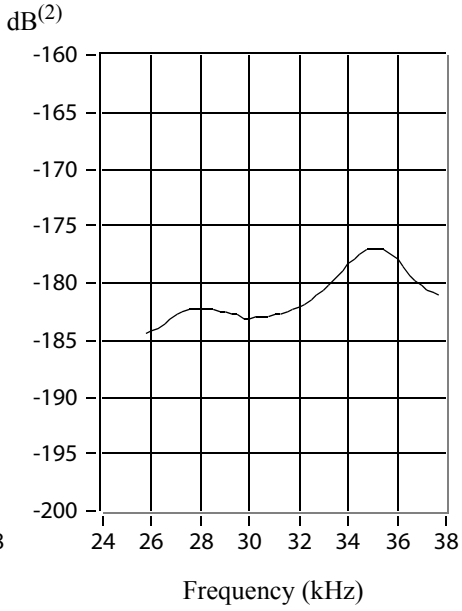
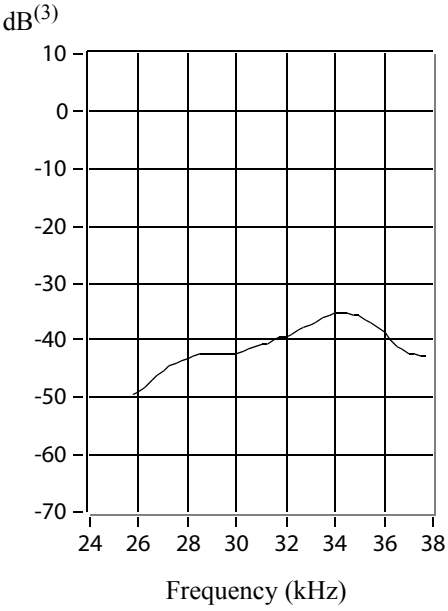


Figure of Merit

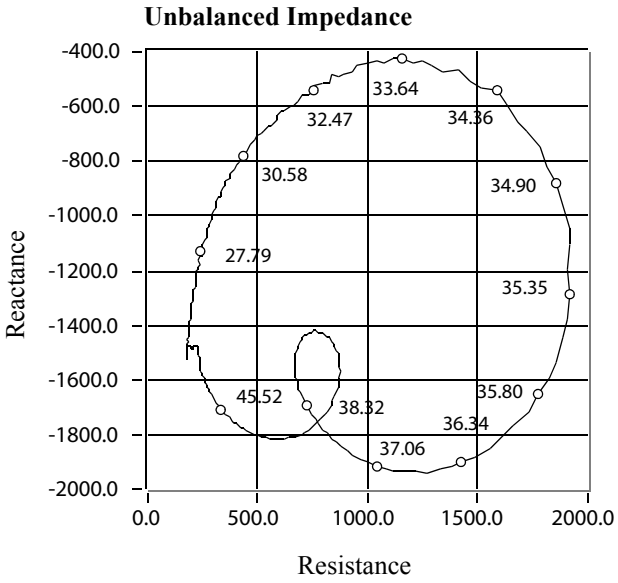


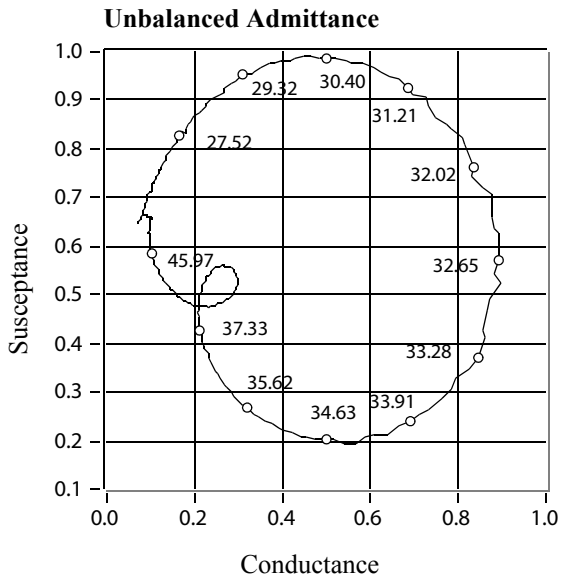
33 kHz-Glq

48mm (1.88") PZT/L

Cable Type: C33
Cable Length: 10.1 m (33.0')

Impedance Data	
	Unbalanced
Parallel: Rp.	1140 ohms -20%, +40%
Parallel: Cp. (nominal)	3130 pF
Series [R – jX] (nominal)	760 – j 540 ohms
1 kHz Capacitance	3730 pF ± 20%





33 kHz-H

Transformed to 60 ohms

Power rating: 3 kW rms @ 2% duty cycle

21 x 44 mm (1.75") PZT/L

Active Area: 326 cm²

Urethane Window

Beamwidth:

-3 dB: 10°

-6 dB: 13°

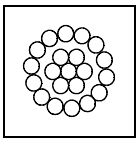
-10 dB: 17°

Directivity Index:	23.8
Frequency Tolerance:	±1.7 kHz
Peak TVR(1), nominal:	170 dB
Peak TVR(1), minimum:	168 dB
Q (transmit):	5
Peak Source Level(4):	223 dB
RVR(2), nominal:	-171 dB
Peak Figure of Merit(3):	-5 dB

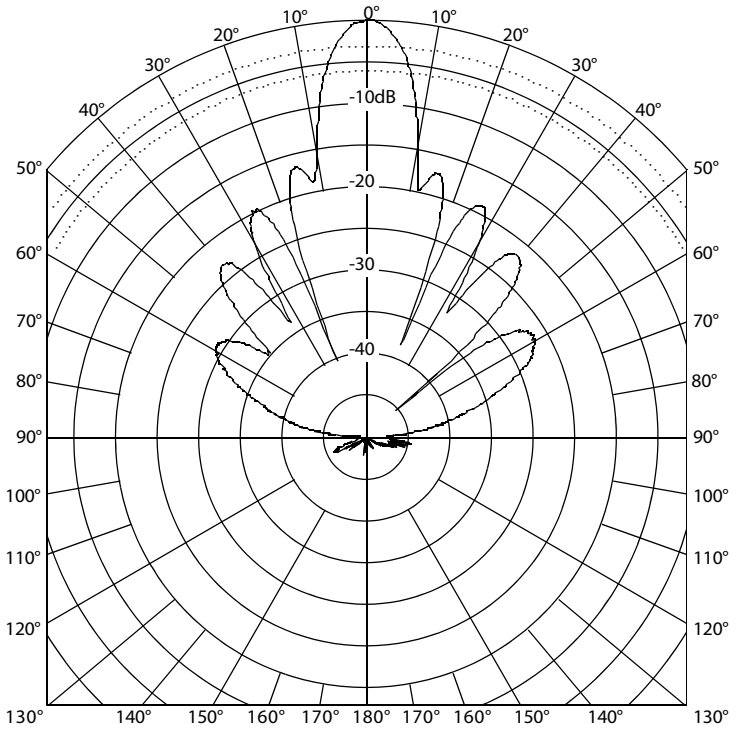
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

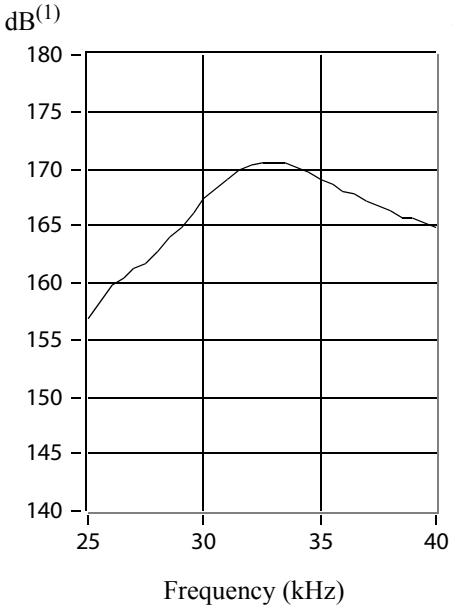
Array:



Transmit Radiation Pattern



TVR



RVR

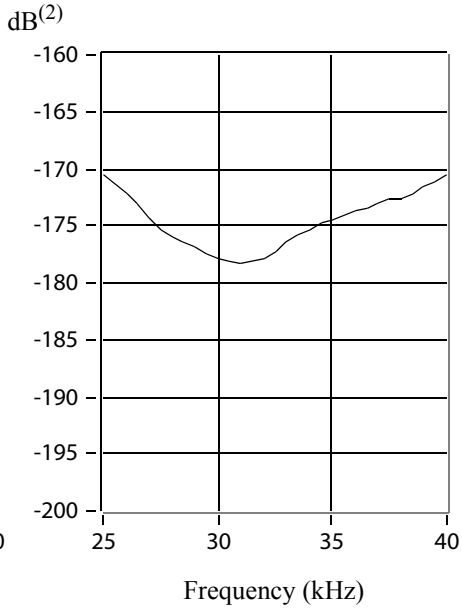
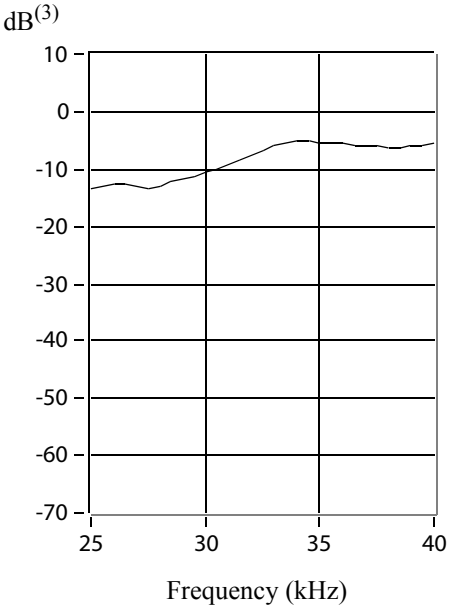


Figure of Merit



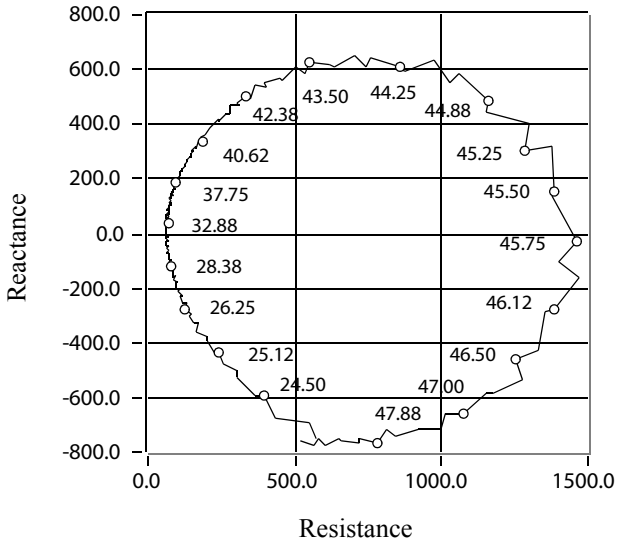
33 kHz-H

21 x 44mm (1.75") PZT/L

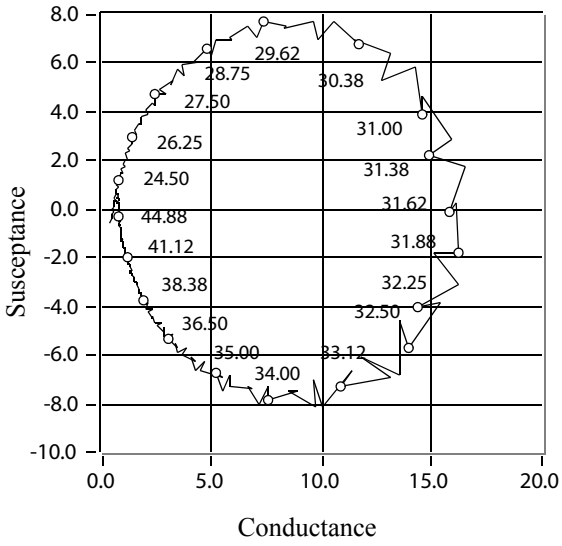
Cable Type: C43
Cable Length: 25.9m (85.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 ohms -20%, +40%	60 ohms -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	60 – j0 ohms	60 – j0 ohms
1 kHz Capacitance	n/a	n/a

Balanced Impedance



Balanced Admittance



33 kHz-M

Transformed to 70 ohms

Power rating: 1 kWrms @ 2% duty cycle
3 x 51 mm (2.0") PZT/L
Active Area: 60 cm²
Urethane Window

Beamwidth:

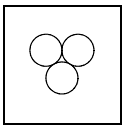
-3 dB: 24°
-6 dB: 33°
-10 dB: 42°

Directivity Index:	16.5
Frequency Tolerance:	±1.7 kHz
Peak TVR (1), nominal:	166 dB
Peak TVR (1), minimum:	164 dB
Q (transmit):	8
Peak Source Level (4):	215 dB
RVR (2), nominal:	-171 dB
Peak Figure of Merit (3):	-15 dB

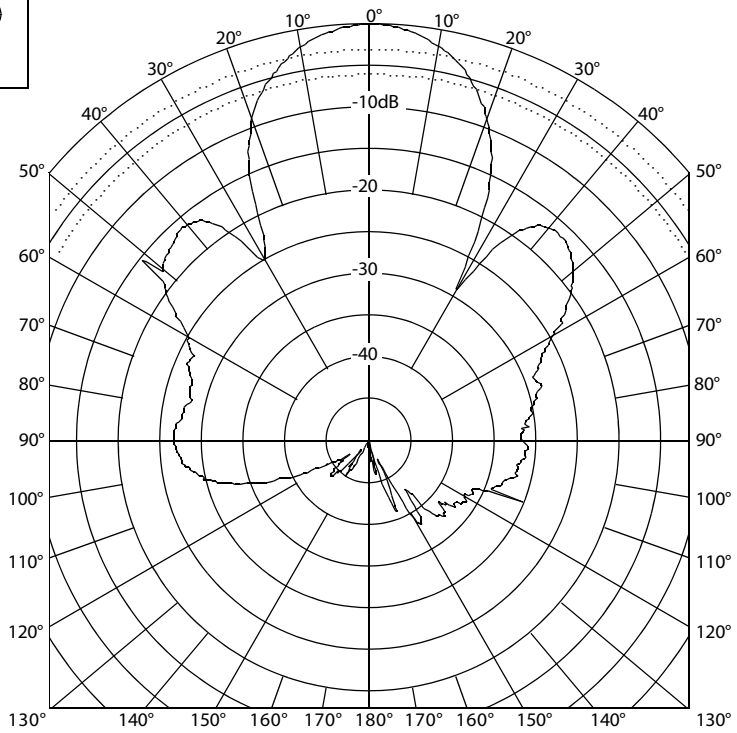
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

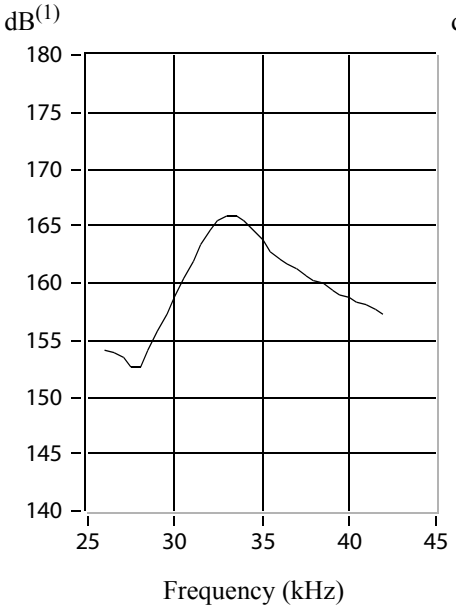
Array:



Transmit Radiation Pattern



TVR



RVR

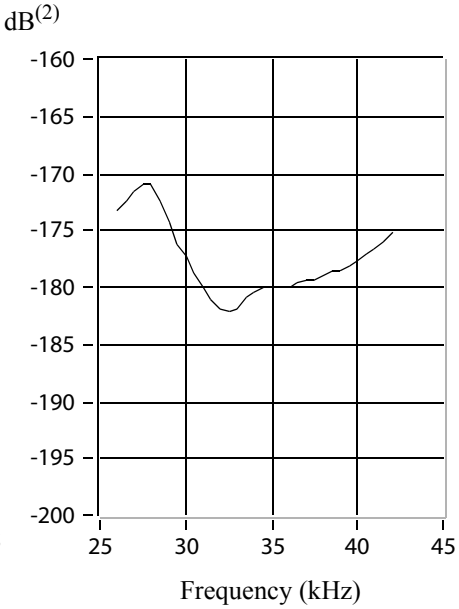
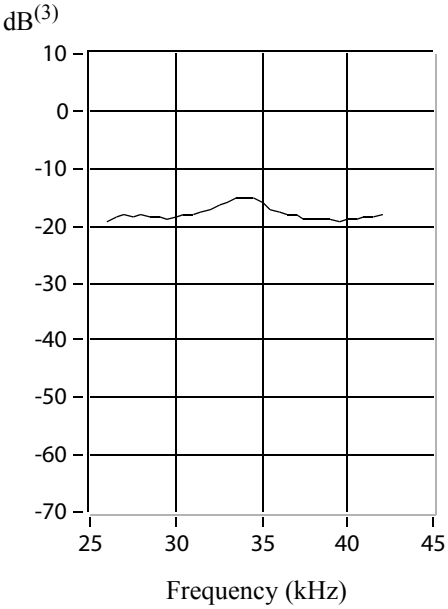


Figure of Merit



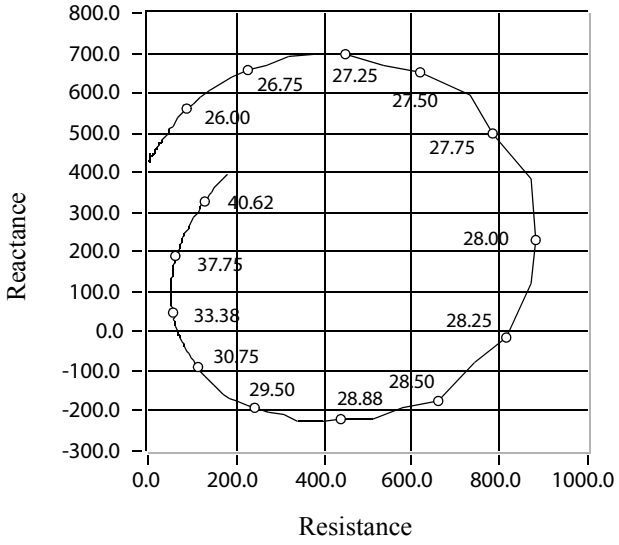
33 kHz-M

3x51mm (2.0") PZT/L

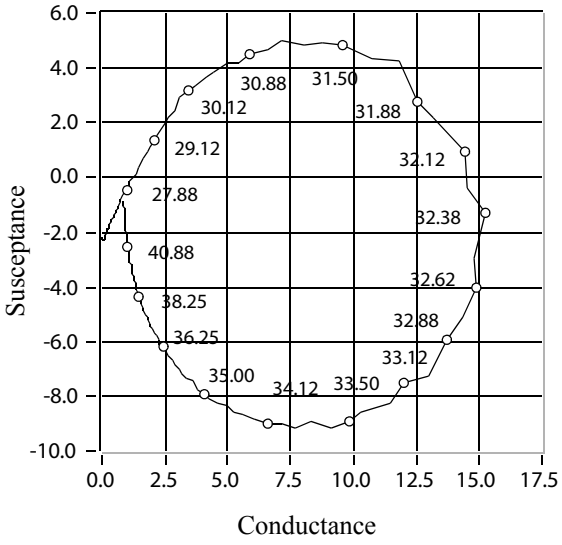
Cable Type: C37
Cable Length: 2.4m (8.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70ohms -20%,+40%	70ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	70 – j0ohms	70 – j0ohms
1 kHz Capacitance	n/a	n/a

Unbalanced Impedance

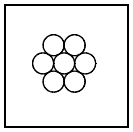


Unbalanced Admittance



38 kHz-B

Array:



Transformed to 60 ohms

Power rating: 1 kW rms @ 2% duty cycle
7 x 38 mm (1.50") PZT/L
Active Area: 80 cm²
Urethane Window

Beamwidth:

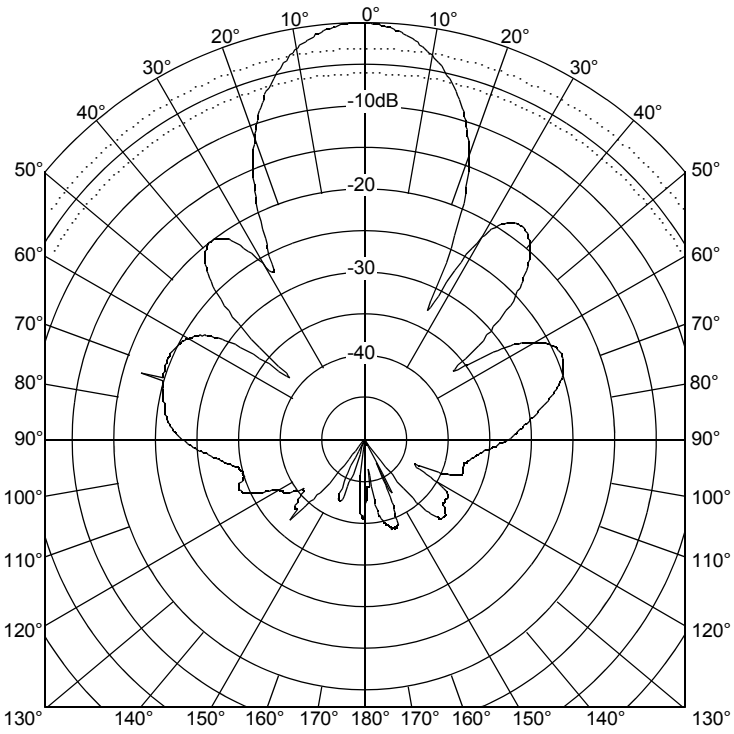
-3 dB: 20°
-6 dB: 29°
-10 dB: 36°

Directivity Index:	18.4
Frequency Tolerance:	±2 kHz
Peak TVR (1), nominal:	169 dB
Peak TVR (1), minimum:	167 dB
Q (transmit):	7
Peak Source Level (4):	217 dB
RVR (2), nominal:	-173 dB
Peak Figure of Merit (3):	-11 dB

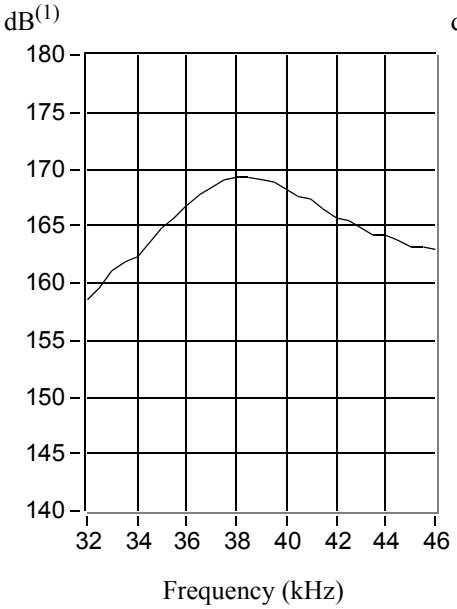
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

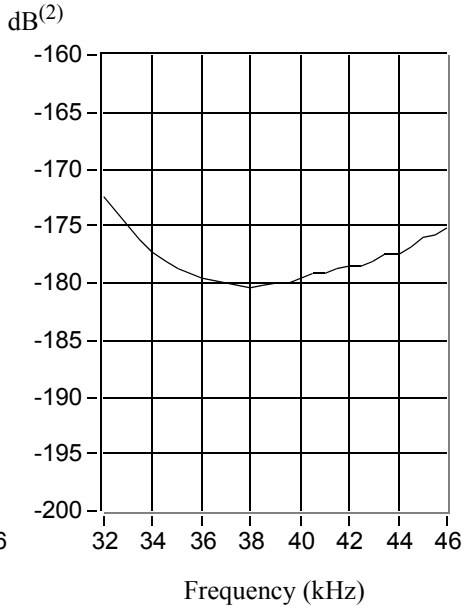
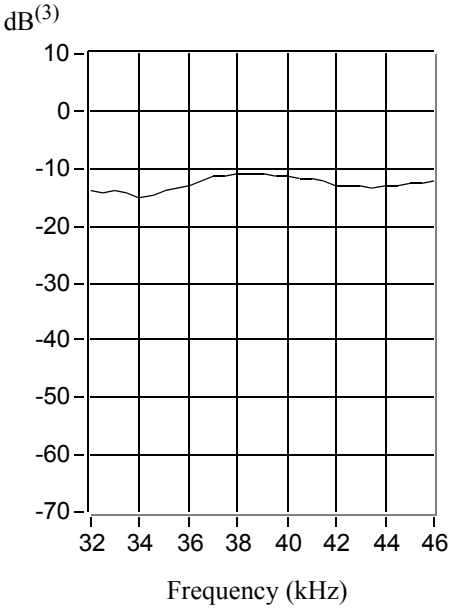


Figure of Merit



38 kHz-B

7x38mm (1.50") PZT/L

Cable Type: C43
Cable Length: 10.1m (33.0')

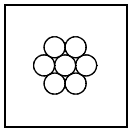
Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60ohms -20%,+40%	60ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	60 – j0ohms	60 – j0ohms
1 kHz Capacitance	n/a	n/a

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (ohms)	Phase Angle (°)	Series Resistance (ohms)	Series Reactance (ohms)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (ohms)	Parallel Capacitance (pF)
32.00	493.71	-32.17	417.90	-262.87	1.7145	1.0785	583.26	5363.88
32.50	381.33	-42.63	280.56	-258.27	1.9294	1.7761	518.31	8697.57
33.00	275.24	-48.81	181.26	-207.13	2.3927	2.7342	417.94	13186.49
33.50	216.94	-47.15	147.52	-159.06	3.1346	3.3797	319.02	16056.65
34.00	181.79	-46.99	124.01	-132.92	3.7525	4.0222	266.49	18827.89
34.50	145.25	-46.80	99.42	-105.89	4.7125	5.0190	212.20	23153.75
35.00	120.47	-41.14	90.72	-79.25	6.2516	5.4614	159.96	24834.40
35.50	105.50	-37.89	83.26	-64.79	7.4804	5.8216	133.68	26099.83
36.00	87.51	-33.23	73.21	-47.96	9.5584	6.2615	104.62	27682.07
36.50	76.65	-23.88	70.09	-31.03	11.9293	5.2817	83.83	23030.36
37.00	70.91	-16.27	68.07	-19.86	13.5378	3.9498	73.87	16989.92
37.50	65.51	-7.56	64.94	-8.62	15.1321	2.0091	66.08	8526.78
38.00	62.49	3.12	62.39	3.40	15.9799	-0.8704	62.58	-3645.40
38.50	64.12	14.20	62.16	15.73	15.1196	-3.8269	66.14	-15819.97
39.00	68.59	22.34	63.44	26.07	13.4853	-5.5421	74.15	-22616.65
39.50	71.02	28.99	62.12	34.42	12.3157	-6.8244	81.20	-27497.25
40.00	80.69	37.78	63.78	49.43	9.7956	-7.5921	102.09	-30208.11
40.50	91.40	39.97	70.05	58.72	8.3845	-7.0285	119.27	-27620.10
41.00	95.65	43.10	69.85	65.35	7.6339	-7.1429	130.99	-27727.44
41.50	109.17	48.10	72.90	81.26	6.1169	-6.8181	163.48	-26147.85
42.00	124.98	47.68	84.15	92.40	5.3876	-5.9159	185.61	-22417.55
42.50	129.20	48.50	85.61	96.77	5.1286	-5.7966	194.99	-21707.31
43.00	147.05	52.16	90.20	116.13	4.1717	-5.3707	239.71	-19878.58
43.50	169.34	49.48	110.02	128.74	3.8363	-4.4892	260.67	-16424.76
44.00	174.13	48.61	115.12	130.65	3.7966	-4.3086	263.39	-15585.05
44.50	196.32	51.24	122.91	153.08	3.1891	-3.9720	313.57	-14205.76
45.00	228.80	48.06	152.92	170.19	2.9212	-3.2510	342.33	-11497.97
45.50	238.34	44.02	171.39	165.62	3.0172	-2.9156	331.44	-10198.66
46.00	260.90	46.08	180.98	187.92	2.6588	-2.7608	376.11	-9552.23

38 kHz-B

Array:



Transformed to 150 ohms

Power rating: 1 kW rms @ 2% duty cycle
7 x 38 mm (1.50") PZT/L
Active Area: 80 cm^2
Urethane Window

Beamwidth:

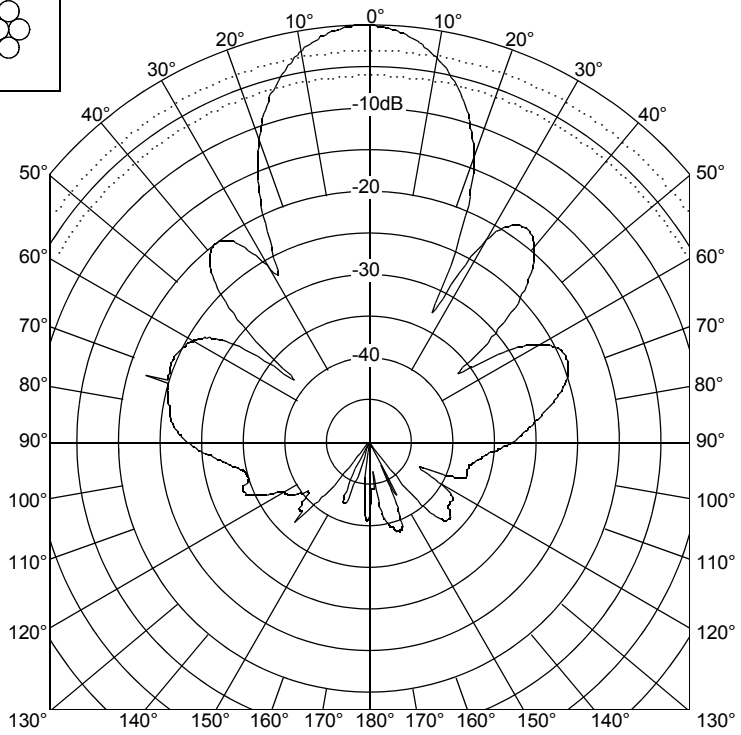
-3 dB:	20°
-6 dB:	29°
-10 dB:	36°

Directivity Index:	18.4
Frequency Tolerance:	±2 kHz
Peak TVR (1), nominal:	164 dB
Peak TVR (1), minimum:	162 dB
Q (transmit):	7
Peak Source Level (4):	216 dB
RVR (2), nominal:	-173 dB
Peak Figure of Merit (3):	-13 dB

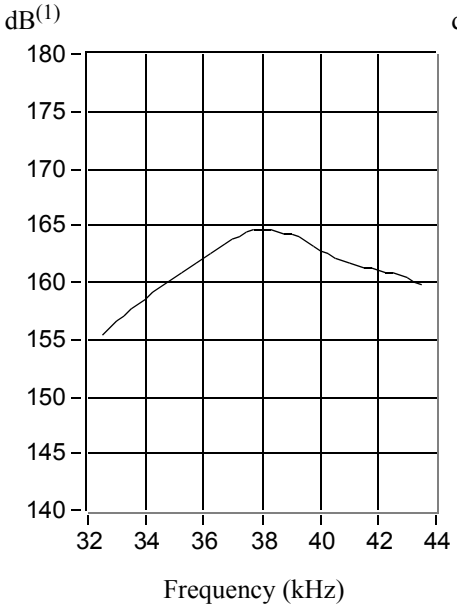
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

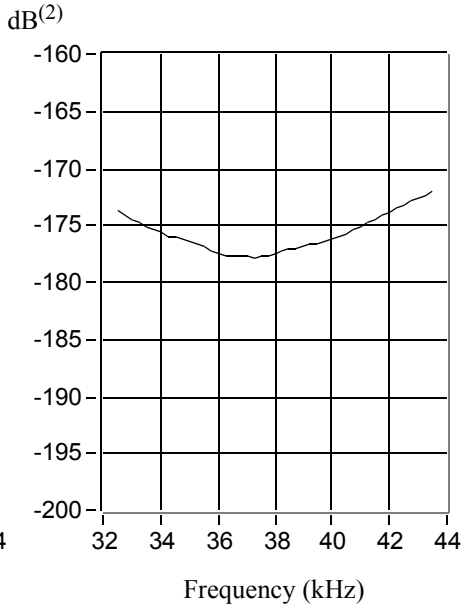
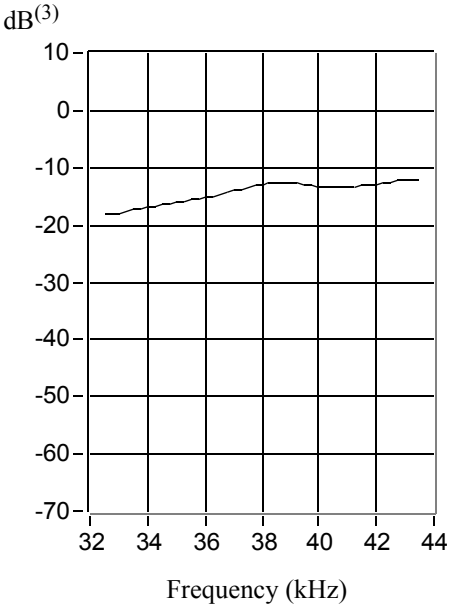


Figure of Merit



38 kHz-B

7 x 38 mm (1.50") PZT/L

Cable Type: C37
Cable Length: 10.1 m (33.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	150 ohms -20%, +40%	150 ohms -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	150 – j0 ohms	150 – j0 ohms
1 kHz Capacitance	n/a	n/a

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (ohms)	Phase Angle (°)	Series Resistance (ohms)	Series Reactance (ohms)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (ohms)	Parallel Capacitance (pF)
33.00	664.61	-49.72	429.67	-507.04	0.9728	1.1479	1028.01	5536.23
33.25	584.43	-50.32	373.13	-449.81	1.0924	1.3169	915.38	6303.71
33.50	525.37	-50.09	337.05	-403.00	1.2211	1.4601	818.91	6936.65
33.75	474.35	-49.04	310.93	-358.23	1.3819	1.5921	723.66	7507.77
34.00	428.30	-47.96	286.80	-318.09	1.5635	1.7340	639.60	8117.13
34.25	388.46	-46.34	268.20	-281.02	1.7773	1.8623	562.64	8653.77
34.50	357.31	-45.46	250.61	-254.69	1.9630	1.9949	509.44	9202.89
34.75	328.95	-43.37	239.13	-225.89	2.2099	2.0876	452.51	9561.01
35.00	305.74	-43.18	222.93	-209.23	2.3850	2.2383	419.30	10178.31
35.25	287.83	-41.85	214.41	-192.03	2.5880	2.3179	386.40	10465.28
35.50	268.38	-39.81	206.16	-171.82	2.8623	2.3855	349.37	10694.95
35.75	248.66	-37.34	197.70	-150.82	3.1974	2.4392	312.76	10859.22
36.00	229.43	-35.20	187.48	-132.25	3.5616	2.5124	280.78	11107.45
36.25	211.51	-33.09	177.22	-115.46	3.9612	2.5809	252.45	11331.23
36.50	197.47	-30.36	170.39	-99.82	4.3693	2.5598	228.87	11161.93
36.75	185.55	-26.91	165.46	-83.98	4.8057	2.4391	208.09	10563.25
37.00	176.75	-22.42	163.39	-67.41	5.2302	2.1579	191.20	9282.20
37.25	167.43	-17.57	159.62	-50.55	5.6939	1.8033	175.63	7704.87
37.50	159.52	-12.71	155.61	-35.10	6.1153	1.3796	163.52	5855.18
37.75	152.46	-7.44	151.18	-19.74	6.5039	0.8492	153.75	3580.25
38.00	148.99	-2.61	148.84	-6.79	6.7048	0.3058	149.15	1280.89
38.25	147.37	2.79	147.20	7.16	6.7775	-0.3298	147.55	-1372.28
38.50	149.60	8.18	148.08	21.28	6.6165	-0.9510	151.14	-3931.14
38.75	153.96	14.12	149.31	37.56	6.2990	-1.5845	158.76	-6507.95
39.00	159.04	19.44	149.97	52.93	5.9293	-2.0927	168.65	-8539.97
39.25	165.26	24.93	149.86	69.66	5.4872	-2.5506	182.24	-10342.63
39.50	170.91	28.87	149.67	82.52	5.1239	-2.8251	195.16	-11383.16
39.75	178.80	32.49	150.82	96.03	4.7178	-3.0040	211.96	-12027.62
40.00	189.91	34.64	156.25	107.93	4.3326	-2.9928	230.81	-11907.88
40.25	204.08	37.10	162.78	123.09	3.9084	-2.9554	255.86	-11686.30
40.50	219.17	39.55	169.00	139.55	3.5182	-2.9051	284.24	-11416.39
40.75	233.48	41.80	174.05	155.62	3.1929	-2.8548	313.20	-11149.77
41.00	246.94	44.10	177.34	171.84	2.9082	-2.8181	343.85	-10939.19
41.25	261.91	45.03	185.09	185.31	2.6982	-2.7014	370.62	-10422.90
41.50	276.82	45.86	192.78	198.66	2.5158	-2.5925	397.49	-9942.26
41.75	297.05	46.28	205.31	214.68	2.3268	-2.4330	429.78	-9274.71
42.00	314.05	47.08	213.85	229.99	2.1683	-2.3319	461.19	-8836.53
42.25	331.64	47.48	224.15	244.42	2.0380	-2.2223	490.67	-8371.41
42.50	349.00	47.97	233.65	259.24	1.9184	-2.1284	521.28	-7970.55
42.75	367.51	48.10	245.46	273.52	1.8173	-2.0251	550.26	-7539.35
43.00	385.06	47.90	258.17	285.70	1.7412	-1.9268	574.33	-7131.73
43.25	410.41	47.41	277.74	302.16	1.6489	-1.7939	606.46	-6601.33

38 kHz-D

Transformed to 60 ohms

Power rating: 1.2 kW$_{rms}$ @ 2% duty cycle
13 x 35 mm (1.38") PZT/L
Active Area: 125 cm^2
Urethane Window

Beamwidth:

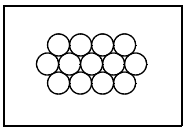
-3 dB: 13° x 22°
-6 dB: 18° x 31°
-10 dB: 23° x 39°

Directivity Index:	21.1
Frequency Tolerance:	±2 kHz
Peak TVR[(1)], nominal:	169 dB
Peak TVR[(1)], minimum:	167 dB
Q (transmit):	7
Peak Source Level[(4)]:	218 dB
Peak RVR[(2)], nominal:	-174 dB
Peak Figure of Merit[(3)]:	-10 dB

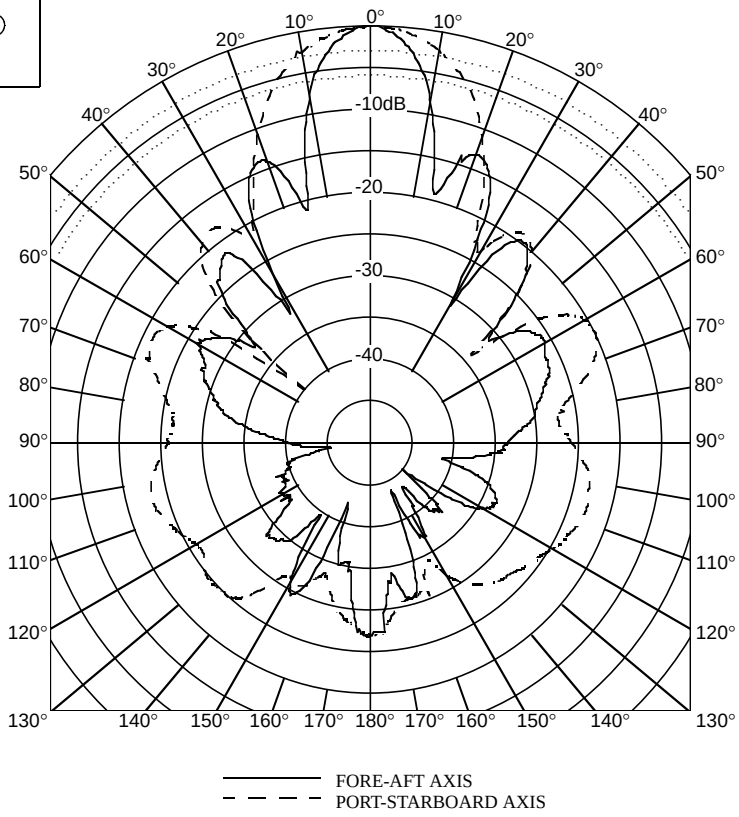
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

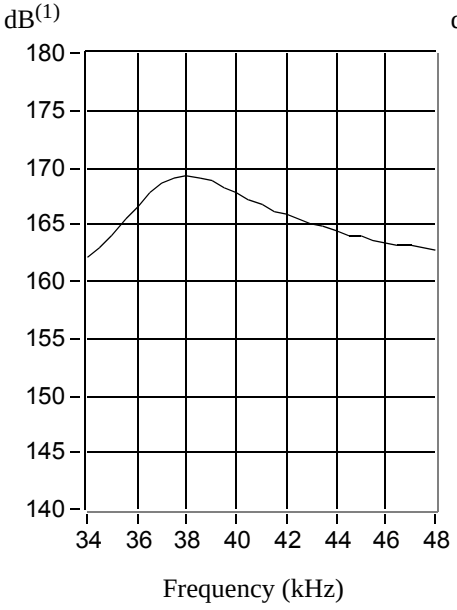
Array:



Transmit Radiation Pattern



TVR



RVR

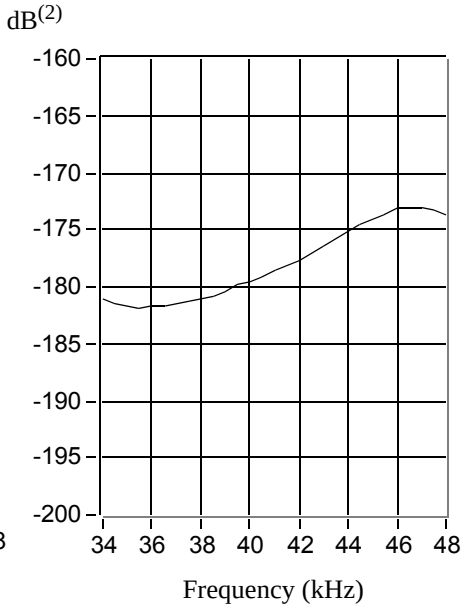
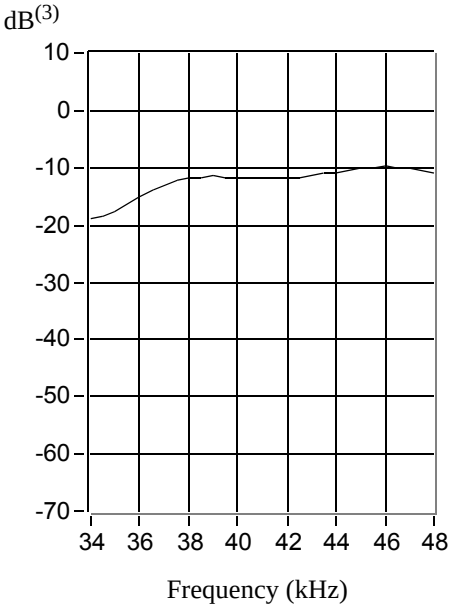


Figure of Merit



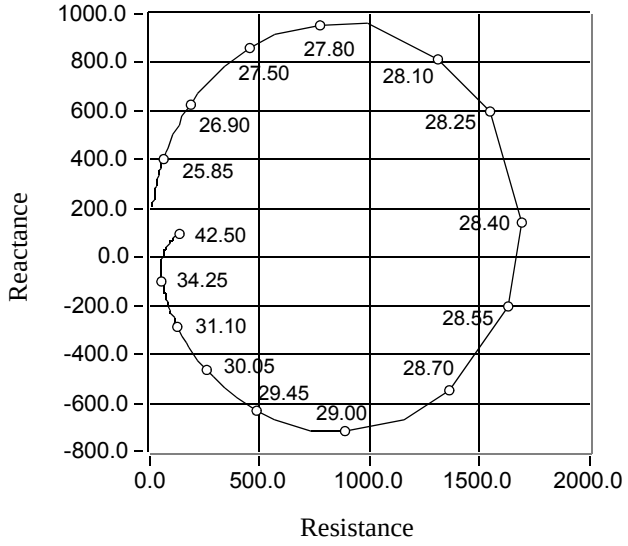
38 kHz-D

13x35mm (1.38") PZT/L

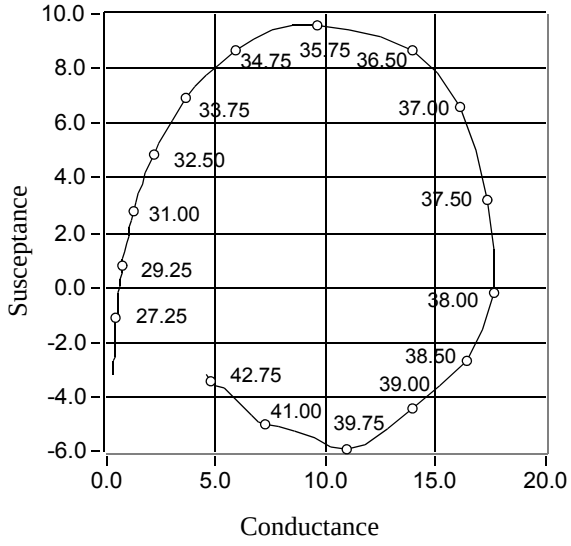
Cable Type: C37
Cable Length: 15.2 m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 ohms -20%, +40%	60 ohms -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	60 – j0 ohms	60 – j0 ohms
1 kHz Capacitance	n/a	n/a

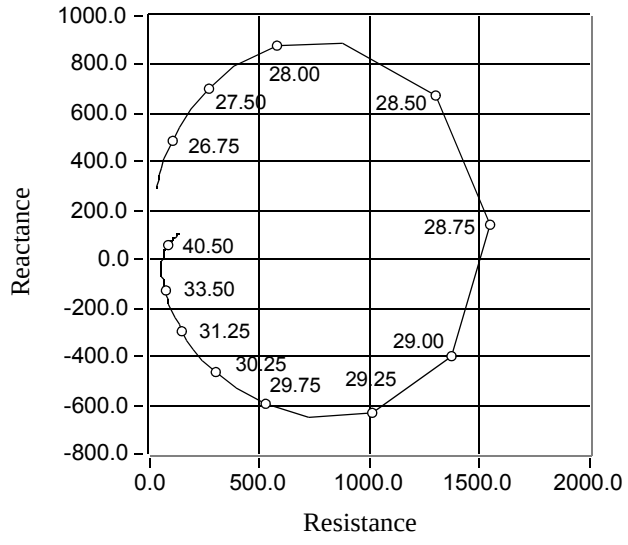
Unbalanced Impedance



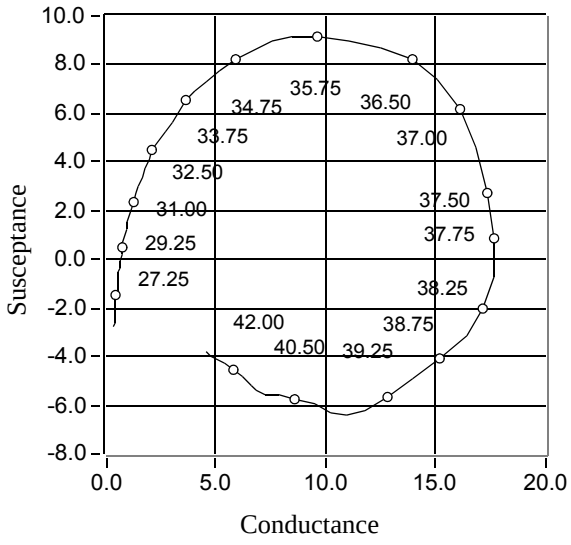
Unbalanced Admittance



Balanced Impedance

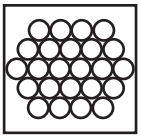


Balanced Admittance



38 kHz-E

Array

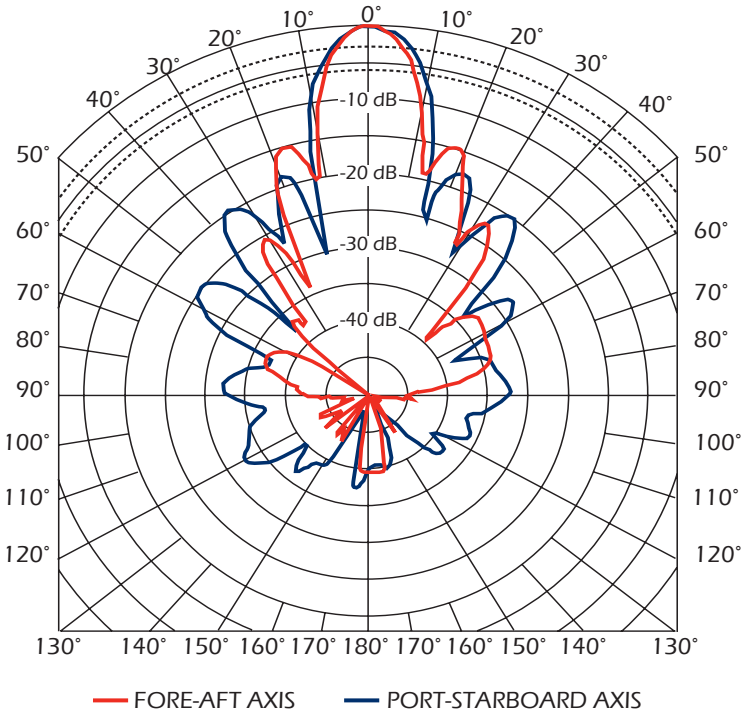


Transformed to 60 ohms
Power Rating: 2.2 kW rms @ 2% duty cycle
24 x 35 mm (1.38") PZT/L
Active Area: 231 cm^2
Urethane Window

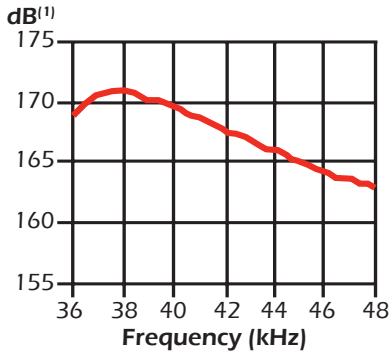
Beamwidth:
-3 dB: 10° x 12°
-6 dB: 14° x 17°
-10 dB: 18° x 21°

Directivity Index:	23.8
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	171 dB
Peak TVR(1), minimum:	169 dB
Q (transmit):	7
Peak Source Level(4):	222 dB
Peak RVR(2), nominal:	-169 dB
Peak Figure of Merit(3):	-4 dB

Transmit Radiation Pattern



TVR



RVR

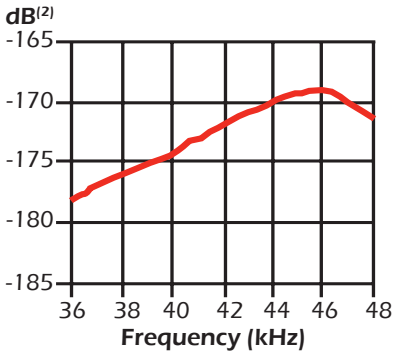
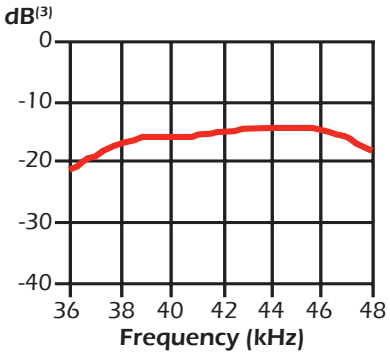


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

38 kHz-E

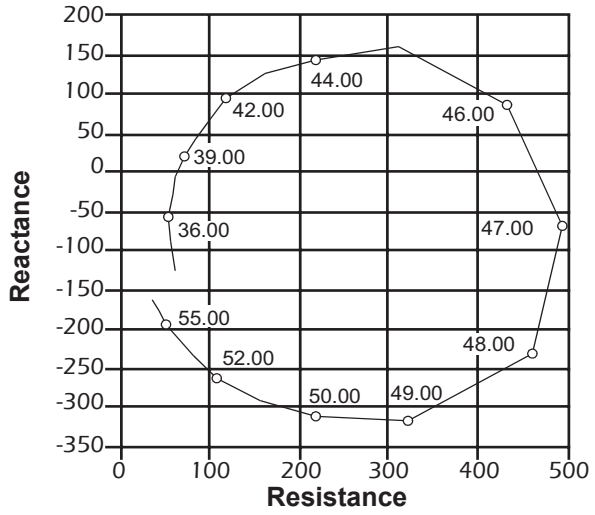
24 x 35 mm (1.38”) PZT/L

Cable Type: C43
Cable Length: 15.2 m (50’)

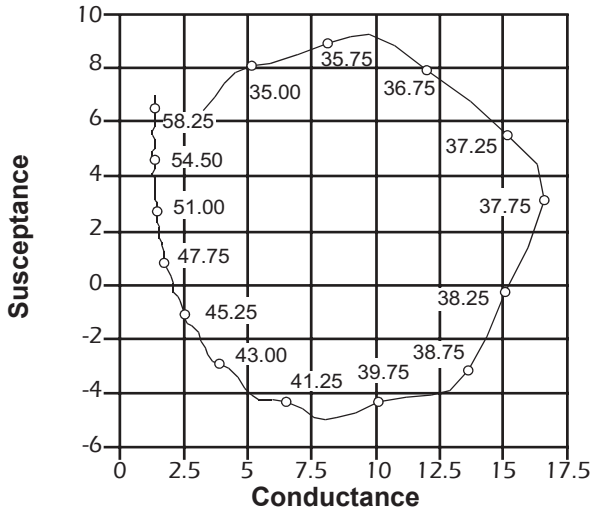
Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	60 Ω - j0 Ω	60 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

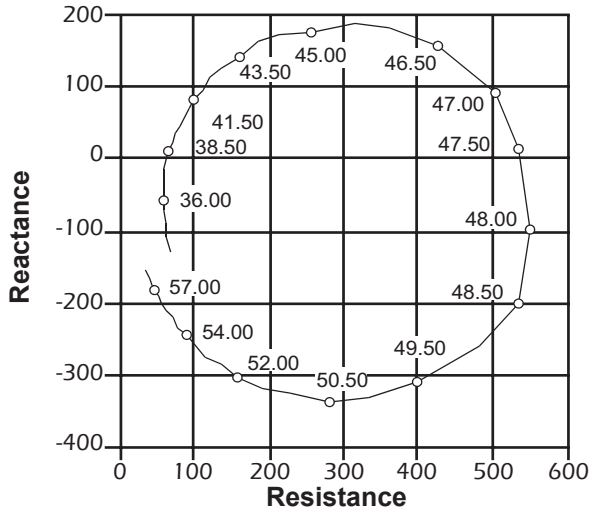
Unbalanced Impedance



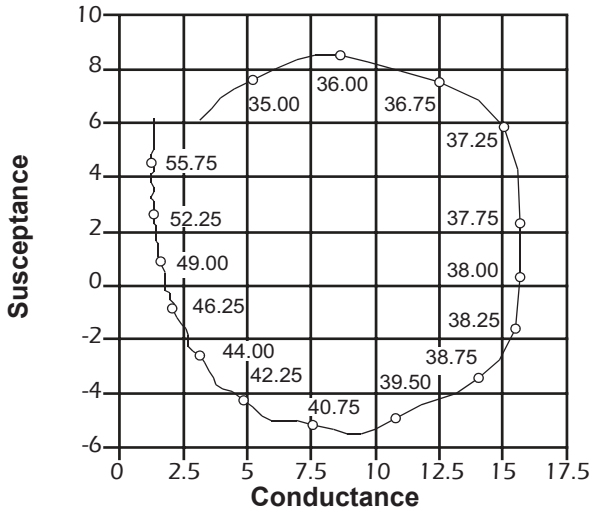
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



38 kHz-F

Transformed to 60 ohms

Power rating: 3 kW$_{rms}$ @ 2% duty cycle
34x35mm (1.38") PZT/L
Active Area: 327cm^2
Urethane Window

Beamwidth:

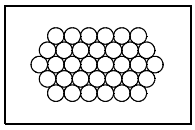
-3 dB:	8° x 13°
-6 dB:	11° x 18°
-10 dB:	20° x 23°

Directivity Index:	25.3
Frequency Tolerance:	±2 kHz
Peak TVR[(1)], nominal:	173 dB
Peak TVR[(1)], minimum:	170 dB
Q (transmit):	9
Peak Source Level[(4)]:	226dB
Peak RVR[(2)], nominal:	-167 dB
Peak Figure of Merit[(3)]:	-2 dB

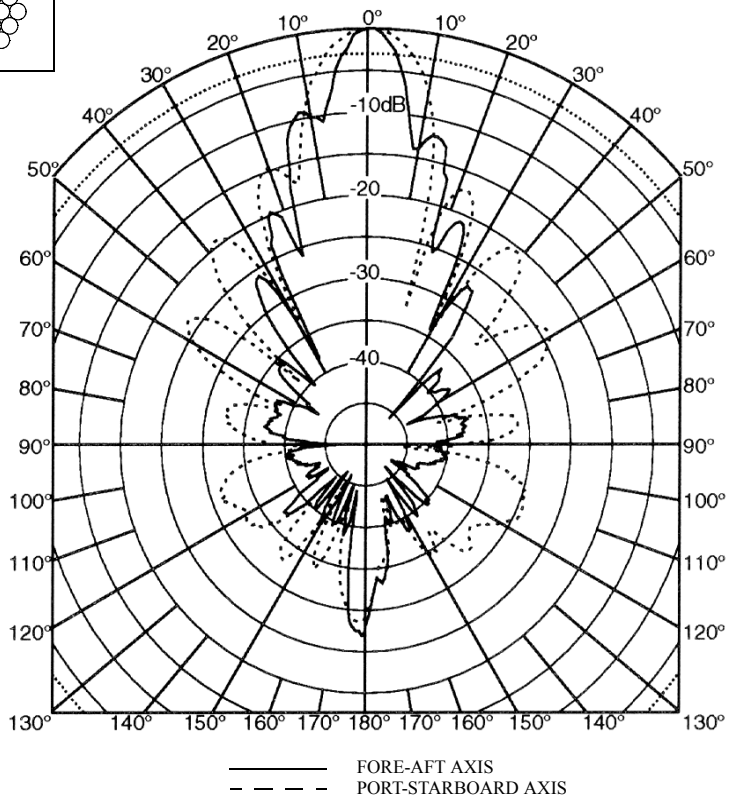
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

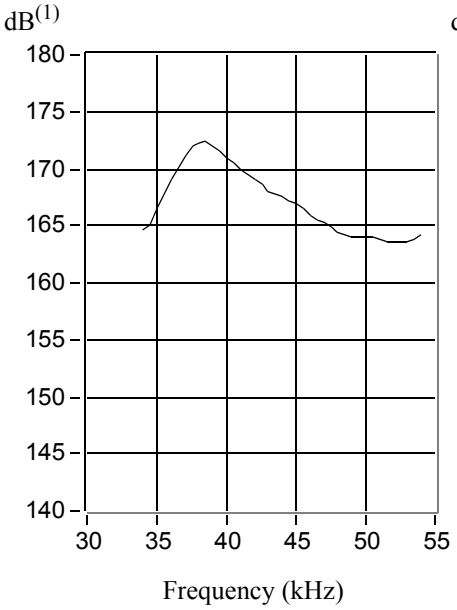
Array:



Transmit Radiation Pattern



TVR



RVR

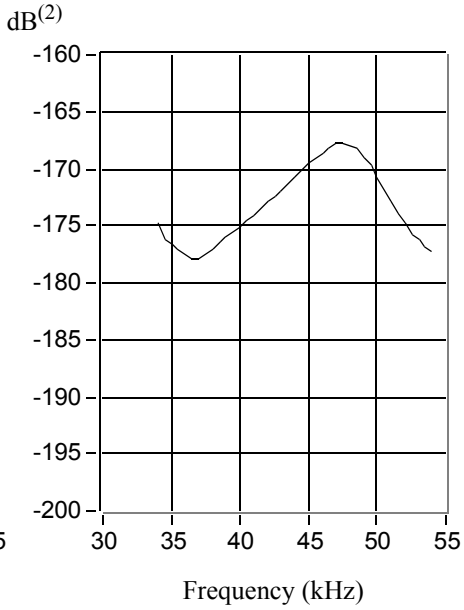
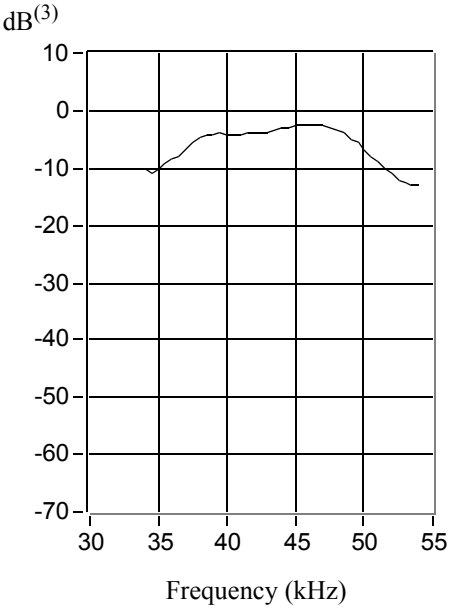


Figure of Merit



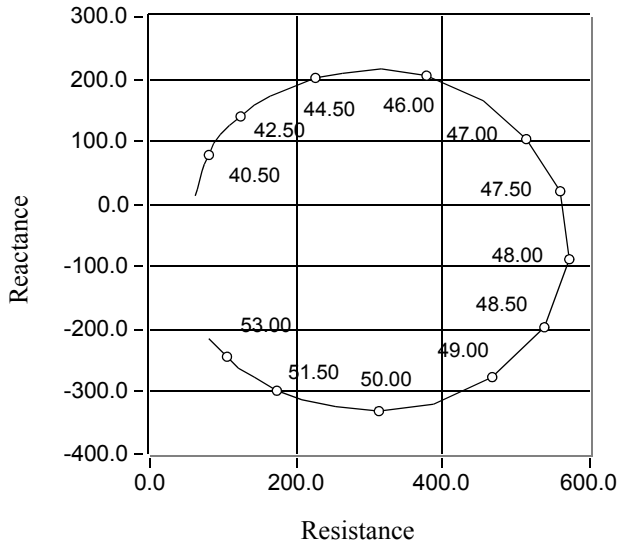
38 kHz-F

34x35mm (1.38") PZT/L

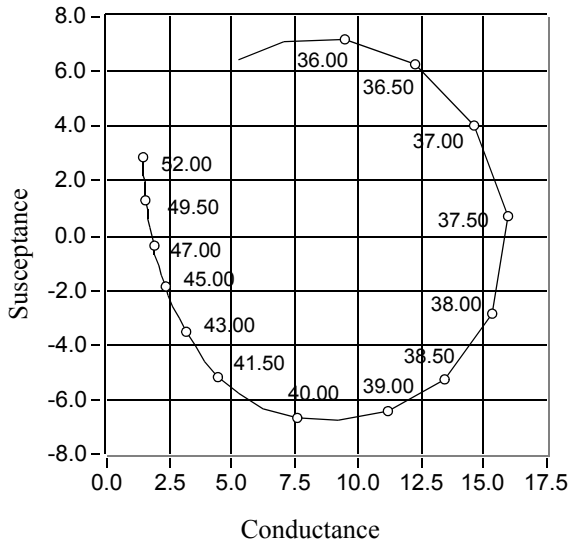
Cable Type: C43
Cable Length: 15.2m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60ohms -20%,+40%	60ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	60 – j0 ohms	60 – j0 ohms
1 kHz Capacitance	n/a	n/a

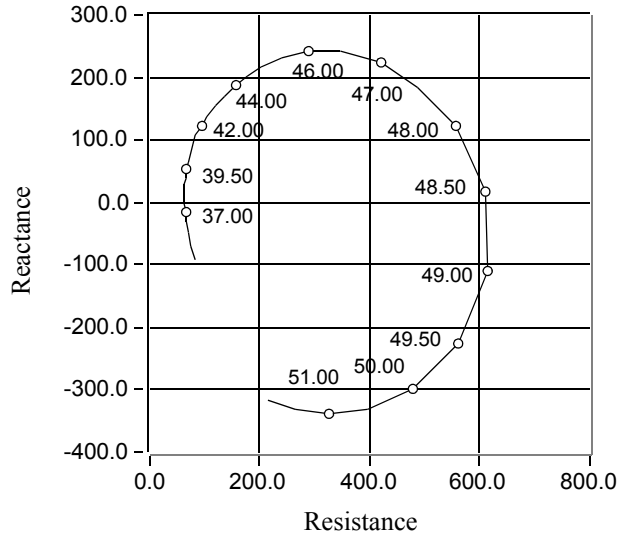
Unbalanced Impedance



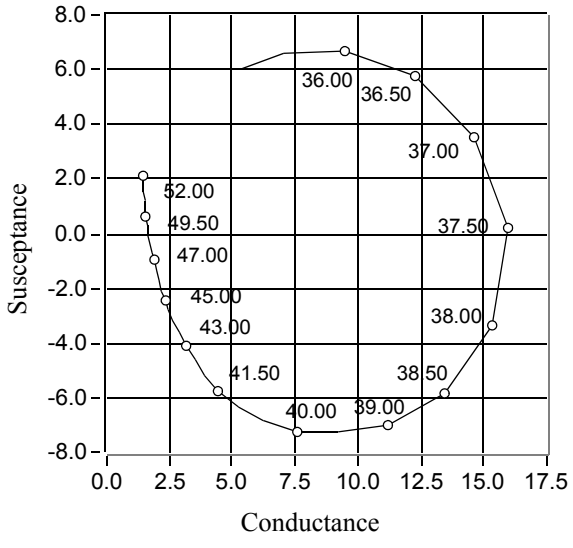
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



38 kHz-J

Transformed to 60 ohms

Power rating: 1 kW$_{rms}$ @ 2% duty cycle

7 x 51 mm (2.05") PZT/L

Active Area: 142 cm^2

Urethane Window

Beamwidth:

-3 dB:	15°
-6 dB:	20°
-10 dB:	26°

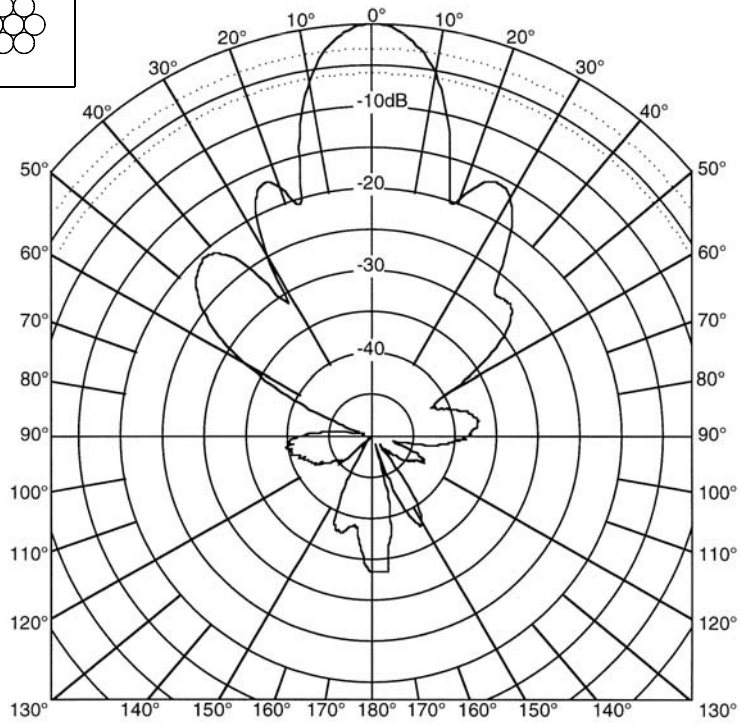
Directivity Index:	22.1
Frequency Tolerance:	±.8 kHz
Peak TVR(1), nominal:	170 dB
Peak TVR(1), minimum:	167 dB
Q (transmit):	11
Peak Source Level(4):	217 dB
RVR(2), nominal:	-170 dB
Peak Figure of Merit(3):	-10 dB

Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

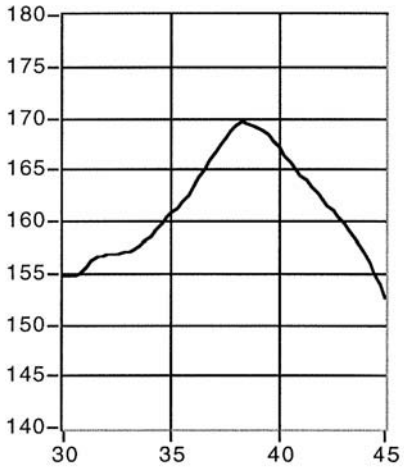
Array:

Transmit Radiation Pattern



TVR

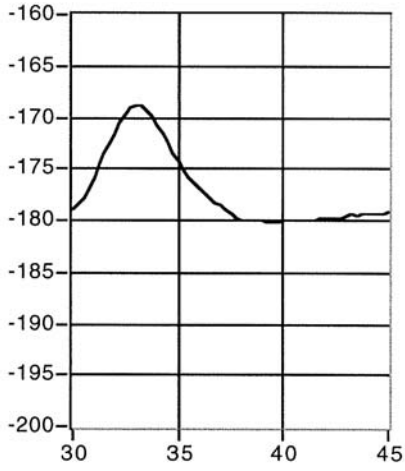
dB(1)



Frequency (kHz)

RVR

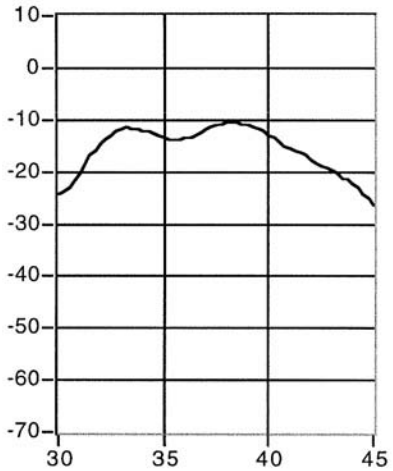
dB(2)



Frequency (kHz)

Figure of Merit

dB(3)



Frequency (kHz)

38 kHz-J

7x51mm (2.05") PZT/L

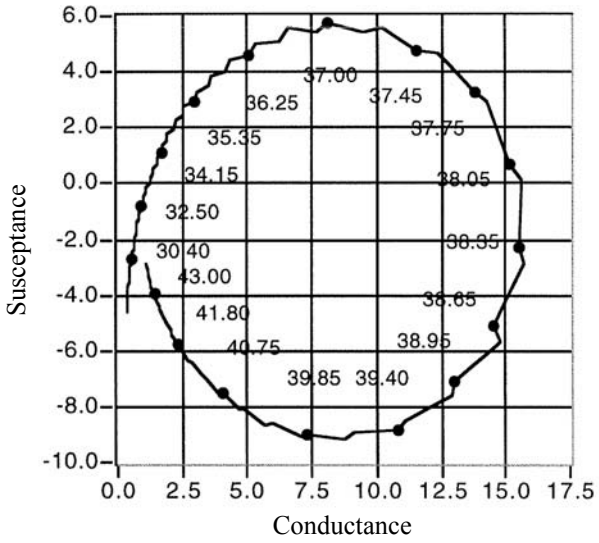
Cable Type: C43
Cable Length: 15.2m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60ohms -20%,+40%	60ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	60 – j0 ohms	60 – j0 ohms
1 kHz Capacitance	n/a	n/a

Balanced Impedance

For Detailed impedance data, contact AIRMAR

Balanced Admittance



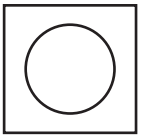
38 kHz-N

Power Rating: 350 W rms @ 2% duty cycle
51 mm (2.0") PZT/L
Active Area: 20 cm^2
Urethane Window

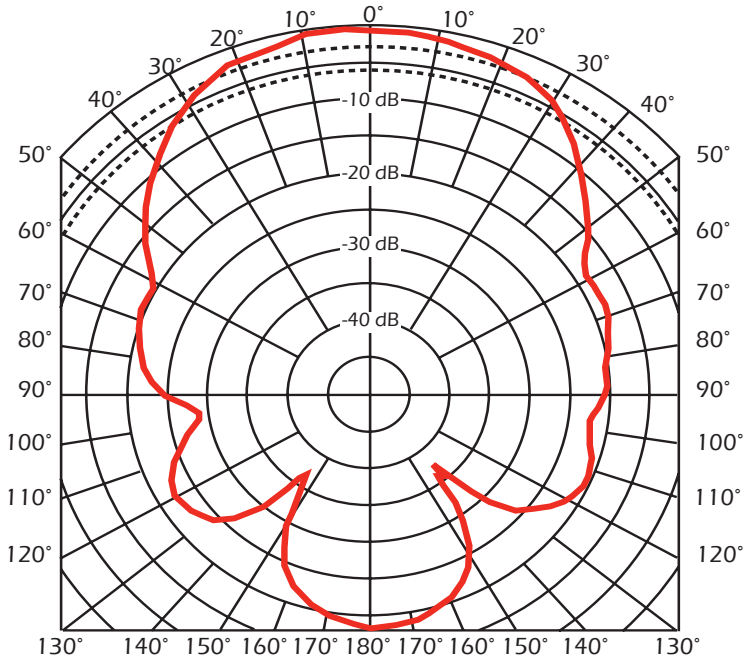
Beamwidth:
-3 dB: 53°
-6 dB: 68°
-10 dB: 84°

Directivity Index:	12.3
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	151 dB
Peak TVR(1), minimum:	149 dB
Q (transmit):	16
Peak Source Level(4):	205 dB
Peak RVR(2), nominal:	-172 dB
Peak Figure of Merit(3):	-26 dB

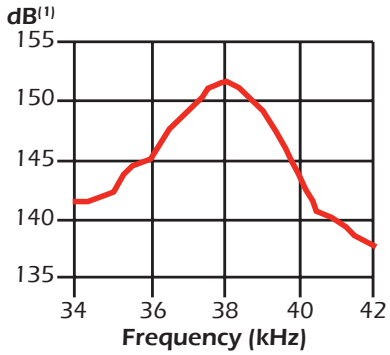
Array



Transmit Radiation Pattern



TVR



RVR

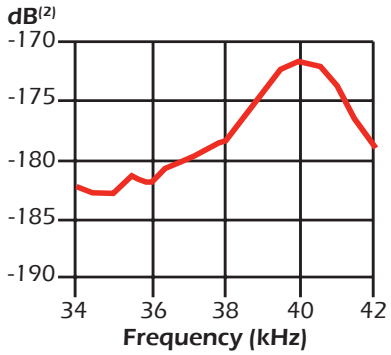
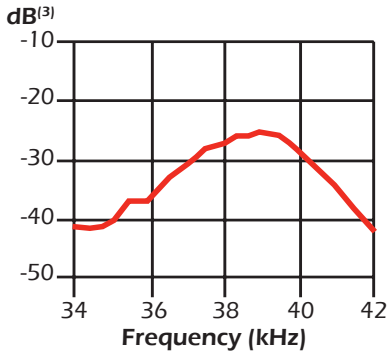


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

38 kHz-N

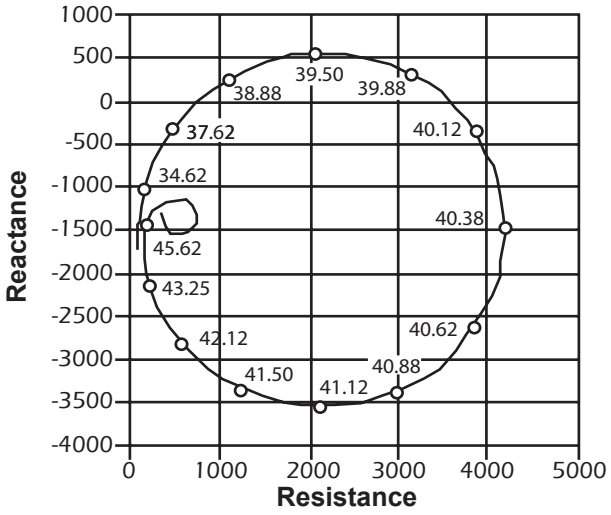
51 mm (2.0”) PZT/L

Cable Type: C44
Cable Length: 3.0 m (10’)

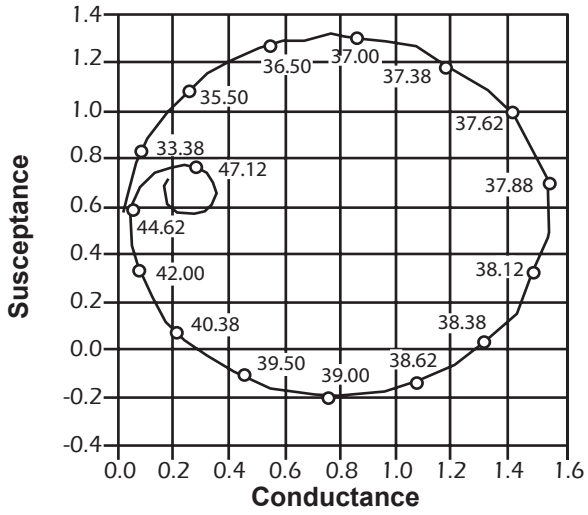
Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	640 Ω: -20%, +40%	640 Ω: -20%, +40%
Parallel: Cp. (nominal)	750 pF	2,020 pF
Series [R - jX]: (nominal)	630 Ω - j70 Ω	590 Ω - j180 Ω
1 kHz capacitance: (nominal)	1,410 pF ± 20%	2,670 pF ± 20%

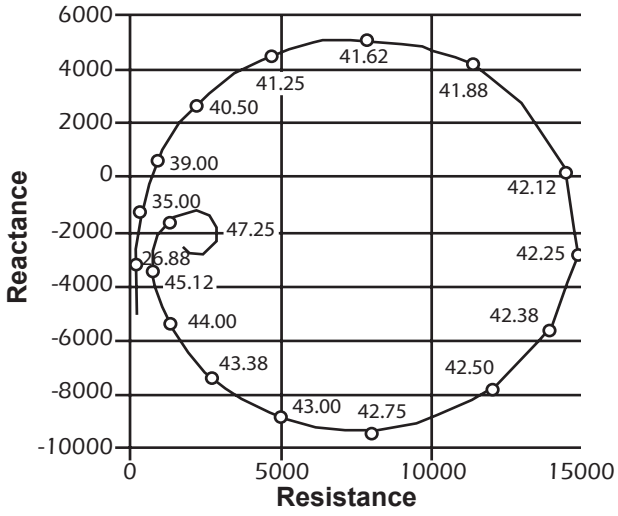
Unbalanced Impedance



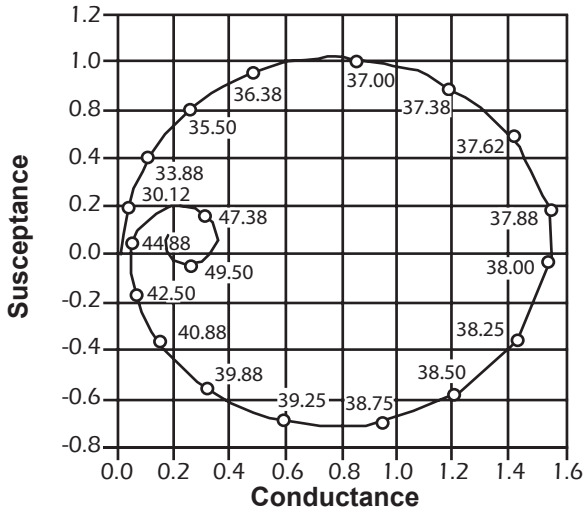
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



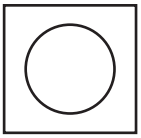
38 kHz-N

Transformed to 60 ohms
Power Rating: 350 W rms @ 2% duty cycle
51 mm (2.0") PZT/L
Active Area: 20 cm²
Urethane Window

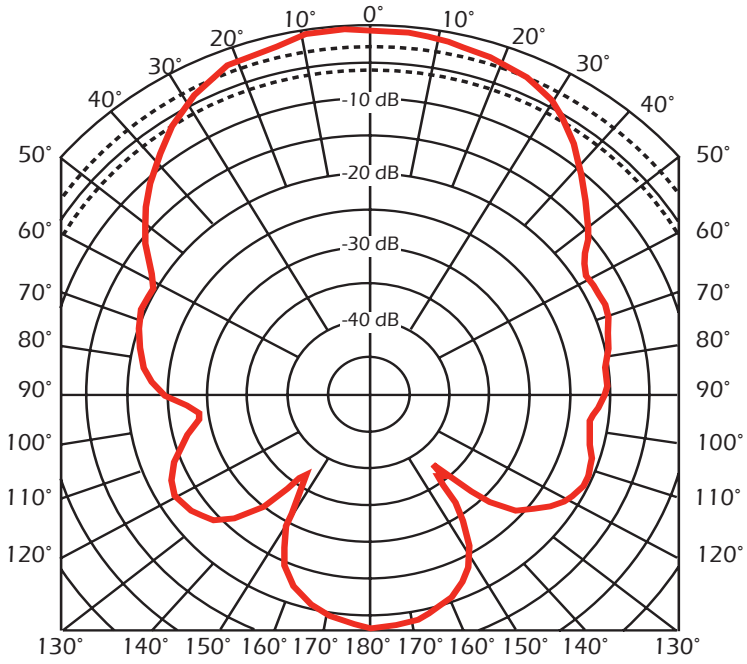
Beamwidth:
-3 dB: 53°
-6 dB: 68°
-10 dB: 84°

Directivity Index:	12.3
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	162 dB
Peak TVR(1), minimum:	160 dB
Q (transmit):	12
Peak Source Level(4):	205 dB
Peak RVR(2), nominal:	-183 dB
Peak Figure of Merit(3):	-26 dB

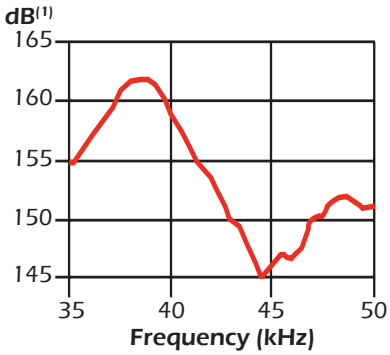
Array



Transmit Radiation Pattern



TVR



RVR

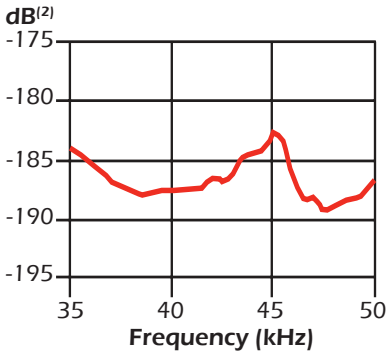
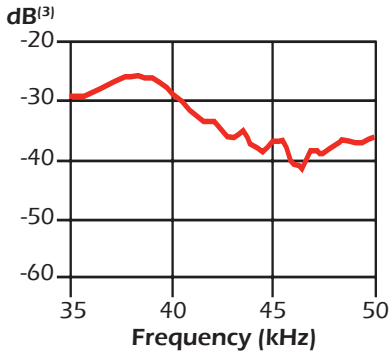


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

38 kHz-N

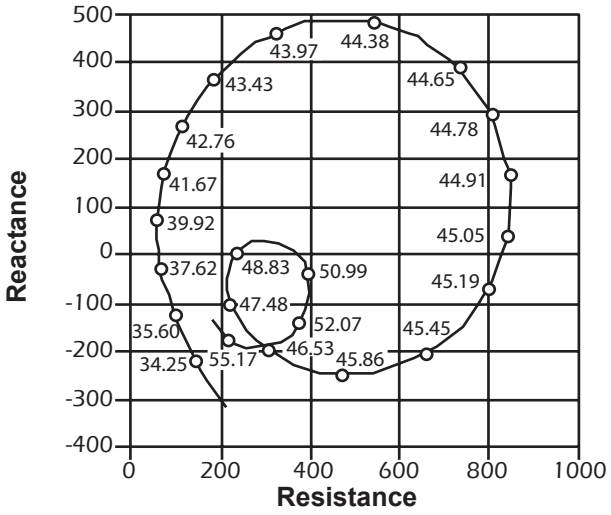
51 mm (2.0”) PZT/L

Cable Type: C37
Cable Length: 0.4 m (1.2’)

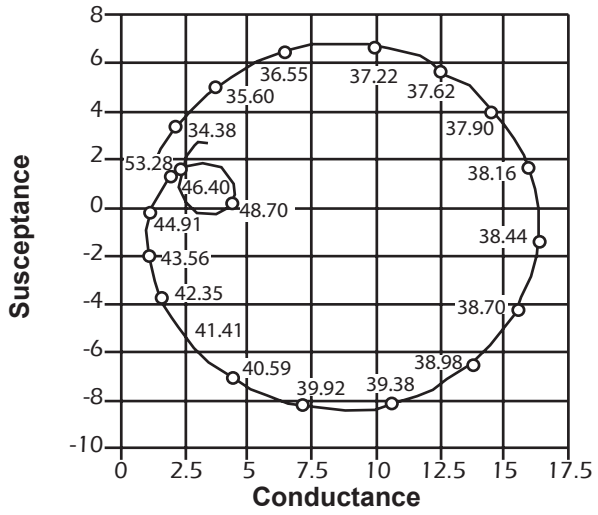
Note:
Impedance data includes cable

Impedance Data	
	Unbalanced
Parallel: Rp.	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF
Series [R - jX]: (nominal)	60 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a

Unbalanced Impedance

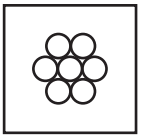


Unbalanced Admittance



40 kHz-H

Array

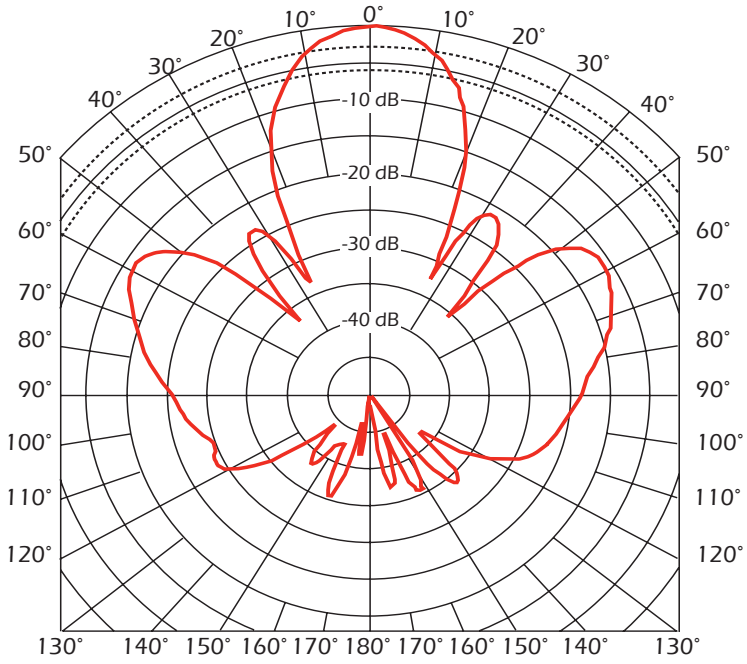


Transformed to 150 ohms
Power Rating: 1 kW rms @ 2% duty cycle
7 x 38 mm (1.50") PZT/L
Active Area: 80 cm²
Urethane Window

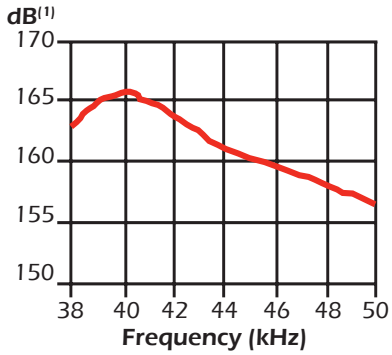
Beamwidth:
-3 dB: 19°
-6 dB: 27°
-10 dB: 34°

Directivity Index:	18.7
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	165 dB
Peak TVR(1), minimum:	163 dB
Q (transmit):	9
Peak Source Level(4):	217 dB
Peak RVR(2), nominal:	-168 dB
Peak Figure of Merit(3):	-10 dB

Transmit Radiation Pattern



TVR



RVR

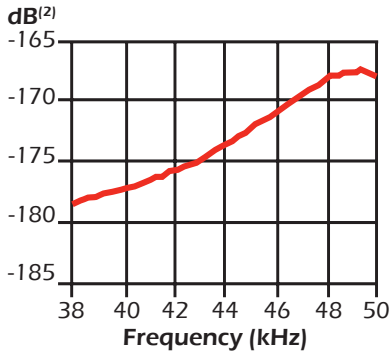
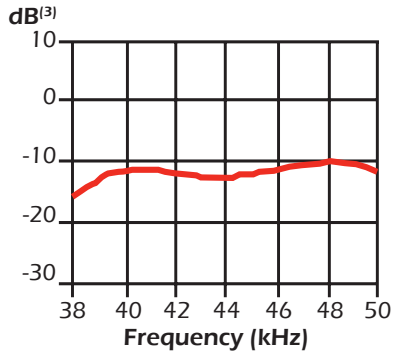


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

40 kHz-H

7 x 38 mm (1.50”) PZT/L

Cable Type: C37
Cable Length: 9.1 m (30’)

Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	150 Ω: -20%, +40%	150 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	150 Ω - j0 Ω	150 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

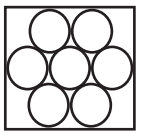
Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
36.00	270.48	-63.45	120.90	-241.95	1.6526	3.3073	605.12	14621.52
36.25	257.03	-61.48	122.71	-225.85	1.8574	3.4185	538.39	15008.98
36.50	241.49	-58.93	124.65	-206.84	2.1373	3.5467	467.87	15464.97
36.75	226.09	-56.65	124.28	-188.86	2.4314	3.6948	411.29	16001.39
37.00	211.18	-54.50	122.63	-171.92	2.7499	3.8552	363.65	16582.96
37.25	199.62	-52.27	122.16	-157.87	3.0657	3.9619	326.19	16927.74
37.50	188.57	-49.31	122.95	-142.98	3.4577	4.0210	289.21	17065.47
37.75	179.09	-45.36	125.84	-127.43	3.9234	3.9731	254.88	16750.51
38.00	169.17	-40.95	127.78	-110.86	4.4649	3.8738	223.97	16224.61
38.25	159.60	-36.12	128.93	-94.08	5.0612	3.6933	197.58	15367.67
38.50	150.97	-31.26	129.05	-78.35	5.6619	3.4375	176.62	14210.37
38.75	145.96	-26.34	130.80	-64.77	6.1396	3.0403	162.88	12487.25
39.00	143.45	-21.03	133.90	-51.47	6.5069	2.5013	153.68	10207.63
39.25	144.64	-15.04	139.68	-37.54	6.6768	1.7945	149.77	7276.69
39.50	145.65	-8.23	144.15	-20.85	6.7950	0.9828	147.17	3959.75
39.75	146.38	-1.85	145.30	-4.71	6.8281	0.2200	146.45	880.88
40.00	148.20	4.61	147.72	11.91	6.7257	-0.5423	148.68	-2157.59
40.25	151.99	8.81	150.19	23.27	6.5020	-1.0073	153.80	-3982.90
40.50	158.37	13.14	154.22	36.00	6.1491	-1.4355	162.63	-5641.05
40.75	170.94	16.59	163.83	48.81	5.6064	-1.6703	178.37	-6523.71
41.00	182.18	21.84	169.10	67.77	6.0951	-2.0421	196.27	-7927.00
41.25	193.76	25.87	174.34	84.55	4.6436	-2.2520	215.35	-8689.09
41.50	201.67	29.43	175.66	99.09	4.3186	-2.4361	231.56	-9342.54
41.75	214.06	32.10	181.33	113.75	3.9575	-2.4825	252.69	-9463.61
42.00	229.41	34.06	190.04	128.49	3.6112	-2.4416	276.92	-9252.12
42.25	249.20	35.77	201.38	145.07	3.2691	-2.3550	305.89	-8871.26
42.50	268.34	37.84	211.90	164.63	3.9428	-2.2864	339.81	-8562.15
42.75	285.18	40.68	216.27	185.89	2.6593	-2.2857	376.04	-8509.54
43.00	304.48	42.38	224.90	205.25	2.4260	-2.2139	412.21	-8194.33
43.25	315.93	43.01	231.01	215.51	2.3145	-2.1592	432.06	-7945.54
43.50	339.05	43.02	247.91	231.30	2.1565	-2.0120	463.71	-7361.52
43.75	364.06	42.64	267.81	246.62	2.0205	-1.8607	494.92	-6768.88
44.00	397.67	43.26	289.61	272.52	1.8314	-1.7232	546.04	-6233.23

50 kHz-AE

Power Rating: 1kW rms @ 1% duty cycle
7 x 28 mm (1.13") PZT/L
Active Area: 45 cm² (6.97 in²)
Radiating Surface: Urethane

Array

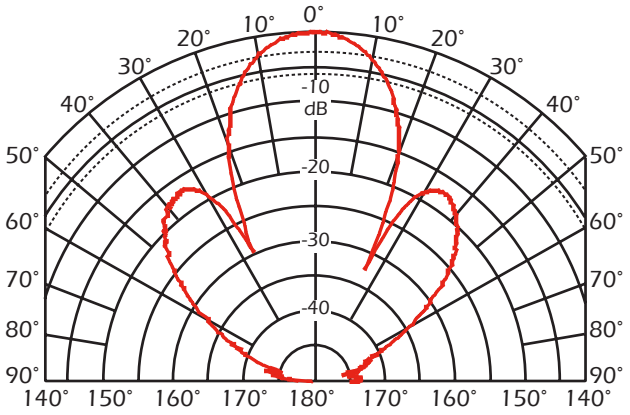


Beamwidth:

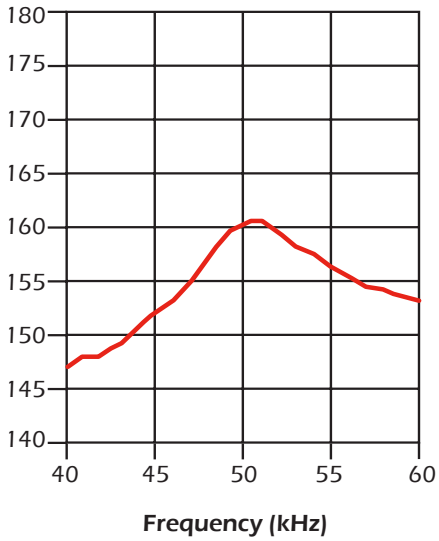
-3 dB:	19°
-6 dB:	27°
-10 dB:	34°

Directivity Index:	18.9 dB
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	160.7 dB
Peak TVR(1), minimum:	158.7 dB
Q (transmit):	9
Peak Source Level(4):	215 dB
Peak RVR(2), nominal:	-176 dB
Peak Figure of Merit(3):	-17.2 dB

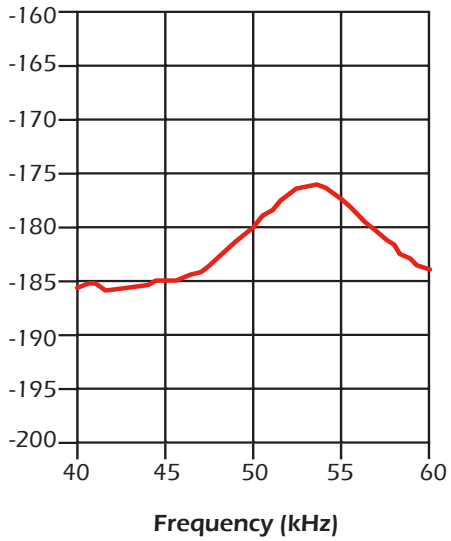
Transmit Radiation Pattern



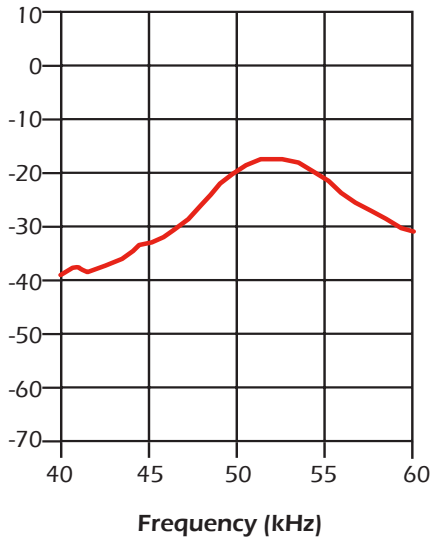
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

50 kHz-AE

7 x 28 mm (1.13”) PZT/L

Cable Type: C332
Cable Length: 10.4 m (34’)

Note:
Impedance data includes cable

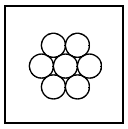
Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	300 Ω: -20%, +40%	300 Ω: -20%, +40%
Parallel: Cp. (nominal)	5,850 pF	7,430 pF
Series [R - jX]: (nominal)	240 - j150 Ω	210 - j160 Ω
1 kHz capacitance: (nominal)	8,100 pF	9,620 pF

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
40.00	583.85	-84.07	60.36	-580.72	0.18	1.70	5647.66	6778.36
40.50	558.21	-84.18	56.62	-555.33	0.18	1.78	5503.00	7003.67
41.00	534.12	-84.19	54.07	-531.38	0.19	1.86	5276.04	7230.36
42.00	487.82	-84.00	51.03	-485.15	0.21	2.04	4663.34	7725.35
42.50	466.79	-83.63	51.82	-463.90	0.24	2.13	4205.12	7973.00
43.00	445.96	-83.11	53.52	-442.73	0.27	2.23	3715.76	8239.66
44.00	407.74	-81.90	57.45	-403.67	0.35	2.43	2893.66	8782.72
44.50	388.90	-80.90	61.52	-384.01	0.41	2.54	2458.52	9080.63
45.00	370.50	-79.69	66.29	-364.52	0.48	2.66	2070.61	9391.90
46.00	335.58	-76.64	77.53	-326.50	0.69	2.90	1452.50	10031.33
46.50	317.44	-74.64	84.10	-306.10	0.83	3.04	1198.22	10396.82
47.00	301.72	-72.14	92.55	-287.18	1.02	3.15	983.64	10682.21
48.00	272.05	-64.54	116.94	-245.64	1.58	3.32	632.93	11004.43
48.50	262.68	-59.79	132.16	-227.01	1.92	3.29	522.11	10796.13
49.00	255.91	-53.29	152.96	-205.17	2.34	3.13	428.17	10175.38
49.50	253.11	-46.44	174.41	-183.43	2.72	2.86	367.32	9205.66
50.00	260.90	-38.85	203.19	-163.65	2.99	2.40	334.99	7652.76
50.50	282.12	-31.58	240.33	-147.75	3.02	1.86	331.17	5850.64
51.00	311.13	-24.83	282.37	-130.66	2.92	1.35	342.83	4211.95
51.50	357.02	-20.43	334.56	-124.64	2.62	0.98	380.99	3021.88
52.00	421.33	-18.63	399.24	-134.61	2.25	0.76	444.63	2320.92
52.50	492.19	-19.47	464.05	-164.05	1.92	0.68	522.04	2052.82
53.00	571.22	-21.77	530.49	-211.83	1.63	0.65	615.08	1949.53
54.00	706.53	-34.07	585.23	-395.85	1.17	0.79	852.98	2337.17
54.50	745.89	-40.07	570.78	-480.17	1.03	0.86	974.73	2520.40
55.00	760.19	-47.11	517.37	-556.98	0.90	0.96	1116.99	2789.00
56.00	740.90	-57.88	393.95	-627.48	0.72	1.14	1393.39	3248.75
56.50	713.58	-62.46	329.97	-632.70	0.65	1.24	1543.15	3500.18
57.00	688.47	-66.22	277.59	-630.03	0.59	1.33	1707.50	3711.37
58.00	635.08	-71.15	205.16	-601.03	0.51	1.49	1965.94	4089.14
58.50	609.86	-73.32	175.04	-584.20	0.47	1.57	2124.82	4273.36
59.00	589.73	-74.91	153.55	-569.39	0.44	1.64	2265.02	4416.40
60.00	546.54	-77.13	121.75	-532.81	0.41	1.78	2453.56	4731.44

50 kHz-AE

Array:



Transformed to 70 ohms

Power rating: 1 kWrms @ 2% duty cycle
7x28mm (1.13") PZT/L
Active Area: 45cm²
Urethane Window

Beamwidth:

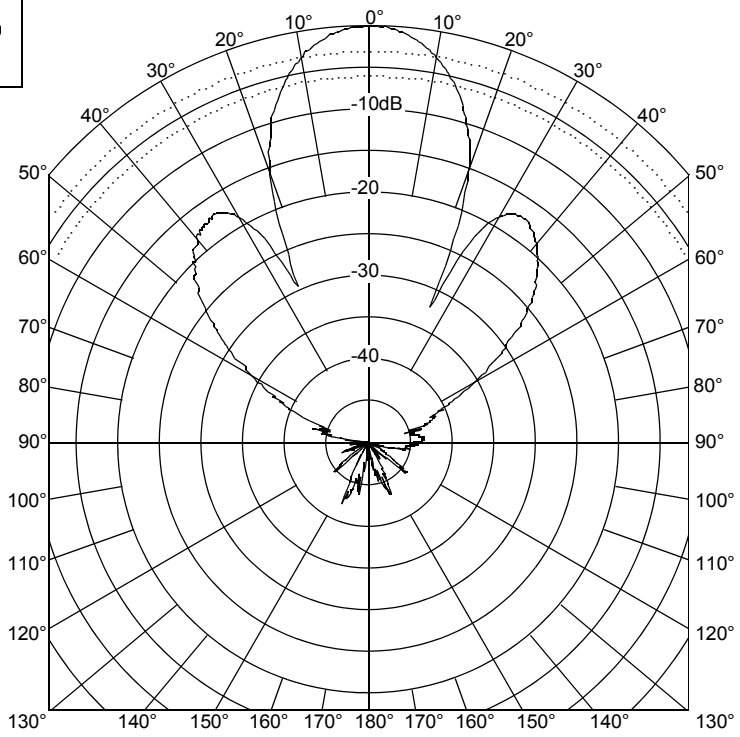
-3dB: 19°
-6dB: 27°
-10dB: 34°

Directivity Index:	18.9
Frequency Tolerance:	±2kHz
Peak TVR(1), nominal:	168dB
Peak TVR(1), minimum:	165dB
Q (transmit):	8
Peak Source Level(4):	217dB
RVR(2), nominal:	-176dB
Peak Figure of Merit(3):	-14dB

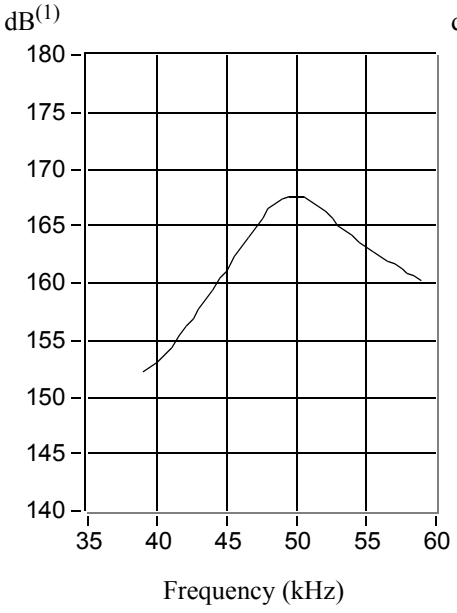
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

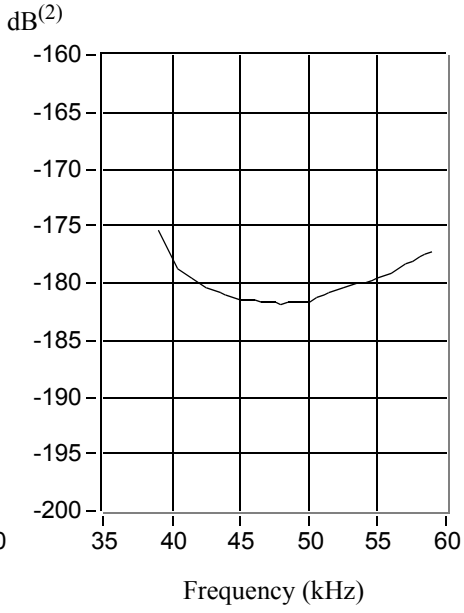
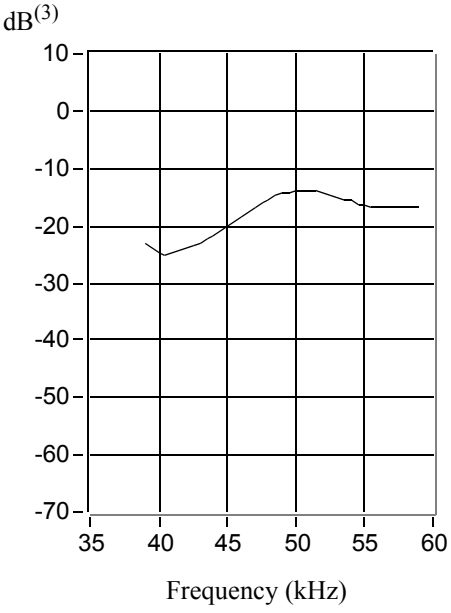


Figure of Merit



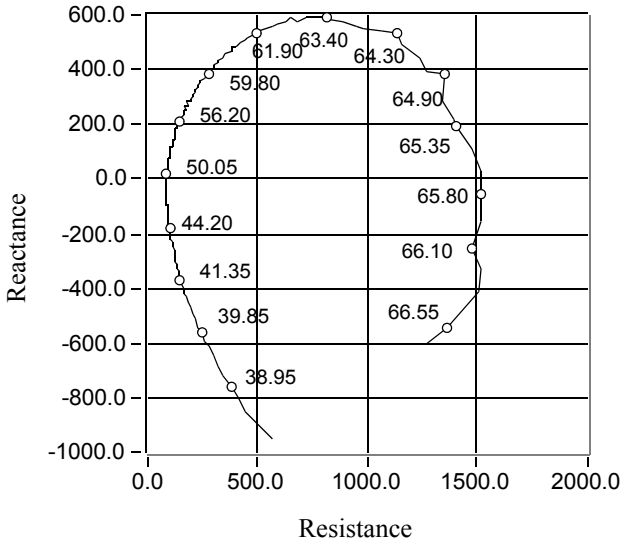
50 kHz-AE

7x28mm (1.13") PZT/L

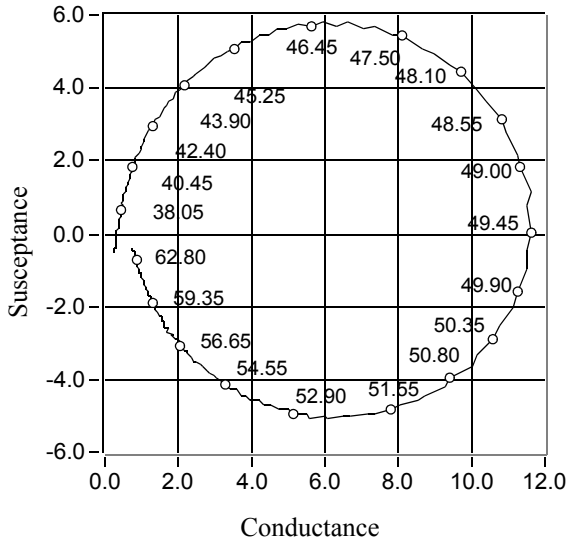
Cable Type: C35
Cable Length: 10.1m (33.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70ohms -20%,+40%	70ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	70 – j0 ohms	70 – j0 ohms
1 kHz Capacitance	n/a	n/a

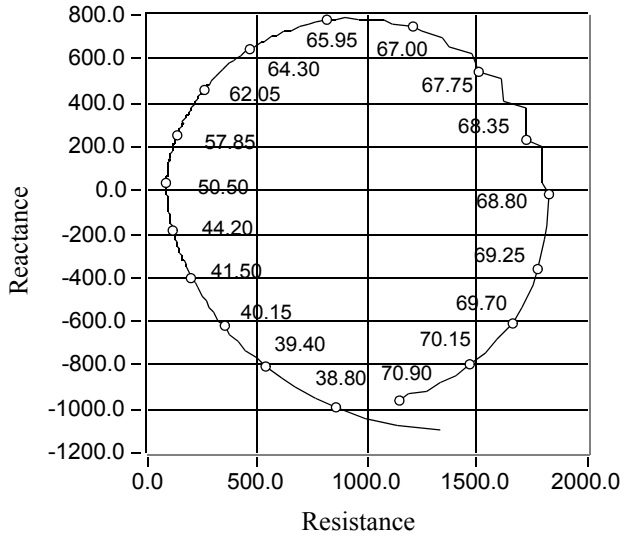
Unbalanced Impedance



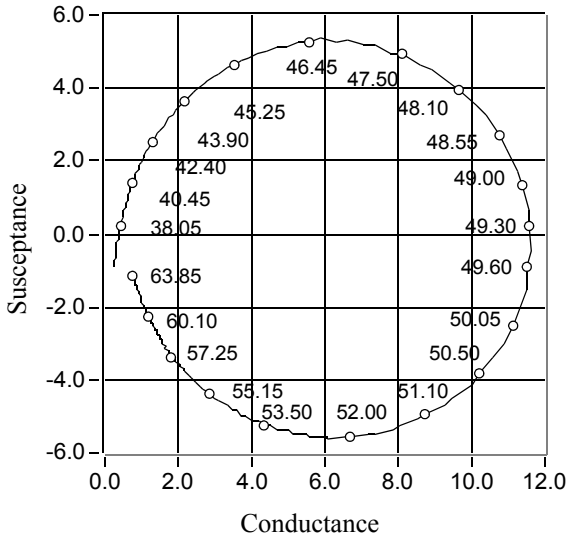
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



50 kHz-AE

Transformed to 130 ohms

Power rating: 1 kWrms @ 2% duty cycle

7x28mm (1.13") PZT/L

Active Area: 45cm^2

Urethane Window

Beamwidth:

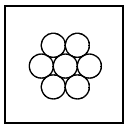
-3 dB: 19°
-6 dB: 27°
-10 dB: 34°

Directivity Index:	18.9
Frequency Tolerance:	±1.5 kHz
Peak TVR(1), nominal:	165 dB
Peak TVR(1), minimum:	163 dB
Q (transmit):	8
Peak Source Level(4):	216 dB
Peak RVR(2), nominal:	-169 dB
Peak Figure of Merit(3):	-14 dB

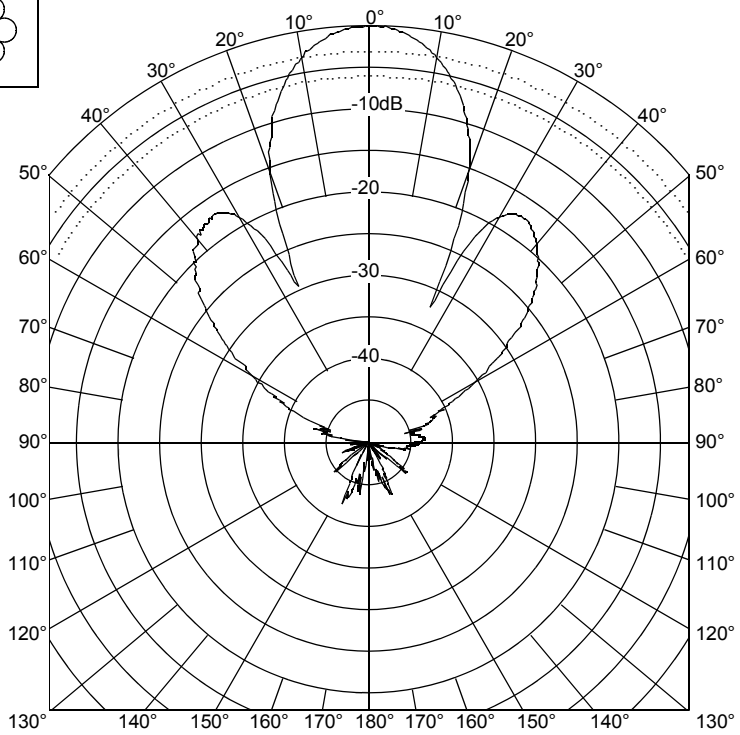
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

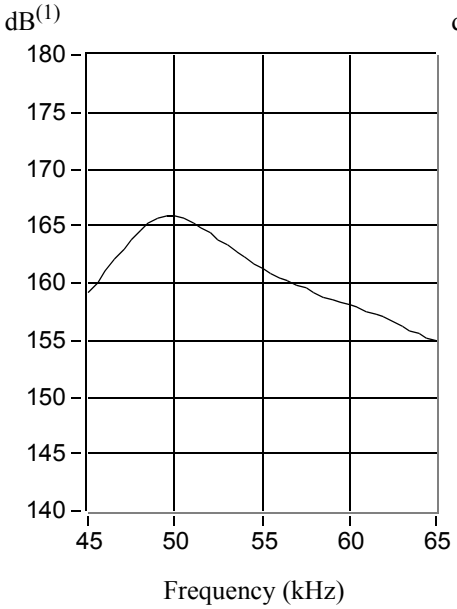
Array:



Transmit Radiation Pattern



TVR



RVR

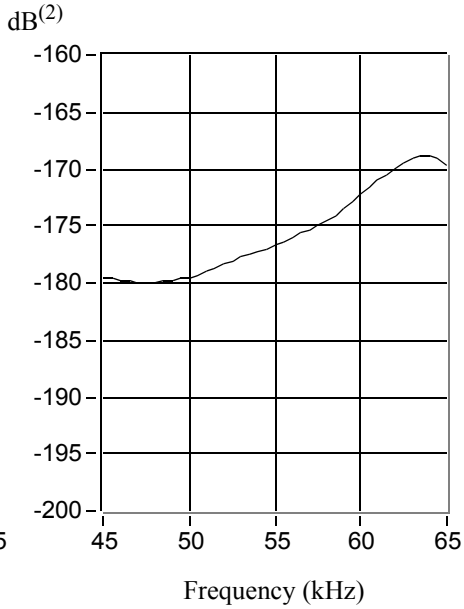
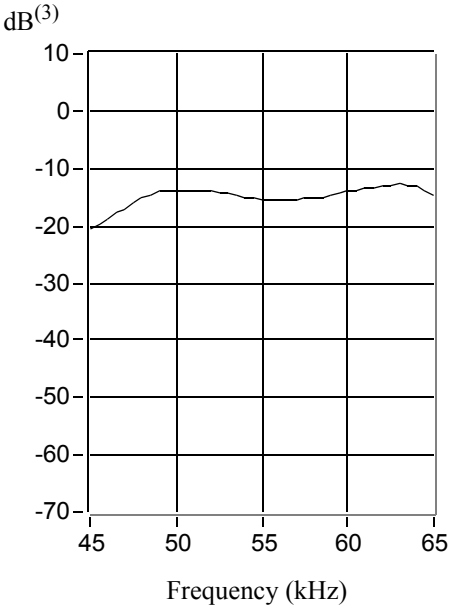


Figure of Merit



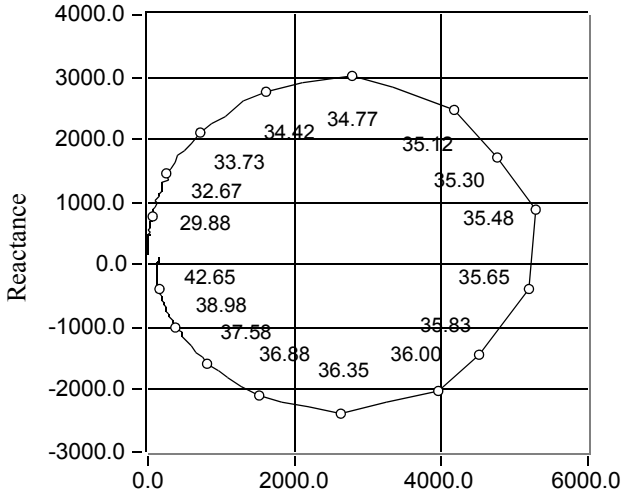
50 kHz-AE

7x28mm (1.13") PZT/L

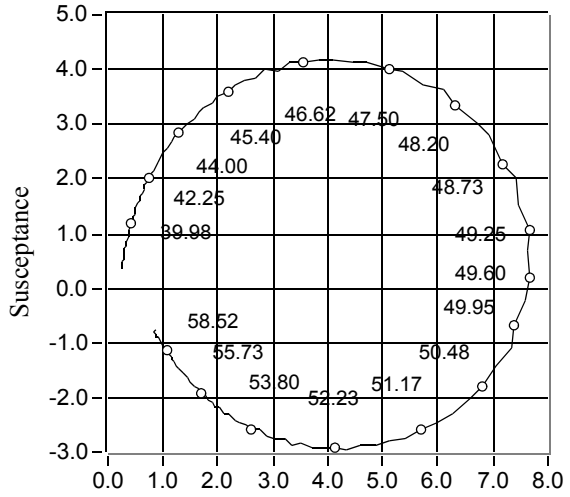
Cable Type: C44
Cable Length: 10.1m (33.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	130ohms-20%,+40%	130ohms-20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	130 – j0 ohms	130 – j0 ohms
1 kHz Capacitance	n/a	n/a

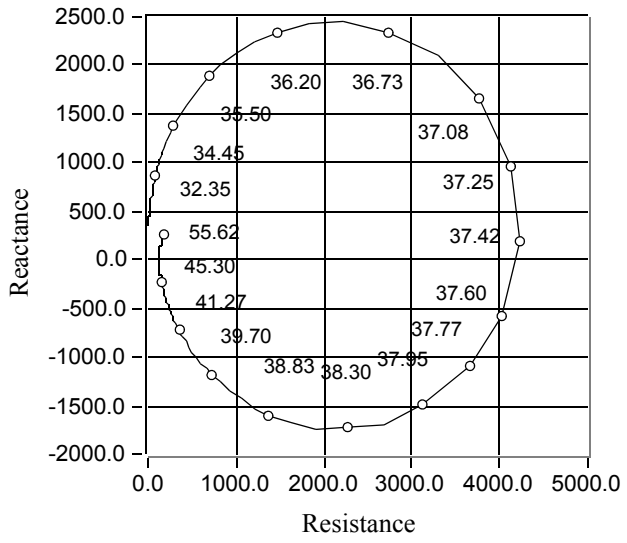
Unbalanced Impedance



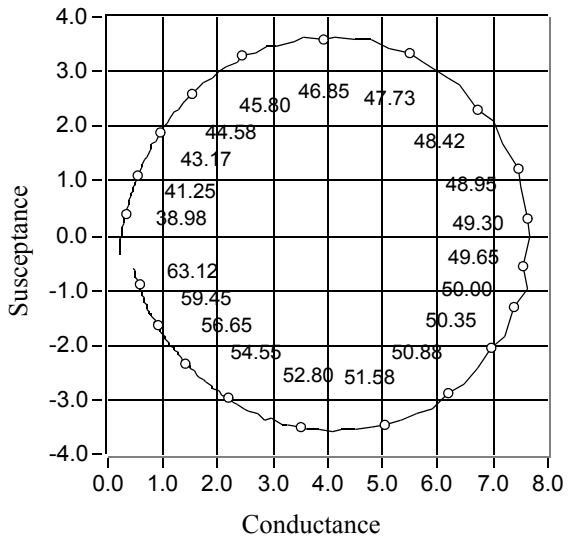
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



50 kHz-AFlq

Transformed to 75 ohms

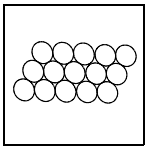
Power rating: 2 kWrms @ 2% duty cycle
15 x 35mm (1.38") PZT/L
Active Area: 144.6cm^2
Epoxy Window
Beamwidth:

-3dB: 8° x 17°
-6dB: 11° x 23°
-10dB: 15° x 29°

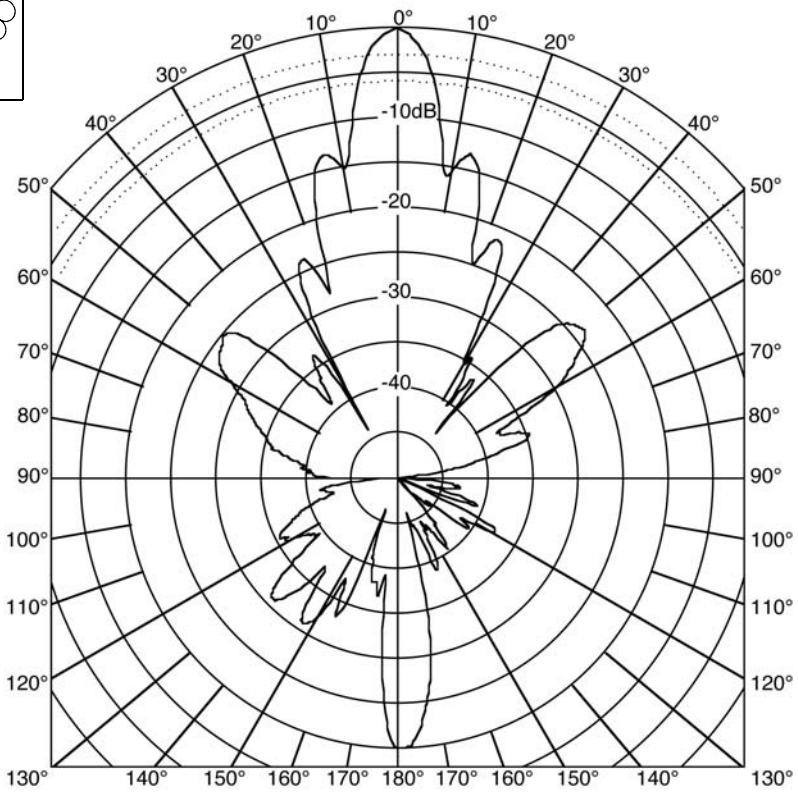
Directivity Index:	24.6
Frequency Tolerance:	±1kHz
Peak TVR(1), nominal:	171dB
Peak TVR(1), minimum:	169dB
Q (transmit):	3
Peak Source Level(4):	223dB
RVR(2), nominal:	-177dB
Peak Figure of Merit(3):	-8dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Array:

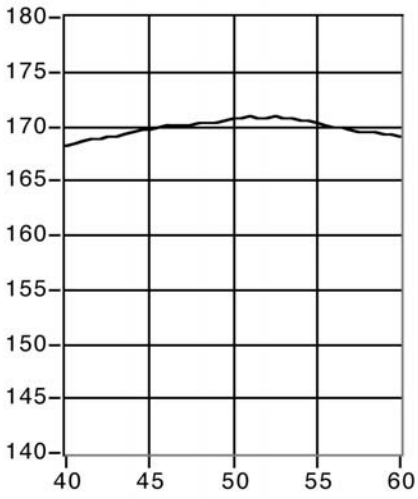


Transmit Radiation Pattern



TVR

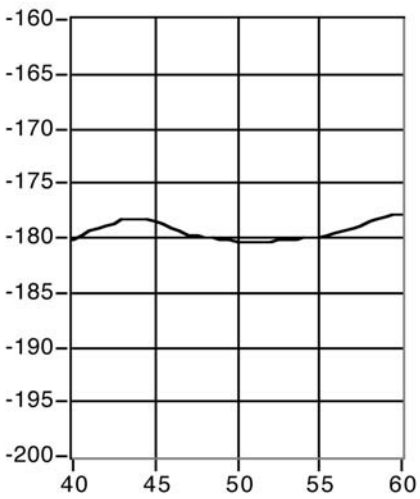
dB(1)



Frequency (kHz)

RVR

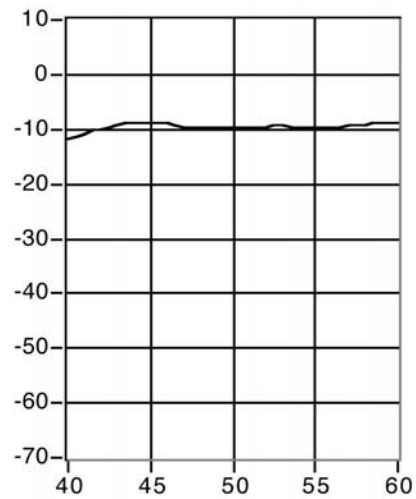
dB(2)



Frequency (kHz)

Figure of Merit

dB(3)



Frequency (kHz)

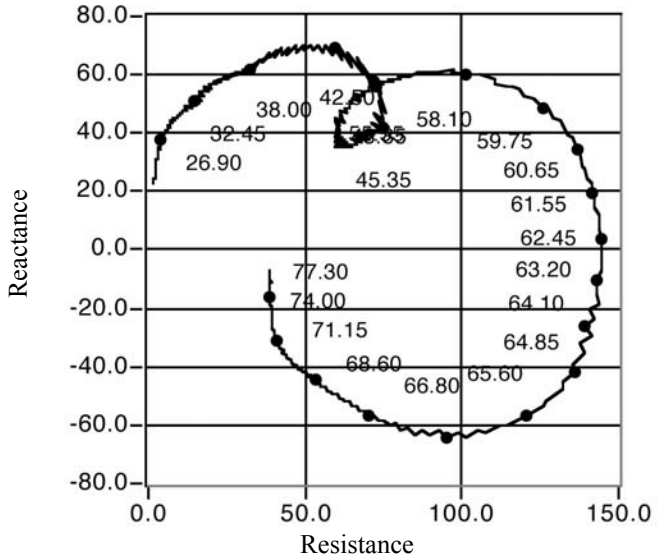
50 kHz-AFIq

15 x 35mm (1.38") PZT/L

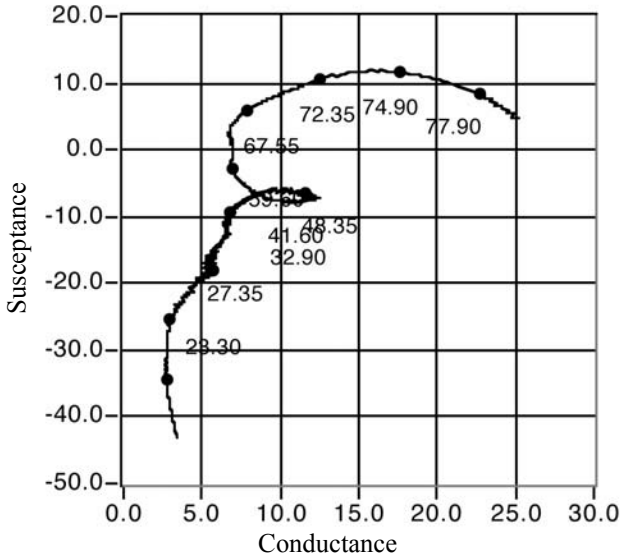
Cable Type: C35
Cable Length: 10.1 m (33.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	75 ohms -20%, +40%	75 ohms -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	75 – j0 ohms	75 – j0 ohms
1 kHz Capacitance	n/a	n/a

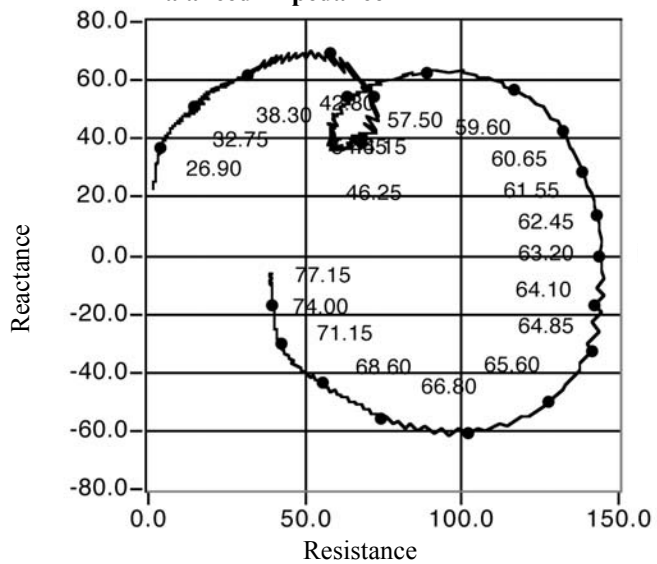
Unbalanced Impedance



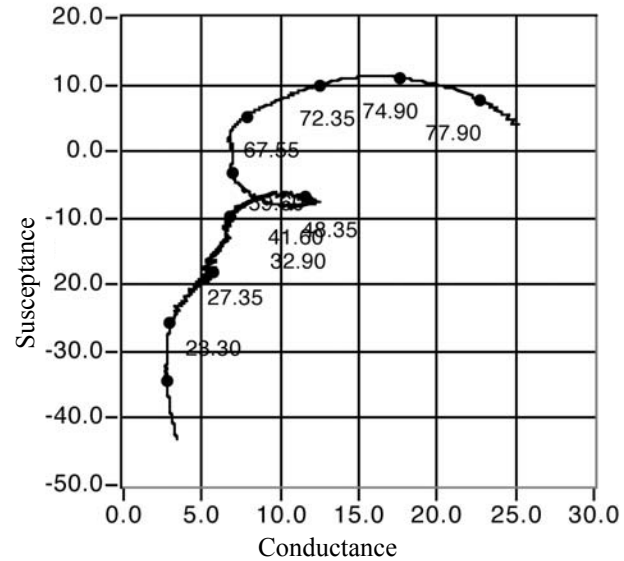
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



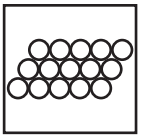
50 kHz-AFIq

Transformed to 100 ohms
Power Rating: 2 kW rms @ 2% duty cycle
15 x 35 mm (1.38") PZT
Active Area: 144.3 cm^2
Radiating Surface: Epoxy

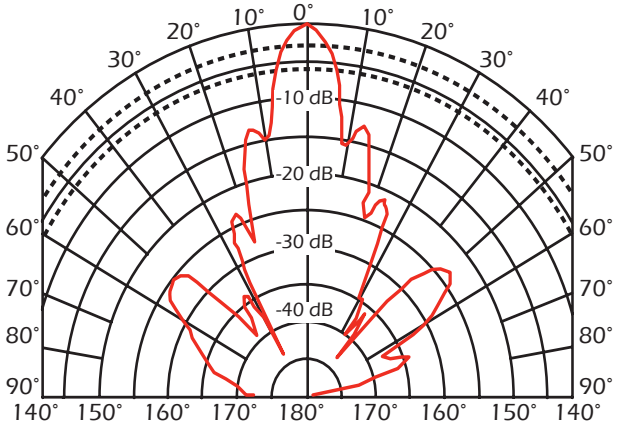
Beamwidth:
-3 dB: 8° x 17°
-6 dB: 11° x 23°
-10 dB: 15° x 29°

Directivity Index:	24.6
Frequency Tolerance:	±1 kHz
Peak TVR(1), nominal:	170 dB
Peak TVR(1), minimum:	168 dB
Q (transmit):	3
Peak Source Level(4):	223 dB
Peak RVR(2), nominal:	-175 dB
Peak Figure of Merit(3):	-9 dB

Array

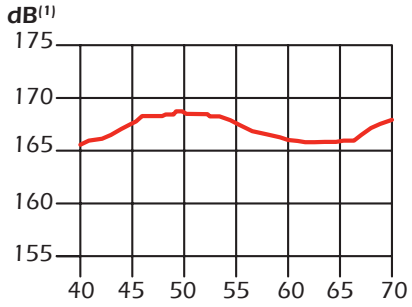


Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

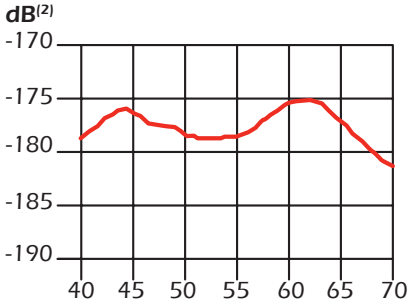
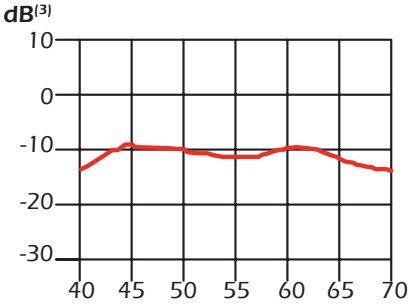


Figure of Merit



50 kHz-AFIq

33 mm (1.38”) PZT

Cable Type: C44
Cable Length: 15.0m (50.0’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	100 Ω: -20%, +40%	100 Ω: -20%, +40%
Parallel: Cp. (nominal)	-15490 pF	-12980 pF
Series [R - jX]: (nominal)	90 - j60 Ω	100 - j50 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
40.00	121.70	62.43	56.34	107.88	3.80	-7.28	262.93	-28979.50
41.00	130.88	58.09	69.17	111.11	4.04	-6.49	247.63	-25178.69
42.00	144.67	52.77	87.52	115.19	4.18	-5.50	239.13	-20855.88
43.00	149.71	46.04	103.92	107.76	4.64	-4.81	215.67	-17796.57
44.00	152.94	37.47	121.38	93.05	5.19	-3.98	192.71	-14388.45
45.00	140.73	30.62	121.10	71.69	6.11	-3.62	163.54	-12802.33
46.00	127.65	26.74	114.00	57.44	7.00	-3.53	142.94	-12197.07
47.00	122.49	29.08	107.05	59.54	7.13	-3.97	140.17	-13437.23
48.00	120.70	27.05	107.49	54.89	7.38	-3.77	135.52	-12492.86
49.00	117.69	26.87	104.98	53.20	7.58	-3.84	131.94	-12475.04
50.00	112.58	28.19	99.23	53.19	7.83	-4.20	127.74	-13357.36
51.00	112.12	29.31	97.76	54.89	7.78	-4.37	128.58	-13626.49
52.00	112.96	32.88	94.86	61.33	7.43	-4.81	134.51	-14711.09
53.00	117.06	34.26	96.75	65.89	7.06	-4.81	141.62	-14440.54
54.00	126.27	36.69	101.25	75.44	6.35	-4.73	157.46	-13947.16
55.00	135.69	38.43	106.30	84.34	5.77	-4.58	173.21	-13255.11
56.00	153.56	39.07	119.23	96.78	5.06	-4.10	197.78	-11663.40
57.00	171.65	37.05	137.01	103.41	4.65	-3.51	215.07	-9799.88
58.00	196.96	33.54	164.17	108.81	4.23	-2.81	236.29	-7697.05
59.00	219.52	27.34	195.00	100.81	4.05	-2.09	247.12	-5643.21
60.00	244.79	19.78	230.34	82.86	3.84	-1.38	260.15	-3667.67
61.00	267.77	10.59	263.21	49.22	3.67	-0.69	272.41	-1791.12
62.00	272.95	-0.99	272.91	-4.73	3.66	0.06	273.00	163.14
63.00	268.01	-12.38	261.77	-57.48	3.64	0.80	274.39	2021.51
64.00	249.90	-21.97	231.75	-93.49	3.71	1.50	269.46	3722.73
65.00	231.27	-29.93	200.44	-115.38	3.75	2.16	266.86	5281.87
66.00	212.04	-38.25	166.52	-131.28	3.70	2.92	270.01	7040.84
67.00	184.80	-44.96	130.75	-130.59	3.83	3.82	261.18	9083.58
68.00	159.47	-48.34	106.00	-119.14	4.17	4.69	239.91	10965.38
69.00	139.44	-50.23	89.20	-107.17	4.59	5.51	217.95	12714.19
70.00	124.20	-50.20	79.51	-95.42	5.15	6.19	194.02	14063.64

50 kHz-AN

Power rating: 600 Wrms @ 2% duty cycle
51 mm (2.0") PZT/L
Active Area: 20 cm²
Layered Plastic Urethane Window

Beamwidth:

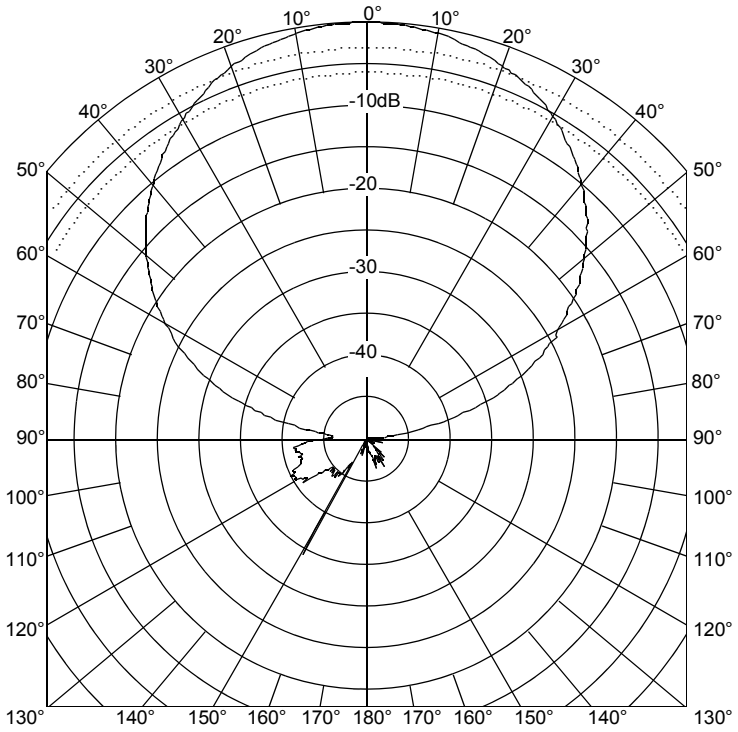
-3 dB:	44°
-6 dB:	62°
-10 dB:	79°

Directivity Index:	14.7
Frequency Tolerance:	±1.5 kHz
Peak TVR (1), nominal:	156 dB
Peak TVR (1), minimum:	153 dB
Q (transmit):	15
Peak Source Level (4):	209 dB
Peak RVR (2), nominal:	-176 dB
Peak Figure of Merit (3):	-26 dB

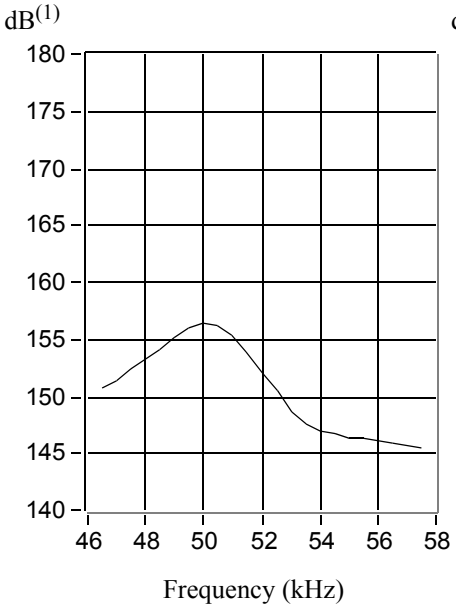
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

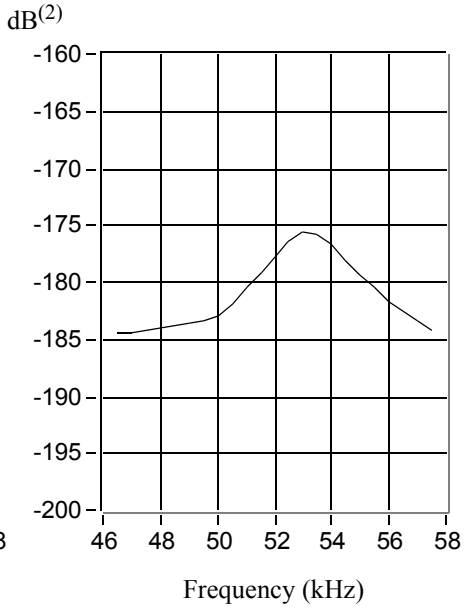
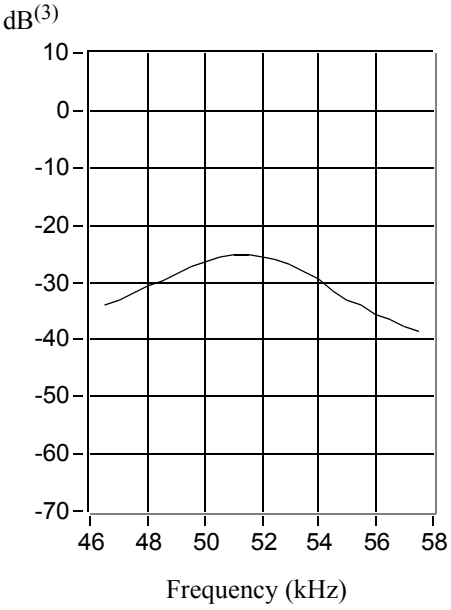


Figure of Merit



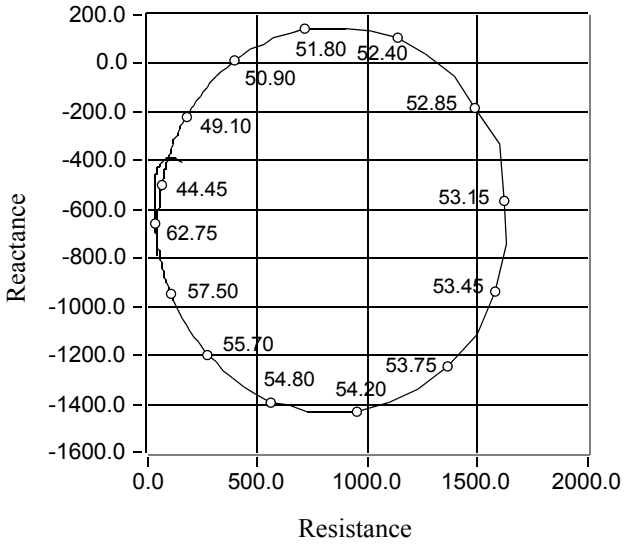
50 kHz-AN

51mm (2.0") PZT/L

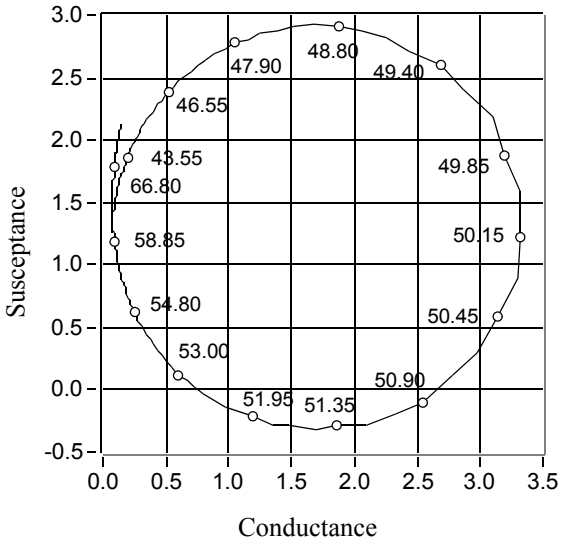
Cable Type: C47
Cable Length: 9.1m (30.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	300ohms-20%,+40%	300ohms-20%,+40%
Parallel: Cp. (nominal)	3540pF	4970pF
Series [R – jX] (nominal)	270 – j90 ohms	250 – j120 ohms
1 kHz Capacitance	3730pF±20%	5140 pF±20%

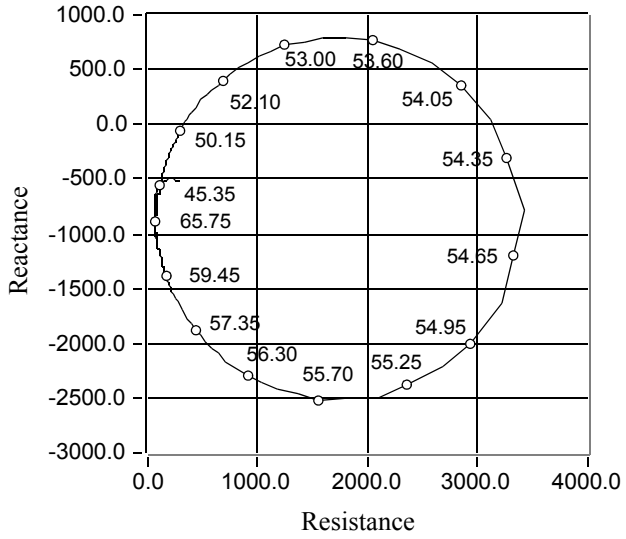
Unbalanced Impedance



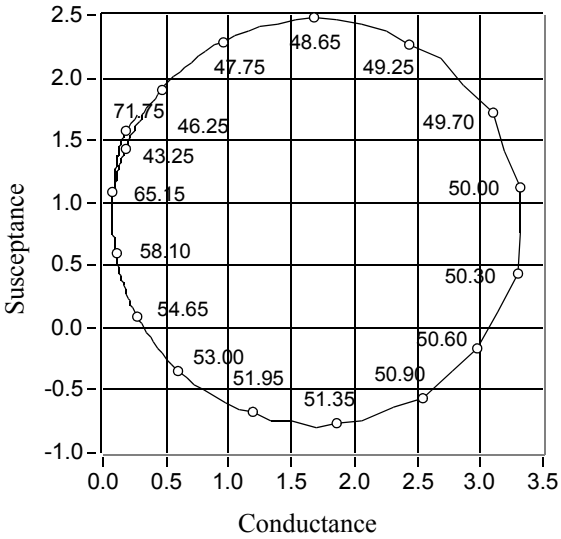
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



50 kHz-AN

Power rating: 600 Wrms @ 2% duty cycle
51 mm (2.0") PZT/L
Active Area: 20 cm²
Urethane Window

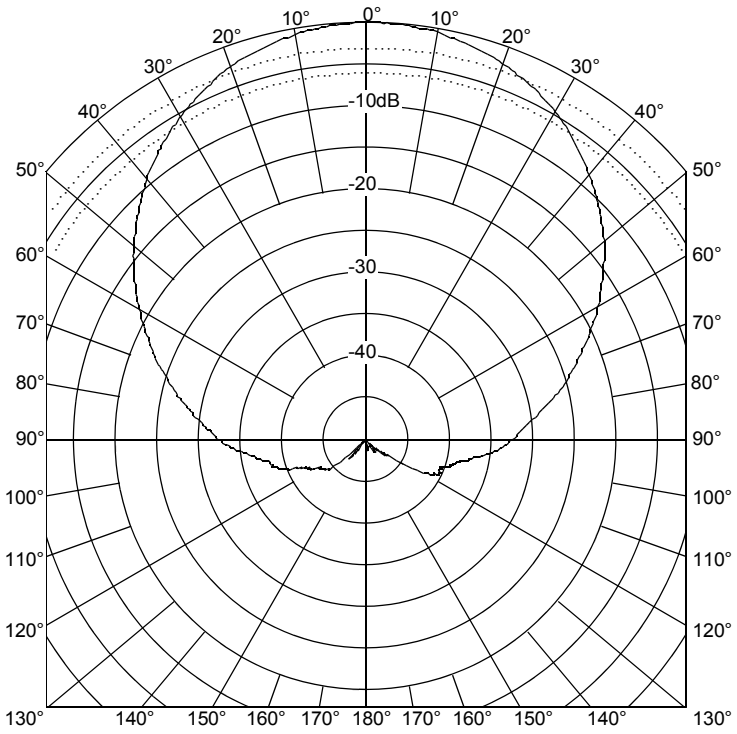
Beamwidth:

-3 dB:	46°
-6 dB:	65°
-10 dB:	85°

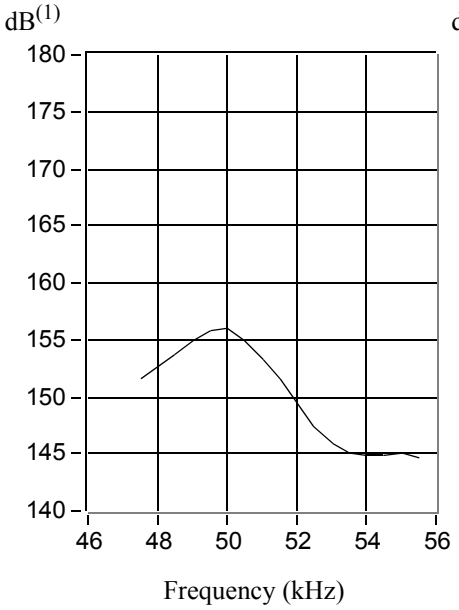
Directivity Index:	14.7
Frequency Tolerance:	±1.5 kHz
Peak TVR (1), nominal:	156 dB
Peak TVR (1), minimum:	154 dB
Q (transmit):	18
Peak Source Level (4):	207 dB
Peak RVR (2), nominal:	-175 dB
Peak Figure of Merit (3):	-27 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

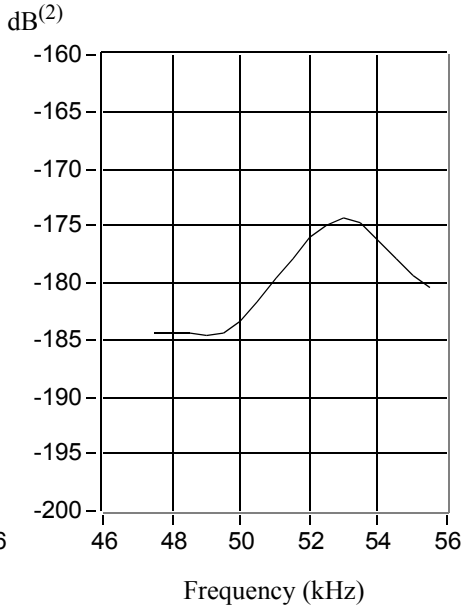
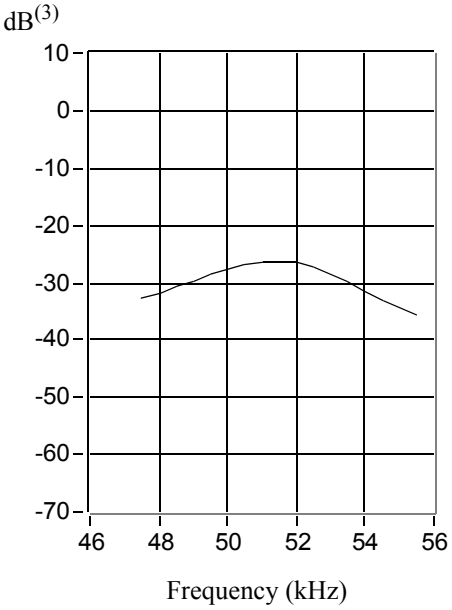


Figure of Merit



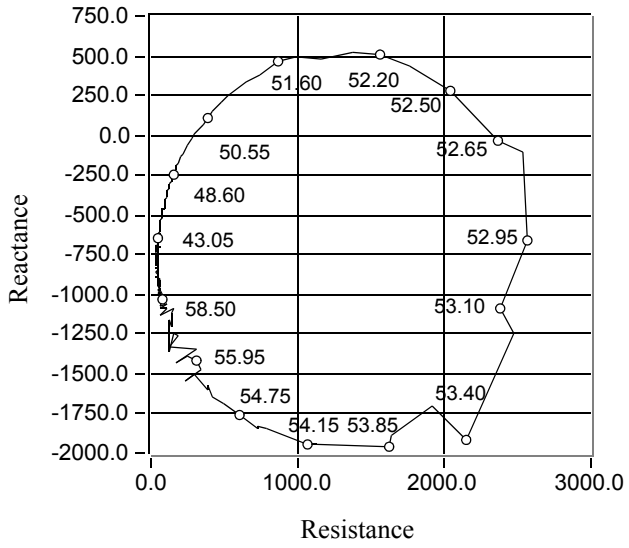
50 kHz-AN

51mm (2.0") PZT/L

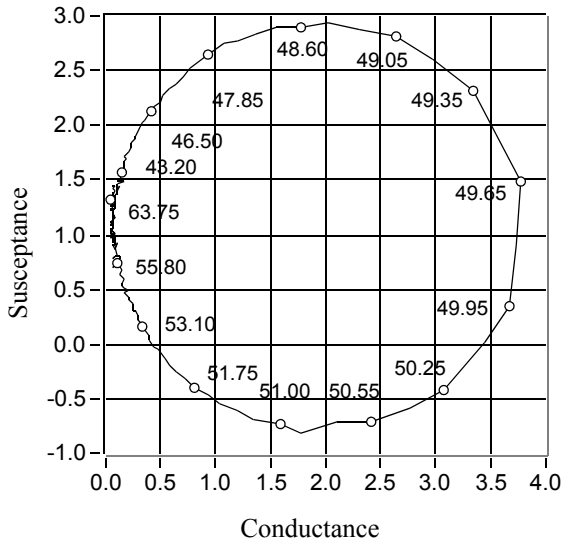
Cable Type: C1
Cable Length: 9.1m (30.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	280ohms-20%,+40%	270ohms-20%,+40%
Parallel: Cp. (nominal)	0pF	790pF
Series [R – jX] (nominal)	280 – j0 ohms	270 – j20 ohms
1 kHz Capacitance	3400pF±20%	4290pF±20%

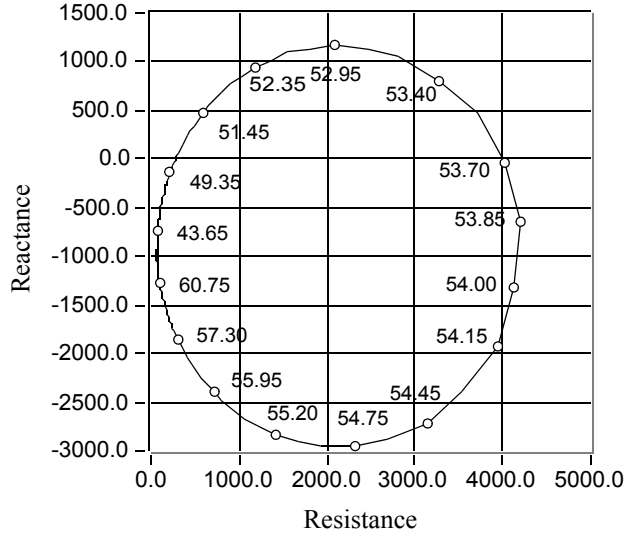
Unbalanced Impedance



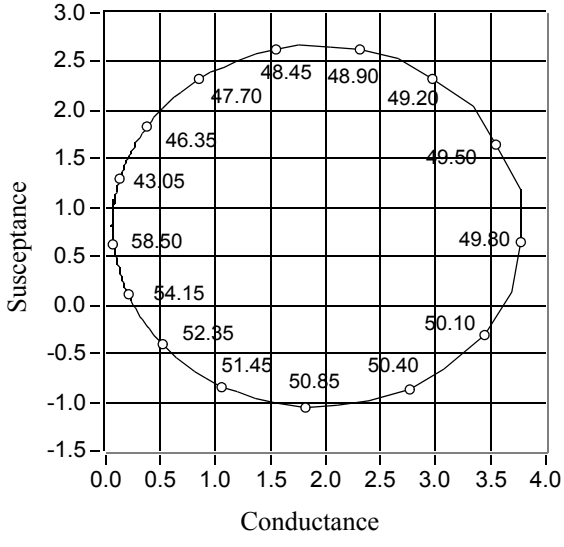
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



50 kHz-AN

Transformed to 90 ohms

Power rating: 600 Wrms @ 2% duty cycle
51mm (2.0") PZT/L
Active Area: 20cm²
Urethane Window

Beamwidth:

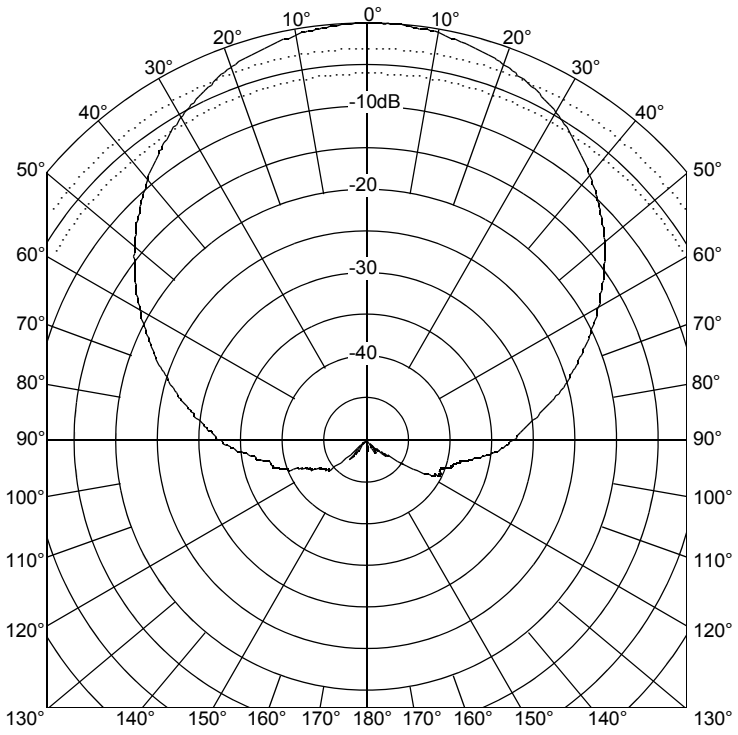
-3dB: 46°
-6dB: 65°
-10dB: 85°

Directivity Index:	14.7
Frequency Tolerance:	±1.5kHz
Peak TVR(1), nominal:	160dB
Peak TVR(1), minimum:	156dB
Q (transmit):	14
Peak Source Level(4):	207dB
RVR(2), nominal:	-185dB
Peak Figure of Merit(3):	-28dB

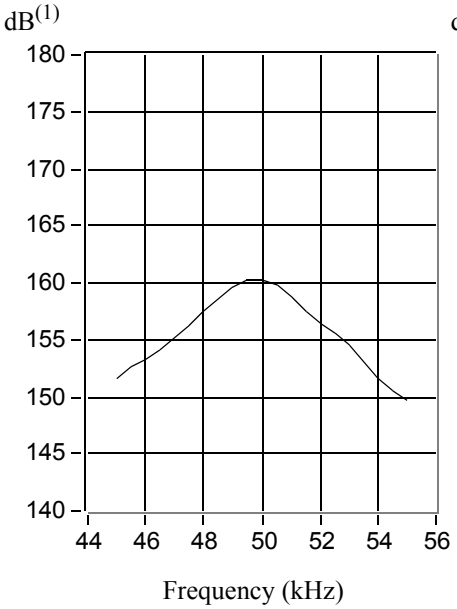
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

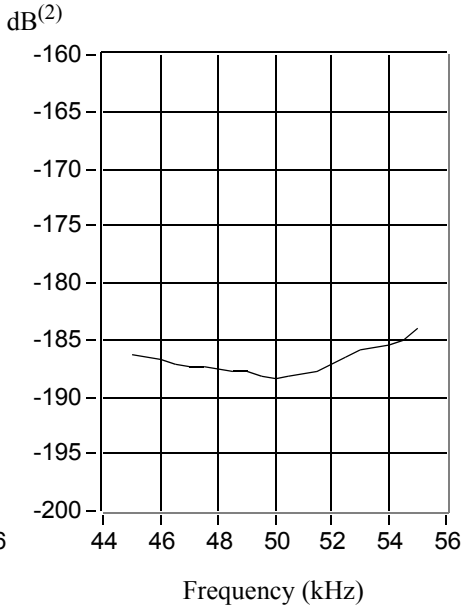
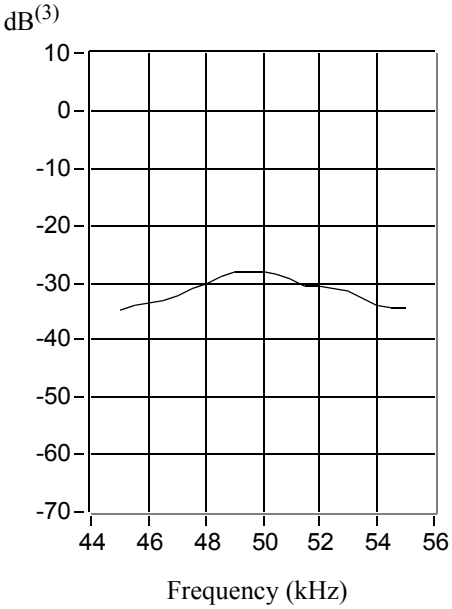


Figure of Merit



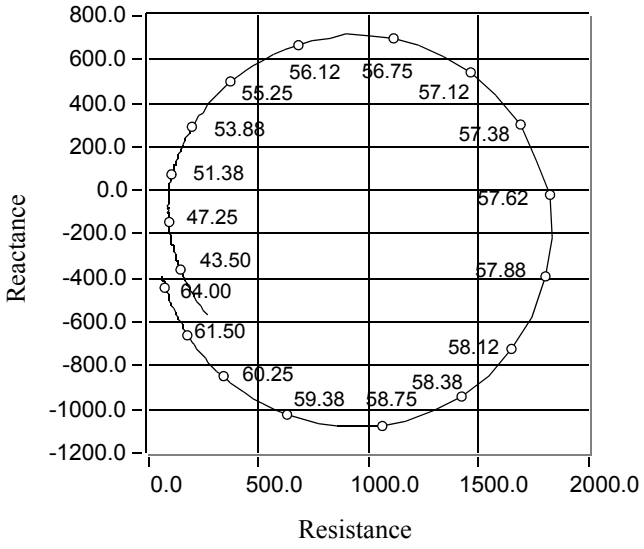
50 kHz-AN

51mm (2.0") PZT/L

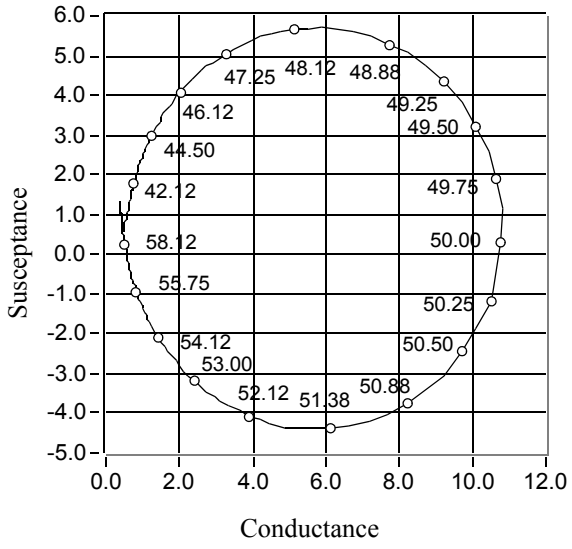
Cable Type: C37
Cable Length: 1.1 m (3.5')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	90 ohms -20%,+40%	90 ohms -20%,+40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	90 – j0 ohms	90 – j0 ohms
1 kHz Capacitance	n/a	n/a

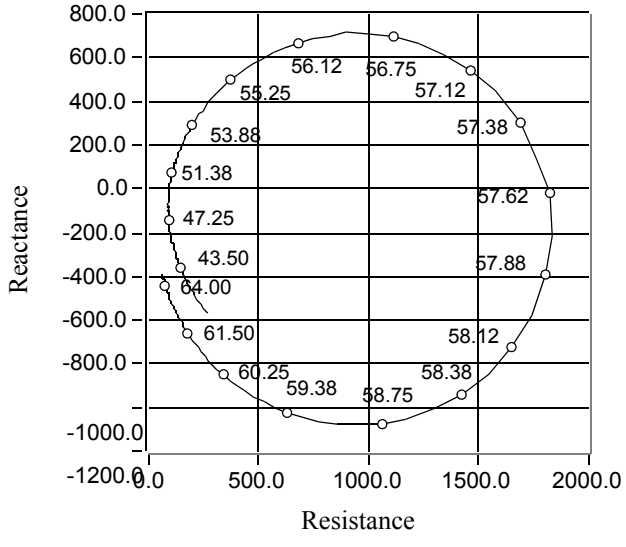
Unbalanced Impedance



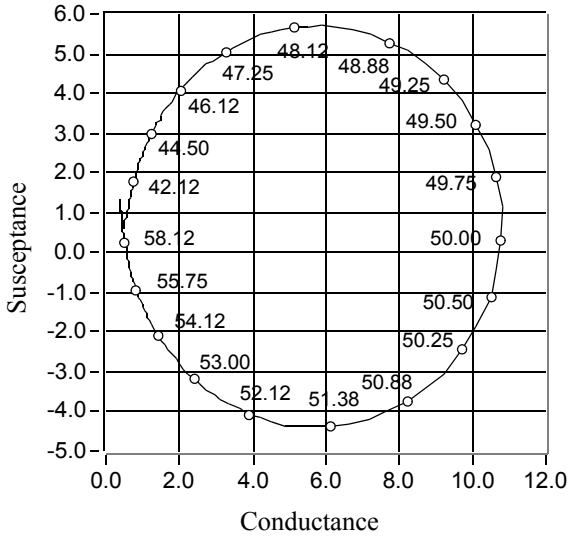
Unbalanced Admittance



Balanced Impedance



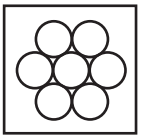
Balanced Admittance



50 kHz-AWlq

Ceramics wired in parallel
Transformed to 250 ohms
Power Rating: 1 kW rms @ 2% duty cycle
7 x 20.3 mm (0.80") PZT4
Active Area: 23 cm^2
Epoxy/Urethane Window

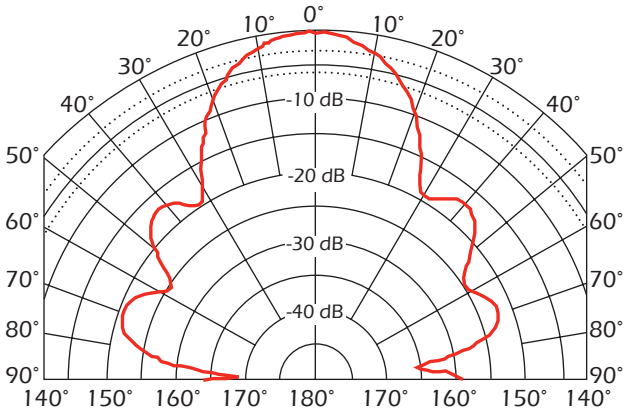
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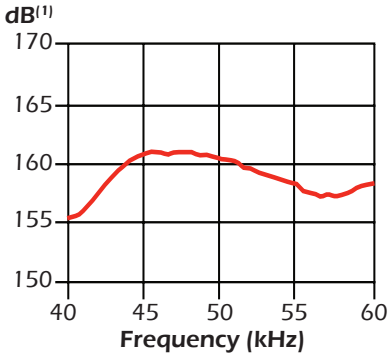
Beamwidth:
-3 dB: 25°
-6 dB: 36°
-10 dB: 45°

Directivity Index:	17.2
Frequency Tolerance:	± 3 kHz
Peak TVR(1), nominal:	161 dB
Peak TVR(1), minimum:	159 dB
Q (transmit):	4
Peak Source Level(4):	212 dB
Peak RVR(2), nominal:	-175 dB
Peak Figure of Merit(3):	-19.1 dB

Transmit Radiation Pattern



TVR



RVR

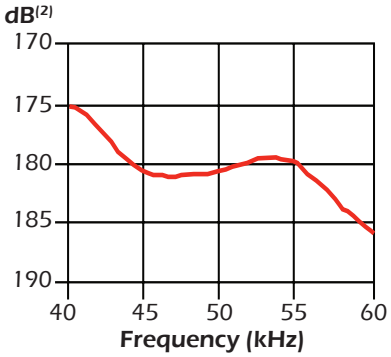
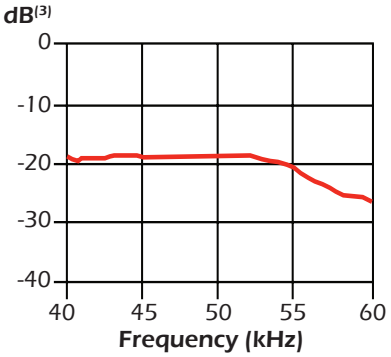


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

50 kHz-AWIq

7 x 20.3 mm (0.80”) PZT4

Cable Type: C332
Cable Length: 10.4 m (34’)

Note:
Impedance data includes cable

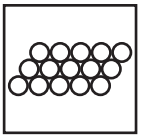
Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	250 Ω: -20%, +40%	250 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	200 + j10 Ω	200 + j10 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
40.00	418.98	-34.21	346.49	-235.56	1.9738	1.3419	506.63	5339.18
41.00	339.61	-34.34	280.41	-191.59	2.4312	1.6611	411.31	6448.24
42.00	287.92	-31.89	244.46	-152.12	2.9488	1.8350	339.12	6953.62
43.00	242.44	-27.10	215.82	-110.45	3.6718	1.8791	272.35	6954.97
44.00	217.38	-21.04	202.89	-78.03	4.2937	1.6512	232.90	5972.68
45.00	205.36	-14.98	198.39	-53.07	4.7041	1.2583	212.58	4450.40
46.00	199.17	-8.79	196.83	-30.43	4.9619	0.7670	201.53	2653.90
47.00	201.44	-4.78	200.74	-16.79	4.9469	0.4138	202.15	1401.15
48.00	200.73	-1.22	200.69	-4.28	4.9806	0.1062	200.78	352.12
49.00	198.34	2.41	198.17	8.33	5.0373	-0.2118	198.52	-687.80
50.00	201.95	8.64	199.66	30.35	4.8954	-0.7442	204.27	-2368.94
51.00	207.39	12.71	202.31	45.63	4.7037	-1.0609	212.60	-3310.78
52.00	221.17	17.41	211.04	66.18	4.3142	-1.3530	231.79	-4141.13
53.00	240.15	21.20	223.90	86.83	3.8824	-1.5056	257.57	-4521.31
54.00	271.57	22.83	250.29	105.38	3.3937	-1.4289	294.67	-4211.38
55.00	306.70	25.43	276.99	131.69	2.9446	-1.4000	339.60	-4051.16
56.00	351.87	24.75	319.56	147.29	2.5810	-1.1897	387.45	-3381.07
57.00	406.37	21.82	377.26	151.04	2.2845	-0.9147	437.73	-2553.90
58.00	456.66	19.17	431.34	149.96	2.0684	-0.7191	483.47	-1973.26
59.00	515.06	10.82	505.90	96.68	1.9070	-0.3644	524.38	-983.09
60.00	559.21	4.13	557.76	40.28	1.7836	-0.1288	560.67	-341.62

50 kHz-AZ

Array

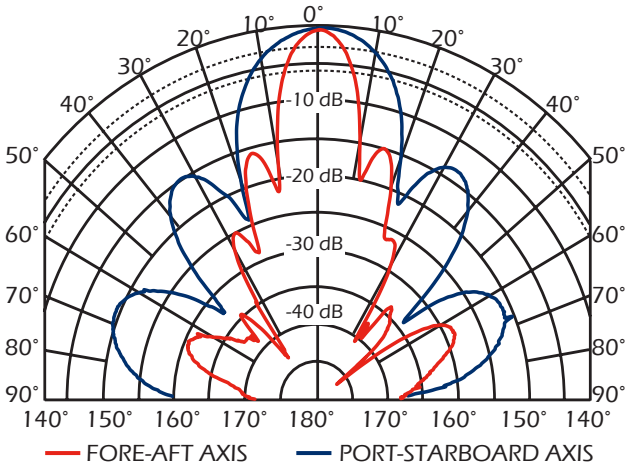


with Parallel Inductor
Power Rating: 2 kW rms @ 1% duty cycle
15 x 28.7 mm (1.13") PZT
Active Area: 96.2 cm² (14.9 in²)
Urethane Window

Beamwidth:
-3 dB: 9° / 19°
-6 dB: 13° / 27°
-10 dB: 16° / 33°

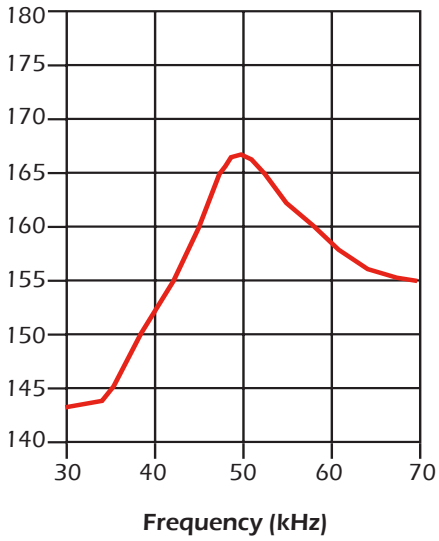
Directivity Index:	23
Frequency Tolerance:	±2 kHz
Peak TVR(1), nominal:	167 dB
Peak TVR(1), minimum:	165 dB
Q (transmit):	8
Peak Source Level(4):	222 dB
Peak RVR(2), nominal:	-169 dB
Peak Figure of Merit(3):	-10 dB

Transmit Radiation Pattern

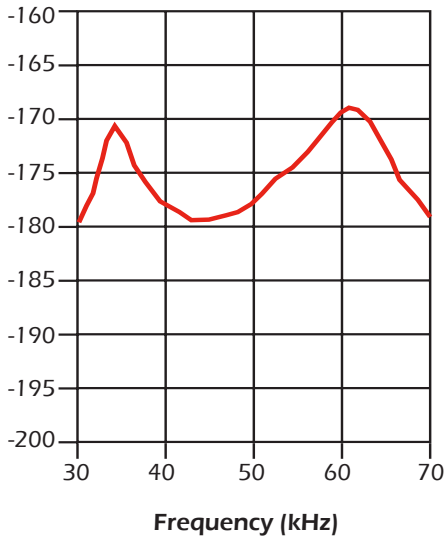


Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

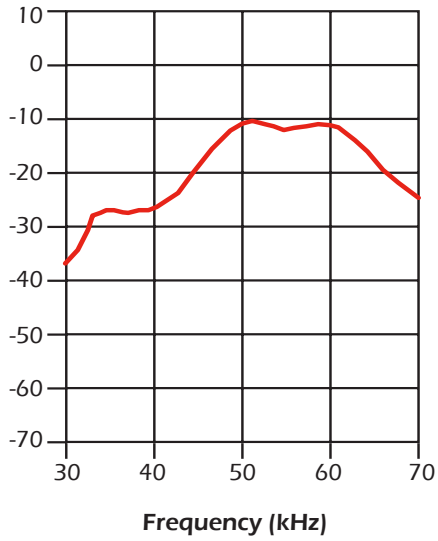
TVR



RVR



FOM



50 kHz-AZ

15 x 28.7 mm (1.13”) PZT

Cable Type: C44-02
Cable Length: 15.2 m (50’)

Note:
Impedance data includes cable

Impedance Data		
	Unbalanced	*Balanced*
Parallel: Rp.	140 Ω: -20%, +40%	140 Ω: -20%, +40%
Parallel: Cp. (nominal)	4640pF	3520pF
Series [R - jX]: (nominal)	140 - j30 Ω	140 - j20 Ω
1 kHz capacitance: (nominal)	N/A	N/A

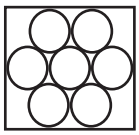
Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
30.00	911.80	75.66	225.84	883.38	0.27	-1.06	3681.26	-5637.07
31.00	1107.42	72.37	335.49	1055.38	0.27	-0.86	3655.47	-4418.17
32.00	1393.23	67.21	539.59	1284.50	0.28	-0.66	3597.32	-3291.22
33.00	1836.55	58.01	972.94	1557.66	0.29	-0.46	3466.74	-2227.28
34.00	2532.98	41.11	1908.59	1665.32	0.30	-0.26	3361.64	-1215.00
36.00	2720.92	-26.63	2432.28	-1219.59	0.33	0.16	3043.81	728.29
37.00	1878.85	-48.07	1255.40	-1397.87	0.36	0.40	2811.91	1703.34
38.00	1336.98	-58.62	696.12	-1141.46	0.39	0.64	2567.84	2674.54
39.00	996.27	-63.80	439.94	-893.87	0.44	0.90	2256.12	3675.17
40.00	772.70	-66.65	306.30	-709.40	0.51	1.19	1949.29	4727.48
42.00	494.63	-67.51	189.25	-457.00	0.77	1.87	1292.83	7078.12
43.00	400.00	-66.07	162.22	-365.63	1.01	2.29	986.31	8457.99
44.00	327.77	-63.39	146.83	-293.04	1.37	2.73	731.67	9866.47
45.00	263.54	-58.92	136.05	-225.71	1.96	3.25	510.52	11493.79
46.00	214.04	-52.11	131.46	-168.92	2.87	3.69	348.51	12756.73
48.00	152.98	-27.41	135.81	-70.43	5.80	3.01	172.33	9978.26
49.00	141.82	-8.84	140.13	-21.79	6.97	1.08	143.52	3519.81
50.00	152.11	9.61	149.98	25.39	6.48	-1.10	154.27	-3492.50
51.00	179.74	23.24	165.15	70.94	5.11	-2.20	195.62	-6852.22
52.00	216.28	32.65	182.10	116.69	3.89	-2.49	256.88	-7635.01
54.00	318.46	42.12	236.22	213.58	2.33	-2.11	429.33	-6206.87
55.00	376.24	43.63	272.32	259.61	1.92	-1.83	519.81	-5306.97
56.00	439.60	44.84	311.70	309.99	1.61	-1.60	619.99	-4558.94
57.00	519.97	46.05	360.88	374.35	1.33	-1.38	749.21	-3866.03
58.00	624.68	45.16	440.47	442.96	1.13	-1.14	885.92	-3114.89
60.00	907.09	40.10	693.89	584.23	0.84	-0.71	1185.79	-1883.47
61.00	1120.10	34.53	922.72	634.99	0.74	-0.51	1359.70	-1320.51
62.00	1382.65	25.66	1246.29	598.74	0.65	-0.31	1533.93	-803.97
63.00	1664.88	13.26	1620.49	381.87	0.58	-0.14	1710.48	-348.04
64.00	1879.99	-2.18	1878.63	-71.38	0.53	0.02	1881.35	50.23
66.00	1784.74	-36.91	1427.09	-1071.78	0.45	0.34	2232.03	811.40
67.00	1559.23	-48.89	1025.14	-1174.85	0.42	0.48	2371.57	1147.91
68.00	1344.04	-57.28	726.59	-1130.71	0.40	0.63	2486.18	1465.00
69.00	1171.82	-63.20	528.39	-1045.93	0.38	0.76	2598.79	1756.92
70.00	1033.28	-67.39	397.17	-953.90	0.37	0.89	2688.18	2031.37

50 kHz-BB

Ceramics Wired in Parallel with Inductor
Power Rating: 2.5 kW @ 2% duty cycle
7 x 38 mm (1.50") PZT
Active Area: 79.8 cm² (12.37 in²)
Radiating Surface: HPC/Urethane

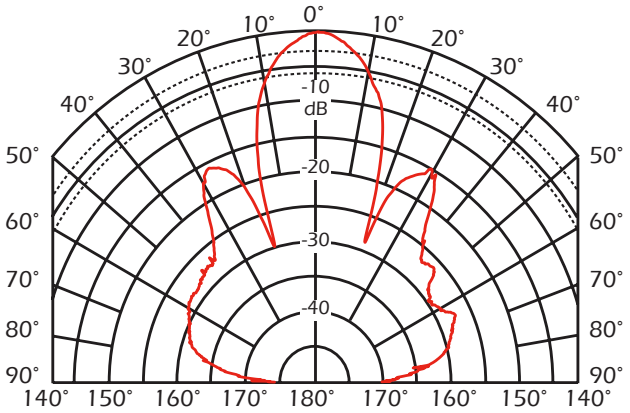
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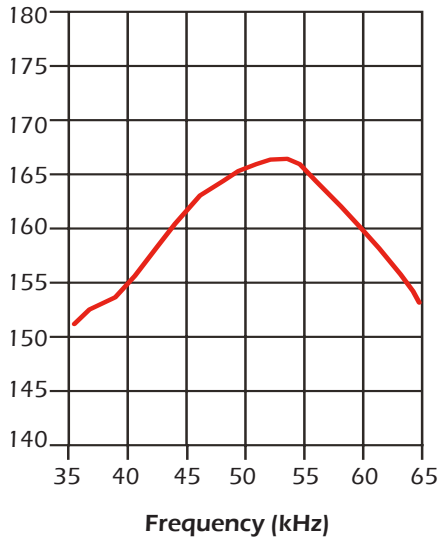
Beamwidth:
-3 dB: 14°
-6 dB: 20°
-10 dB: 26°

Directivity Index:	22
Frequency Tolerance:	-2kHz/+6kHz
Peak TVR(1), nominal:	166 dB
Peak TVR(1), minimum:	164 dB
Q (transmit):	5
Peak Source Level(4):	220 dB
Peak RVR(2), nominal:	-175 dB
Peak Figure of Merit(3):	-16 dB

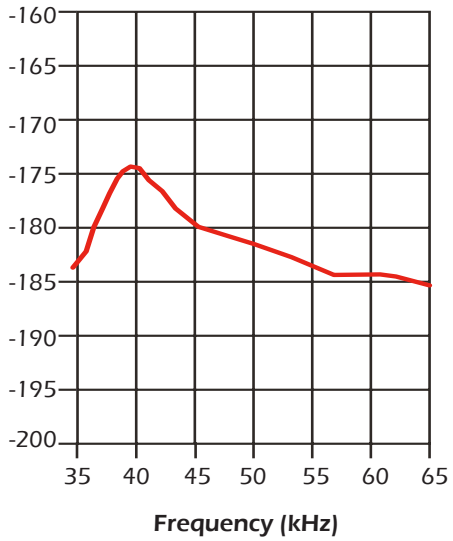
Transmit Radiation Pattern



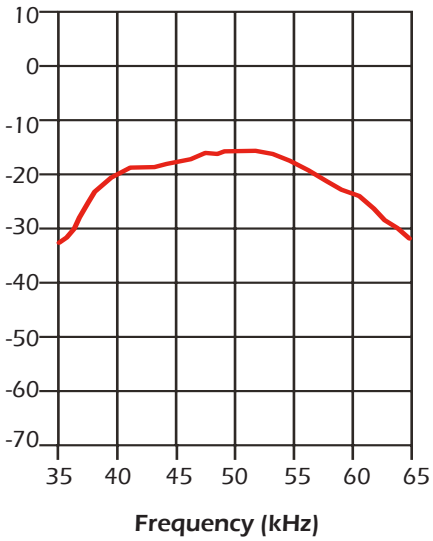
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

50 kHz-BB

7 x 38 mm (1.50”) PZT

Cable Type: C44-02
Cable Length: 15 m (50’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	100 Ω: -20%, +40%	100 Ω: -20%, +40%
Parallel: Cp. (nominal)	n/a	n/a
Series [R - jX]: (nominal)	100 Ω	100 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
35.00	319.37	75.02	82.54	308.52	0.81	-3.02	1235.66	-13754.59
36.00	379.22	71.54	120.07	359.71	0.83	-2.50	1197.70	-11058.40
37.00	461.54	65.06	194.61	418.51	0.91	-1.96	1094.60	-8450.83
38.00	578.75	53.66	342.97	466.18	1.02	-1.39	976.64	-5829.20
39.00	698.19	35.68	567.10	407.26	1.16	-0.84	859.57	-3409.43
40.00	707.66	10.25	696.37	125.89	1.39	-0.25	719.13	-1000.25
41.00	579.74	-13.33	564.11	-133.69	1.68	0.40	595.80	1544.11
42.00	437.15	-26.59	390.92	-195.65	2.05	1.02	488.85	3879.66
43.00	327.79	-31.88	278.34	-173.13	2.59	1.61	386.03	5963.99
44.00	248.03	-33.46	206.93	-136.75	3.36	2.22	297.30	8040.10
45.00	199.75	-32.12	169.18	-106.19	4.24	2.66	235.83	9413.48
46.00	167.08	-27.57	148.11	-77.32	5.31	2.77	188.47	9583.49
47.00	143.46	-22.10	132.92	-53.97	6.46	2.62	154.84	8879.48
48.00	129.46	-16.74	123.97	-37.28	7.40	2.22	135.18	7376.17
49.00	120.71	-10.75	118.59	-22.52	8.14	1.55	122.87	5019.86
50.00	113.15	-5.47	112.63	-10.78	8.80	0.84	113.66	2679.86
51.00	106.15	-0.46	106.15	-0.85	9.42	0.08	106.15	235.51
52.00	100.65	5.29	100.22	9.29	9.89	-0.92	101.08	-2806.05
53.00	94.51	12.67	92.21	20.74	10.32	-2.32	96.87	-6971.47
54.00	91.24	21.89	84.66	34.02	10.17	-4.09	98.33	-12045.46
55.00	92.70	32.50	78.18	49.81	9.10	-5.80	109.92	-16774.29
56.00	99.52	43.19	72.55	68.12	7.33	-6.88	136.51	-19547.54
57.00	112.44	51.70	69.69	88.25	5.51	-6.98	181.44	-19487.94
58.00	130.61	57.76	69.67	110.48	4.08	-6.48	244.86	-17771.17
59.00	151.58	62.23	70.61	134.12	3.07	-5.84	325.38	-15747.60
60.00	174.42	65.12	73.38	158.24	2.41	-5.20	414.61	-13796.71
61.00	201.55	67.16	78.24	185.74	1.93	-4.57	519.16	-11930.02
62.00	233.62	68.89	84.13	217.95	1.54	-3.99	648.76	-10250.83
63.00	272.30	70.12	92.58	256.07	1.25	-3.45	800.84	-8724.87
64.00	320.21	70.68	105.94	302.18	1.03	-2.95	967.92	-7328.73
65.00	381.34	70.70	126.05	359.90	0.87	-2.48	1153.66	-6060.03

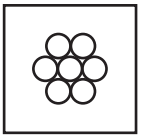
50 kHz-T

Transformed to 80 ohms
Power Rating: 1 kW rms @ 2% duty cycle
7 x 35 mm (1.38") PZT/L
Active Area: 67 cm²
Urethane Window

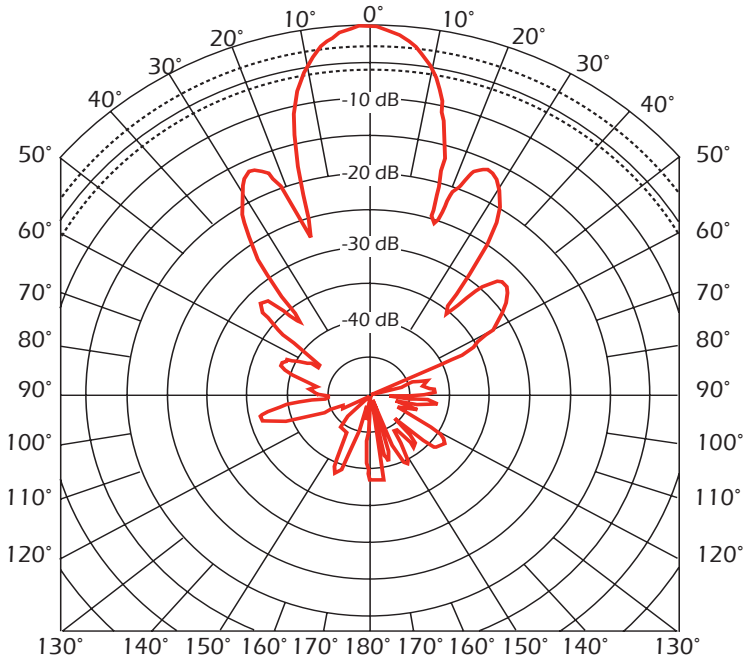
Beamwidth:
-3 dB: 15°
-6 dB: 21°
-10 dB: 26°

Directivity Index:	20.6
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	168 dB
Peak TVR(1), minimum:	166 dB
Q (transmit):	8
Peak Source Level(4):	217 dB
Peak RVR(2), nominal:	-174 dB
Peak Figure of Merit(3):	-13 dB

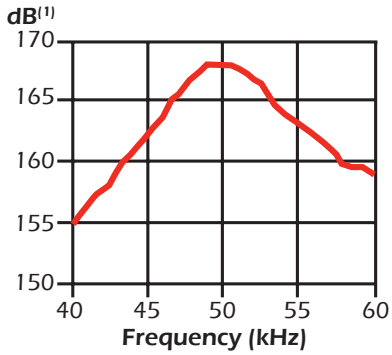
Array



Transmit Radiation Pattern



TVR



RVR

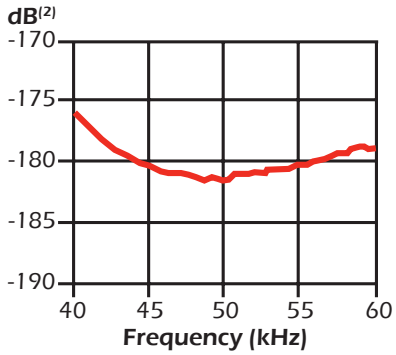
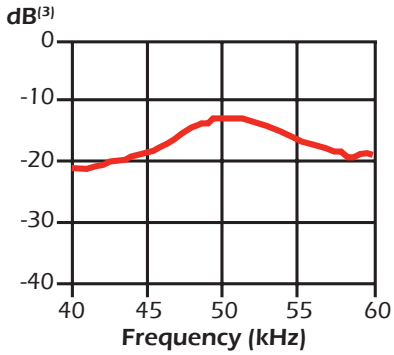


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

50 kHz-T

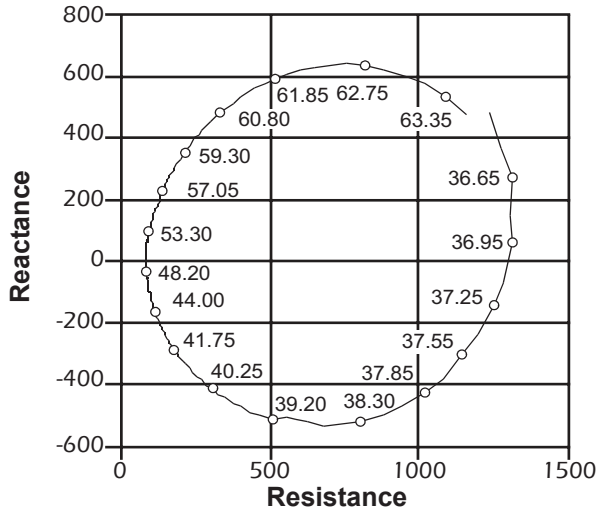
7 x 35 mm (1.38”) PZT/L

Cable Type: C44
Cable Length: 20.1 m (66’)

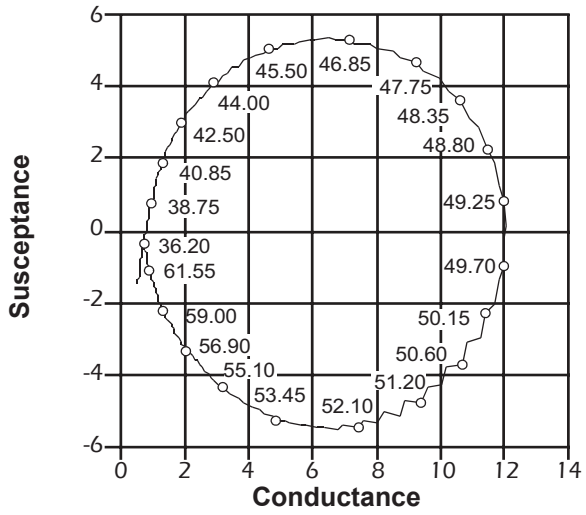
Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	80 Ω: -20%, +40%	80 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	80 Ω - j0 Ω	80 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

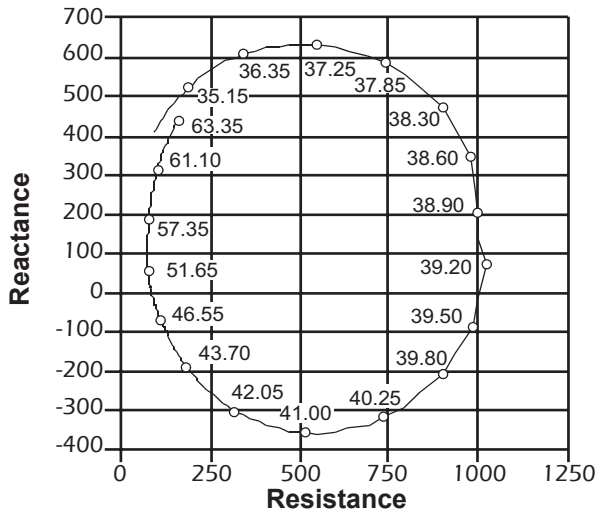
Unbalanced Impedance



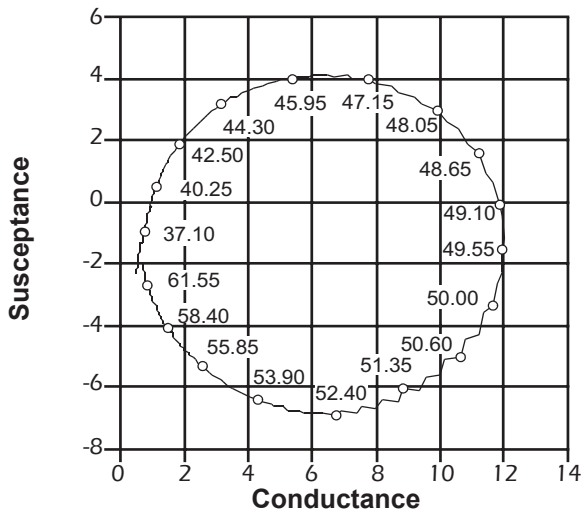
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



50 kHz-W

Power rating: 150 Wrms @ 2% duty cycle
35 mm (1.38") PZT/L
Active Area: 9.5 cm²
Urethane Window

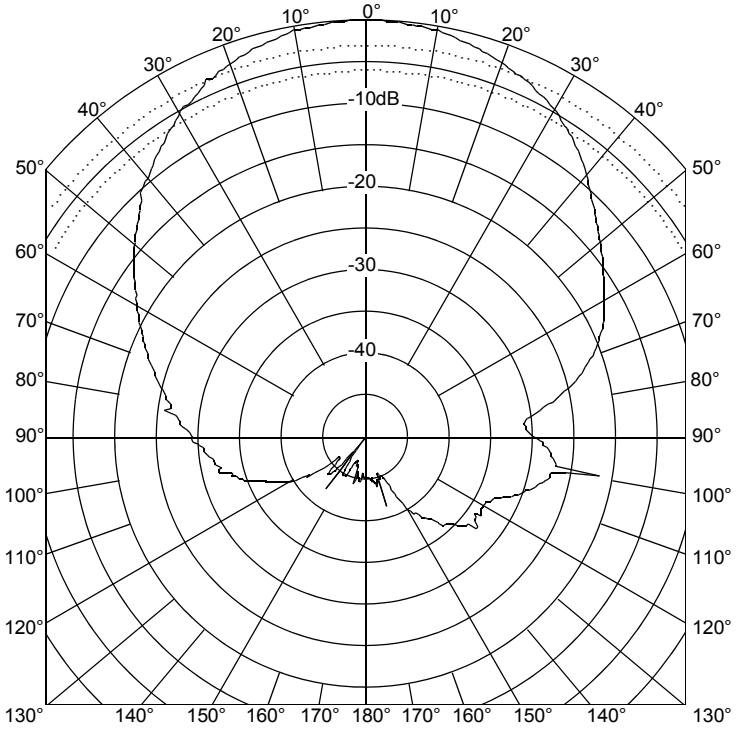
Beamwidth:

-3 dB:	45°
-6 dB:	64°
-10 dB:	84°

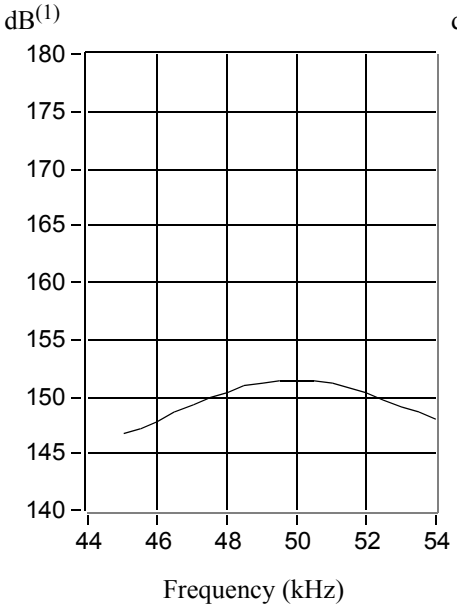
Directivity Index:	11.5
Frequency Tolerance:	±2 kHz
Peak TVR(1), nominal:	151 dB
Peak TVR(1), minimum:	149 dB
Q (transmit):	10
Peak Source Level(4):	120 dB
Peak RVR(2), nominal:	-177 dB
Peak Figure of Merit(3):	-29 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

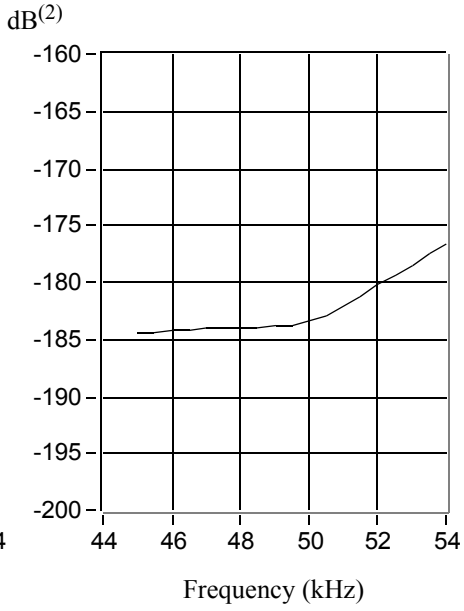
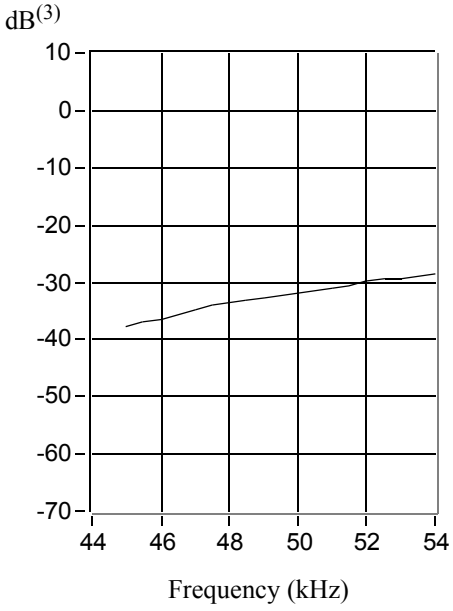


Figure of Merit



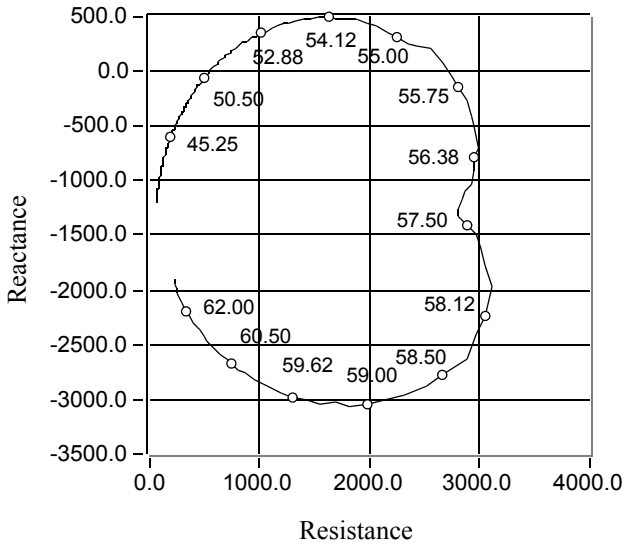
50 kHz-W

35 mm (1.38") PZT/L

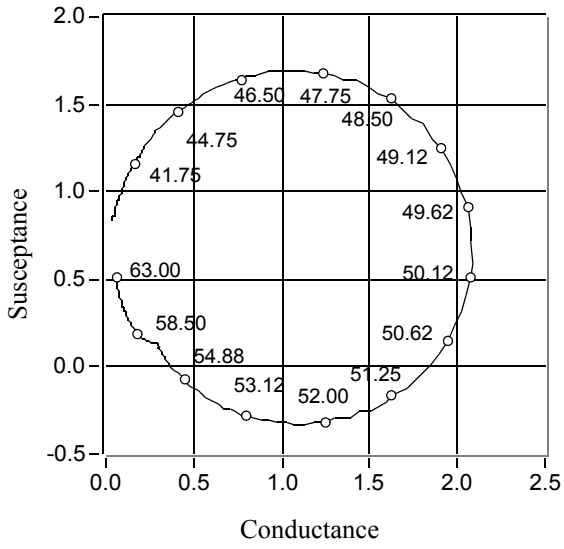
Cable Type: C1
Cable Length: 9.1 m (30.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	480 ohms -20%, +40%	480 ohms -20%, +40%
Parallel: Cp. (nominal)	1130 pF	1880 pF
Series [R – jX] (nominal)	470 – j80 ohms	440 – j130 ohms
1 kHz Capacitance	2040 pF ±20%	2810 pF ±20%

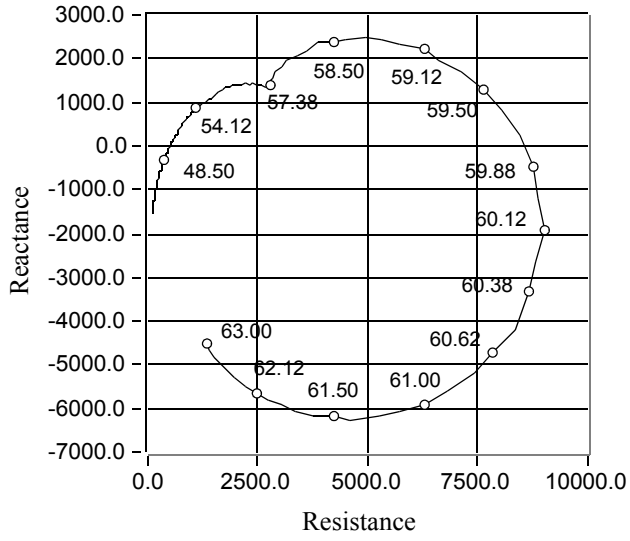
Unbalanced Impedance



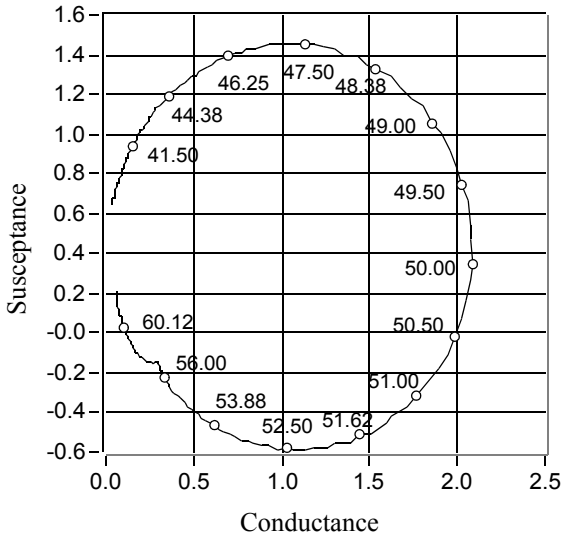
Unbalanced Admittance



Balanced Impedance



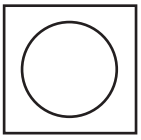
Balanced Admittance



50/200 kHz-A (50 kHz)

Power Rating: 600W rms @ 1% duty cycle
44 mm (1.75") PZT
Active Area: 15.5 cm² (2.40 in²)
Radiating Surface: Plastic

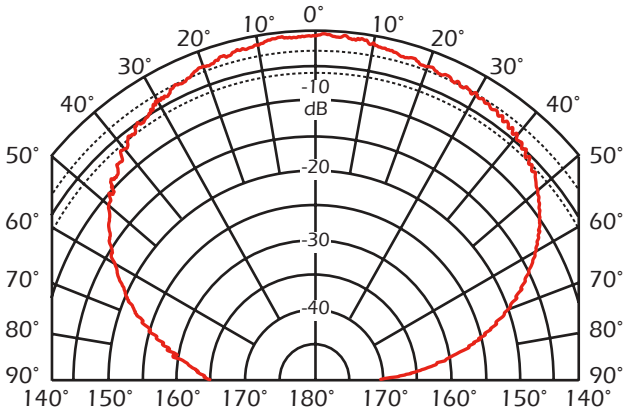
Array



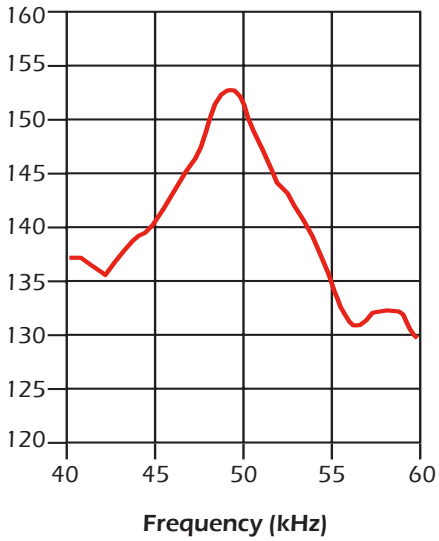
Beamwidth:
-3 dB: 50°
-6 dB: 73°
-10 dB: 106°

Directivity Index:	12.4
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	153 dB
Peak TVR(1), minimum:	151 dB
Q (transmit):	22
Peak Source Level(4):	205.1 dB
Peak RVR(2), nominal:	-175.9 dB
Peak Figure of Merit(3):	-33.2 dB

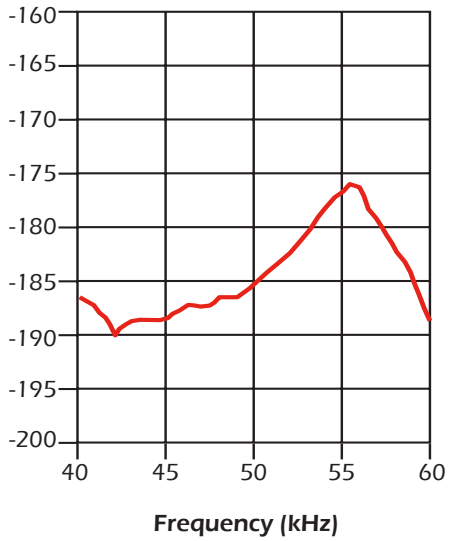
Transmit Radiation Pattern



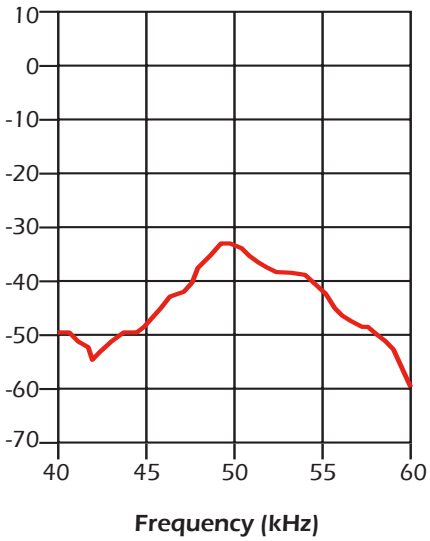
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

50/200 kHz-A (50 kHz)

44 mm (1.75”) PZT

Cable Type: C2
Cable Length: 2.3 m (7.5’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	280 Ω: -20%, +40%	280 Ω: -20%, +40%
Parallel: Cp. (nominal)	-70 pF	200 pF
Series [R - jX]: (nominal)	280 - j0 Ω	280 - j0 Ω
1 kHz capacitance: (nominal)	1830 pF	2100 pF

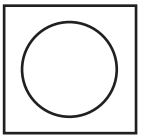
Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
44.50	944.58	-81.42	140.91	-934.01	0.16	1.05	6331.89	3743.99
45.00	877.57	-80.37	146.85	-865.20	0.19	1.12	5244.24	3973.36
45.50	809.42	-78.97	154.81	-794.48	0.24	1.21	4232.18	4241.71
46.00	737.21	-77.18	163.59	-718.83	0.30	1.32	3322.28	4576.21
46.50	660.95	-74.86	172.58	-638.02	0.40	1.46	2531.30	4998.76
47.00	582.02	-71.61	183.64	-552.29	0.54	1.63	1844.64	5520.98
47.50	500.49	-66.82	197.02	-460.08	0.79	1.84	1271.38	6154.13
48.00	417.85	-59.53	211.86	-360.15	1.21	2.06	824.10	6839.63
48.50	340.00	-47.44	229.96	-250.44	1.99	2.17	502.69	7109.12
49.00	283.88	-27.39	252.06	-130.58	3.13	1.62	319.71	5263.12
49.50	279.08	0.34	279.07	1.65	3.58	-0.02	279.08	-68.15
50.00	346.03	25.32	312.79	147.99	2.61	-1.24	382.81	-3934.23
50.50	475.07	41.33	356.75	313.72	1.58	-1.39	632.63	-4380.83
51.00	643.54	50.47	409.59	496.37	0.99	-1.20	1011.11	-3740.23
51.50	852.21	55.95	477.21	706.07	0.66	-0.97	1521.89	-3004.45
52.00	1100.33	59.68	555.53	949.79	0.46	-0.78	2179.39	-2401.05
52.50	1405.46	61.80	664.10	1238.66	0.34	-0.63	2974.43	-1900.98
53.00	1778.56	62.88	810.89	1582.95	0.26	-0.50	3901.01	-1502.71
53.50	2250.74	63.43	1006.71	2013.05	0.20	-0.40	5032.04	-1182.14
54.00	2847.67	62.95	1294.98	2536.19	0.16	-0.31	6262.05	-921.78
54.50	3665.70	61.32	1759.19	3215.99	0.13	-0.24	7638.39	-698.92
55.00	4810.22	58.69	2499.39	4109.90	0.11	-0.18	9257.55	-513.99

50/200 kHz-A (200 kHz)

Power Rating: 600W rms @ 1% duty cycle
44 mm (1.75") PZT
Active Area: 15.5 cm² (2.40 in²)
Radiating Surface: Plastic

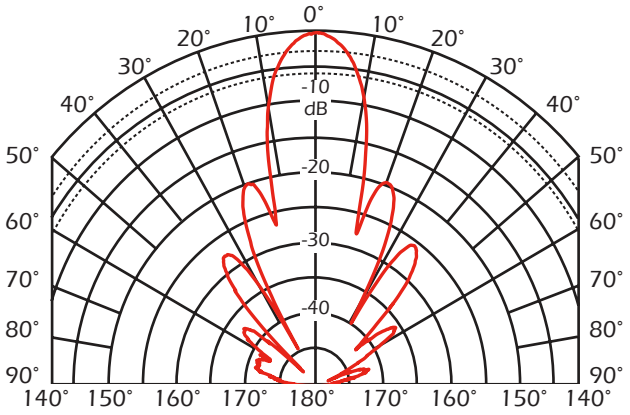
Array



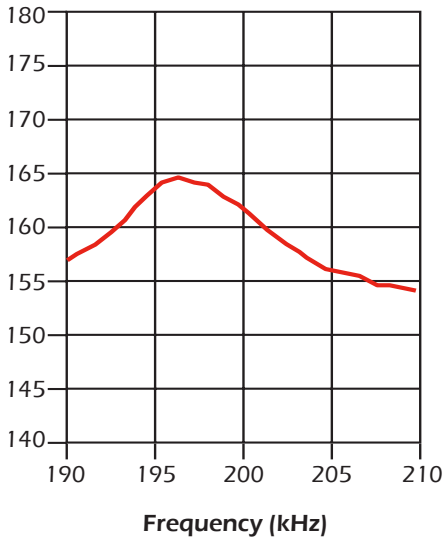
Beamwidth:
-3 dB: 12°
-6 dB: 16°
-10 dB: 20°

Directivity Index:	23.5
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	164.8 dB
Peak TVR(1), minimum:	162.2 dB
Q (transmit):	31
Peak Source Level(4):	218.7 dB
Peak RVR(2), nominal:	-177.8 dB
Peak Figure of Merit(3):	-16.0 dB

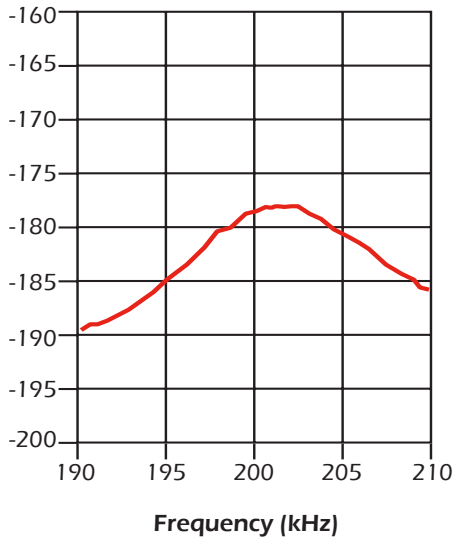
Transmit Radiation Pattern



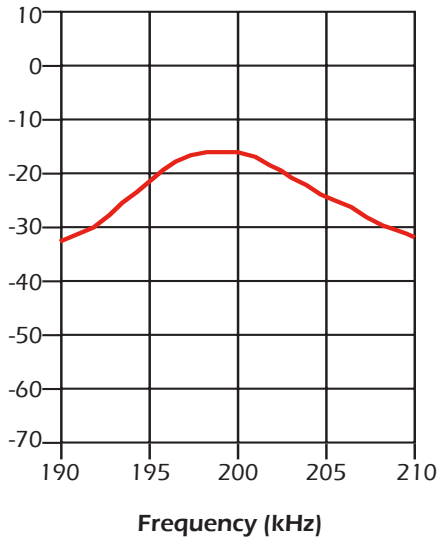
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

50/200 kHz-A (200 kHz)

44 mm (1.75”) PZT

Cable Type: C2
Cable Length: 2.3 m (7.5’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	410 Ω: -20%, +40%	410 Ω: -20%, +40%
Parallel: Cp. (nominal)	800 pF	1080 pF
Series [R - jX]: (nominal)	350 - j140 Ω	320 - j170 Ω
1 kHz capacitance: (nominal)	1830 pF	2120 pF

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	506.77	-62.15	236.77	-448.06	0.92	1.74	1084.70	1461.43
191.00	484.92	-57.23	262.45	-407.76	1.12	1.73	895.99	1444.94
192.00	465.97	-53.39	277.88	-374.04	1.28	1.72	781.36	1428.00
193.00	433.39	-49.08	283.87	-327.49	1.51	1.74	661.67	1437.77
194.00	395.59	-40.83	299.31	-258.67	1.91	1.65	522.85	1356.01
195.00	382.41	-28.79	335.14	-184.18	2.29	1.26	436.36	1027.94
196.00	402.24	-15.35	387.90	-106.46	2.40	0.66	417.12	534.30
197.00	454.35	-1.79	454.12	-14.21	2.20	0.07	454.57	55.62
198.00	573.33	7.95	567.82	79.25	1.73	-0.24	578.88	-193.81
199.00	738.46	12.08	722.10	154.60	1.32	-0.28	755.20	-226.73
200.00	935.29	14.30	906.33	230.96	1.04	-0.26	965.18	-210.10
201.00	1198.62	12.03	1172.29	249.84	0.82	-0.17	1225.54	-137.70
202.00	1529.96	5.95	1521.73	158.50	0.65	-0.07	1538.24	-53.35
203.00	1834.54	-3.30	1831.50	-105.61	0.54	0.03	1837.59	24.60
204.00	2116.96	-13.84	2055.54	-506.23	0.46	0.11	2180.21	88.13
205.00	2299.16	-27.02	2048.27	-1044.38	0.39	0.20	2580.78	153.39
206.00	2259.70	-40.05	1729.64	-1454.17	0.34	0.28	2952.21	220.02
207.00	2107.65	-49.18	1377.84	-1594.91	0.31	0.36	3224.02	276.05
208.00	1940.45	-55.96	1086.12	-1608.01	0.29	0.43	3466.80	326.77
209.00	1746.11	-60.06	871.53	-1513.06	0.29	0.50	3498.34	377.91
210.00	1600.09	-60.15	796.32	-1387.87	0.31	0.54	3215.17	410.83

50/200 kHz – A (50 kHz)

Power rating: 600 Wrms @ 2% duty cycle
44mm (1.75") PZT
Active Area: 15.5cm²
Urethane Window

Beamwidth:

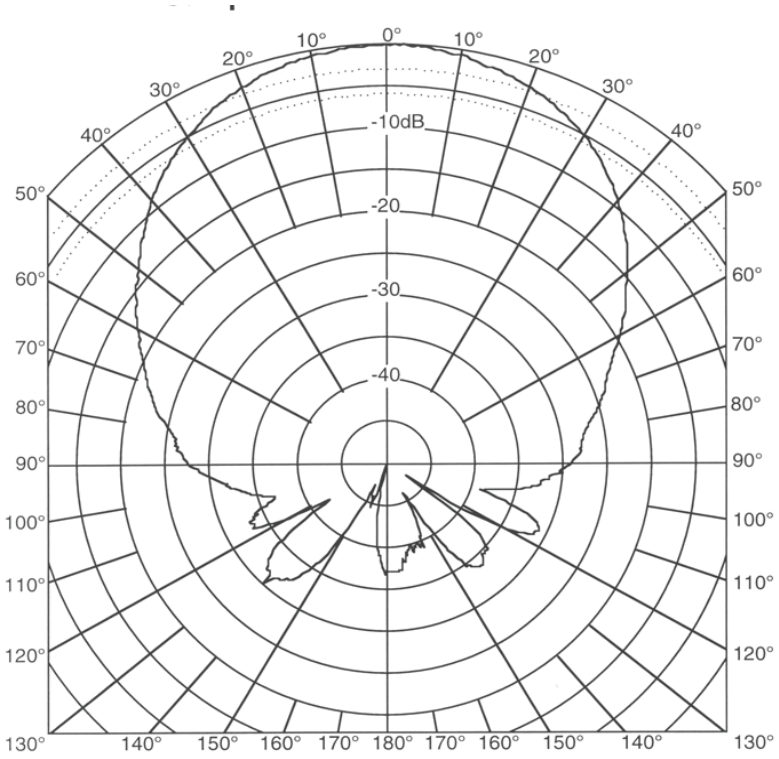
-3dB:	45°
-6dB:	64°
-10dB:	85°

Directivity Index:	13.6
Frequency Tolerance:	±2kHz
Peak TVR(1), nominal:	154dB
Peak TVR(1), minimum:	152 dB
Q (transmit):	28
Peak Source Level(4):	206 dB
Peak RVR(2), nominal:	-175 dB
Peak Figure of Merit(3):	-33 dB

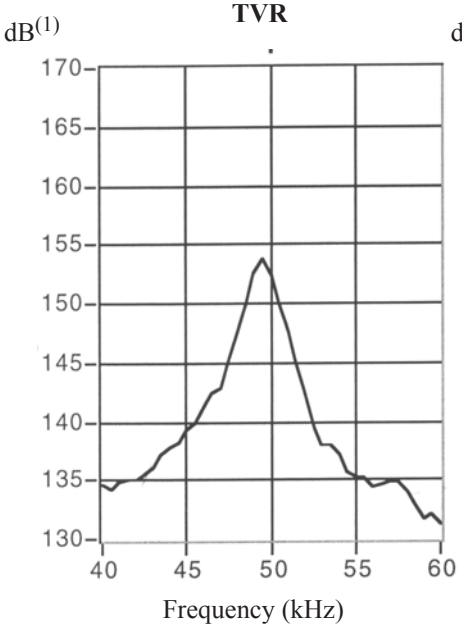
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

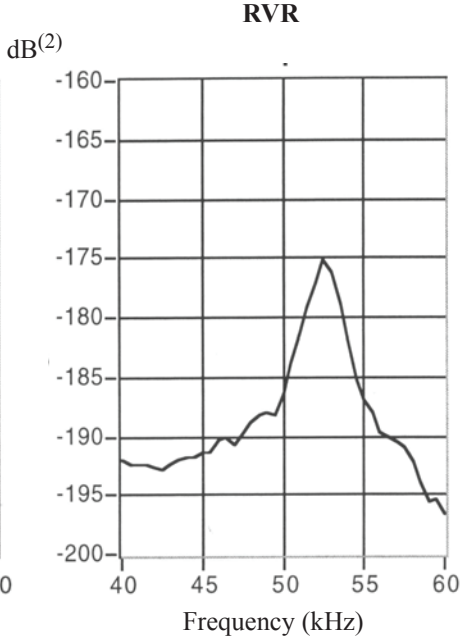
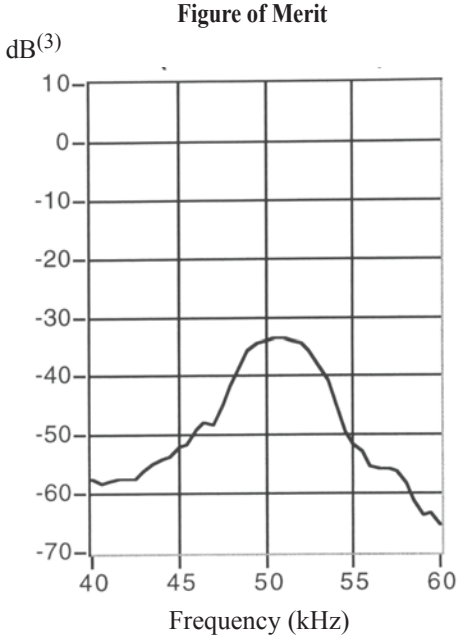


Figure of Merit



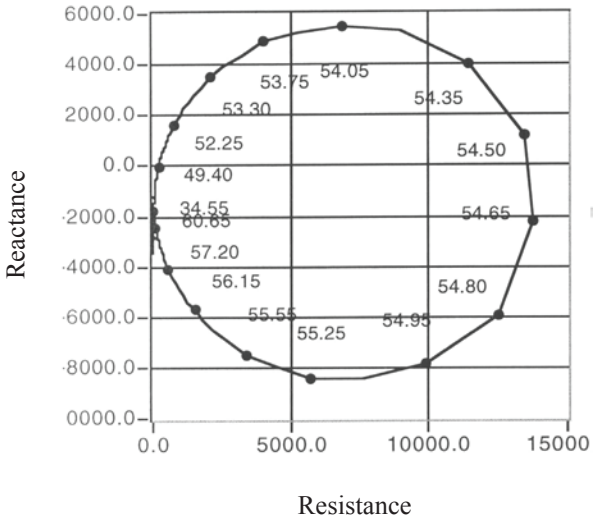
50/200 kHz – A (50 kHz)

44mm (1.75") PZT

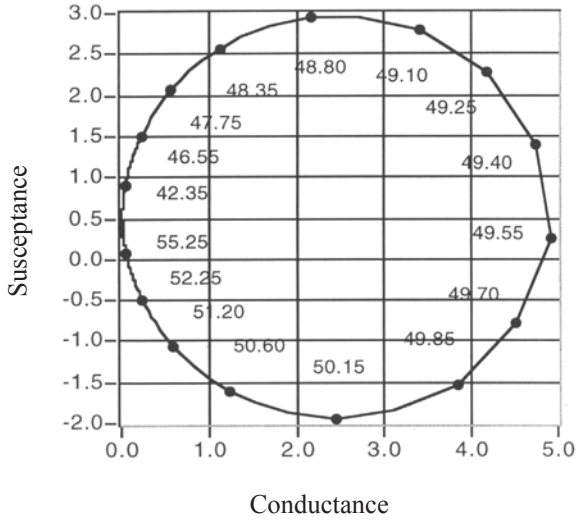
Cable Type: C144
Cable Length: 10.1 m (33.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	200 ohms -20%, +40%	200 ohms -20%, +40%
Parallel: Cp. (nominal)	720 pF	2210 pF
Series [R – jX] (nominal)	200 – j0 ohms	200 – j12 ohms
1 kHz Capacitance	2220 pF ±20%	3400 pF ±20%

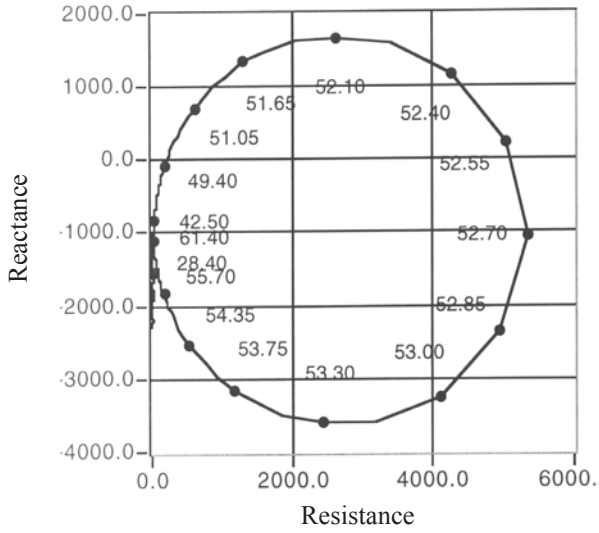
Unbalanced Impedance



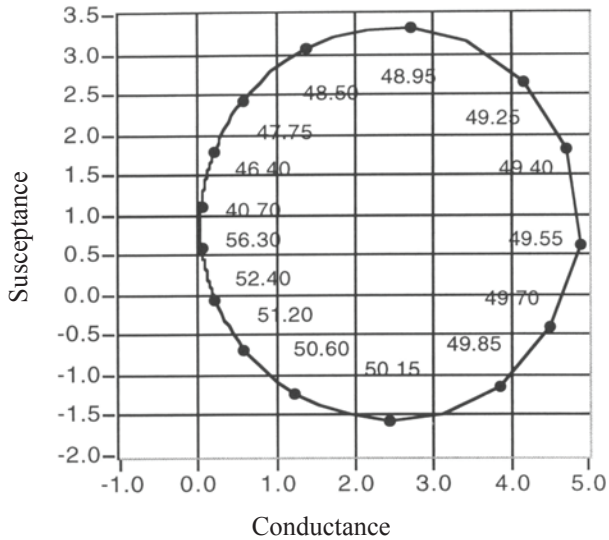
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



50/200 kHz – A (200 kHz)

Power rating: 600 Wrms @ 2% duty cycle
44mm (1.75") PZT
Active Area: 15.5cm²
Urethane Window

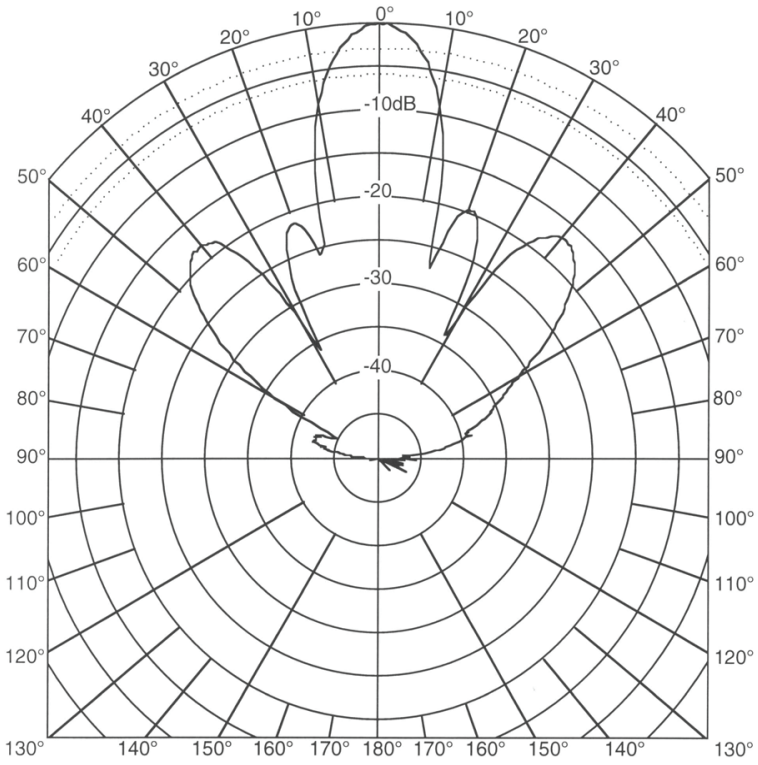
Beamwidth:

-3dB:	12°
-6dB:	17°
-10dB:	22°

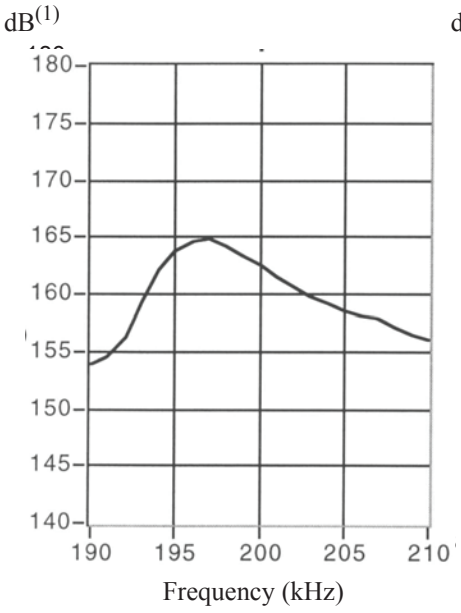
Directivity Index:	25.6
Frequency Tolerance:	±4kHz
Peak TVR (1), nominal:	164dB
Peak TVR (1), minimum:	162dB
Q (transmit):	30
Peak Source Level (4):	218dB
Peak RVR (2), nominal:	-185dB
Peak Figure of Merit (3):	-21dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

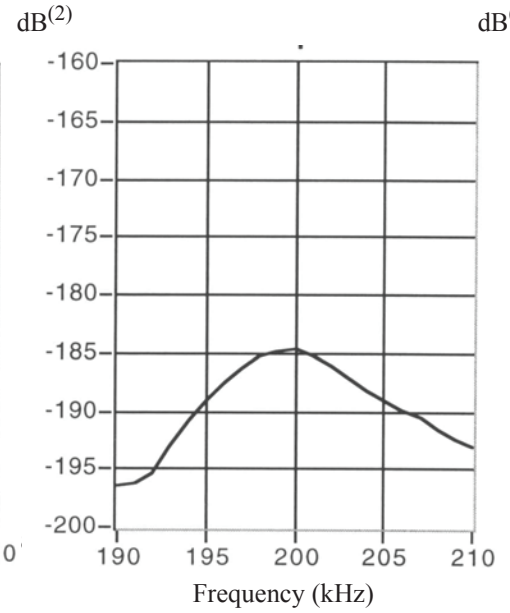
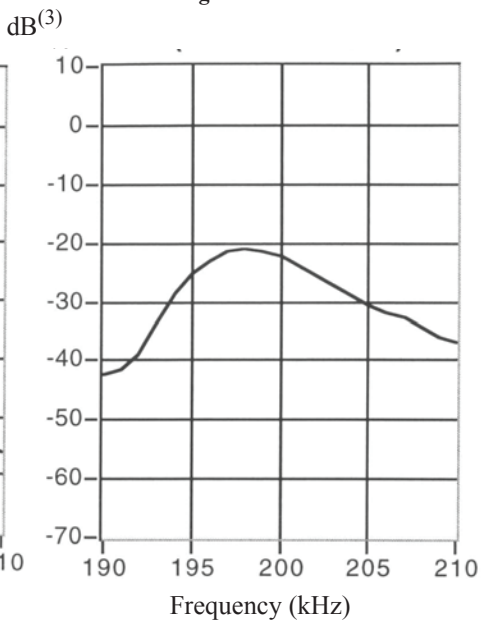


Figure of Merit



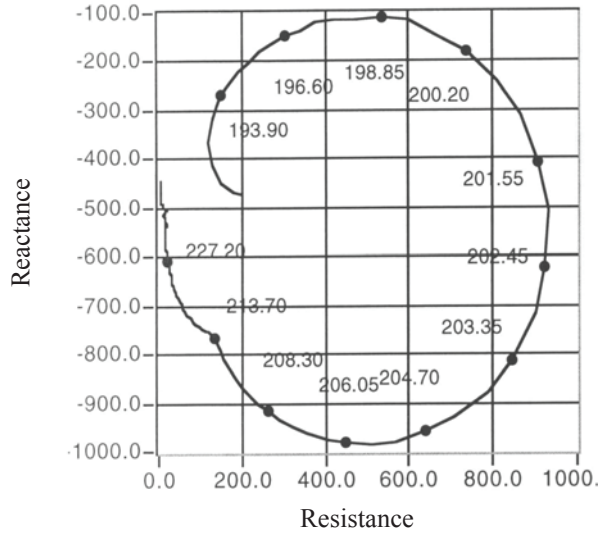
50/200 kHz – A (200 kHz)

44mm (1.75") PZT

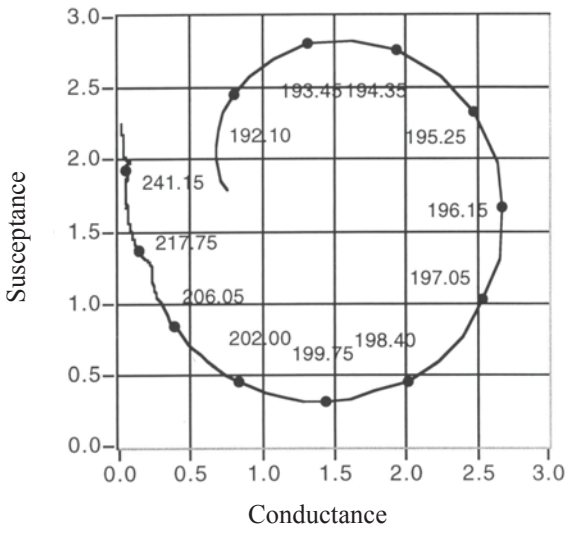
Cable Type: C144
Cable Length: 10.1 m (33.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	375 ohms -20%, +40%	375 ohms -20%, +40%
Parallel: Cp. (nominal)	1200 pF	2400 pF
Series [R – jX] (nominal)	315 – j30 ohms	240 – j50 ohms
1 kHz Capacitance	2210 pF ±20%	3390 pF ±20%

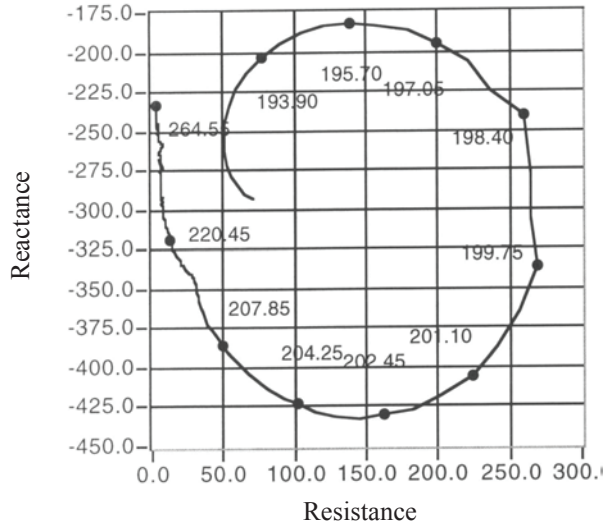
Unbalanced Impedance



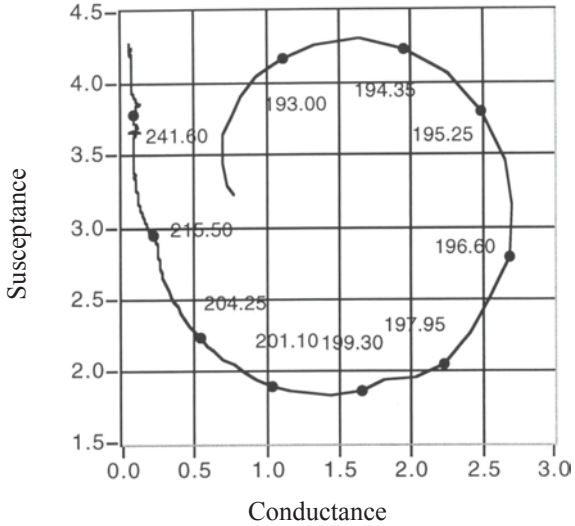
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



50/200 kHz – Alq (50 kHz)

Power rating: 600 Wrms @ 2% duty cycle
44mm (1.75") PZT
Active Area: 15.5cm²
Layered Plastic Urethane Window

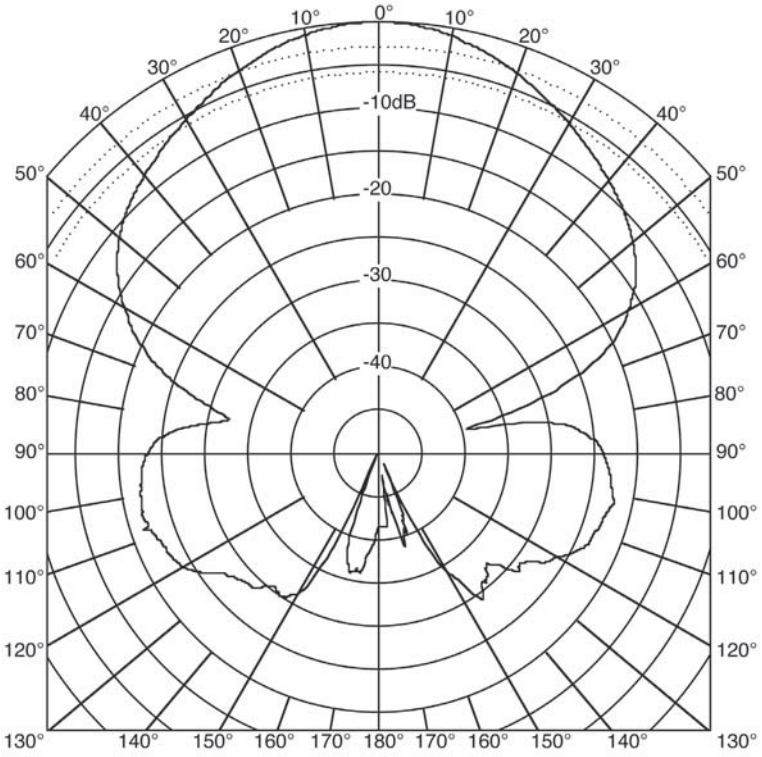
Beamwidth:

-3dB:	38°
-6dB:	57°
-10dB:	82°

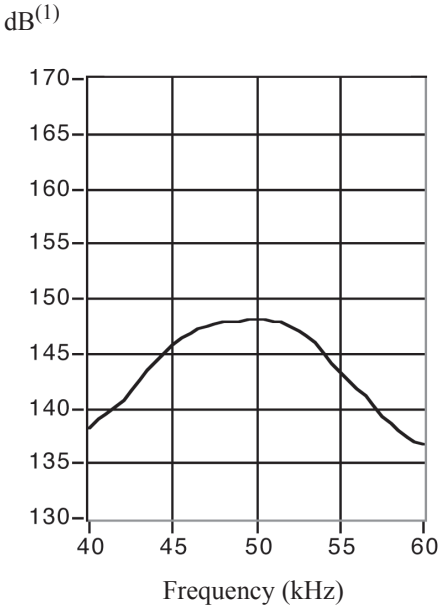
Directivity Index:	12.4
Frequency Tolerance:	±2kHz
Peak TVR (1), nominal:	148dB
Peak TVR (1), minimum:	146dB
Q (transmit):	5
Peak Source Level (4):	207dB
Peak RVR (2), nominal:	-182 dB
Peak Figure of Merit (3):	-32dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

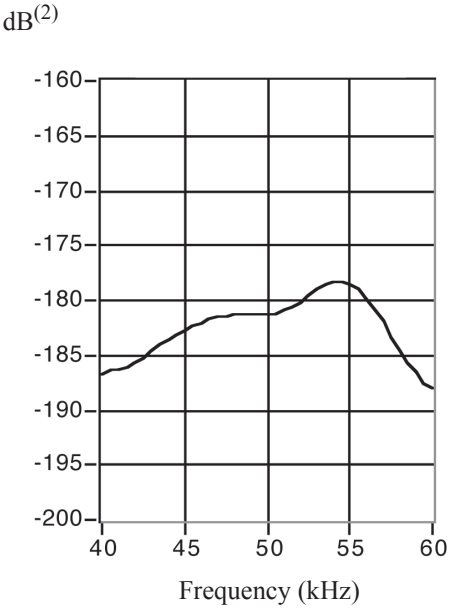
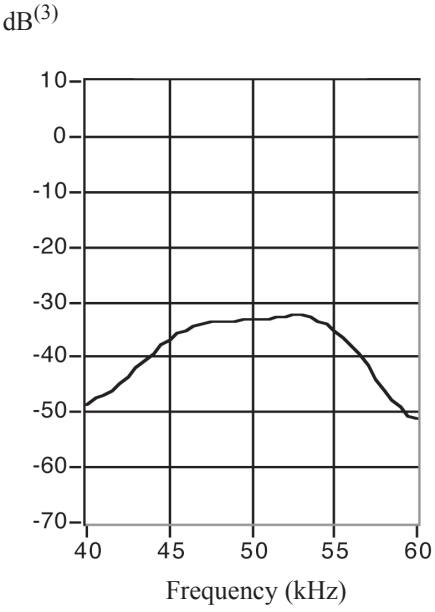


Figure of Merit



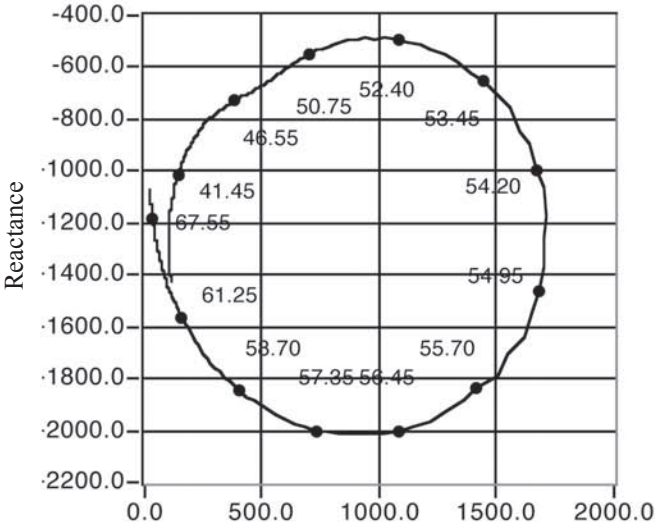
50/200 kHz – Alq (50 kHz)

44mm (1.75") PZT

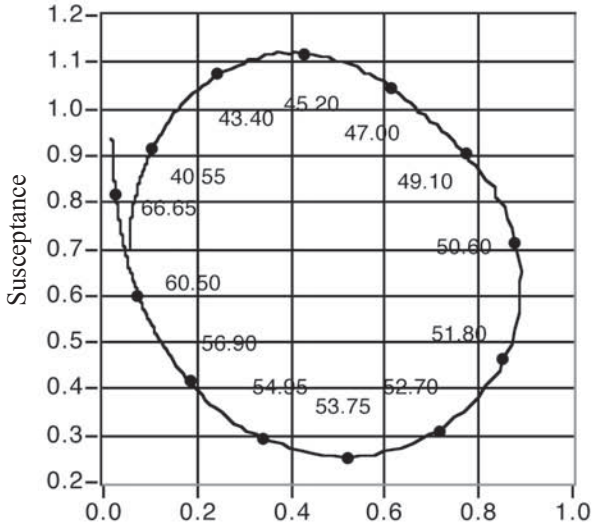
Cable Type: C172
Cable Length: 7.6m (25.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	860ohms-20%,+40%	860ohms-20%,+40%
Parallel: Cp. (nominal)	2660pF	2660pF
Series [R – jX] (nominal)	600 – j520 ohms	600 – j520 ohms
1 kHz Capacitance	2200pF±20%	2180pF±20%

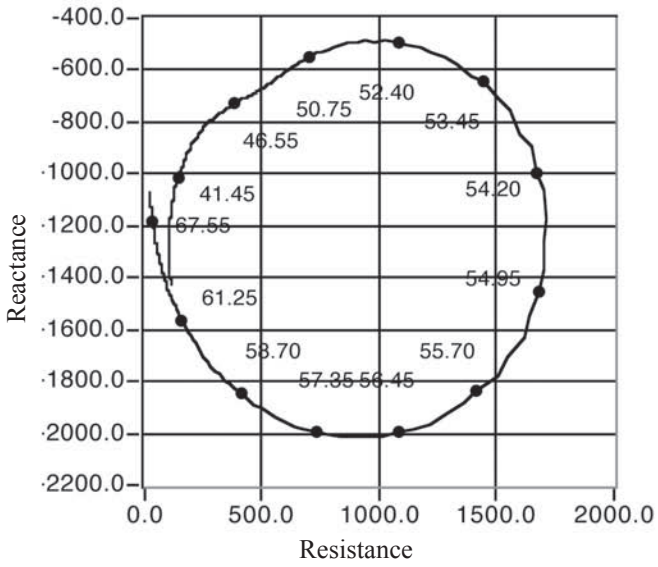
Unbalanced Impedance



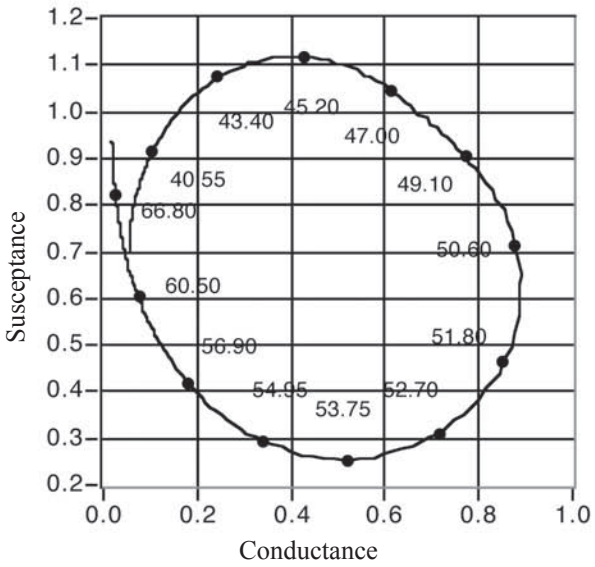
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



50/200 kHz – Alq (200 kHz)

Power rating: 600 Wrms @ 2% duty cycle 44mm (1.75") PZT
Active Area: 15.5cm^2
Layered Plastic Urethane Window

Beamwidth:

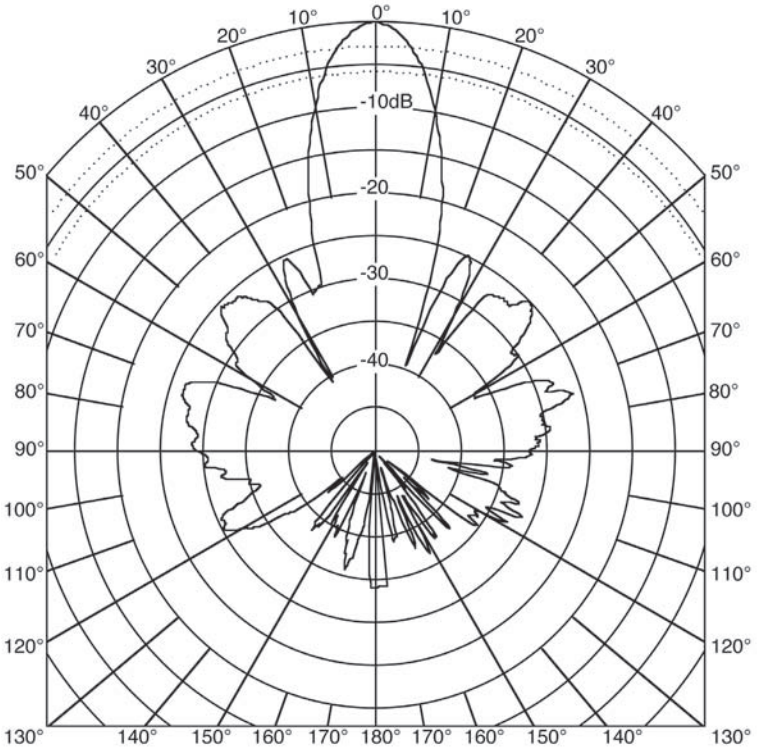
-3dB: 12°
-6dB: 17°
-10dB: 22°

Directivity Index:	25.6
Frequency Tolerance:	±4kHz
Peak TVR(1), nominal:	162dB
Peak TVR(1), minimum:	160dB
Q (transmit):	37
Peak Source Level(4):	216dB
Peak RVR(2), nominal:	-186dB
Peak Figure of Merit(3):	-24dB

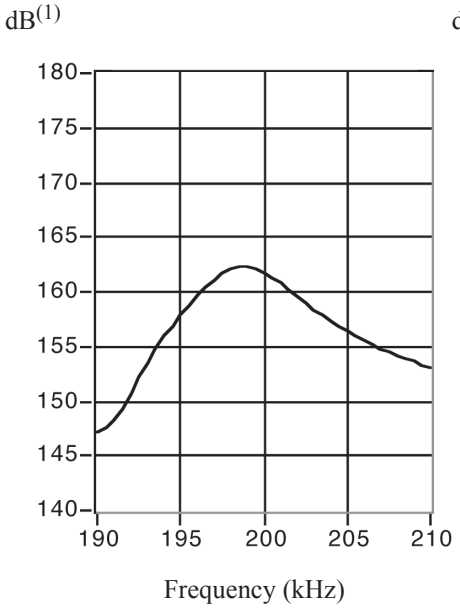
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

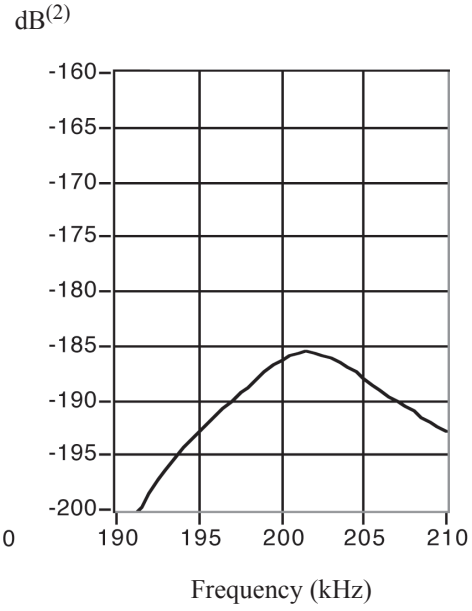
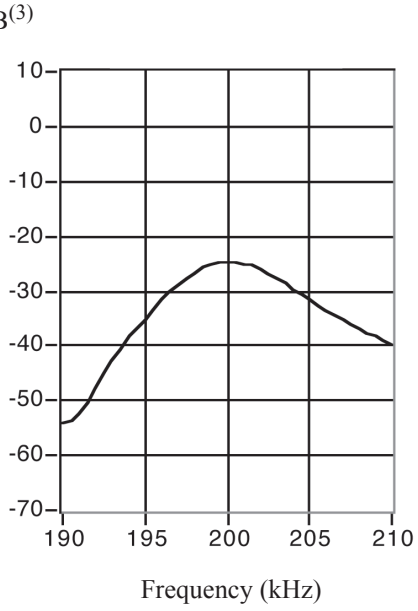


Figure of Merit



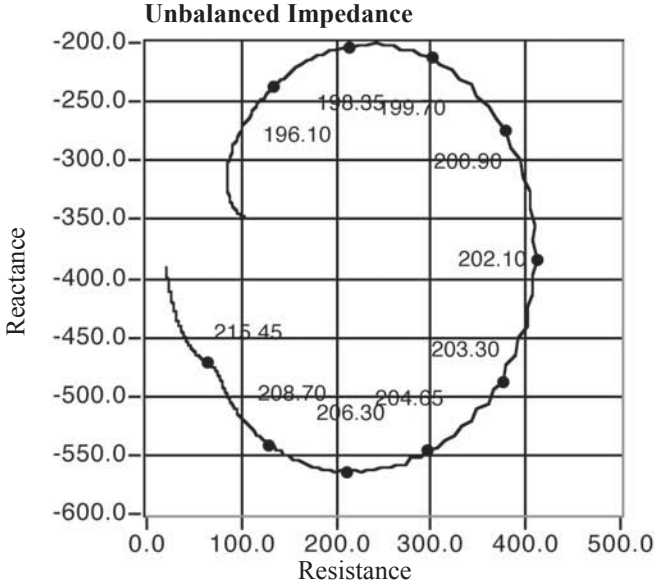
50/200 kHz – Alq (200 kHz)

44mm (1.75") PZT

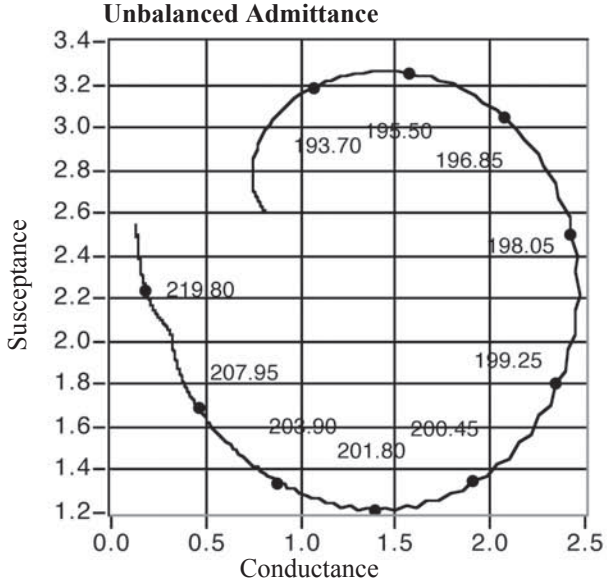
Cable Type: C172
Cable Length: 7.6m (25.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	370ohms-20%,+40%	370ohms-20%,+40%
Parallel: Cp. (nominal)	240pF	240pF
Series [R – jX] (nominal)	1015 – j350 ohms	1015 – j350 ohms
1 kHz Capacitance	2180pF±20%	2180pF±20%

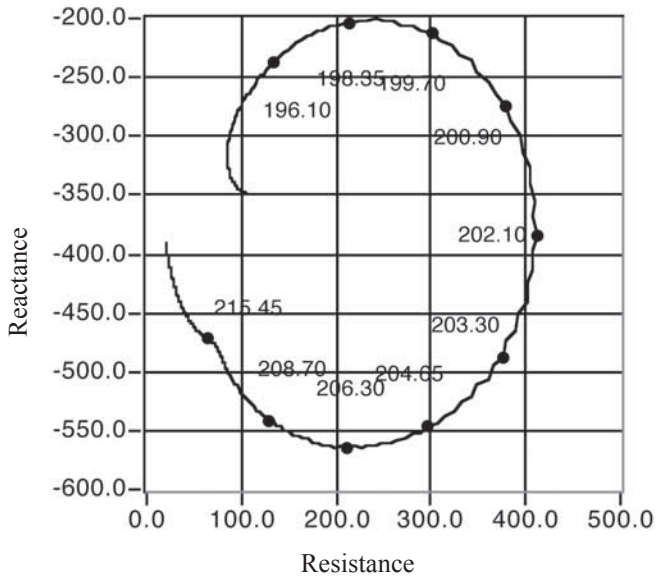
Unbalanced Impedance



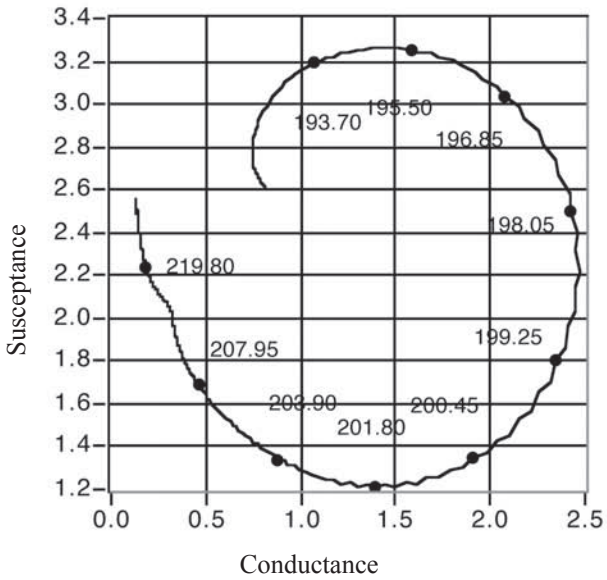
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



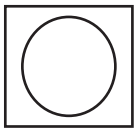
50/200 kHz-Alq (50 kHz)

100m cable with inductor

Power Rating: 600 W @ 1% duty cycle
44 mm (1.75") PZT
Active Area: 15.5 cm²
Radiating Surface: Epoxy/Urethane

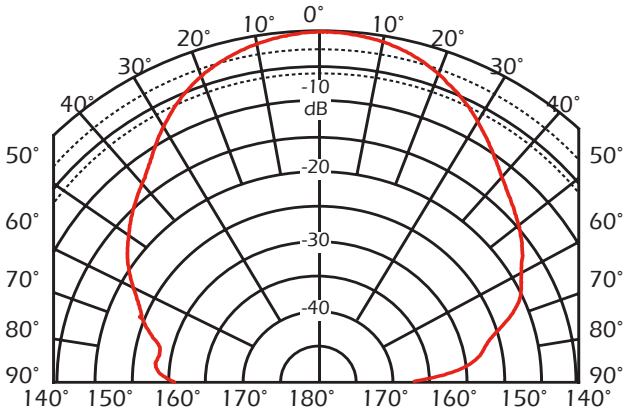
Beamwidth:
-3 dB: 37°
-6 dB: 53°
-10 dB: 69°

Array

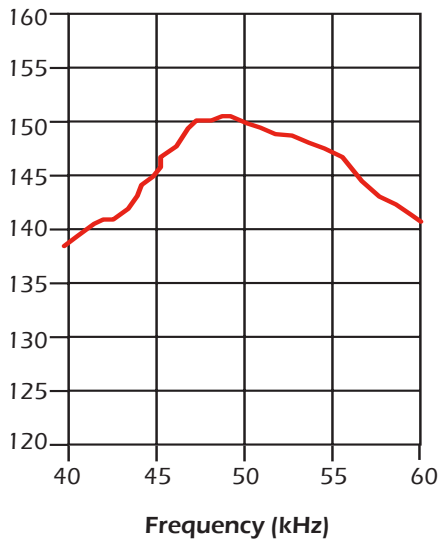


Directivity Index:	13.6
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	150 dB
Peak TVR(1), minimum:	148 dB
Q (transmit):	6
Peak Source Level(4):	207 dB
Peak RVR(2), nominal:	-183 dB
Peak Figure of Merit(3):	-32 dB

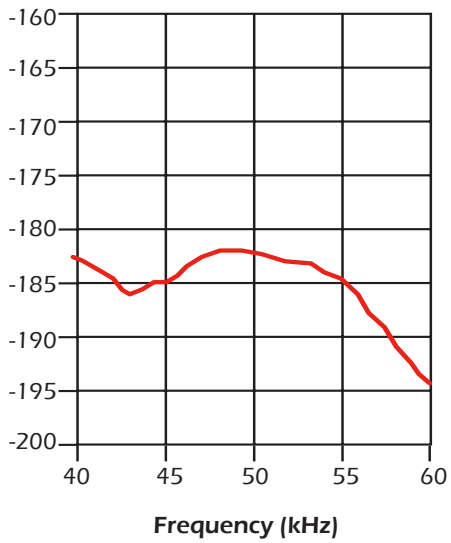
Transmit Radiation Pattern



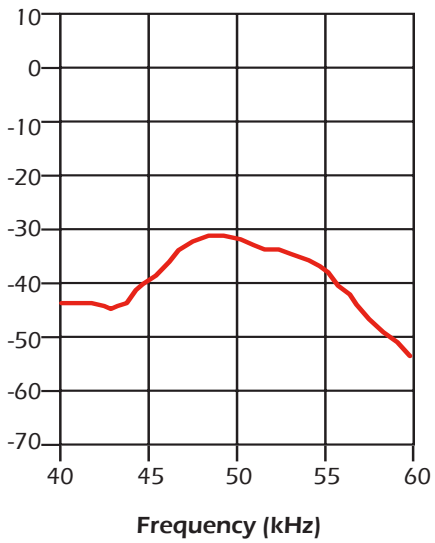
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

50/200 kHz-Alq (50 kHz)

100m cable with inductor
44 mm (1.75”) PZT

Cable Type: C324
Cable Length: 100 m (329’)

Note:
Impedance data includes cable

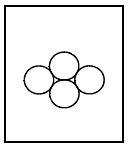
Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	975 Ω: -20%, +40%	1000 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	4150 pF
Series [R - jX]: (nominal)	975- j0 Ω	360- j500 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
41	2662.2	66.5	1060.5	2441.9	0.1496	-0.3445	6683.0	-1337.2
42	4529.3	30.2	3914.0	2279.2	0.1908	-0.1111	5241.2	-424.6
43	4712.8	15.9	4531.9	1293.1	0.204	-0.0582	4900.9	-215.2
44	3876.6	-21.9	3595.8	-1448.5	0.2393	0.0964	4179.3	348.6
45	2466.8	-37.7	1951.7	-1508.7	0.3207	0.2479	3118.0	876.9
46	1720.9	-38.5	1346.8	-1071.2	0.4548	0.3617	2198.8	1251.6
47	1314.9	-33.6	1094.6	-728.6	0.6331	0.4214	1579.5	1427.0
48	1102.3	-25.1	998.4	-467.3	0.8216	0.3846	1217.1	1275.2
49	1075.1	-15.3	1037.1	-283.3	0.8973	0.2451	1114.4	796.2
50	1004.0	-9.2	991.1	-160.4	0.9832	0.1591	1017.1	506.4
51	1095.7	-3.5	1093.6	-67.6	0.9109	0.0563	1097.8	175.7
52	1109.0	-1.6	1108.5	-31.3	0.9014	0.0255	1109.4	77.9
53	1198.6	0.4	1198.5	9.2	0.8343	-0.0064	1198.6	-17.5
54	1360.0	3.9	1356.8	93.2	0.7336	-0.0504	1363.2	-147.4
55	1531.3	5.3	1524.8	141.2	0.6503	-0.0602	1537.8	-174.5
56	1900.1	6.3	1888.8	207.4	0.5231	-0.0574	1911.5	-164.1
57	2416.5	-4.7	2408.2	-199.4	0.4124	0.0341	2424.7	95.3
58	2735.9	-24.4	2490.8	-1131.8	0.3328	0.1512	3005.1	414.9
59	2892.0	-49.0	1896.7	-2183.2	0.2268	0.261	4409.8	704.1
60	2437.4	-63.9	1071.3	-2189.3	0.1803	0.3685	5545.3	977.5
61	2032.4	-73.8	568.3	-1951.3	0.1376	0.4724	7268.6	1232.6
62	1742.4	-78.6	345.8	-1707.8	0.1139	0.5625	8779.9	1444.0

50/200 kHz – B (50 kHz)

Array:



Ceramics wired in parallel
Power rating: 1.2 kWrms @ 2% duty cycle
4x44mm (1.75") PZT
Active Area: 62cm²
Urethane Window

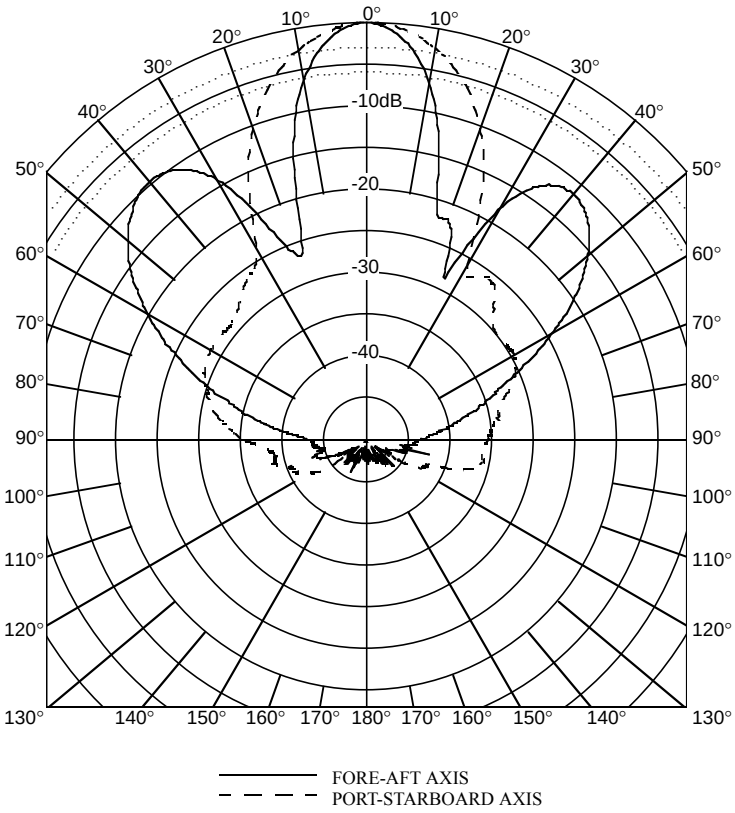
Beamwidth:

-3dB:	14° x 23°
-6dB:	19° x 31°
-10dB:	25° x 40°

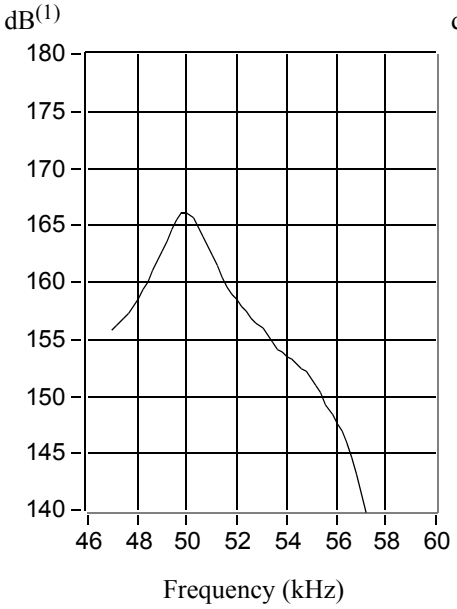
Directivity Index:	20.2
Frequency Tolerance:	±2kHz
Peak TVR(1), nominal:	166dB
Peak TVR(1), minimum:	164dB
Q (transmit):	28
Peak Source Level(4):	213dB
Peak RVR(2), nominal:	-171dB
Peak Figure of Merit(3):	-21dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

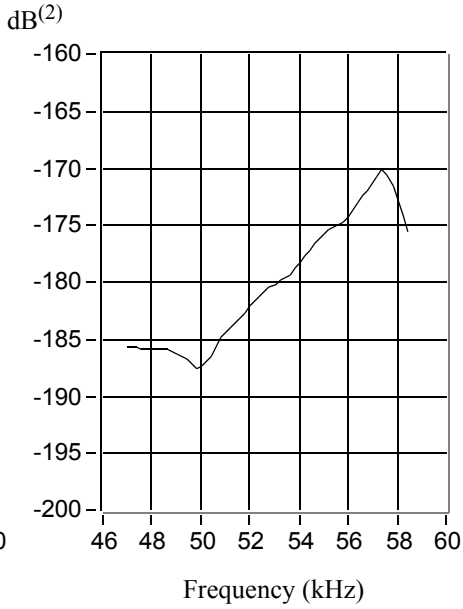
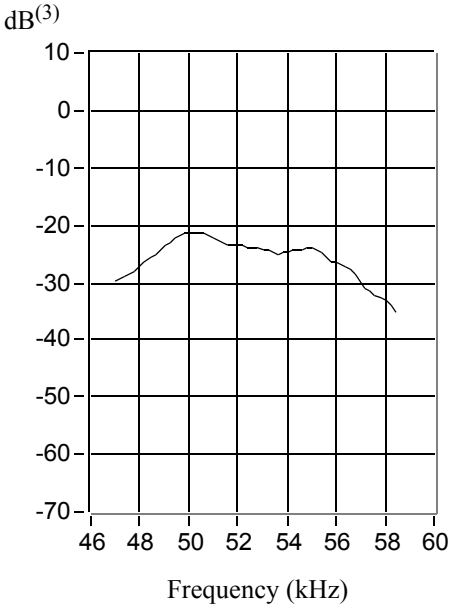


Figure of Merit



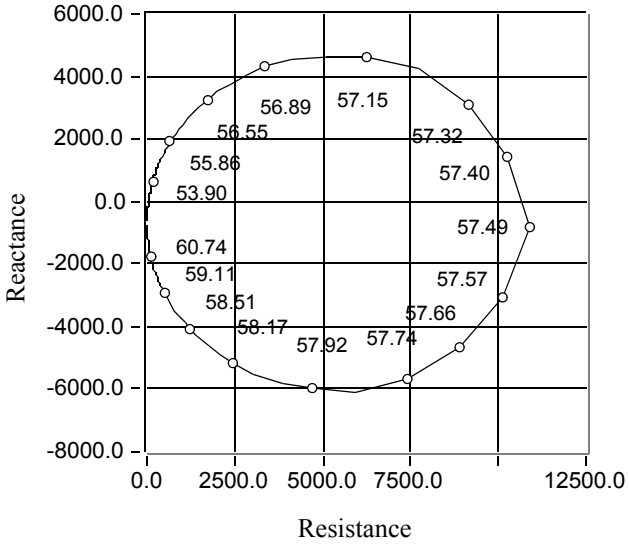
50/200 kHz – B (50 kHz)

4x44mm (1.75") PZT

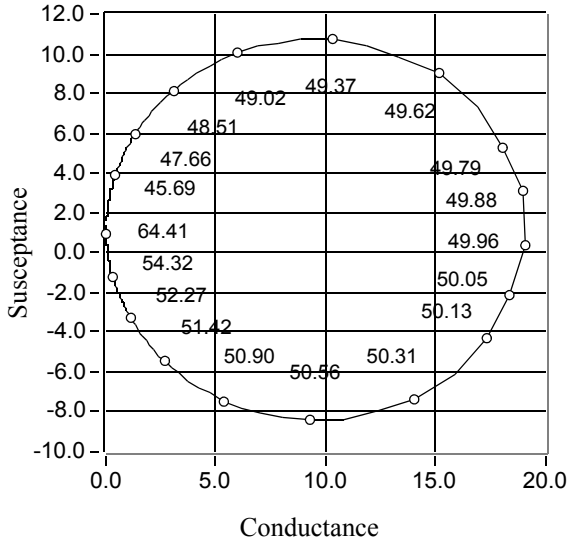
Cable Type: C32
Cable Length: 10.1m (33.0')

Impedance Data	
	Balanced
Parallel: Rp.	55ohms -20%,+40%
Parallel: Cp. (nominal)	5000pF
Series [R – jX] (nominal)	50 – j5 ohms
1 kHz Capacitance	5880pF±20%

Balanced Impedance



Balanced Admittance



50/200 kHz – B (200 kHz)

Ceramics wired in parallel

Power rating: 1.2 kW$_{rms}$ @ 2% duty cycle

4x44mm (1.75") PZT

Active Area: 62cm^2

Urethane Window

Beamwidth:

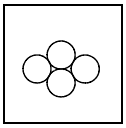
--3dB:	3° x 5°
-6dB:	5° x 7°
-10dB:	7° x 9°

Directivity Index:	31.7
Frequency Tolerance:	±4kHz
Peak TVR(1), nominal:	175dB
Peak TVR(1), minimum:	172dB
Q (transmit):	30
Peak Source Level(4):	225dB
Peak RVR(2), nominal:	-178dB
Peak Figure of Merit(3):	-8dB

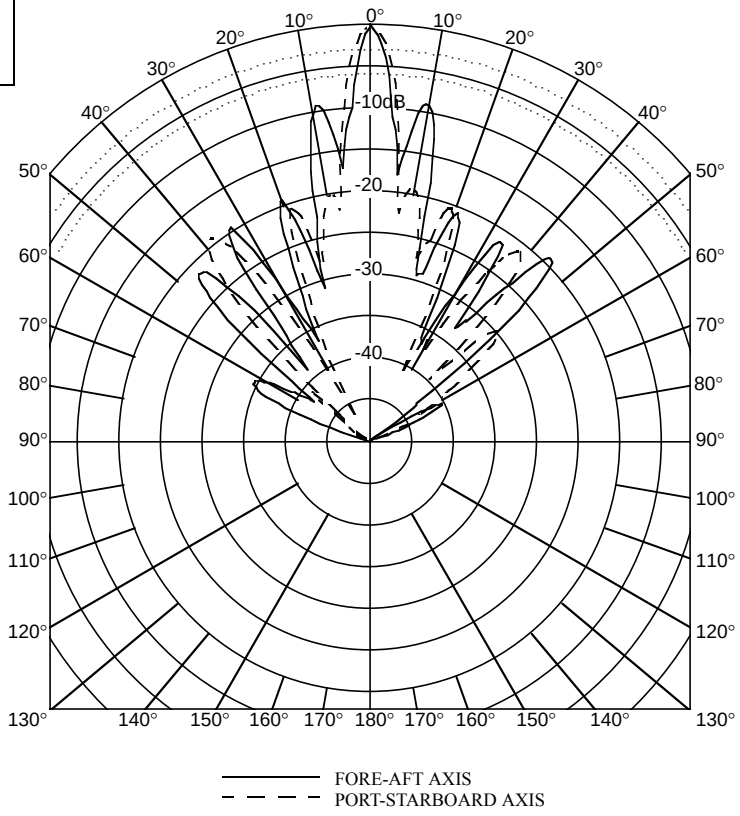
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

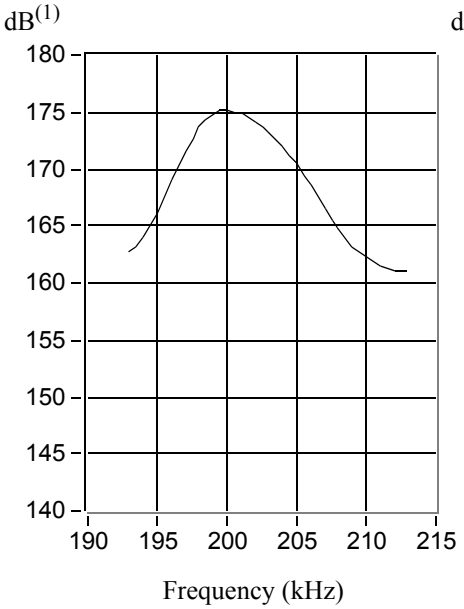
Array:



Transmit Radiation Pattern



TVR



RVR

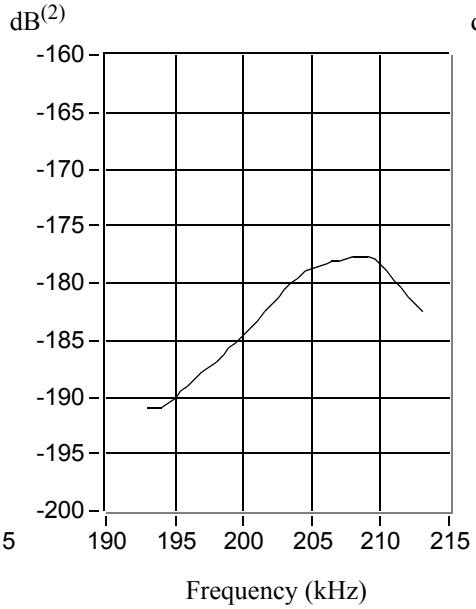
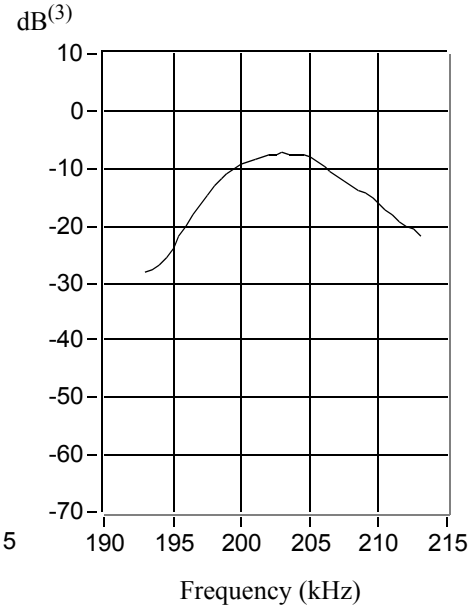


Figure of Merit



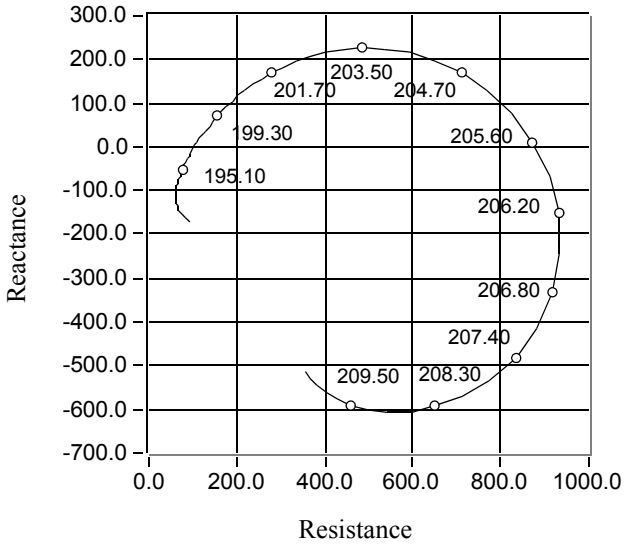
50/200 kHz – B (200 kHz)

4x44mm (1.75") PZT

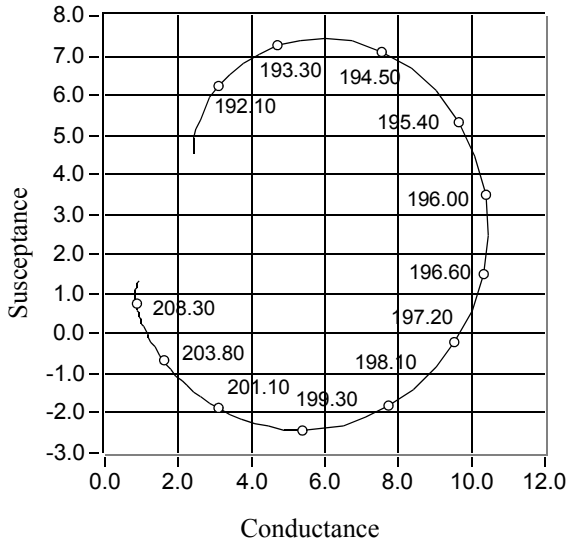
Cable Type: C32
Cable Length: 10.1 m (33.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	95 ohms -20%, +40%	95 ohms -20%, +40%
Parallel: Cp. (nominal)	2000 pF	3300 pF
Series [R – jX] (nominal)	90 – j20 ohms	80 – j35 ohms
1 kHz Capacitance	5910 pF ±20%	5870 pF ±20%

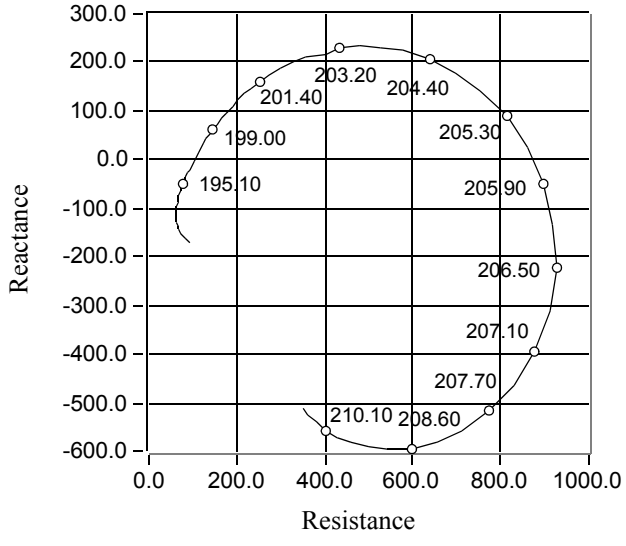
Unbalanced Impedance



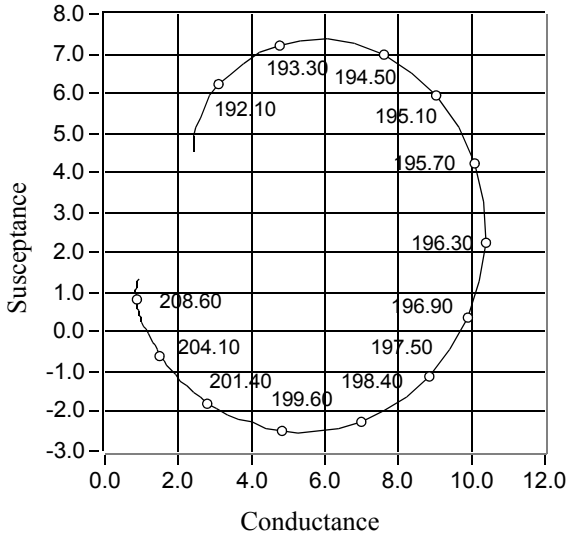
Unbalanced Admittance



Balanced Impedance

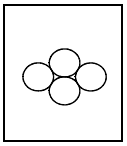


Balanced Admittance



50/200 kHz – B (50 kHz)

Array:



Ceramics wired in series/parallel
Power rating: 1.2 kWrms @ 2% duty cycle
4x44mm (1.75") PZT
Active Area: 62cm²
Urethane Window

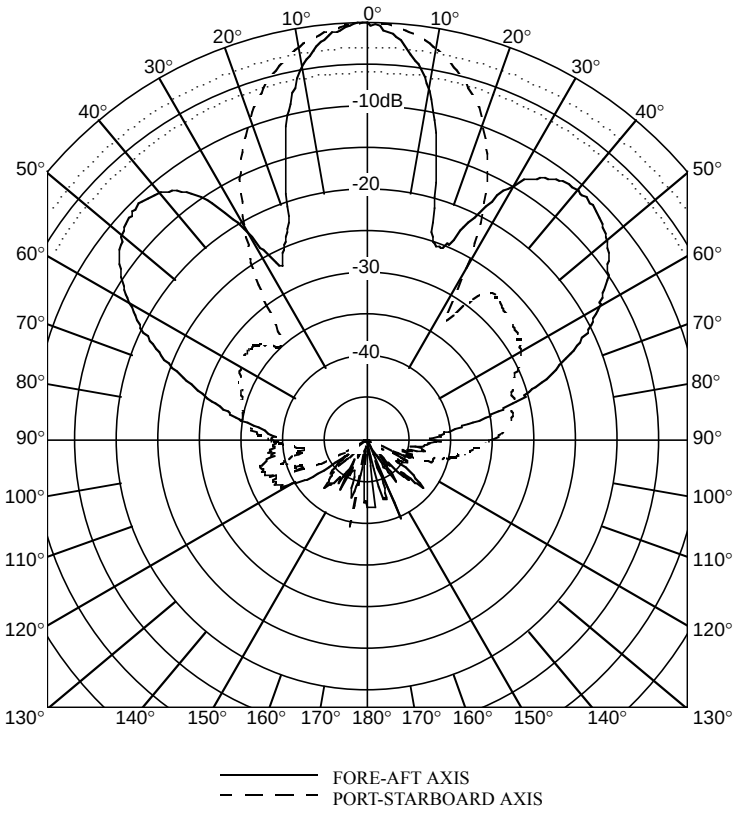
Beamwidth:

-3dB:	14° x 23°
-6dB:	20° x 32°
-10dB:	25° x 41°

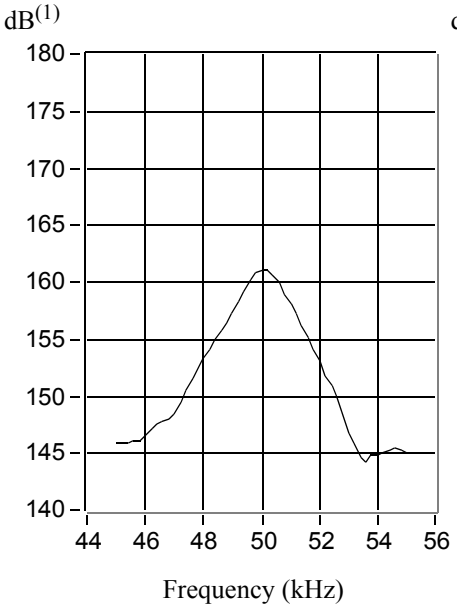
Directivity Index:	20.2
Frequency Tolerance:	±2kHz
Peak TVR(1), nominal:	161dB
Peak TVR(1), minimum:	159dB
Q (transmit):	27
Peak Source Level(4):	214dB
Peak RVR(2), nominal:	-168dB
Peak Figure of Merit(3):	-19dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

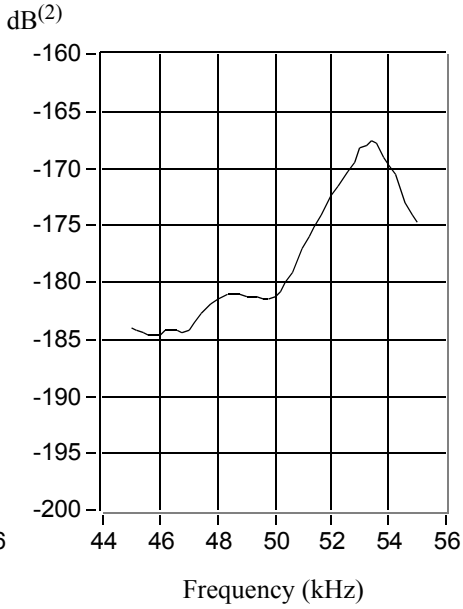
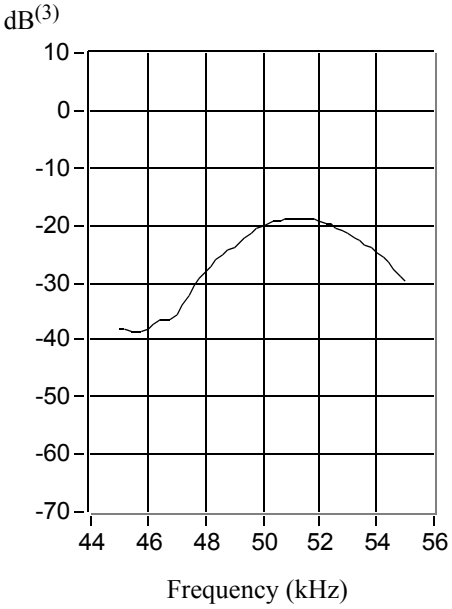


Figure of Merit



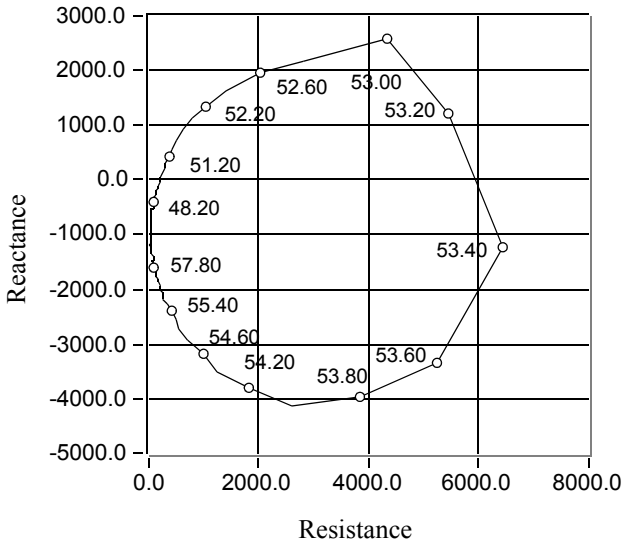
50/200 kHz – B (50 kHz)

4x44mm (1.75") PZT

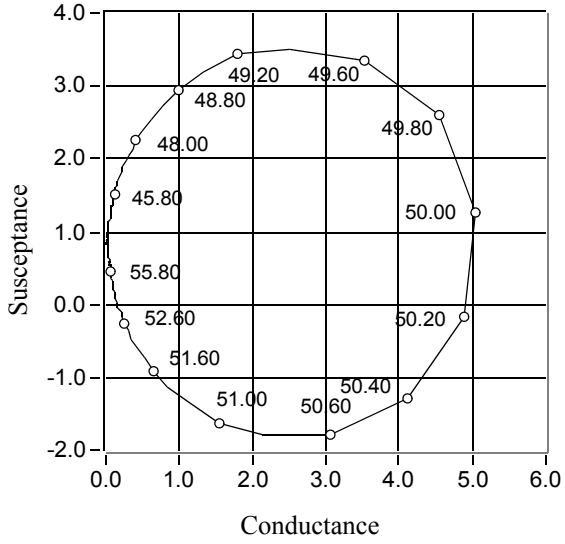
Cable Type: C32
Cable Length: 10.1m (33.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	200ohms-20%,+40%	200ohms-20%,+40%
Parallel: Cp. (nominal)	2390pF	4070pF
Series [R – jX] (nominal)	190 – j30 ohms	190 – j50 ohms
1 kHz Capacitance	1560pF±20%	3310pF±20%

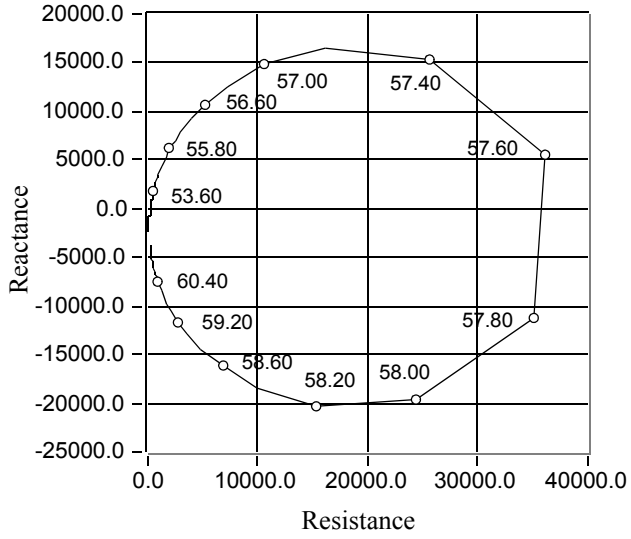
Unbalanced Impedance



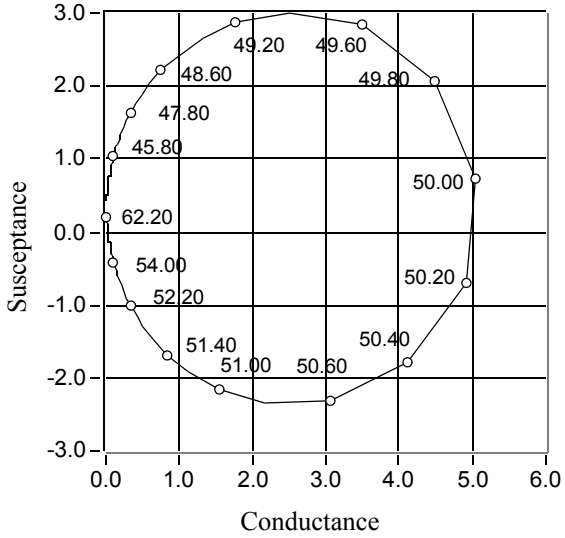
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



50/200 kHz – B (200 kHz)

Array:

Ceramics wired in series/parallel

Power rating: 1.2 kWrms @ 2% duty cycle
4x44mm (1.75") PZT
Active Area: 62cm²
Urethane Window

Beamwidth:

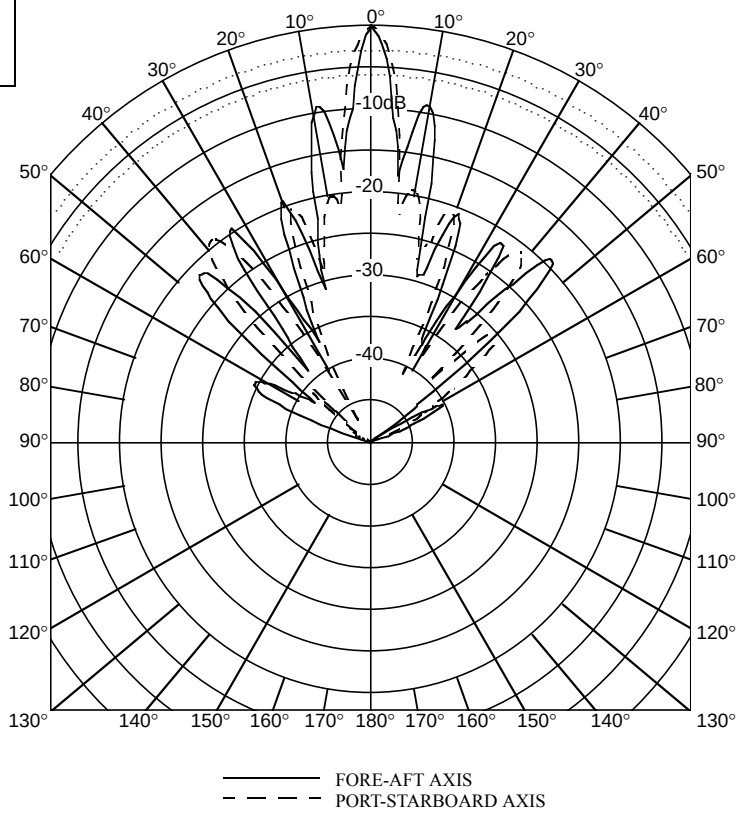
-3dB:	3° x 5°
-6dB:	5° x 7°
-10dB:	7° x 9°

Directivity Index:	31.7
Frequency Tolerance:	±4kHz
Peak TVR(1), nominal:	170dB
Peak TVR(1), minimum:	168dB
Q (transmit):	30
Peak Source Level(4):	226dB
Peak RVR(2), nominal:	-178dB
Peak Figure of Merit(3):	-9dB

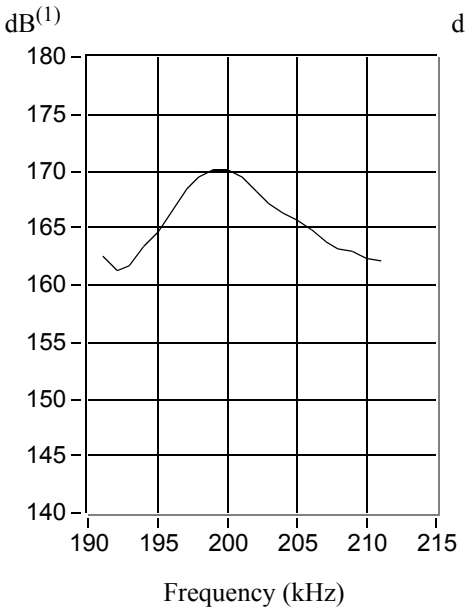
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

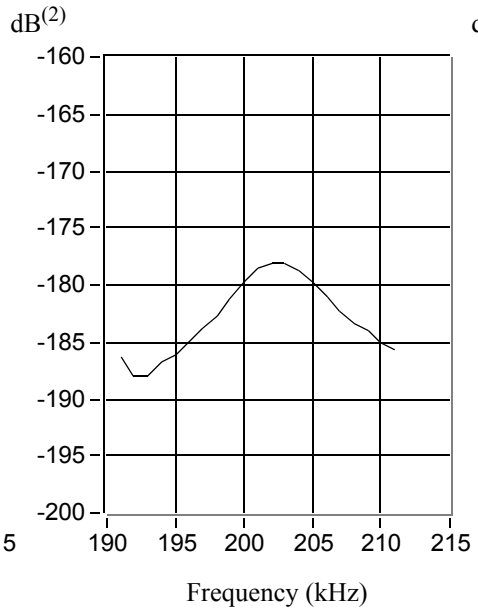
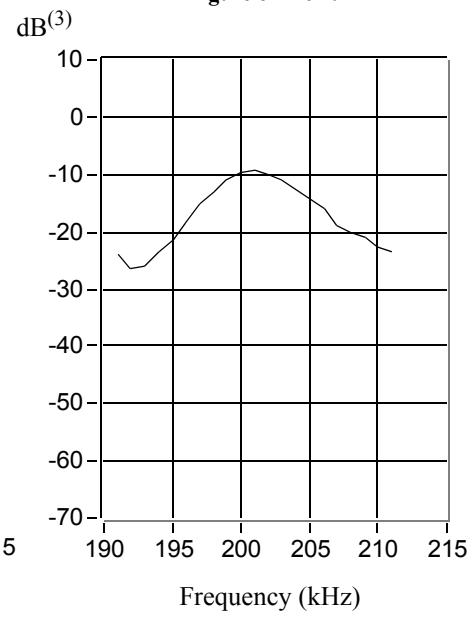


Figure of Merit



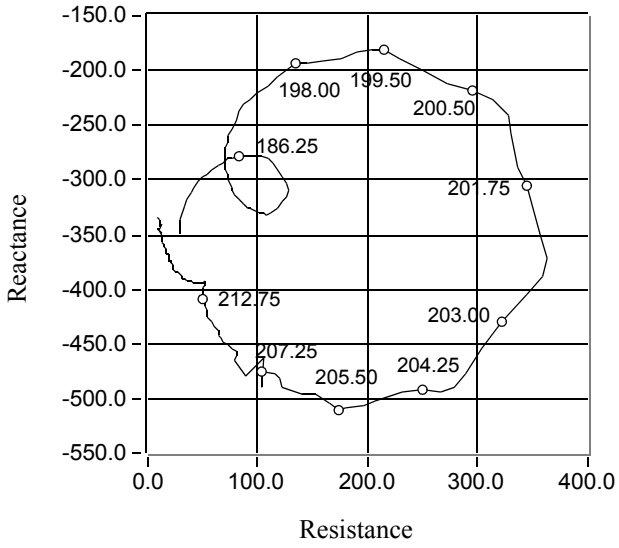
50/200 kHz – B (200 kHz)

4x44mm (1.75") PZT

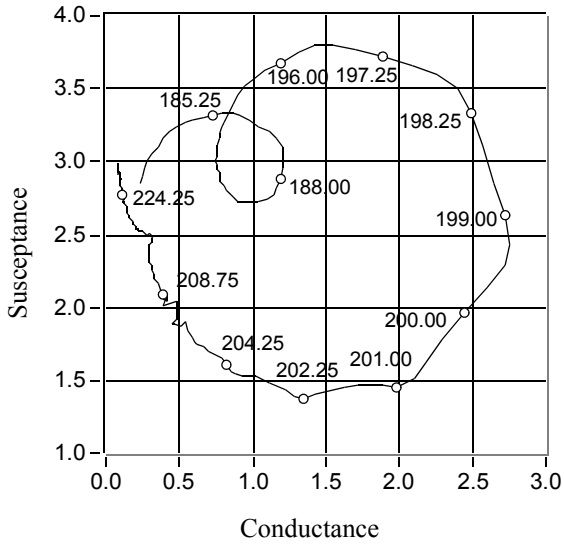
Cable Type: C33
Cable Length: 10.4m (34.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	370ohms-20%,+40%	370ohms-20%,+40%
Parallel: Cp. (nominal)	880pF	2170pF
Series [R – jX] (nominal)	320 – j130 ohms	180 – j190 ohms
1 kHz Capacitance	1860pF±20%	3200pF±20%

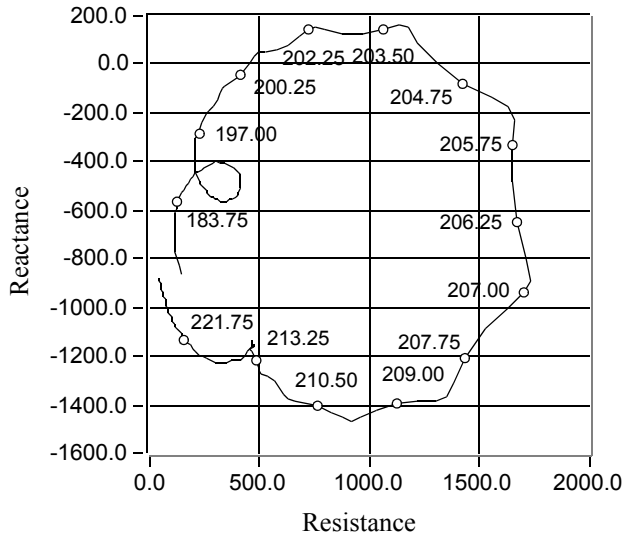
Unbalanced Impedance



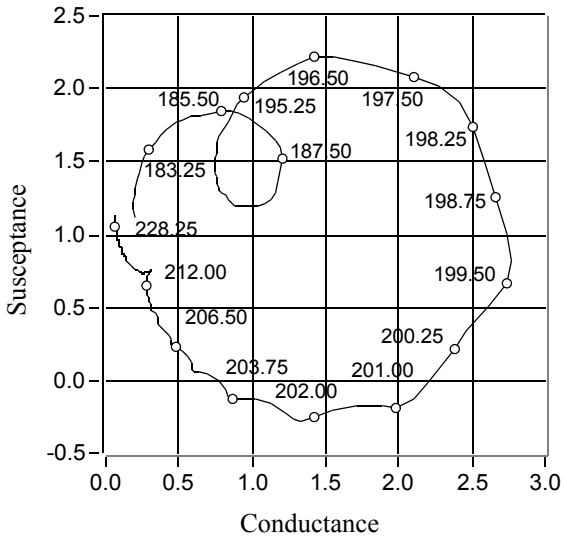
Unbalanced Admittance



Balanced Impedance

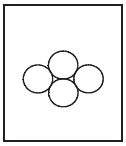


Balanced Admittance



50/200 kHz – Blq (50 kHz)

Array:



Ceramics wired in parallel
Power rating: 1 kWrms @ 2% duty cycle
4 x 44mm (1.75") PZT/L
Active Area: 62cm²
Epoxy/Urethane Window

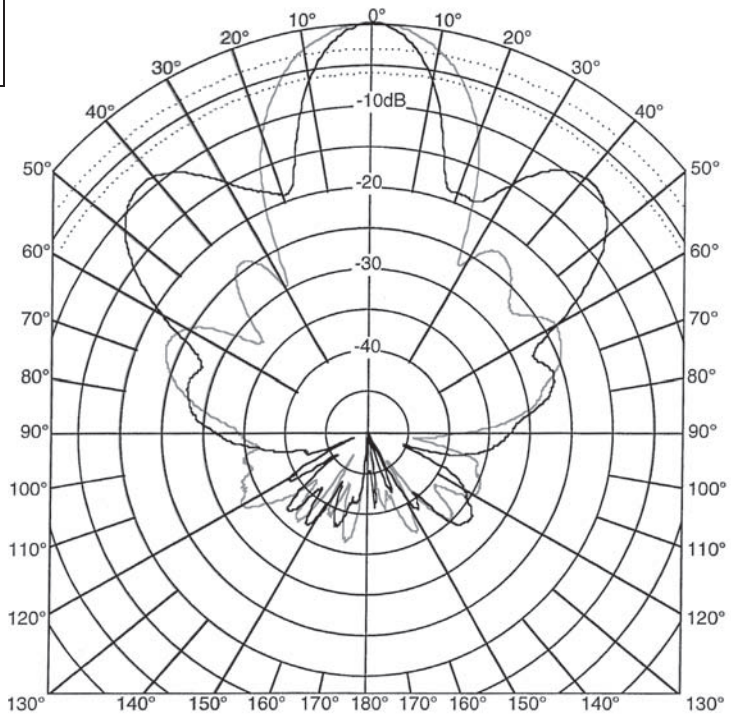
Beamwidth:

-3 dB:	15° x 21°
-6 dB:	21° x 30°
-10 dB:	26° x 38°

Directivity Index:	20.2
Frequency Tolerance:	±2 kHz
Peak TVR (1), nominal:	161 dB
Peak TVR (1), minimum:	158 dB
Q (transmit):	8
Peak Source Level (4):	214 dB
Peak RVR (2), nominal:	-174 dB
Peak Figure of Merit (3):	-18 dB

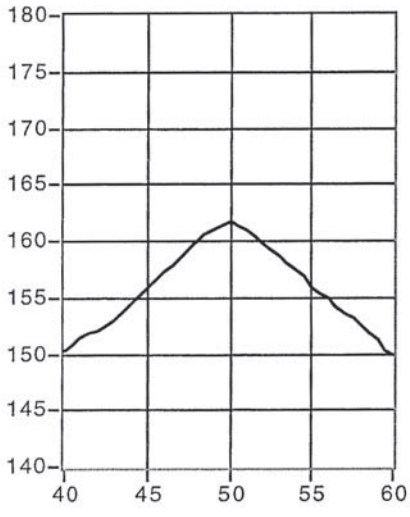
Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR

dB(1)



RVR

dB(2)

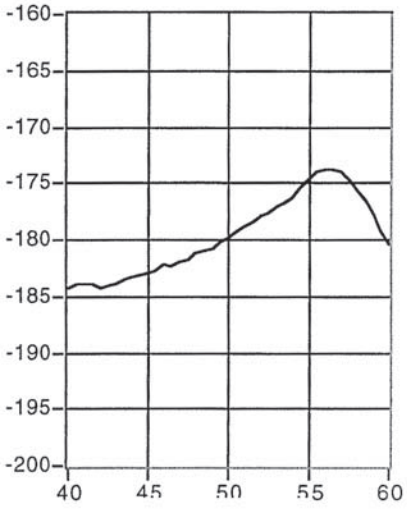
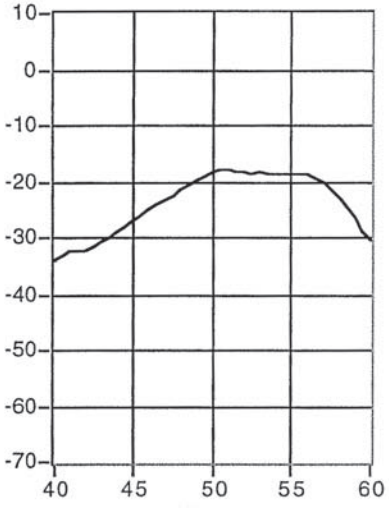


Figure of Merit

dB(3)



50/200 kHz – Blq (50 kHz)

4x44mm (1.75") PZT

Cable Type: C32
Cable Length: 10.1m (33.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	210ohms-20%,+40%	210ohms-20%,+40%
Parallel: Cp. (nominal)	5350pF	5350pF
Series [R – jX] (nominal)	210 – j25ohms	210 – j25ohms
1 kHz Capacitance	7370±20%	7340±20%

Unbalanced Impedance Table (For balanced data, contact Airmar)

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
40.00	374.29	-83.22	44.22	-371.67	0.3156	2.6530	3168.30	10556.07
40.50	362.89	-81.95	50.82	-359.32	0.3859	2.7285	2591.09	10722.19
41.00	351.40	-81.97	49.10	-347.96	0.3976	2.8178	2514.83	10938.22
41.50	338.85	-80.76	54.43	-334.45	0.4740	2.9128	2109.70	11170.79
42.00	325.68	-80.14	55.78	-320.87	0.5259	3.0251	1901.47	11463.31
42.50	315.85	-78.35	63.80	-309.34	0.6396	3.1008	1563.60	11611.88
43.00	311.47	-76.55	72.43	-302.93	0.7466	3.1226	1339.46	11557.55
43.50	295.86	-76.28	70.15	-287.43	0.8014	3.2836	1247.79	12013.66
44.00	283.30	-74.50	75.71	-273.00	0.9433	3.4015	1060.14	12303.66
44.50	273.05	-72.35	82.80	-260.19	1.1106	3.4899	900.39	12481.72
45.00	260.90	-71.41	83.17	-247.29	1.2219	3.6329	818.38	12848.74
45.50	248.38	-69.91	85.34	-233.26	1.3832	3.7810	722.94	13225.64
46.00	243.59	-64.84	103.57	-220.48	1.7455	3.7156	572.90	12855.58
46.50	226.58	-62.53	104.53	-201.03	2.0361	3.9157	491.13	13402.08
47.00	224.21	-59.25	114.63	-192.69	2.2803	3.8331	438.54	12979.80
47.50	214.30	-54.34	124.92	-174.12	2.7203	3.7915	367.61	12703.95
48.00	207.08	-49.38	134.80	-157.19	3.1436	3.6657	318.10	12154.54
48.50	202.70	-44.14	145.47	-141.16	3.5404	3.4356	282.45	11274.15
49.00	201.82	-36.75	161.72	-120.75	3.9701	2.9645	251.88	9628.77
49.50	204.52	-29.50	178.01	-100.71	4.2556	2.4076	234.99	7740.91
50.00	212.24	-20.92	198.25	-75.77	4.4012	1.6820	227.21	5354.02
50.50	238.88	-14.03	231.75	-57.91	4.0614	1.0148	246.22	3198.25
51.00	259.27	-7.79	256.88	-35.13	3.8214	0.5226	261.68	1630.93
51.50	292.59	-3.42	292.07	-17.47	3.4117	0.2040	293.11	630.54
52.00	337.97	-1.48	337.86	-8.75	2.9579	0.0766	338.08	234.49
52.50	373.51	0.89	373.46	5.80	2.6770	-0.0416	373.55	-126.04
53.00	426.68	2.02	426.41	15.07	2.3422	-0.0828	426.95	-248.51
53.50	478.35	3.62	477.39	30.19	2.0864	-0.1320	479.30	-392.54
54.00	556.84	5.62	554.16	54.51	1.7872	-0.1758	559.52	-518.15
54.50	667.11	4.25	665.27	49.43	1.4949	-0.1111	668.95	-324.35
55.00	819.73	0.30	819.72	4.28	1.2199	-0.0064	819.74	-18.42
55.50	951.90	-7.58	943.58	-125.62	1.0413	0.1386	960.30	397.55
56.00	1035.93	-16.08	995.42	-286.87	0.9276	0.2673	1078.09	759.72
56.50	1128.77	-24.62	1026.18	-470.18	0.8054	0.3690	1241.61	1039.50
57.00	1172.16	-32.76	985.72	-634.28	0.7174	0.4616	1393.86	1289.00
57.50	1157.94	-42.17	858.27	-777.30	0.6401	0.5797	1562.24	1604.61
58.00	1134.47	-50.17	726.59	-871.26	0.5645	0.6770	1771.33	1857.61
58.50	1098.58	-54.82	632.96	-897.91	0.5245	0.7440	1906.72	2024.11
59.00	1047.22	-60.99	507.86	-915.83	0.4631	0.8351	2159.38	2252.72
59.50	987.59	-65.11	415.61	-895.88	0.4261	0.9185	2346.77	2456.96
60.00	909.03	-69.08	324.57	-849.11	0.3928	1.0276	2545.93	2725.69

50/200 kHz – Blq (200 kHz)

Array:

Ceramics wired in parallel

Power rating: 1 kW$_{rms}$ @ 2% duty cycle
4x44mm (1.75") PZT/L
Active Area: 62cm^2
Epoxy/Urethane Window

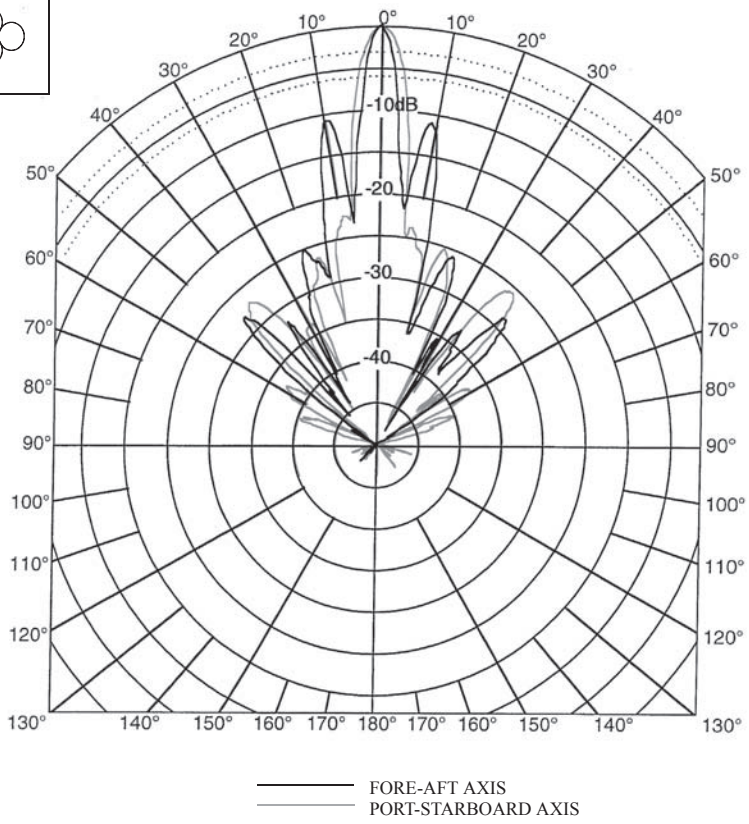
Beamwidth:

--3dB:	3° x 5°
-6dB:	5° x 7°
-10dB:	7° x 10°

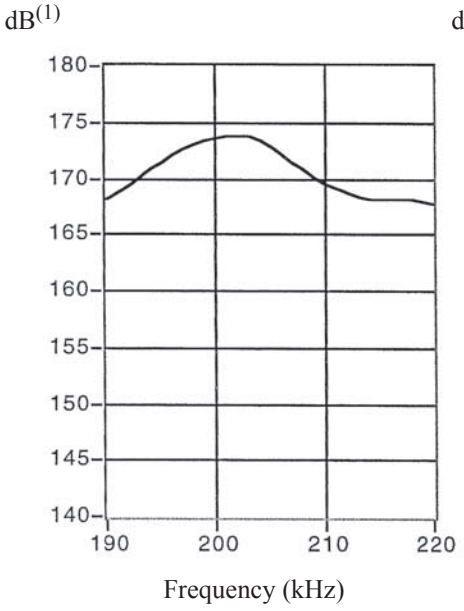
Directivity Index:	31.7
Frequency Tolerance:	±4kHz
Peak TVR[(1)], nominal:	173dB
Peak TVR[(1)], minimum:	170dB
Q (transmit):	15
Peak Source Level[(4)]:	223dB
Peak RVR[(2)], nominal:	-182dB
Peak Figure of Merit[(3)]:	-9dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

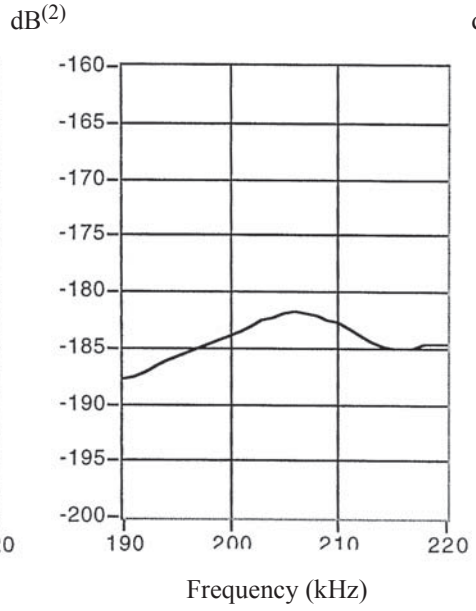
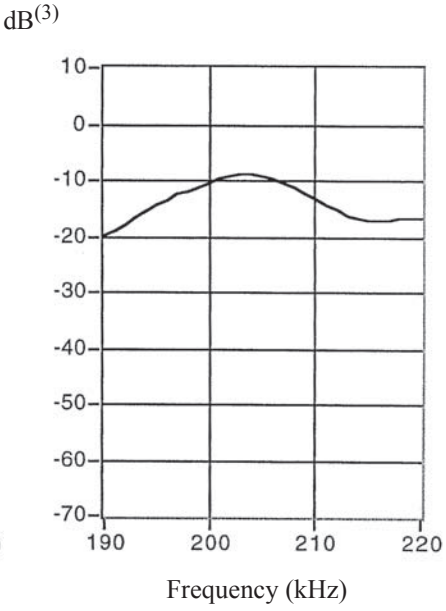


Figure of Merit



50/200 kHz – Blq (200 kHz)

4x44mm (1.75") PZT

Cable Type: C32
Cable Length: 10.1m (33.0')

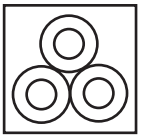
Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	200ohms-20%,+40%	200 ohms-20%,+40%
Parallel: Cp. (nominal)	3750pF	3750pF
Series [R – jX] (nominal)	140 – j42 ohms	140 – j42 ohms
1 kHz Capacitance	8070pF±20%	8040 pF ±20%

Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	150.76	-67.84	56.87	-139.62	2.5023	6.1430	399.63	5145.76
191.00	146.44	-67.38	56.33	-135.17	2.6269	6.3034	380.68	5252.47
192.00	142.06	-66.52	56.60	-130.30	2.8046	6.4566	356.56	5352.05
193.00	138.08	-65.15	58.02	-125.29	3.0434	6.5719	328.58	5419.43
194.00	134.79	-63.42	60.30	-120.55	3.3190	6.6350	301.29	5443.26
195.00	131.95	-61.32	63.34	-115.76	3.6375	6.6484	274.91	5426.29
196.00	129.94	-58.81	67.30	-111.15	3.9861	6.5833	250.87	5345.71
197.00	128.96	-56.14	71.86	-107.08	4.3211	6.4391	231.42	5202.13
198.00	128.86	-53.28	77.04	-103.29	4.6399	6.2207	215.52	5000.27
199.00	129.67	-50.01	83.33	-99.35	4.9558	5.9085	201.78	4725.46
200.00	132.25	-46.59	90.88	-96.07	5.1965	5.4932	192.44	4371.34
201.00	136.83	-42.96	100.14	-93.25	5.3485	4.9802	186.97	3943.38
202.00	144.18	-39.73	110.89	-92.15	5.3343	4.4330	187.47	3492.74
203.00	154.38	-37.27	122.86	-93.48	5.1550	3.9223	193.99	3075.11
204.00	167.17	-35.18	136.63	-96.32	4.8893	3.4467	204.53	2689.00
205.00	184.37	-34.44	152.04	-104.28	4.4730	3.0678	223.56	2381.76
206.00	202.61	-35.84	164.25	-118.63	4.0011	2.8897	249.93	2232.61
207.00	219.87	-38.09	173.04	-135.64	3.5795	2.8058	279.37	2157.30
208.00	235.66	-41.78	175.73	-157.01	3.1644	2.8273	316.01	2163.33
209.00	244.97	-45.73	171.00	-175.41	2.8496	2.9230	350.93	2225.90
210.00	251.49	-49.80	162.31	-192.09	2.5664	3.0373	389.65	2301.89
211.00	251.35	-53.84	148.32	-202.92	2.3477	3.2120	425.94	2422.75
212.00	247.61	-56.58	136.39	-206.66	2.2246	3.3706	449.52	2530.45
213.00	243.69	-58.39	127.71	-207.55	2.1505	3.4949	465.01	2611.39
214.00	240.54	-59.78	121.07	-207.85	2.0925	3.5924	477.89	2671.69
215.00	237.61	-60.53	116.90	-206.86	2.0706	3.6640	482.96	2712.30
216.00	237.28	-60.75	115.95	-207.02	2.0596	3.6769	485.54	2709.28
217.00	240.47	-61.06	116.35	-210.45	2.0120	3.6394	497.01	2669.27
218.00	245.83	-61.92	115.71	-216.89	1.9147	3.5891	522.28	2620.27
219.00	253.49	-63.24	114.13	-226.35	1.7762	3.5224	563.01	2559.84
220.00	259.22	-65.95	105.66	-236.71	1.5724	3.5227	635.97	2548.45

50/200 kHz-Glq (50 kHz)

Array

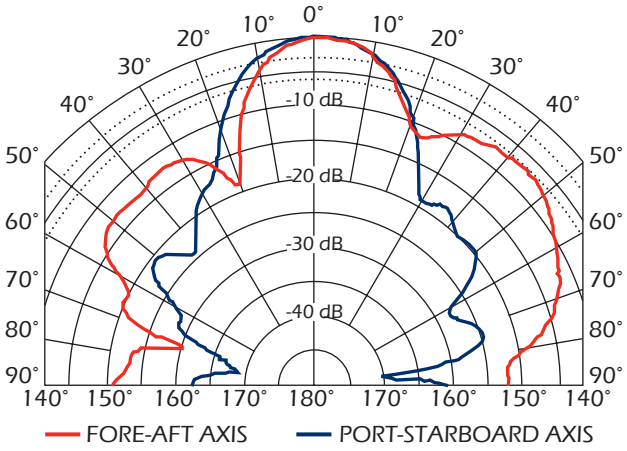


Ceramics wired in parallel
Transformed to 240 ohms
Power Rating: 1 kW rms @ 2% duty cycle
3 x 35 mm (1.38") PZT4
Active Area: 29 cm²
Epoxy/Urethane Window

Beamwidth:
-3 dB: 22° / 20°
-6 dB: 31° / 27°
-10 dB: 39° / 34°

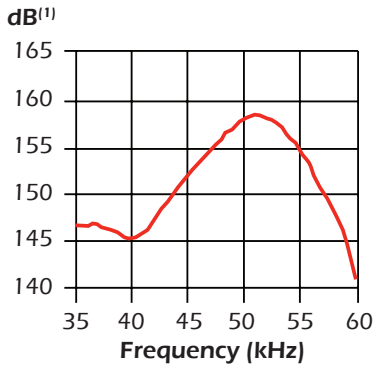
Directivity Index:	17
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	158 dB
Peak TVR(1), minimum:	156 dB
Q (transmit):	7
Peak Source Level(4):	212 dB
Peak RVR(2), nominal:	-174 dB
Peak Figure of Merit(3):	-23 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

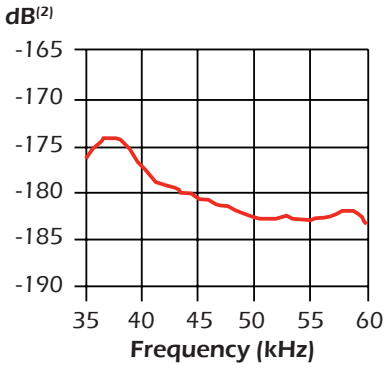
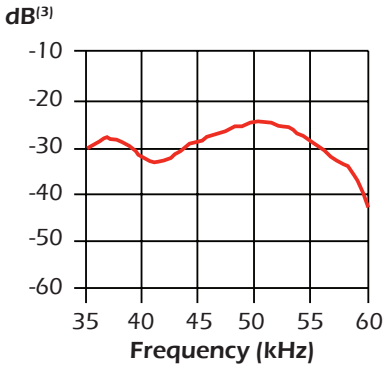


Figure of Merit



50/200 kHz-Glq (50 kHz)

3 x 35 mm (1.38”) PZT4

Cable Type: C332
Cable Length: 10.4 m (34’)

Note:
Impedance data includes cable

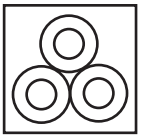
Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	240 Ω: -20%, +40%	240 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,190 pF	1,190 pF
Series [R - jX]: (nominal)	240 - j20 Ω	240 - j20 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
40.00	1612.74	-14.04	1564.56	-391.27	0.6015	0.1504	1662.41	598.56
40.50	1489.57	-21.62	1384.82	-548.73	0.6241	0.2473	1602.25	971.85
41.00	1360.55	-28.57	1194.84	-650.74	0.6455	0.3515	1549.25	1364.63
41.50	1209.24	-34.00	1002.49	-676.22	0.6856	0.4624	1458.63	1773.52
42.00	1059.11	-37.85	836.25	-649.93	0.7455	0.5794	1341.37	2195.60
42.50	936.96	-40.85	708.71	-612.88	0.8073	0.6981	1238.71	2614.37
43.50	746.52	-43.15	544.67	-510.52	0.9773	0.9161	1023.18	3351.62
44.00	672.20	-43.96	483.89	-466.58	1.0709	1.0326	933.78	3735.12
44.50	616.54	-43.74	445.47	-426.23	1.1719	1.1213	853.30	4010.43
45.00	561.12	-42.93	410.86	-382.17	1.3049	1.2138	766.35	4292.92
45.50	510.99	-42.67	375.69	-346.36	1.4388	1.3265	695.01	4639.93
46.00	472.55	-42.12	350.49	-316.95	1.5696	1.4194	637.11	4910.85
47.00	393.60	-38.19	309.36	-243.34	1.9969	1.5708	500.77	5319.03
47.50	362.22	-36.57	290.89	-215.84	2.2171	1.6451	451.04	5511.97
48.00	331.66	-33.45	276.72	-182.82	2.5157	1.6621	397.51	5510.92
48.50	306.15	-29.35	266.85	-150.06	2.8471	1.6011	351.23	5253.94
49.00	282.40	-25.31	255.29	-120.75	3.2010	1.5141	312.40	4917.80
49.50	265.98	-19.74	250.34	-89.85	3.5387	1.2701	282.59	4083.55
50.50	243.78	-5.28	242.74	-22.42	4.0848	0.3772	244.81	1188.81
51.00	247.15	1.61	247.05	6.95	4.0445	-0.1138	247.25	-355.14
51.50	254.38	8.95	251.28	39.59	3.8832	-0.6118	257.52	-1890.77
52.00	263.94	15.72	254.07	71.50	3.6471	-1.0264	274.19	-3141.38
52.50	281.07	21.22	262.02	101.72	3.3167	-1.2876	301.51	-3903.33
53.00	304.27	26.36	272.64	135.08	2.9449	-1.4591	339.57	-4381.50
54.00	352.46	35.87	285.63	206.50	2.2992	-1.6623	434.93	-4899.26
54.50	387.62	39.82	297.72	248.22	1.9815	-1.6521	504.67	-4824.48
55.00	432.70	44.06	310.95	300.89	1.6608	-1.6071	602.11	-4650.46
55.50	489.16	47.15	332.66	358.63	1.3903	-1.4988	719.28	-4298.02
56.00	561.04	49.18	366.77	424.56	1.1652	-1.3488	858.22	-3833.31
56.50	652.84	50.36	416.51	502.72	0.9773	-1.1795	1023.27	-3322.62
57.50	870.59	49.30	567.69	660.04	0.7490	-0.8708	1335.10	-2410.43
58.00	1014.58	47.64	683.67	749.65	0.6642	-0.7283	1505.66	-1998.37
58.50	1186.92	45.36	834.06	844.47	0.5920	-0.5994	1689.07	-1630.82
59.00	1401.70	41.49	1049.90	928.70	0.5344	-0.4727	1871.39	-1275.07
59.50	1660.74	36.27	1338.97	982.46	0.4855	-0.3562	2059.84	-952.82
60.00	1988.72	29.26	1734.94	972.11	0.4387	-0.2458	2279.62	-651.98

50/200 kHz-Glq (200 kHz)

Array

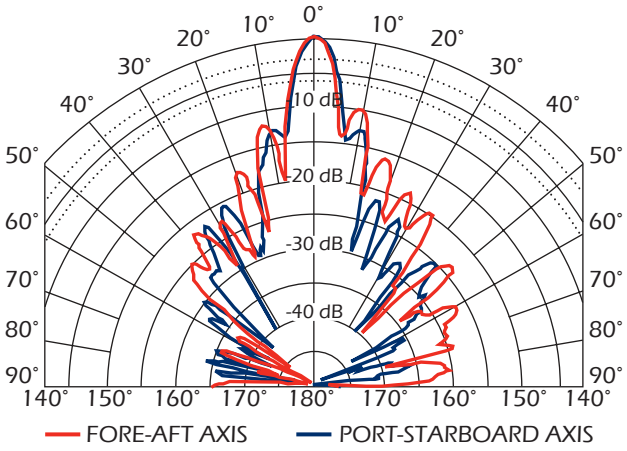


Ceramics wired in parallel
Transformed to 180 ohms
Power Rating: 1 kW rms @ 2% duty cycle
3 x 35 mm (1.38") PZT4
Active Area: 29 cm²
Epoxy/Urethane Window

Beamwidth:
-3 dB: 6° / 6°
-6 dB: 8° / 8°
-10 dB: 11° / 10°

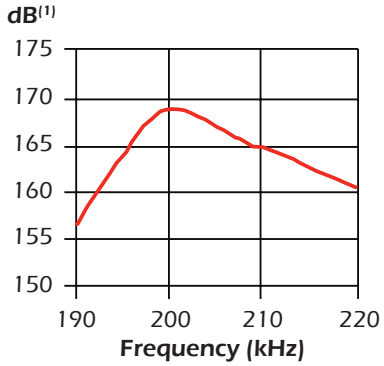
Directivity Index:	28.6
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	168 dB
Peak TVR(1), minimum:	166 dB
Q (transmit):	17
Peak Source Level(4):	220 dB
Peak RVR(2), nominal:	-187 dB
Peak Figure of Merit(3):	-20 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

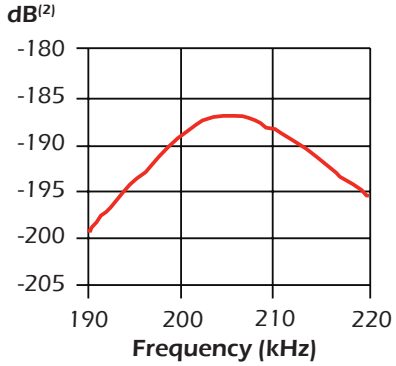
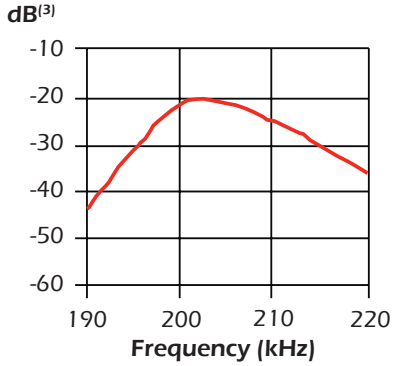


Figure of Merit



50/200 kHz-Glq (200 kHz)

3 x 35 mm (1.38”) PZT4

Cable Type: C332
Cable Length: 10.4 m (34’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	180 Ω: -20%, +40%	180 Ω: -20%, +40%
Parallel: Cp. (nominal)	3,790 pF	3790 pF
Series [R - jX]: (nominal)	100 - j90 Ω	100 - j90 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	162.25	-77.38	35.44	-158.33	1.3461	6.0146	742.87	5038.15
191.00	154.13	-76.10	37.03	-149.61	1.5587	6.2981	641.55	5247.99
192.00	146.54	-74.46	39.25	-141.19	1.8279	6.5745	547.08	5449.79
193.00	139.44	-72.30	42.39	-132.84	2.1800	6.8319	458.71	5633.87
194.00	133.08	-69.54	46.52	-124.68	2.6269	7.0401	380.68	5775.59
195.00	127.82	-66.15	51.69	-116.90	3.1636	7.1552	316.09	5839.91
196.00	123.61	-61.96	58.11	-109.10	3.8032	7.1402	262.93	5797.91
197.00	121.69	-56.91	66.44	-101.95	4.4866	6.8844	222.89	5561.87
198.00	122.69	-51.44	76.48	-95.94	5.0808	6.3733	196.82	5122.90
199.00	127.62	-45.70	89.13	-91.33	5.4730	5.6079	182.71	4485.02
200.00	137.28	-40.84	103.85	-89.78	5.5105	4.7641	181.47	3791.14
201.00	151.14	-37.86	119.33	-92.77	5.2235	4.0608	191.44	3215.37
202.00	168.83	-36.70	135.37	-100.89	4.7493	3.5394	210.56	2788.72
203.00	186.32	-37.60	147.57	-113.75	4.2507	3.2767	235.25	2569.00
204.00	203.94	-39.37	157.67	-129.36	3.7908	3.1100	263.80	2426.37
205.00	218.92	-42.90	160.37	-149.03	3.3461	3.1094	298.86	2414.05
206.00	230.18	-46.37	158.84	-166.60	2.9978	3.1443	333.58	2429.29
207.00	239.75	-50.54	152.37	-185.10	2.6509	3.2203	377.22	2476.00
208.00	243.35	-54.75	140.44	-198.73	2.3716	3.3559	421.65	2567.82
209.00	244.85	-58.57	127.66	-208.94	2.1294	3.4850	469.62	2653.88
210.00	242.54	-62.51	111.95	-215.16	1.9031	3.6576	525.46	2772.00
211.00	237.99	-65.50	98.68	-216.57	1.7423	3.8236	573.96	2884.09
212.00	232.93	-68.46	85.52	-216.66	1.5761	3.9933	634.47	2997.93
213.00	226.23	-70.98	73.74	-213.88	1.4407	4.1789	694.11	3122.48
214.00	219.70	-72.96	64.37	-210.06	1.3335	4.3519	749.88	3236.54
215.00	212.97	-74.86	55.60	-205.58	1.2260	4.5326	815.68	3355.32
216.00	206.00	-76.23	49.04	-200.07	1.1557	4.7149	865.24	3474.06
217.00	199.64	-77.54	43.08	-194.93	1.0810	4.8911	925.10	3587.27
218.00	193.23	-78.54	38.39	-189.38	1.0280	5.0720	972.74	3702.90
219.00	187.28	-79.27	34.88	-184.00	0.9945	5.2462	1005.55	3812.62
220.00	181.43	-79.95	31.66	-178.65	0.9619	5.4271	1039.66	3926.13

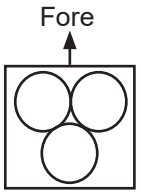
50/200 kHz-L (50 kHz)

Ceramics Wired in Parallel
Power Rating: 1.5 kW @ 1% duty cycle
3 x 42.4 mm (1.67") PZT
Active Area: 42.38 cm² (6.57 in²)
Radiating Surface: Urethane

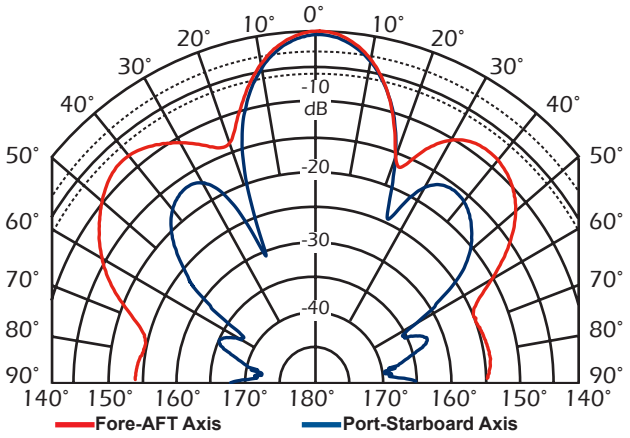
Beamwidth:
-3 dB: 18°/18°
-6 dB: 25°/25°
-10 dB: 32°/31°

Directivity Index:	20
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	159 dB
Peak TVR(1), minimum:	157 dB
Q (transmit):	8
Peak Source Level(4):	215 dB
Peak RVR(2), nominal:	-173 dB
Peak Figure of Merit(3):	-20 dB

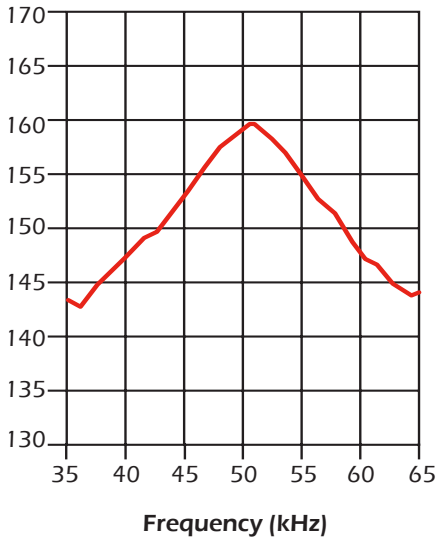
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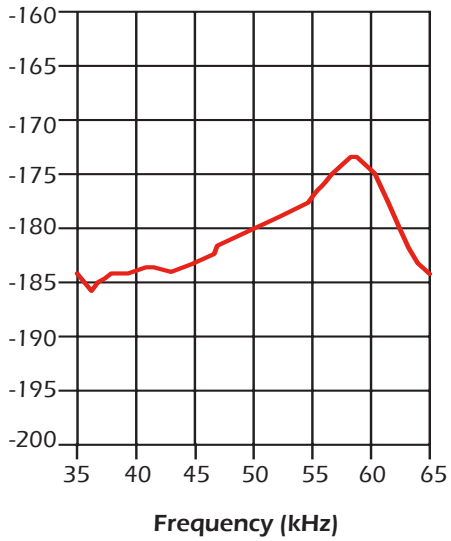
Transmit Radiation Pattern



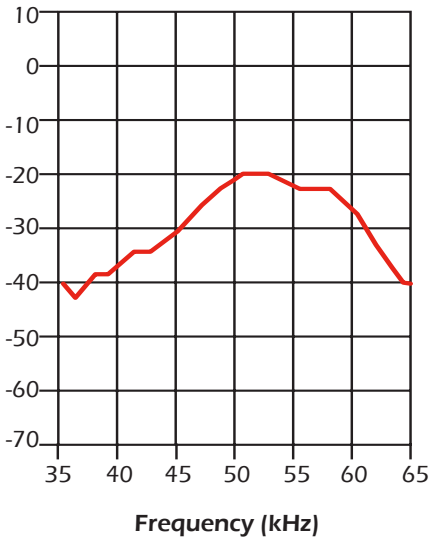
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

50/200 kHz-L (50 kHz)

3 x 42.4 mm (1.67”) PZT

Cable Type: C315
Cable Length: 15 m (50’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	310 Ω: -20%, +40%	290 Ω: -20%, +40%
Parallel: Cp. (nominal)	3360 pF	2850 pF
Series [R - jX]: (nominal)	280 - j100 Ω	270 - j70 Ω
1 kHz capacitance: (nominal)	4980pF	5160pF

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
35.00	751.81	-86.06	51.70	-750.03	0.09	1.33	10932.33	6034.15
36.00	712.74	-85.98	50.02	-710.98	0.10	1.40	10156.22	6187.48
37.00	672.28	-85.64	51.08	-670.33	0.11	1.48	8847.94	6379.89
38.00	633.11	-85.07	54.39	-630.77	0.14	1.57	7369.96	6590.99
39.00	595.56	-84.40	58.10	-592.72	0.16	1.67	6104.41	6819.52
40.00	556.82	-83.58	62.26	-553.33	0.20	1.78	4979.70	7100.92
41.00	518.69	-82.38	68.76	-514.11	0.26	1.91	3912.87	7417.91
42.00	478.86	-80.81	76.45	-472.72	0.33	2.06	2999.59	7811.91
43.00	440.45	-78.65	86.72	-431.83	0.45	2.23	2237.14	8238.94
44.00	400.22	-75.57	99.73	-387.60	0.62	2.42	1606.13	8752.79
45.00	364.19	-71.17	117.56	-344.69	0.89	2.60	1128.17	9191.57
46.00	332.06	-65.25	139.02	-301.55	1.26	2.73	793.14	9462.53
47.00	308.92	-57.93	164.02	-261.78	1.72	2.74	581.82	9288.88
48.00	290.81	-49.79	187.74	-222.09	2.22	2.63	450.45	8707.37
49.00	277.52	-40.19	212.02	-179.08	2.75	2.33	363.27	7551.96
50.00	270.95	-27.91	239.45	-126.81	3.26	1.73	306.61	5498.23
51.00	282.47	-13.28	274.91	-64.89	3.45	0.81	290.23	2537.90
52.00	325.46	0.86	325.42	4.90	3.07	-0.05	325.49	-141.54
53.00	408.14	10.62	401.14	75.25	2.41	-0.45	415.26	-1356.53
54.00	492.50	16.85	471.35	142.79	1.94	-0.59	514.61	-1735.06
55.00	638.67	25.92	574.43	279.17	1.41	-0.68	710.10	-1980.45
56.00	900.07	26.23	807.40	397.78	1.00	-0.49	1003.37	-1395.49
57.00	1203.65	22.02	1115.81	451.38	0.77	-0.31	1298.40	-869.93
58.00	1621.71	15.29	1564.30	427.67	0.59	-0.16	1681.22	-446.22
59.00	2177.70	2.28	2175.98	86.61	0.46	-0.02	2179.42	-49.26
60.00	2653.97	-17.98	2524.41	-819.10	0.36	0.12	2790.18	308.47
61.00	2693.87	-40.61	2045.04	-1753.49	0.28	0.24	3548.55	630.44
62.00	2375.33	-57.19	1287.25	-1996.29	0.23	0.35	4383.14	908.25
63.00	2023.06	-67.98	758.49	-1875.49	0.19	0.46	5395.92	1157.65
64.00	1748.82	-74.66	462.77	-1686.48	0.15	0.55	6608.87	1371.30
65.00	1532.95	-78.87	295.98	-1504.10	0.13	0.64	7939.51	1567.22

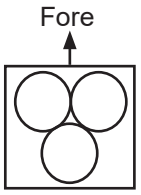
50/200 kHz-L (200 kHz)

Ceramics Wired in Parallel
Power Rating: 1.5 kW @ 1% duty cycle
3 x 42.4 mm (1.67") PZT
Active Area: 42.38 cm² (6.57 in²)
Radiating Surface: Urethane

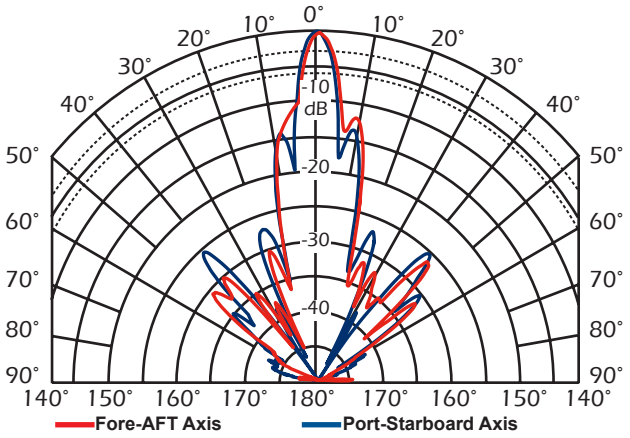
Beamwidth:
-3 dB: 5°/5°
-6 dB: 7°/7°
-10 dB: 9°/8°

Directivity Index:	31
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	172 dB
Peak TVR(1), minimum:	170 dB
Q (transmit):	14
Peak Source Level(4):	227 dB
Peak RVR(2), nominal:	-179 dB
Peak Figure of Merit(3):	-10 dB

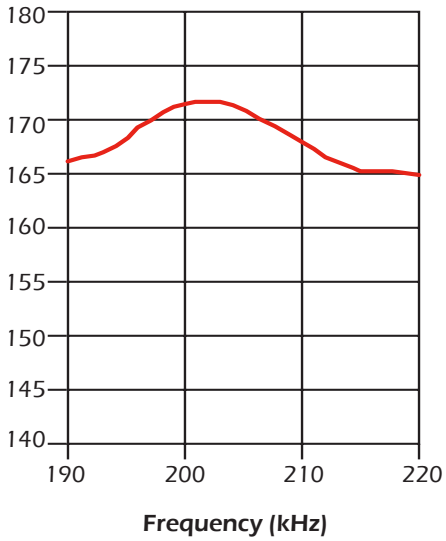
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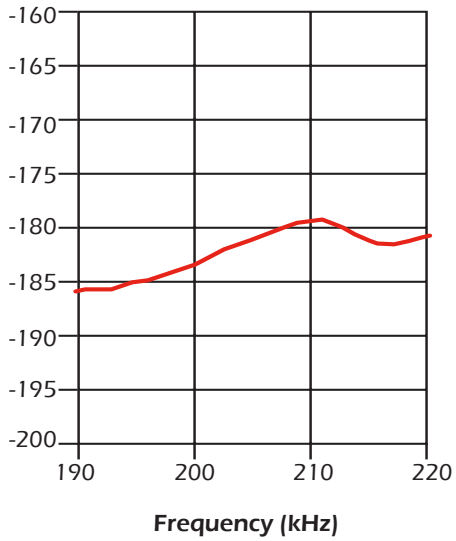
Transmit Radiation Pattern



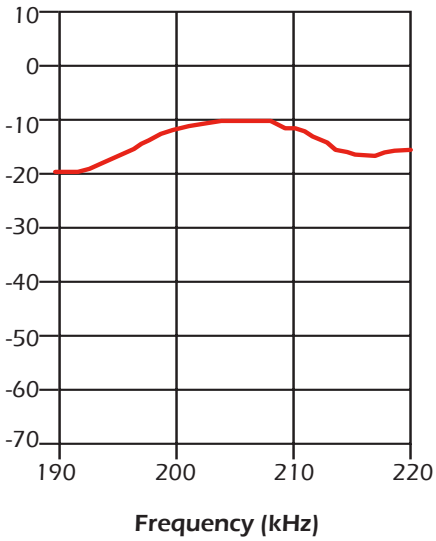
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

50/200 kHz-L (200 kHz)

3 x 42.4 mm (1.67”) PZT

Cable Type: C315
Cable Length: 15 m (50’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	230 Ω: -20%, +40%	220 Ω: -20%, +40%
Parallel: Cp. (nominal)	1390 pF	2110 pF
Series [R - jX]: (nominal)	200 - j80 Ω	160 - j100 Ω
1 kHz capacitance: (nominal)	4940pF	5140pF

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	256.72	-52.39	156.69	-203.36	2.38	3.09	420.62	2584.69
191.00	254.33	-53.54	151.12	-204.57	2.34	3.16	428.03	2635.20
192.00	249.51	-54.10	146.32	-202.10	2.35	3.25	425.47	2691.07
193.00	242.47	-54.82	139.70	-198.18	2.38	3.37	420.84	2779.74
194.00	231.09	-54.85	133.04	-188.95	2.49	3.54	401.39	2902.76
195.00	218.70	-53.72	129.42	-176.29	2.71	3.69	369.56	3008.31
196.00	206.68	-51.07	129.87	-160.78	3.04	3.76	328.92	3056.29
197.00	198.26	-47.53	133.87	-146.23	3.41	3.72	293.61	3005.72
198.00	192.24	-43.02	140.54	-131.16	3.80	3.55	262.94	2852.86
199.00	189.85	-37.92	149.78	-116.67	4.16	3.24	240.65	2588.70
200.00	191.49	-32.35	161.77	-102.45	4.41	2.79	226.66	2223.53
201.00	197.17	-26.83	175.94	-89.00	4.53	2.29	220.96	1812.80
202.00	206.55	-21.42	192.28	-75.44	4.51	1.77	221.88	1393.32
203.00	221.77	-16.49	212.65	-62.95	4.32	1.28	231.29	1003.43
204.00	241.28	-12.02	235.99	-50.23	4.05	0.86	246.68	673.14
205.00	268.98	-8.98	265.69	-41.98	3.67	0.58	272.32	450.44
206.00	300.69	-6.95	298.48	-36.37	3.30	0.40	302.91	310.79
207.00	337.78	-6.21	335.80	-36.53	2.94	0.32	339.77	246.19
208.00	378.90	-6.24	376.66	-41.22	2.62	0.29	381.17	219.67
209.00	429.27	-7.28	425.81	-54.36	2.31	0.30	432.75	224.64
210.00	483.94	-10.20	476.29	-85.68	2.03	0.37	491.70	277.26
211.00	539.25	-15.07	520.71	-140.20	1.79	0.48	558.46	363.66
212.00	579.32	-20.67	542.04	-204.45	1.62	0.61	619.16	457.34
213.00	604.28	-26.75	539.61	-271.98	1.48	0.74	676.70	556.55
214.00	606.15	-32.42	511.69	-324.95	1.39	0.88	718.05	657.76
215.00	596.50	-36.28	480.84	-352.98	1.35	0.99	739.96	734.38
216.00	581.74	-38.04	458.14	-358.51	1.35	1.06	738.68	780.56
217.00	583.62	-38.03	459.69	-359.58	1.35	1.06	740.96	774.27
218.00	608.20	-37.77	480.75	-372.54	1.30	1.01	769.44	735.26
219.00	659.55	-39.07	512.05	-415.71	1.18	0.96	849.54	694.49
220.00	716.41	-43.20	522.27	-490.38	1.02	0.96	982.71	691.21

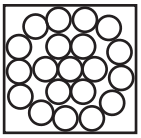
70 kHz-A

Transformed to 55 ohms
Power Rating: 3 kW rms @ 2% duty cycle
20 x 38 mm (1.50") BT/L
Active Area: 228 cm²
Urethane Window

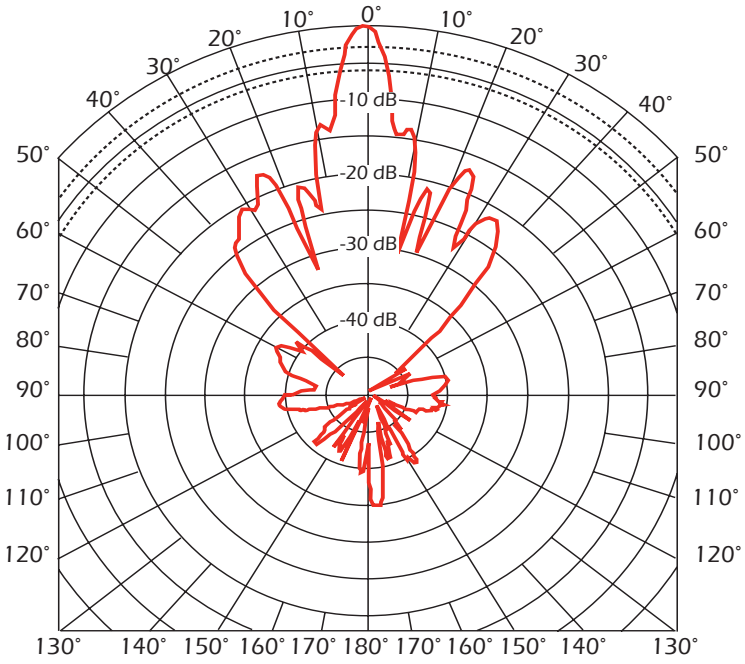
Beamwidth:
-3 dB: 6°
-6 dB: 8°
-10 dB: 10°

Directivity Index:	28.3
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	173 dB
Peak TVR(1), minimum:	171 dB
Q (transmit):	9
Peak Source Level(4):	226 dB
Peak RVR(2), nominal:	-172 dB
Peak Figure of Merit(3):	-6 dB

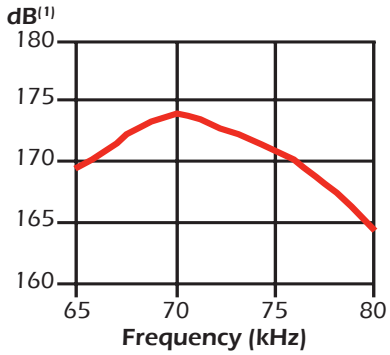
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Transmit Radiation Pattern



TVR



RVR

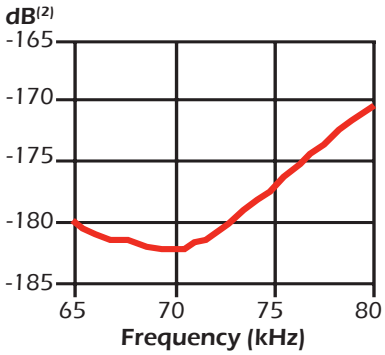
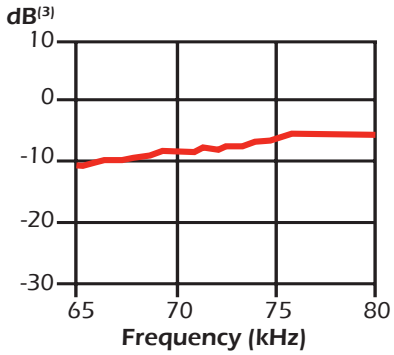


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

70 kHz-A

20 x 38 mm (1.50”) BT/L

Cable Type: C37
Cable Length: 9.1 m (30’)

Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	55 Ω: -20%, +40%	55 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	55 Ω - j0 Ω	55 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
65.00	137.65	-56.35	76.27	-114.59	4.0250	6.0476	248.45	14807.82
65.50	121.21	-55.34	68.93	-99.70	4.6922	6.7862	213.12	16489.51
66.00	109.40	-52.48	66.63	-86.77	4.5672	7.2495	179.63	17481.83
66.50	97.62	-49.50	63.39	-74.24	6.6521	7.7899	150.33	18643.57
67.00	89.00	-46.98	60.72	-65.07	7.6655	8.2142	130.45	19512.47
67.50	81.68	-42.63	60.09	-55.32	9.0078	8.2924	111.02	19552.18
68.00	74.60	-38.31	58.54	-46.25	10.5179	8.3092	96.08	19447.85
68.50	69.27	-34.18	57.30	-38.92	11.9421	8.1107	83.74	18844.74
69.00	64.65	-28.56	56.78	-30.91	13.5852	7.3948	73.61	17056.72
69.50	60.26	-22.46	55.69	-23.02	15.3357	6.3397	65.21	14517.97
70.00	57.22	-15.71	55.08	-15.49	16.8230	4.7322	59.44	10759.22
70.50	55.33	-7.55	54.85	-7.27	17.9158	2.3757	55.82	5363.16
71.00	55.17	0.94	55.17	0.90	18.1219	-0.2963	55.18	-664.12
71.50	56.78	9.25	56.04	9.13	17.3840	-2.8326	57.52	-6305.29
72.00	59.85	17.34	57.13	17.84	15.9497	-4.9796	62.70	-11007.34
72.50	64.25	24.35	58.54	26.49	14.1792	-6.4161	70.53	-14084.99
73.00	71.04	30.92	60.95	36.50	12.0764	-7.2325	82.81	-15768.39
73.50	78.64	36.55	63.18	46.83	10.2157	-7.5724	97.89	-16397.01
74.00	88.90	40.26	67.84	57.45	8.5845	-7.2689	116.49	-15633.63
74.50	101.44	43.82	73.19	70.24	7.1125	-6.8255	140.60	-14581.39
75.00	115.48	46.13	80.03	83.26	6.0009	-6.2431	166.64	-13248.24
75.50	131.36	47.29	89.11	96.52	5.1640	-5.5932	193.65	-11790.62
76.00	151.10	48.02	101.07	112.33	4.4266	-4.9196	225.91	-10302.33
76.50	173.61	48.21	115.70	129.44	3.8387	-4.2944	260.51	-8934.38
77.00	198.13	47.06	134.98	145.04	3.4385	-3.6946	290.82	-7636.65
77.50	232.03	45.36	163.04	165.10	3.0283	-3.0665	330.22	-6297.49
78.00	269.52	43.44	195.69	185.32	2.6940	-2.5513	371.20	-5205.71
78.50	311.19	38.87	242.28	195.30	2.5018	-2.0167	399.71	-4088.81
79.00	371.65	33.44	310.12	204.81	2.2453	-1.4828	445.38	-2987.26
79.50	432.92	26.96	385.88	196.26	2.0589	-1.0472	485.70	-2096.41
80.00	506.21	17.34	483.21	150.85	1.8857	-0.5887	530.30	-1171.20

75 kHz-F

Transformed to 140 ohms

Power rating: 1 kW$_{rms}$ @ 2% duty cycle

10x25mm (1.0") PZT/L

Active Area: 50cm^2

Urethane Window

Beamwidth:

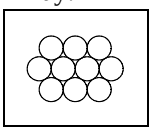
-3dB:	9° x 13°
-6dB:	12° x 18°
-10dB:	15° x 23°

Directivity Index:	22.9
Frequency Tolerance:	±2kHz
Peak TVR[(1)], nominal:	167dB
Peak TVR[(1)], minimum:	165dB
Q (transmit):	7
Peak Source Level[(4)]:	219dB
Peak RVR[(2)], nominal:	-177dB
Figure of Merit[(3)]:	-12dB

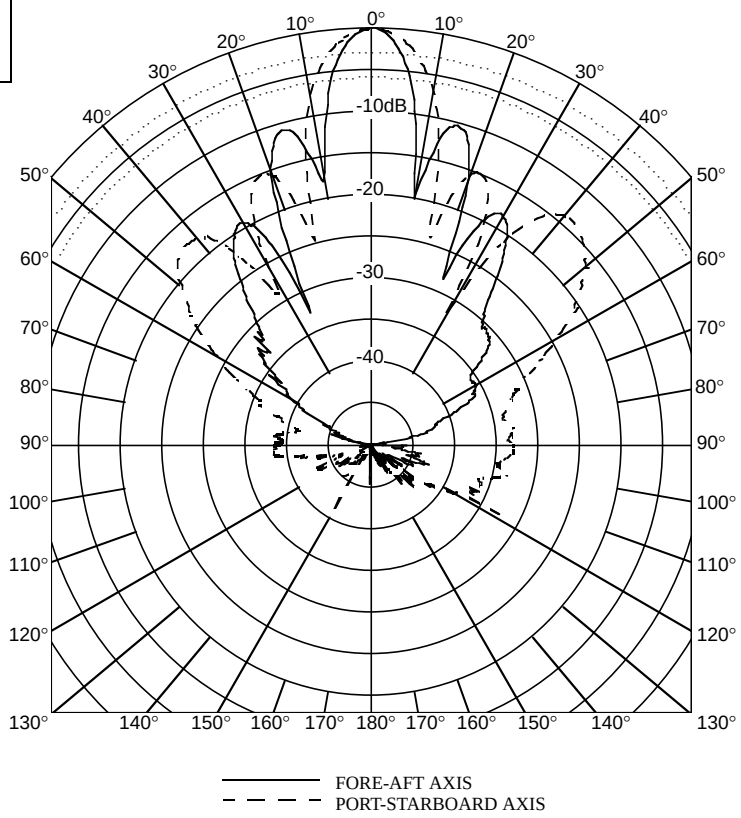
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

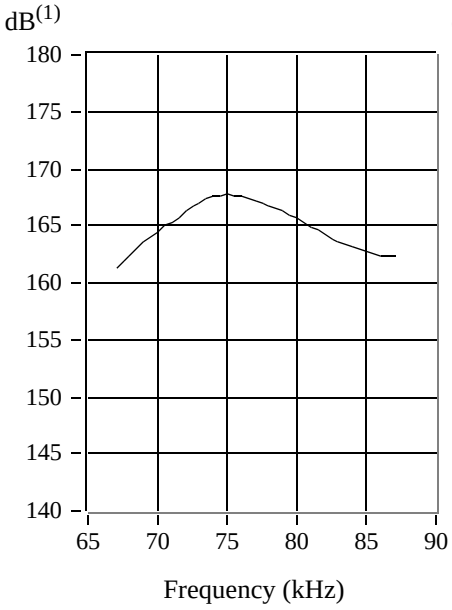
Array:



Transmit Radiation Pattern



TVR



RVR

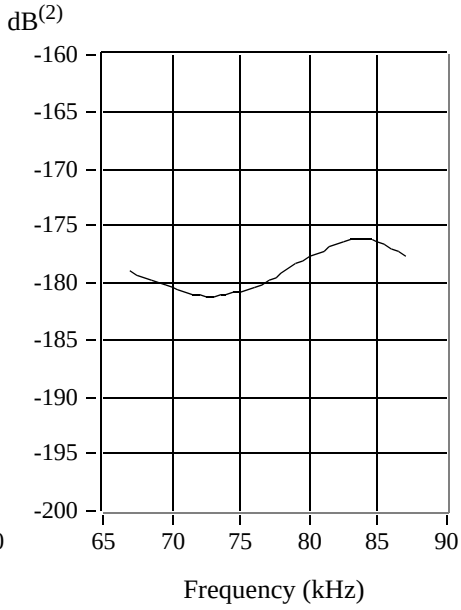
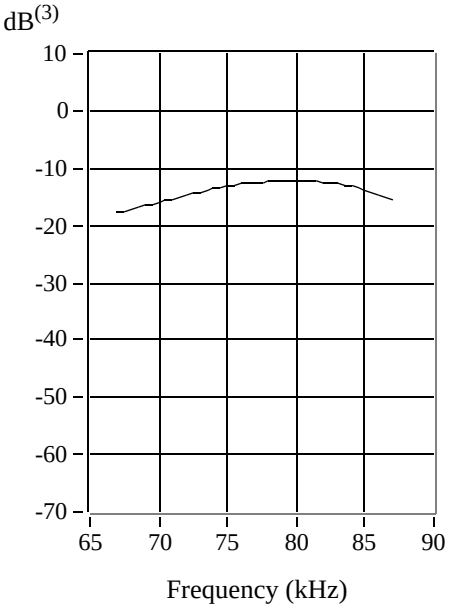


Figure of Merit



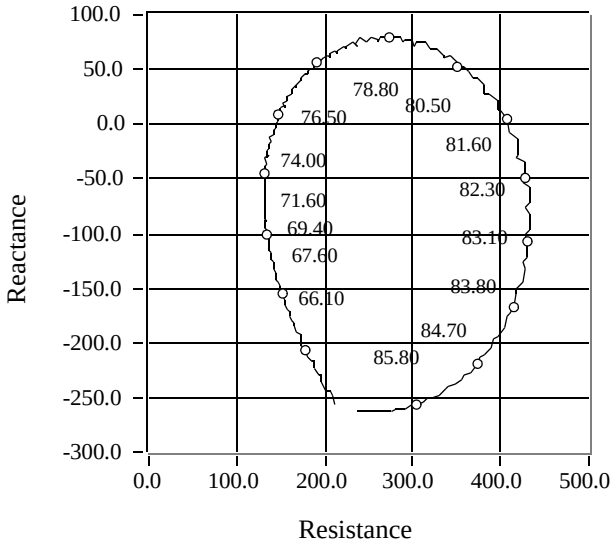
75 kHz-F

10x25mm (1.0") PZT/L

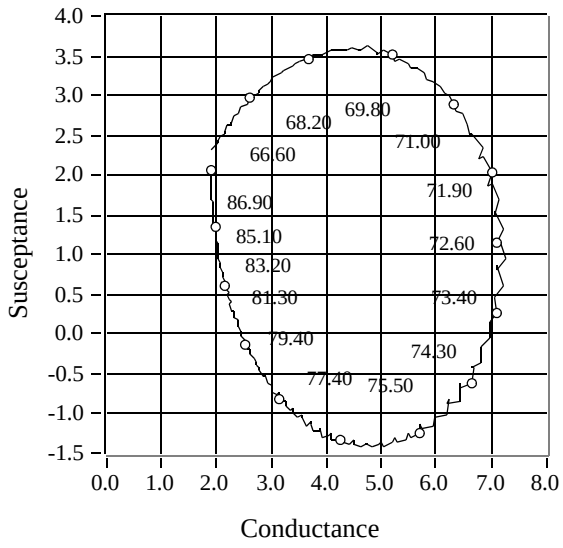
Cable Type: C44
Cable Length: 10.1m (33.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	140ohms-20%,+40%	140ohms-20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	140 – j0 ohms	140 – j0 ohms
1 kHz Capacitance	n/a	n/a

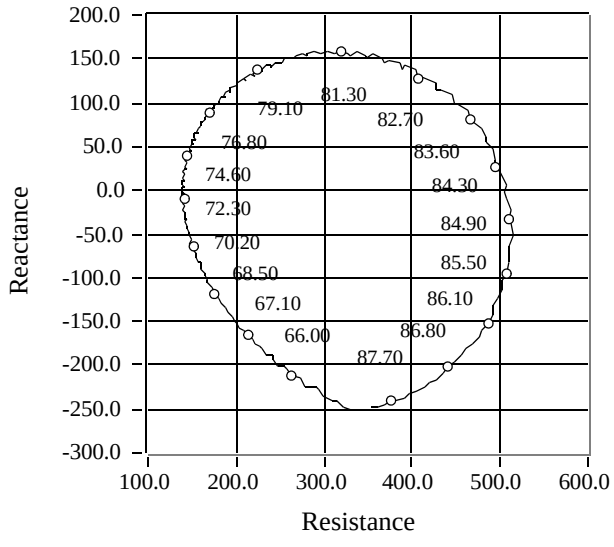
Unbalanced Impedance



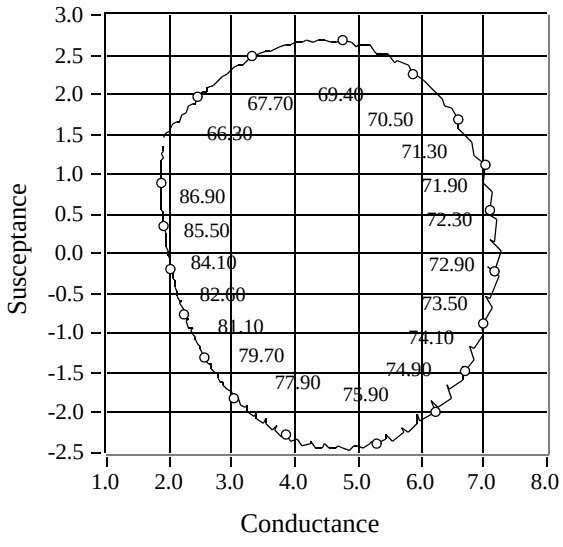
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



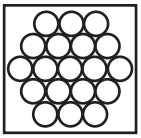
75 kHz-L

Transformed to 70 ohms
Power Rating: 1.5 kW rms @ 2% duty cycle
19 x 25 mm (1.0") PZT/L
Active Area: 93.4 cm²
Urethane Window

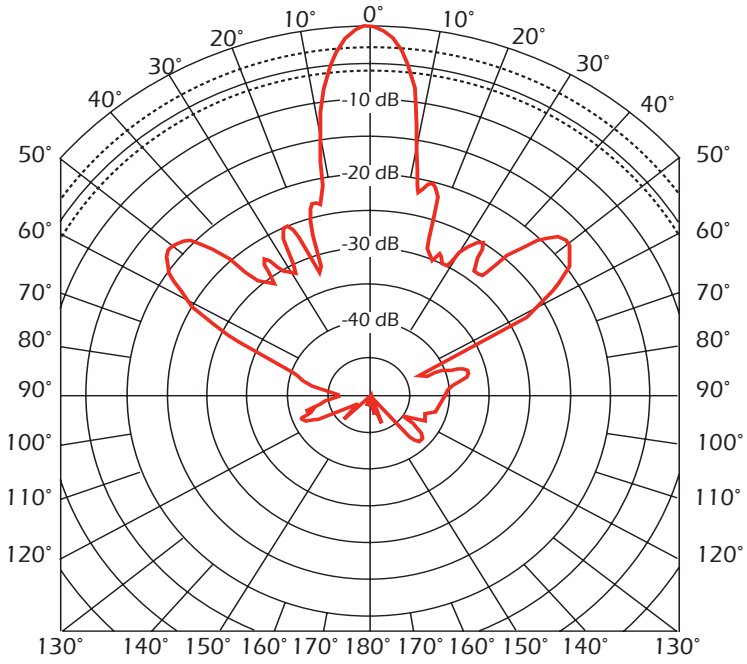
Beamwidth:
-3 dB: 10°
-6 dB: 13°
-10 dB: 17°

Directivity Index:	25.7
Frequency Tolerance:	± 2.5 kHz
Peak TVR(1), nominal:	172 dB
Peak TVR(1), minimum:	169 dB
Q (transmit):	6
Peak Source Level(4):	225 dB
Peak RVR(2), nominal:	-178 dB
Peak Figure of Merit(3):	-10 dB

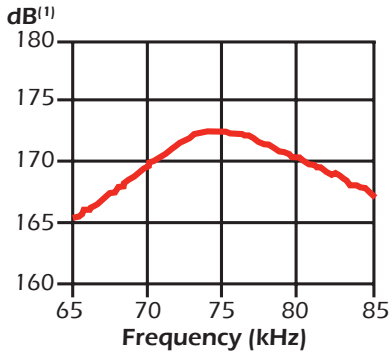
Array



Transmit Radiation Pattern



TVR



RVR

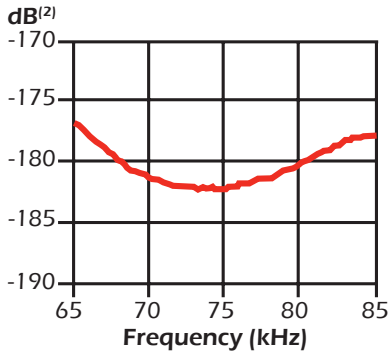
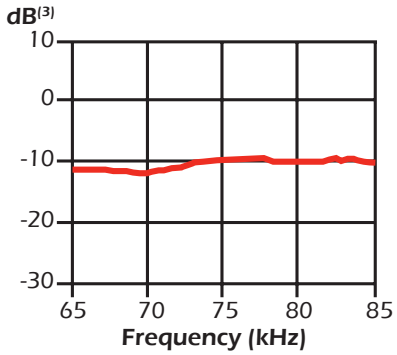


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

75 kHz-L

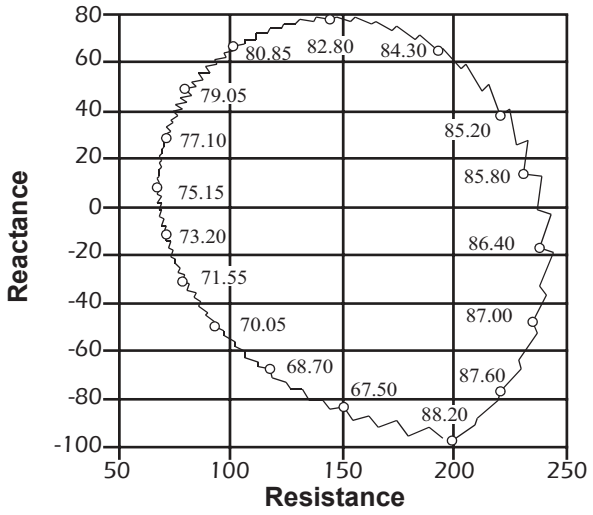
19 x 25 mm (1.0”) PZT/L

Cable Type: C37
Cable Length: 20.1 m (66’)

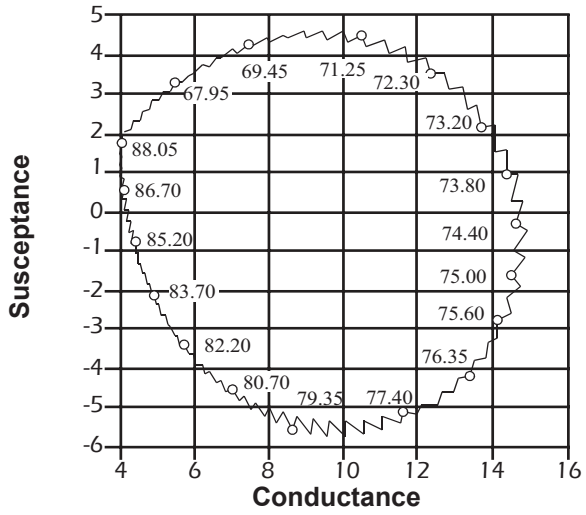
Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70 Ω: -20%, +40%	70 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	70 Ω - j0 Ω	70 Ω - j0 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balanced Impedance



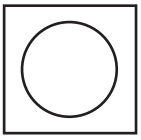
Balanced Admittance



77/200 kHz-A (77kHz)

Power Rating: 300 W rms @ 1% duty cycle
27mm (1.07") PZT
Active Area: 5.8 cm^2 (0.90 in^2)
Radiating Surface: Urethane

Array

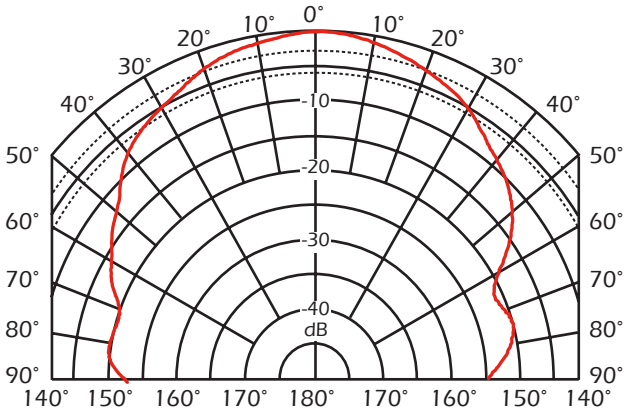


Beamwidth:

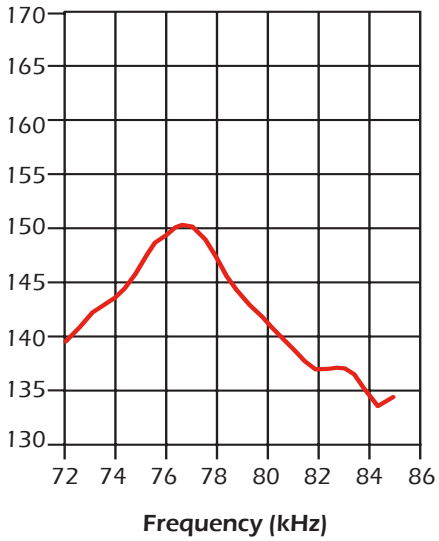
-3 dB:	43°
-6 dB:	67°
-10 dB:	89°

Directivity Index:	12.33
Frequency Tolerance:	+/-2kHz
Peak TVR(1), nominal:	150.2 dB
Peak TVR(1), minimum:	148.2 dB
Q (transmit):	26
Peak Source Level(4):	202.3 dB
Peak RVR(2), nominal:	-183 dB
Peak Figure of Merit(3):	-37.1 dB

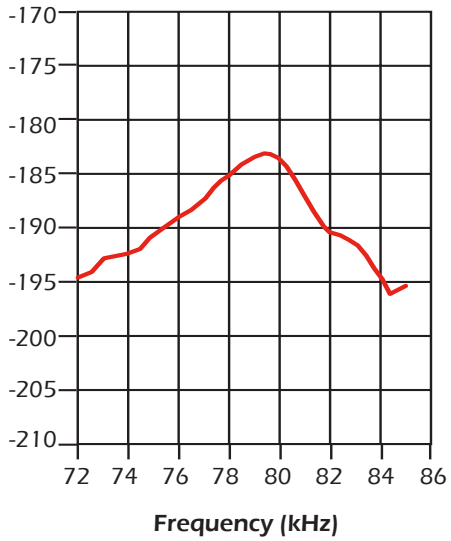
Transmit Radiation Pattern



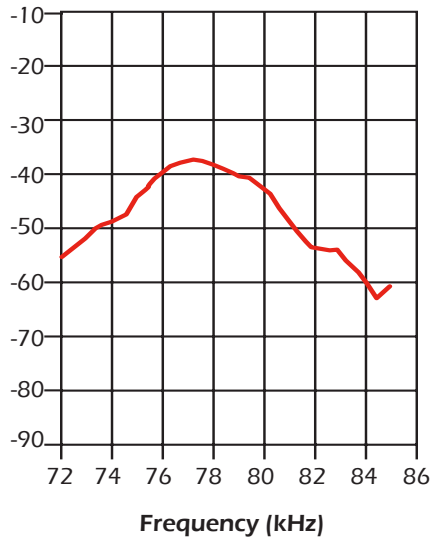
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

77/200 kHz-A (77kHz)

27mm (1.07”) PZT

Cable Type: Customer Supplied
Cable Length: 10.3m (34’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	550 Ω: -20%, +40%	540 Ω: -20%, +40%
Parallel: Cp. (nominal)	860 pF	2,390 pF
Series [R - jX]: (nominal)	520-j120 Ω	390-j240 Ω
1 kHz capacitance: (nominal)	610 pF	2,190 pF

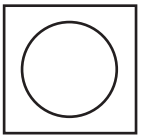
Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
72.00	1362.01	-77.27	300.13	-1328.53	0.16	0.72	6180.93	1583.06
72.50	1260.67	-75.43	317.23	-1220.10	0.20	0.77	5009.94	1685.30
73.00	1157.26	-73.13	335.76	-1107.48	0.25	0.83	3988.68	1802.90
73.50	1050.76	-70.19	356.07	-988.59	0.32	0.90	3100.80	1938.84
74.00	943.37	-66.36	378.21	-864.23	0.43	0.97	2353.02	2088.61
74.50	835.70	-61.38	400.33	-733.57	0.57	1.05	1744.55	2243.92
75.00	732.44	-54.27	427.72	-594.58	0.80	1.11	1254.25	2351.92
75.50	637.21	-44.54	454.14	-446.97	1.12	1.10	894.06	2320.56
76.00	564.59	-30.66	485.64	-287.94	1.52	0.90	656.37	1891.71
76.50	532.93	-12.80	519.70	-118.04	1.83	0.42	546.50	864.63
77.00	561.17	6.42	557.66	62.70	1.77	-0.20	564.71	-411.53
77.50	652.97	23.33	599.59	258.58	1.41	-0.61	711.11	-1245.46
78.00	799.02	35.95	646.85	469.06	1.01	-0.73	986.99	-1499.14
78.50	988.35	45.15	697.04	700.69	0.71	-0.72	1401.39	-1454.31
79.00	1219.99	51.60	757.76	956.12	0.51	-0.64	1964.17	-1294.18
79.50	1486.11	56.28	825.00	1236.08	0.37	-0.56	2677.00	-1120.46
80.00	1791.32	59.76	902.16	1547.56	0.28	-0.48	3556.82	-959.47
80.50	2136.23	62.36	990.95	1892.48	0.22	-0.41	4605.14	-819.90
81.00	2530.78	64.42	1092.78	2282.69	0.17	-0.36	5861.07	-700.28
81.50	2984.55	65.98	1214.67	2726.19	0.14	-0.31	7333.28	-597.67
82.00	3518.51	67.29	1358.18	3245.81	0.11	-0.26	9115.06	-508.88
82.50	4139.74	68.29	1531.39	3846.07	0.09	-0.22	11190.75	-432.95
83.00	4880.21	68.96	1751.84	4554.94	0.07	-0.19	13595.13	-366.73
83.50	5774.60	69.49	2023.34	5408.52	0.06	-0.16	16480.70	-309.15
84.00	6878.01	69.78	2377.58	6454.00	0.05	-0.14	19897.15	-258.49
84.50	8294.64	69.85	2857.51	7786.89	0.04	-0.11	24077.30	-213.17
85.00	10164.10	69.72	3522.66	9534.14	0.03	-0.09	29326.95	-172.80

77/200 kHz-A (200kHz)

Power Rating: 300 W rms @ 1% duty cycle
27mm (1.07") PZT
Active Area: 5.8 cm^2 (0.90 in^2)
Radiating Surface: Urethane

Array

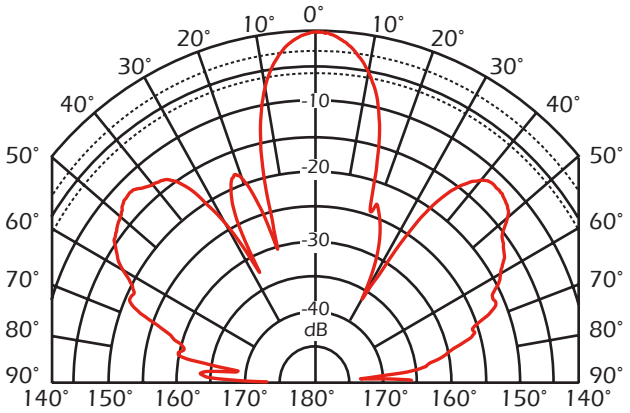


Beamwidth:

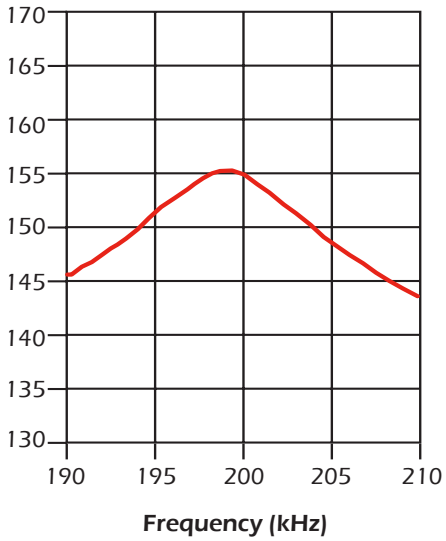
-3 dB:	14°
-6 dB:	20°
-10 dB:	24°

Directivity Index:	22.07
Frequency Tolerance:	+/-4kHz
Peak TVR(1), nominal:	155.5 dB
Peak TVR(1), minimum:	153.5 dB
Q (transmit):	31
Peak Source Level(4):	209.1 dB
Peak RVR(2), nominal:	-192.3 dB
Peak Figure of Merit(3):	-37.3 dB

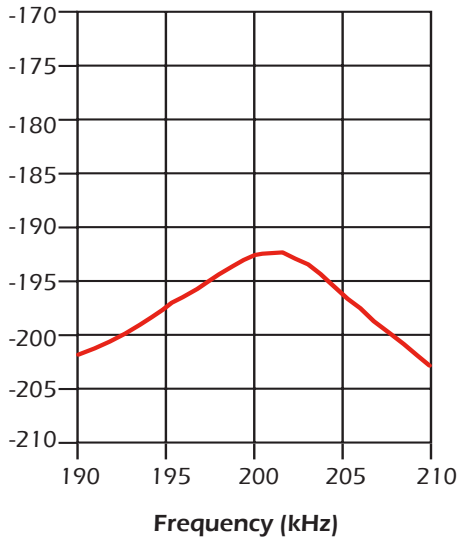
Transmit Radiation Pattern



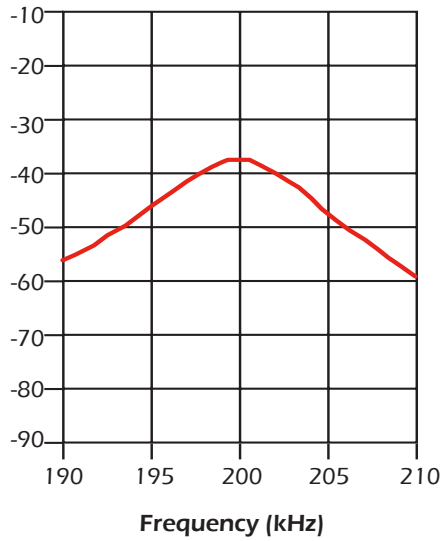
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

77/200 kHz-A (200kHz)

27mm (1.07”) PZT

Cable Type: Customer Supplied
Cable Length: 10.3m (34’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	770 Ω: -20%, +40%	730 Ω: -20%, +40%
Parallel: Cp. (nominal)	270 pF	1,780pF
Series [R - jX]: (nominal)	720-j180 Ω	200-j330 Ω
1 kHz capacitance: (nominal)	600 pF	5,280 pF

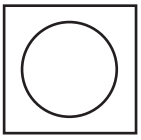
Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	1406.58	-83.87	150.29	-1398.53	0.08	0.71	13164.41	592.12
191.00	1320.22	-81.81	188.18	-1306.74	0.11	0.75	9262.16	624.72
191.50	1275.73	-80.73	205.40	-1259.09	0.13	0.77	7923.40	642.97
192.00	1230.72	-79.43	225.80	-1209.83	0.15	0.80	6708.04	662.10
193.00	1141.15	-76.24	271.34	-1108.42	0.21	0.85	4799.30	701.91
193.50	1096.54	-74.44	294.22	-1056.33	0.24	0.88	4086.74	722.59
194.00	1049.93	-72.40	317.42	-1000.80	0.29	0.91	3472.89	744.81
194.50	1003.47	-69.91	344.73	-942.40	0.34	0.94	2921.01	765.82
195.00	959.44	-67.16	372.43	-884.20	0.40	0.96	2471.68	783.98
196.00	871.54	-60.16	433.65	-756.00	0.57	1.00	1751.60	808.18
196.50	832.24	-55.85	467.14	-688.76	0.67	0.99	1482.67	805.44
197.00	795.05	-50.85	501.96	-616.55	0.79	0.98	1259.25	788.02
197.50	763.98	-45.06	539.61	-540.82	0.92	0.93	1081.64	746.69
198.00	740.13	-38.42	579.91	-459.89	1.06	0.84	944.62	674.83
199.00	727.13	-22.89	669.88	-282.81	1.27	0.53	789.28	427.79
199.50	744.12	-14.39	720.76	-184.98	1.30	0.33	768.23	266.51
200.00	781.06	-6.02	776.76	-81.90	1.27	0.13	785.39	106.84
200.50	839.39	1.85	838.95	27.05	1.19	-0.04	839.83	-30.47
201.00	916.87	9.08	905.37	144.73	1.08	-0.17	928.51	-136.32
202.00	1130.27	21.09	1054.59	406.62	0.83	-0.32	1211.38	-250.78
202.50	1267.44	26.11	1138.12	557.75	0.71	-0.35	1411.45	-272.88
203.00	1435.00	30.36	1238.16	725.38	0.60	-0.35	1663.13	-276.18
203.50	1623.28	33.94	1346.68	906.36	0.51	-0.34	1956.69	-269.01
204.00	1848.94	37.10	1474.66	1115.33	0.43	-0.33	2318.22	-254.54
205.00	2401.35	41.77	1790.97	1599.66	0.31	-0.28	3219.75	-215.37
205.50	2751.68	43.43	1998.30	1891.70	0.26	-0.25	3789.08	-193.49
206.00	3146.78	44.62	2239.73	2210.40	0.23	-0.22	4421.18	-172.46
206.50	3635.03	45.70	2538.75	2601.57	0.19	-0.20	5204.70	-151.75
207.00	4200.99	46.43	2895.67	3043.59	0.16	-0.17	6094.73	-132.60
208.00	5781.03	46.50	3979.44	4193.38	0.12	-0.13	8398.25	-96.01
208.50	6843.75	45.44	4802.34	4875.90	0.10	-0.10	9752.94	-79.47
209.00	8297.99	44.34	5934.67	5799.68	0.09	-0.08	11602.43	-64.14
210.00	12761.60	38.24	10023.73	7898.30	0.06	-0.05	16247.28	-36.76

77/200 kHz-A (77kHz)

Power Rating: 300 W rms @ 1% duty cycle
27mm (1.07") PZT
Active Area: 5.8 cm^2 (0.90 in^2)
Radiating Surface: Urethane/Plastic

Array

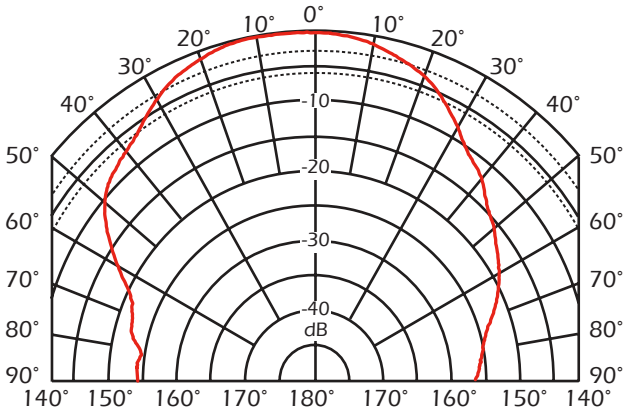


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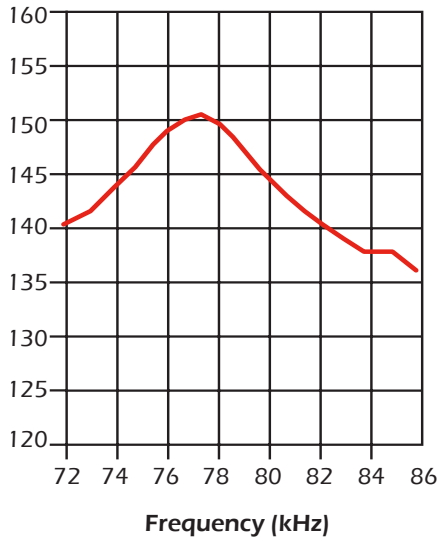
-3 dB:	46°
-6 dB:	61°
-10 dB:	84°

Directivity Index:	11.8
Frequency Tolerance:	+/-2kHz
Peak TVR(1), nominal:	150.5 dB
Peak TVR(1), minimum:	148.5 dB
Q (transmit):	22
Peak Source Level(4):	203 dB
Peak RVR(2), nominal:	-182.1 dB
Peak Figure of Merit(3):	-35.3 dB

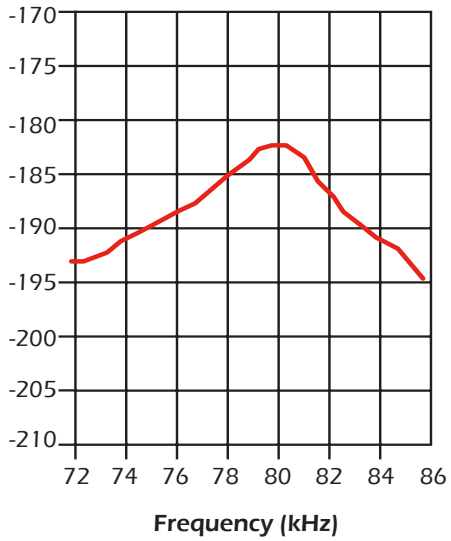
Transmit Radiation Pattern



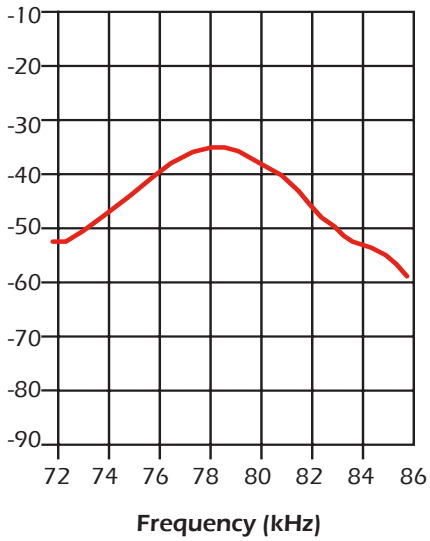
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

77/200 kHz-A (77kHz)

27mm (1.07”) PZT

Cable Type: 22-1288-01
Cable Length: 10.3m (34’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	620 Ω: -20%, +40%	620 Ω: -20%, +40%
Parallel: Cp. (nominal)	930 pF	1,980 pF
Series [R - jX]: (nominal)	570-j160 Ω	460-j270 Ω
1 kHz capacitance: (nominal)	1,070 pF	2,130 pF

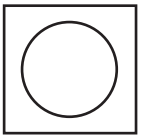
Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
72.00	1137.02	-81.16	174.71	-1123.52	0.14	0.87	7399.57	1921.02
72.50	1082.90	-79.96	188.84	-1066.31	0.16	0.91	6209.81	1996.13
73.00	1027.40	-78.40	206.56	-1006.42	0.20	0.95	5110.24	2078.73
73.50	969.46	-76.49	226.45	-942.64	0.24	1.00	4150.40	2171.81
74.00	909.26	-74.18	247.93	-874.81	0.30	1.06	3334.67	2275.73
74.50	844.67	-71.08	273.94	-799.02	0.38	1.12	2604.52	2392.45
75.00	782.11	-66.98	305.83	-719.83	0.50	1.18	2000.11	2497.23
75.50	716.65	-61.55	341.39	-630.11	0.66	1.23	1504.39	2586.29
76.00	654.88	-54.17	383.40	-530.92	0.89	1.24	1118.62	2592.45
76.50	606.12	-44.24	434.21	-422.90	1.18	1.15	846.09	2394.85
77.00	579.26	-31.14	495.79	-299.56	1.48	0.89	676.79	1845.30
77.50	595.62	-15.68	573.46	-160.96	1.62	0.45	618.64	931.76
78.00	669.43	-0.44	669.41	-5.13	1.49	0.01	669.45	23.35
78.50	815.47	12.48	796.20	176.22	1.20	-0.27	835.20	-537.28
79.00	1039.20	21.66	965.82	383.56	0.89	-0.36	1118.15	-715.54
79.50	1336.89	27.59	1184.81	619.27	0.66	-0.35	1508.49	-693.65
80.00	1750.40	30.77	1504.07	895.36	0.49	-0.29	2037.07	-581.37
80.50	2281.83	31.40	1947.61	1188.93	0.37	-0.23	2673.40	-451.45
81.00	3014.04	29.54	2622.18	1486.14	0.29	-0.16	3464.46	-321.44
81.50	3990.75	24.58	3629.16	1659.90	0.23	-0.10	4388.37	-203.53
82.00	5239.92	15.87	5040.11	1433.19	0.18	-0.05	5447.65	-101.31
82.50	6706.45	2.49	6700.10	291.82	0.15	-0.01	6712.81	-12.52
83.00	7761.57	-15.50	7479.34	-2073.99	0.12	0.03	8054.45	66.02
83.50	7984.22	-33.90	6627.19	-4452.88	0.10	0.07	9619.13	133.14
84.00	7408.21	-49.28	4833.06	-5614.55	0.09	0.10	11355.46	193.83
84.50	6641.52	-59.98	3323.25	-5750.29	0.08	0.13	13273.09	245.54
85.00	5931.03	-67.44	2275.11	-5477.32	0.06	0.16	15461.73	291.55
85.50	5324.70	-72.56	1595.60	-5080.01	0.06	0.18	17769.12	333.52
86.00	4851.86	-76.29	1150.32	-4713.52	0.05	0.20	20464.29	370.55

77/200 kHz-A (200kHz)

Power Rating: 300 W rms @ 1% duty cycle
27mm (1.07") PZT
Active Area: 5.8 cm^2 (0.90 in^2)
Radiating Surface: Urethane/Plastic

Array

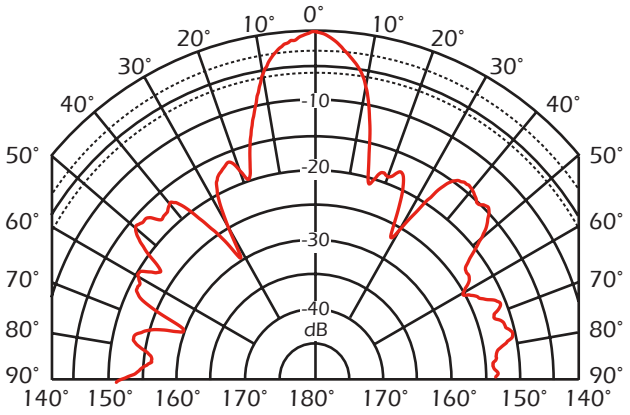


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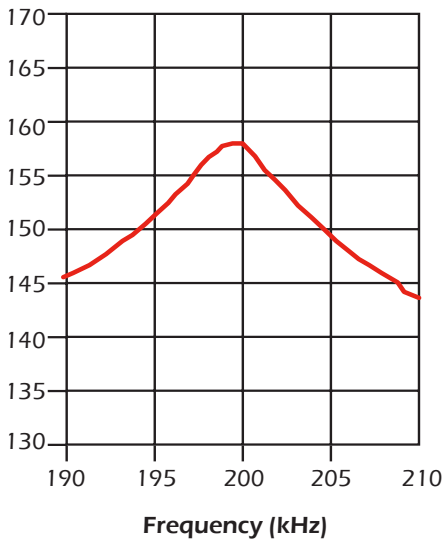
-3 dB:	13°
-6 dB:	19°
-10 dB:	24°

Directivity Index:	21
Frequency Tolerance:	+/-4kHz
Peak TVR(1), nominal:	158.1 dB
Peak TVR(1), minimum:	156.1 dB
Q (transmit):	45
Peak Source Level(4):	210 dB
Peak RVR(2), nominal:	-190.3 dB
Peak Figure of Merit(3):	-33.4 dB

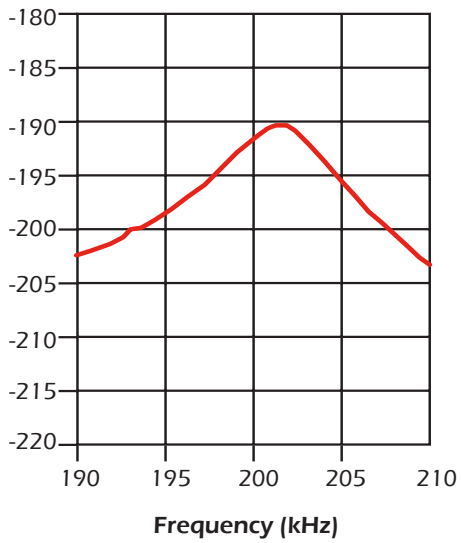
Transmit Radiation Pattern



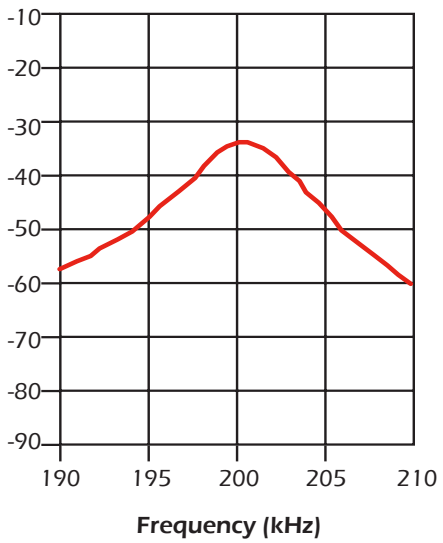
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

77/200 kHz-A (200kHz)

27mm (1.07”) PZT

Cable Type: 22-1288-01
Cable Length: 10.3m (34’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	530 Ω: -20%, +40%	520 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,040 pF	2,090 pF
Series [R - jX]: (nominal)	360-j240 Ω	180-j250 Ω
1 kHz capacitance: (nominal)	1,070 pF	2,130 pF

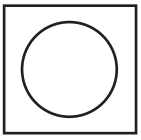
Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	699.37	-86.63	41.11	-698.16	0.08	1.43	11898.76	1195.66
191.00	674.07	-85.89	48.34	-672.33	0.11	1.48	9398.80	1233.00
191.50	660.38	-85.49	51.90	-658.33	0.12	1.51	8401.93	1254.62
192.00	646.86	-84.96	56.82	-644.36	0.14	1.54	7364.54	1276.53
193.00	616.73	-83.68	67.92	-612.98	0.18	1.61	5600.06	1328.97
193.50	600.75	-82.84	74.83	-596.07	0.21	1.65	4823.06	1358.47
194.00	583.61	-81.89	82.33	-577.77	0.24	1.70	4137.09	1391.66
194.50	565.38	-80.78	90.63	-558.07	0.28	1.75	3527.08	1428.58
195.00	546.63	-79.31	101.43	-537.14	0.34	1.80	2946.05	1467.17
196.00	506.46	-75.55	126.35	-490.44	0.49	1.91	2029.98	1552.63
196.50	485.45	-72.90	142.78	-463.98	0.61	1.97	1650.58	1594.64
197.00	463.09	-69.54	161.89	-433.87	0.75	2.02	1324.63	1634.50
197.50	442.49	-65.21	185.52	-401.72	0.95	2.05	1055.38	1653.38
198.00	425.13	-59.55	215.42	-366.51	1.19	2.03	839.00	1630.02
199.00	414.61	-43.94	298.56	-287.69	1.74	1.67	575.77	1338.46
199.50	433.94	-34.31	358.43	-244.60	1.90	1.30	525.35	1036.29
200.00	478.85	-24.80	434.69	-200.84	1.90	0.88	527.49	697.02
200.50	555.36	-17.21	530.50	-164.29	1.72	0.53	581.38	422.84
201.00	670.59	-11.82	656.38	-137.31	1.46	0.31	685.11	241.78
202.00	999.20	-10.05	983.88	-174.32	0.99	0.17	1014.76	137.56
202.50	1215.58	-13.23	1183.32	-278.20	0.80	0.19	1248.72	147.97
203.00	1442.65	-18.61	1367.24	-460.31	0.66	0.22	1522.21	173.40
203.50	1656.25	-26.61	1480.77	-741.95	0.54	0.27	1852.53	211.53
204.00	1815.26	-35.84	1471.62	-1062.78	0.45	0.32	2239.14	251.63
205.00	1883.04	-53.11	1130.34	-1506.05	0.32	0.42	3136.98	329.75
205.50	1834.64	-60.08	915.09	-1590.13	0.27	0.47	3678.22	365.88
206.00	1765.63	-65.44	733.79	-1605.93	0.24	0.52	4248.42	398.00
206.50	1686.02	-69.64	586.73	-1580.64	0.21	0.56	4844.96	428.56
207.00	1614.31	-72.99	472.30	-1543.68	0.18	0.59	5517.71	455.44
208.00	1490.29	-77.70	317.56	-1456.06	0.14	0.66	6993.93	501.64
208.50	1437.22	-79.53	261.28	-1413.27	0.13	0.68	7905.59	522.27
209.00	1388.26	-80.98	217.64	-1371.09	0.11	0.71	8855.36	541.75
210.00	1302.95	-83.22	153.78	-1293.84	0.09	0.76	11039.99	577.60

83/200 kHz-A (83 kHz)

Power Rating: 300W rms @ 1% duty cycle
24 mm (0.95") PZT
Active Area: 4.53 cm² (0.72 in²)
Radiating Surface: Plastic

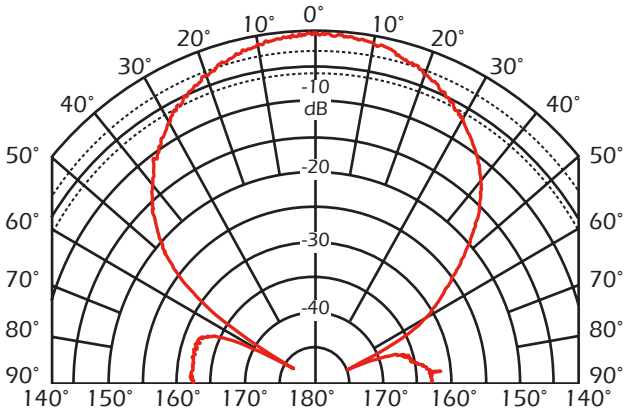
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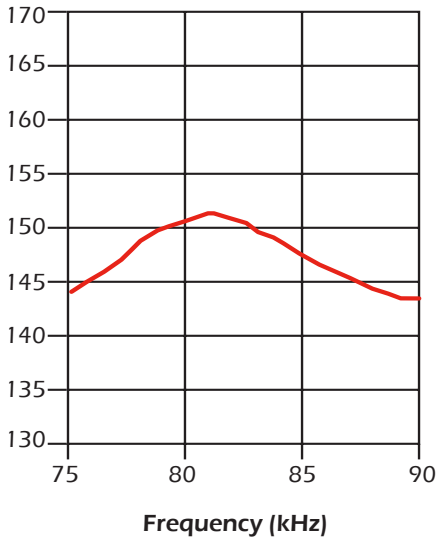
Beamwidth:
-3 dB: 38°
-6 dB: 55°
-10 dB: 71°

Directivity Index:	14
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	151 dB
Peak TVR(1), minimum:	149 dB
Q (transmit):	12
Peak Source Level(4):	205 dB
Peak RVR(2), nominal:	-181 dB
Peak Figure of Merit(3):	-32 dB

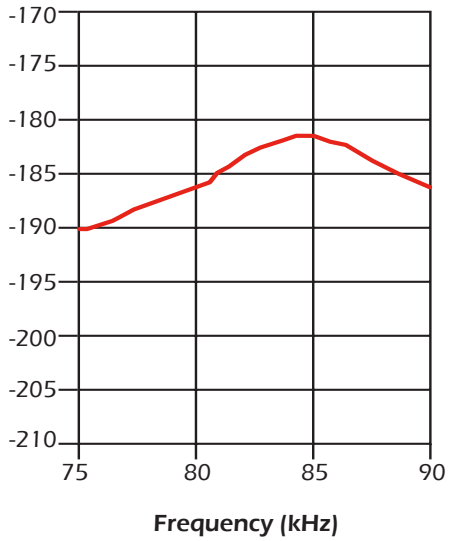
Transmit Radiation Pattern



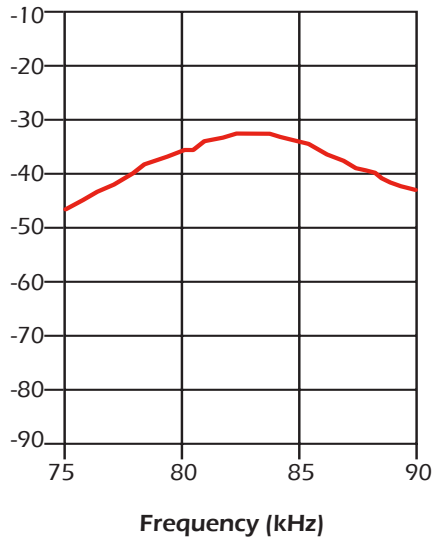
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

83/200 kHz-A (83 kHz)

24 mm (0.95”) PZT

Cable Type: Customer Supplied
Cable Length: 6 m (20’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	810 Ω: -20%, +40%	810 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,010 pF	1,770 pF
Series [R - jX]: (nominal)	690 - j280 Ω	530 - j380 Ω
1 kHz capacitance: (nominal)	1,190 pF	1,960 pF

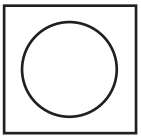
Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
75.00	729.17	-80.64	118.64	-719.46	0.22	1.35	4481.68	2871.45
75.50	705.34	-79.32	130.72	-693.12	0.26	1.39	3805.92	2936.88
76.00	681.89	-77.71	145.14	-666.27	0.31	1.43	3203.70	3000.71
76.50	659.18	-75.81	161.55	-639.07	0.37	1.47	2689.59	3059.89
77.00	635.75	-73.45	181.13	-609.40	0.45	1.51	2231.40	3116.43
77.50	615.82	-70.64	204.19	-580.99	0.54	1.53	1857.30	3146.11
78.00	596.72	-67.27	230.58	-550.37	0.65	1.55	1544.23	3153.84
78.50	582.49	-63.11	263.41	-519.52	0.78	1.53	1288.08	3104.47
79.00	574.68	-58.50	300.31	-489.98	0.91	1.48	1099.75	2988.89
79.50	572.97	-53.07	344.23	-458.04	1.05	1.40	953.71	2793.15
80.00	584.87	-47.35	396.24	-430.19	1.16	1.26	863.28	2501.92
80.50	609.36	-41.67	455.19	-405.12	1.23	1.09	815.75	2157.03
81.00	651.62	-35.97	527.36	-382.74	1.24	0.90	805.15	1771.16
81.50	715.12	-31.74	608.14	-376.24	1.19	0.74	840.92	1436.72
82.00	794.11	-27.85	702.15	-370.93	1.11	0.59	898.11	1141.67
82.50	894.76	-25.93	804.67	-391.29	1.01	0.49	994.94	942.87
83.00	1007.69	-25.32	910.86	-431.01	0.90	0.42	1114.81	813.91
83.50	1143.52	-26.14	1026.56	-503.79	0.79	0.39	1273.80	734.34
84.00	1267.37	-28.75	1111.18	-609.51	0.69	0.38	1445.51	718.98
84.50	1404.55	-31.90	1192.45	-742.17	0.60	0.38	1654.37	708.59
85.00	1513.37	-36.46	1217.23	-899.25	0.53	0.39	1881.56	735.17
85.50	1602.17	-41.07	1207.97	-1052.50	0.47	0.41	2125.00	763.23
86.00	1669.89	-45.91	1161.98	-1199.31	0.42	0.43	2399.82	795.93
86.50	1693.86	-50.44	1078.76	-1305.93	0.38	0.46	2659.69	837.47
87.00	1713.24	-54.72	989.63	-1398.51	0.34	0.48	2965.95	871.62
87.50	1701.62	-58.61	886.40	-1452.52	0.31	0.50	3266.60	912.45
88.00	1685.76	-62.01	791.06	-1488.63	0.28	0.52	3592.38	947.40
88.50	1664.72	-65.06	702.02	-1509.46	0.25	0.54	3947.62	979.53
89.00	1629.32	-67.51	623.23	-1505.41	0.23	0.57	4259.54	1014.08
89.50	1599.40	-69.92	549.00	-1502.22	0.21	0.59	4659.51	1044.28
90.00	1563.30	-71.92	485.16	-1486.11	0.20	0.61	5037.33	1075.34

83/200 kHz-A (200 kHz)

Power Rating: 300W rms @ 1% duty cycle
24 mm (0.95") PZT
Active Area: 4.53 cm² (0.72 in²)
Radiating Surface: Plastic

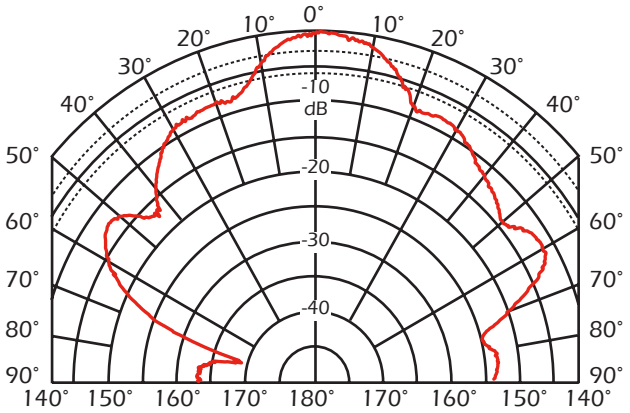
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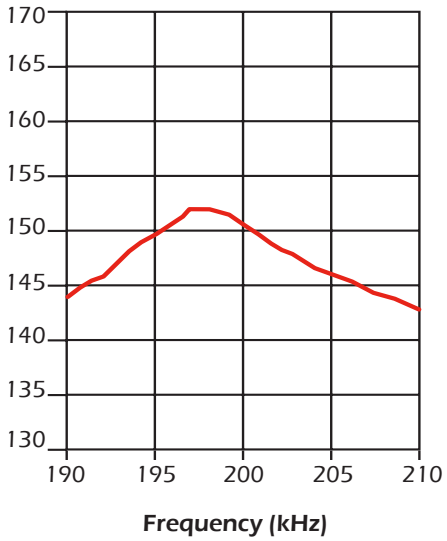
Beamwidth:
-3 dB: 21°
-6 dB: 29°
-10 dB: 67°

Directivity Index:	19.1
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	152 dB
Peak TVR(1), minimum:	150 dB
Q (transmit):	28
Peak Source Level(4):	206 dB
Peak RVR(2), nominal:	-194 dB
Peak Figure of Merit(3):	-43 dB

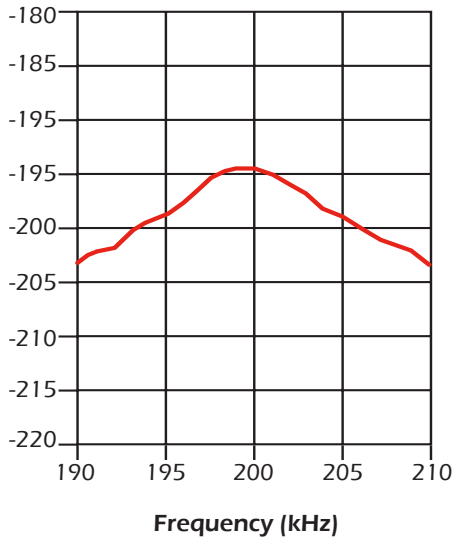
Transmit Radiation Pattern



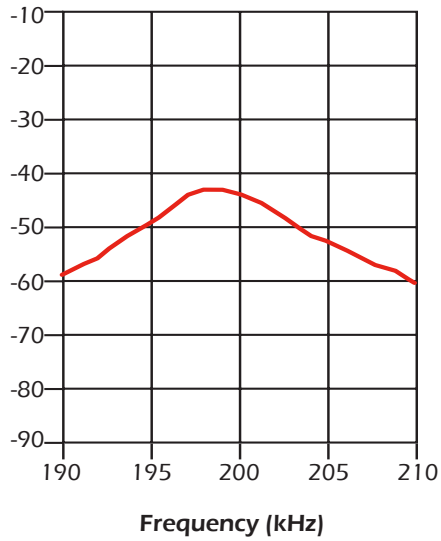
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

83/200 kHz-A (200 kHz)

24 mm (0.95”) PZT

Cable Type: Customer Supplied
Cable Length: 6 m (20’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	870 Ω: -20%, +40%	870 Ω: -20%, +40%
Parallel: Cp. (nominal)	810 pF	1,590 pF
Series [R - jX]: (nominal)	490 - j430 Ω	220 - j380 Ω
1 kHz capacitance: (nominal)	1,180 pF	1,950 pF

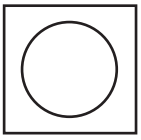
Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	425.44	-85.15	35.97	-423.91	0.20	2.34	5031.64	1961.88
191.00	415.24	-84.11	42.60	-413.04	0.25	2.40	4046.99	1996.16
192.00	404.87	-82.70	51.47	-401.58	0.31	2.45	3184.43	2030.81
193.00	394.67	-80.76	63.40	-389.54	0.41	2.50	2456.81	2062.31
194.00	384.77	-78.11	79.28	-376.51	0.54	2.54	1867.43	2086.42
195.00	378.48	-74.51	101.10	-364.73	0.71	2.55	1416.97	2078.10
196.00	380.36	-70.18	128.97	-357.82	0.89	2.47	1121.71	2008.41
197.00	397.15	-64.31	172.19	-357.88	1.09	2.27	916.01	1833.09
198.00	437.67	-59.89	219.58	-378.59	1.15	1.98	872.34	1588.71
199.00	500.10	-58.93	258.12	-428.34	1.03	1.71	968.95	1369.75
200.00	562.96	-61.79	266.09	-496.10	0.84	1.57	1191.01	1245.69
201.00	602.58	-66.63	239.00	-553.15	0.66	1.52	1519.24	1206.27
202.00	617.44	-71.40	196.95	-585.19	0.52	1.54	1935.70	1209.41
203.00	616.86	-75.33	156.22	-596.75	0.41	1.57	2435.81	1229.54
204.00	607.27	-78.39	122.22	-594.84	0.33	1.61	3017.31	1258.44
205.00	594.79	-80.63	96.87	-586.85	0.27	1.66	3652.09	1287.85
206.00	582.19	-82.30	77.97	-576.95	0.23	1.70	4347.13	1315.09
207.00	569.97	-83.59	63.59	-566.41	0.20	1.74	5108.90	1340.53
208.00	558.72	-84.61	52.49	-556.25	0.17	1.78	5947.08	1363.45
209.00	547.79	-85.39	44.07	-546.02	0.15	1.82	6808.41	1385.63
210.00	538.08	-86.00	37.52	-536.77	0.13	1.85	7716.45	1405.05

83/200 kHz-A (83 kHz)

Power Rating: 300W rms @ 1% duty cycle
24 mm (0.95") PZT
Active Area: 4.53 cm² (0.72 in²)
Radiating Surface: Urethane

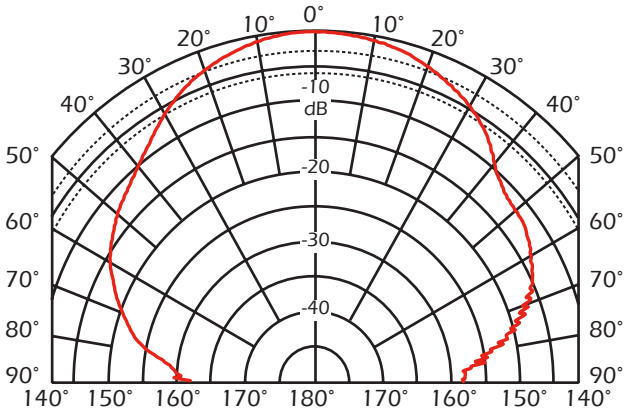
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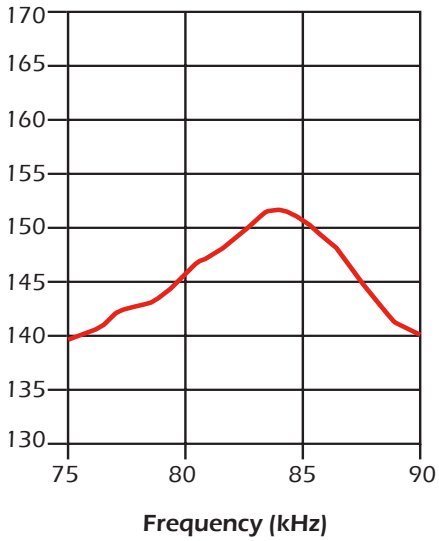
Beamwidth:
-3 dB: 44°
-6 dB: 63°
-10 dB: 81°

Directivity Index:	12
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	151 dB
Peak TVR(1), minimum:	149 dB
Q (transmit):	20
Peak Source Level(4):	204 dB
Peak RVR(2), nominal:	-181 dB
Peak Figure of Merit(3):	-34 dB

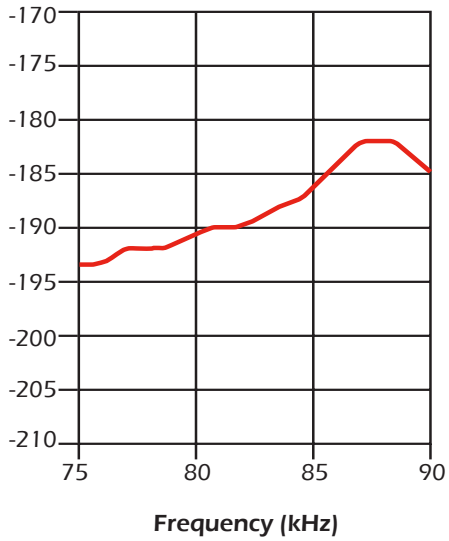
Transmit Radiation Pattern



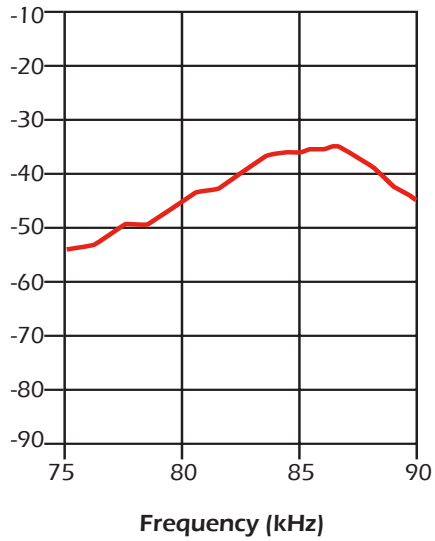
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

83/200 kHz-A (83 kHz)

24 mm (0.95”) PZT

Cable Type: C2
Cable Length: 7 m (25’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	510 Ω: -20%, +40%	510 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,100 pF	1,830 pF
Series [R - jX]: (nominal)	470 - j140 Ω	410 - j200 Ω
1 kHz capacitance: (nominal)	1,100 pF	1,850 pF

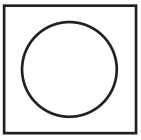
Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
75.00	1199.17	-83.63	132.95	-1191.78	0.09	0.83	10816.46	1758.70
75.50	1162.75	-83.08	140.14	-1154.27	0.10	0.85	9647.24	1799.74
76.00	1126.34	-82.51	146.82	-1116.73	0.12	0.88	8640.91	1843.38
76.50	1088.40	-81.90	153.29	-1077.55	0.13	0.91	7727.97	1892.43
77.00	1049.81	-81.06	163.22	-1037.04	0.15	0.94	6752.16	1944.93
77.50	1009.40	-80.17	172.30	-994.59	0.17	0.98	5913.61	2004.63
78.00	967.75	-79.15	182.16	-950.45	0.19	1.01	5141.16	2070.76
78.50	925.05	-77.88	194.18	-904.44	0.23	1.06	4406.84	2142.89
79.00	879.87	-76.43	206.39	-855.32	0.27	1.10	3750.97	2225.80
79.50	833.10	-74.72	219.59	-803.64	0.32	1.16	3160.75	2318.03
80.00	786.41	-72.60	235.10	-750.44	0.38	1.21	2630.49	2414.08
80.50	736.75	-70.00	251.93	-692.33	0.46	1.28	2154.53	2521.76
81.00	686.79	-66.68	271.88	-630.69	0.58	1.34	1734.91	2627.23
81.50	636.01	-62.51	293.57	-564.20	0.73	1.39	1377.89	2723.77
82.00	587.65	-57.10	319.17	-493.42	0.92	1.43	1081.97	2773.21
82.50	542.87	-50.11	348.12	-416.56	1.18	1.41	846.57	2726.80
83.00	506.44	-40.92	382.66	-331.74	1.49	1.29	670.25	2480.20
83.50	486.94	-29.62	423.30	-240.68	1.79	1.02	560.15	1934.77
84.00	490.90	-16.60	470.45	-140.22	1.95	0.58	512.24	1102.44
84.50	529.08	-3.13	528.29	-28.85	1.89	0.10	529.87	194.12
85.00	604.35	9.07	596.78	95.31	1.63	-0.26	612.00	-488.63
85.50	723.36	18.87	684.46	234.00	1.31	-0.45	764.46	-832.47
86.00	880.84	26.10	791.01	387.53	1.02	-0.50	980.87	-924.36
86.50	1081.97	31.35	924.05	562.84	0.79	-0.48	1266.87	-884.62
87.00	1335.43	34.65	1098.56	759.31	0.62	-0.43	1623.38	-778.89
87.50	1644.48	36.50	1321.88	978.24	0.49	-0.36	2045.81	-657.96
88.00	2033.88	36.93	1625.75	1222.13	0.39	-0.30	2544.47	-534.32
88.50	2518.15	35.81	2042.08	1473.42	0.32	-0.23	3105.20	-417.87
89.00	3140.68	33.43	2621.04	1730.32	0.27	-0.18	3763.34	-313.70
89.50	3924.45	28.86	3437.09	1894.12	0.22	-0.12	4480.91	-218.70
90.00	4892.47	22.05	4534.60	1836.76	0.19	-0.08	5278.58	-135.70

83/200 kHz-A (200 kHz)

Power Rating: 300W rms @ 1% duty cycle
24 mm (0.95") PZT
Active Area: 4.53 cm² (0.72 in²)
Radiating Surface: Urethane

Array

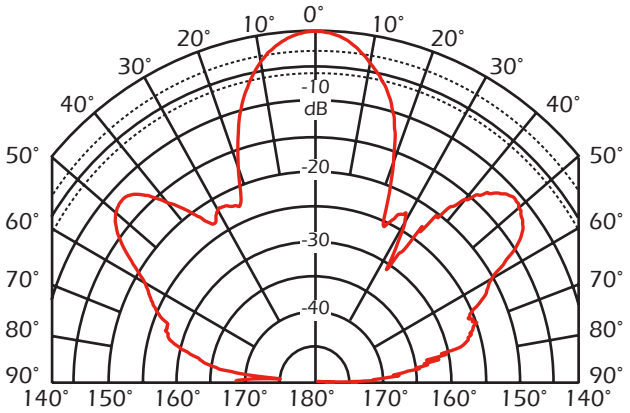


Beamwidth:

-3 dB:	18°
-6 dB:	25°
-10 dB:	32°

Directivity Index:	10
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	154 dB
Peak TVR(1), minimum:	152 dB
Q (transmit):	25
Peak Source Level(4):	209 dB
Peak RVR(2), nominal:	-192 dB
Peak Figure of Merit(3):	-38 dB

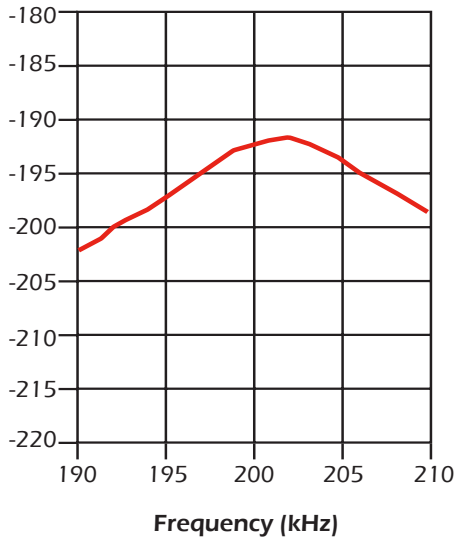
Transmit Radiation Pattern



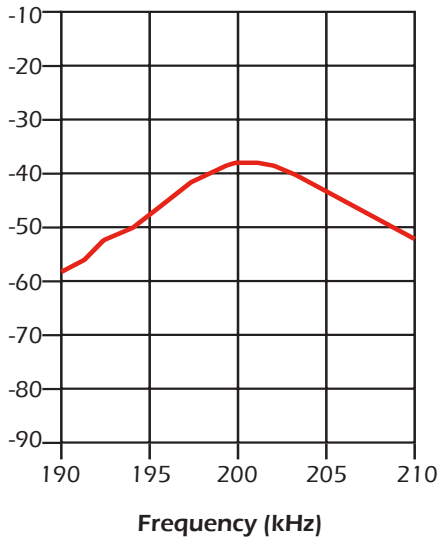
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

83/200 kHz-A (200 kHz)

24 mm (0.95”) PZT

Cable Type: C2
Cable Length: 7 m (25’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	1,060 Ω: -20%, +40%	1,060 Ω: -20%, +40%
Parallel: Cp. (nominal)	780 pF	1,500 pF
Series [R - jX]: (nominal)	510 - j530 Ω	210 - j430 Ω
1 kHz capacitance: (nominal)	1,090 pF	1,830 pF

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	814.07	-83.80	87.95	-809.31	0.13	1.22	7535.09	1022.95
191.00	790.34	-82.93	97.28	-784.33	0.16	1.26	6420.77	1046.31
192.00	765.60	-81.81	109.13	-757.78	0.19	1.29	5371.06	1071.67
193.00	738.98	-80.32	124.31	-728.45	0.23	1.33	4392.89	1100.01
194.00	712.78	-78.23	145.38	-697.80	0.29	1.37	3494.79	1126.77
195.00	686.64	-75.56	171.28	-664.94	0.36	1.41	2752.69	1151.08
196.00	663.44	-71.80	207.17	-630.27	0.47	1.43	2124.60	1162.74
197.00	646.87	-66.97	253.03	-595.33	0.60	1.42	1653.72	1149.42
198.00	643.12	-60.55	316.16	-560.04	0.76	1.35	1308.22	1088.41
199.00	669.29	-53.19	401.05	-535.83	0.90	1.20	1116.95	956.66
200.00	738.34	-46.08	512.12	-531.87	0.94	0.98	1064.50	776.39
201.00	859.28	-41.56	643.00	-570.01	0.87	0.77	1148.31	611.28
202.00	1013.94	-41.11	763.90	-666.74	0.74	0.65	1345.83	510.97
203.00	1188.40	-43.65	859.95	-820.23	0.61	0.58	1642.29	455.34
204.00	1346.12	-49.49	874.34	-1023.51	0.48	0.56	2072.47	440.67
205.00	1438.17	-56.69	789.76	-1201.92	0.38	0.58	2618.94	451.15
206.00	1460.40	-63.34	655.26	-1305.14	0.31	0.61	3254.83	472.79
207.00	1443.27	-68.60	526.66	-1343.75	0.25	0.65	3955.16	495.99
208.00	1412.06	-72.68	420.40	-1348.03	0.21	0.68	4742.86	517.31
209.00	1373.53	-75.94	333.75	-1332.36	0.18	0.71	5652.61	537.80
210.00	1332.05	-78.58	263.83	-1305.66	0.15	0.74	6725.45	557.69

100 kHz-A

Transformed to 90 ohms

Power rating: 300 Wrms @ 2% duty cycle
51 mm (2.0") PZT
Active Area: 20 cm²
Urethane Window

Beamwidth:

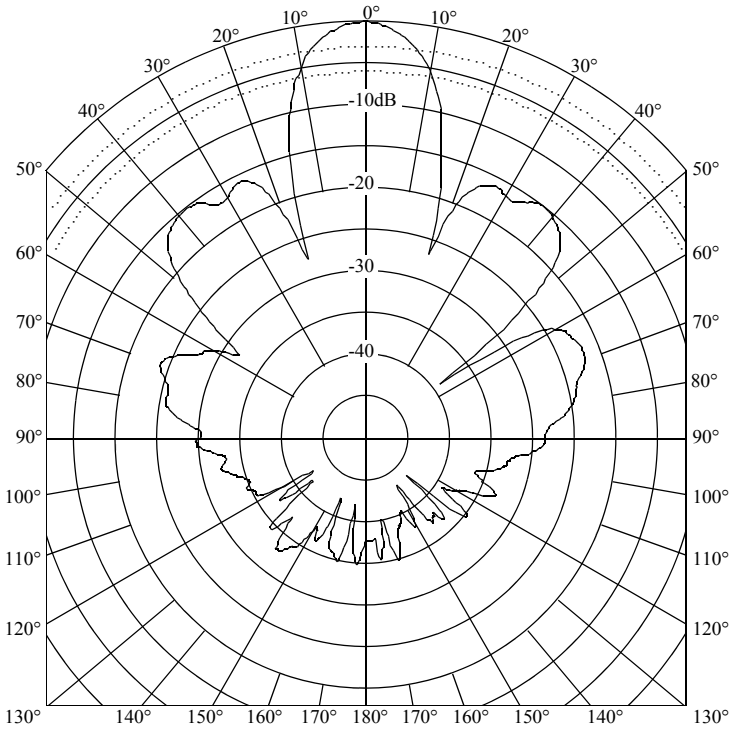
-3 dB:	15°
-6 dB:	21°
-10 dB:	26°

Directivity Index:	20.7
Frequency Tolerance:	±2.5 kHz
Peak TVR(1), nominal:	164 dB
Peak TVR(1), minimum:	162 dB
Q (transmit):	21
Peak Source Level(4):	208 dB
Peak RVR(2), nominal:	-187 dB
Peak Figure of Merit(3):	-26 dB

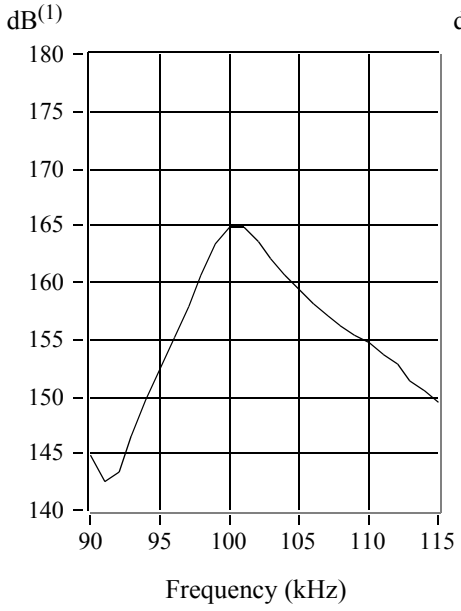
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

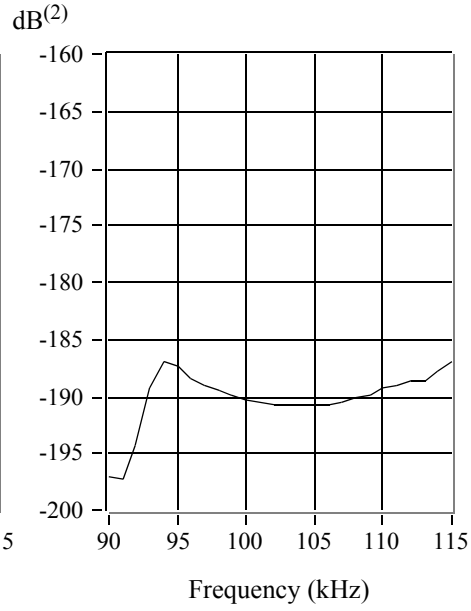
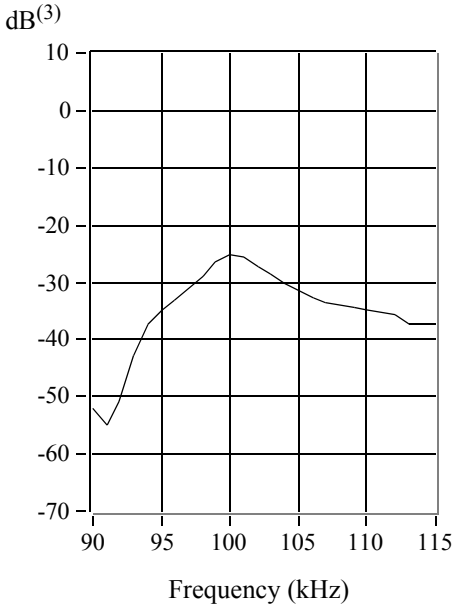


Figure of Merit



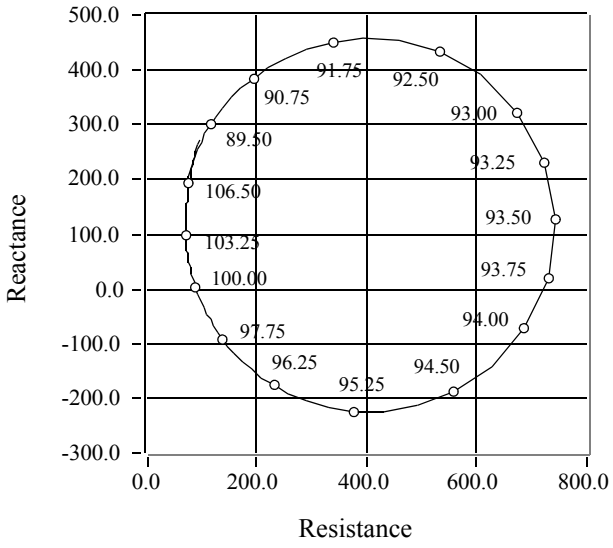
100 kHz-A

51mm (2.0") PZT

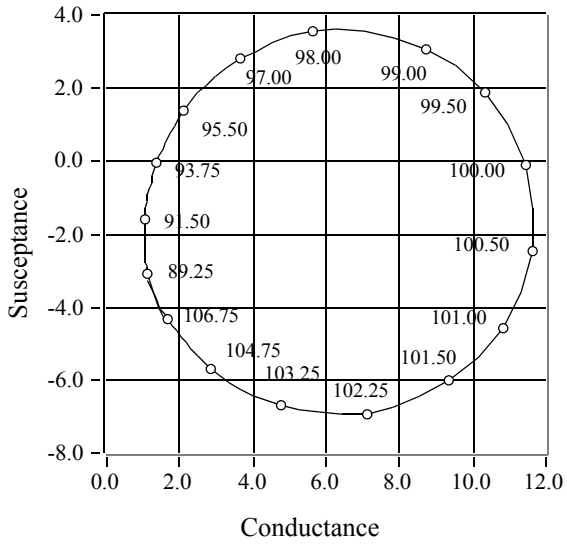
Cable Type: C33
Cable Length: 30.5m (100.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	90ohms -20%,+40%	90ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	90 – j0 ohms	90 – j0 ohms
1 kHz Capacitance	n/a	n/a

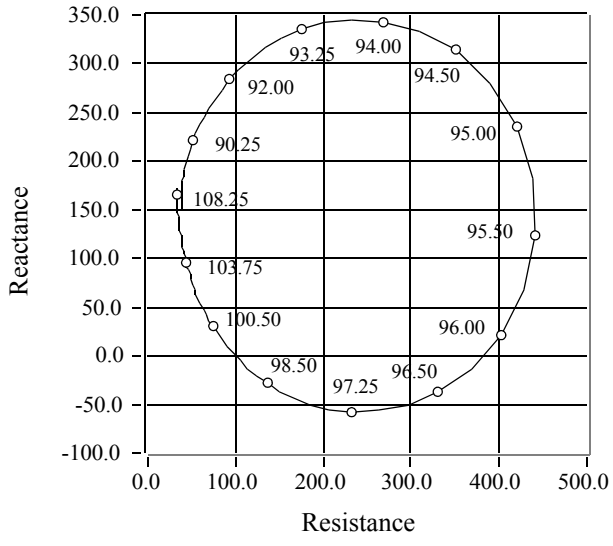
Unbalanced Impedance



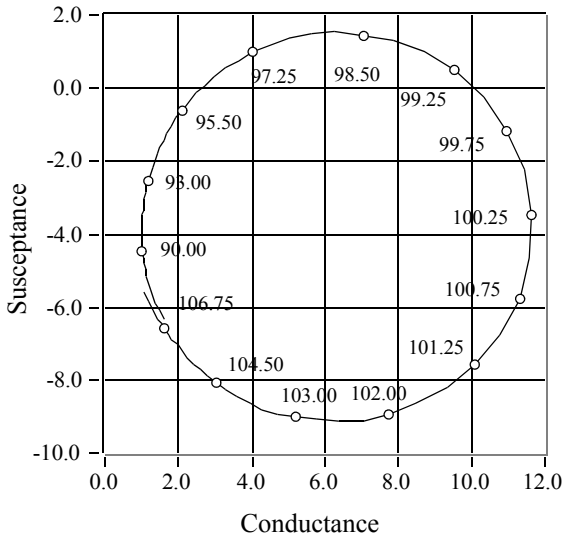
Unbalanced Admittance



Balanced Impedance

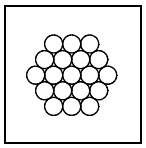


Balanced Admittance



100 kHz-B

Array:



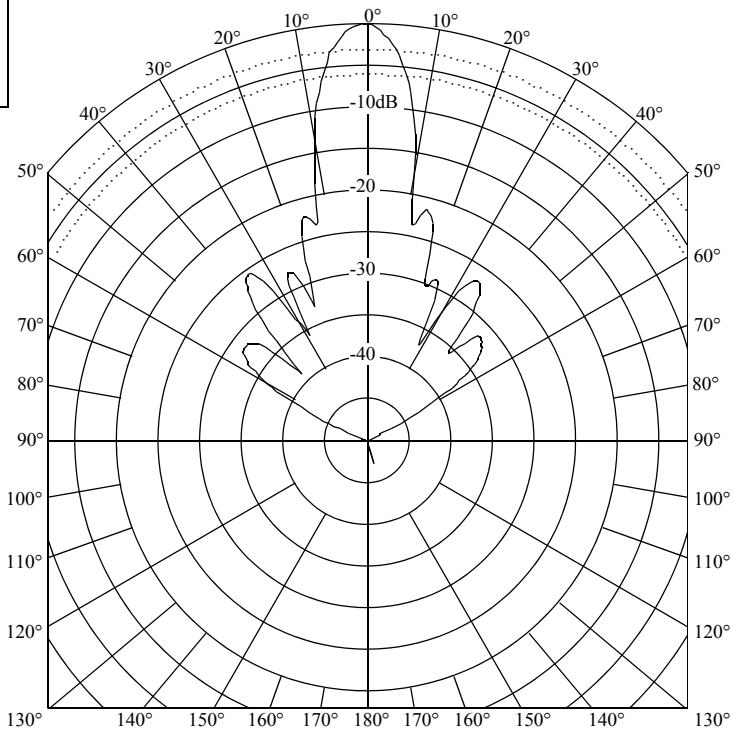
Transformed to 130 ohms

Power rating: 1 kWrms @ 2% duty cycle
19 x 19mm (0.75") PZT/L
Active Area: 54cm²
Urethane Window
Beamwidth:
-3 dB: 9°
-6 dB: 13°
-10 dB: 17°

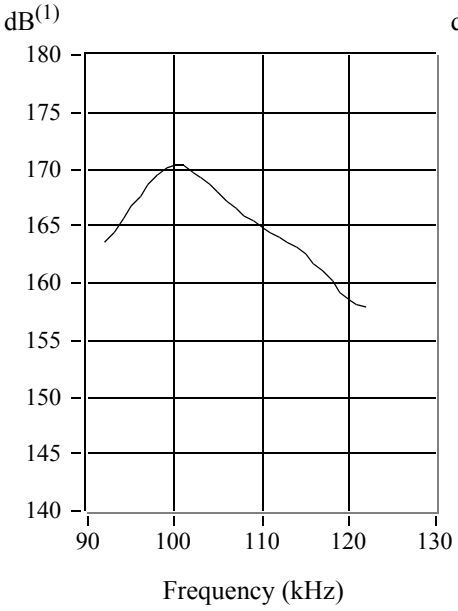
Directivity Index:	25.7
Frequency Tolerance:	±2.5 kHz
Peak TVR(1), nominal:	170 dB
Peak TVR(1), minimum:	168 dB
Q (transmit):	10
Peak Source Level(4):	221 dB
Peak RVR(2), nominal:	-171 dB
Peak Figure of Merit(3):	-11 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

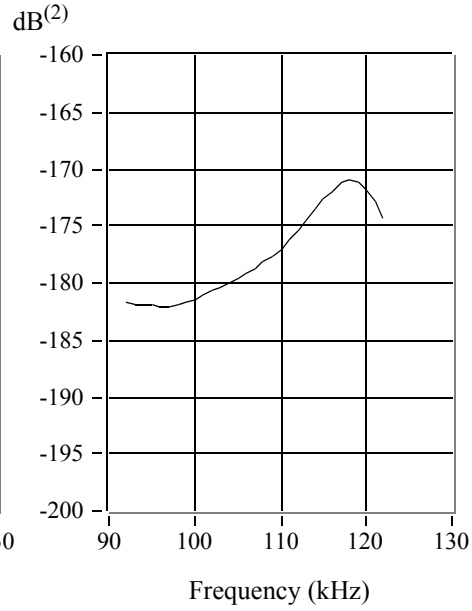
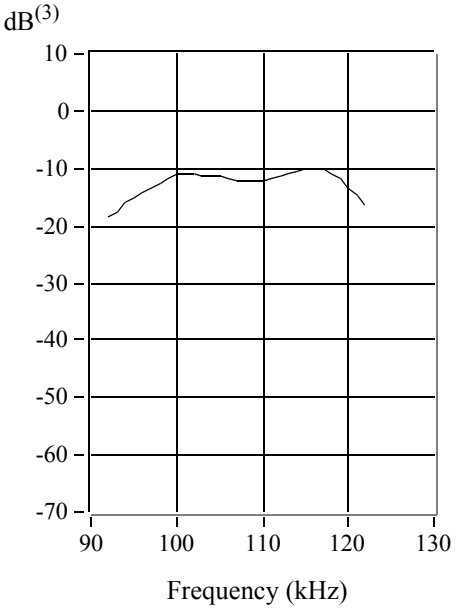


Figure of Merit



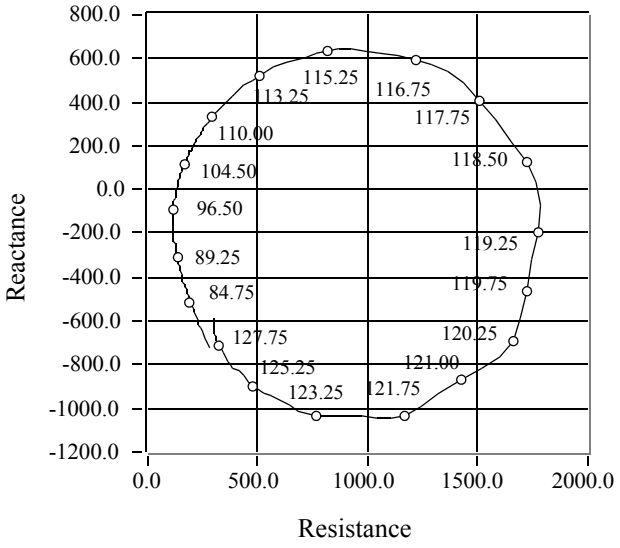
100 kHz-B

19 x 19mm (0.75") PZT/L

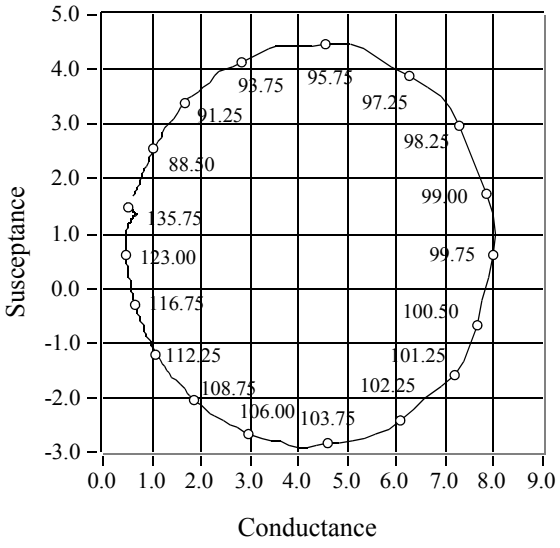
Cable Type: C43
Cable Length: 9.1 m (30.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	130 ohms -20%, +40%	130 ohms -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	130 – j0 ohms	130 – j0 ohms
1 kHz Capacitance	n/a	n/a

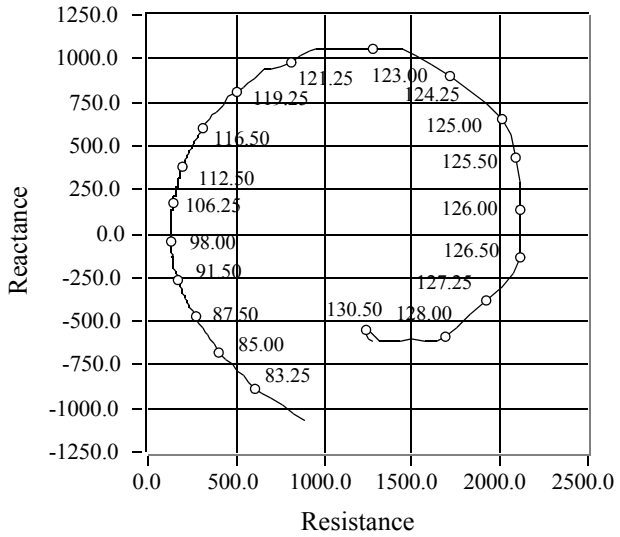
Unbalanced Impedance



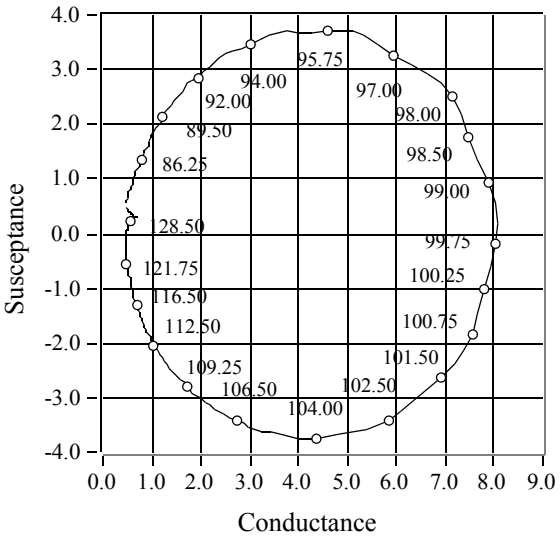
Unbalanced Admittance



Balanced Impedance



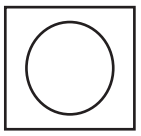
Balanced Admittance



100 kHz-Nlq

Power Rating: 100 W rms @ 1% duty cycle
20 mm (0.78") PZT5
Active Area: 3.14 cm^2 (0.48 in^2)
Radiating Surface: Urethane

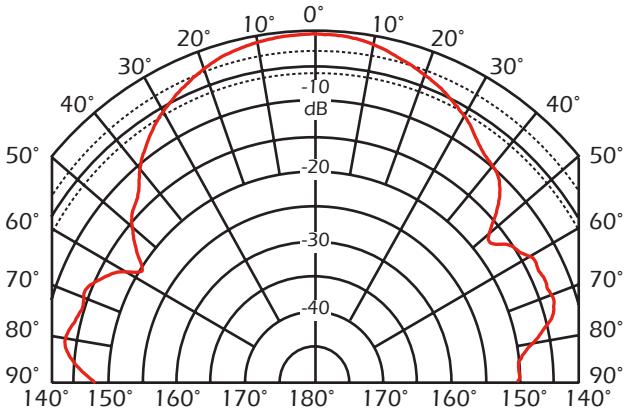
Array



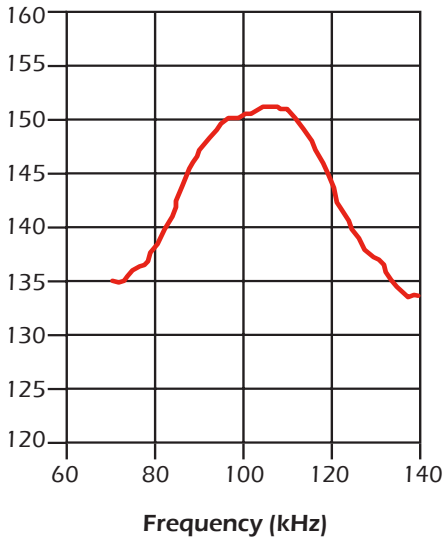
Beamwidth:
-3 dB: 42°
-6 dB: 61°
-10 dB: 80°

Directivity Index:	13
Frequency Tolerance:	± 10 kHz
Peak TVR(1), nominal:	151 dB
Peak TVR(1), minimum:	149 dB
Q (transmit):	5
Peak Source Level(4):	198 dB
Peak RVR(2), nominal:	-185 dB
Peak Figure of Merit(3):	-38 dB

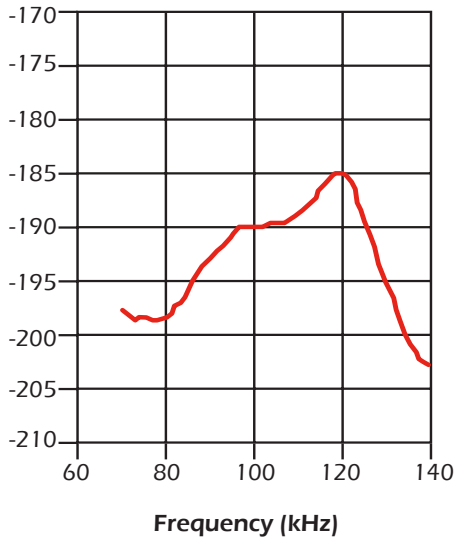
Transmit Radiation Pattern



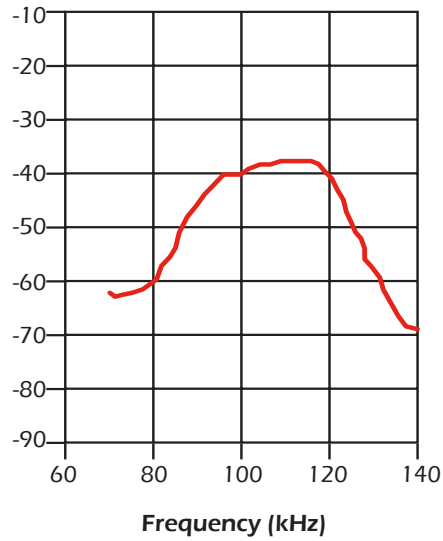
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

100 kHz-Nlq

20 mm (0.78”) PZT5

Cable Type: C189-02
Cable Length: 4.5 m (15’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	510 Ω: -20%, +40%	510 Ω: -20%, +40%
Parallel: Cp. (nominal)	630 pF	970 pF
Series [R - jX]: (nominal)	490 - j110 Ω	460 - j150 Ω
1 kHz capacitance: (nominal)	2,070 pF	2,420 pF

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
70.00	899.21	-82.60	115.82	-891.72	0.14	1.10	6981.24	2507.42
72.00	849.49	-82.01	118.02	-841.25	0.16	1.17	6114.41	2576.89
74.00	802.18	-81.32	121.08	-792.99	0.19	1.23	5314.78	2650.39
76.00	754.67	-80.52	124.25	-744.37	0.22	1.31	4583.73	2737.04
78.00	707.28	-79.38	130.34	-695.17	0.26	1.39	3838.11	2835.50
80.00	658.28	-77.88	138.24	-643.60	0.32	1.49	3134.71	2954.80
82.00	608.89	-75.64	151.03	-589.86	0.41	1.59	2454.80	3088.03
84.00	563.40	-72.31	171.21	-536.76	0.54	1.69	1853.98	3203.92
88.00	499.15	-62.47	230.68	-442.65	0.93	1.78	1080.08	3213.15
90.00	482.63	-56.81	264.18	-403.91	1.13	1.73	881.72	3066.40
92.00	476.31	-51.01	299.70	-370.21	1.32	1.63	757.01	2822.89
94.00	478.44	-45.48	335.48	-341.11	1.47	1.49	682.32	2523.14
96.00	488.76	-40.62	370.98	-318.21	1.55	1.33	643.93	2208.37
98.00	498.89	-37.05	398.16	-300.61	1.60	1.21	625.11	1961.47
100.00	501.13	-33.89	415.98	-279.45	1.66	1.11	603.72	1771.01
102.00	493.71	-29.97	427.70	-246.61	1.75	1.01	569.90	1578.68
106.00	490.84	-16.50	470.62	-139.41	1.95	0.58	511.92	868.85
108.00	510.95	-7.55	506.52	-67.14	1.94	0.26	515.42	379.00
110.00	556.39	2.31	555.94	22.38	1.80	-0.07	556.84	-104.62
112.00	652.39	12.02	638.10	135.82	1.50	-0.32	667.01	-453.47
114.00	812.12	19.10	767.42	265.71	1.16	-0.40	859.42	-562.45
116.00	1048.57	23.23	963.59	413.51	0.88	-0.38	1141.04	-516.00
118.00	1391.76	23.80	1273.42	561.60	0.66	-0.29	1521.10	-391.06
120.00	1916.11	20.31	1796.94	665.20	0.49	-0.18	2043.19	-240.30
124.00	3481.73	-9.57	3433.30	-578.72	0.28	0.05	3530.85	61.27
126.00	3691.84	-34.44	3044.80	-2087.80	0.22	0.15	4476.39	193.49
128.00	3251.01	-53.59	1929.89	-2616.22	0.18	0.25	5476.51	307.78
130.00	2742.46	-65.33	1144.59	-2492.19	0.15	0.33	6570.98	405.67
132.00	2333.33	-72.24	711.88	-2222.08	0.13	0.41	7647.91	492.10
134.00	2035.25	-76.41	478.38	-1978.23	0.12	0.48	8658.90	567.23
136.00	1818.25	-79.01	346.51	-1784.93	0.10	0.54	9541.07	631.82
138.00	1652.92	-80.86	262.67	-1631.92	0.10	0.60	10401.31	688.87
140.00	1523.49	-82.22	206.30	-1509.46	0.09	0.65	11250.70	739.32

120 kHz-A

Power rating: 100 Wrms @ 2% duty cycle
19mm (0.75") PZT/L
Active Area: 2.8cm²
Layered Plastic Epoxy Window

Beamwidth:

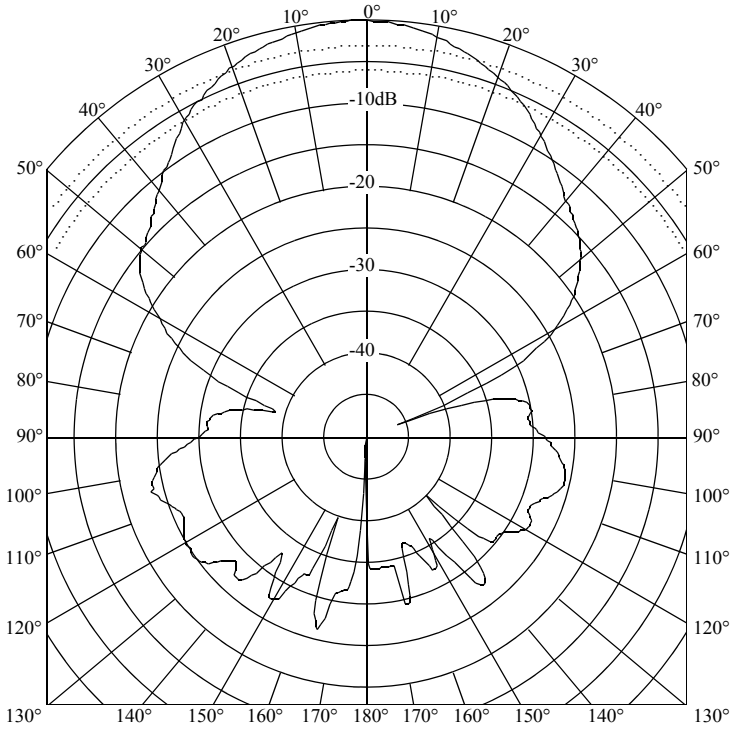
-3dB: 37°
-6dB: 54°
-10dB: 71°

Directivity Index:	13.8
Frequency Tolerance:	±3kHz
Peak TVR(1), nominal:	156dB
Peak TVR(1), minimum:	154dB
Q (transmit):	13
Peak Source Level(4):	203dB
Peak RVR(2), nominal:	-186dB
Peak Figure of Merit(3):	-31dB

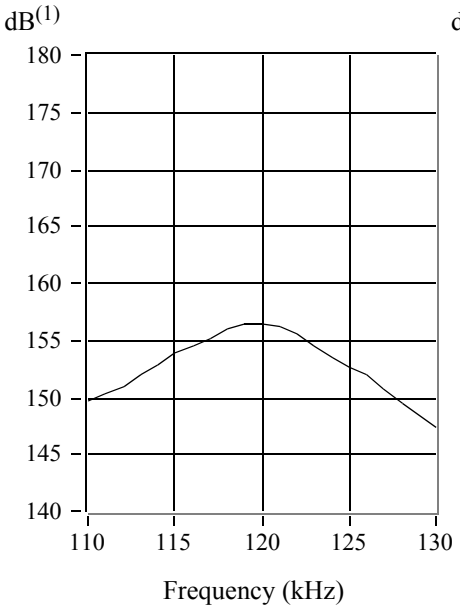
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

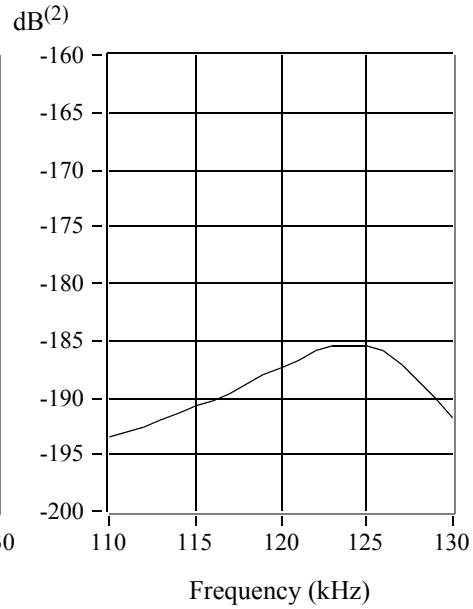
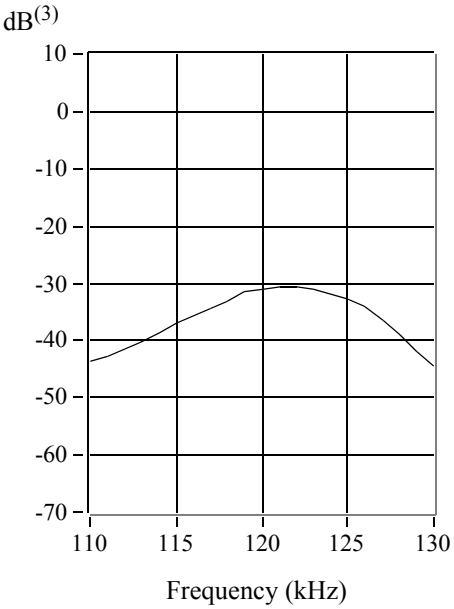


Figure of Merit



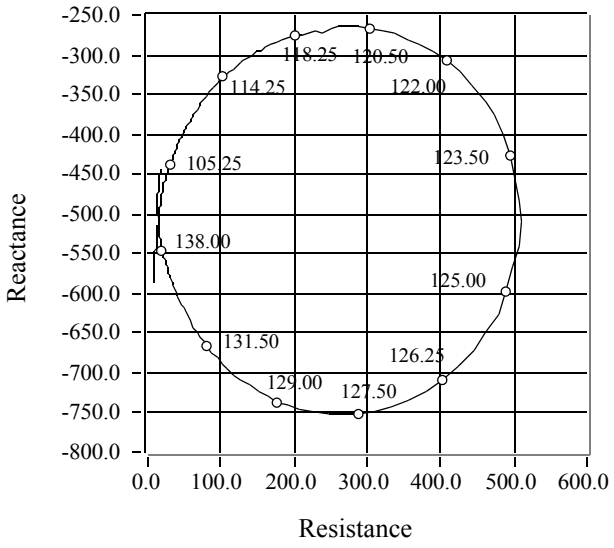
120 kHz-A

19mm (0.75") PZT/L

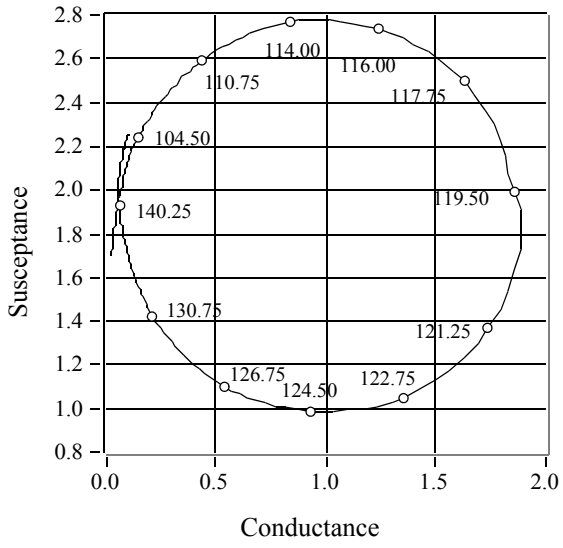
Cable Type: C32
Cable Length: 9.1 m (30.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	530 ohms -20%, +40%	530 ohms -20%, +40%
Parallel: Cp. (nominal)	870 pF	2410 pF
Series [R – jX] (nominal)	470 – j 160 ohms	270 – j 270 ohms
1 kHz Capacitance	1220 pF ±20%	2770 pF ±20%

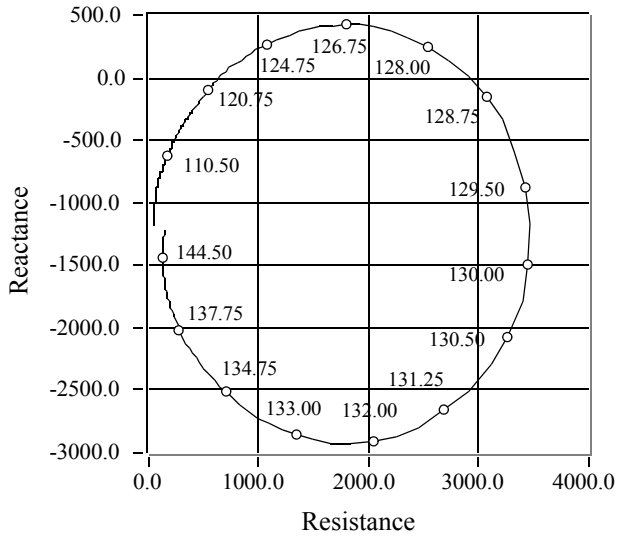
Unbalanced Impedance



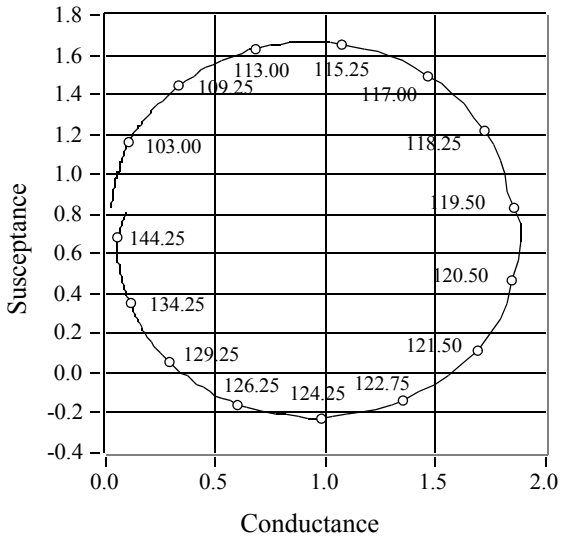
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



120 kHz-A

Power rating: 100 Wrms @ 2% duty cycle
19 mm (0.75") PZT/L
Active Area: 2.8 cm²
Urethane Window

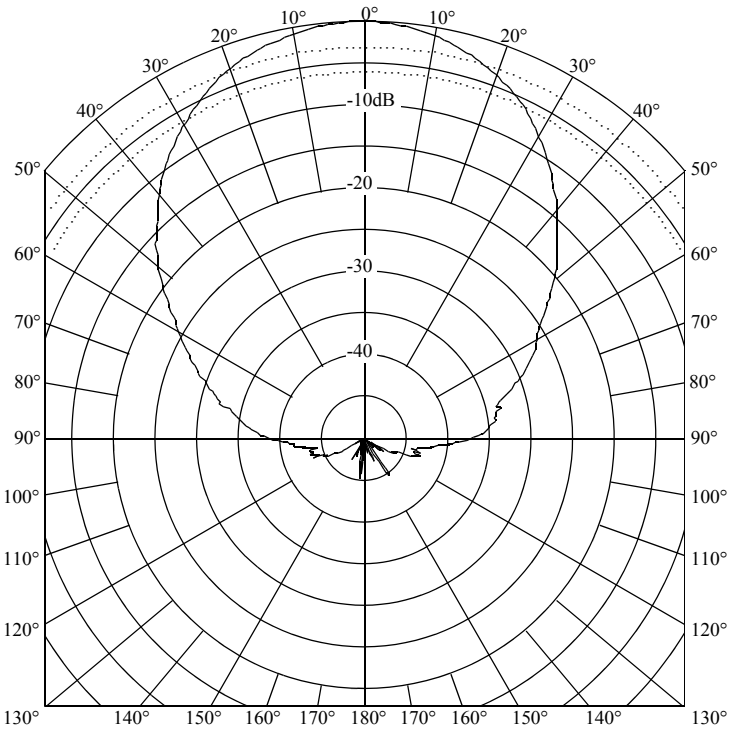
Beamwidth:

-3 dB:	38°
-6 dB:	54°
-10 dB:	69°

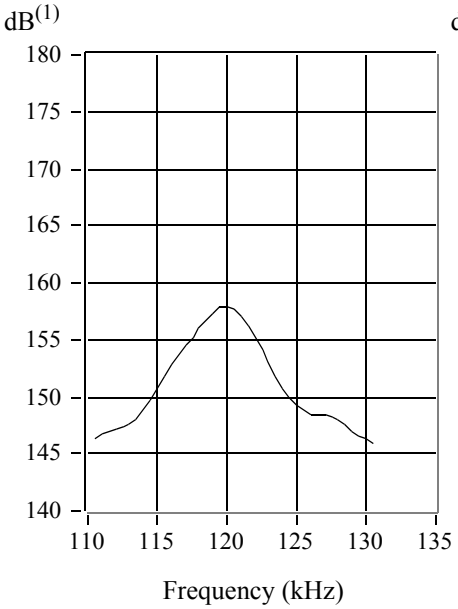
Directivity Index:	13.8
Frequency Tolerance:	±3 kHz
Peak TVR(1), nominal:	157 dB
Peak TVR(1), minimum:	154 dB
Q (transmit):	25
Peak Source Level(4):	200 dB
Peak RVR(2), nominal:	-183 dB
Peak Figure of Merit(3):	-32 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

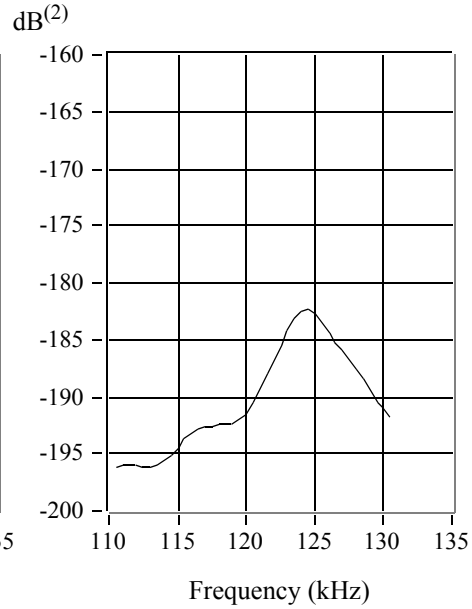
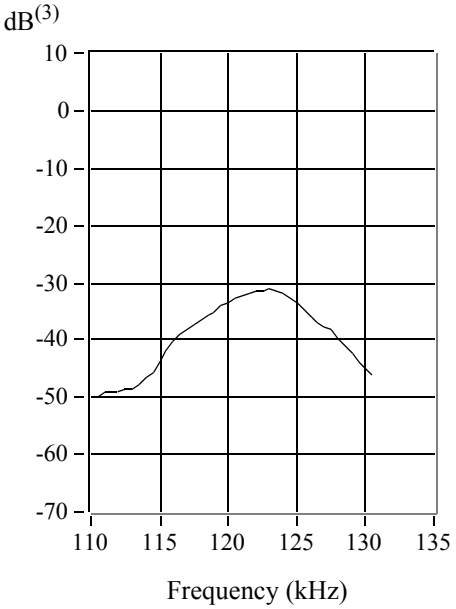


Figure of Merit



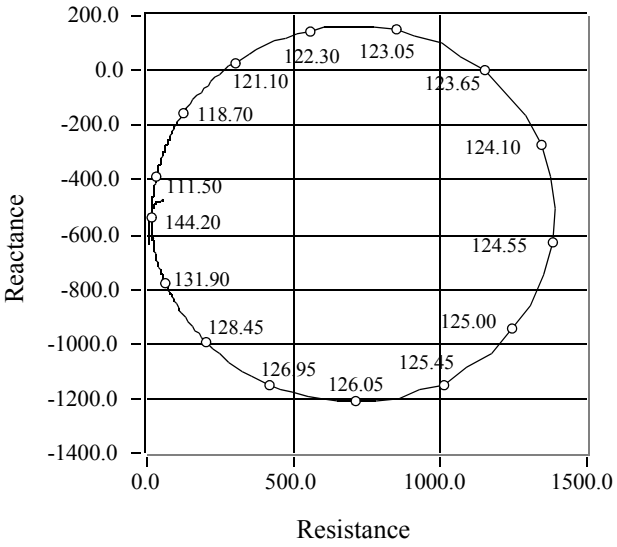
120 kHz-A

19mm (0.75") PZT/L

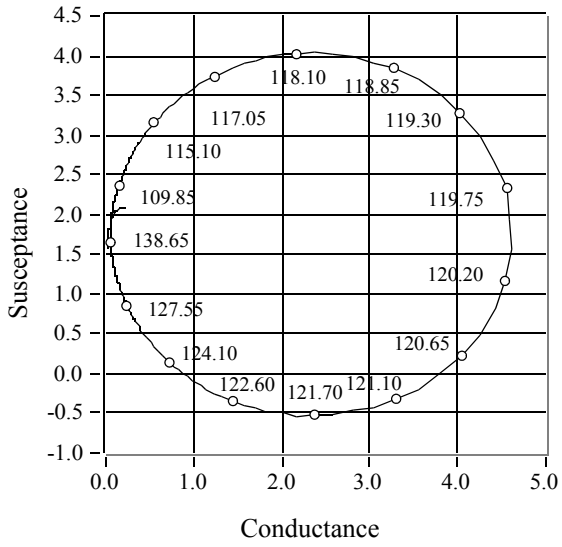
Cable Type: C2
Cable Length: 7.6m (25.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	220ohms-20%,+40%	220ohms-20%,+40%
Parallel: Cp. (nominal)	1040pF	2250pF
Series [R – jX] (nominal)	210 – j40 ohms	190 – j70 ohms
1 kHz Capacitance	1340pF±20%	2530 pF±20%

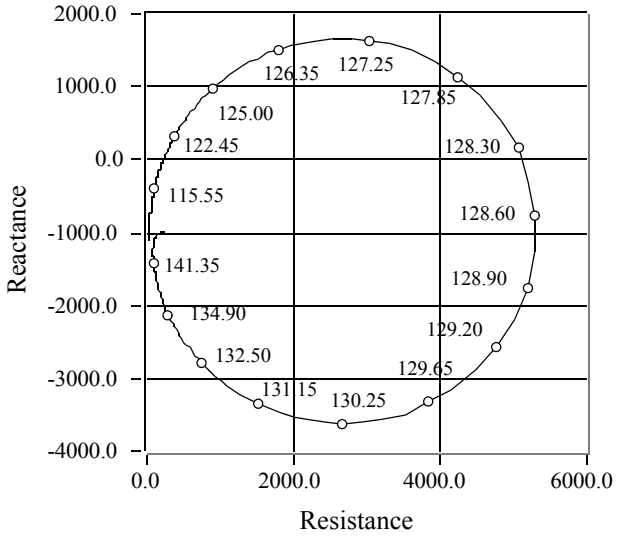
Unbalanced Impedance



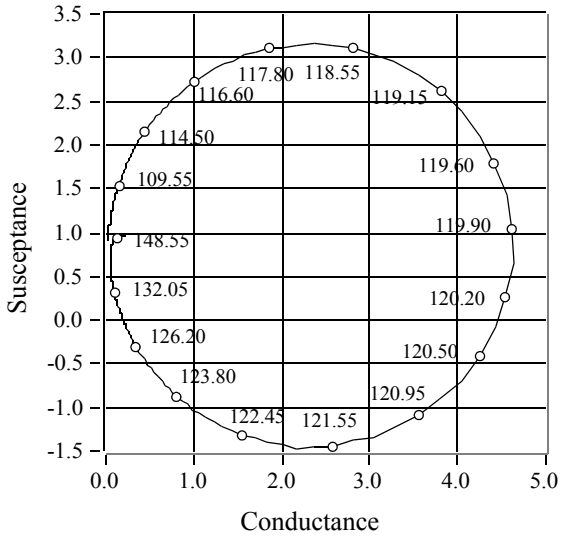
Unbalanced Admittance



Balanced Impedance



Balanced Admittance

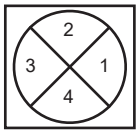


120 kHz-AAlq
Split Beam

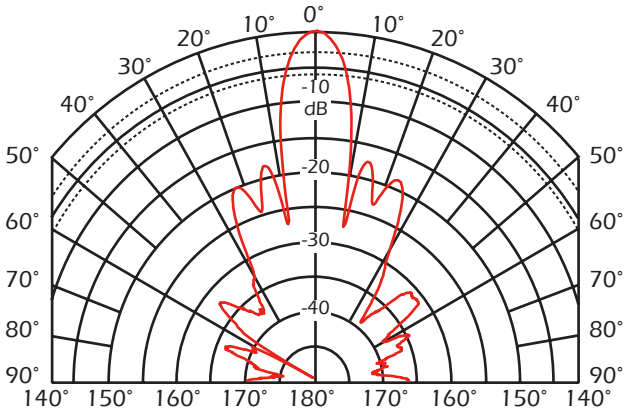
Power Rating: 2kW rms @ 1% duty cycle
88 mm (3.46") PZT
Active Area: 61 cm² (9.4 in²)
Radiating Surface: Urethane

Beamwidth:
-3 dB: 8°
-6 dB: 12°
-10 dB: 14°

Array view from water

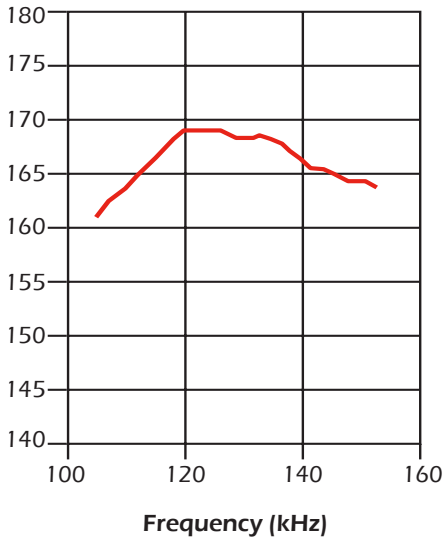


Transmit Radiation Pattern

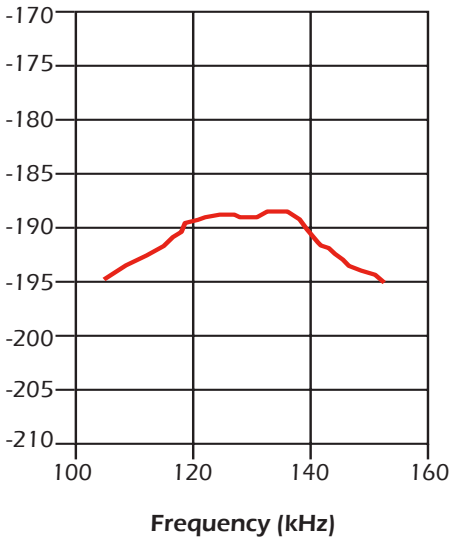


Directivity Index:	27
Frequency Tolerance:	± 10 kHz
Peak TVR(1), nominal:	169 dB
Peak TVR(1), minimum:	167 dB
Q (transmit):	5
Peak Source Level(4):	224 dB
Peak RVR(2), nominal:	-188 dB
Peak Figure of Merit(3):	-19.5 dB

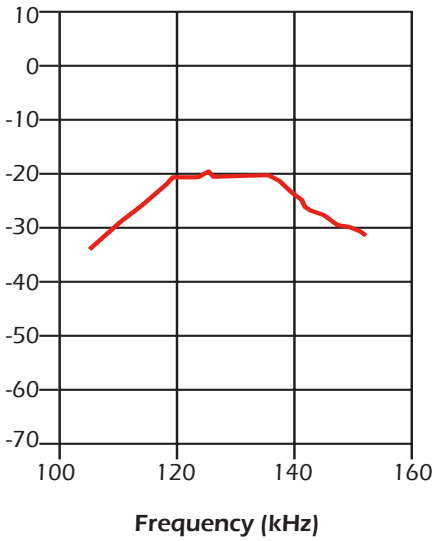
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

120 kHz-AAlq
All 4 Quadrants

88 mm (3.46”) PZT

Cable Type: C415
Cable Length: 15 m (50’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	160 Ω: -20%, +40%	160 Ω: -20%, +40%
Parallel: Cp. (nominal)	11,490 pF	15,060 pF
Series [R - jX]: (nominal)	50 - j80 Ω	40 - j70 Ω
1 kHz capacitance: (nominal)	15,120 pF	19,470 pF

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
105.00	104.50	-79.28	19.43	-102.67	1.78	9.40	561.87	14252.10
106.00	102.39	-78.95	19.62	-100.49	1.87	9.59	534.40	14392.62
108.00	98.94	-78.01	20.55	-96.79	2.10	9.89	476.32	14568.83
109.00	96.94	-77.53	20.94	-94.66	2.23	10.07	448.91	14706.24
111.00	93.43	-75.89	22.78	-90.61	2.61	10.38	383.18	14883.89
112.00	91.40	-75.17	23.39	-88.36	2.80	10.58	357.14	15028.92
114.00	88.06	-72.50	26.48	-83.98	3.42	10.83	292.79	15120.16
115.00	86.59	-71.32	27.73	-82.03	3.70	10.94	270.37	15141.15
117.00	83.89	-67.17	32.54	-77.32	4.62	10.99	216.26	14945.51
118.00	83.45	-64.96	35.32	-75.61	5.07	10.86	197.16	14642.95
120.00	85.47	-59.46	43.43	-73.61	5.95	10.08	168.19	13365.42
121.00	88.19	-57.93	46.83	-74.73	6.02	9.61	166.08	12638.32
123.00	92.54	-55.28	52.70	-76.06	6.15	8.88	162.48	11493.77
124.00	95.17	-54.51	55.25	-77.49	6.10	8.56	163.91	10980.69
126.00	101.13	-53.18	60.61	-80.95	5.93	7.92	168.73	9998.85
127.00	103.97	-53.28	62.16	-83.34	5.75	7.71	173.91	9662.40
129.00	109.26	-53.00	65.76	-87.25	5.51	7.31	181.54	9018.18
130.00	111.93	-53.51	66.57	-89.98	5.31	7.18	188.20	8793.12
132.00	116.92	-52.97	70.41	-93.34	5.15	6.83	194.14	8232.93
133.00	121.23	-53.19	72.64	-97.06	4.94	6.60	202.32	7902.54
135.00	130.37	-54.63	75.46	-106.31	4.44	6.26	225.22	7374.18
136.00	135.83	-56.28	75.41	-112.97	4.09	6.12	244.66	7166.02
138.00	142.70	-61.55	67.97	-125.47	3.34	6.16	299.59	7106.24
139.00	143.26	-64.41	61.89	-129.21	3.02	6.30	331.64	7208.01
141.00	139.26	-68.94	50.04	-129.96	2.58	6.70	387.57	7564.22
142.00	137.11	-70.30	46.21	-129.08	2.46	6.87	406.78	7696.43
144.00	133.06	-72.63	39.72	-127.00	2.24	7.17	445.77	7927.47
145.00	131.05	-73.47	37.28	-125.64	2.17	7.32	460.74	8029.37
147.00	127.57	-74.72	33.62	-123.06	2.07	7.56	484.10	8186.75
148.00	126.68	-75.01	32.77	-122.37	2.04	7.63	489.69	8199.84
150.00	126.31	-76.50	29.50	-122.81	1.85	7.70	540.88	8168.17
151.00	125.20	-77.64	26.80	-122.30	1.71	7.80	584.88	8223.58
153.00	122.25	-79.54	22.19	-120.22	1.48	8.04	673.57	8367.35

120 kHz-AAlq
Quadrant 1

88 mm (3.46”) PZT

Cable Type: C415
Cable Length: 15 m (50’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	680 Ω: -20%, +40%	660 Ω: -20%, +40%
Parallel: Cp. (nominal)	2,900 pF	4,100 pF
Series [R - jX]: (nominal)	210 - j210 Ω	126 - j260 Ω
1 kHz capacitance: (nominal)	3,610 pF	5,330 pF

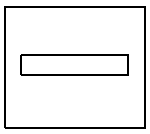
Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
105.00	437.20	-78.92	84.03	-429.04	0.44	2.24	2274.61	3402.36
106.00	428.26	-78.55	85.01	-419.73	0.46	2.29	2157.51	3436.23
108.00	412.79	-77.46	89.61	-402.94	0.53	2.36	1901.50	3484.87
109.00	404.78	-76.80	92.43	-394.09	0.56	2.41	1772.70	3511.91
111.00	389.55	-75.14	99.91	-376.52	0.66	2.48	1518.81	3557.62
112.00	381.81	-74.15	104.26	-367.29	0.72	2.52	1398.14	3580.38
114.00	367.85	-71.60	116.09	-349.04	0.86	2.58	1165.51	3601.36
115.00	360.85	-70.05	123.12	-339.20	0.95	2.61	1057.62	3605.14
117.00	351.07	-65.62	144.91	-319.76	1.18	2.59	850.52	3529.28
118.00	350.27	-62.87	159.71	-311.74	1.30	2.54	768.21	3427.08
120.00	365.52	-57.82	194.67	-309.37	1.46	2.32	686.31	3071.11
121.00	376.85	-56.31	209.02	-313.57	1.47	2.21	679.43	2904.29
123.00	396.64	-54.57	229.92	-323.20	1.46	2.05	684.23	2658.25
124.00	407.54	-53.63	241.68	-328.14	1.46	1.98	687.21	2535.86
126.00	429.04	-52.97	258.36	-342.53	1.40	1.86	712.47	2350.42
127.00	438.81	-52.46	267.37	-347.94	1.39	1.81	720.16	2264.52
129.00	463.49	-52.10	284.72	-365.73	1.33	1.70	754.50	2100.41
130.00	473.65	-52.27	289.85	-374.61	1.29	1.67	774.01	2044.26
132.00	500.48	-51.76	309.77	-393.09	1.24	1.57	808.61	1892.23
133.00	519.99	-52.03	319.94	-409.91	1.18	1.52	845.13	1814.14
135.00	562.53	-53.97	330.90	-454.91	1.05	1.44	956.30	1694.82
136.00	584.05	-55.81	328.23	-483.10	0.96	1.42	1039.27	1657.35
138.00	609.86	-61.32	292.72	-535.02	0.79	1.44	1270.61	1659.01
139.00	609.72	-64.06	266.68	-548.31	0.72	1.47	1394.07	1688.76
141.00	591.69	-68.21	219.67	-549.41	0.63	1.57	1593.80	1771.34
142.00	583.75	-69.38	205.54	-546.37	0.60	1.60	1657.91	1797.07
144.00	570.00	-71.80	178.07	-541.47	0.55	1.67	1824.56	1841.96
145.00	561.99	-72.71	167.03	-536.59	0.53	1.70	1890.82	1864.84
147.00	547.38	-73.87	152.09	-525.83	0.51	1.75	1970.07	1900.05
148.00	544.90	-74.24	147.99	-524.42	0.50	1.77	2006.40	1899.34
150.00	543.78	-76.05	131.08	-527.75	0.44	1.78	2255.87	1893.66
151.00	539.10	-77.29	118.57	-525.90	0.41	1.81	2451.16	1907.24
153.00	524.11	-79.25	97.79	-514.91	0.36	1.87	2808.91	1949.89

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120 kHz-H

Array:



Power rating: 200 Wrms @ 2% duty cycle
10 x 57 mm (2.24") PZT
Active Area: 5.9 cm²
Layered Plastic Urethane Window

Beamwidth:

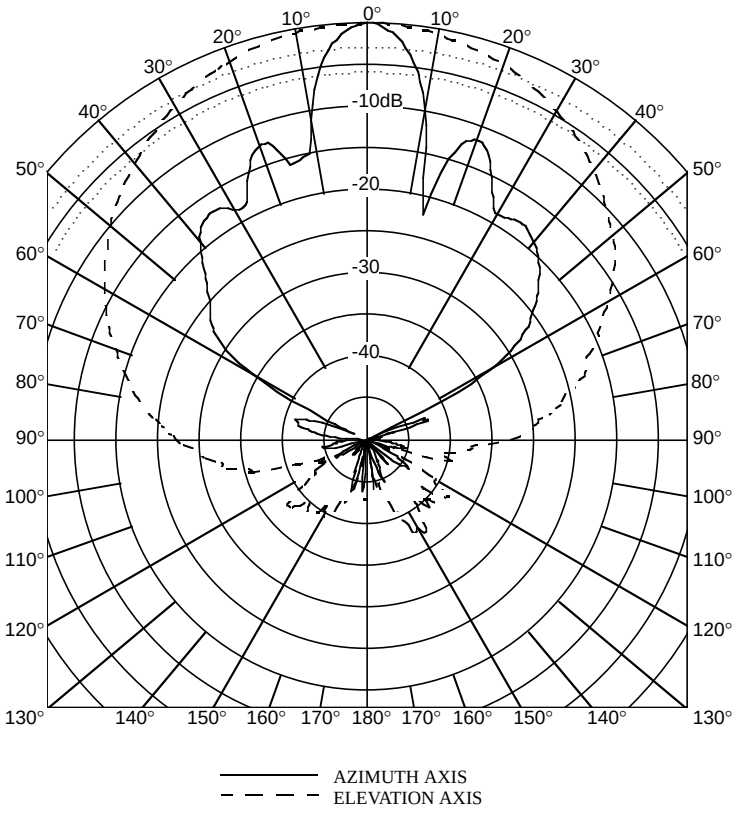
-3 dB:	11° x 52°
-6 dB:	16° x 72°
-10 dB:	19° x 95°

Directivity Index:	17.5
Frequency Tolerance:	±3 kHz
Peak TVR(1), nominal:	156 dB
Peak TVR(1), minimum:	154 dB
Q (transmit):	14
Peak Source Level(4):	207 dB
Peak RVR(2), nominal:	-181 dB
Peak Figure of Merit(3):	-26 dB

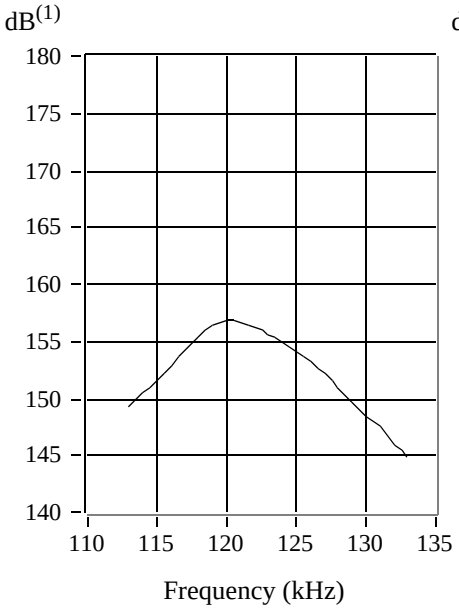
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

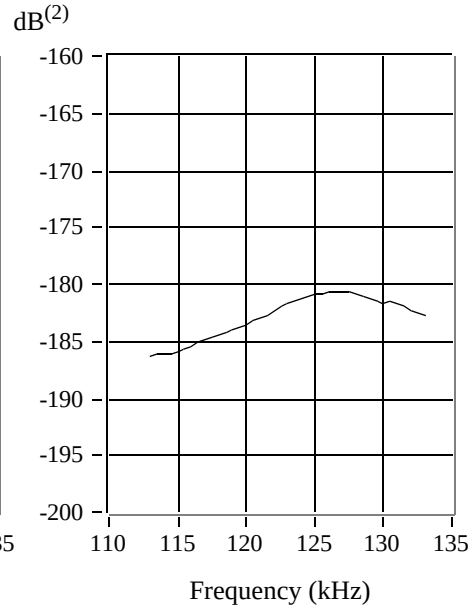
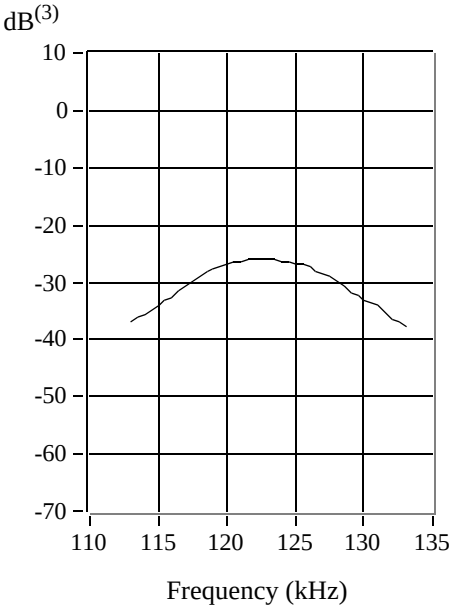


Figure of Merit



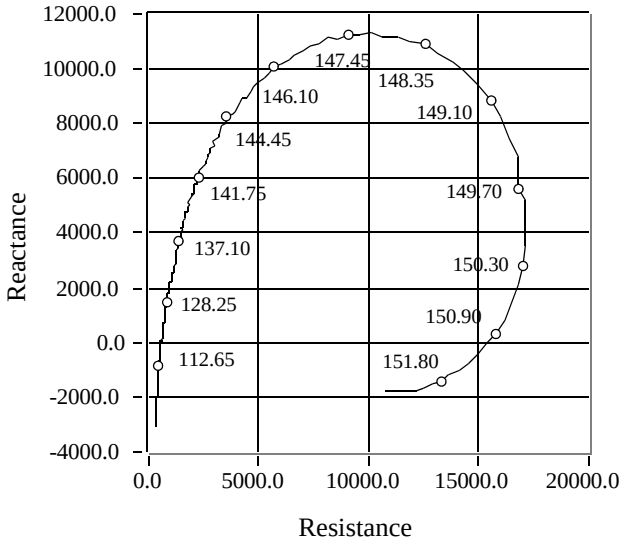
120 kHz-H

10x57mm (2.24") PZT

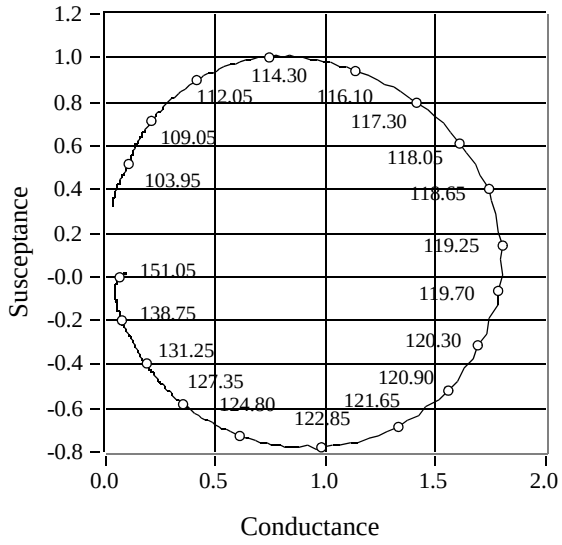
Cable Type: Test Cable
Cable Length: 2.4m (8.0')

Impedance Data	
	Unbalanced
Parallel: Rp.	560 ohms -20%, +40%
Parallel: Cp. (nominal)	40 pF
Series [R – jX] (nominal)	560 – j10 ohms
1 kHz Capacitance	420 pF ±20%

Unbalanced Impedance

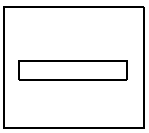


Unbalanced Admittance



120 kHz-H

Array:



Power rating: 200 W
10x57mm (2.24") PZT
Active Area: 5.9cm^2
Urethane Window

Beamwidth:

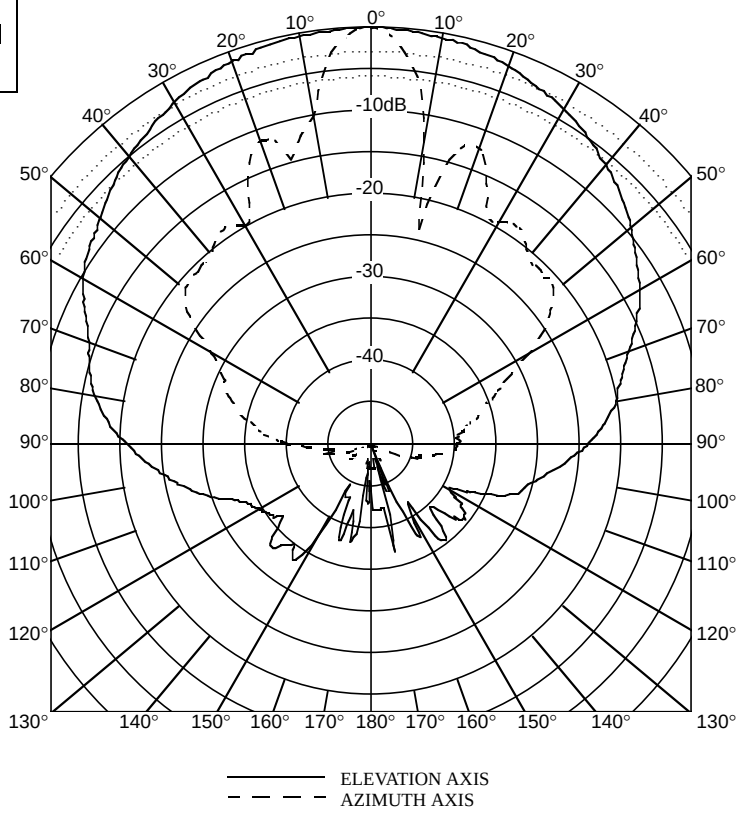
-3dB:	11° x 57°
-6dB:	15° x 82°
-10dB:	19° x 110°

Directivity Index:	17.5
Frequency Tolerance:	±3kHz
Peak TVR(1), nominal:	158dB
Peak TVR(1), minimum:	156dB
Q (transmit):	15
Peak Source Level(4):	208dB
Peak RVR(2), nominal:	-177dB
Peak Figure of Merit(3):	-23dB

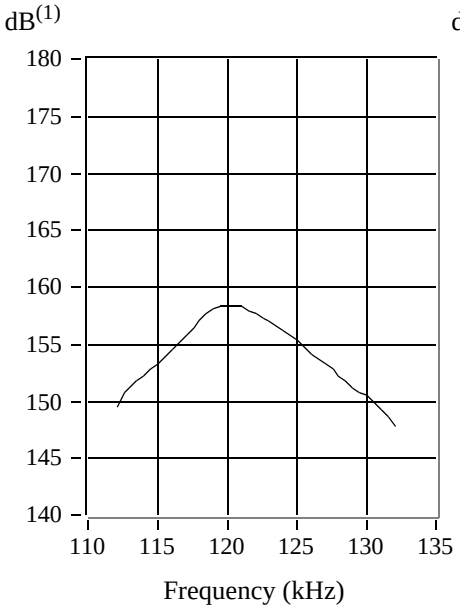
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

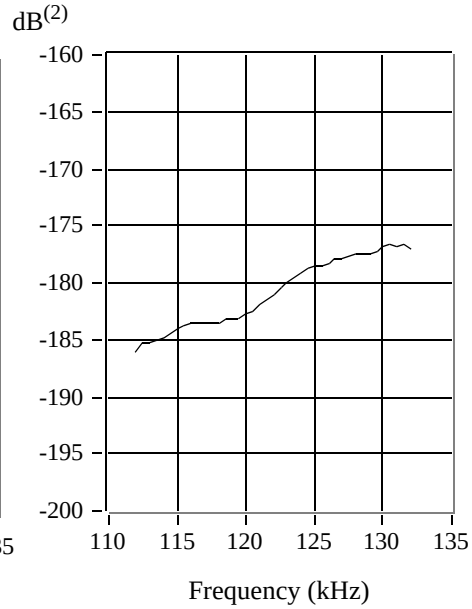
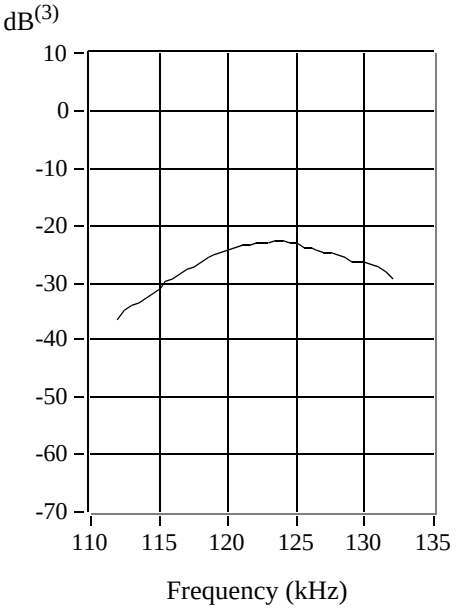


Figure of Merit



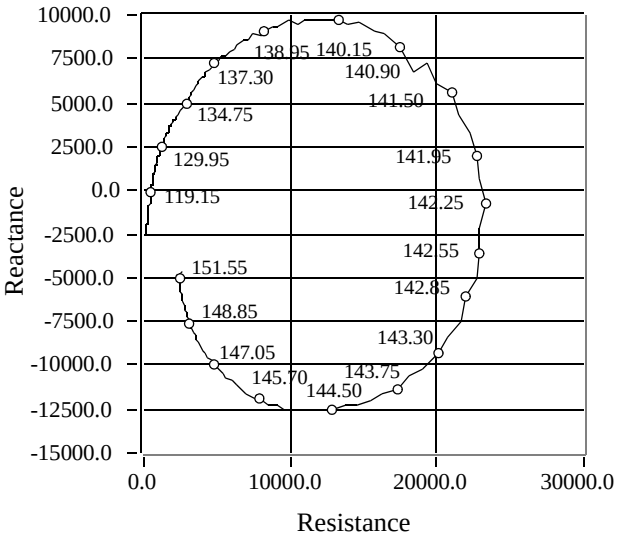
120 kHz-H

10x57mm (2.24") PZT

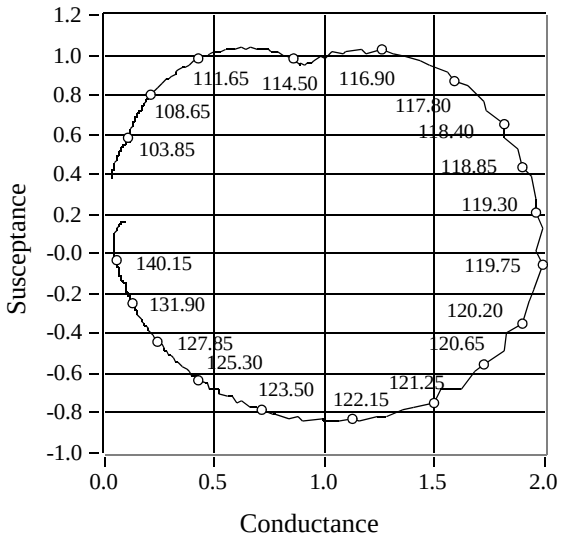
Cable Type: Test Cable
Cable Length: 1.5m (5.0')

Impedance Data	
	Unbalanced
Parallel: Rp.	500 ohms -20%, +40%
Parallel: Cp. (nominal)	110 pF
Series [R – jX] (nominal)	500 – j20 ohms
1 kHz Capacitance	530 pF ±20%

Unbalanced Impedance

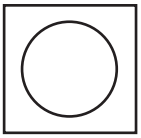


Unbalanced Admittance



120 kHz-T

Array

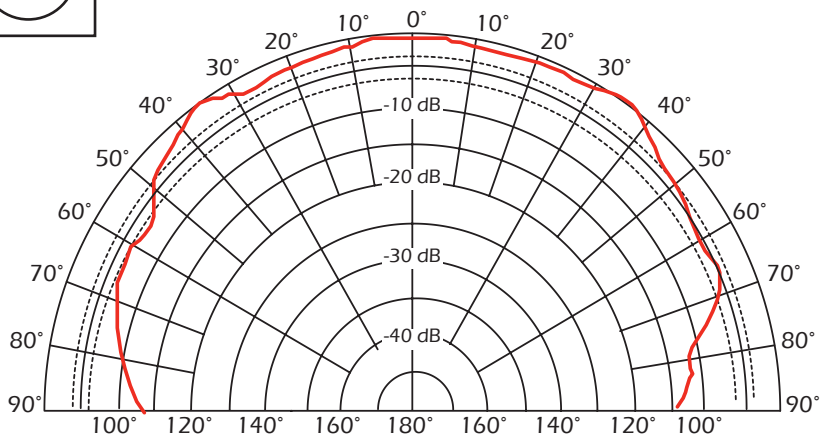


Power Rating: 85 W @ 1% duty cycle
19 mm (0.75") PZT
Active Area: 2.8 cm^2
HPC Window

Beamwidth:
-3 dB: 90°
-6 dB: 120°
-10 dB: 157°

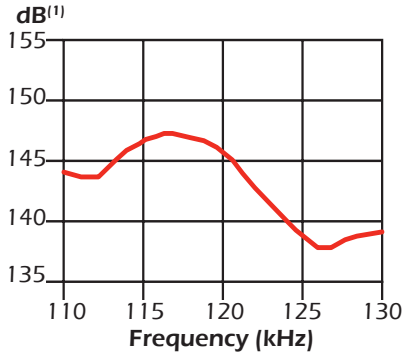
Directivity Index:	6.5
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	147 dB
Peak TVR(1), minimum:	144 dB
Q (transmit):	12
Peak Source Level(4):	192 dB
Peak RVR(2), nominal:	-195.1 dB
Peak Figure of Merit(3):	-48.0 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

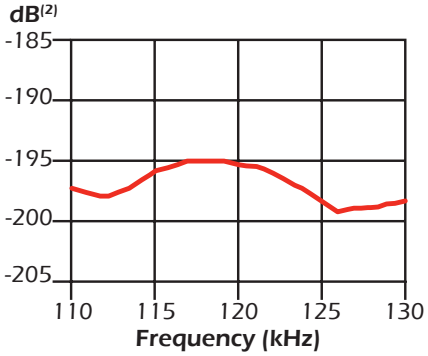
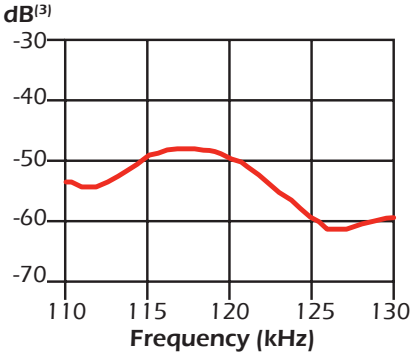


Figure of Merit



120 kHz-T

19 mm (0.75”) PZT

Cable Type: C189-02
Cable Length: 3m (10’)

Note:
Impedance data includes cable

Impedance Data	
	Unbalanced
Parallel: Rp.	700 Ω: -20%, +40%
Parallel: Cp. (nominal)	600pF
Series [R - jX]: (nominal)	580+ j150 Ω
1 kHz capacitance: (nominal)	1000pF: ±20%

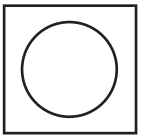
Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
110.00	790.11	-71.69	248.17	-750.12	0.40	1.20	2515.49	1738.55
111.00	735.67	-70.14	249.96	-691.90	0.46	1.28	2165.16	1833.05
112.00	680.54	-67.29	262.74	-627.78	0.57	1.36	1762.73	1926.20
113.00	631.38	-63.34	283.35	-564.23	0.71	1.42	1406.90	1993.50
114.00	588.18	-57.64	314.79	-496.85	0.91	1.44	1099.00	2005.03
115.00	566.96	-50.88	357.69	-439.89	1.11	1.37	898.67	1893.92
116.00	559.51	-44.64	398.11	-393.13	1.27	1.26	786.33	1723.03
117.00	549.34	-37.31	436.91	-333.00	1.45	1.10	690.71	1501.03
118.00	564.99	-30.38	487.42	-285.72	1.53	0.90	654.91	1207.24
119.00	574.34	-23.50	526.68	-229.05	1.60	0.69	626.30	928.71
120.00	601.35	-14.28	582.77	-148.32	1.61	0.41	620.52	544.00
121.00	684.66	-6.57	680.17	-78.30	1.45	0.17	689.18	219.71
122.00	782.95	-1.67	782.62	-22.81	1.28	0.04	783.28	48.54
123.00	918.62	0.90	918.50	14.51	1.09	-0.02	918.73	-22.25
124.00	1069.33	-0.35	1069.31	-6.48	0.94	0.01	1069.35	7.28
125.00	1170.95	-4.35	1167.57	-88.88	0.85	0.06	1174.34	82.53
126.00	1179.51	-7.47	1169.51	-153.27	0.84	0.11	1189.60	139.16
127.00	1164.24	-6.08	1157.69	-123.32	0.85	0.09	1170.83	114.01
128.00	1200.47	-1.69	1199.95	-35.37	0.83	0.02	1200.99	30.52
129.00	1297.74	1.89	1297.03	42.83	0.77	-0.03	1298.45	-31.38
130.00	1437.72	5.39	1431.37	134.96	0.69	-0.07	1444.10	-79.94

120 kHz-Ylq

Transformed to 120 ohms
Power Rating: 300 W rms @ 1% duty cycle
33.2 mm (1.30") PZT
Active Area: 8.56 cm² (1.33 in²)
Radiating Surface: Urethane

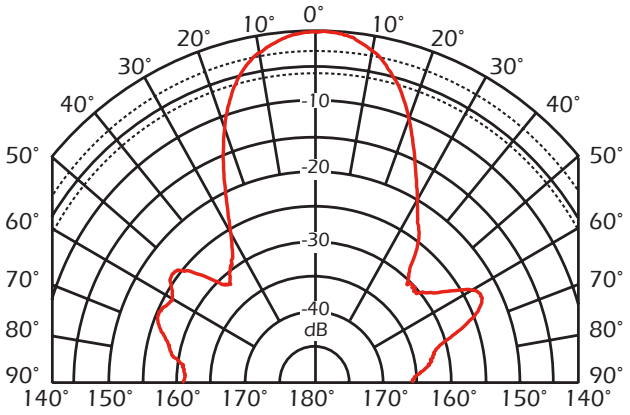
Array



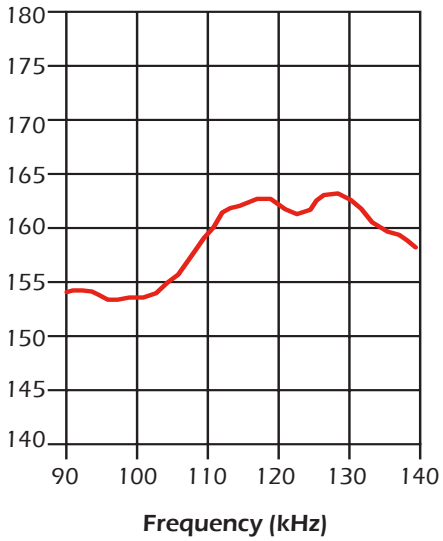
Beamwidth:
-3 dB: 23°
-6 dB: 31°
-10 dB: 39°

Directivity Index:	17.8
Frequency Tolerance:	+/-10kHz
Peak TVR(1), nominal:	163 dB
Peak TVR(1), minimum:	161 dB
Q (transmit):	5.3
Peak Source Level(4):	209 dB
Peak RVR(2), nominal:	-185.5 dB
Peak Figure of Merit(3):	-26.3 dB

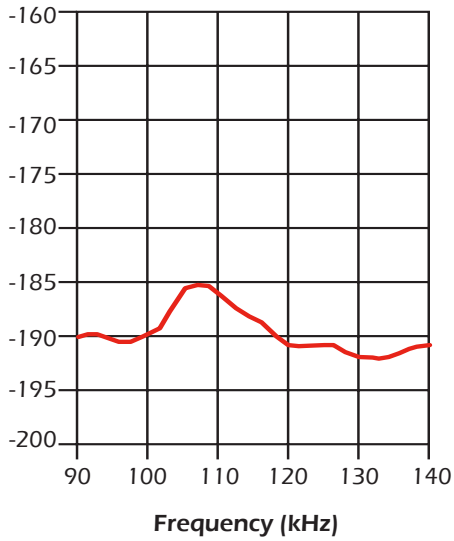
Transmit Radiation Pattern



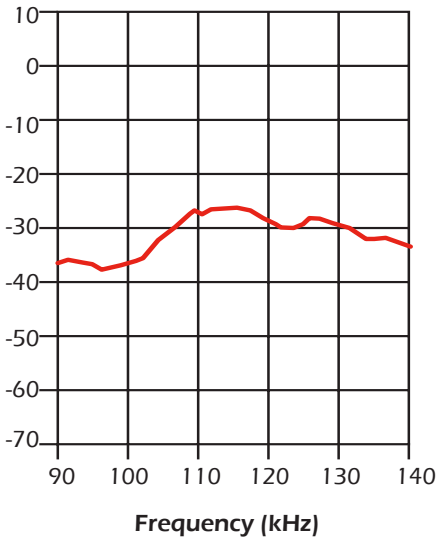
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

120kHz-Ylq

33.2 mm (1.30”) PZT

Cable Type: C-2
Cable Length: 0.3m (1’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	120 Ω: -20%, +40%	120 Ω: -20%, +40%
Parallel: Cp. (nominal)	N/A	N/A
Series [R - jX]: (nominal)	120+j30 Ω	120+j20 Ω
1 kHz capacitance: (nominal)	N/A	N/A

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
90.00	259.69	68.53	95.07	241.66	1.41	-3.58	709.37	-6336.98
92.00	268.40	63.47	119.87	240.14	1.66	-3.33	600.94	-5766.87
94.00	271.73	60.04	135.70	235.42	1.84	-3.19	544.13	-5398.43
96.00	278.62	57.76	148.62	235.67	1.91	-3.04	522.31	-5033.09
98.00	293.99	56.40	162.69	244.87	1.88	-2.83	531.26	-4601.21
100.00	323.38	54.02	189.97	261.69	1.82	-2.50	550.45	-3982.85
102.00	365.32	48.56	241.80	273.85	1.81	-2.05	551.95	-3201.69
104.00	415.31	38.34	325.73	257.65	1.89	-1.49	529.53	-2286.01
106.00	438.41	21.66	407.45	161.81	2.12	-0.84	471.71	-1264.03
108.00	384.46	3.08	383.91	20.63	2.60	-0.14	385.02	-205.68
110.00	291.58	-8.08	288.69	-40.97	3.40	0.48	294.50	697.29
112.00	216.25	-9.67	213.18	-36.33	4.56	0.78	219.37	1103.85
113.00	190.14	-7.58	188.48	-25.09	5.21	0.69	191.82	977.53
114.00	173.73	-3.85	173.34	-11.67	5.74	0.39	174.12	539.93
115.00	164.58	-0.70	164.56	-2.00	6.08	0.07	164.59	102.18
116.00	158.08	0.80	158.06	2.20	6.33	-0.09	158.10	-120.60
117.00	145.75	1.38	145.71	3.50	6.86	-0.16	145.79	-224.37
118.00	131.59	5.28	131.04	12.10	7.57	-0.70	132.15	-942.59
119.00	123.30	11.89	120.65	25.40	7.94	-1.67	126.00	-2234.64
120.00	124.18	19.08	117.36	40.60	7.61	-2.63	131.40	-3491.73
121.00	130.41	23.71	119.40	52.44	7.02	-3.08	142.43	-4055.56
122.00	138.78	25.58	125.18	59.92	6.50	-3.11	153.86	-4058.08
123.00	144.32	24.98	130.83	60.94	6.28	-2.93	159.21	-3785.61
124.00	145.18	23.30	133.34	57.44	6.33	-2.73	158.08	-3497.52
125.00	139.59	21.72	129.68	51.67	6.65	-2.65	150.27	-3376.05
126.00	130.49	22.22	120.80	49.34	7.09	-2.90	140.95	-3660.04
128.00	114.67	29.94	99.36	57.24	7.56	-4.35	132.33	-5412.65
130.00	113.72	42.14	84.33	76.30	6.52	-5.90	153.36	-7222.55
132.00	124.89	52.32	76.33	98.85	4.89	-6.34	204.33	-7641.02
134.00	143.15	59.00	73.73	122.70	3.60	-5.99	277.93	-7111.82
136.00	165.51	62.81	75.62	147.22	2.76	-5.37	362.24	-6289.49
138.00	190.47	65.09	80.24	172.75	2.21	-4.76	452.17	-5491.51
140.00	222.05	66.38	88.96	203.45	1.80	-4.13	554.25	-4690.79

150 kHz-A

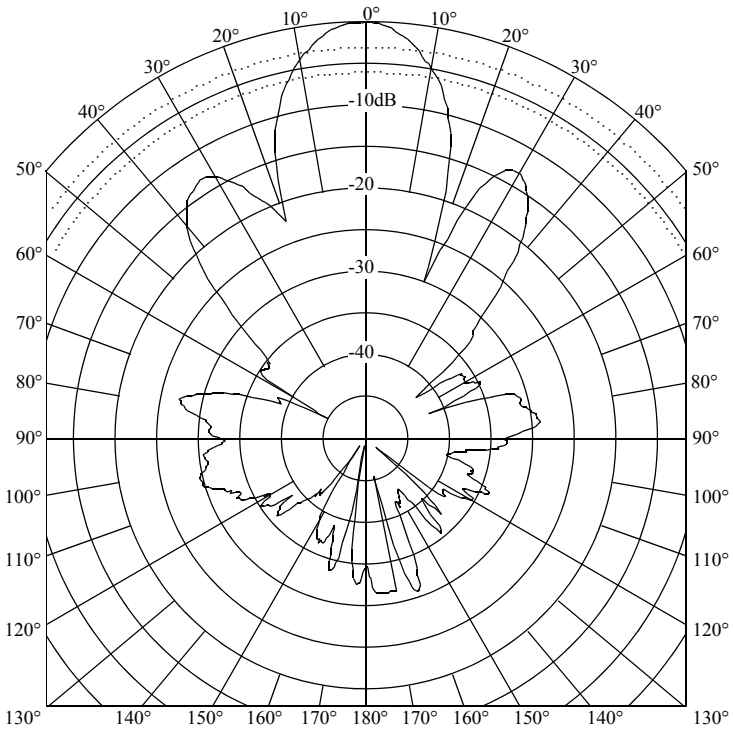
Power rating: 200 Wrms @ 2% duty cycle
27 mm (1.08") PZT
Active Area: 5.5 cm²
Layered Plastic Epoxy Window

Beamwidth:
-3 dB: 16°
-6 dB: 23°
-10 dB: 29°

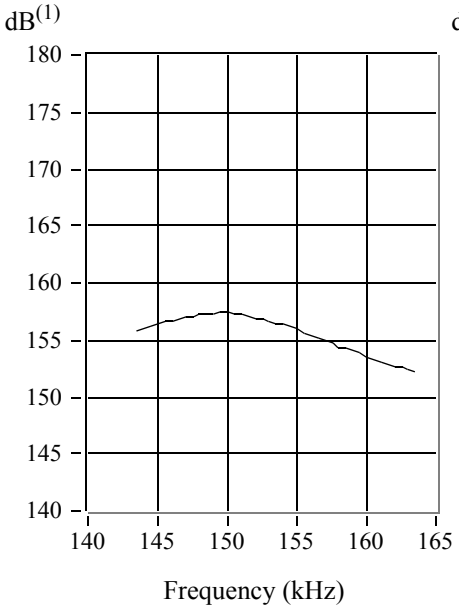
Directivity Index:	18.9
Frequency Tolerance:	±4 kHz
Peak TVR (1), nominal:	157 dB
Peak TVR (1), minimum:	155 dB
Q (transmit):	9
Peak Source Level (4):	210 dB
Peak RVR (2), nominal:	-185 dB
Peak Figure of Merit (3):	-28 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

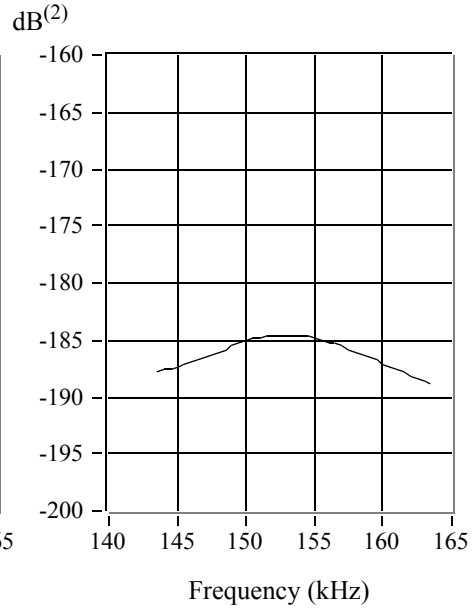
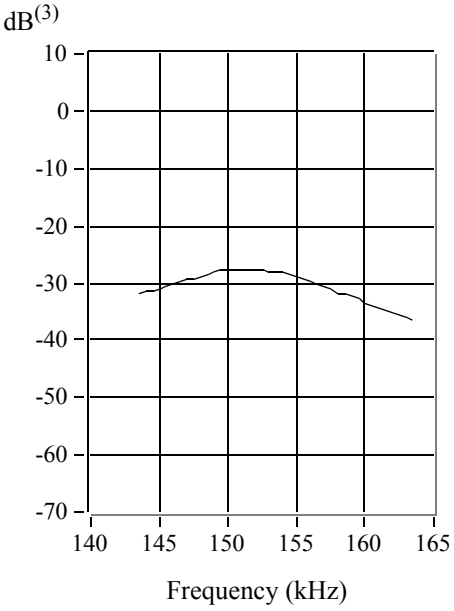


Figure of Merit

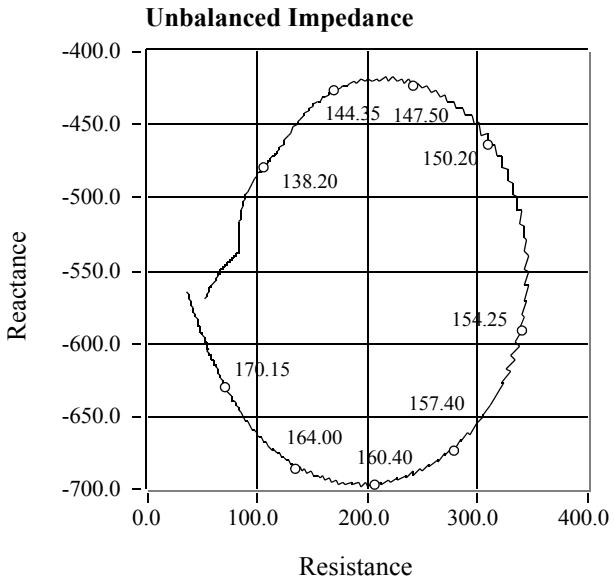


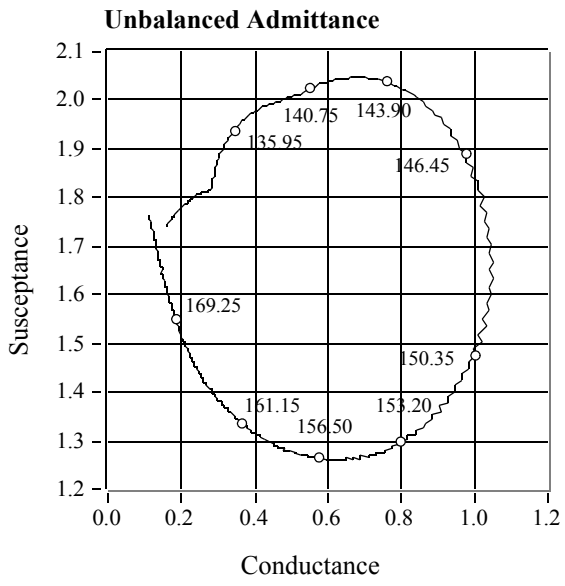
150 kHz-A

27mm (1.08") PZT

Cable Type: C2
Cable Length: 9.1 m (30.0')

Impedance Data	
	Unbalanced
Parallel: Rp.	960 ohms -20%, +40%
Parallel: Cp. (nominal)	1760 pF
Series [R – jX] (nominal)	280 – j440 ohms
1 kHz Capacitance	2100 pF ±20%





150 kHz-A

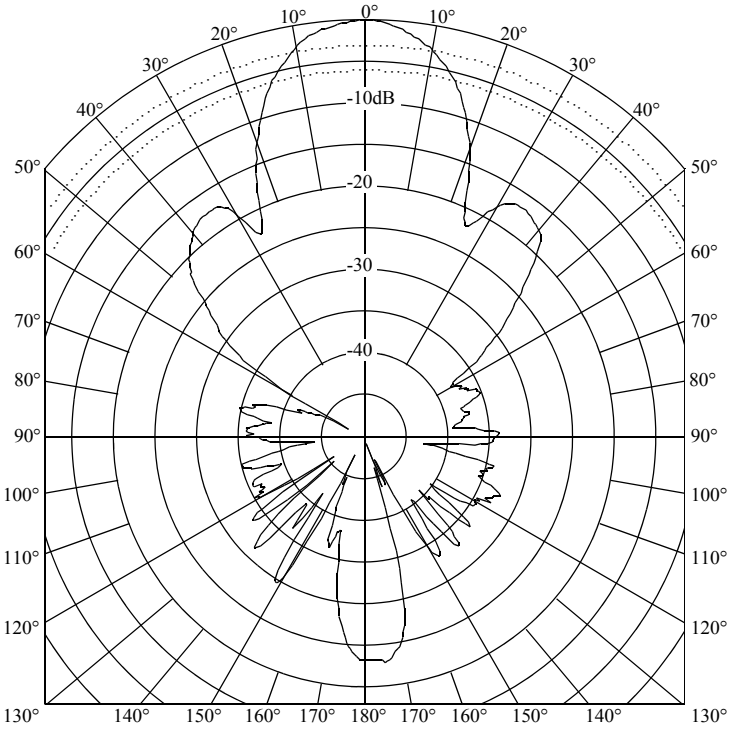
Power rating: 200 Wrms @ 2% duty cycle
27 mm (1.08") PZT
Active Area: 5.5 cm²
Layered Plastic Urethane Window

Beamwidth:
-3 dB: 20°
-6 dB: 29°
-10 dB: 36°

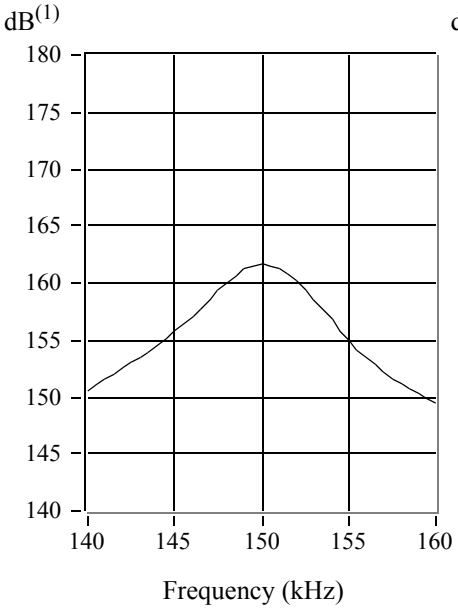
Directivity Index:	18.9
Frequency Tolerance:	±4 kHz
Peak TVR(1), nominal:	161 dB
Peak TVR(1), minimum:	159 dB
Q (transmit):	26
Peak Source Level(4):	209dB
Peak RVR(2), nominal:	-182 dB
Peak Figure of Merit(3):	-24 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

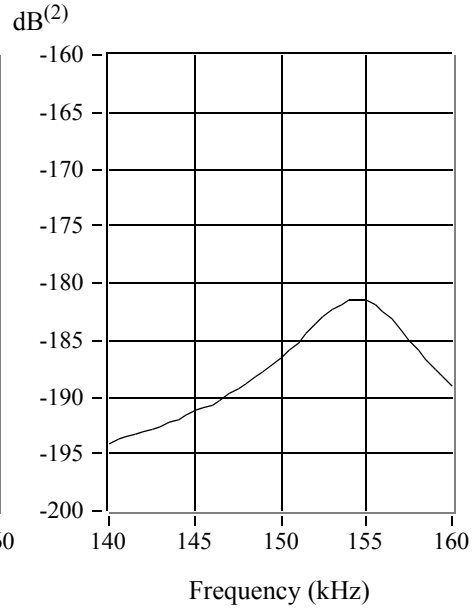
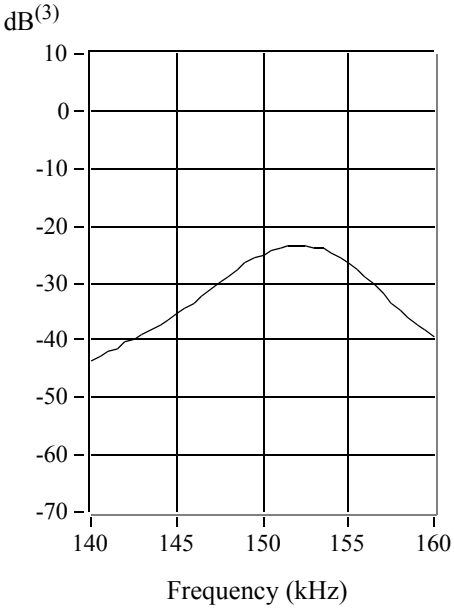


Figure of Merit



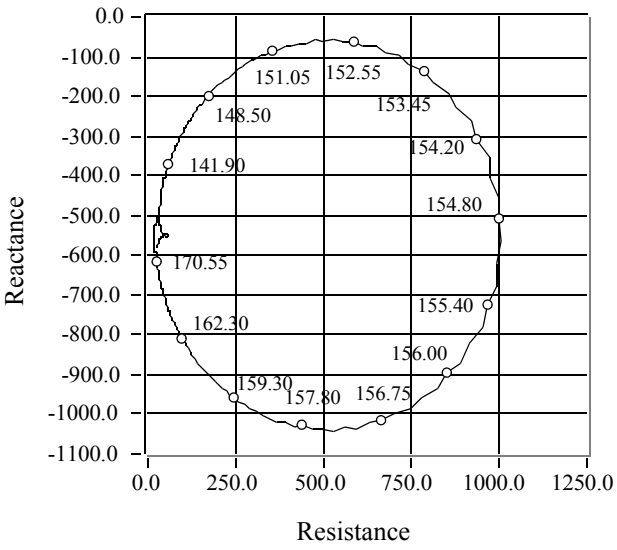
150 kHz-A

27mm (1.08") PZT

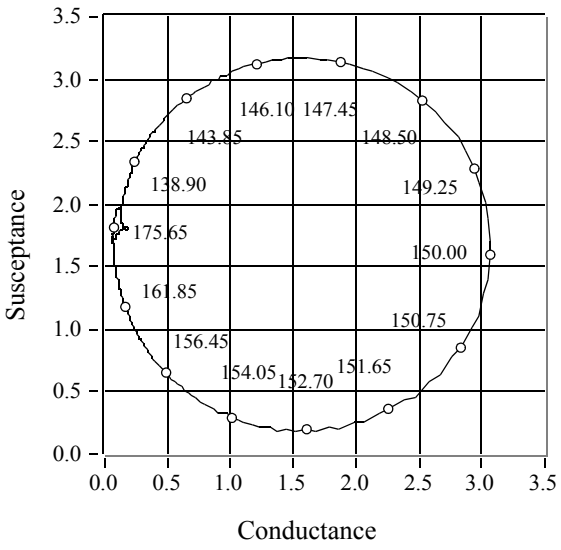
Cable Type: C2
Cable Length: 9.1 m (30.0')

Impedance Data	
	Unbalanced
Parallel: Rp.	330 ohms -20%, +40%
Parallel: Cp. (nominal)	1660 pF
Series [R – jX] (nominal)	260 – j 130 ohms
1 kHz Capacitance	2130 pF ±20%

Unbalanced Impedance



Unbalanced Admittance



150 kHz-A

Power rating: 200 Wrms @ 2% duty cycle
27 mm (1.08") PZT
Active Area: 5.5 cm²
Urethane Window

Beamwidth:

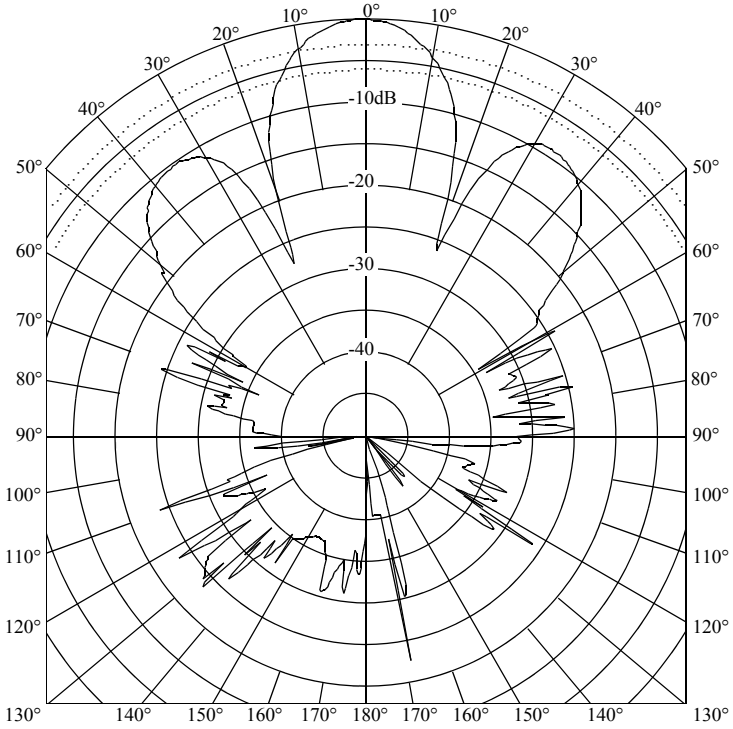
-3 dB:	19°
-6 dB:	26°
-10 dB:	32°

Directivity Index:	18.9
Frequency Tolerance:	±3 kHz
Peak TVR(1), nominal:	160 dB
Peak TVR(1), minimum:	158 dB
Q (transmit):	23
Peak Source Level(4):	209 dB
Peak RVR(2), nominal:	-185 dB
Peak Figure of Merit(3):	-27 dB

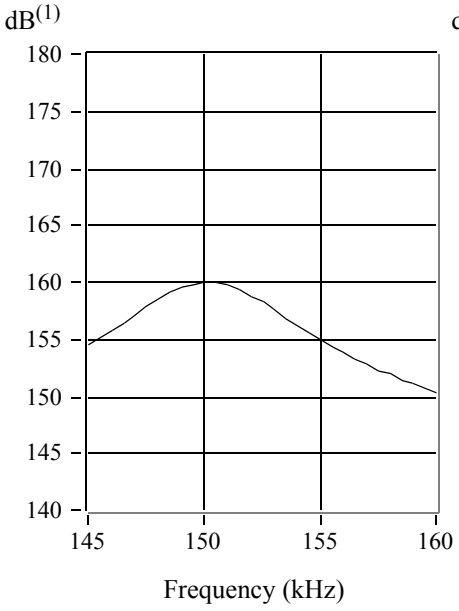
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

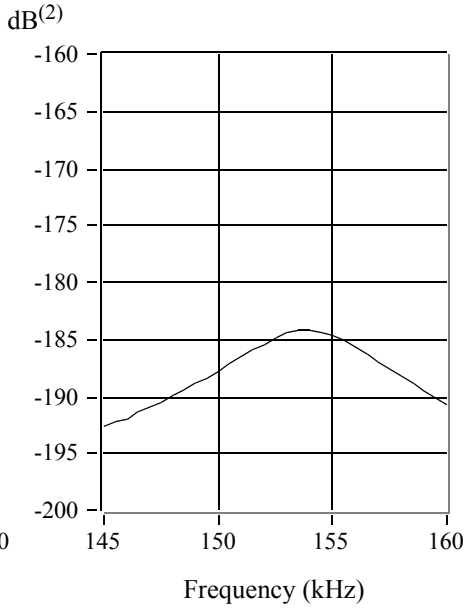
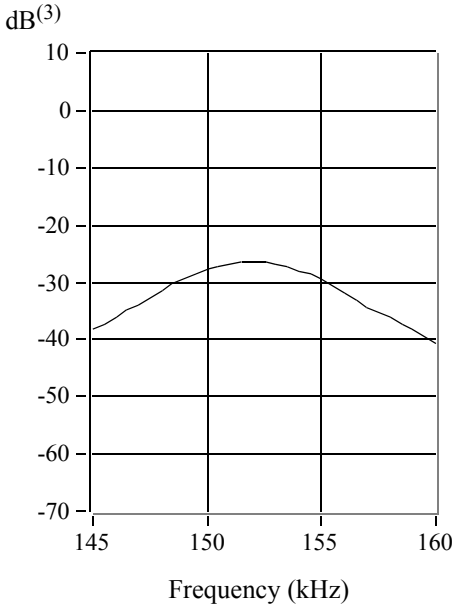


Figure of Merit



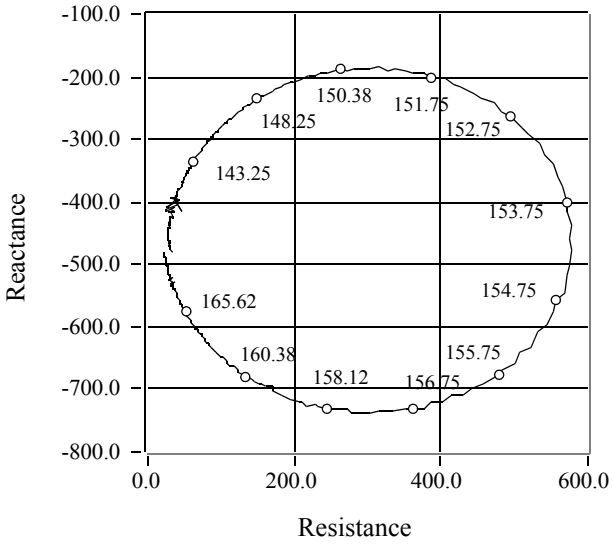
150 kHz-A

27mm (1.08") PZT

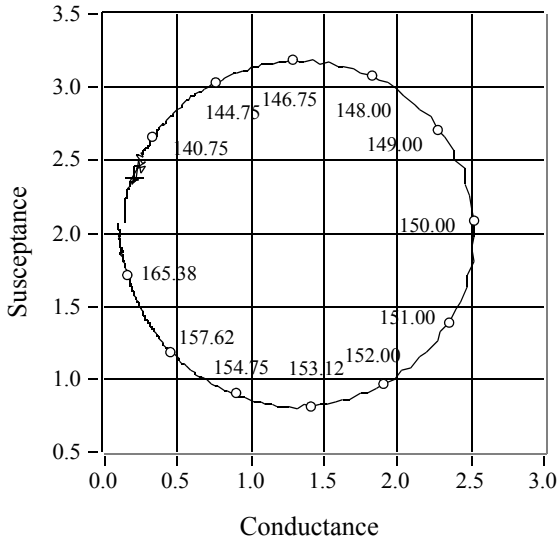
Cable Type: C-144
Cable Length: 9.1 m (30.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	400 ohms -20%, +40%	400 ohms -20%, +40%
Parallel: Cp. (nominal)	550 pF	2190 pF
Series [R – jX] (nominal)	380 – j80 ohms	240 – j190 ohms
1 kHz Capacitance	700 pF ±20%	2430 pF ±20%

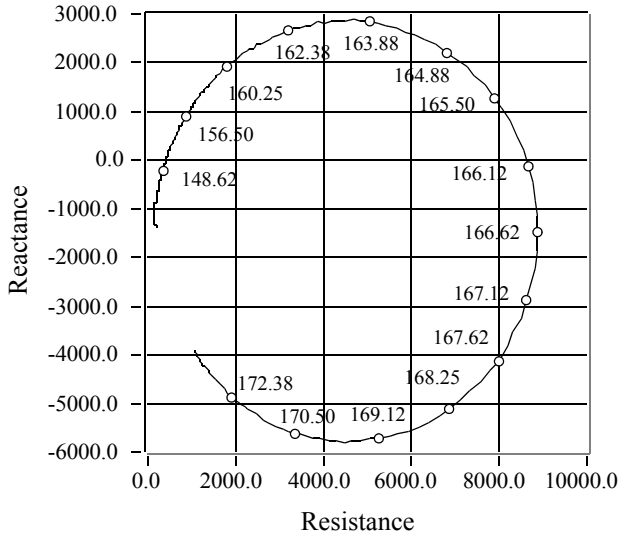
Unbalanced Impedance



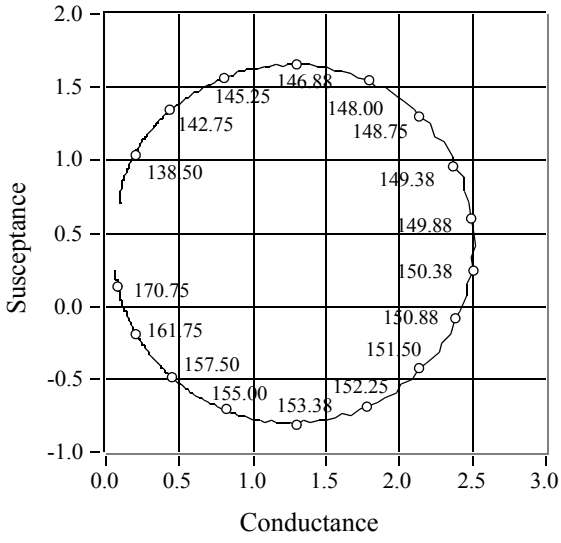
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



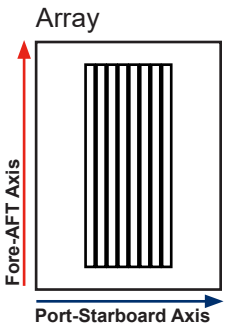
165 kHz-A

Ceramics Wired in Parallel

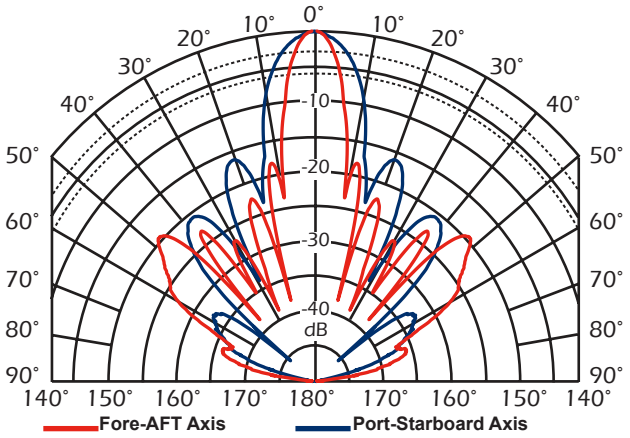
Power Rating: 1 kW rms @ 1% duty cycle
73.7 mm x 31.3 mm
(2.90" x 1.23") PZT
Active Area: 23.04 cm^2 (3.57 in^2)
Radiating Surface: Urethane

Beamwidth: (F-A) / (P-S)
-3 dB: 6° / 12°
-6 dB: 9° / 17°
-10 dB: 11° / 21°

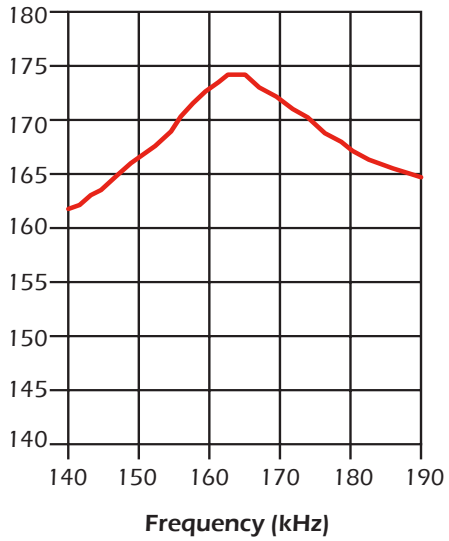
Directivity Index:	25.7
Frequency Tolerance:	+/-5kHz
Peak TVR(1), nominal:	174.3 dB
Peak TVR(1), minimum:	172.3 dB
Q (transmit):	12
Peak Source Level(4):	221.9 dB
Peak RVR(2), nominal:	-188.2 dB
Peak Figure of Merit(3):	-15.6 dB



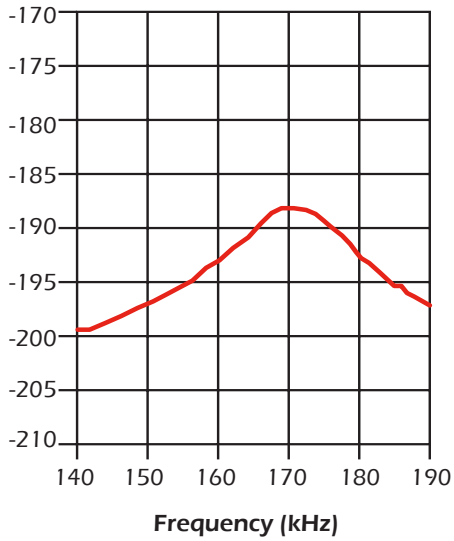
Transmit Radiation Pattern



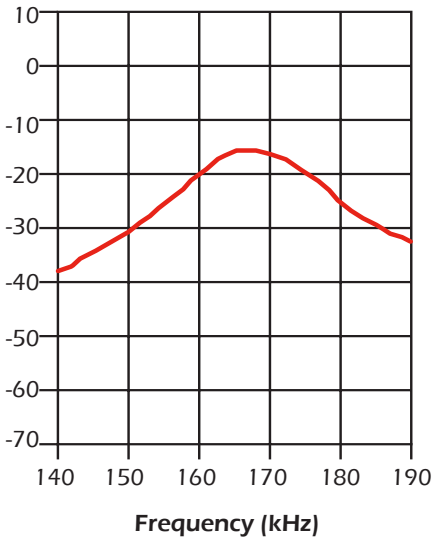
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

165 kHz-A

73.7 mm x 31.3 (2.90” x 1.23”) PZT

Cable Type: C19
Cable Length: 10m (33’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	66 Ω: -+/- 30%	66 Ω: -+/- 30%
Parallel: Cp. (nominal)	1,750 pF	13,790 pF
Series [R - jX]: (nominal)	50-j10 Ω	30-j30 Ω
1 kHz capacitance: (nominal)	8,320 pF	23,490 pF

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
140.00	119.71	-78.11	24.67	-117.14	1.72	8.17	580.93	9292.40
142.00	114.14	-77.24	25.22	-111.32	1.94	8.54	516.63	9576.87
144.00	108.61	-75.94	26.39	-105.35	2.24	8.93	446.94	9871.30
146.00	102.14	-74.69	26.97	-98.52	2.59	9.44	386.81	10293.50
148.00	96.32	-72.76	28.55	-91.99	3.08	9.92	324.96	10662.90
150.00	89.22	-70.71	29.48	-84.21	3.70	10.58	270.00	11224.74
152.00	83.08	-67.67	31.57	-76.84	4.57	11.13	218.61	11658.12
154.00	75.47	-63.72	33.41	-67.67	5.87	11.88	170.48	12278.22
156.00	69.15	-58.87	35.75	-59.20	7.48	12.38	133.77	12629.42
158.00	62.30	-50.72	39.44	-48.22	10.16	12.42	98.40	12515.54
159.00	59.57	-46.52	40.99	-43.23	11.55	12.18	86.58	12192.37
160.00	57.24	-41.93	42.58	-38.25	13.00	11.67	76.94	11612.24
161.00	56.22	-35.58	45.72	-32.71	14.47	10.35	69.12	10232.42
162.00	55.29	-27.61	48.99	-25.62	16.03	8.38	62.39	8235.72
163.00	54.35	-19.26	51.30	-17.93	17.37	6.07	57.57	5927.46
164.00	54.99	-11.89	53.81	-11.33	17.80	3.75	56.19	3637.10
165.00	58.82	-5.46	58.55	-5.59	16.93	1.62	59.08	1559.50
166.00	65.41	2.08	65.37	2.37	15.28	-0.55	65.45	-532.00
167.00	72.26	9.32	71.30	11.71	13.66	-2.24	73.23	-2136.89
168.00	79.67	14.65	77.08	20.16	12.14	-3.18	82.35	-3007.96
169.00	87.46	17.79	83.28	26.73	10.89	-3.49	91.86	-3290.54
170.00	98.30	19.38	92.73	32.62	9.60	-3.38	104.20	-3160.17
171.00	112.56	21.57	104.68	41.38	8.26	-3.27	121.04	-3040.09
172.00	125.50	24.63	114.09	52.30	7.24	-3.32	138.06	-3072.30
174.00	150.95	25.82	135.87	65.76	5.96	-2.89	167.70	-2639.65
176.00	191.74	26.29	171.90	84.94	4.68	-2.31	213.87	-2089.21
178.00	234.60	25.42	211.89	100.71	3.85	-1.83	259.75	-1636.00
180.00	293.45	19.73	276.22	99.06	3.21	-1.15	311.75	-1017.12
182.00	352.62	14.98	340.64	91.15	2.74	-0.73	365.03	-641.01
184.00	413.69	4.92	412.17	35.51	2.41	-0.21	415.23	-179.45
186.00	470.23	-4.39	468.85	-36.02	2.12	0.16	471.62	139.39
188.00	494.17	-14.32	478.82	-122.20	1.96	0.50	510.01	423.62
190.00	531.81	-24.39	484.37	-219.57	1.71	0.78	583.90	650.33

170 kHz-A

Power rating: 500 Wrms @ 2% duty cycle
51 mm (2.0") PZT
Active Area: 20 cm²
Layered Plastic Epoxy Window

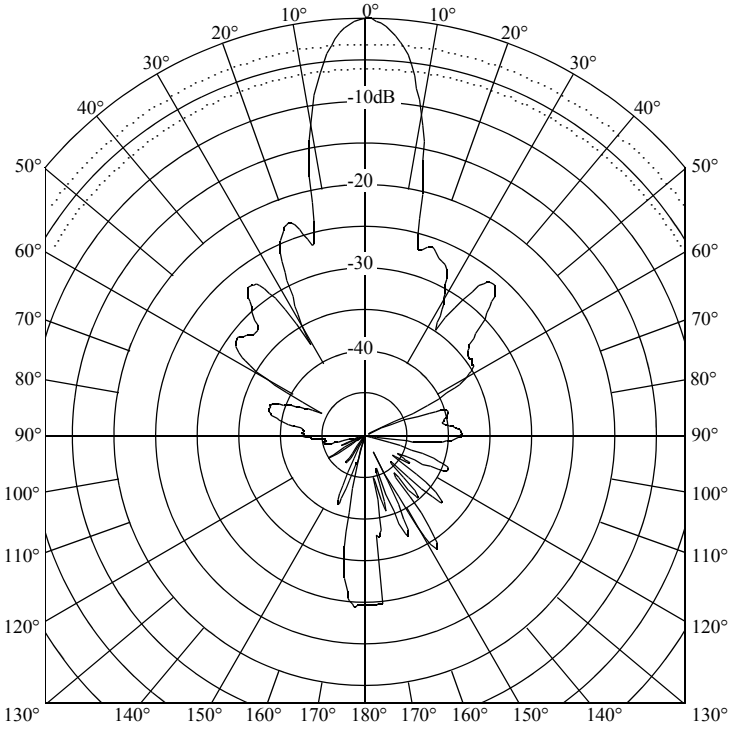
Beamwidth:

-3dB:	10°
-6dB:	14°
-10dB:	18°

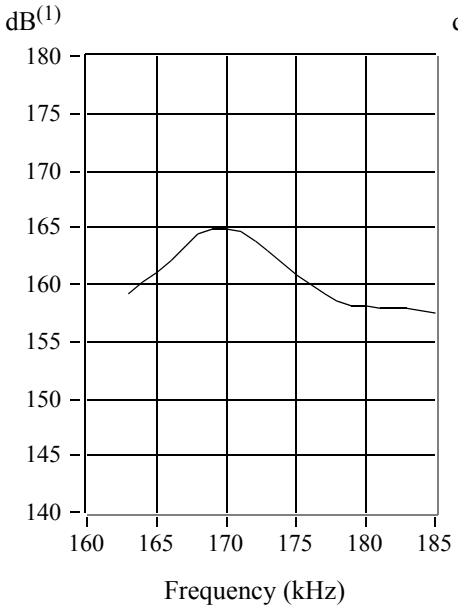
Directivity Index:	25.4
Frequency Tolerance:	±4 kHz
Peak TVR(1), nominal:	164 dB
Peak TVR(1), minimum:	162 dB
Q (transmit):	21
Peak Source Level(4):	218 dB
Peak RVR(2), nominal:	-180 dB
Peak Figure of Merit(3):	-16 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

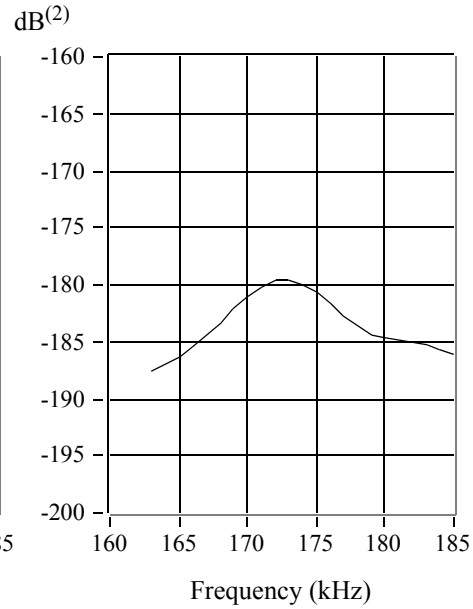
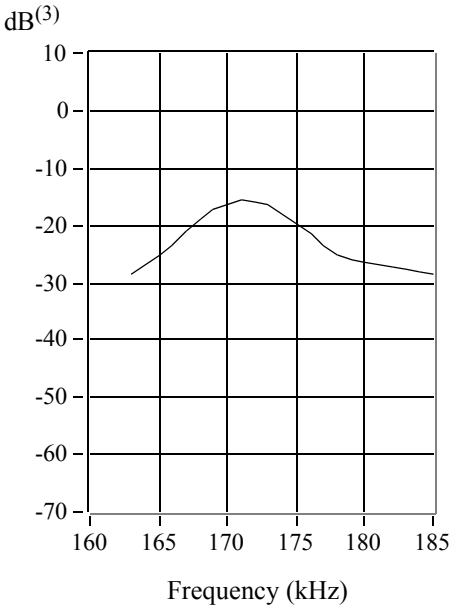


Figure of Merit



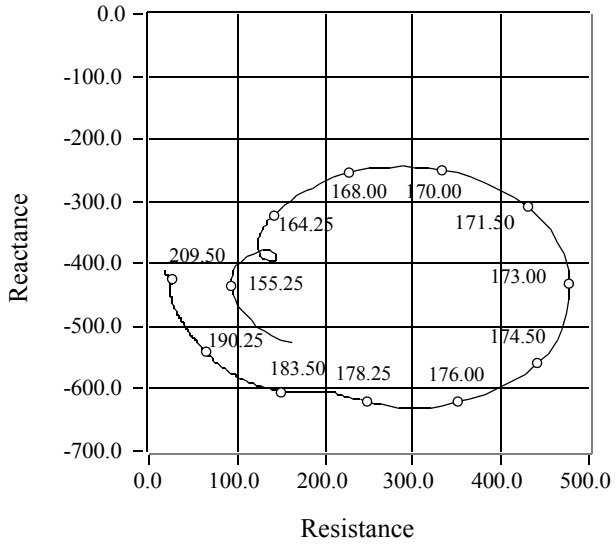
170 kHz-A

51mm (2.0") PZT

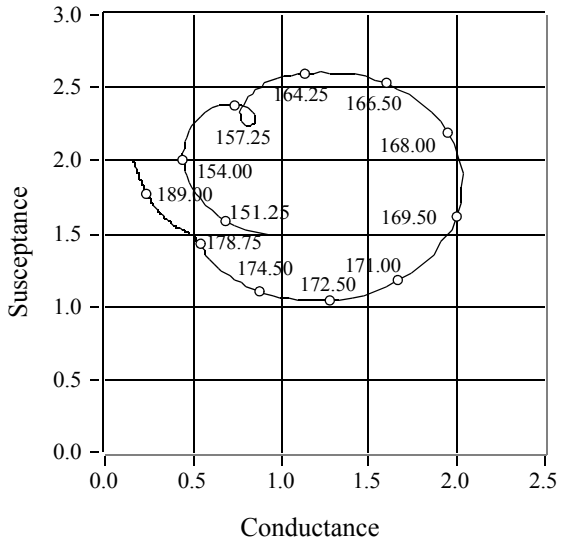
Cable Type: C13
Cable Length: 10.7m (35.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	500ohms-20%,+40%	490ohms-20%,+40%
Parallel: Cp. (nominal)	640pF	1740pF
Series [R – jX] (nominal)	450 – j150 ohms	270 – j240 ohms
1 kHz Capacitance	2030pF±20%	3170pF±20%

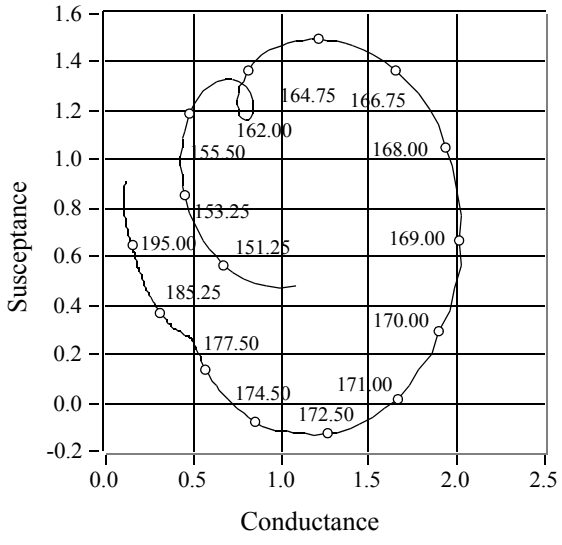
Unbalanced Impedance



Unbalanced Admittance



Balanced Admittance



170 kHz-A

Power rating: 500 Wrms @ 2% duty cycle
51 mm (2.0") PZT
Active Area: 20 cm²
Layered Plastic Urethane Window

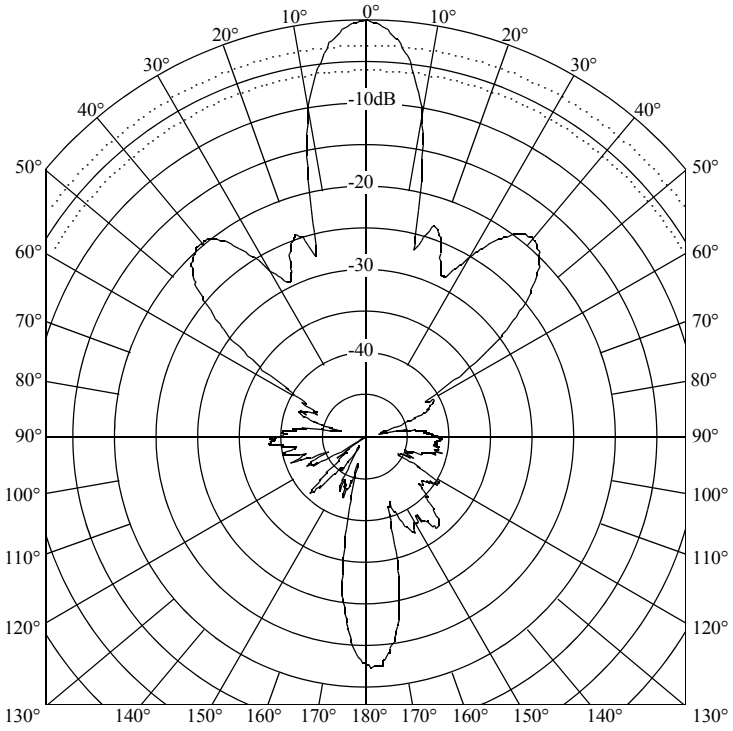
Beamwidth:

-3dB:	11°
-6dB:	15°
-10dB:	19°

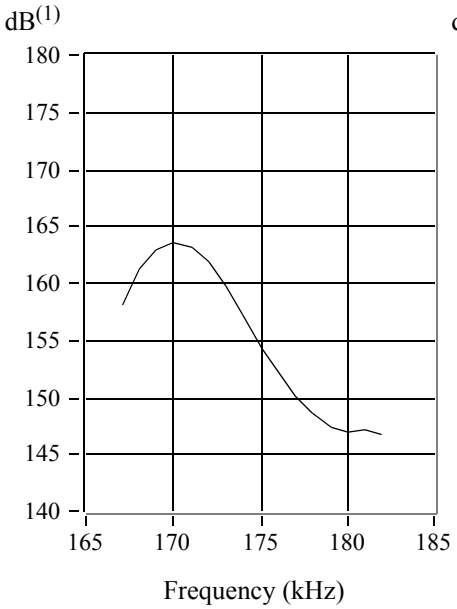
Directivity Index:	25.4
Frequency Tolerance:	±4 kHz
Peak TVR(1), nominal:	163 dB
Peak TVR(1), minimum:	161 dB
Q (transmit):	35
Peak Source Level(4):	215 dB
Peak RVR(2), nominal:	-180 dB
Peak Figure of Merit(3):	-19 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

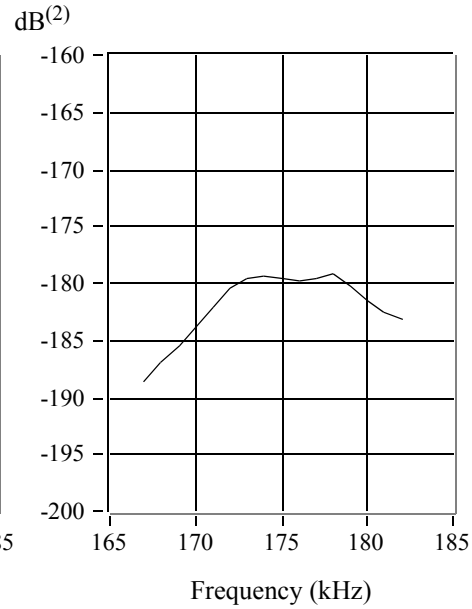
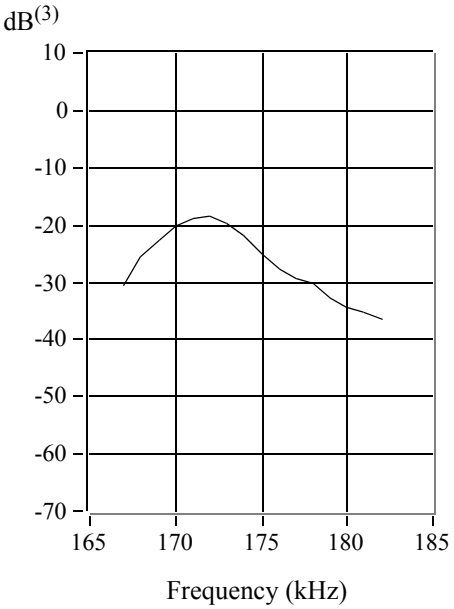


Figure of Merit



170 kHz-A

51mm (2.0") PZT

Cable Type: Test Cable
Cable Length: 3.0m (10.0')

Impedance Data	
	Balanced
Parallel: Rp.	320ohms-20%,+40%
Parallel: Cp. (nominal)	580pF
Series [R – jX] (nominal)	310 – j60 ohms
1 kHz Capacitance	n/a

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (ohms)	Phase Angle (°)	Series Resistance (ohms)	Series Reactance (ohms)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (ohms)	Parallel Capacitance (pF)
165.00	376.35	-49.71	243.38	-287.06	1.7183	2.0267	581.96	1954.90
166.00	319.46	-32.68	268.89	-172.49	2.6348	1.6901	379.54	1620.42
167.00	312.37	-10.89	306.74	-59.03	3.1437	0.6050	318.10	576.53
168.00	361.83	9.90	356.44	62.20	2.7226	-0.4751	367.29	-450.06
169.00	466.84	25.81	420.28	203.24	1.9284	-0.9325	518.56	-878.20
170.00	648.40	36.32	522.40	384.08	1.2426	-0.9136	804.79	-855.28
171.00	912.47	40.35	695.36	590.83	0.8352	-0.7096	1197.37	-660.46
172.00	1267.12	39.73	974.56	809.83	0.6070	-0.5044	1647.51	-466.71
173.00	1730.35	33.92	1435.86	965.62	0.4796	-0.3225	2085.24	-296.70
174.00	2187.20	26.80	1952.31	986.07	0.4081	-0.2061	2450.35	-188.54
175.00	2878.43	17.30	2748.19	856.04	0.3317	-0.1033	3014.84	-93.96
176.00	3570.52	-0.05	3570.52	-2.82	0.2801	0.0002	3570.52	0.20
177.00	3707.77	-20.27	3478.25	-1284.26	0.2530	0.0934	3952.43	84.00
178.00	3339.56	-34.36	2756.70	-1885.00	0.2472	0.1690	4045.65	151.12
179.00	2962.32	-40.48	2253.19	-1923.14	0.2568	0.2192	3894.63	194.86
180.00	2848.30	-41.70	2126.67	-1894.75	0.2621	0.2336	3814.79	206.50

170 kHz-A

Transformed to 70 ohms

Power rating: 500 Wrms @ 2% duty cycle
51 mm (2.0") PZT
Active Area: 20 cm²
Layered Plastic Urethane Window

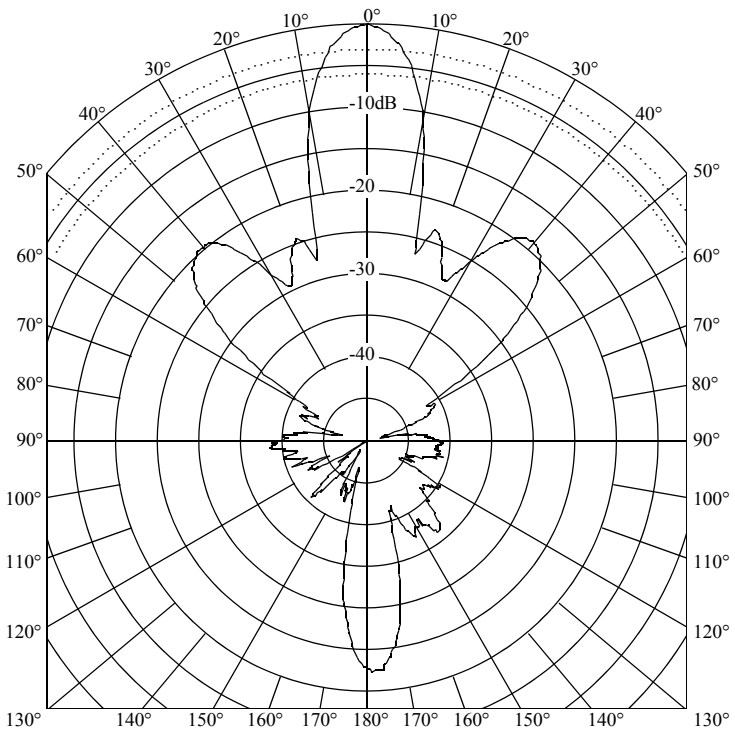
Beamwidth:

-3dB:	11°
-6dB:	15°
-10dB:	19°

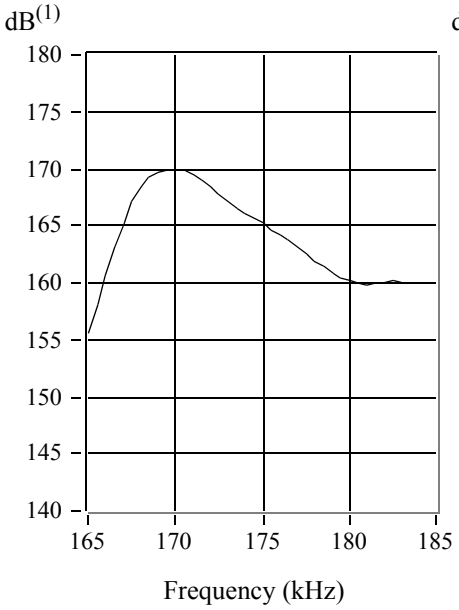
Directivity Index:	25.4
Frequency Tolerance:	±4 kHz
Peak TVR (1), nominal:	170 dB
Peak TVR (1), minimum:	167 dB
Q (transmit):	30
Peak Source Level (4):	215 dB
Peak RVR (2), nominal:	-179 dB
Peak Figure of Merit (3):	-18 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

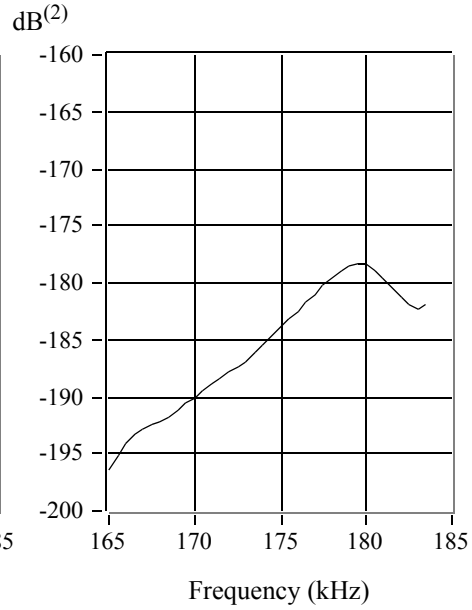
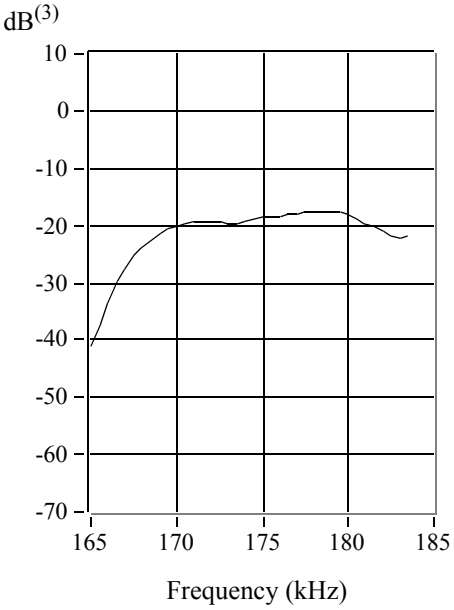


Figure of Merit



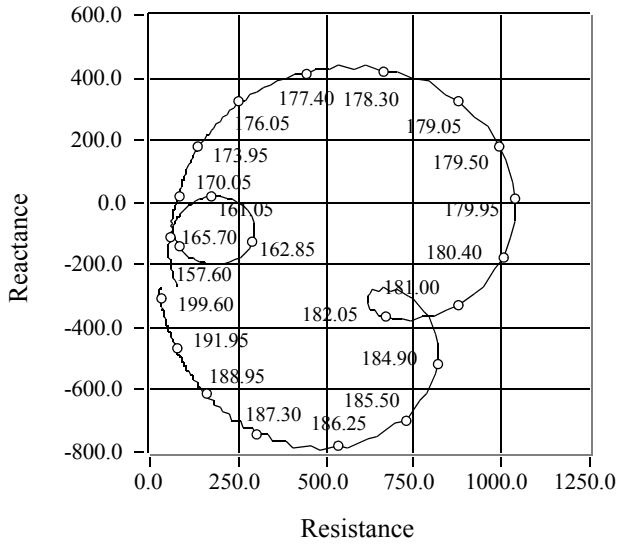
170 kHz-A

51mm (2.0") PZT

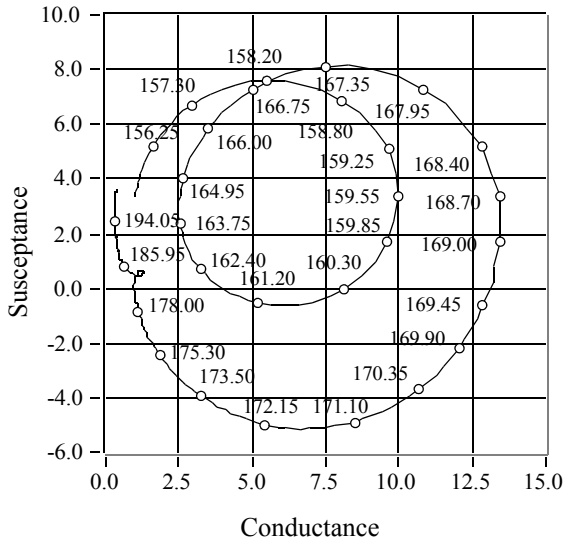
Cable Type: C2
Cable Length:15.2 m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70 ohms -20%,+40%	70 ohms -20%,+40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	70 – j0 ohms	70 – j0 ohms
1 kHz Capacitance	n/a	n/a

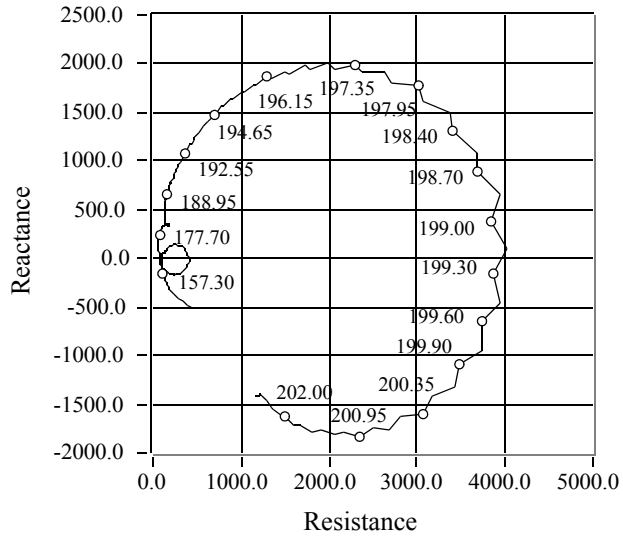
Unbalanced Impedance



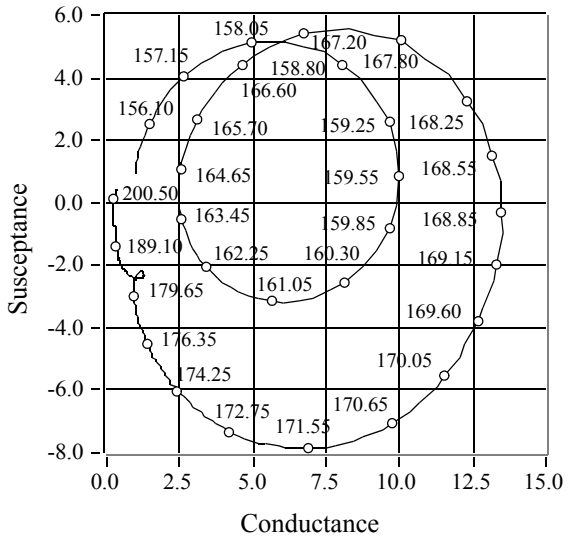
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



170 kHz-A

Transformed to 70 ohms

Power rating: 500 Wrms @ 2% duty cycle
51 mm (2.0") PZT
Active Area: 20 cm²
Urethane Window

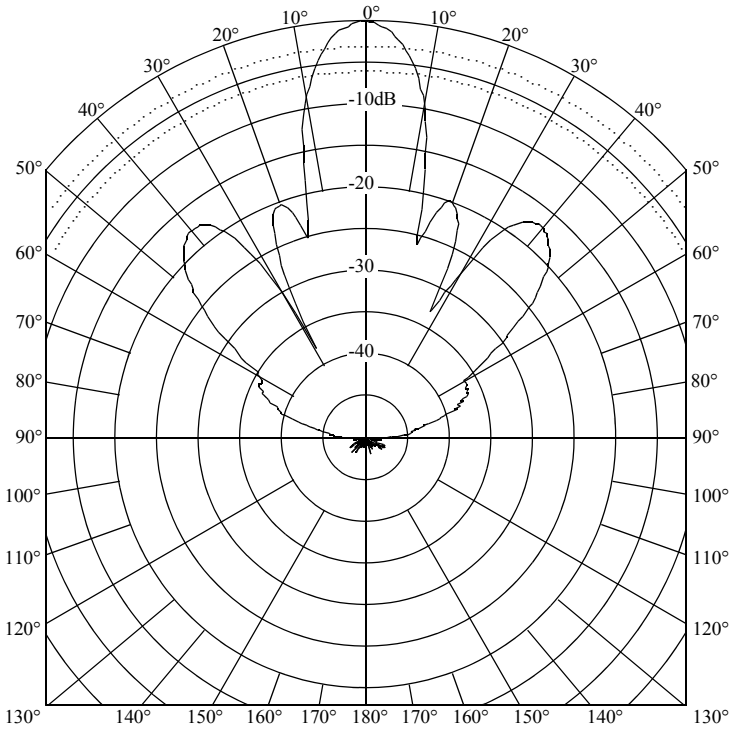
Beamwidth:

-3dB:	12°
-6dB:	16°
-10dB:	21°

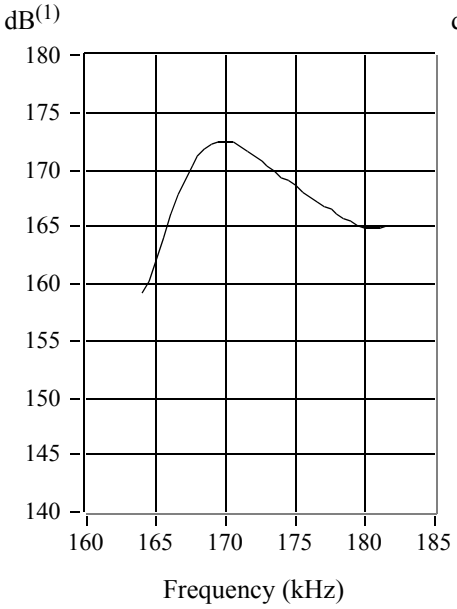
Directivity Index:	25.4
Frequency Tolerance:	±4 kHz
Peak TVR(1), nominal:	172 dB
Peak TVR(1), minimum:	170 dB
Q (transmit):	25
Peak Source Level(4):	215 dB
Peak RVR(2), nominal:	-183 dB
Peak Figure of Merit(3):	-17 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

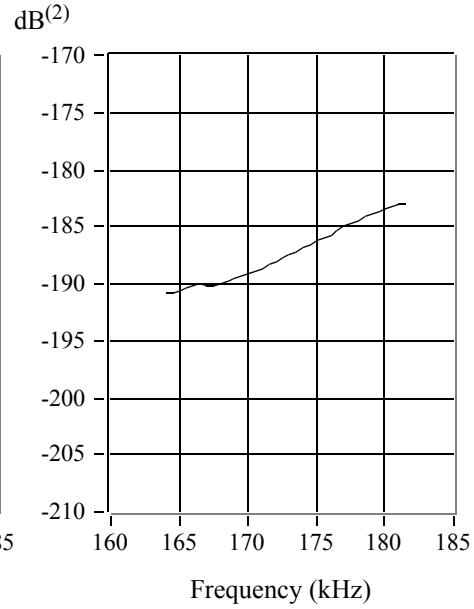
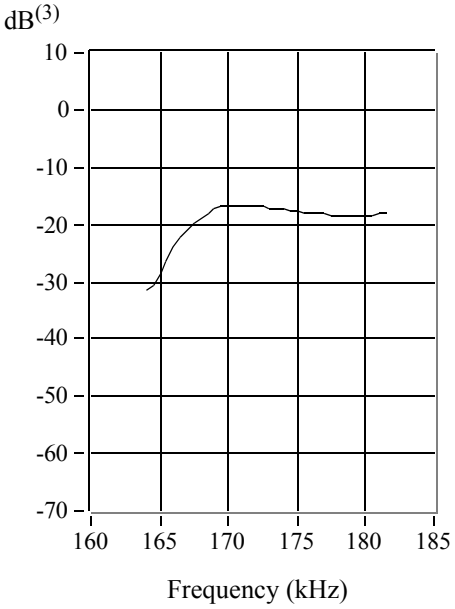


Figure of Merit



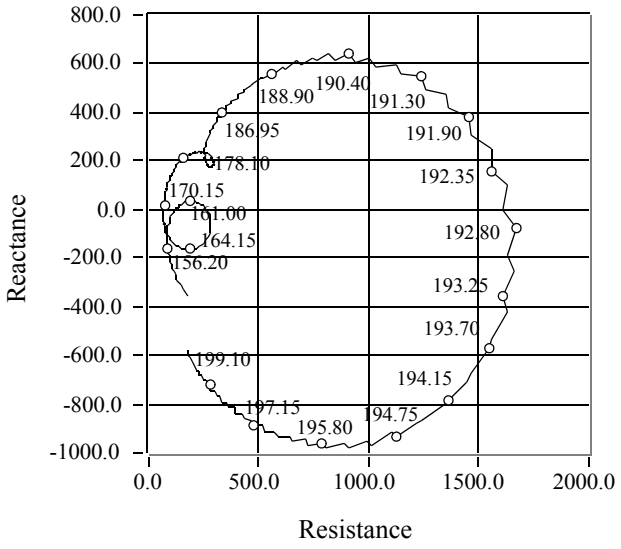
170 kHz-A

51mm (2.0") PZT

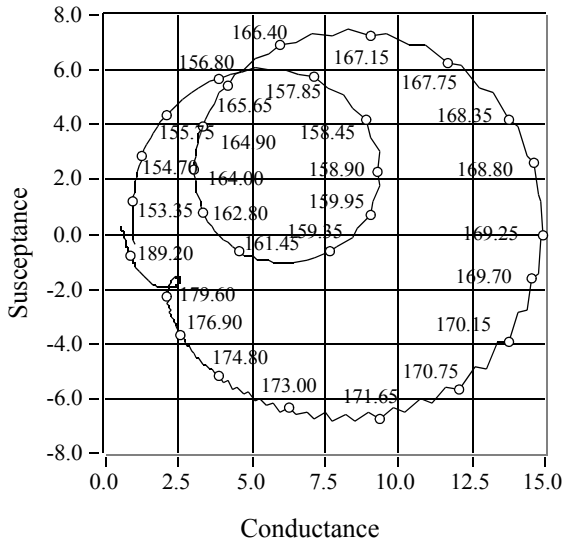
Cable Type: C156
Cable Length: 15.2m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70ohms -20%,+40%	70ohms -20%,+40%
Parallel: Cp. (nominal)	0pF	0pF
Series [R – jX] (nominal)	70 – j0 ohms	70 – j0 ohms
1 kHz Capacitance	n/a	n/a

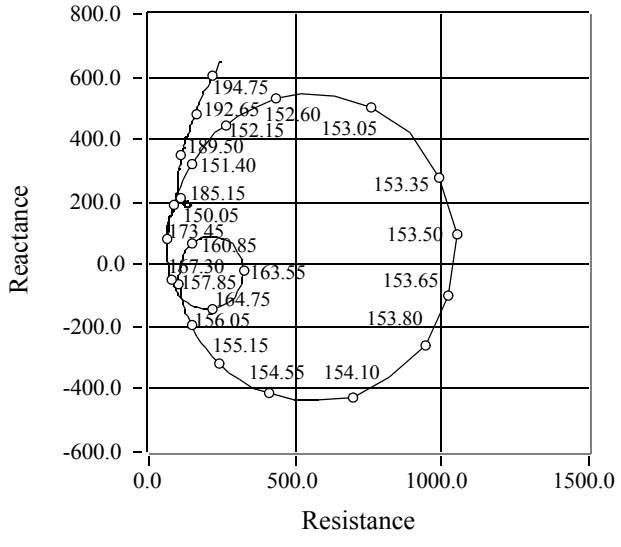
Unbalanced Impedance



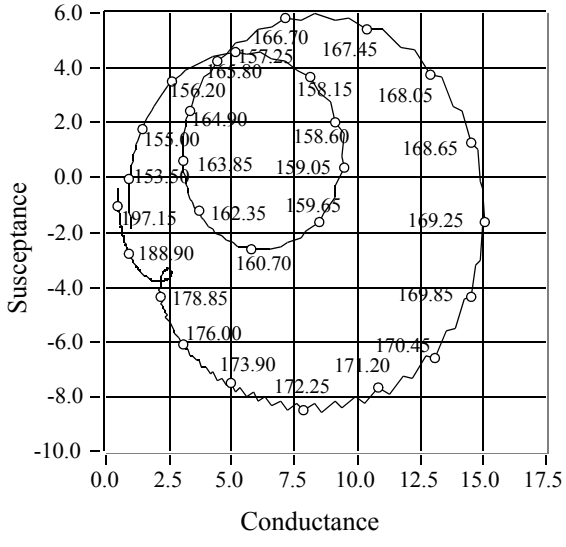
Unbalanced Admittance



Balanced Impedance



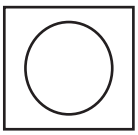
Balanced Admittance



170 kHz-C

Power Rating: 200 W rms @ 1% duty cycle
28 mm (1.08") PZT
Active Area: 5.5 cm² (0.92 in²)
Radiating Surface: Urethane

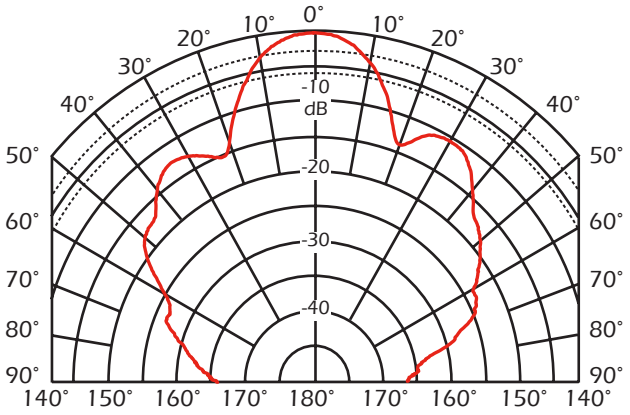
Array



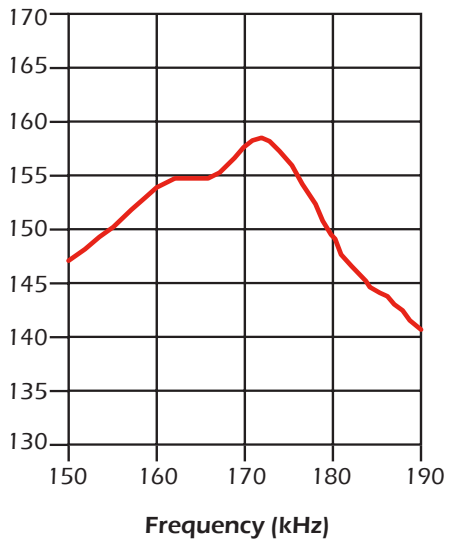
Beamwidth:
-3 dB: 19°
-6 dB: 26°
-10 dB: 33°

Directivity Index:	20
Frequency Tolerance:	± 5 kHz
Peak TVR(1), nominal:	158.4 dB
Peak TVR(1), minimum:	156.4 dB
Q (transmit):	21
Peak Source Level(4):	207.6 dB
Peak RVR(2), nominal:	-183.5 dB
Peak Figure of Merit(3):	-29.2 dB

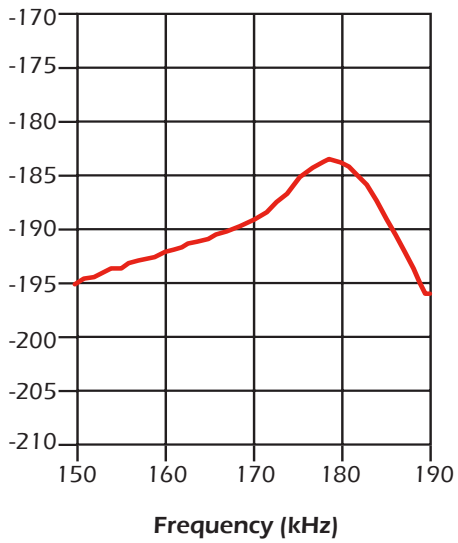
Transmit Radiation Pattern



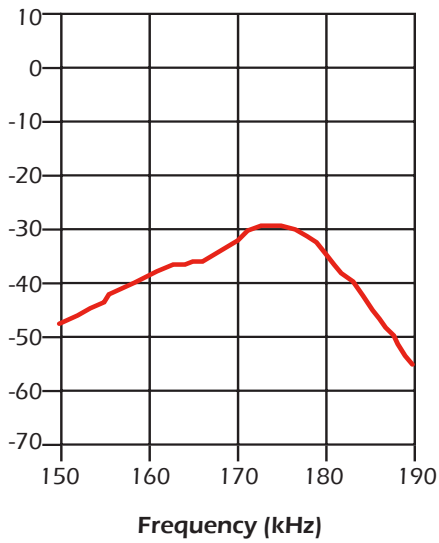
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

170 kHz-C

28 mm (1.08”) PZT

Cable Type: Customer Supplied
Cable Length: 0.9 m (3’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	400 Ω: -20%, +40%	400 Ω: -20%, +40%
Parallel: Cp. (nominal)	390 pF	720 pF
Series [R - jX]: (nominal)	390 - j70 Ω	370 - j110 Ω
1 kHz capacitance: (nominal)	920 pF	1,270 pF

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
150.00	726.04	-80.18	123.83	-715.40	0.23	1.36	4257.06	1439.98
151.00	701.13	-79.28	130.43	-688.89	0.27	1.40	3769.02	1477.07
152.00	675.33	-78.18	138.32	-661.01	0.30	1.45	3297.14	1517.59
153.00	650.03	-77.06	145.60	-633.51	0.34	1.50	2901.92	1559.62
155.00	593.52	-74.33	160.27	-571.47	0.46	1.62	2197.92	1665.74
156.00	564.32	-72.62	168.61	-538.54	0.53	1.69	1888.75	1725.31
157.00	532.98	-70.23	180.24	-501.57	0.63	1.77	1576.01	1789.95
158.00	503.72	-67.01	196.72	-463.72	0.78	1.83	1289.81	1840.92
160.00	456.37	-58.25	240.13	-388.08	1.15	1.86	867.31	1853.51
161.00	444.02	-52.59	269.74	-352.70	1.37	1.79	730.91	1768.42
162.00	441.50	-46.80	302.21	-321.85	1.55	1.65	644.97	1622.19
163.00	450.51	-41.03	339.83	-295.77	1.67	1.46	597.25	1422.90
165.00	491.60	-33.84	408.32	-273.77	1.69	1.13	591.87	1092.69
166.00	505.18	-32.57	425.73	-271.95	1.67	1.07	599.46	1021.67
167.00	502.96	-32.28	425.22	-268.63	1.68	1.06	594.92	1012.00
168.00	480.05	-30.93	411.78	-246.76	1.79	1.07	559.65	1014.41
170.00	413.27	-20.29	387.63	-143.31	2.27	0.84	440.61	785.56
171.00	396.88	-9.51	391.42	-65.58	2.49	0.42	402.41	387.51
172.00	411.58	2.77	411.11	19.85	2.43	-0.12	412.06	-108.45
173.00	457.90	14.75	442.82	116.58	2.11	-0.56	473.51	-511.49
175.00	652.82	30.46	562.72	330.94	1.32	-0.78	757.34	-706.23
176.00	790.78	34.95	648.15	453.04	1.04	-0.72	964.81	-655.13
177.00	966.01	37.11	770.34	582.89	0.83	-0.62	1211.38	-561.65
178.00	1171.71	37.81	925.75	718.26	0.67	-0.52	1483.02	-467.78
180.00	1720.59	34.18	1423.46	966.54	0.48	-0.33	2079.75	-288.68
181.00	2047.57	31.10	1753.34	1057.51	0.42	-0.25	2391.17	-221.79
182.00	2482.85	26.58	2220.41	1111.00	0.36	-0.18	2776.31	-157.60
183.00	3016.52	19.23	2848.20	993.55	0.31	-0.11	3194.79	-94.96
185.00	4047.61	-6.00	4025.47	-422.80	0.25	0.03	4069.87	22.20
186.00	4150.30	-21.00	3874.64	-1487.34	0.22	0.09	4445.58	73.89
187.00	3958.71	-34.74	3252.99	-2255.97	0.21	0.14	4817.53	122.52
188.00	3582.39	-45.84	2495.73	-2569.99	0.19	0.20	5142.19	169.53
190.00	2806.95	-59.09	1441.76	-2408.38	0.18	0.31	5464.82	256.05

170 kHz-C

Transformed to 70 ohms

Power rating: 200 Wrms @ 2% duty cycle
28 mm (1.08") PZT
Active Area: 5.5 cm²
Layered Plastic Epoxy Window

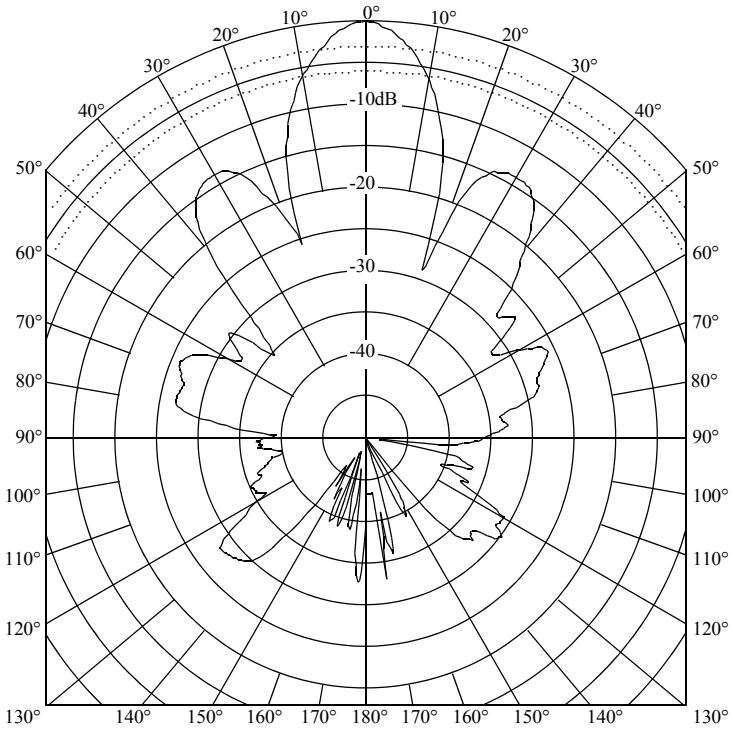
Beamwidth:

-3dB:	13°
-6dB:	20°
-10dB:	26°

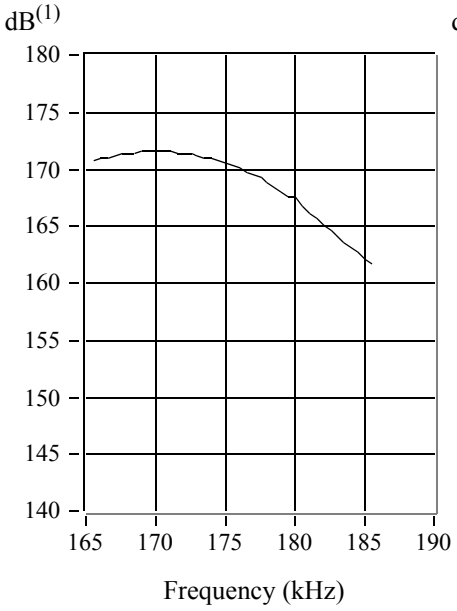
Directivity Index:	20.0
Frequency Tolerance:	±5 kHz
Peak TVR(1), nominal:	171 dB
Peak TVR(1), minimum:	168 dB
Q (transmit):	15
Peak Source Level(4):	213 dB
Peak RVR(2), nominal:	-194 dB
Peak Figure of Merit(3):	-22 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

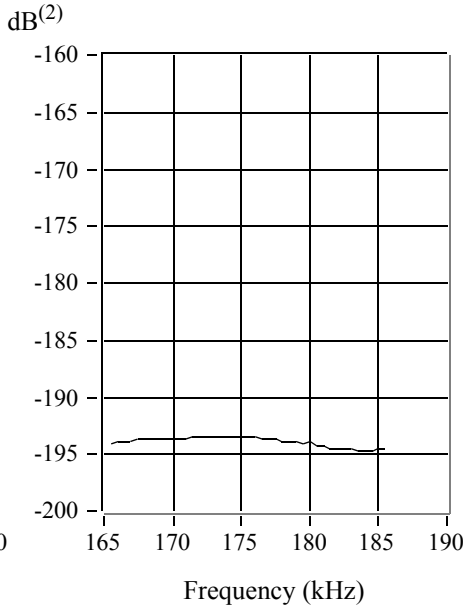
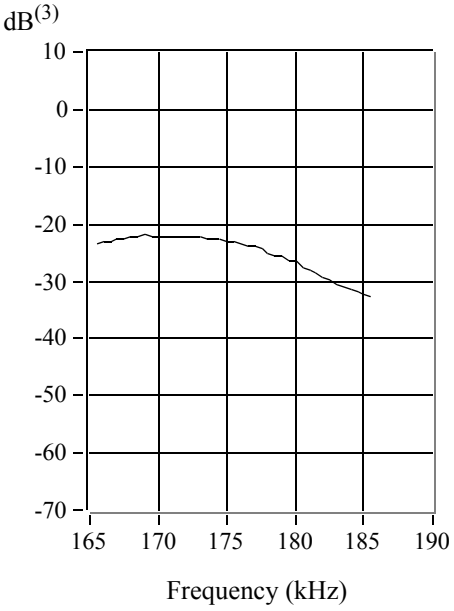


Figure of Merit



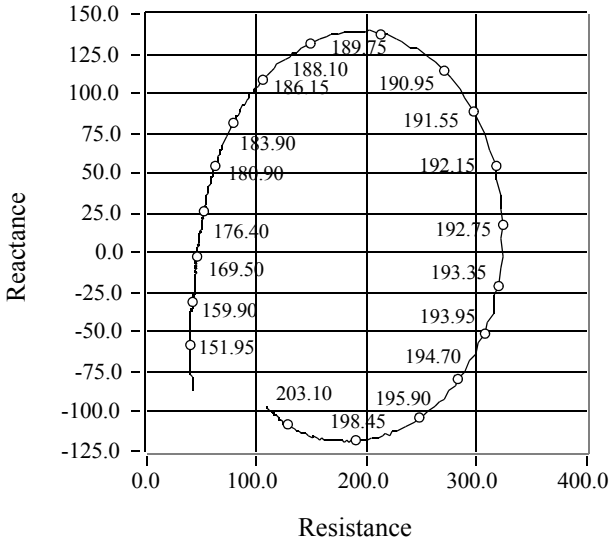
170 kHz-C

28mm (1.08") PZT

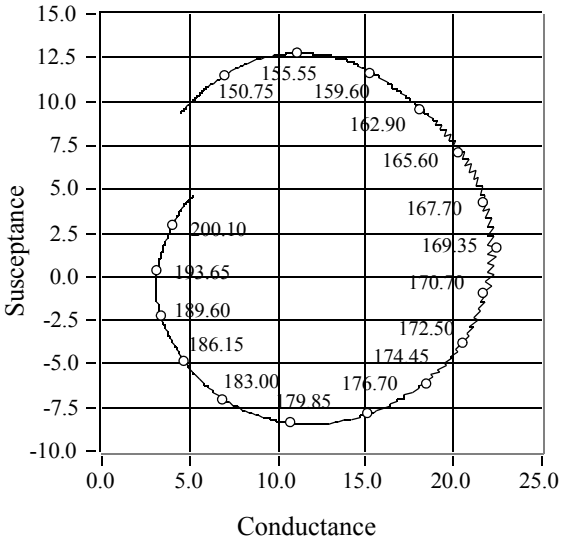
Cable Type: C2
Cable Length: 15.2 m (50.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	70 ohms -20%, +40%	70 ohms -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R – jX] (nominal)	70 – j0 ohms	70 – j0 ohms
1 kHz Capacitance	n/a	n/a

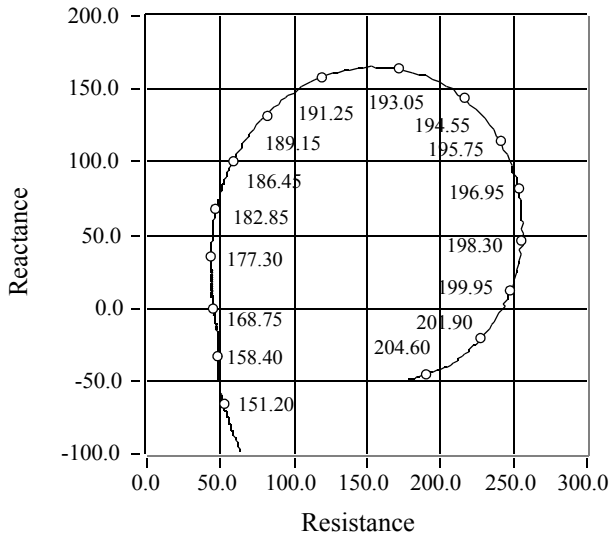
Unbalanced Impedance



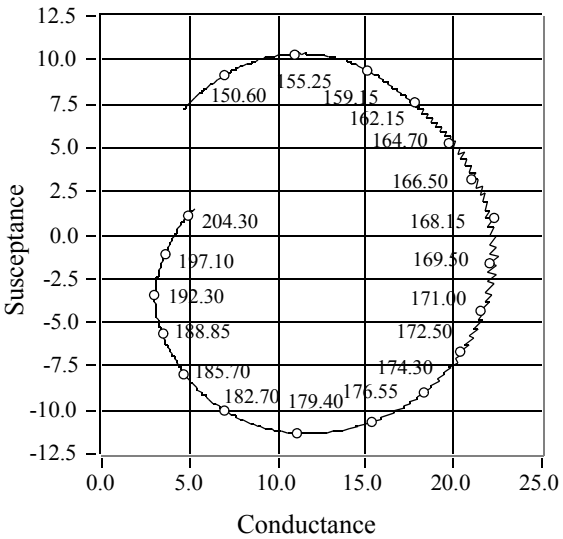
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



170 kHz-D

Power rating: 100 Wrms @ 2% duty cycle
8x29mm (0.30"x1.2") PZT
Active Area: 2cm²
Urethane Window

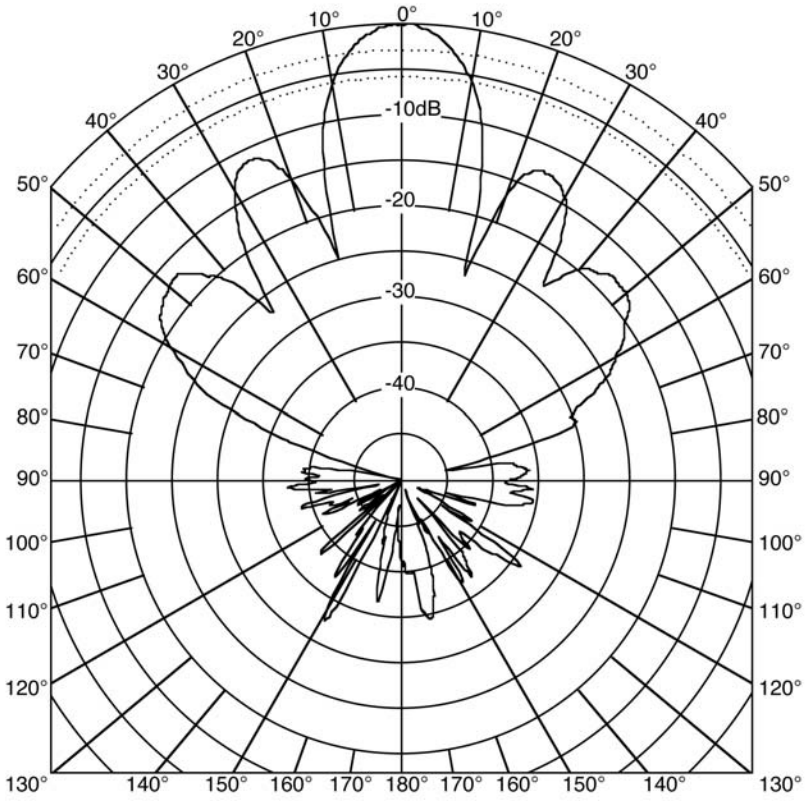
Beamwidth:

-3dB:	14° x 56°
-6dB:	20° x 79°
-10dB:	25° x 105°

Directivity Index:	16.4
Frequency Tolerance:	±4kHz
Peak TVR(1), nominal:	155 dB
Peak TVR(1), minimum:	153 dB
Q (transmit):	21
Peak Source Level(4):	204dB
Peak RVR(2), nominal:	-184dB
Peak Figure of Merit(3):	-32dB

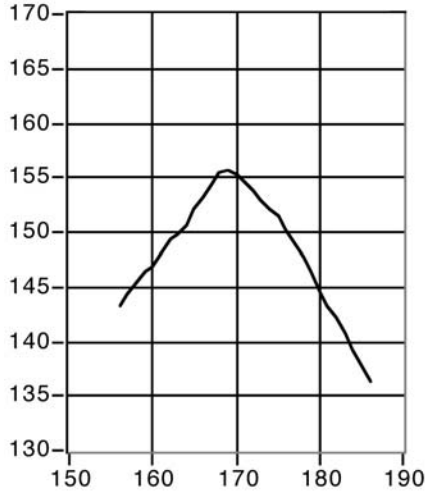
Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR

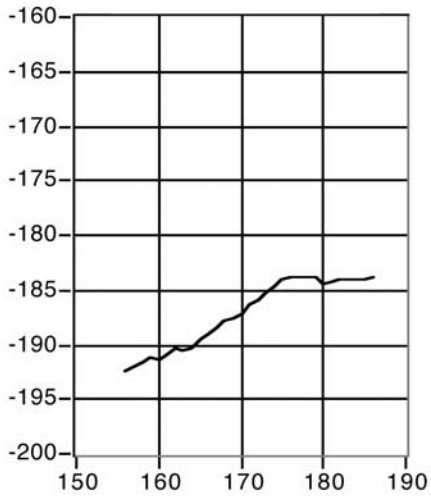
dB(1)



Frequency (kHz)

RVR

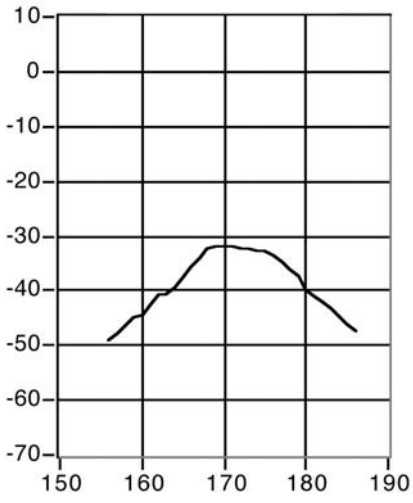
dB(2)



Frequency (kHz)

Figure of Merit

dB(3)



Frequency (kHz)

170 kHz-D

8mmx29mm (0.30"x1.2") PZT

Cable Type: Test Cable
Cable Length: 3.0 m (20.0')

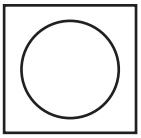
Impedance Data w/transformer	
	Balanced
Parallel: Rp.	600 ohms -20%, +40%
Parallel: Cp. (nominal)	0 pF
Series [R – jX] (nominal)	600 – j0 ohms
1 kHz Capacitance	360pF±20%

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
155.00	1346.76	-71.99	416.33	-1280.79	0.2295	0.7062	4356.50	725.08
156.00	1262.68	-70.38	424.05	-1189.35	0.2660	0.7460	3759.84	761.06
157.00	1184.58	-68.68	430.69	-1103.51	0.3069	0.7864	3258.06	797.20
158.00	1107.63	-66.70	438.21	-1017.26	0.3572	0.8292	2799.70	835.23
159.00	1028.00	-64.15	448.15	-925.18	0.4241	0.8755	2358.12	876.32
160.00	949.90	-61.09	459.26	-831.50	0.5090	0.9215	1964.70	916.65
161.00	874.58	-57.14	474.59	-734.61	0.6205	0.9604	1611.67	949.41
162.00	804.77	-52.10	494.34	-635.05	0.7633	0.9805	1310.14	963.31
163.00	746.82	-46.11	517.76	-538.20	0.9283	0.9650	1077.21	942.22
164.00	697.65	-39.42	538.98	-442.96	1.1074	0.9101	903.03	883.22
165.00	654.38	-31.96	555.21	-346.35	1.2966	0.8088	771.27	780.16
166.00	610.09	-23.16	560.91	-239.98	1.5070	0.6447	663.58	618.15
167.00	573.87	-11.40	562.54	-113.45	1.7082	0.3445	585.42	328.32
168.00	579.24	3.22	578.32	32.53	1.7237	-0.0970	580.15	-91.86
169.00	636.82	17.18	608.42	188.05	1.5003	-0.4637	666.54	-436.69
170.00	735.50	27.87	650.16	343.88	1.2019	-0.6357	832.04	-595.12
171.00	859.96	36.09	694.95	506.52	0.9397	-0.6849	1064.14	-637.48
172.00	1012.28	42.32	748.43	681.59	0.7304	-0.6652	1369.15	-615.48
173.00	1182.21	46.88	808.03	862.97	0.5781	-0.6175	1729.67	-568.04
174.00	1371.21	50.54	871.38	1058.73	0.4634	-0.5631	2157.74	-515.05
175.00	1592.74	53.30	951.91	1276.99	0.3752	-0.5034	2664.99	-457.80
176.00	1831.02	55.31	1042.02	1505.60	0.3108	-0.4491	3217.44	-406.10
177.00	2092.29	57.00	1139.63	1754.68	0.2603	-0.4008	3841.30	-360.41
178.00	2398.88	58.17	1265.22	2038.10	0.2199	-0.3542	4548.32	-316.67
179.00	2746.44	58.87	1419.83	2350.96	0.1882	-0.3117	5312.56	-277.12
180.00	3122.72	59.35	1591.74	2686.58	0.1632	-0.2755	6126.23	-243.60
181.00	3576.43	59.65	1807.24	3086.22	0.1413	-0.2413	7077.58	-212.16
182.00	4115.60	59.37	2097.05	3541.26	0.1238	-0.2091	8077.14	-182.83
183.00	4718.77	58.33	2477.81	4015.88	0.1113	-0.1804	8986.49	-156.85
184.00	5454.56	57.28	2948.06	4589.24	0.0991	-0.1542	10092.13	-133.42
185.00	6334.97	55.34	3602.32	5211.06	0.0898	-0.1298	11140.55	-111.71

200 kHz-A

Array

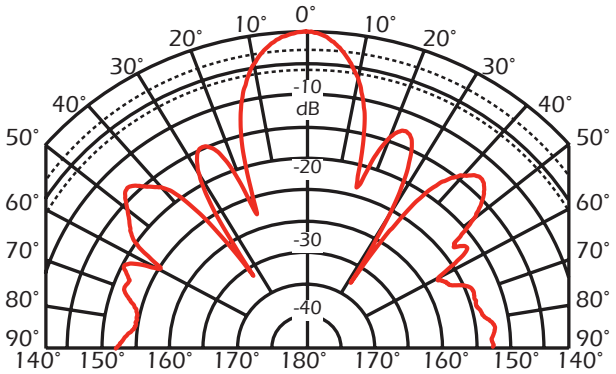


Power Rating: 300W @ 2% duty cycle
27 mm (1.08") PZT
Active Area: 5.7 cm^2
Radiating Surface:
Layered HPC Window

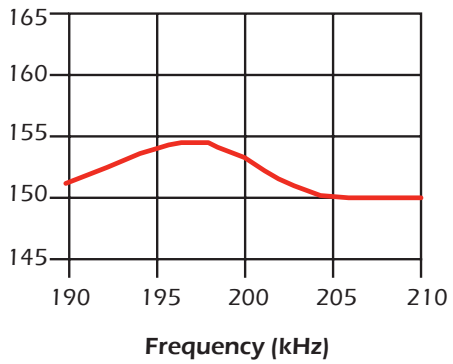
Beamwidth:
-3 dB: 15°
-6 dB: 21°
-10 dB: 26°

Directivity Index:	21
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	154 dB
Peak TVR(1), minimum:	152 dB
Q (transmit):	17
Peak Source Level(4):	209 dB
Peak RVR(2), nominal:	-194 dB
Peak Figure of Merit(3):	-40 dB

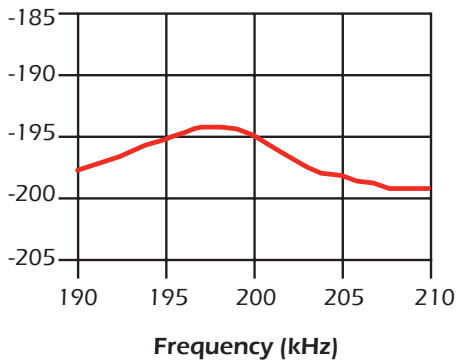
Transmit Radiation Pattern



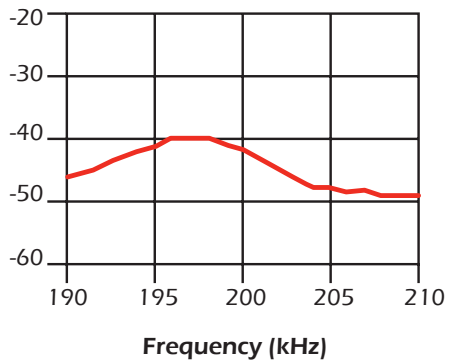
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

200 kHz-A

27 mm (1.08”) PZT

Cable Type: C33
Cable Length: 10 m (33’)

Note:
Impedance data includes cable

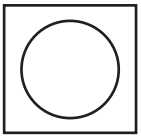
Impedance Data	
	Unbalanced
Parallel: Rp.	1100 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,900 pF
Series [R - jX]: (nominal)	100 - j390 Ω
1 kHz capacitance: (nominal)	1970 pF: ±20%

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	349.40	-80.22	59.35	-344.32	0.49	2.82	2057.03	2362.58
191.00	346.84	-79.11	65.55	-340.59	0.54	2.83	1835.28	2359.19
192.00	345.60	-77.98	71.97	-338.03	0.60	2.83	1659.61	2345.92
193.00	345.99	-76.72	79.47	-336.73	0.66	2.81	1506.21	2319.71
194.00	348.77	-75.49	87.39	-337.65	0.72	2.78	1391.91	2277.17
195.00	353.95	-74.05	97.26	-340.33	0.78	2.72	1288.16	2217.15
196.00	360.74	-73.02	105.33	-345.03	0.81	2.65	1235.54	2152.86
197.00	371.47	-72.46	111.98	-354.19	0.81	2.57	1232.29	2073.70
198.00	383.26	-72.55	114.94	-365.62	0.78	2.49	1277.98	2000.74
199.00	395.26	-73.21	114.18	-378.40	0.73	2.42	1368.24	1937.16
200.00	404.04	-74.38	108.81	-389.11	0.67	2.38	1500.25	1896.77
201.00	407.98	-75.89	99.44	-395.67	0.60	2.38	1673.77	1882.30
202.00	410.35	-77.33	90.00	-400.36	0.53	2.38	1870.96	1873.32
203.00	408.20	-78.71	79.89	-400.31	0.48	2.40	2085.66	1883.51
204.00	403.53	-79.85	71.09	-397.22	0.44	2.44	2290.56	1903.13
205.00	398.79	-80.71	64.39	-393.56	0.40	2.47	2469.80	1921.24
206.00	391.28	-81.16	60.13	-386.63	0.39	2.53	2546.33	1951.08
207.00	388.21	-81.54	57.08	-384.00	0.38	2.55	2640.27	1958.99
208.00	382.50	-81.75	54.86	-378.54	0.38	2.59	2666.98	1979.76
209.00	378.52	-81.85	53.64	-374.70	0.37	2.62	2671.20	1991.49
210.00	374.07	-81.85	53.04	-370.29	0.38	2.65	2638.46	2005.56

200 kHz-A

Array

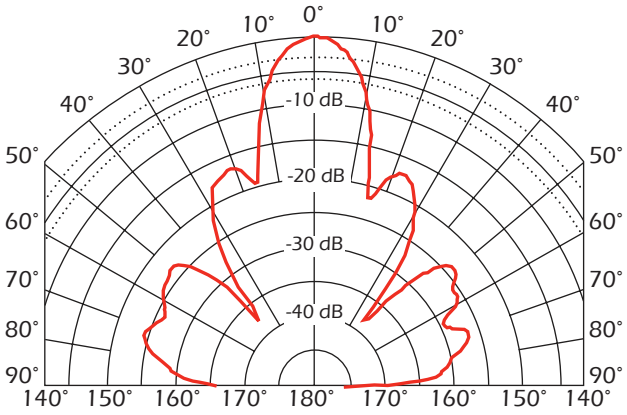


Power Rating: 300 W rms @ 2% duty cycle
27 mm (1.08”) PZT
Active Area: 5.7 cm^2
Layered Plastic Epoxy Window

Beamwidth:
-3 dB: 13°
-6 dB: 18°
-10 dB: 22°

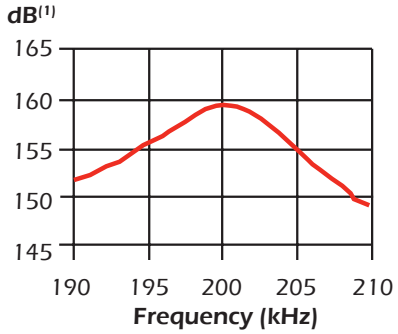
Directivity Index:	21
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	159 dB
Peak TVR(1), minimum:	156 dB
Q (transmit):	26
Peak Source Level(4):	213 dB
Peak RVR(2), nominal:	-188 dB
Peak Figure of Merit(3):	-29 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

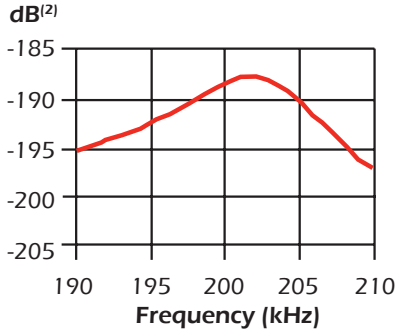
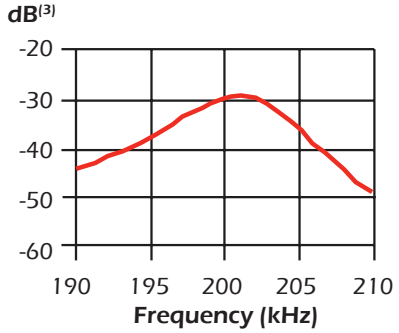


Figure of Merit



200 kHz-A

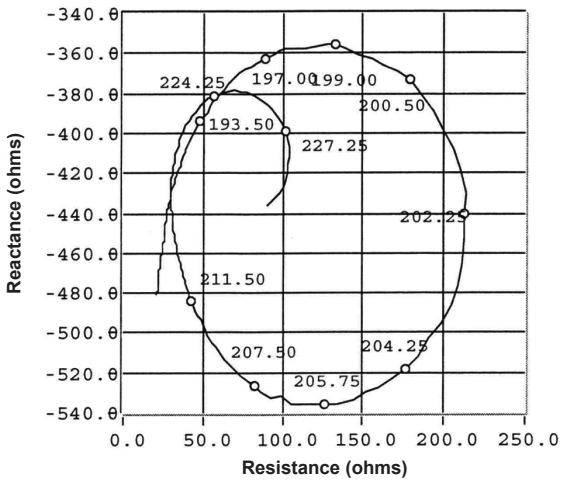
27 mm (1.08”) PZT

Cable Type: C172
Cable Length: 10.1 m (33’)

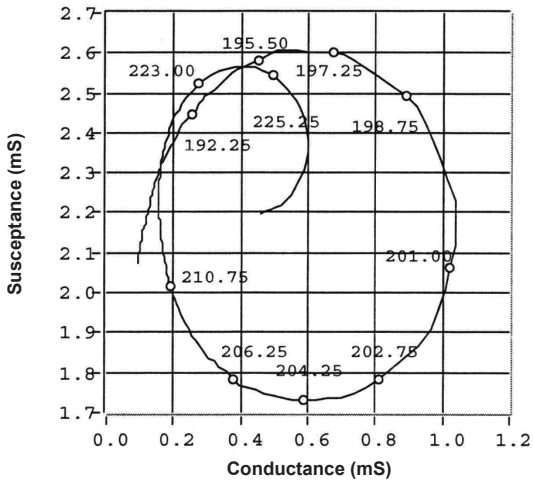
Note:
Impedance data includes cable

Impedance Data	
	Unbalanced
Parallel: Rp.	970 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,630 pF
Series [R - jX]: (nominal)	190 - j390 Ω
1 kHz capacitance: (nominal)	2020 pF: ±20%

Unbalance Impedance

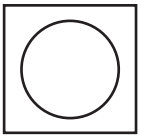


Unbalance Admittance



200 kHz-A

Array

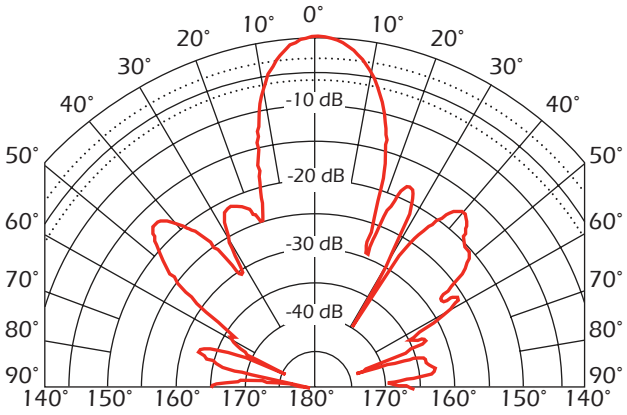


Power Rating: 300 W rms @ 2% duty cycle
27 mm (1.08") PZT
Active Area: 5.7 cm^2
Layered Plastic Urethane Window

Beamwidth:
-3 dB: 15°
-6 dB: 20°
-10 dB: 26°

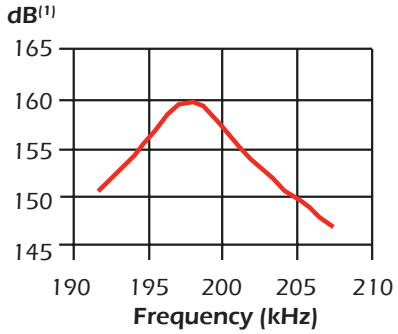
Directivity Index:	21
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	159 dB
Peak TVR(1), minimum:	157 dB
Q (transmit):	33
Peak Source Level(4):	210 dB
Peak RVR(2), nominal:	-190 dB
Peak Figure of Merit(3):	-30 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

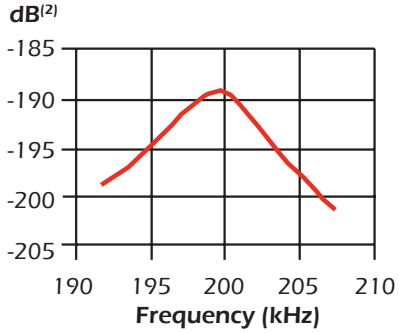
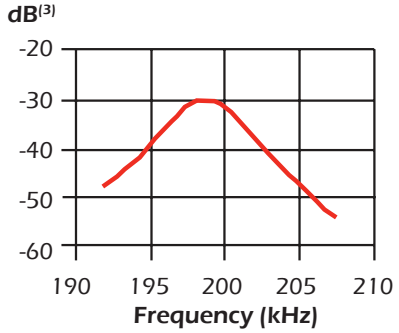


Figure of Merit



200 kHz-A

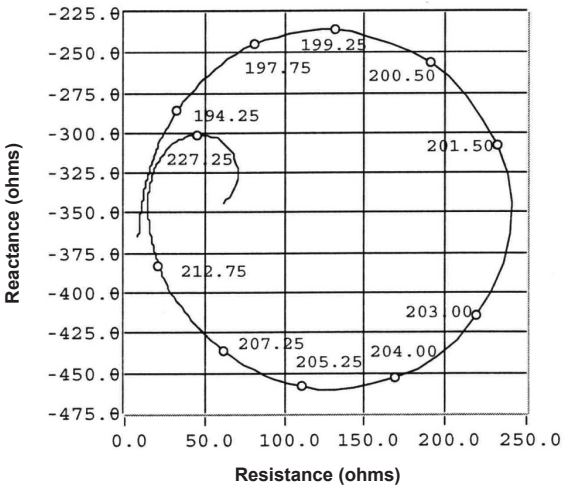
27 mm (1.08”) PZT

Cable Type: C2
Cable Length: 10.4 m (34’)

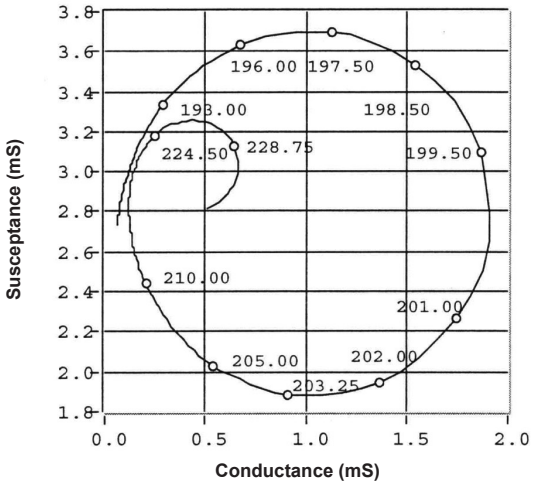
Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	525 Ω: -20%, +40%	525 Ω: -20%, +40%
Parallel: Cp. (nominal)	560 pF	560 pF
Series [R - jX]: (nominal)	465 - j170 Ω	465 - j170 Ω
1 kHz capacitance: (nominal)	860 pF: ±20%	860 pF: ±20%

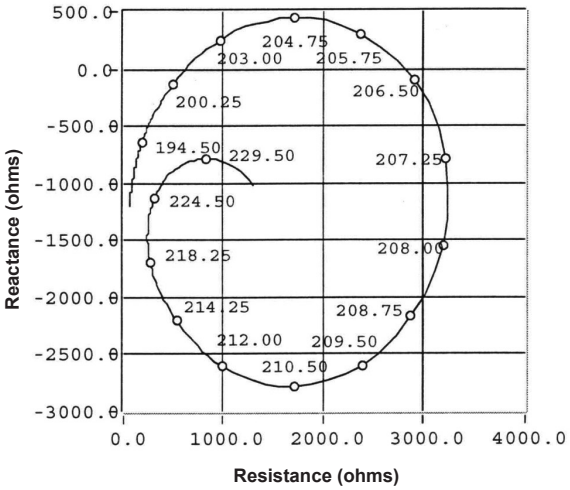
Unbalance Impedance



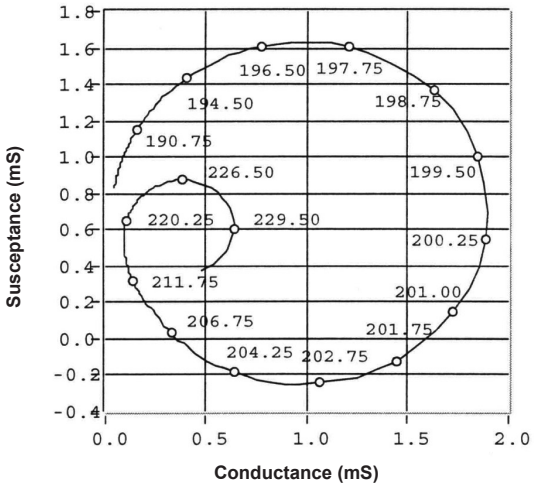
Unbalance Admittance



Balance Impedance



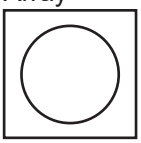
Balanced Admittance



200 kHz-AW

Power Rating: 1 kW @ 2% duty cycle
67.3 mm (2.65") PZT
Active Area: 35.6 cm² (5.51 in²)
Radiating Surface: Urethane

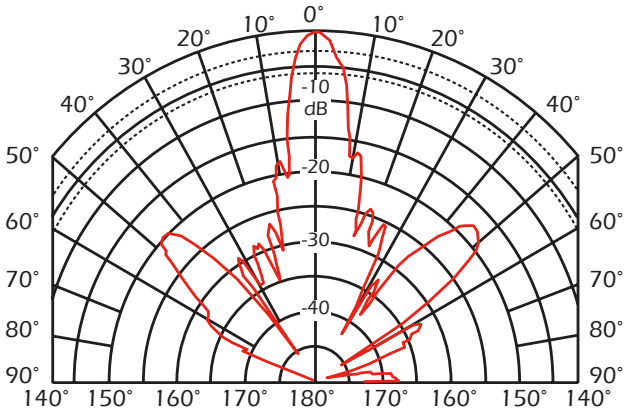
Array



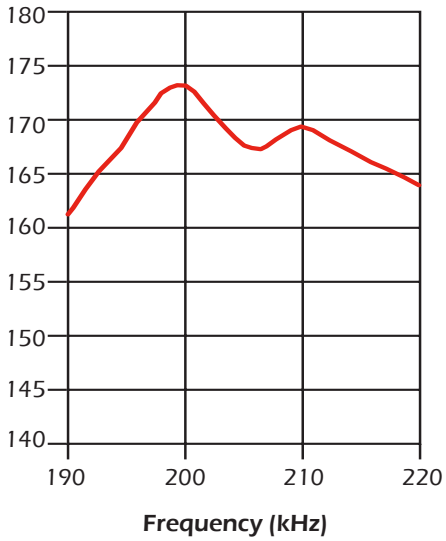
Beamwidth:
-3 dB: 7°
-6 dB: 10°
-10 dB: 12°

Directivity Index:	28
Frequency Tolerance:	+/- 4kHz
Peak TVR(1), nominal:	173 dB
Peak TVR(1), minimum:	171 dB
Q (transmit):	30
Peak Source Level(4):	222 dB
Peak RVR(2), nominal:	-184 dB
Peak Figure of Merit(3):	-14 dB

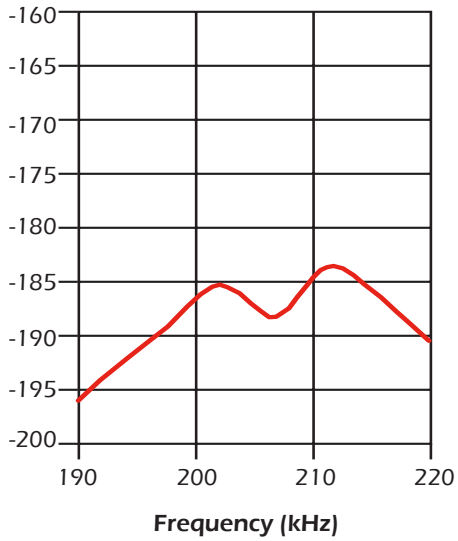
Transmit Radiation Pattern



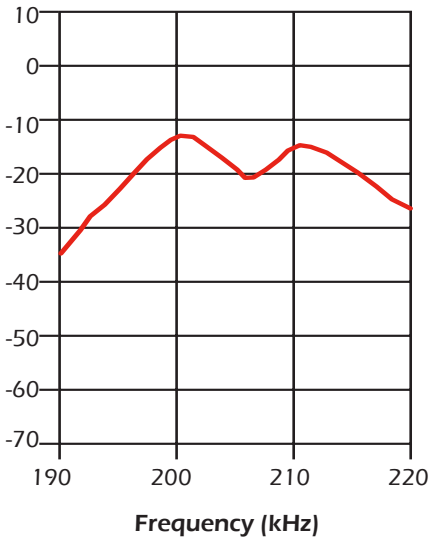
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

200 kHz-AW

67.3 mm (2.65”) PZT

Cable Type: C44-02
Cable Length: 15 m (50’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	120 Ω: -20%, +40%	120 Ω: -20%, +40%
Parallel: Cp. (nominal)	3760 pF	5300 pF
Series [R - jX]: (nominal)	90 - j50 Ω	70 - j60 Ω
1 kHz capacitance: (nominal)	5190 pF: ±20%	6720 pF: ±20%

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	165.39	-78.82	32.06	-162.26	1.17	5.93	853.26	4968.62
191.00	152.42	-78.04	31.59	-149.11	1.36	6.42	735.33	5348.21
192.00	141.57	-76.63	32.73	-137.74	1.63	6.87	612.38	5696.58
193.00	131.74	-74.71	34.74	-127.08	2.00	7.32	499.55	6037.94
194.00	122.45	-72.05	37.75	-116.49	2.52	7.77	397.26	6373.32
195.00	113.55	-68.40	41.79	-105.58	3.24	8.19	308.50	6683.44
196.00	105.14	-63.27	47.29	-93.91	4.28	8.49	233.76	6897.74
197.00	98.45	-55.88	55.22	-81.51	5.70	8.41	175.54	6793.66
198.00	95.43	-46.14	66.12	-68.81	7.26	7.56	137.72	6073.50
199.00	98.65	-34.76	81.05	-56.25	8.33	5.78	120.08	4622.22
200.00	111.02	-23.99	101.43	-45.14	8.23	3.66	121.52	2914.19
201.00	134.11	-16.80	128.38	-38.77	7.14	2.16	140.09	1706.84
202.00	166.04	-14.89	160.46	-42.68	5.82	1.55	171.81	1219.70
203.00	199.39	-18.13	189.50	-62.03	4.77	1.56	209.81	1223.31
204.00	223.93	-24.26	204.15	-92.02	4.07	1.84	245.63	1431.66
205.00	231.46	-30.59	199.25	-117.79	3.72	2.20	268.88	1706.88
206.00	224.32	-34.45	184.99	-126.88	3.68	2.52	272.02	1948.05
207.00	212.91	-34.11	176.29	-119.39	3.89	2.63	257.15	2024.98
208.00	207.91	-29.85	180.33	-103.47	4.17	2.39	239.70	1831.58
209.00	218.19	-23.17	200.59	-85.86	4.21	1.80	237.34	1373.37
210.00	252.16	-17.16	240.94	-74.38	3.79	1.17	263.91	886.59
211.00	312.52	-15.68	300.89	-84.48	3.08	0.86	324.60	652.40
212.00	387.46	-20.55	362.81	-136.01	2.42	0.91	413.79	680.13
213.00	452.03	-30.26	390.46	-227.76	1.91	1.11	523.31	832.88
214.00	484.26	-41.39	363.28	-320.21	1.55	1.37	645.53	1015.51
215.00	483.33	-51.51	300.83	-378.30	1.29	1.62	776.56	1198.76
216.00	463.73	-59.48	235.53	-399.47	1.10	1.86	913.04	1368.71
217.00	437.41	-65.50	181.42	-398.02	0.95	2.08	1054.65	1525.74
218.00	411.15	-69.93	141.07	-386.20	0.83	2.28	1198.35	1667.87
219.00	387.64	-73.25	111.72	-371.19	0.74	2.47	1344.98	1795.22
220.00	365.86	-75.67	90.53	-354.48	0.68	2.65	1478.59	1915.86

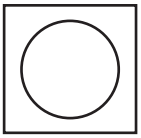
200 kHz-AWIq

Power Rating: 1 kW rms @ 2% duty cycle
67 mm (2.65") PZT
Active Area: 35.3 cm^2
Epoxy/Urethane Window

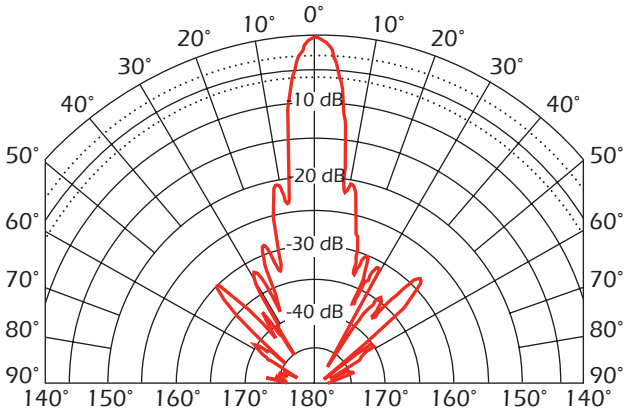
Beamwidth:
-3 dB: 7°
-6 dB: 8°
-10 dB: 9°

Directivity Index:	28.6
Frequency Tolerance:	± 5 kHz
Peak TVR(1), nominal:	170 dB
Peak TVR(1), minimum:	167 dB
Q (transmit):	10
Peak Source Level(4):	225 dB
Peak RVR(2), nominal:	-182 dB
Peak Figure of Merit(3):	-12.7 dB

Array

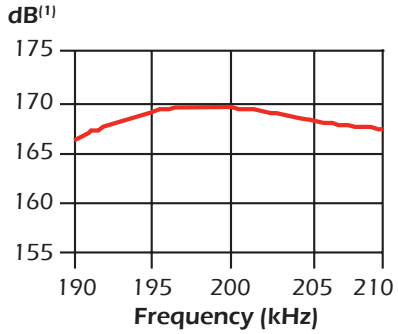


Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

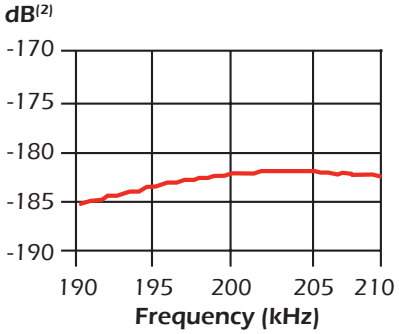
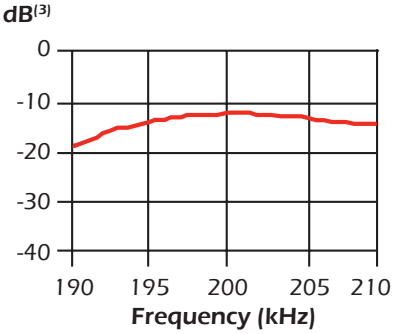


Figure of Merit



200 kHz-AWlq

67 mm (2.65”) PZT

Cable Type: C32
Cable Length: 10.1 m (33’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	310 Ω: -20%, +40%	310 Ω: -20%, +40%
Parallel: Cp. (nominal)	2,100 pF	2,100 pF
Series [R - jX]: (nominal)	190 - j150 Ω	190 - j150 Ω
1 kHz capacitance: (nominal)	7,670 pF: ±20%	7,710 pF: ±20%

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	254.56	-53.93	149.90	-205.75	2.3132	3.1751	432.30	2659.64
190.50	250.90	-53.46	149.37	-201.58	2.3730	3.2024	421.42	2675.44
191.00	245.55	-52.62	149.08	-195.12	2.4724	3.2361	404.46	2696.53
191.50	241.84	-51.81	149.51	-190.08	2.5564	3.2501	391.17	2701.14
192.00	239.75	-50.83	151.41	-185.88	2.6343	3.2339	379.61	2680.72
193.00	235.77	-48.89	155.02	-177.64	2.7888	3.1957	358.57	2635.27
193.50	235.04	-47.31	159.38	-172.75	2.8850	3.1271	346.62	2572.03
194.00	233.47	-46.69	160.14	-169.90	2.9378	3.1169	340.39	2557.02
194.50	235.32	-45.27	165.62	-167.17	2.9908	3.0189	334.36	2470.26
195.00	233.72	-44.18	167.62	-162.87	3.0686	2.9817	325.88	2433.63
196.00	236.76	-41.77	176.58	-157.72	3.1500	2.8136	317.46	2284.68
196.50	238.00	-41.30	178.80	-157.08	3.1567	2.7731	316.79	2246.03
197.00	241.87	-39.92	185.51	-155.20	3.1711	2.6529	315.35	2143.27
197.50	242.01	-39.01	188.05	-152.33	3.2108	2.6010	311.45	2096.01
198.00	247.12	-38.31	193.89	-153.21	3.1750	2.5088	314.96	2016.63
199.00	253.07	-36.72	202.86	-151.30	3.1675	2.3624	315.70	1889.41
199.50	257.40	-35.63	209.22	-149.93	3.1579	2.2630	316.66	1805.33
200.00	261.05	-35.18	213.37	-150.40	3.1310	2.2070	319.39	1756.25
200.50	266.29	-34.63	219.12	-151.33	3.0900	2.1340	323.62	1693.95
201.00	272.09	-34.06	225.40	-152.40	3.0447	2.0586	328.44	1630.01
201.50	276.02	-33.79	229.40	-153.51	3.0109	2.0149	332.12	1591.45
202.00	283.64	-33.68	236.03	-157.29	2.9338	1.9552	340.85	1540.49
202.50	287.73	-33.07	241.12	-157.00	2.9125	1.8964	343.34	1490.44
203.00	293.83	-33.79	244.19	-163.42	2.8284	1.8928	353.56	1484.02
203.50	300.88	-33.15	251.91	-164.53	2.7827	1.8174	359.37	1421.38
204.00	304.01	-33.82	252.58	-169.20	2.7328	1.8307	365.92	1428.24
25.00	315.02	-34.22	260.47	-177.18	2.6247	1.7854	381.00	1386.12
25.50	321.94	-34.98	263.80	-184.55	2.5452	1.7805	392.90	1378.97
206.00	325.95	-35.08	266.74	-187.32	2.5107	1.7632	398.29	1362.24
206.50	329.37	-35.94	266.69	-193.30	2.4583	1.7818	406.79	1373.27
207.00	334.58	-36.24	269.87	-197.78	2.4107	1.7667	414.81	1358.38
208.00	340.44	-37.57	269.84	-207.57	2.3282	1.7909	429.51	1370.37
208.50	341.05	-37.73	269.73	-208.71	2.3190	1.7944	431.22	1369.71
209.00	343.74	-38.80	267.91	-215.36	2.2674	1.8227	441.03	1388.02
209.50	349.19	-38.70	270.18	-216.45	2.2544	1.8060	443.58	1372.02
210.00	346.06	-39.60	266.64	-220.60	2.2265	1.8420	449.14	1396.03

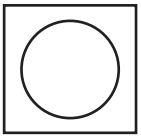
200 kHz-AWlq

Transformed to 60 ohms
Power Rating: 1 kW rms @ 1% duty cycle
67 mm (2.65") PZT
Active Area: 35.3 cm^2 (5.5 in^2)
Epoxy/Urethane Window

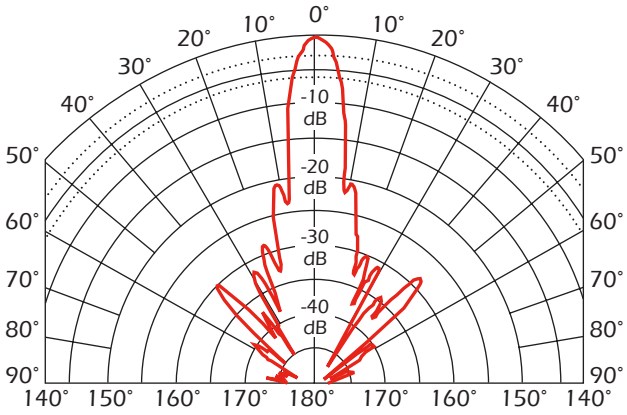
Beamwidth:
-3 dB: 7°
-6 dB: 8°
-10 dB: 9°

Directivity Index:	28
Frequency Tolerance:	± 5 kHz
Peak TVR(1), nominal:	177 dB
Peak TVR(1), minimum:	175 dB
Q (transmit):	5
Peak Source Level(4):	224 dB
Peak RVR(2), nominal:	-184 dB
Peak Figure of Merit(3):	-9 dB

Array

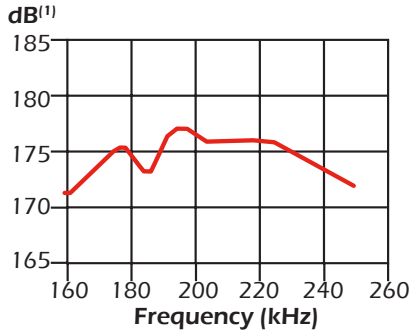


Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

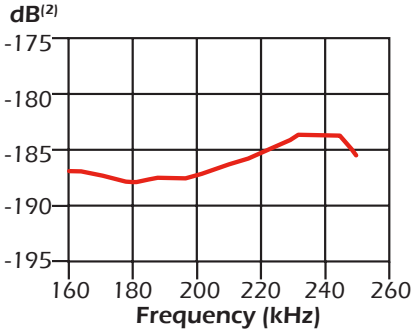
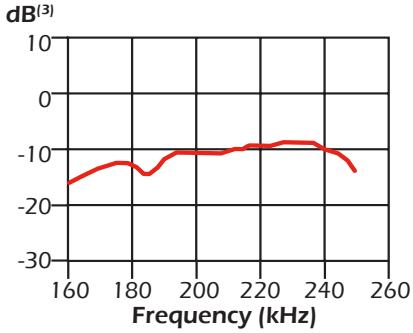


Figure of Merit



200 kHz-AWIq

67 mm (2.65”) PZT

Cable Type: C44-02
Cable Length: 15 m (50’)

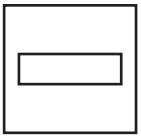
Note:
Impedance data includes cable

Impedance Data		
	Unbalanced	*Balanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	0	0
Series [R - jX]: (nominal)	60 - j0 Ω	60 - j0 Ω
1 kHz capacitance: (nominal)		

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
160.00	101.60	-18.00	96.63	-31.40	9.36	3.04	106.83	3025.63
162.00	99.56	-16.66	95.39	-28.54	9.62	2.88	103.93	2828.68
166.00	88.15	-18.61	83.54	-28.13	10.75	3.62	93.01	3470.96
168.00	81.50	-17.39	77.77	-24.36	11.71	3.67	85.40	3474.41
172.00	74.86	-15.43	72.17	-19.91	12.88	3.55	77.66	3287.71
174.00	68.31	-14.04	66.27	-16.57	14.20	3.55	70.41	3248.09
178.00	62.72	-2.65	62.65	-2.90	15.93	0.74	62.79	658.05
180.00	66.42	2.91	66.34	3.38	15.04	-0.77	66.51	-676.37
184.00	81.01	1.80	80.97	2.55	12.34	-0.39	81.05	-335.70
186.00	83.45	-4.90	83.15	-7.13	11.94	1.02	83.76	876.55
190.00	66.62	-11.46	65.29	-13.23	14.71	2.98	67.97	2497.63
192.00	60.74	-7.84	60.18	-8.29	16.31	2.25	61.32	1862.08
196.00	56.53	2.68	56.47	2.64	17.67	-0.83	56.59	-671.72
198.00	57.88	8.18	57.29	8.24	17.10	-2.46	58.48	-1976.03
200.00	61.17	12.51	59.71	13.25	15.96	-3.54	62.65	-2818.20
202.00	65.75	15.03	63.50	17.05	14.69	-3.94	68.08	-3107.74
204.00	70.76	15.49	68.19	18.90	13.62	-3.78	73.42	-2945.12
208.00	76.83	14.11	74.51	18.73	12.62	-3.17	79.22	-2428.73
210.00	78.29	13.62	76.09	18.44	12.41	-3.01	80.56	-2279.82
214.00	81.46	14.70	78.80	20.67	11.87	-3.12	84.22	-2316.83
216.00	84.20	15.59	81.10	22.62	11.44	-3.19	87.41	-2351.34
220.00	91.45	16.06	87.88	25.30	10.51	-3.02	95.16	-2188.28
222.00	94.76	16.18	91.01	26.41	10.13	-2.94	98.67	-2108.67
226.00	105.01	17.62	100.08	31.78	9.08	-2.88	110.17	-2029.52
228.00	112.97	17.44	107.77	33.86	8.44	-2.65	118.41	-1852.26
232.00	131.51	14.21	127.49	32.28	7.37	-1.87	135.66	-1280.24
234.00	139.70	11.79	136.75	28.54	7.01	-1.46	142.71	-994.57
238.00	158.93	7.28	157.65	20.15	6.24	-0.80	160.22	-533.37
240.00	171.75	4.61	171.20	13.81	5.80	-0.47	172.31	-310.52
244.00	209.01	-4.90	208.24	-17.87	4.77	0.41	209.78	266.84
246.00	228.23	-12.87	222.50	-50.84	4.27	0.98	234.12	631.49
250.00	239.63	-34.05	198.54	-134.18	3.46	2.34	289.22	1487.62

200 kHz-BA

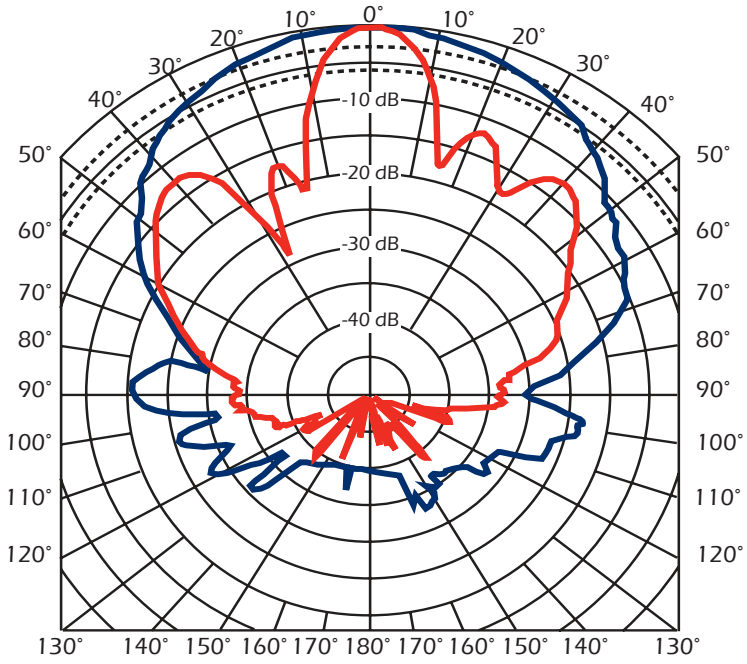


Power Rating: 100 W rms @ 2% duty cycle
6.6 mm (0.26") x 29 mm (1.15") PZT
Active Area: 1.9 cm^2
Urethane Window

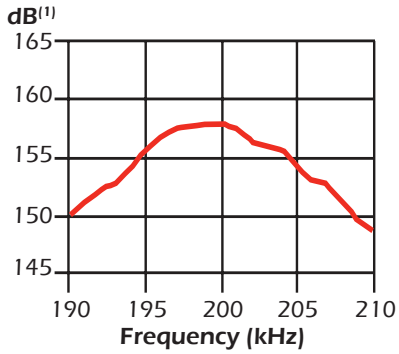
Beamwidth:
-3 dB: 13° x 50°
-6 dB: 22° x 70°
-10 dB: 28° x 90°

Directivity Index:	17
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	159 dB
Peak TVR(1), minimum:	156 dB
Q (transmit):	26
Peak Source Level(4):	204 dB
Peak RVR(2), nominal:	-187 dB
Peak Figure of Merit(3):	-32 dB

Transmit Radiation Pattern



TVR



RVR

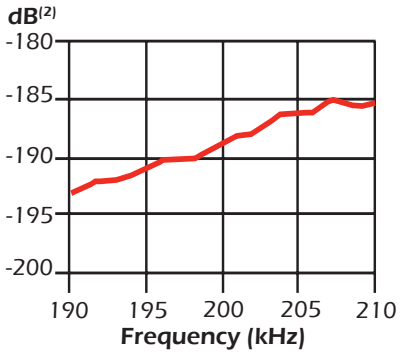
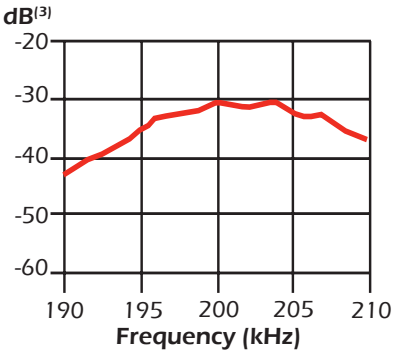


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

200 kHz-BA

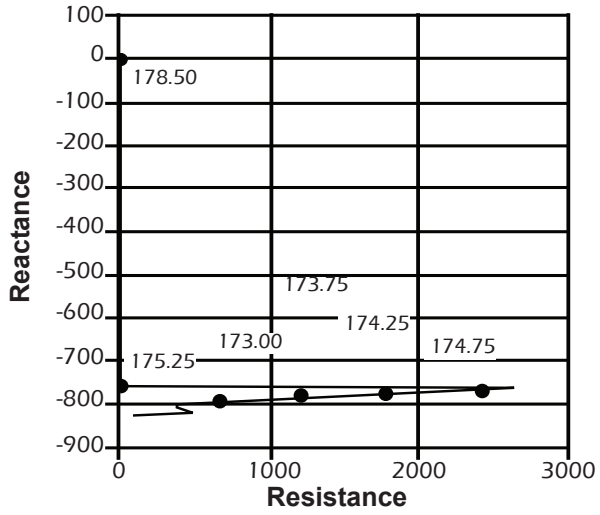
6.6 mm (0.26”) x 29 mm (1.15”) PZT

Cable Type: C47
Cable Length: 9.1 m (30’)

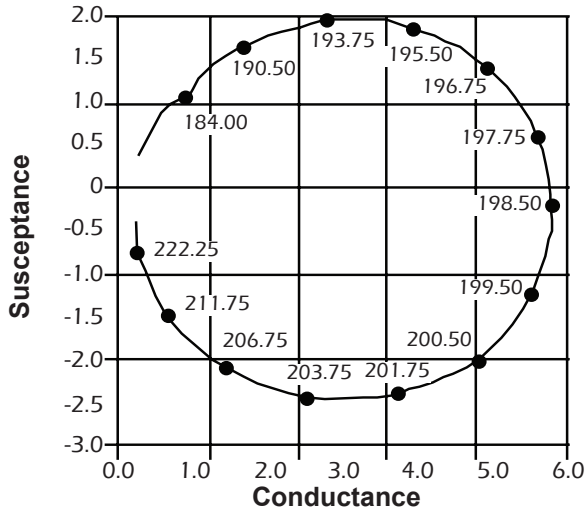
Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	400 Ω: -20%, +40%	400 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	575 pF
Series [R - jX]: (nominal)	450 Ω - j65 Ω	450 Ω - j65 Ω
1 kHz capacitance: (nominal)	130pF ± 20%	1040pF ± 20%

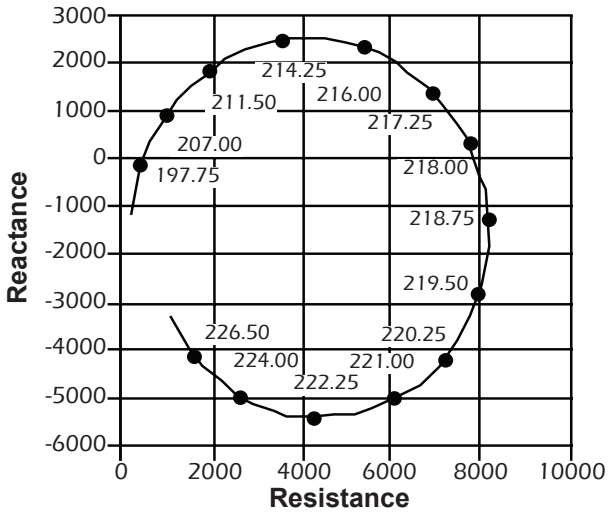
Unbalanced Impedance



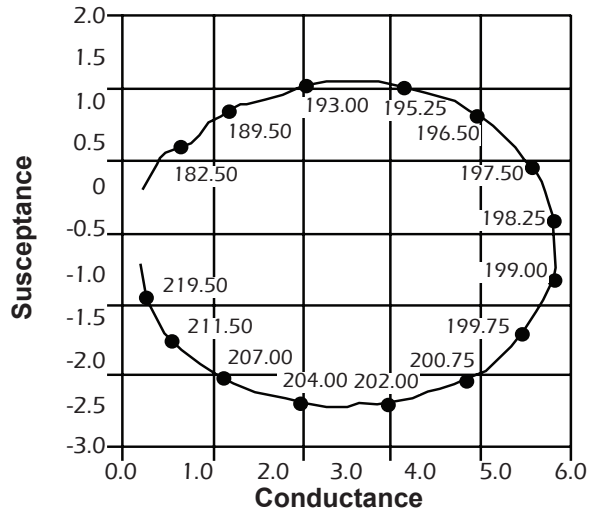
Unbalanced Admittance



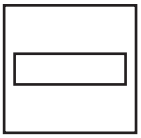
Balanced Impedance



Balanced Admittance



200 kHz-BAlq

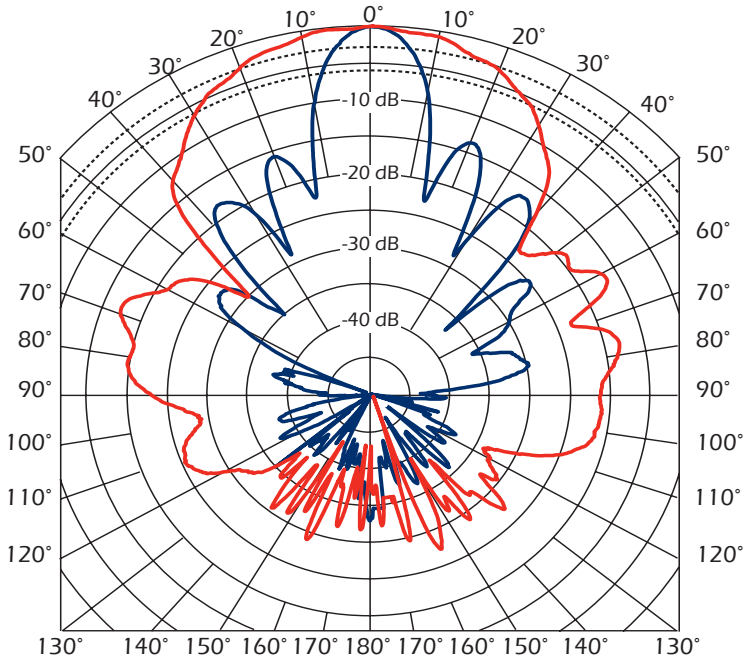


Power Rating: 100 W rms @ 2% duty cycle
6.6 mm (0.26") x 29 mm (1.15") PZT
Active Area: 1.9 cm^2
HPC/Urethane Window

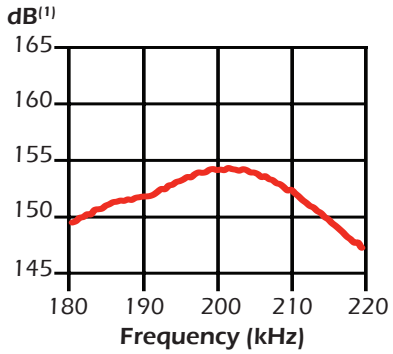
Beamwidth:
-3 dB: 12° x 39°
-6 dB: 16° x 55°
-10 dB: 21° x 67°

Directivity Index:	17 dB
Frequency Tolerance:	± 8 kHz
Peak TVR(1), nominal:	154 dB
Peak TVR(1), minimum:	151 dB
Q (transmit):	7
Peak Source Level(4):	204 dB
Peak RVR(2), nominal:	-190 dB
Peak Figure of Merit(3):	-137 dB

Transmit Radiation Pattern



TVR



RVR

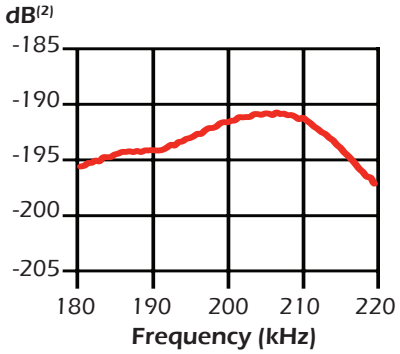
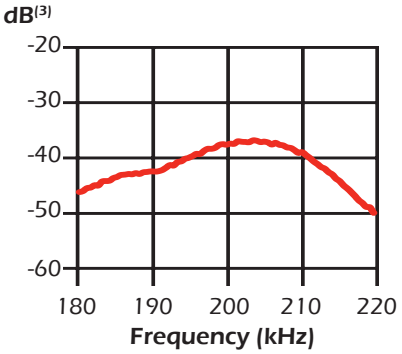


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

200 kHz-BAlq

6.6 mm (0.26”) x 29 mm (1.15”) PZT

Cable Type: C274
Cable Length: 7.6 m (25’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	1150 Ω: -20%, +40%	1150 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,350 pF	1,350 pF
Series [R - jX]: (nominal)	240 Ω - j470 Ω	240 Ω - j470 Ω
1 kHz capacitance: (nominal)	1520pF: ±20%	1520pF: ±20%

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
180.00	510.04	-79.65	91.59	-501.75	0.35	1.93	2840.22	1705.41
181.50	505.68	-78.85	97.80	-496.13	0.38	1.94	2614.68	1701.33
183.00	501.16	-78.02	104.03	-490.25	0.41	1.95	2414.37	1697.56
184.50	498.22	-77.02	111.87	-485.49	0.45	1.96	2218.81	1687.22
186.00	495.69	-76.15	118.69	-481.27	0.48	1.96	2070.20	1676.00
187.50	492.69	-75.28	125.20	-476.52	0.52	1.96	1938.92	1666.29
189.00	490.03	-74.37	132.00	-471.91	0.55	1.97	1819.12	1654.93
190.50	486.82	-73.29	140.01	-466.25	0.59	1.97	1692.73	1643.64
192.00	483.36	-71.87	150.37	-459.37	0.64	1.97	1553.72	1629.85
193.50	482.65	-70.31	162.60	-454.43	0.70	1.95	1432.66	1604.54
195.00	484.79	-68.50	177.65	-451.06	0.76	1.92	1322.92	1566.47
196.50	491.43	-66.54	195.64	-450.81	0.81	1.87	1234.42	1511.89
198.00	502.94	-64.80	214.17	-455.06	0.85	1.80	1181.08	1446.07
199.50	518.07	-63.32	232.66	-462.89	0.87	1.72	1153.62	1375.87
201.00	537.48	-62.23	250.44	-475.56	0.87	1.65	1153.48	1303.51
202.50	558.18	-61.51	266.29	-490.57	0.85	1.57	1170.02	1237.49
204.00	582.60	-60.98	282.60	-509.47	0.83	1.50	1201.09	1171.03
205.50	613.41	-61.18	295.71	-537.43	0.79	1.43	1272.45	1106.18
207.00	646.78	-62.08	302.83	-571.51	0.72	1.37	1381.38	1050.40
208.50	679.13	-64.09	296.74	-610.86	0.64	1.32	1554.24	1011.02
210.00	703.58	-66.75	277.78	-646.43	0.56	1.31	1782.11	989.67
211.50	717.54	-69.88	246.82	-673.76	0.48	1.31	2086.05	984.73
213.00	721.42	-73.00	210.92	-689.90	0.41	1.33	2467.49	990.48
214.50	715.81	-75.84	175.08	-694.07	0.34	1.35	2926.63	1005.07
216.00	703.75	-78.20	143.88	-688.88	0.29	1.39	3442.10	1024.89
217.50	689.04	-80.11	118.39	-678.79	0.25	1.43	4010.18	1046.19
219.00	673.54	-81.64	97.93	-666.39	0.22	1.47	4632.49	1067.51
220.00	662.75	-82.41	87.53	-656.94	0.20	1.50	5017.95	1082.01

200 kHz-BB

Power rating: 250 Wrms @ 2% duty cycle
28mm (1.1") BT
Active Area: 6.1cm²
Layered Plastic Epoxy Window

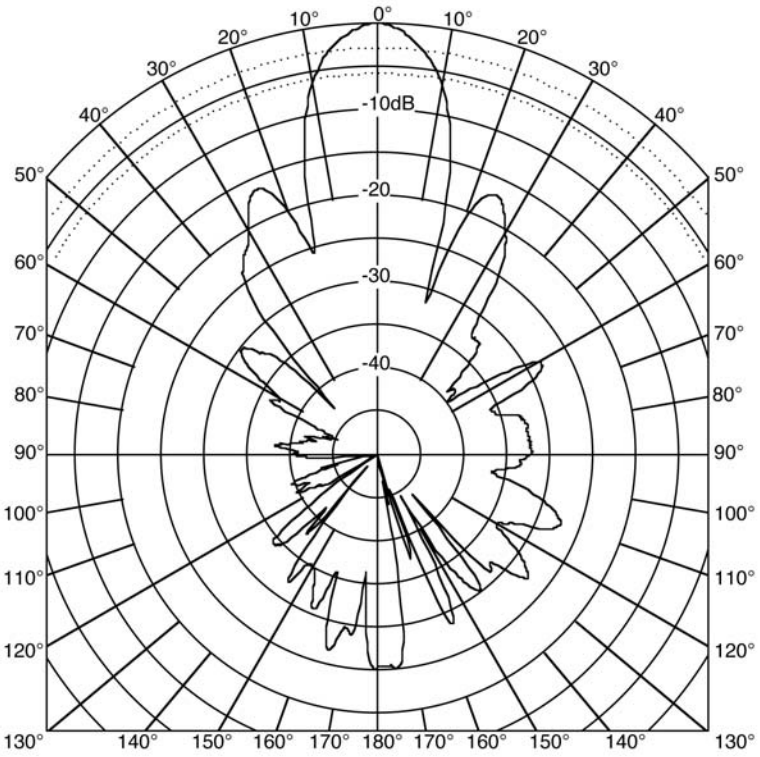
Beamwidth:

-3dB:	14°
-6dB:	19°
-10dB:	24°

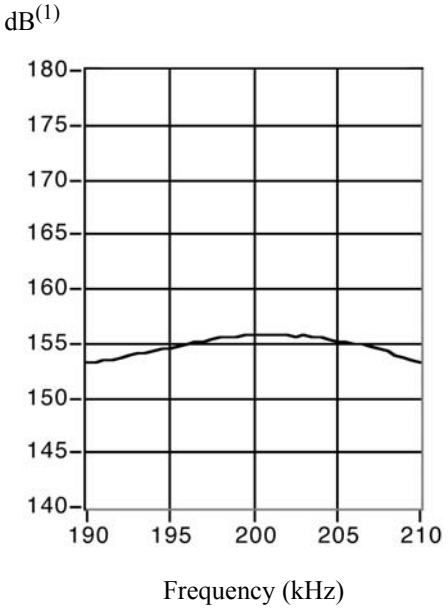
Directivity Index:	21.6
Frequency Tolerance:	±4kHz
Peak TVR(1), nominal:	156dB
Peak TVR(1), minimum:	154dB
Q (transmit):	10
Peak Source Level(4):	212dB
Peak RVR(2), nominal:	-186dB
Peak Figure of Merit(3):	-31dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

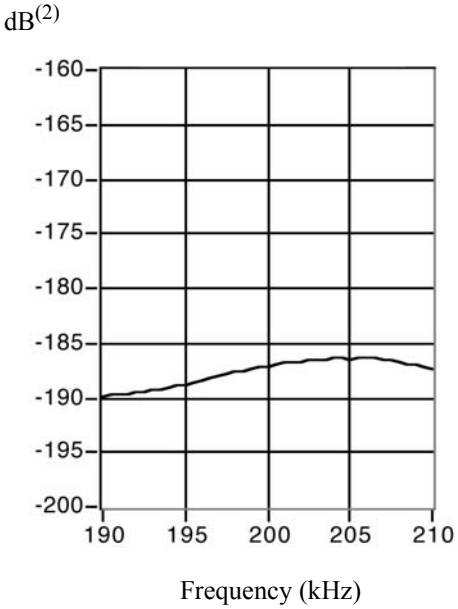
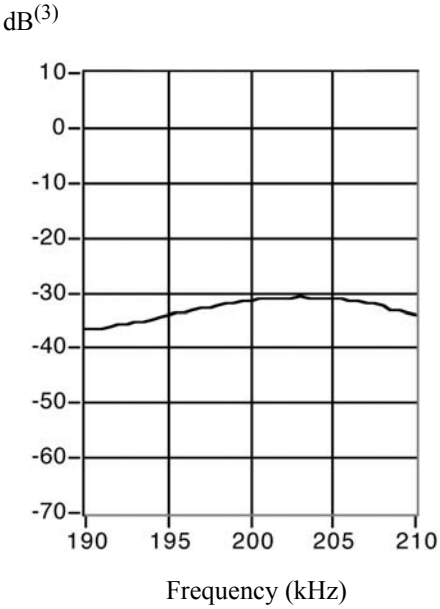


Figure of Merit



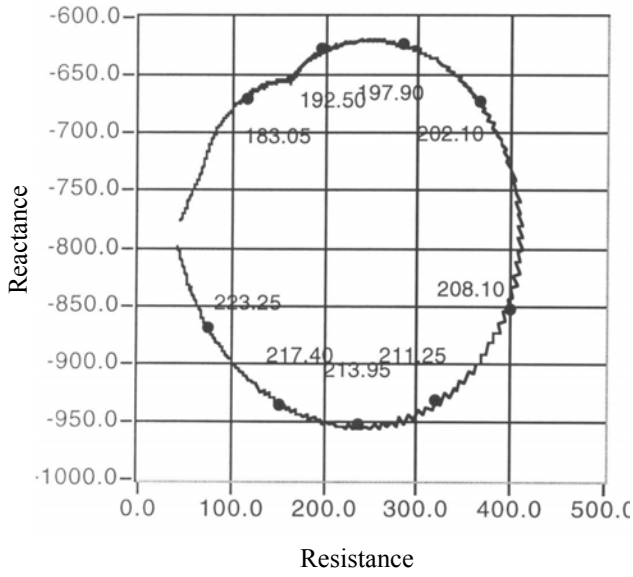
200 kHz-BB

28mm (1.1") BT

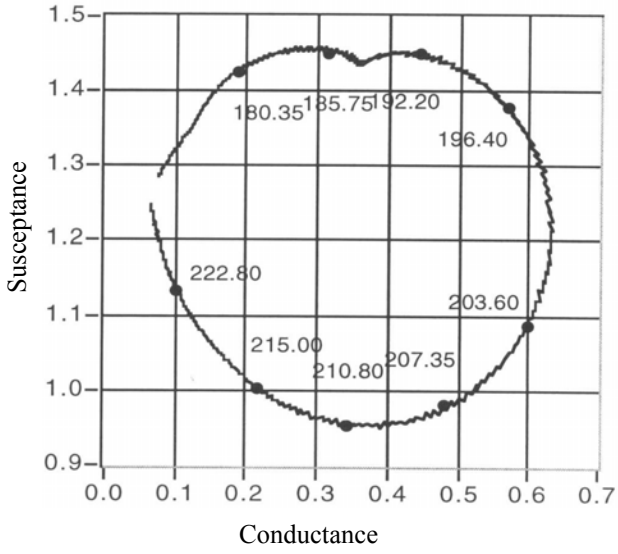
Cable Type: C2
Cable Length: 7.6m (25')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	1580 ohms-20%, +40%	1585 ohms-20%, +40%
Parallel: Cp. (nominal)	990 pF	990 pF
Series [R – jX] (nominal)	325 – 640 ohms	315 – j635 ohms
1 kHz Capacitance	1060±20%	1070±20%

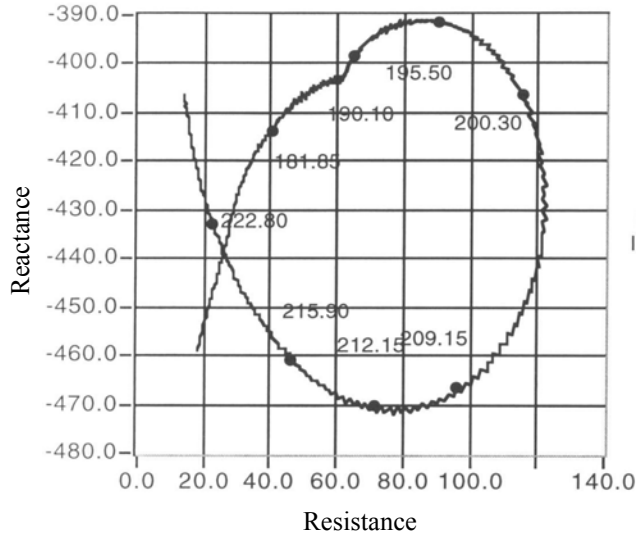
Unbalanced Impedance



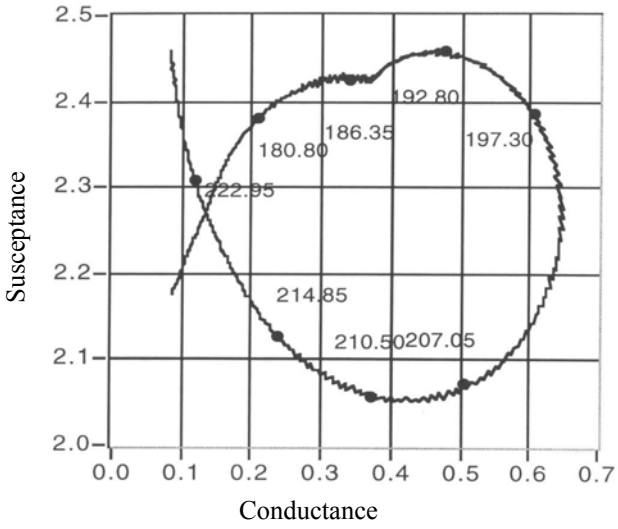
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



200 kHz-BB

Power rating: 250 Wrms @ 2% duty cycle
28mm (1.1") BT
Active Area: 6.1cm²
Layered Plastic Urethane Window

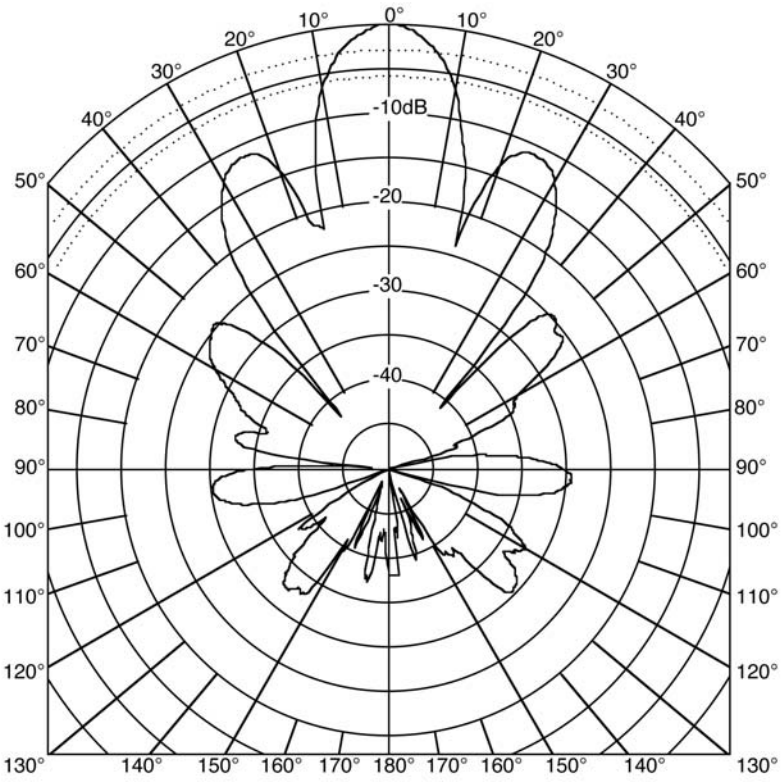
Beamwidth:

-3dB:	14°
-6dB:	19°
-10dB:	24°

Directivity Index:	21.6
Frequency Tolerance:	+4/-5kHz
Peak TVR(1), nominal:	161dB
Peak TVR(1), minimum:	159dB
Q (transmit):	41
Peak Source Level(4):	212dB
Peak RVR(2), nominal:	-187dB
Peak Figure of Merit(3):	-29dB

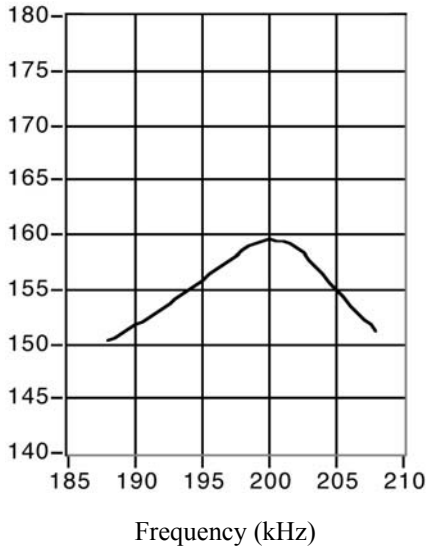
Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR

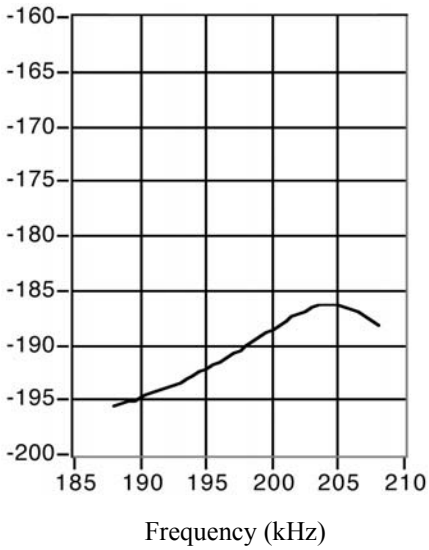
dB(1)



Frequency (kHz)

RVR

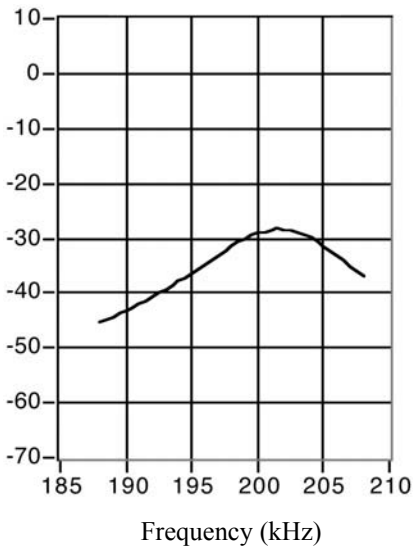
dB(2)



Frequency (kHz)

Figure of Merit

dB(3)



Frequency (kHz)

200 kHz-BB

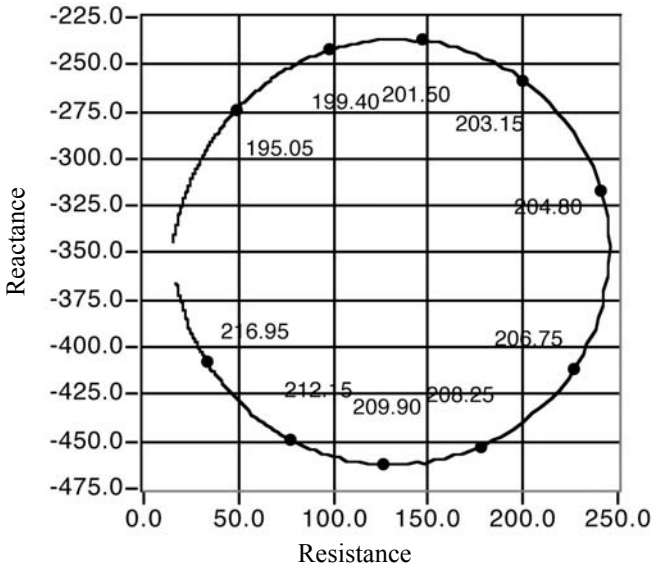
28mm (1.1") BT

Cable Type: C2
Cable Length: 9.1m (30')

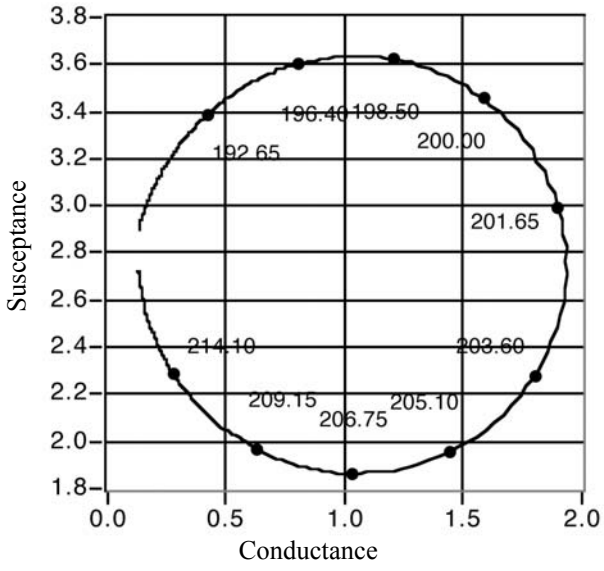
Impedance Data

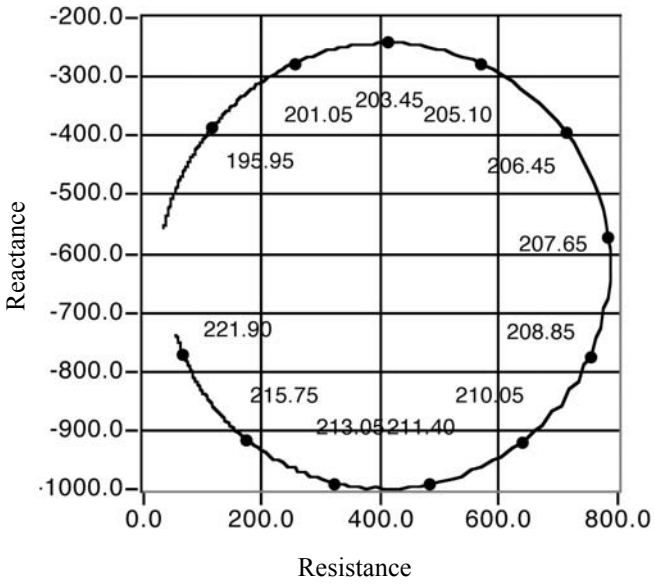
	Balanced	*Unbalanced*
Parallel: Rp.	405ohms-20%,+40%	400ohms-20%,+40%
Parallel: Cp. (nominal)	105pF	950pF
Series [R – jX] (nominal)	540 – j40 ohms	380 – j250ohms
1 kHz Capacitance	1080±20%	1940±20%

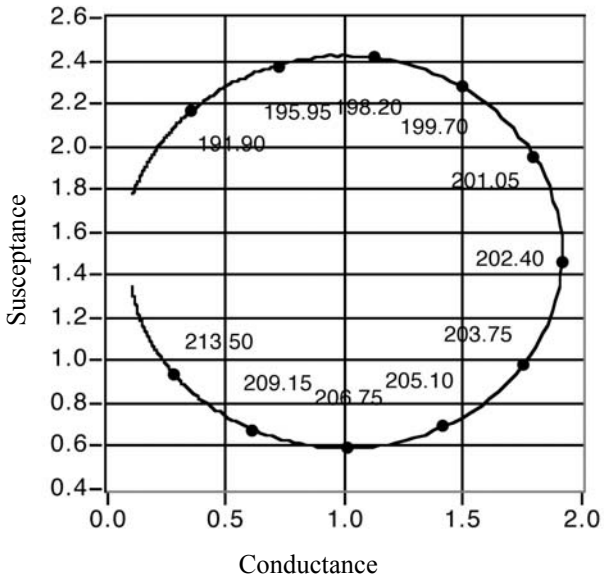
Unbalanced Impedance



Unbalanced Admittance







200 kHz-BB

Power rating: 250 Wrms @ 2% duty cycle
28mm (1.1") BT
Active Area: 6.1cm²
Urethane Window

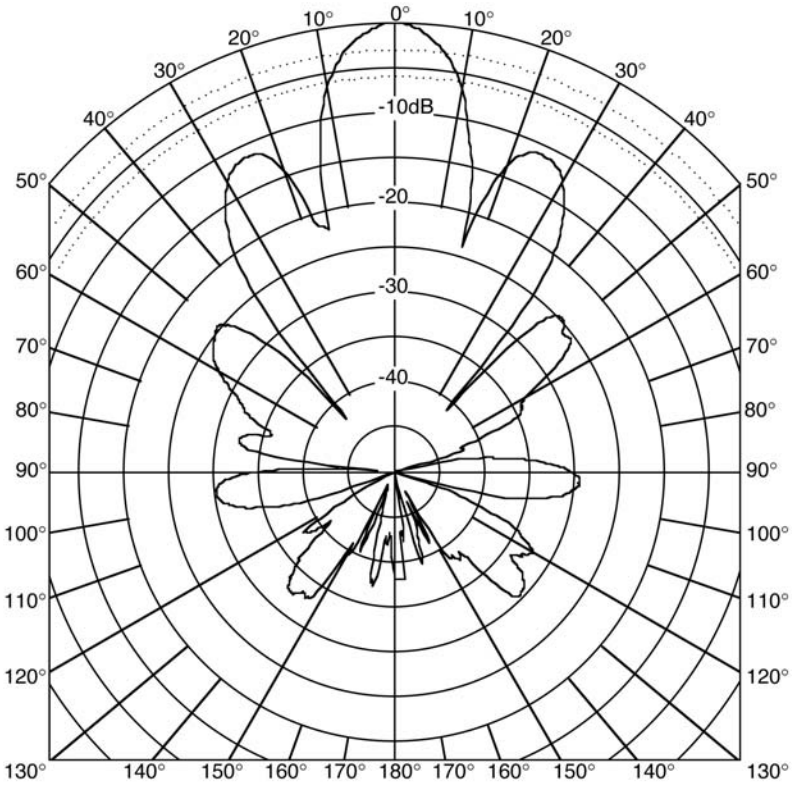
Beamwidth:

-3dB:	14°
-6dB:	19°
-10dB:	23°

Directivity Index:	21.6
Frequency Tolerance:	±4kHz
Peak TVR(1), nominal:	159dB
Peak TVR(1), minimum:	157dB
Q (transmit):	24
Peak Source Level(4):	212dB
Peak RVR(2), nominal:	-187dB
Peak Figure of Merit(3):	-29dB

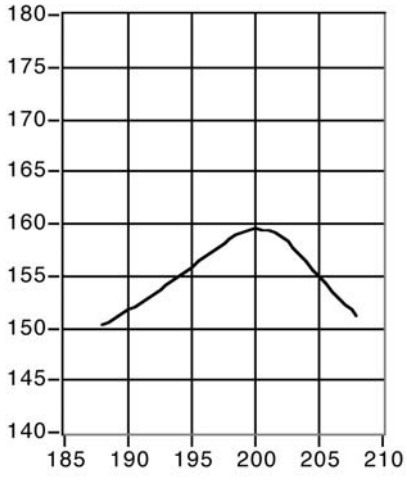
Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR

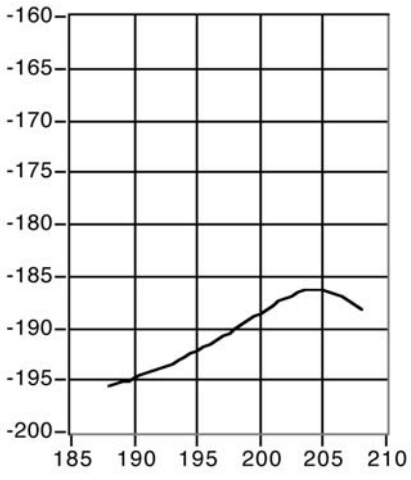
dB(1)



Frequency (kHz)

RVR

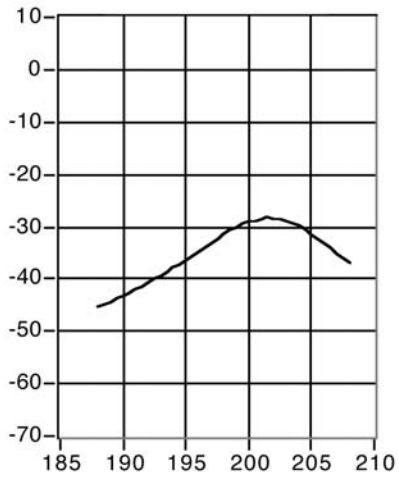
dB(2)



Frequency (kHz)

Figure of Merit

dB(3)



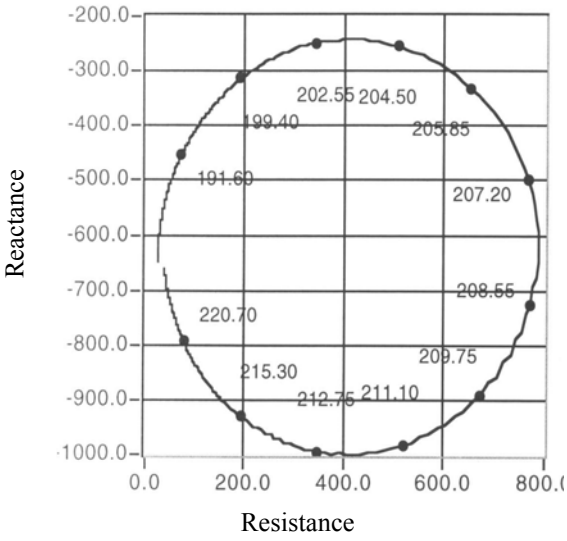
Frequency (kHz)

200 kHz-BB

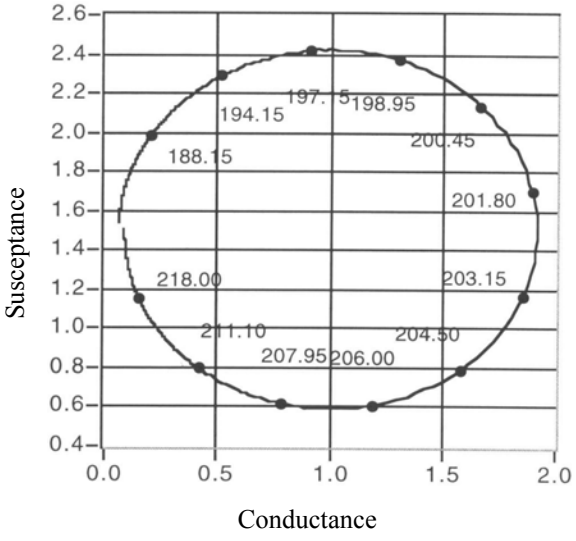
28mm (1.1") BT
Cable Type: C2
Cable Length: 9.1m (30')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	545 ohms -20%, +40%	525 ohms -20%, +40%
Parallel: Cp. (nominal)	1775pF	1680pF
Series [R – jX] (nominal)	210 – j300 ohms	300 – j250 ohms
1 kHz Capacitance	1300±20%	1300±20%

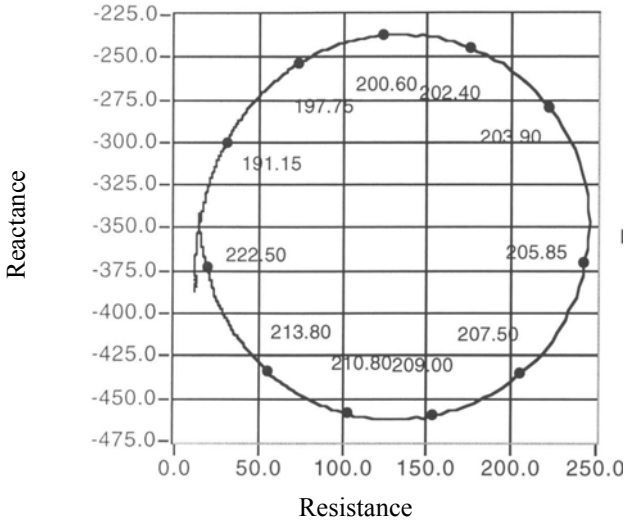
Unbalanced Impedance



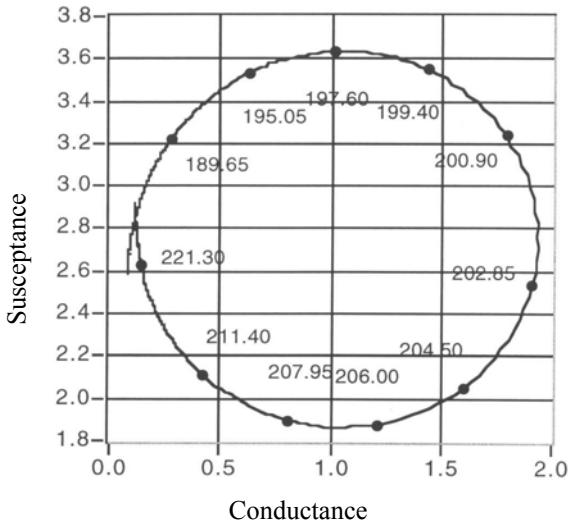
Unbalanced Admittance



Balanced Impedance



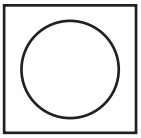
Balanced Admittance



200 kHz | 500 W

200 kHz-BC

Array

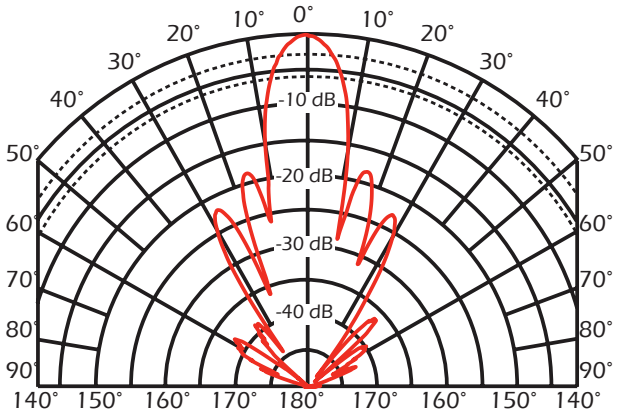


Power Rating: 500W rms @ 1% duty cycle
51 mm (2”) PZT
Active Area: 20.4 cm^2
Radiating Surface: Urethane

Beamwidth:
-3 dB: 9°
-6 dB: 12°
-10 dB: 15°

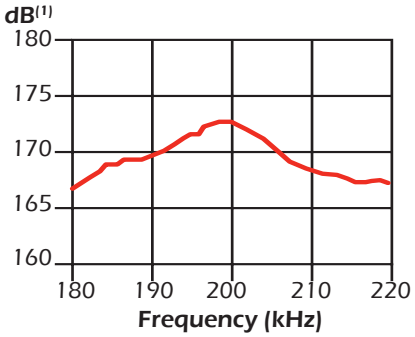
Directivity Index:	26.8
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	173 dB
Peak TVR(1), minimum:	171 dB
Q (transmit):	9
Peak Source Level(4):	220 dB
Peak RVR(2), nominal:	-186 dB
Peak Figure of Merit(3):	-13 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

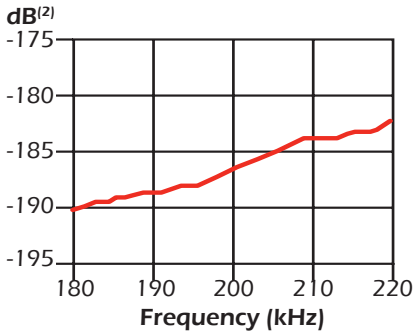
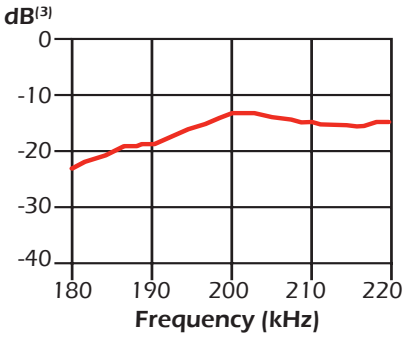


Figure of Merit



200 kHz-BC

51 mm (2”) PZT

Cable Type: C189-02
Cable Length: 4.6 m (15’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	100 Ω: -20%, +40%	100 Ω: -20%, +40%
Parallel: Cp. (nominal)	800 pF	1000 pF
Series [R - jX]: (nominal)	100 - j15 Ω	100 - j15 Ω
1 kHz capacitance: (nominal)	3850 pF	4090 pF

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
180.00	132.91	-65.38	55.37	-120.83	3.13	6.84	319.02	5884.35
181.00	130.00	-63.29	58.42	-116.13	3.46	6.87	289.25	5880.08
182.00	126.47	-61.78	59.80	-111.43	3.74	6.97	267.45	5929.94
183.00	123.11	-58.86	63.67	-105.37	4.20	6.95	238.03	5885.26
185.00	118.73	-53.91	69.94	-95.94	4.96	6.81	201.56	5701.33
186.00	119.50	-50.94	75.30	-92.79	5.27	6.50	189.65	5414.66
187.00	118.79	-48.71	78.39	-89.26	5.55	6.33	180.02	5243.03
188.00	120.50	-46.04	83.64	-86.74	5.76	5.97	173.60	4926.62
190.00	120.46	-43.56	87.29	-83.01	6.02	5.72	166.22	4668.96
191.00	119.44	-42.82	87.60	-81.19	6.14	5.69	162.84	4621.22
192.00	115.86	-40.83	87.67	-75.75	6.53	5.64	153.12	4558.66
193.00	113.96	-38.73	88.90	-71.30	6.85	5.49	146.09	4413.00
195.00	107.84	-32.79	90.66	-58.40	7.80	5.02	128.28	3995.80
196.00	105.99	-28.49	93.15	-50.57	8.29	4.50	120.60	3564.00
197.00	104.20	-23.23	95.76	-41.10	8.82	3.78	113.40	2982.10
198.00	105.61	-18.04	100.42	-32.70	9.00	2.93	111.07	2298.75
200.00	112.01	-6.64	111.26	-12.95	8.87	1.03	112.76	801.39
201.00	117.92	-1.89	117.85	-3.88	8.48	0.28	117.98	215.64
202.00	126.56	3.68	126.30	8.12	7.89	-0.51	126.82	-389.60
203.00	139.02	7.07	137.97	17.11	7.14	-0.89	140.09	-677.45
205.00	170.41	13.06	166.00	38.52	5.72	-1.33	174.94	-1005.29
206.00	186.27	14.36	180.46	46.19	5.20	-1.33	192.28	-1004.10
207.00	210.55	14.76	203.61	53.63	4.59	-1.21	217.73	-908.17
208.00	230.91	12.73	225.24	50.87	4.22	-0.95	236.73	-712.79
210.00	264.62	7.44	262.39	34.28	3.75	-0.49	266.87	-362.41
211.00	267.53	5.95	266.09	27.72	3.72	-0.39	268.98	-285.36
212.00	275.00	5.29	273.83	25.36	3.62	-0.34	276.18	-245.99
213.00	278.89	5.73	277.50	27.82	3.57	-0.36	280.29	-261.15
215.00	310.77	6.35	308.86	34.37	3.20	-0.36	312.69	-257.45
216.00	322.03	5.04	320.79	28.30	3.09	-0.27	323.28	-196.55
217.00	331.63	3.61	330.97	20.89	3.01	-0.19	332.29	-136.21
218.00	328.29	4.43	327.31	25.36	3.04	-0.24	329.28	-167.91
220.00	360.43	9.28	355.71	58.14	2.74	-0.45	365.21	-316.55

200 kHz-BCIq Broadband

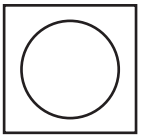
Transformed to 60 ohms

Power Rating:500W rms @ 2% duty cycle
51 mm (2") PZT
Active Area: 20.4 cm^2
Radiating Surface: Urethane

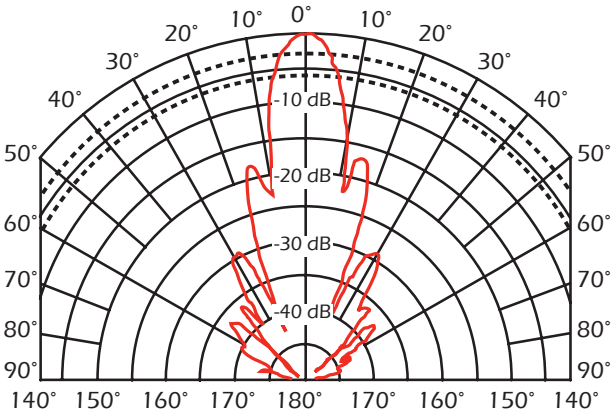
Beamwidth:
-3 dB: 8°
-6 dB: 11°
-10 dB: 14°

Directivity Index:	26.8
Frequency Tolerance:	± 8 kHz
Peak TVR(1), nominal:	176 dB
Peak TVR(1), minimum:	174 dB
Q (transmit):	2
Peak Source Level(4):	221 dB
Peak RVR(2), nominal:	-186.4 dB
Peak Figure of Merit(3):	-10.8 dB

Array

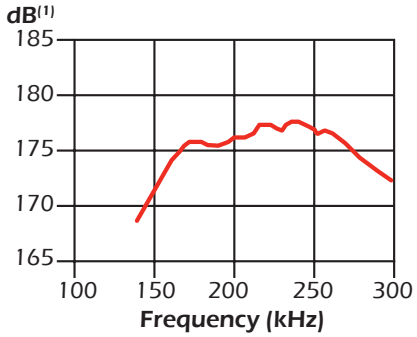


Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

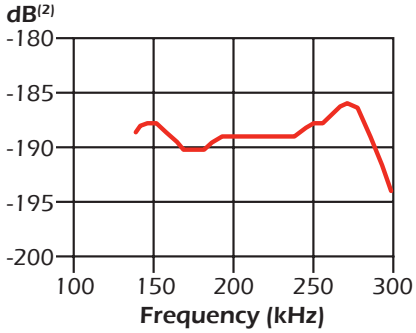
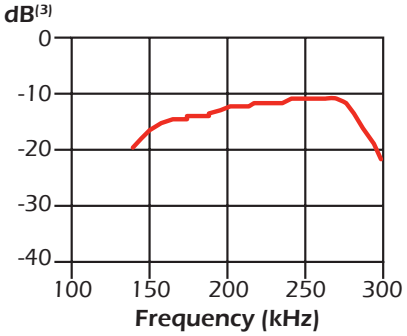


Figure of Merit



200 kHz-BClq Broadband

51 mm (2”) PZT

Cable Type: C33
Cable Length: 10.1 m (33’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	-5870 pF	-4430 pF
Series [R - jX]: (nominal)	40 - j10 Ω	40 - j10 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Unbalanced Impedance Table

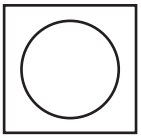
Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
140.00	95.20	43.49	69.06	65.52	7.62	-7.23	131.22	-8218.95
145.00	94.87	29.13	82.87	46.18	9.21	-5.13	108.60	-5632.14
150.00	89.71	16.02	86.23	24.76	10.71	-3.08	93.34	-3263.69
155.00	75.54	3.39	75.41	4.47	13.22	-0.78	75.67	-803.79
160.00	60.46	-0.35	60.46	-0.37	16.54	0.10	60.46	100.74
165.00	49.83	1.13	49.82	0.99	20.07	-0.40	49.84	-383.03
170.00	44.59	7.44	44.21	5.77	22.24	-2.90	44.97	-2719.49
175.00	43.62	13.13	42.48	9.91	22.33	-5.21	44.79	-4736.03
180.00	44.47	18.66	42.13	14.23	21.31	-7.19	46.93	-6361.71
185.00	48.90	21.87	45.38	18.22	18.98	-7.62	52.69	-6553.23
190.00	54.45	20.14	51.12	18.75	17.24	-6.32	58.00	-5297.87
195.00	56.35	14.53	54.54	14.14	17.18	-4.45	58.21	-3634.05
200.00	55.17	12.00	53.96	11.47	17.73	-3.77	56.40	-2999.64
205.00	55.39	11.07	54.36	10.64	17.72	-3.47	56.44	-2691.35
210.00	56.52	7.75	56.00	7.62	17.53	-2.39	57.04	-1808.74
215.00	53.42	5.28	53.20	4.91	18.64	-1.72	53.65	-1274.65
220.00	50.67	6.88	50.31	6.07	19.59	-2.36	51.04	-1709.34
225.00	52.27	11.04	51.30	10.00	18.78	-3.66	53.25	-2590.54
230.00	57.50	8.92	56.81	8.91	17.18	-2.70	58.20	-1864.98
235.00	54.79	6.69	54.42	6.38	18.13	-2.13	55.17	-1440.43
239.00	54.97	10.08	54.13	9.62	17.91	-3.18	55.84	-2120.28
244.00	59.88	12.84	58.38	13.31	16.28	-3.71	61.42	-2421.38
250.00	70.13	10.67	68.91	12.98	14.01	-2.64	71.36	-1680.78
255.00	73.58	5.57	73.23	7.14	13.53	-1.32	73.93	-823.04
260.00	76.96	5.57	76.60	7.47	12.93	-1.26	77.33	-772.44
265.00	89.13	3.78	88.93	5.87	11.20	-0.74	89.32	-443.88
270.00	104.72	-2.83	104.59	-5.17	9.54	0.47	104.85	277.66
275.00	119.04	-15.23	114.86	-31.27	8.11	2.21	123.38	1277.10
280.00	123.23	-30.23	106.47	-62.05	7.01	4.09	142.63	2322.61
285.00	115.31	-44.79	81.84	-81.24	6.15	6.11	162.49	3411.74
290.00	102.83	-56.40	56.91	-85.64	5.38	8.10	185.79	4445.33
295.00	87.83	-65.75	36.08	-80.08	4.68	10.38	213.81	5600.40
300.00	74.03	-71.03	24.07	-70.01	4.39	12.77	227.70	6777.20

200 kHz-BCIq Broadband

Transformed to 100 ohms

Power Rating:500W rms @ 2% duty cycle
51 mm (2") PZT
Active Area: 20.4 cm^2 (3.16 in^2)
Radiating Surface: Urethane

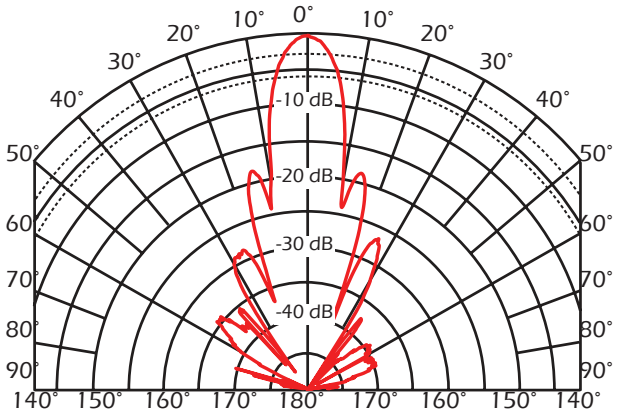
Array



Beamwidth:
-3 dB: 8°
-6 dB: 11°
-10 dB: 14°

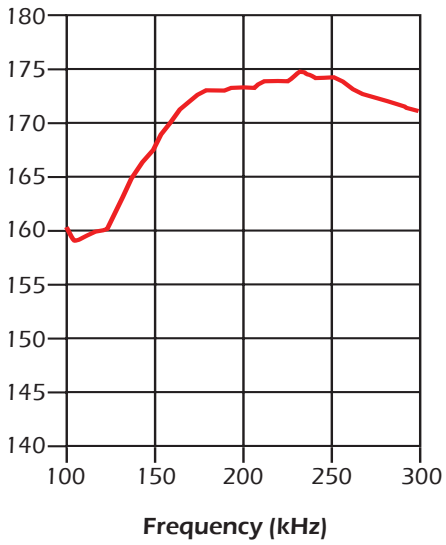
Directivity Index:	26.8
Frequency Tolerance:	± 8 kHz
Peak TVR(1), nominal:	173 dB
Peak TVR(1), minimum:	171 dB
Q (transmit):	2
Peak Source Level(4):	220 dB
Peak RVR(2), nominal:	-188.4 dB
Peak Figure of Merit(3):	-11 dB

Transmit Radiation Pattern

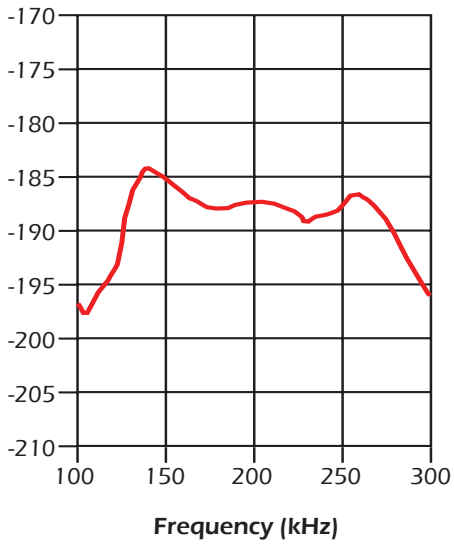


Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

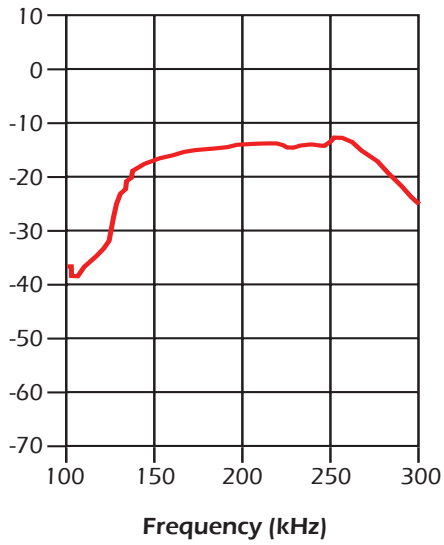
TVR



RVR



FOM



200 kHz-BCIq Broadband

51 mm (2”) PZT

Cable Type: C33
Cable Length: 26 m (85’)

Note:
Impedance data includes cable

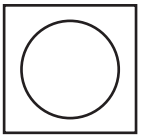
Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	100 Ω: -20%, +40%	100 Ω: -20%, +40%
Parallel: Cp. (nominal)	1100 pF	1350 pF
Series [R - jX]: (nominal)	85 - j10 Ω	80 - j10 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
100.00	68.10	82.90	8.41	67.58	1.81	-14.57	551.21	-23191.55
101.00	69.90	82.78	8.78	69.35	1.80	-14.19	556.43	-22365.09
109.00	88.39	80.64	14.38	87.22	1.84	-11.16	543.30	-16298.36
116.00	110.61	75.17	28.31	106.93	2.31	-8.74	432.26	-11990.95
123.00	136.10	70.54	45.34	128.33	2.45	-6.93	408.58	-8964.10
130.00	194.82	57.78	103.89	164.81	2.74	-4.34	365.35	-5316.13
137.00	226.22	29.09	197.67	110.00	3.86	-2.15	258.88	-2497.11
144.00	201.44	6.36	200.20	22.32	4.93	-0.55	202.69	-607.92
151.00	156.95	-10.79	154.17	-29.39	6.26	1.19	159.78	1257.63
158.00	124.73	-15.51	120.19	-33.36	7.73	2.14	129.45	2159.62
165.00	98.02	-17.48	93.50	-29.45	9.73	3.06	102.77	2956.33
172.00	84.00	-14.04	81.49	-20.38	11.55	2.89	86.59	2673.15
179.00	79.05	-6.80	78.49	-9.35	12.56	1.50	79.61	1330.99
186.00	85.33	-3.13	85.20	-4.66	11.70	0.64	85.46	547.61
193.00	87.83	-5.23	87.47	-8.01	11.34	1.04	88.20	856.44
198.00	89.38	-4.62	89.09	-7.19	11.15	0.90	89.67	723.75
199.00	90.82	-4.99	90.48	-7.90	10.97	0.96	91.17	765.99
200.00	91.85	-4.99	91.51	-7.99	10.85	0.95	92.20	753.86
201.00	92.47	-5.24	92.09	-8.45	10.77	0.99	92.86	782.07
202.00	94.51	-6.01	93.99	-9.90	10.52	1.11	95.03	873.39
210.00	92.19	-14.57	89.23	-23.19	10.50	2.73	95.26	2067.72
217.00	87.08	-13.91	84.52	-20.94	11.15	2.76	89.71	2025.14
224.00	88.36	-18.25	83.91	-27.67	10.75	3.54	93.04	2518.12
231.00	77.21	-15.69	74.33	-20.88	12.47	3.50	80.20	2413.50
238.00	85.02	-10.28	83.65	-15.17	11.57	2.10	86.40	1403.65
245.00	91.93	-12.16	89.87	-19.37	10.63	2.29	94.04	1488.80
252.00	106.94	-10.84	105.03	-20.11	9.18	1.76	108.88	1110.49
259.00	128.73	-23.35	118.18	-51.02	7.13	3.08	140.21	1892.16
266.00	130.29	-37.00	104.06	-78.40	6.13	4.62	163.13	2763.47
273.00	124.66	-50.76	78.85	-96.55	5.07	6.21	197.08	3622.42
279.00	110.28	-61.26	53.02	-96.70	4.36	7.95	229.37	4535.66
286.00	92.06	-68.87	33.19	-85.86	3.92	10.13	255.32	5638.50
292.00	80.03	-72.22	24.44	-76.21	3.82	11.90	262.09	6485.11
299.00	69.13	-75.90	16.84	-67.05	3.52	14.03	283.78	7467.32
300.00	67.69	-76.33	15.99	-65.77	3.49	14.36	286.48	7615.78

200 kHz-BF Broadband

Array

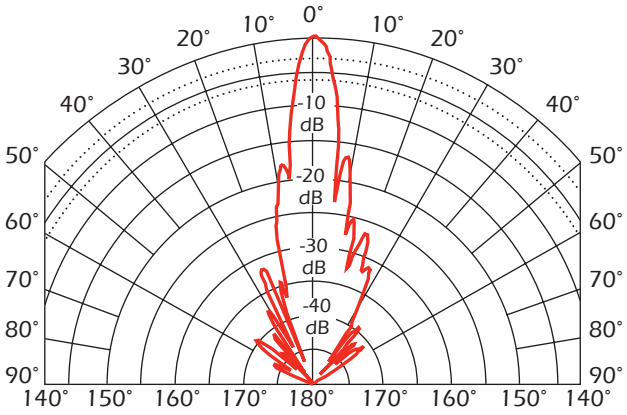


Ceramics wired in parallel
Transformed to 100 ohms
Power Rating: 2 kW rms @ 2% duty cycle
88 mm (3.5”) PZT
Active Area: 61 cm^2
Urethane Window

Beamwidth:
-3 dB: 5°
-6 dB: 7°
-10 dB: 9°

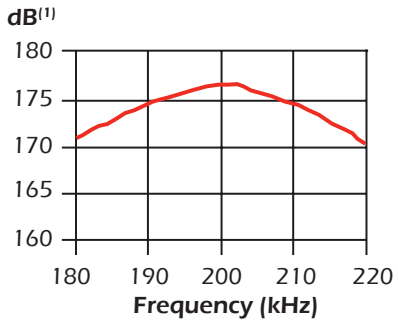
Directivity Index:	31.1
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	176 dB
Peak TVR(1), minimum:	172 dB
Q (transmit):	7.9
Peak Source Level(4):	229 dB
Peak RVR(2), nominal:	-177 dB
Peak Figure of Merit(3):	-5.2 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

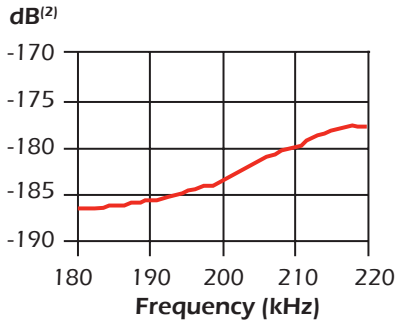
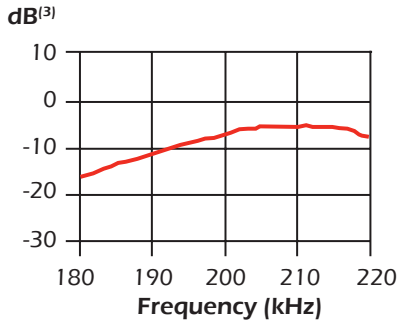


Figure of Merit



200 kHz-BF (Broadband)

88 mm (3.5”) PZT

Cable Type: C37
Cable Length: 10.1 m (33’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	100 Ω: -20%, +40%	100 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,450 pF	1,450 pF
Series [R - jX]: (nominal)	100 - j20 Ω	100 - j20 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

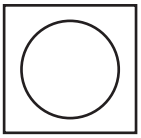
Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
175.00	159.31	-71.44	50.72	-151.02	1.9984	5.9506	500.39	5411.83
176.00	155.52	-70.42	52.12	-146.53	2.1550	6.0582	464.05	5478.35
177.00	151.69	-69.94	52.02	-142.50	2.2607	6.1925	442.35	5565.15
179.00	142.44	-68.50	52.20	-132.53	2.5727	6.5319	388.69	5807.73
180.00	138.94	-67.35	53.50	-128.22	2.7717	6.6423	360.79	5873.10
181.00	135.47	-66.60	53.81	-124.33	2.9318	6.7744	341.09	5956.81
182.00	131.19	-65.75	53.89	-119.61	3.1311	6.9498	319.37	6077.46
183.00	127.20	-64.40	54.97	-114.71	3.3972	7.0898	294.36	6166.00
184.00	124.14	-62.80	56.74	-110.42	3.6815	7.1646	271.63	6197.17
186.00	118.01	-60.67	57.81	-102.89	4.1507	7.3874	240.92	6321.21
187.00	114.36	-59.06	58.80	-98.08	4.4962	7.4997	222.41	6382.98
188.00	111.87	-56.79	61.28	-93.59	4.8965	7.4787	204.23	6331.27
189.00	110.41	-55.56	62.44	-91.06	5.1222	7.4695	195.23	6290.02
190.00	107.08	-54.53	62.14	-87.21	5.4192	7.6052	184.53	6370.54
191.00	102.81	-52.23	62.96	-81.27	5.9569	7.6892	167.87	6407.16
193.00	98.64	-47.12	67.12	-72.28	6.8982	7.4284	144.97	6125.76
194.00	96.64	-44.90	68.45	-68.21	7.3300	7.3045	136.42	5992.49
195.00	93.74	-41.92	69.75	-62.63	7.9371	7.1276	125.99	5817.43
196.00	92.25	-38.08	72.61	-56.89	8.5334	6.6859	117.19	5429.07
197.00	92.78	-34.53	76.44	-52.59	8.8795	6.1091	112.62	4935.49
198.00	93.13	-31.85	79.11	-49.14	9.1217	5.6659	109.63	4554.34
200.00	93.98	-25.46	84.86	-40.39	9.6075	4.5733	104.09	3639.33
201.00	94.45	-21.58	87.83	-34.75	9.8449	3.8946	101.58	3083.82
202.00	95.77	-18.76	90.68	-30.81	9.8868	3.3587	101.15	2646.27
203.00	95.51	-15.21	92.17	-25.06	10.1031	2.7465	98.98	2153.33
204.00	96.91	-10.36	95.33	-17.43	10.1509	1.8564	98.51	1448.33
205.00	101.56	-5.62	101.07	-9.94	9.7995	0.9639	102.05	748.33
207.00	113.24	0.62	113.23	1.22	8.8306	-0.0952	113.24	-73.21
208.00	119.75	4.69	119.35	9.80	8.3225	-0.6834	120.16	-522.94
209.00	130.66	7.61	129.51	17.30	7.5860	-1.0132	131.82	-771.59
210.00	142.62	8.55	141.04	21.20	6.9336	-1.0420	144.23	-789.75
211.00	151.81	9.61	149.68	25.34	6.4948	-1.0995	153.97	-829.32
212.00	163.36	11.37	160.16	32.21	6.0012	-1.2068	166.63	-906.00
213.00	179.08	11.46	175.51	3558.00	5.4727	-1.1094	182.73	-828.97
214.00	191.22	10.34	188.12	34.31	5.1448	-0.9383	194.37	-697.80
216.00	210.78	12.62	205.68	46.06	4.6297	-1.0367	215.99	-763.87

200 kHz-BFlq Broadband

Transformed to 60 ohms

Power Rating: 2 kW @ 1% duty cycle
89 mm (3.46”) PZT
Active Area: 61 cm² (9.4 in²)
Radiating Surface:
Cast Resin/Urethane

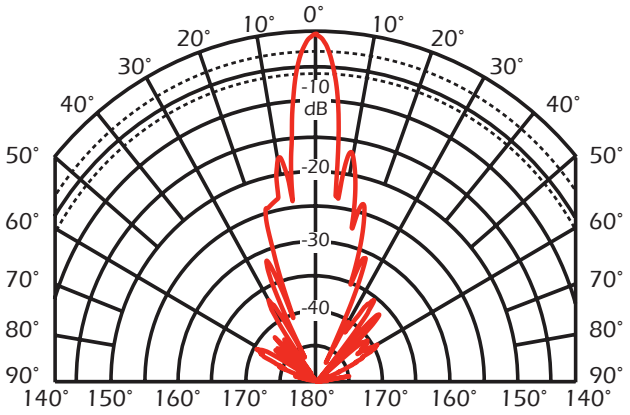
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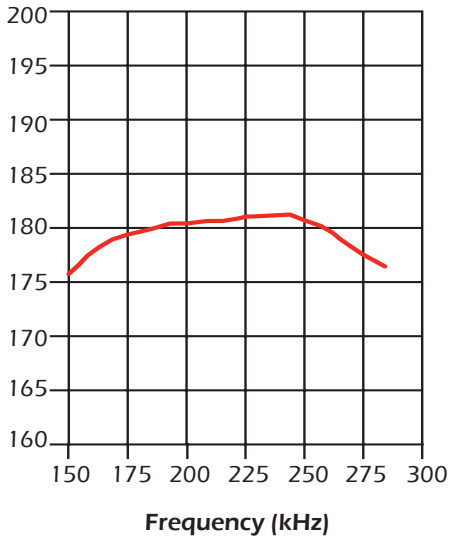
Beamwidth:
-3 dB: 5°
-6 dB: 7°
-10 dB: 9°

Directivity Index:	31.6
Frequency Tolerance:	± 8 kHz
Peak TVR(1), nominal:	181.0 dB
Peak TVR(1), minimum:	179.0 dB
Q (transmit):	2.1
Peak Source Level(4):	231 dB
Peak RVR(2), nominal:	-184.0 dB
Peak Figure of Merit(3):	-2.6 dB

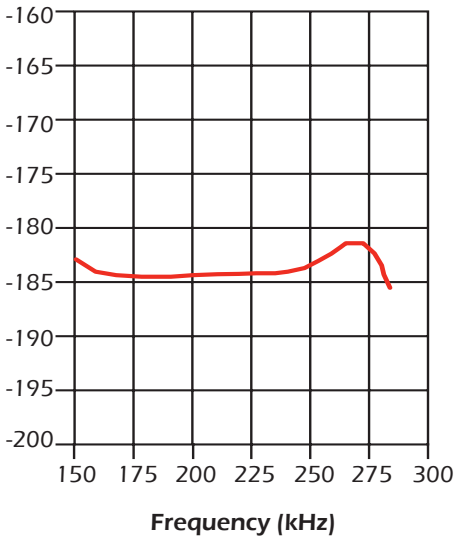
Transmit Radiation Pattern



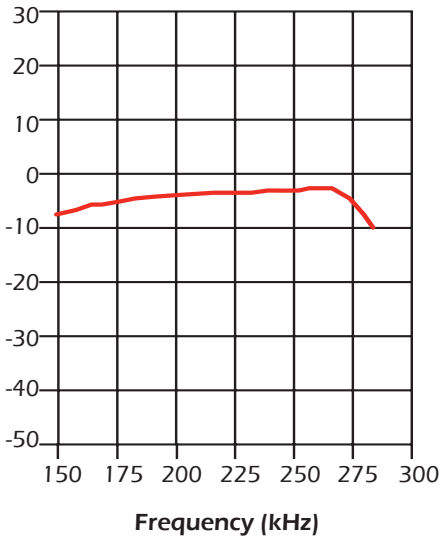
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

200 kHz-BFlq Broadband

88 mm (3.46”) PZT

Cable Type: C33
Cable Length: 10 m (33’)

Note:
Impedance data includes cable

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	60 Ω: -20%, +40%
Parallel: Cp. (nominal)	-2740 pF	-1220 pF
Series [R - jX]: (nominal)	50 - j10 Ω	50 - j10 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
150.00	85.97	-10.52	84.53	-15.70	11.44	2.12	87.44	2253.55
155.00	69.77	-9.85	68.74	-11.94	14.12	2.45	70.81	2518.83
160.00	63.14	-6.02	62.79	-6.62	15.75	1.66	63.49	1652.62
165.00	56.93	-4.67	56.74	-4.63	17.51	1.43	57.12	1379.65
170.00	56.03	-0.03	56.03	-0.03	17.85	0.01	56.03	10.07
175.00	55.84	1.21	55.83	1.18	17.90	-0.38	55.85	-344.25
180.00	54.85	2.24	54.80	2.14	18.22	-0.71	54.89	-629.00
185.00	54.40	4.44	54.24	4.21	18.33	-1.42	54.57	-1224.32
190.00	55.10	5.25	54.87	5.04	18.07	-1.66	55.34	-1390.45
195.00	55.60	6.15	55.28	5.96	17.88	-1.93	55.92	-1573.13
200.00	56.76	5.53	56.50	5.47	17.54	-1.70	57.03	-1350.90
205.00	57.29	5.65	57.01	5.64	17.37	-1.72	57.57	-1335.00
210.00	58.45	6.20	58.11	6.31	17.01	-1.85	58.79	-1399.71
215.00	59.64	4.53	59.46	4.71	16.71	-1.32	59.83	-979.62
220.00	59.94	4.78	59.73	4.99	16.62	-1.39	60.15	-1004.91
225.00	60.99	4.58	60.79	4.87	16.34	-1.31	61.18	-925.72
230.00	61.07	3.93	60.93	4.19	16.33	-1.12	61.22	-776.86
235.00	62.69	5.77	62.37	6.30	15.87	-1.60	63.01	-1086.16
240.00	64.62	6.37	64.22	7.17	15.38	-1.72	65.02	-1138.18
245.00	67.53	8.70	66.75	10.21	14.64	-2.24	68.31	-1454.75
250.00	76.84	10.54	75.54	14.05	12.79	-2.38	78.16	-1515.33
255.00	87.09	9.04	86.01	13.69	11.34	-1.80	88.18	-1126.52
260.00	102.20	5.74	101.69	10.22	9.74	-0.98	102.72	-598.93
265.00	123.82	-2.75	123.68	-5.93	8.07	0.39	123.97	232.39
270.00	138.43	-16.11	132.99	-38.42	6.94	2.00	144.09	1181.75
275.00	142.86	-32.04	121.10	-75.78	5.93	3.71	168.52	2149.02
280.00	130.58	-48.24	86.96	-97.41	5.10	5.71	196.08	3247.18
285.00	110.69	-58.83	57.29	-94.70	4.68	7.73	213.84	4316.72

200 kHz-BG

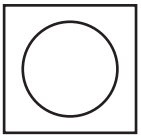
Please see 200 kHz-BB for technical data information.

200 kHz-BB and 200 kHz-BG are very similar, except 200 kHz-BG ceramic has a tighter frequency tolerance.

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200 kHz-BH

Array

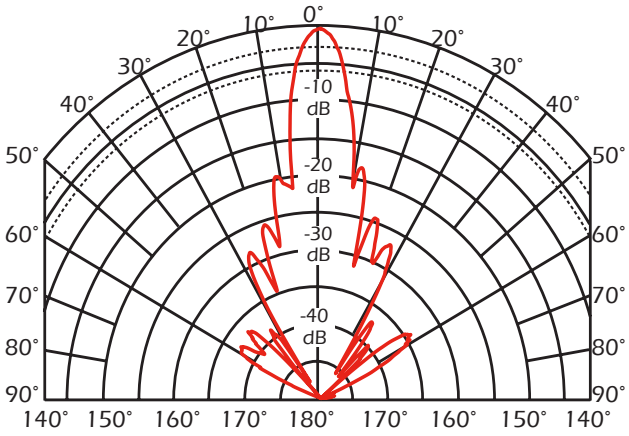


with Parallel Inductor
Power Rating: 1 kW rms @ 1% duty cycle
65 mm (2.56") PZT
Active Area: 33 cm^2 (5.1 in^2)
Urethane Window

Beamwidth:
-3 dB: 6°
-6 dB: 9°
-10 dB: 12°

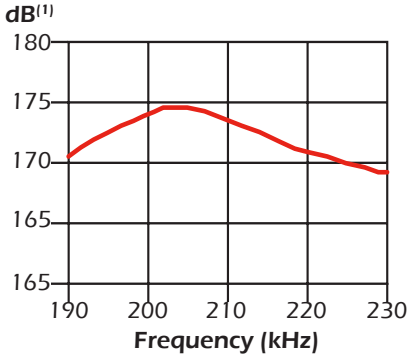
Directivity Index:	27
Frequency Tolerance:	± 8 kHz
Peak TVR(1), nominal:	175 dB
Peak TVR(1), minimum:	173 dB
Q (transmit):	9
Peak Source Level(4):	225 dB
Peak RVR(2), nominal:	-180 dB
Peak Figure of Merit(3):	-10 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

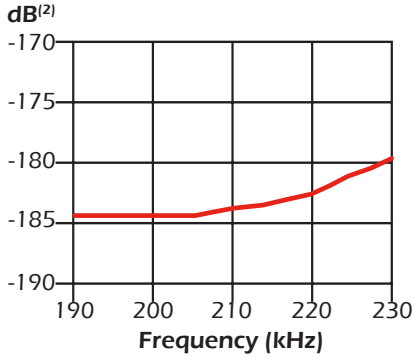
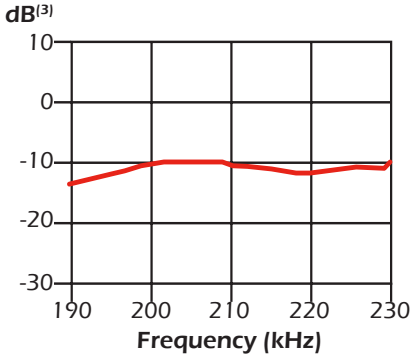


Figure of Merit



200 kHz-BH

65 mm (2.56”) PZT

Cable Type: C44-02
Cable Length: 15.2 m (50’)

Note:
Impedance data includes cable

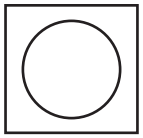
Impedance Data		
	Unbalanced	*Balanced*
Parallel: Rp.	110 Ω: -20%, +40%	110 Ω: -20%, +40%
Parallel: Cp. (nominal)	N/A	N/A
Series [R - jX]: (nominal)	110 - j0 Ω	110 - j0 Ω
1 kHz capacitance: (nominal)	N/A	N/A

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	194.09	-30.58	167.10	-98.74	4.44	2.62	225.44	2195.57
191.00	181.02	-28.83	158.59	-87.29	4.84	2.66	206.63	2219.57
192.00	169.98	-26.79	151.74	-76.61	5.25	2.65	190.42	2197.67
193.00	160.77	-24.47	146.33	-66.60	5.66	2.58	176.64	2124.76
194.00	153.08	-21.92	142.02	-57.14	6.06	2.44	165.00	2000.32
196.00	140.89	-17.27	134.54	-41.82	6.78	2.11	147.54	1710.67
197.00	135.49	-15.07	130.83	-35.23	7.13	1.92	140.31	1550.36
198.00	129.96	-12.74	126.75	-28.67	7.51	1.70	133.24	1364.55
199.00	124.79	-10.04	122.88	-21.76	7.89	1.40	126.73	1117.66
200.00	120.01	-6.97	119.13	-14.56	8.27	1.01	120.91	804.68
202.00	112.57	0.44	112.56	0.86	8.88	-0.07	112.57	-53.21
203.00	110.55	4.71	110.18	9.07	9.01	-0.74	110.93	-582.05
204.00	109.48	9.28	108.05	17.66	9.01	-1.47	110.93	-1149.28
205.00	109.99	13.83	106.80	26.28	8.83	-2.17	113.27	-1686.91
206.00	111.96	18.17	106.38	34.92	8.49	-2.79	117.84	-2152.29
208.00	120.20	25.65	108.36	52.03	7.50	-3.60	133.34	-2755.27
209.00	125.28	28.47	110.13	59.73	7.02	-3.81	142.52	-2897.69
210.00	130.44	30.52	112.36	66.25	6.60	-3.89	151.42	-2950.85
211.00	135.41	32.25	114.52	72.25	6.25	-3.94	160.11	-2972.23
212.00	139.97	33.97	116.09	78.20	5.93	-3.99	168.77	-2996.53
214.00	149.62	37.85	118.15	91.80	5.28	-4.10	189.47	-3049.76
215.00	155.68	39.72	119.74	99.49	4.94	-4.11	202.40	-3038.82
216.00	162.32	41.28	121.98	107.10	4.63	-4.06	216.02	-2995.03
217.00	169.78	42.32	125.54	114.31	4.35	-3.97	229.63	-2908.37
218.00	177.07	43.14	129.20	121.08	4.12	-3.86	242.67	-2819.39
219.00	183.38	43.94	132.04	127.25	3.93	-3.78	254.68	-2750.04
220.00	189.74	45.01	134.13	134.19	3.73	-3.73	268.39	-2696.68
222.00	206.34	47.76	138.71	152.76	3.26	-3.59	306.94	-2572.26
223.00	216.75	48.67	143.14	162.77	3.05	-3.46	328.22	-2472.59
224.00	228.15	49.10	149.39	172.44	2.87	-3.31	348.43	-2353.84
225.00	240.02	49.09	157.17	181.41	2.73	-3.15	366.55	-2227.33
226.00	250.34	49.14	163.79	189.32	2.61	-3.02	382.62	-2127.48
228.00	268.67	49.80	173.43	205.20	2.40	-2.84	416.22	-1984.36
229.00	279.46	50.64	177.23	216.08	2.27	-2.77	440.67	-1922.83
230.00	293.09	51.52	182.38	229.43	2.12	-2.67	470.99	-1848.16

200 kHz-BH

Array

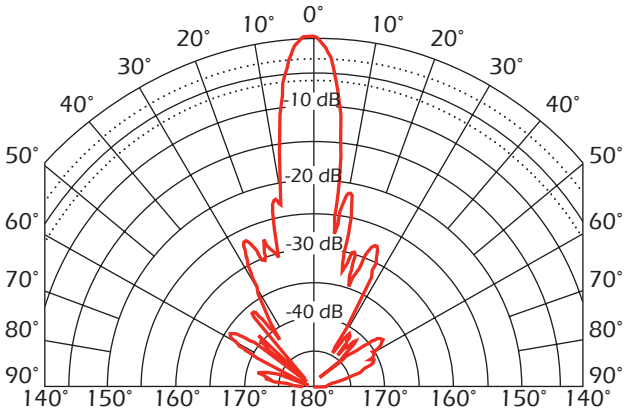


Power Rating: 1 kW rms @ 2% duty cycle
65 mm (2.56") PZT
Active Area: 33 cm^2
Urethane Window

Beamwidth:
-3 dB: 7°
-6 dB: 9°
-10 dB: 12°

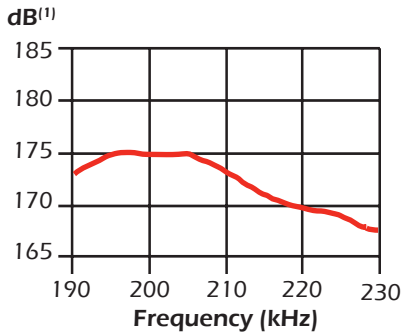
Directivity Index:	29.2
Frequency Tolerance:	± 8 kHz
Peak TVR(1), nominal:	175 dB
Peak TVR(1), minimum:	173 dB
Q (transmit):	8
Peak Source Level(4):	225 dB
Peak RVR(2), nominal:	-182 dB
Peak Figure of Merit(3):	-10 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

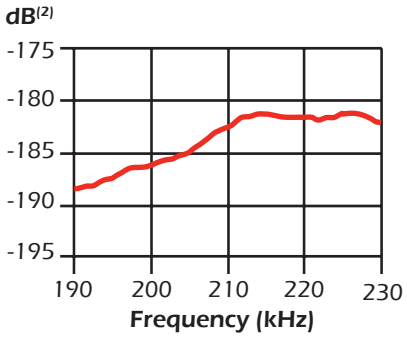
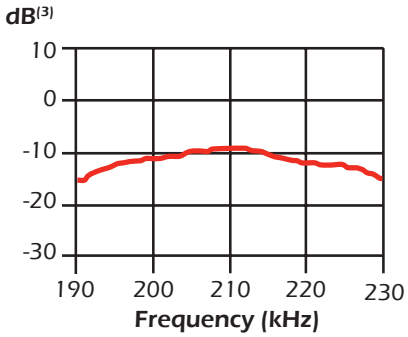


Figure of Merit



200 kHz-BH

65 mm (2.56”) PZT

Cable Type: C332
Cable Length: 10.4 m (34’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	100 Ω: -20%, +40%	100 Ω: -20%, +40%
Parallel: Cp. (nominal)	1510 pF	2960 pF
Series [R - jX]: (nominal)	90 - j20 Ω	90 - j20 Ω
1 kHz capacitance: (nominal)	n/a	n/a

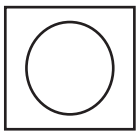
Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
180.00	113.07	-58.93	58.35	-96.84	4.56	7.58	219.08	6698.23
182.00	107.82	-53.34	64.38	-86.49	5.54	7.44	180.57	6505.62
184.00	108.56	-51.18	68.06	-84.58	5.77	7.18	173.17	6207.53
186.00	103.03	-50.53	65.50	-79.53	6.17	7.49	162.07	6410.90
188.00	96.02	-47.75	64.55	-71.08	7.00	7.71	142.81	6526.81
190.00	90.11	-43.14	65.75	-61.62	8.10	7.59	123.50	6356.72
192.00	86.60	-37.24	68.95	-52.40	9.19	6.99	108.78	5791.63
194.00	85.64	-31.05	73.37	-44.18	10.00	6.02	99.97	4941.41
196.00	86.35	-25.03	78.24	-36.53	10.49	4.90	95.30	3978.41
198.00	87.95	-18.86	83.22	-28.43	10.76	3.68	92.94	2955.08
200.00	91.29	-12.38	89.16	-19.57	10.70	2.35	93.46	1868.90
202.00	97.91	-5.46	97.46	-9.31	10.17	0.97	98.35	765.09
204.00	109.37	0.85	109.36	1.62	9.14	-0.14	109.38	-105.59
206.00	126.91	4.76	126.47	10.54	7.85	-0.65	127.35	-505.53
208.00	149.87	6.05	149.03	15.80	6.64	-0.70	150.71	-538.15
210.00	176.36	3.95	175.94	12.15	5.66	-0.39	176.78	-296.08
212.00	199.04	-0.88	199.02	-3.07	5.02	0.08	199.07	58.18
214.00	212.62	-6.34	211.32	-23.47	4.67	0.52	213.93	386.08
216.00	216.04	-10.18	212.64	-38.20	4.56	0.82	219.50	603.05
218.00	223.00	-7.91	220.88	-30.68	4.44	0.62	225.15	450.38
220.00	262.75	-10.18	258.61	-46.46	3.75	0.67	266.96	486.82
222.00	289.51	-17.21	276.54	-85.66	3.30	1.02	303.08	732.73
224.00	311.18	-25.19	281.58	-132.45	2.91	1.37	343.88	971.90
226.00	315.52	-34.23	260.88	-177.47	2.62	1.78	381.60	1255.37
228.00	303.59	-42.01	225.58	-203.17	2.45	2.20	408.57	1538.82
230.00	288.73	-47.76	194.09	-213.76	2.33	2.56	429.51	1774.34

200 kHz-BH

Transformed to 60ohms
Power Rating: 1 kW rms @ 1% duty cycle
65 mm (2.56") PZT
Active Area: 33.2 cm² (5.1 in²)
Radiating Surface: Urethane

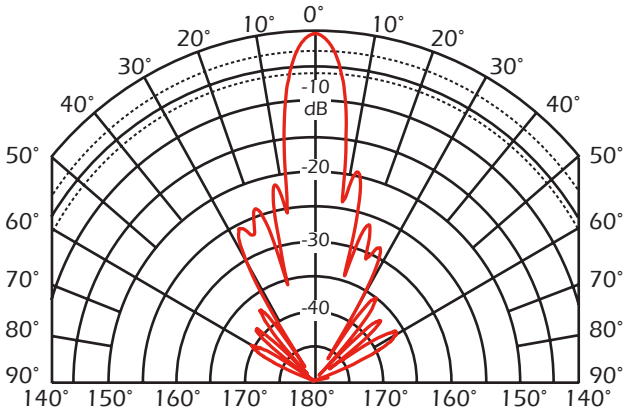
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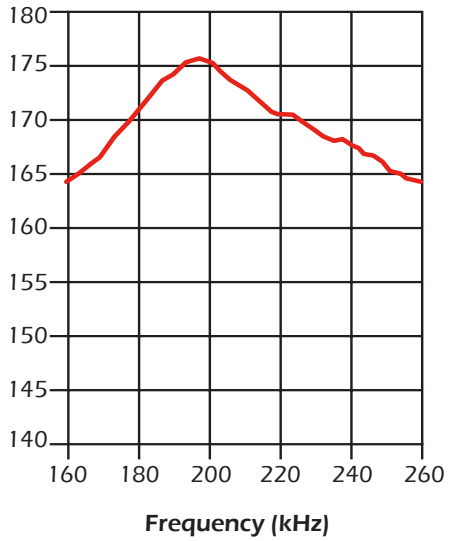
Beamwidth:
-3 dB: 7°
-6 dB: 10°
-10 dB: 13°

Directivity Index:	27
Frequency Tolerance:	± 8 kHz
Peak TVR(1), nominal:	175 dB
Peak TVR(1), minimum:	173 dB
Q (transmit):	8
Peak Source Level(4):	223 dB
Peak RVR(2), nominal:	-180 dB
Peak Figure of Merit(3):	-12 dB

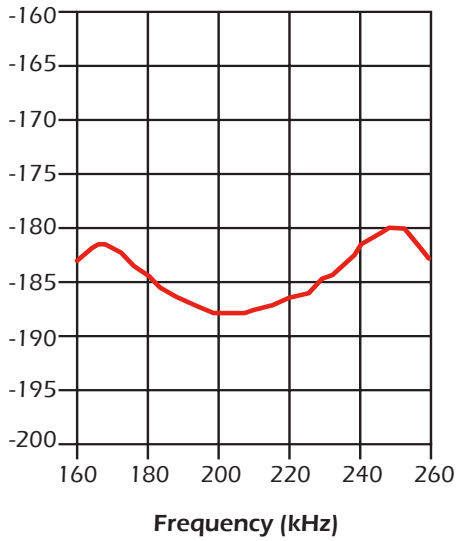
Transmit Radiation Pattern



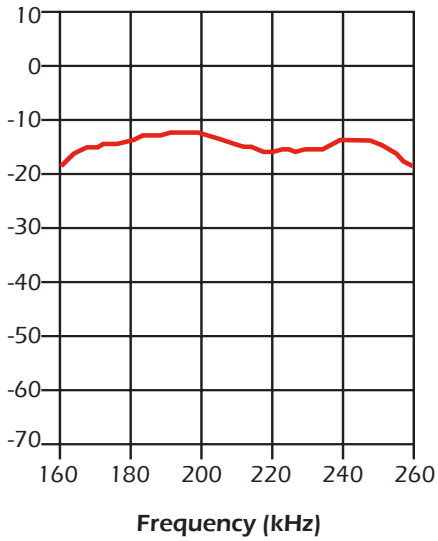
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

200 kHz-BH

Transformed to 60ohms

65 mm (2.56”) PZT

Cable Type: C332
Cable Length: 15 m (50’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	60 Ω: -20%, +40%	70 Ω: -20%, +40%
Parallel: Cp. (nominal)	-3,450 pF	-2,300 pF
Series [R - jX]: (nominal)	60 + j20 Ω	60 + j10 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
160.00	269.07	48.70	177.60	202.13	2.45	-2.79	407.66	-2777.19
162.00	287.99	43.15	210.12	196.95	2.53	-2.37	394.73	-2332.95
166.00	316.84	26.68	283.12	142.24	2.82	-1.42	354.58	-1358.50
168.00	318.05	16.26	305.33	89.06	3.02	-0.88	331.30	-834.06
172.00	270.38	-2.79	270.06	-13.18	3.69	0.18	270.70	166.80
174.00	239.55	-8.92	236.65	-37.15	4.12	0.65	242.48	592.09
178.00	187.39	-17.67	178.54	-56.89	5.08	1.62	196.67	1448.58
180.00	162.44	-21.09	151.56	-58.45	5.74	2.22	174.11	1958.56
184.00	118.33	-21.78	109.89	-43.91	7.85	3.14	127.43	2712.53
190.00	82.86	-9.48	81.73	-13.64	11.90	1.99	84.01	1664.39
192.00	76.92	-5.47	76.57	-7.34	12.94	1.24	77.27	1027.94
196.00	64.70	6.67	64.26	7.51	15.35	-1.79	65.14	-1457.09
198.00	62.36	15.53	60.08	16.69	15.45	-4.29	64.72	-3450.58
202.00	66.11	31.92	56.11	34.96	12.84	-8.00	77.89	-6302.53
204.00	71.46	37.77	56.48	43.77	11.06	-8.57	90.40	-6687.97
208.00	80.62	44.32	57.68	56.33	8.87	-8.67	112.70	-6631.28
210.00	85.47	48.32	56.84	63.83	7.78	-8.74	128.52	-6622.49
214.00	100.66	54.27	58.78	81.71	5.80	-8.06	172.36	-5997.97
216.00	109.72	55.26	62.52	90.16	5.19	-7.49	192.55	-5518.88
220.00	126.37	55.85	70.94	104.58	4.44	-6.55	225.10	-4737.50
222.00	131.73	55.36	74.88	108.38	4.31	-6.25	231.76	-4477.65
226.00	146.15	59.80	73.52	126.31	3.44	-5.91	290.52	-4164.58
228.00	159.97	60.98	77.61	139.89	3.03	-5.47	329.75	-3815.64
234.00	206.64	58.96	106.55	177.06	2.50	-4.15	400.77	-2820.17
238.00	238.51	58.77	123.67	203.95	2.17	-3.59	460.02	-2397.38
240.00	261.84	57.82	139.47	221.61	2.03	-3.23	491.60	-2143.46
244.00	314.68	53.66	186.47	253.48	1.88	-2.56	531.05	-1669.70
246.00	336.35	51.81	207.96	264.36	1.84	-2.34	544.03	-1511.79
250.00	419.08	48.63	276.99	314.49	1.58	-1.79	634.05	-1139.98
252.00	471.05	45.02	332.99	333.17	1.50	-1.50	666.35	-948.34
256.00	605.13	33.71	503.41	335.81	1.37	-0.92	727.42	-570.13
258.00	675.90	25.99	607.53	296.21	1.33	-0.65	751.95	-399.98
260.00	745.32	16.52	714.55	211.95	1.29	-0.38	777.42	-233.56

200 kHz-BL

Transformed to 60 ohms

Power rating: 3 kWrms @ 2% duty cycle
7 x 51 mm (2.01") PZT
Active Area: 143 cm^2

Beamwidth:

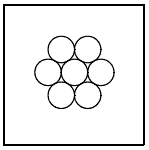
-3dB:	3°
-6dB:	4°
-10dB:	7°

Directivity Index:	35.5
Frequency Tolerance:	±8 kHz
Peak TVR (1), nominal:	180 dB
Peak TVR (1), minimum:	177 dB
Q (transmit):	7
Peak Source Level (4):	232 dB
Peak RVR (2), nominal:	-179 dB
Peak Figure of Merit (3):	-4 dB

Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

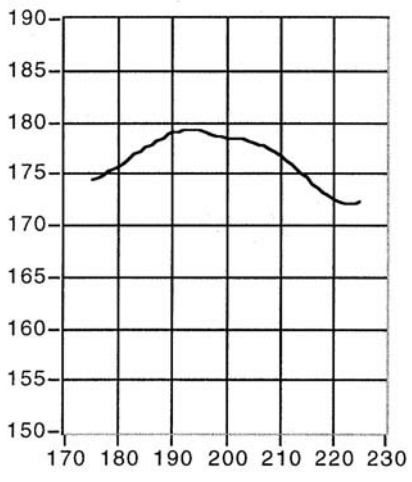
Array:



Transmit Radiation Pattern

TVR

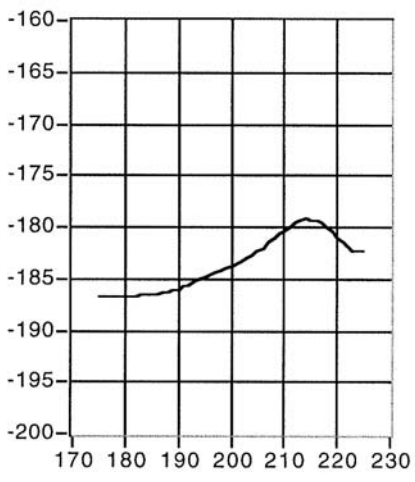
dB(1)



Frequency (kHz)

RVR

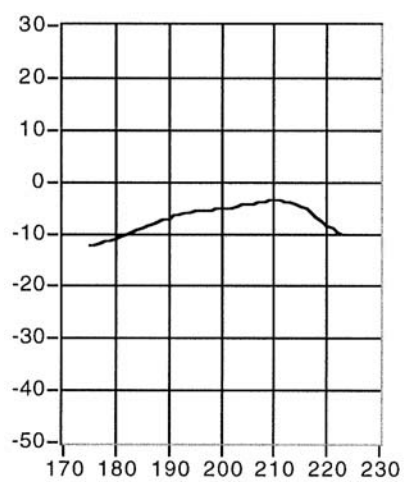
dB(2)



Frequency (kHz)

Figure of Merit

dB(3)



Frequency (kHz)

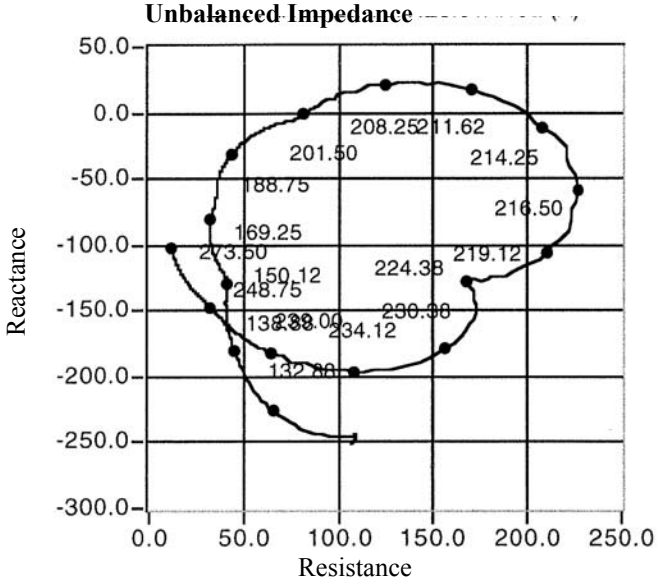
200 kHz-BL

7 x 51mm (2.01") PZT

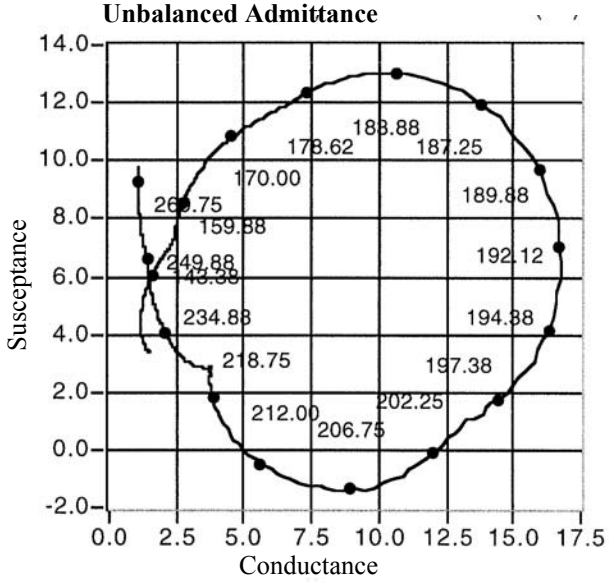
Cable Type: C33
Cable Length: 10.1 m (33.0')

Impedance Data w/transformer		
	Balanced	*Unbalanced*
Parallel: Rp.	60 ohms-20%,+40%	60 ohms-20%,+40%
Parallel: Cp. (nominal)	2300 pF	4730 pF
Series [R – jX] (nominal)	60 – j10 ohms	60 – j20 ohms
1 kHz Capacitance	n/a	n/a

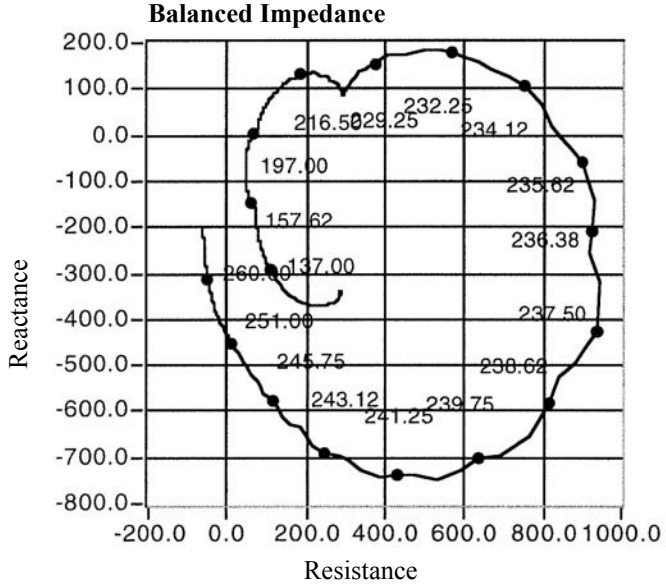
Unbalanced Impedance



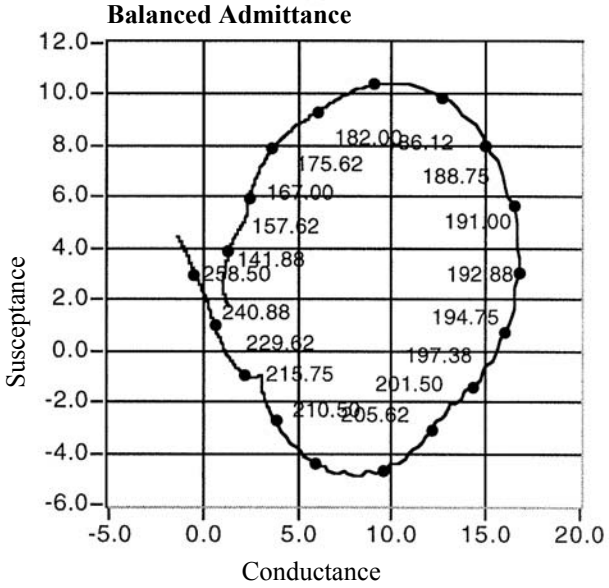
Unbalanced Admittance



Balanced Impedance



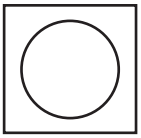
Balanced Admittance





200 kHz-BM

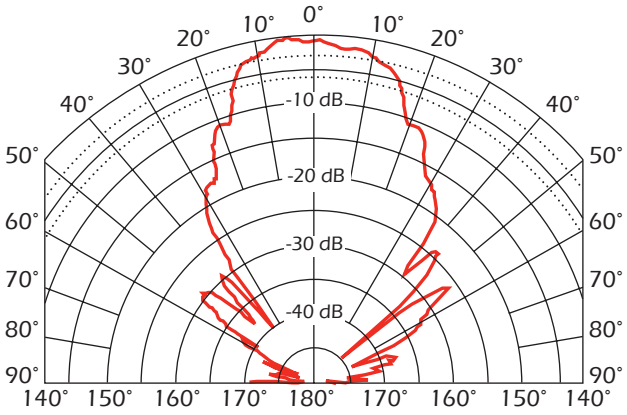
Array



Power Rating: 1 kW rms @ 2% duty cycle
65 mm (2.5") PZT
Active Area: 33 cm^2
Urethane Window

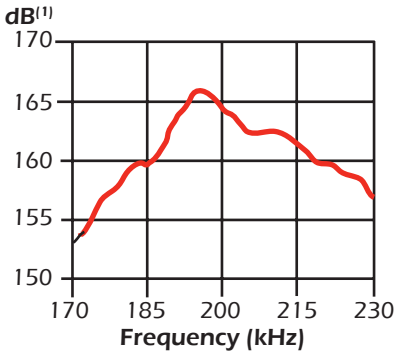
Beamwidth:
-3 dB: 25°
-6 dB: 32°
-10 dB: 36°

Transmit Radiation Pattern



Directivity Index:	17.2
Frequency Tolerance:	± 10 kHz
Peak TVR(1), nominal:	165 dB
Peak TVR(1), minimum:	163 dB
Q (transmit):	7
Peak Source Level(4):	214 dB
Peak RVR(2), nominal:	-194 dB
Peak Figure of Merit(3):	-30 dB

TVR



RVR

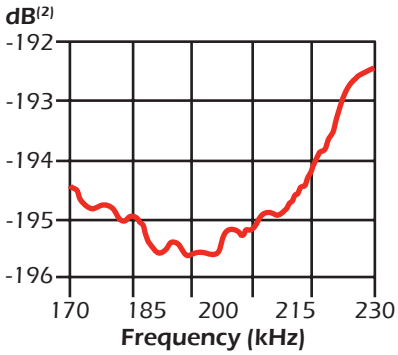
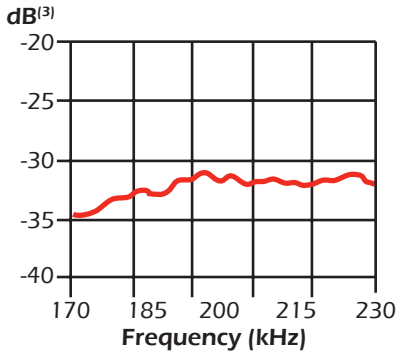


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

200 kHz-BM

65 mm (2.5”) PZT

Cable Type: C332
Cable Length: 10.4 m (34’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	90 Ω: -20%, +40%	90 Ω: -20%, +40%
Parallel: Cp. (nominal)	200 pF	200 pF
Series [R - jX]: (nominal)	96 - j7 Ω	96 - j7 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
170.00	302.52	-57.76	161.39	-255.87	1.76	2.80	567.07	2617.52
173.00	257.79	-58.82	133.47	-220.54	2.01	3.32	497.88	3053.14
176.00	219.90	-58.39	115.26	-187.27	2.38	3.87	419.53	3502.22
179.00	187.05	-56.07	104.41	-155.20	2.98	4.44	335.10	3944.10
182.00	161.78	-51.48	100.76	-126.58	3.85	4.84	259.78	4229.03
185.00	146.93	-45.99	102.08	-105.67	4.73	4.90	211.46	4211.14
188.00	134.57	-41.92	100.13	-89.90	5.53	4.96	180.85	4202.98
191.00	118.76	-37.28	94.50	-71.93	6.70	5.10	149.25	4249.38
194.00	102.02	-28.23	89.89	-48.25	8.64	4.64	115.79	3803.23
197.00	94.13	-12.46	91.92	-20.32	10.37	2.29	96.41	1852.33
200.00	103.69	3.04	103.54	5.50	9.63	-0.51	103.83	-407.04
203.00	121.96	9.86	120.16	20.87	8.08	-1.40	123.79	-1100.29
206.00	130.96	12.94	127.63	29.32	7.44	-1.71	134.37	-1320.94
208.00	135.92	16.67	130.21	39.00	7.05	-2.11	141.89	-1615.25
210.00	140.64	19.94	132.21	47.96	6.68	-2.42	149.61	-1837.72
212.00	144.53	25.35	130.61	61.89	6.25	-2.96	159.94	-2224.20
214.00	157.67	31.76	134.06	82.99	5.39	-3.34	185.44	-2482.77
216.00	177.47	35.56	144.36	103.22	4.58	-3.28	218.17	-2414.79
218.00	194.48	37.37	154.56	118.05	4.09	-3.12	244.72	-2278.61
219.00	202.45	38.60	158.21	126.31	3.86	-3.08	259.06	-2239.69
221.00	222.95	42.02	165.63	149.24	3.33	-3.00	300.10	-2162.18
222.00	236.42	43.39	171.80	162.42	3.07	-2.91	325.34	-2083.14
224.00	266.94	45.53	187.01	190.49	2.62	-2.67	381.04	-1899.38
226.00	303.76	46.72	208.27	221.12	2.26	-2.40	443.04	-1687.66
227.00	325.24	46.95	222.02	237.67	2.10	-2.25	476.45	-1575.34
230.00	404.83	45.72	282.62	289.85	1.72	-1.77	579.89	-1223.85

200 kHz-C

Power rating: 80 Wrms @ 2% duty cycle
16mm (0.64") PZT
Active Area: 2.0cm²
Layered Plastic Urethane Window

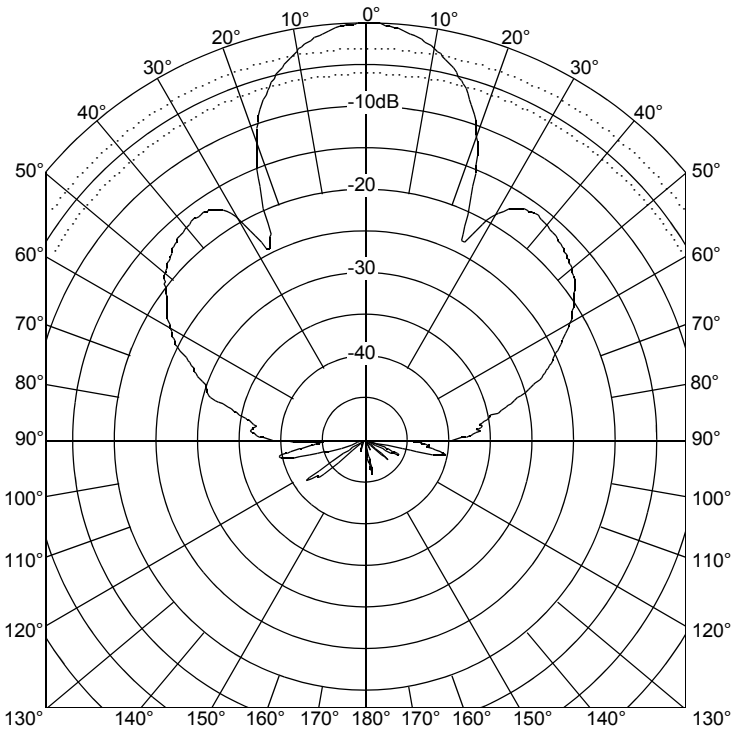
Beamwidth:

-3dB:	22°
-6dB:	31°
-10dB:	38°

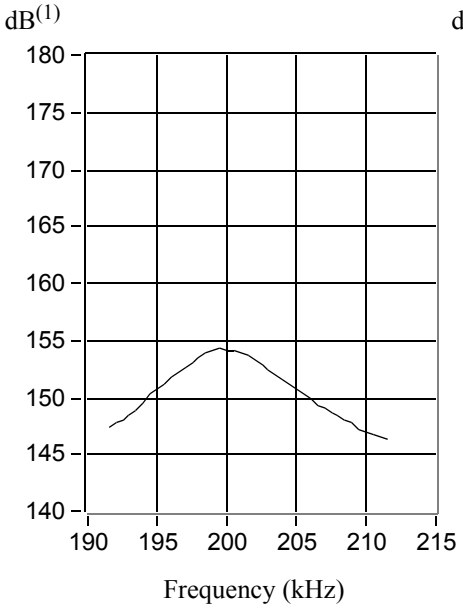
Directivity Index:	16.9
Frequency Tolerance:	±4kHz
Peak TVR(1), nominal:	153 dB
Peak TVR(1), minimum:	151 dB
Q (transmit):	25
Peak Source Level(4):	202dB
Peak RVR(2), nominal:	-191 dB
Peak Figure of Merit(3):	-39 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

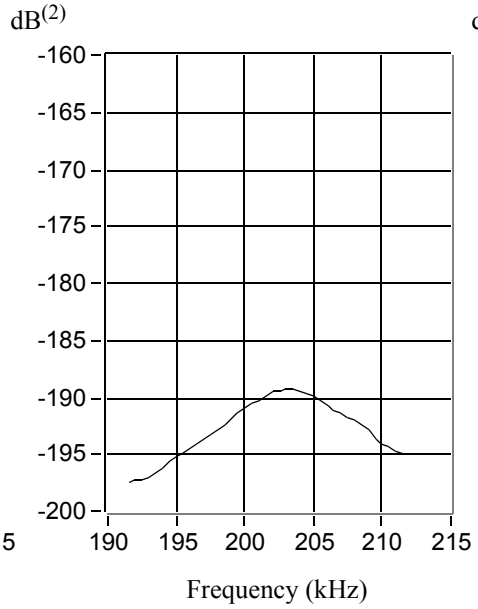
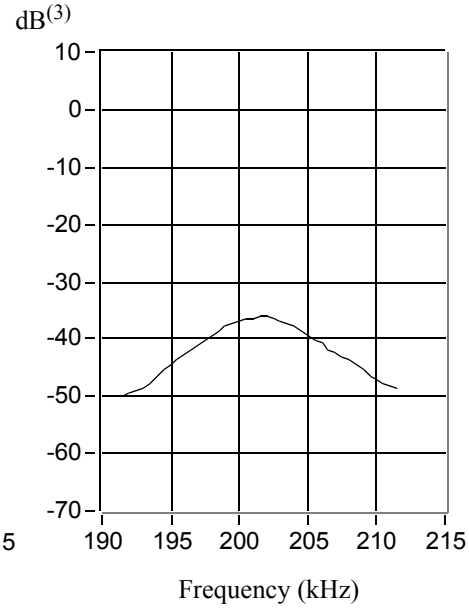


Figure of Merit



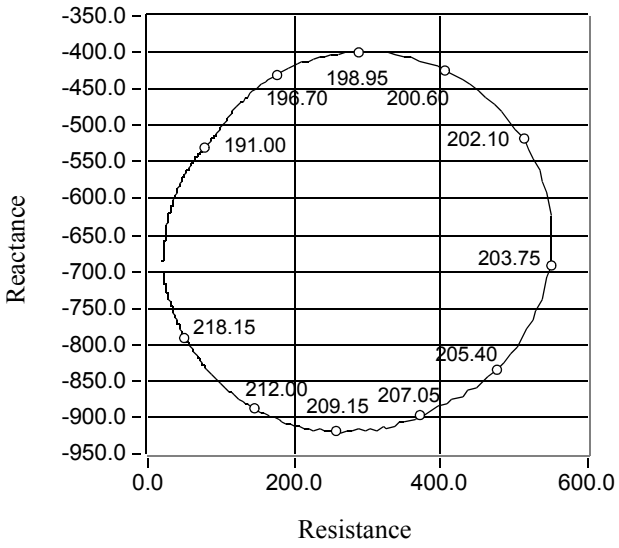
200 kHz-C

16mm (0.64") PZT

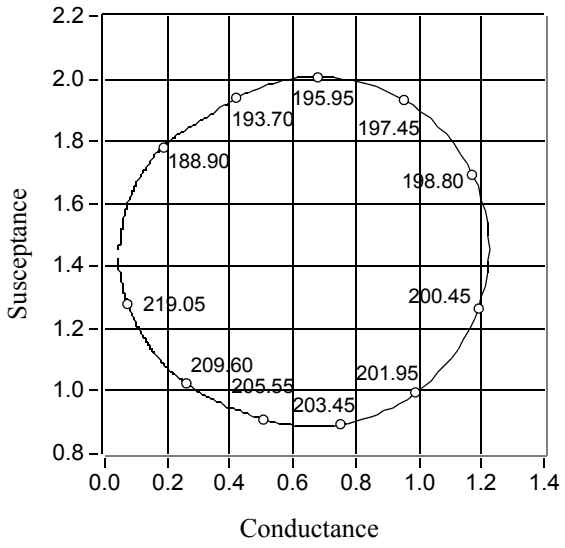
Cable Type: C2
Cable Length: 6.1 m (20.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	880 ohms-20%,+40%	880 ohms-20%,+40%
Parallel: Cp. (nominal)	140 pF	1080 pF
Series [R – jX] (nominal)	860 – j 130 ohms	370 – j 440 ohms
1 kHz Capacitance	330 pF ±20%	1250 pF ±20%

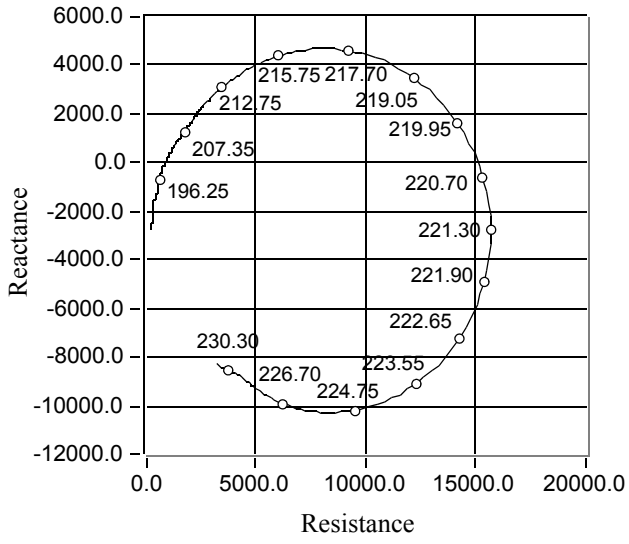
Unbalanced Impedance



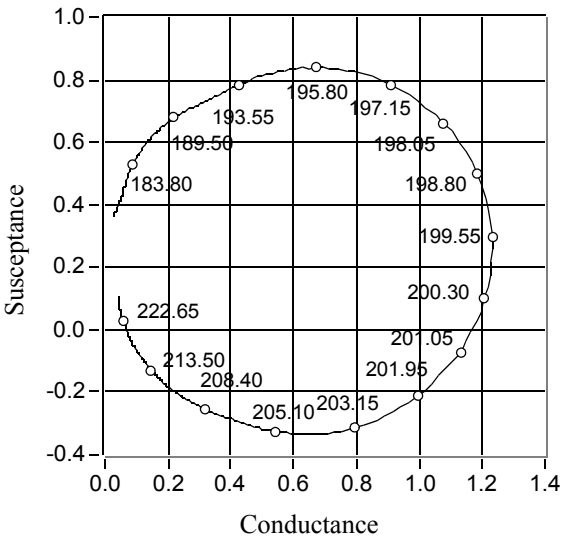
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



200 kHz-C

Power rating: 80 Wrms @ 2% duty cycle
16mm (0.64") PZT
Active Area: 2.0cm²
Urethane Window

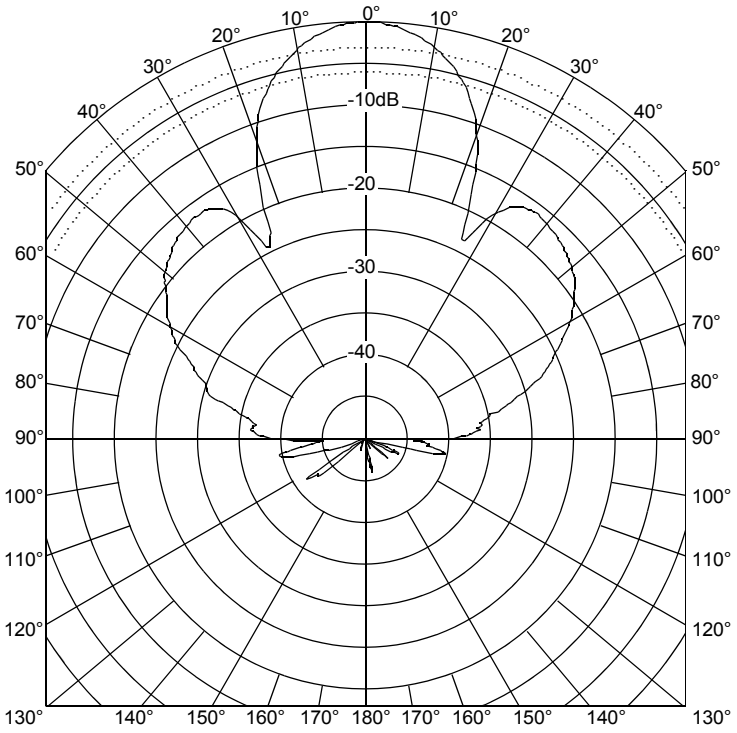
Beamwidth:

-3dB:	22°
-6dB:	31°
-10dB:	38°

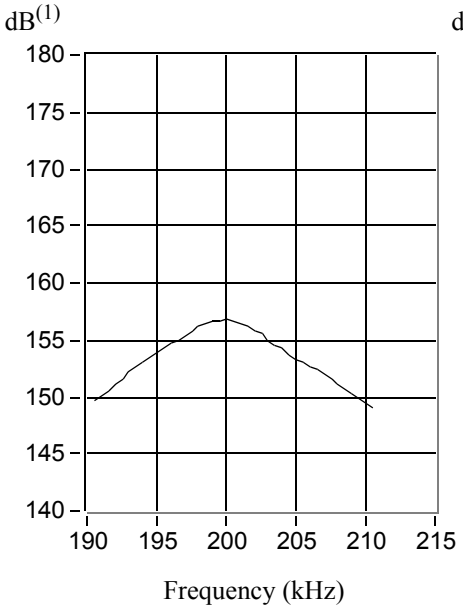
Directivity Index:	16.9
Frequency Tolerance:	±4kHz
Peak TVR(1), nominal:	156dB
Peak TVR(1), minimum:	153dB
Q (transmit):	21
Peak Source Level(4):	204dB
Peak RVR(2), nominal:	-196dB
Peak Figure of Merit(3):	-39dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

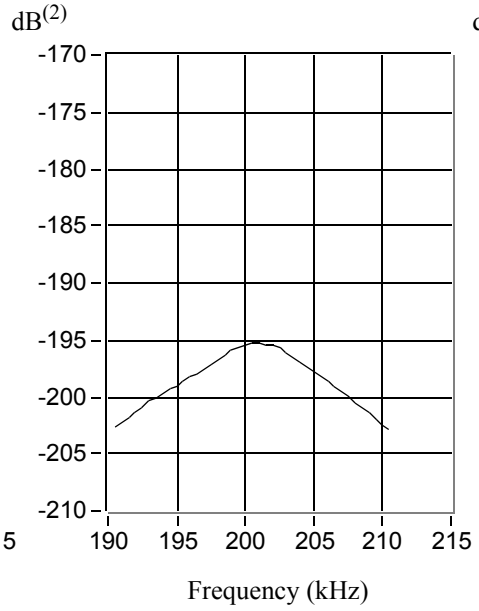
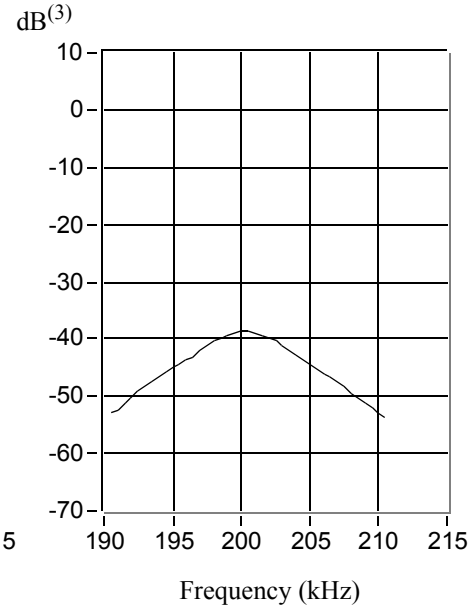


Figure of Merit



200 kHz-C

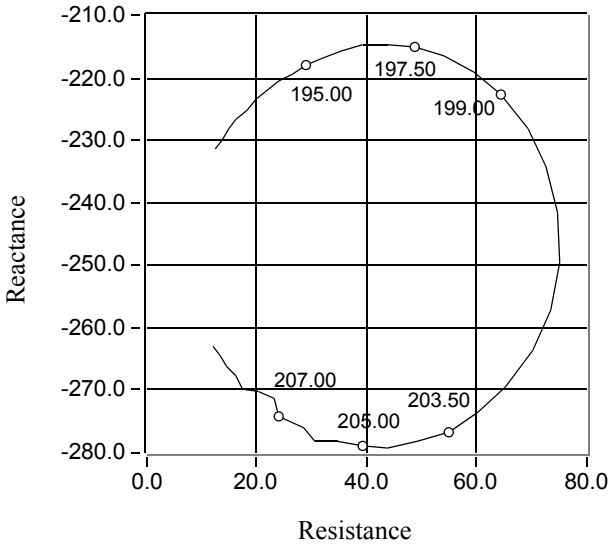
16mm (0.64") PZT

Cable Type: C144

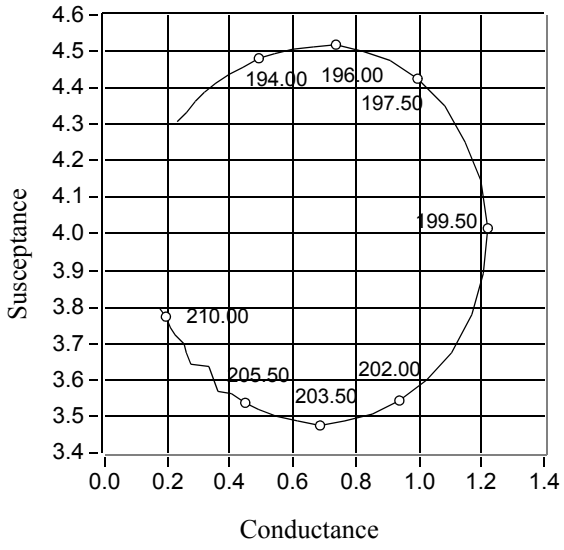
Cable Length: 15.2m (50.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	790 ohms -20%, +40%	820 ohms -20%, +40%
Parallel: Cp. (nominal)	360 pF	3210 pF
Series [R – jX] (nominal)	700 – j250 ohms	70 – j230 ohms
1 kHz Capacitance	510 pF ±20%	3390 pF ±20%

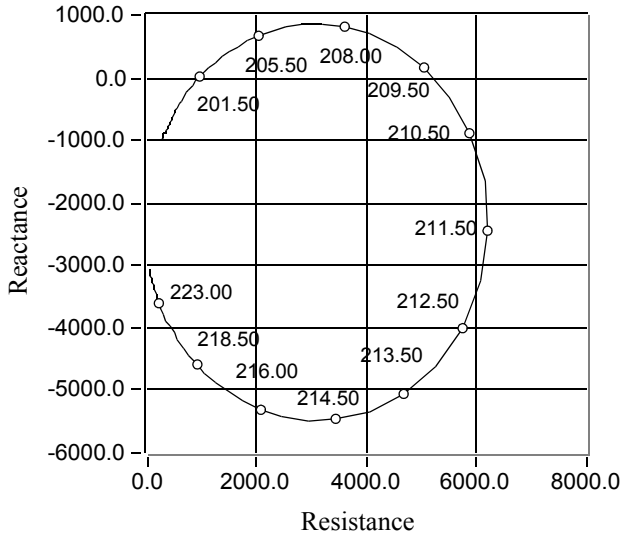
Unbalanced Impedance



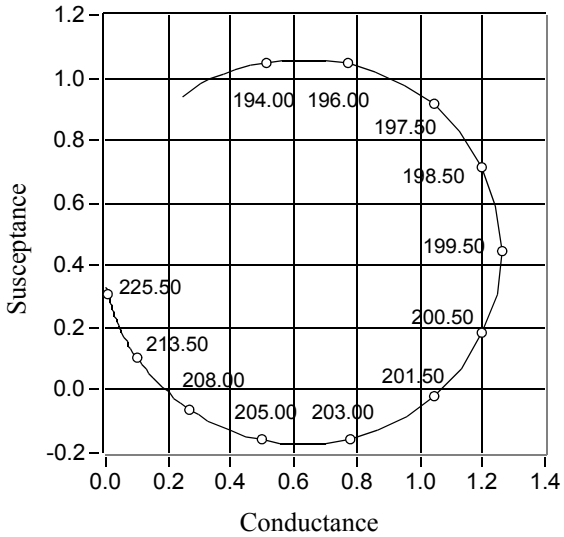
Unbalanced Admittance



Balanced Impedance



Balanced Admittance

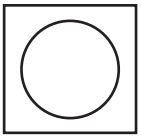


200 kHz-Hlq

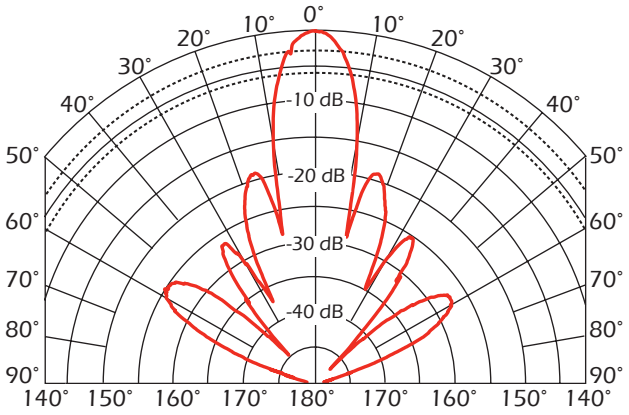
Power Rating: 600 W rms @ 2% duty cycle
51 mm (2.0") PZT
Active Area: 20 cm²
Epoxy/Urethane Window

Beamwidth:
-3 dB: 8°
-6 dB: 12°
-10 dB: 16°

Array

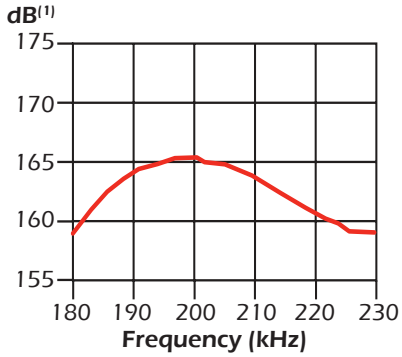


Transmit Radiation Pattern



Directivity Index:	28 dB
Frequency Tolerance:	± 6 kHz
Peak TVR(1), nominal:	165 dB
Peak TVR(1), minimum:	163 dB
Q (transmit):	7
Peak Source Level(4):	221 dB
Peak RVR(2), nominal:	-180 dB
Peak Figure of Merit(3):	-15 dB

TVR



RVR

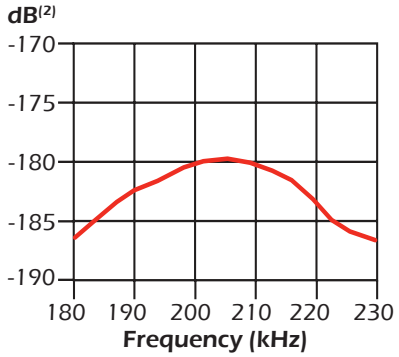
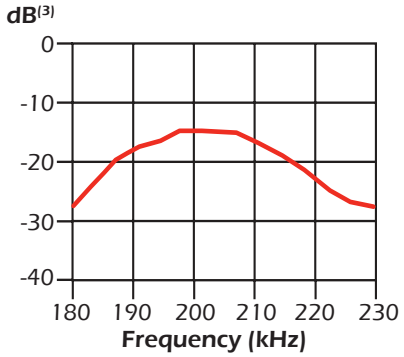


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

200 kHz-Hlq

51 mm (2.0”) PZT

Cable Type: C11
Cable Length: 9.1 m (30’)

Note:
Impedance data includes cable

Impedance Data	
	Unbalanced
Parallel: Rp.	800 Ω: -20%, +40%
Parallel: Cp. (nominal)	1200 pF
Series [R - jX]: (nominal)	330 - j50 Ω
1 kHz capacitance: (nominal)	2560 pF ± 20%

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
180.00	487.51	-71.46	155.02	-462.21	0.65	1.94	1533.14	1719.55
182.00	462.61	-69.67	160.70	-433.80	0.75	2.03	1331.73	1772.60
184.00	445.42	-66.91	174.67	-409.74	0.88	2.07	1135.81	1786.38
186.00	436.56	-63.56	194.36	-390.91	1.02	2.05	980.58	1755.09
188.00	439.99	-60.43	217.13	-382.68	1.12	1.98	891.59	1673.46
190.00	443.06	-58.56	231.08	-378.03	1.18	1.93	849.51	1613.11
192.00	449.38	-56.25	249.69	-373.63	1.24	1.85	808.76	1533.65
194.00	458.67	-53.67	271.73	-369.51	1.29	1.76	774.20	1440.95
196.00	474.88	-51.12	298.07	-369.69	1.32	1.64	756.58	1331.14
198.00	500.66	-49.12	327.67	-378.54	1.31	1.51	764.97	1213.89
200.00	516.17	-49.78	333.29	-394.14	1.25	1.48	799.40	1177.22
202.00	560.07	-49.64	362.67	-426.79	1.16	1.36	864.91	1072.01
204.00	588.10	-50.48	374.23	-453.66	1.08	1.31	924.19	1023.36
206.00	612.36	-51.40	382.04	-478.57	1.02	1.28	981.54	986.03
208.00	638.26	-52.39	389.56	-505.59	0.96	1.24	1045.74	949.64
210.00	666.70	-53.78	393.94	-537.86	0.89	1.21	1128.30	917.10
212.00	695.48	-56.34	385.48	-578.87	0.80	1.20	1254.76	898.47
214.00	712.97	-60.12	355.15	-618.22	0.70	1.22	1431.29	904.49
216.00	716.26	-63.97	314.30	-643.61	0.61	1.25	1632.27	924.39
218.00	706.93	-67.36	272.10	-652.47	0.54	1.31	1836.66	953.17
220.00	688.37	-68.65	250.59	-641.13	0.53	1.35	1890.93	978.83
222.00	667.00	-71.59	210.63	-632.86	0.47	1.42	2112.14	1019.84
224.00	653.29	-72.65	194.85	-623.55	0.46	1.46	2190.30	1038.10
226.00	636.67	-74.03	175.14	-612.10	0.43	1.51	2314.36	1063.44
228.00	619.39	-74.82	162.17	-597.78	0.42	1.56	2365.63	1087.68
230.00	603.23	-74.99	156.25	-582.64	0.43	1.60	2328.77	1107.98

200 kHz-U

Power rating: 375 W
38mm (1.5") BT
Active Area: 11.2cm² Layered
Plastic Epoxy Window

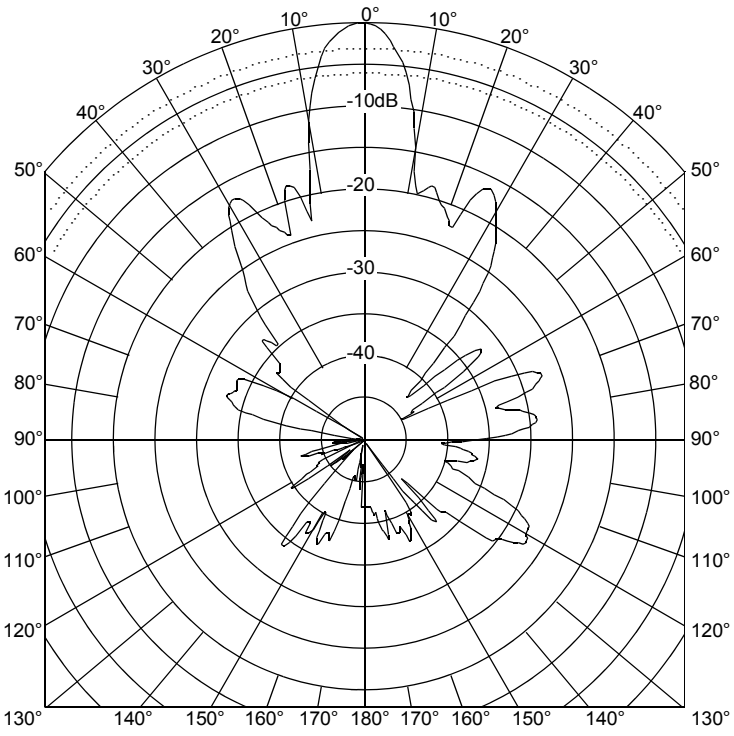
Beamwidth:

-3dB:	10°
-6dB:	14°
-10dB:	18°

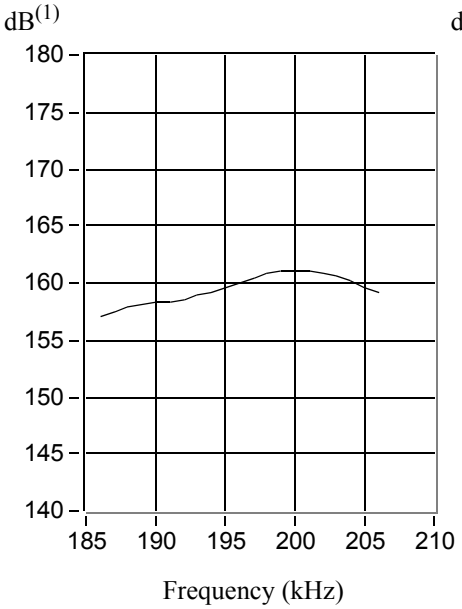
Directivity Index:	24.3
Frequency Tolerance:	±5kHz
Peak TVR(1), nominal:	161dB
Peak TVR(1), minimum:	159dB
Q (transmit):	12
Peak Source Level(4):	218dB
Peak RVR(2), nominal:	-187dB
Peak Figure of Merit(3):	-26dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

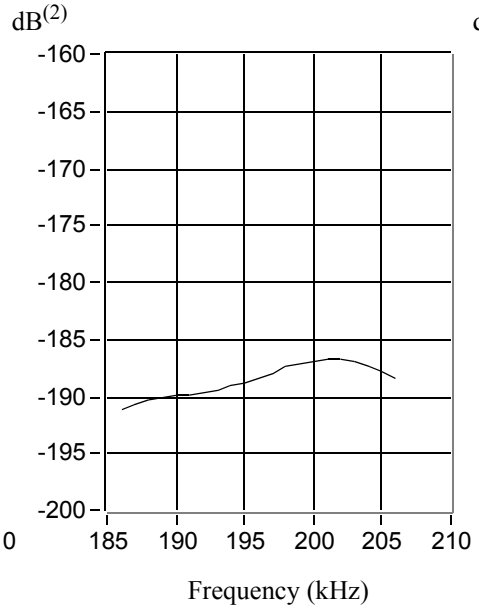
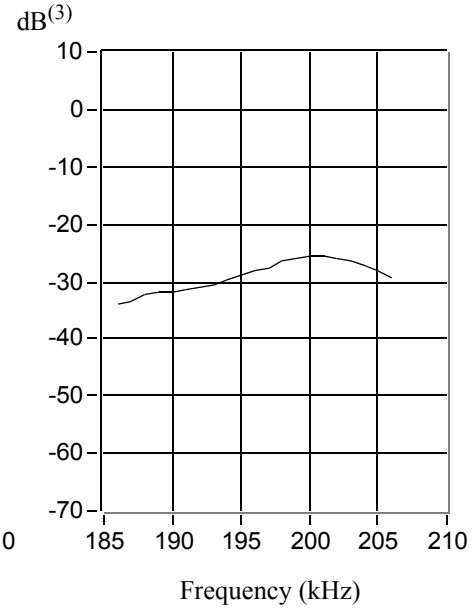


Figure of Merit



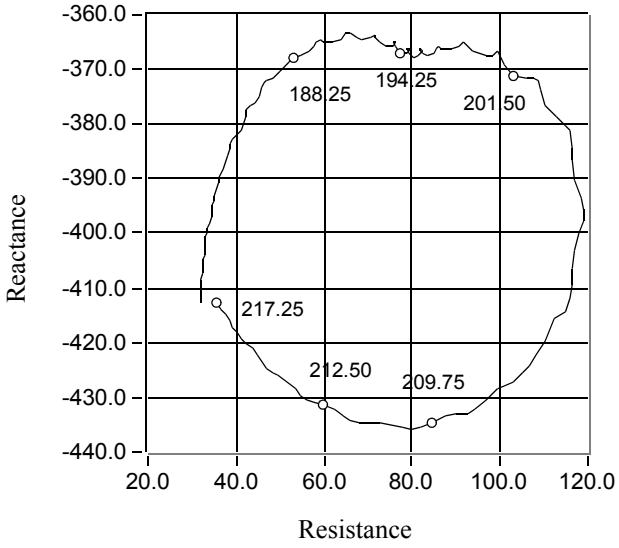
200 kHz-U

38mm (1.5") BT

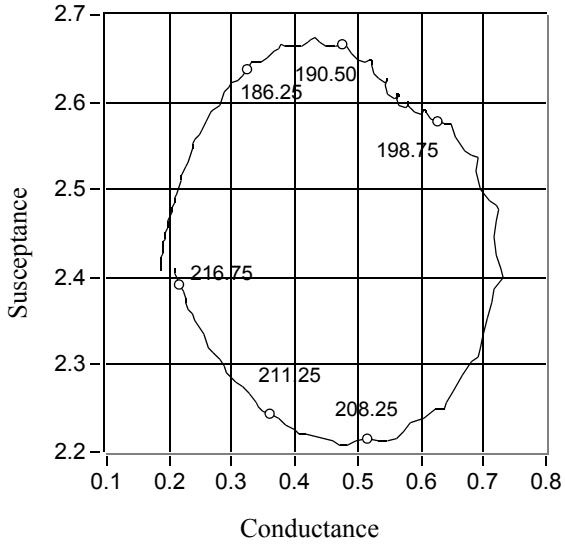
Cable Type: C2
Cable Length: 7.6m (25.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	1410ohms -20%,+40%	1380ohms -20%,+40%
Parallel: Cp. (nominal)	730pF	1910pF
Series [R – jX] (nominal)	520 – j680 ohms	110 – j380 ohms
1 kHz Capacitance	970pF±20%	2150pF±20%

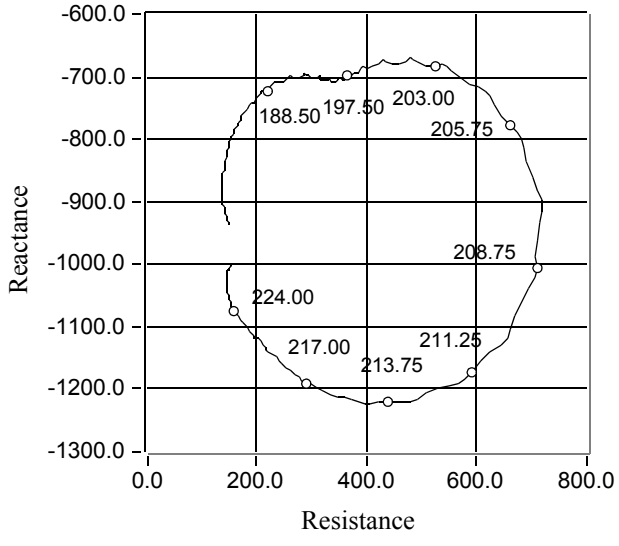
Unbalanced Impedance



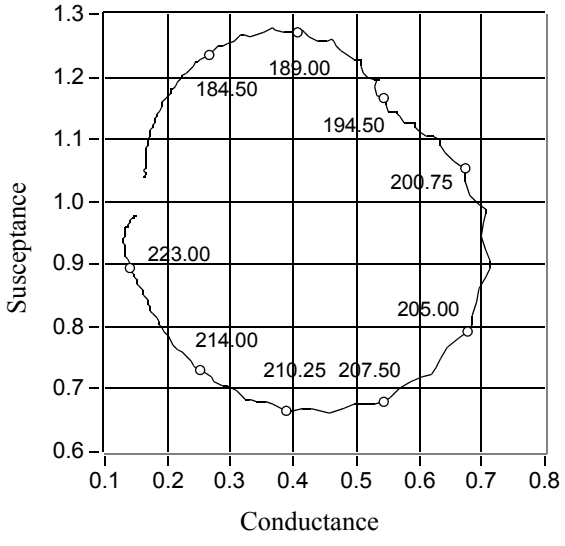
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



200 kHz-U

Power rating: 375 Wrms @ 2% duty cycle
38mm (1.5") BT
Active Area: 11.2cm²
Layered Plastic Urethane Window

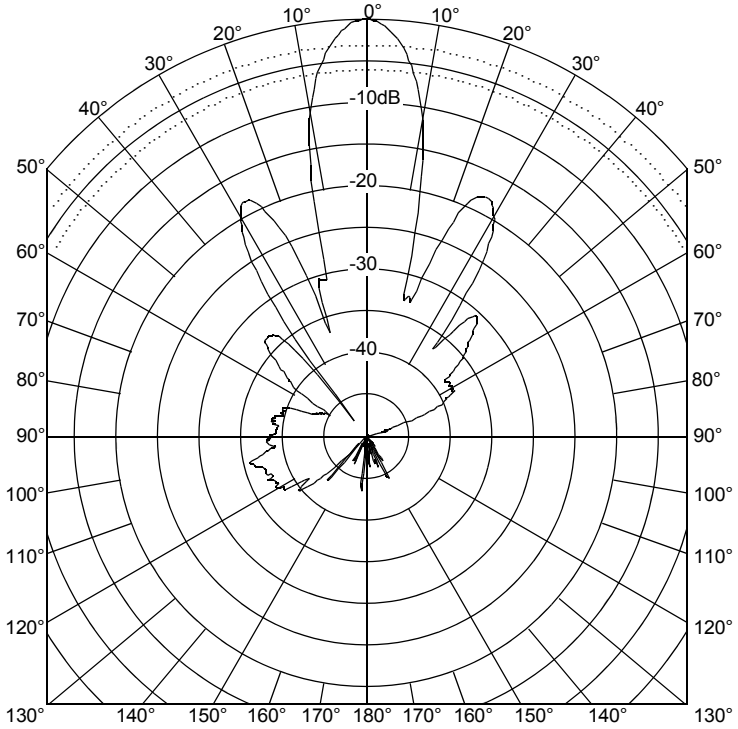
Beamwidth:

-3dB:	11°
-6dB:	15°
-10dB:	19°

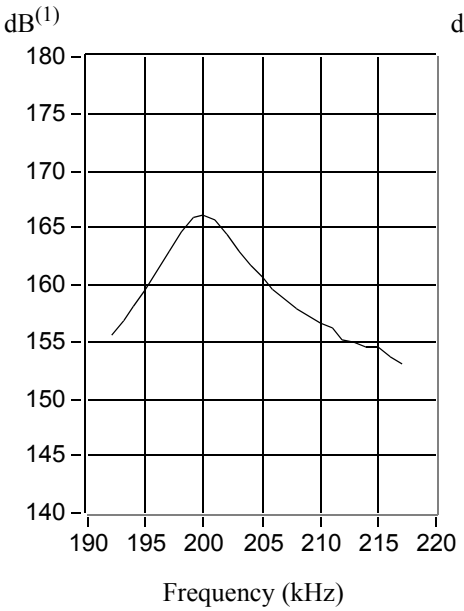
Directivity Index:	24.3
Frequency Tolerance:	±4kHz
Peak TVR(1), nominal:	166dB
Peak TVR(1), minimum:	163dB
Q (transmit):	35
Peak Source Level(4):	218dB
Peak RVR(2), nominal:	-185dB
Peak Figure of Merit(3):	-20dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

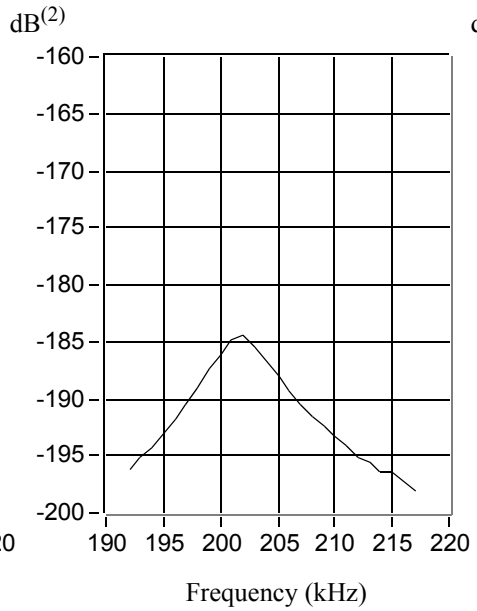
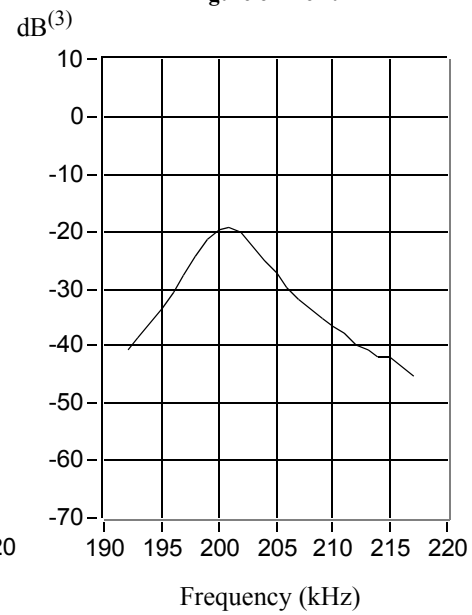


Figure of Merit



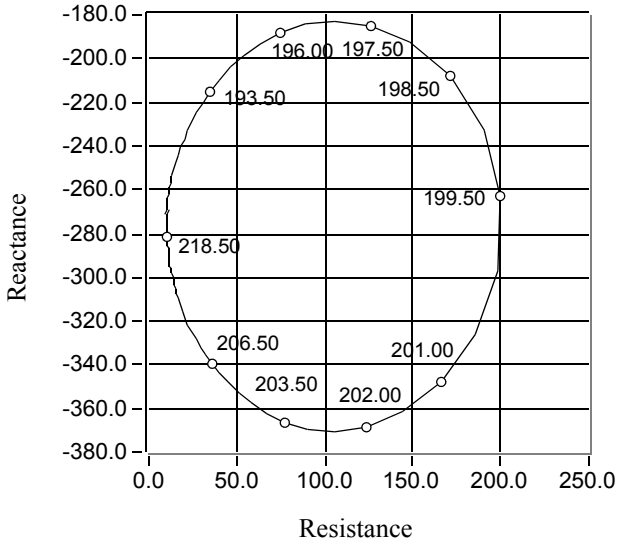
200 kHz-U

38mm (1.5") BT

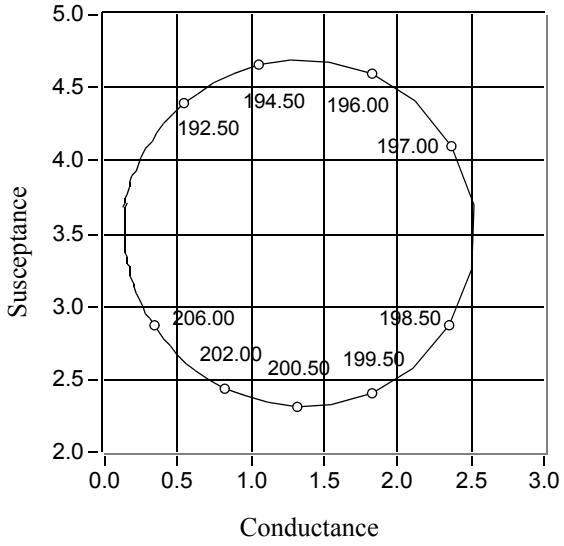
Cable Type: C144
Cable Length: 12.2m (40.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	400ohms-20%,+40%	400ohms-20%,+40%
Parallel: Cp. (nominal)	680pF	2630pF
Series [R – jX] (nominal)	360 – j120 ohms	150 – j190 ohms
1 kHz Capacitance	1010pF±20%	2950pF±20%

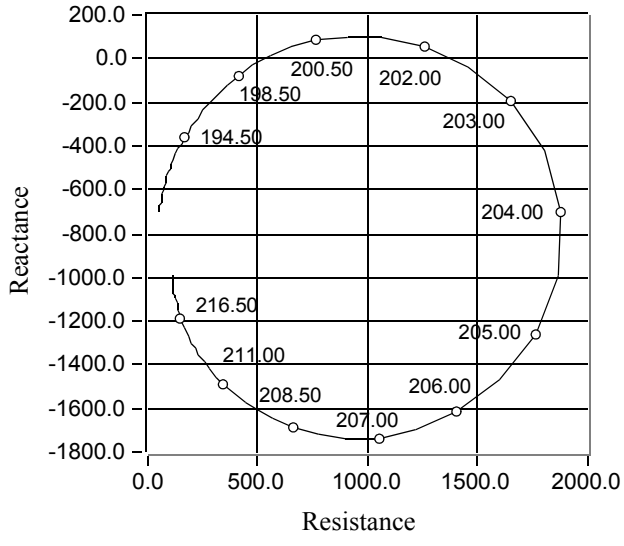
Unbalanced Impedance



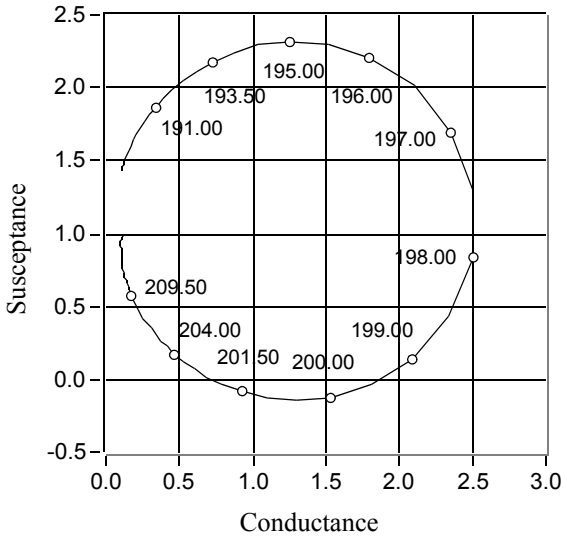
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



200 kHz-U

Power rating: 375 Wrms @ 2% duty cycle
38mm (1.5") BT
Active Area: 11.2cm²
Urethane Window

Beamwidth:

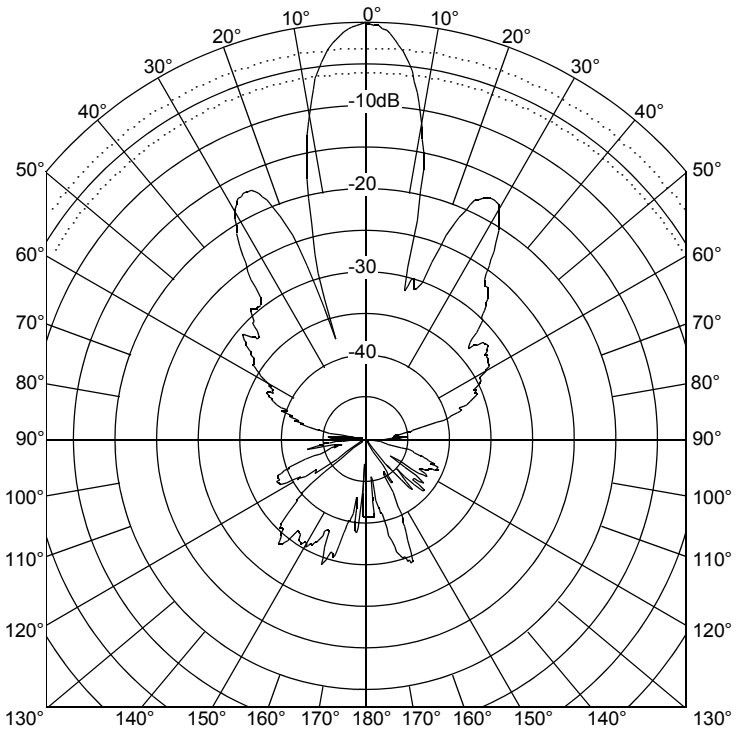
-3dB:	11°
-6dB:	15°
-10dB:	19°

Directivity Index:	24.3
Frequency Tolerance:	±4kHz
Peak TVR(1), nominal:	164dB
Peak TVR(1), minimum:	161dB
Q (transmit):	22
Peak Source Level(4):	217dB
Peak RVR(2), nominal:	-185dB
Peak Figure of Merit(3):	-22dB

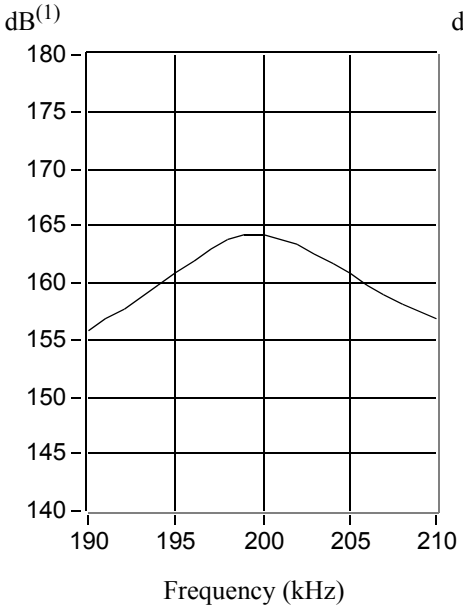
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

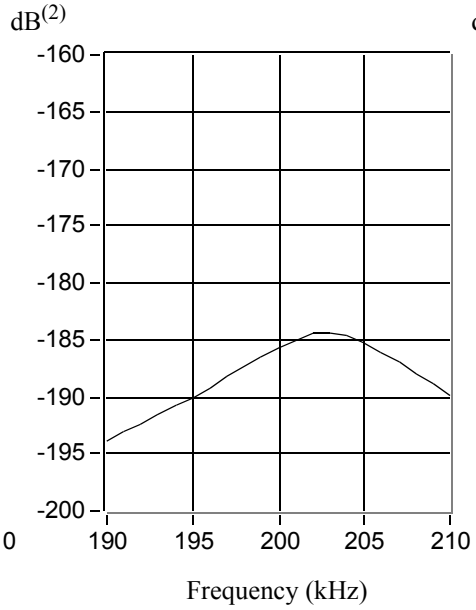
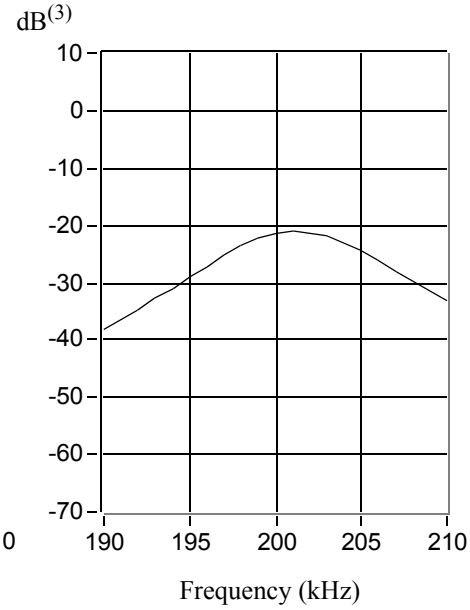


Figure of Merit



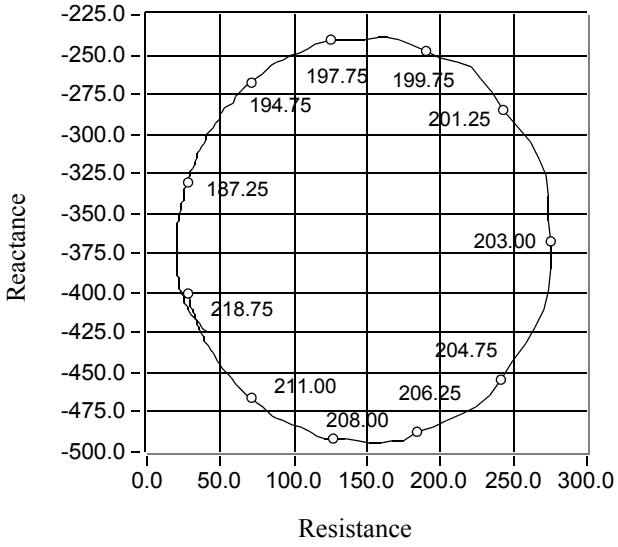
200 kHz-U

38mm (1.5") BT

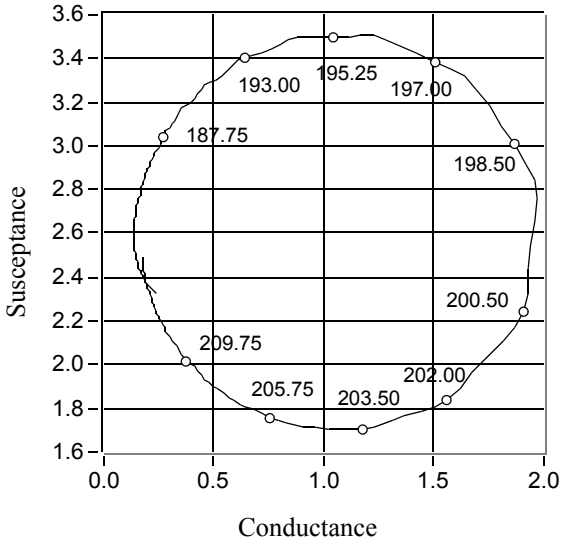
Cable Type: C2
Cable Length: 7.6m (25.0')

Impedance Data	
	Unbalanced
Parallel: Rp.	510ohms-20%,+40%
Parallel: Cp. (nominal)	1930pF
Series [R – jX] (nominal)	200 – j250 ohms
1 kHz Capacitance	2310pF±20%

Unbalanced Impedance

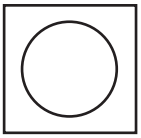


Unbalanced Admittance



210 kHz-F

Array

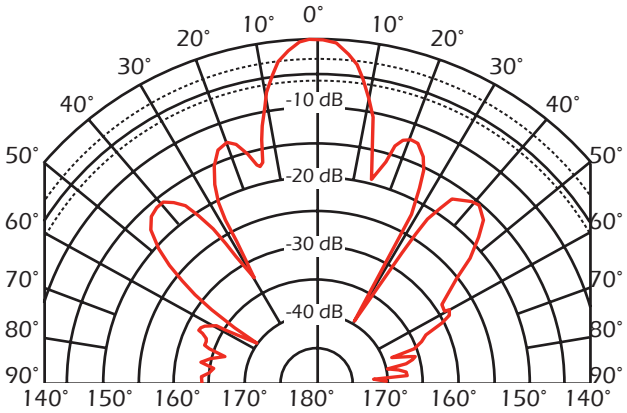


Power Rating: 300 W @ 1% duty cycle
27 mm (1.08") PZT
Active Area: 5.7 cm^2 (0.88 in^2)
Stainless Steel Window

Beamwidth:
-3 dB: 13°
-6 dB: 17°
-10 dB: 22°

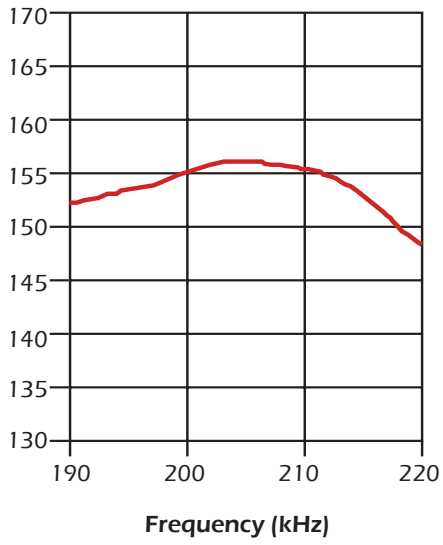
Directivity Index:	21
Frequency Tolerance:	± 4 kHz
Peak TVR(1), nominal:	156 dB
Q (transmit):	9
Peak Source Level(4):	212 dB
Peak RVR(2), nominal:	-193 dB
Peak Figure of Merit(3):	-37 dB

Transmit Radiation Pattern

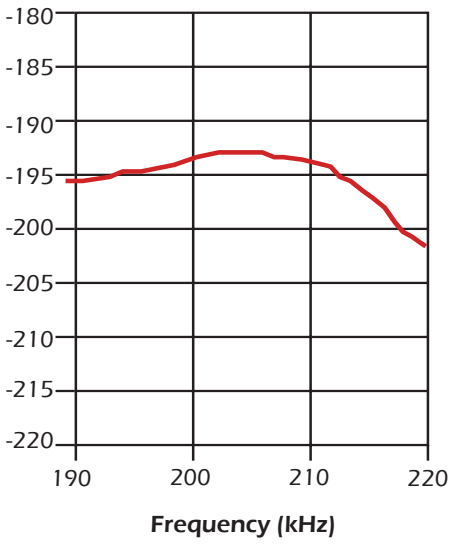


Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

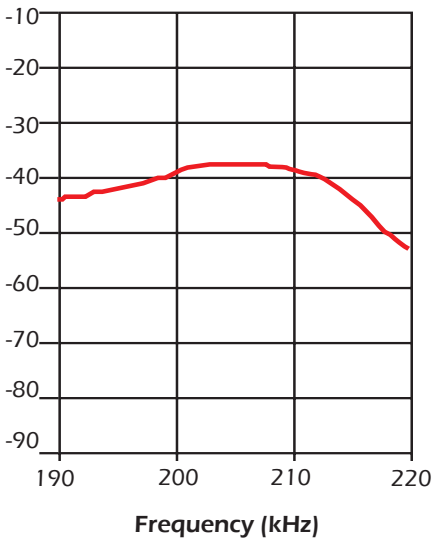
TVR



RVR



FOM



210 kHz-F

27 mm (1.08”) PZT

Cable Type: C33
Cable Length: 10 m (33’)

Note:
Impedance data includes cable

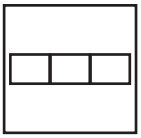
Impedance Data	
	Unbalanced
Parallel: Rp.	1745 Ω: -20%, +40%
Parallel: Cp. (nominal)	2040pF
Series [R - jX]: (nominal)	80+ j360 Ω
1 kHz capacitance: (nominal)	2380pF: ±20%

Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	388.89	-83.47	44.22	-386.37	0.29	2.55	3420.02	2139.97
191.00	383.58	-83.37	44.28	-381.02	0.30	2.59	3323.09	2157.82
192.00	380.43	-83.08	45.86	-377.65	0.32	2.61	3155.66	2163.05
193.00	378.71	-82.57	48.95	-375.53	0.34	2.62	2929.89	2159.25
194.00	375.87	-82.40	49.73	-372.56	0.35	2.64	2841.01	2163.48
195.00	371.60	-82.30	49.82	-368.25	0.36	2.67	2771.90	2176.55
196.00	367.39	-81.77	52.60	-363.60	0.39	2.69	2565.97	2187.48
197.00	364.93	-81.11	56.42	-360.54	0.42	2.71	2360.48	2187.21
198.00	363.78	-80.35	60.98	-358.63	0.46	2.71	2170.03	2178.37
199.00	362.82	-80.03	62.83	-357.34	0.48	2.71	2095.32	2171.02
200.00	363.65	-79.28	67.65	-357.30	0.51	2.70	1954.73	2150.08
201.00	361.26	-79.19	67.75	-354.86	0.52	2.72	1926.36	2152.90
202.00	362.19	-78.75	70.68	-355.22	0.54	2.71	1856.03	2133.57
203.00	364.62	-78.13	75.00	-356.82	0.56	2.68	1772.71	2104.27
204.00	366.46	-77.77	77.66	-358.14	0.58	2.67	1729.40	2080.56
205.00	370.13	-77.10	82.60	-360.80	0.60	2.63	1658.55	2044.63
206.00	372.02	-77.09	83.13	-362.61	0.60	2.62	1664.90	2024.25
207.00	374.80	-77.66	80.11	-366.14	0.57	2.61	1753.55	2003.97
208.00	375.72	-77.90	78.74	-367.37	0.56	2.60	1792.81	1991.33
209.00	376.80	-77.81	79.54	-368.31	0.56	2.59	1785.07	1975.43
210.00	379.18	-77.54	81.83	-370.24	0.57	2.58	1756.98	1951.64
211.00	383.50	-77.62	82.23	-374.58	0.56	2.55	1788.45	1921.10
212.00	387.22	-77.95	80.84	-378.69	0.54	2.53	1854.65	1896.05
213.00	390.40	-78.37	78.73	-382.38	0.52	2.51	1935.85	1874.63
214.00	390.52	-78.54	77.57	-382.74	0.51	2.51	1966.11	1866.48
215.00	394.52	-78.72	77.14	-386.90	0.50	2.49	2017.71	1840.13
216.00	399.54	-79.71	71.39	-393.11	0.45	2.46	2236.17	1814.50
217.00	398.08	-81.19	60.99	-393.38	0.38	2.48	2598.14	1820.65
218.00	392.16	-81.87	55.48	-388.21	0.36	2.52	2772.01	1842.96
219.00	388.70	-82.30	52.11	-385.19	0.34	2.55	2899.38	1852.79
220.00	386.49	-82.76	48.73	-383.41	0.33	2.57	3065.61	1856.87

225 kHz-B

Array

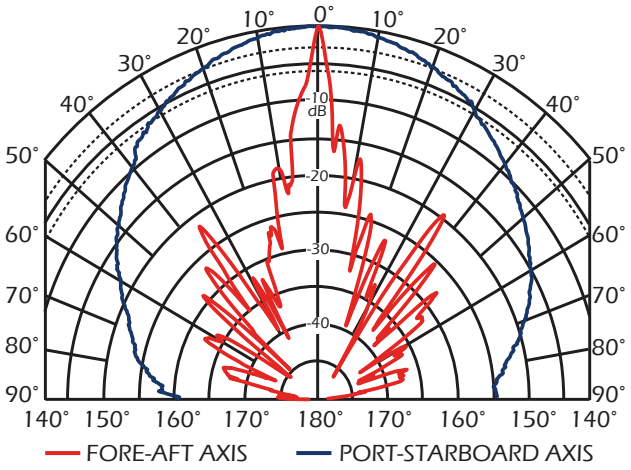


wired in Series/Parallel
Power Rating: 100 W rms @ 1% duty cycle
3X 68.02 mm x 5.84 mm
(2.68" x 0.23") PZT
Active Area: 11.93 cm^2 (1.85 in^2)
Urethane Window

Beamwidth:
-3 dB: 2° / 41°
-6 dB: 3° / 61°
-10 dB: 7° / 83°

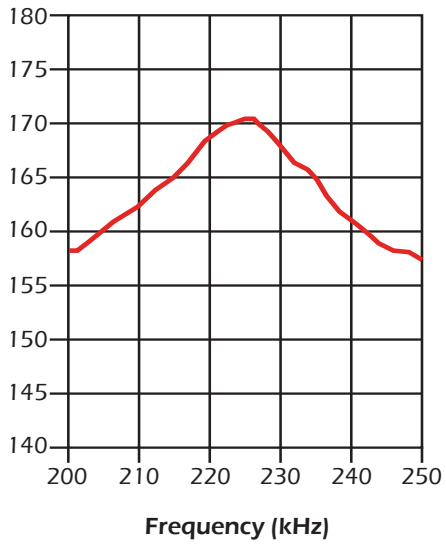
Directivity Index:	25
Frequency Tolerance:	±4 kHz
Peak TVR(1), nominal:	171 dB
Peak TVR(1), minimum:	169 dB
Q (transmit):	18
Peak Source Level(4):	210 dB
Peak RVR(2), nominal:	-182 dB
Peak Figure of Merit(3):	-19 dB

Transmit Radiation Pattern

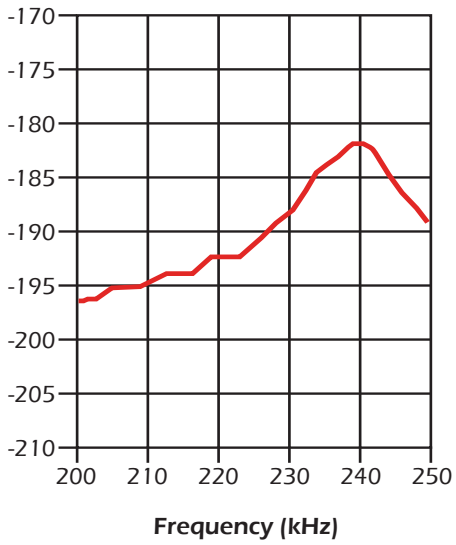


Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

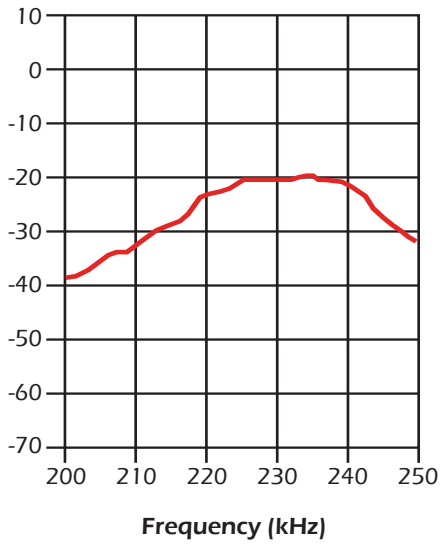
TVR



RVR



FOM



225 kHz-B

3X 68.02 mm x 5.84 mm
(2.68” x 0.23”) PZT

Cable Type: Cust specified
Cable Length: 12 m (40’)
Note:
Impedance data includes cable

Impedance Data		
	Unbalanced	*Balanced*
Parallel: Rp.	90 Ω: -20%, +40%	90 Ω: -20%, +40%
Parallel: Cp. (nominal)	500pF	1,730pF
Series [R - jX]: (nominal)	90 - j10 Ω	90 - j20 Ω
1 kHz capacitance: (nominal)	1,770pF	2,310pF

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
200.00	261.54	-81.09	40.52	-258.38	0.59	3.78	1687.97	3005.88
201.00	255.36	-80.63	41.59	-251.95	0.64	3.86	1567.74	3059.42
203.00	238.91	-79.33	44.25	-234.77	0.78	4.11	1289.80	3224.90
204.00	232.68	-79.05	44.20	-228.44	0.82	4.22	1224.76	3291.93
206.00	216.86	-76.97	48.89	-211.27	1.04	4.49	961.86	3470.96
207.00	210.29	-76.67	48.50	-204.62	1.10	4.63	911.78	3557.57
209.00	194.68	-73.97	53.77	-187.11	1.42	4.94	704.83	3759.41
210.00	187.03	-73.47	53.21	-179.30	1.52	5.13	657.43	3884.82
212.00	171.52	-69.83	59.15	-161.00	2.01	5.47	497.37	4108.35
213.00	163.52	-69.00	58.60	-152.66	2.19	5.71	456.33	4265.99
215.00	148.26	-64.28	64.34	-133.58	2.93	6.08	341.65	4498.16
216.00	138.67	-62.58	63.86	-123.09	3.32	6.40	301.13	4716.52
218.00	123.64	-55.96	69.22	-102.45	4.53	6.70	220.86	4892.55
219.00	113.51	-52.31	69.39	-89.83	5.39	6.97	185.68	5066.55
221.00	100.06	-40.41	76.18	-64.87	7.61	6.48	131.41	4666.21
222.00	91.91	-33.50	76.65	-50.73	9.07	6.00	110.22	4304.74
224.00	88.51	-15.22	85.41	-23.23	10.90	2.97	91.73	2107.23
225.00	87.00	-3.55	86.83	-5.38	11.47	0.71	87.16	503.14
227.00	101.40	14.96	97.96	26.18	9.53	-2.55	104.96	-1785.43
228.00	111.05	25.51	100.22	47.83	8.13	-3.88	123.04	-2707.66
230.00	143.32	36.12	115.77	84.49	5.64	-4.11	177.43	-2846.10
231.00	164.35	42.51	121.16	111.05	4.49	-4.11	222.94	-2832.60
233.00	206.71	47.98	138.37	153.56	3.24	-3.59	308.80	-2454.95
234.00	237.11	51.38	148.00	185.25	2.63	-3.30	379.88	-2241.10
236.00	295.20	54.53	171.32	240.40	1.97	-2.76	508.67	-1860.42
237.00	337.51	56.04	188.53	279.95	1.66	-2.46	604.23	-1650.32
239.00	413.97	57.94	219.71	350.86	1.28	-2.05	780.00	-1363.36
240.00	466.11	59.20	238.67	400.37	1.10	-1.84	910.29	-1222.06
242.00	582.58	59.20	298.32	500.40	0.88	-1.47	1137.71	-969.66
243.00	663.47	59.08	340.96	569.16	0.77	-1.29	1291.04	-846.84
245.00	836.44	58.46	437.52	712.89	0.63	-1.02	1599.11	-661.92
246.00	961.45	57.22	520.50	808.37	0.56	-0.87	1775.96	-565.77
248.00	1257.53	54.24	734.96	1020.40	0.46	-0.65	2151.64	-414.10
249.00	1478.75	51.69	916.73	1160.31	0.42	-0.53	2385.34	-339.16
250.00	1705.83	47.64	1149.40	1260.45	0.40	-0.43	2531.63	-275.76

235 kHz-A

Power rating: 600 Wrms @ 2% duty cycle
51mm (2.0") PZT
Active Area: 20cm²
Layered Plastic Epoxy Window

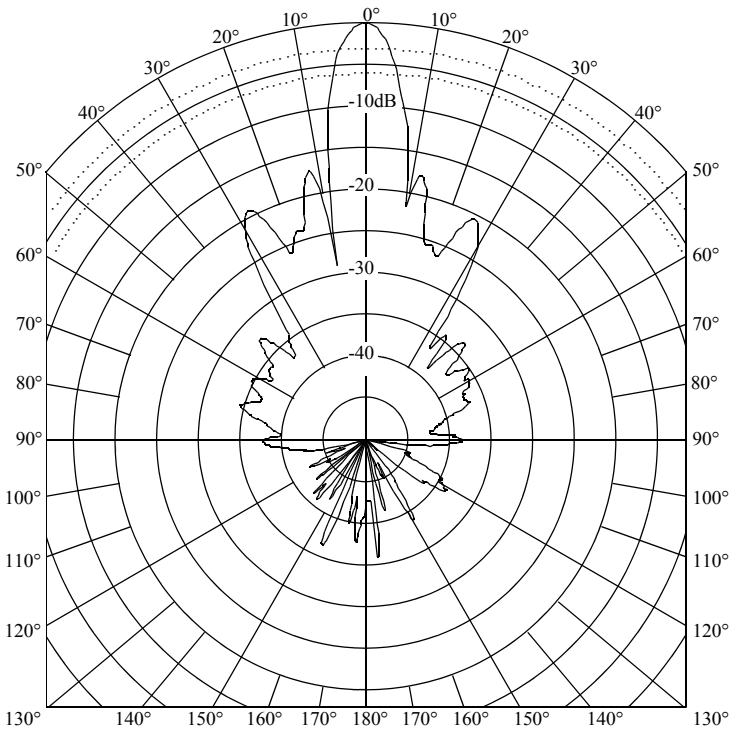
Beamwidth:

-3dB:	7°
-6dB:	10°
-10dB:	13°

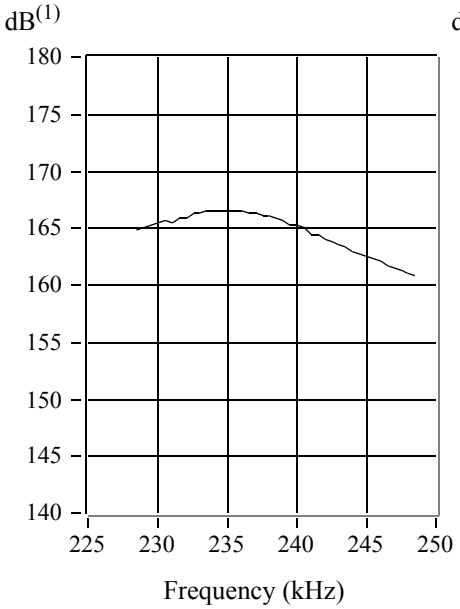
Directivity Index:	28.2
Frequency Tolerance:	±5kHz
Peak TVR(1), nominal:	166dB
Peak TVR(1), minimum:	164dB
Q (transmit):	15
Peak Source Level(4):	221dB
Peak RVR(2), nominal:	-185dB
Peak Figure of Merit(3):	-19dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

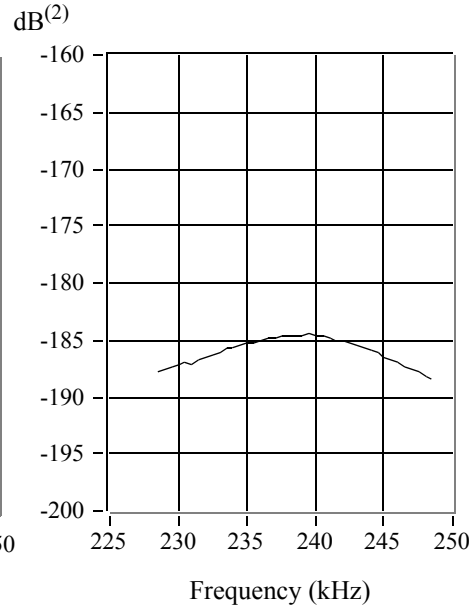
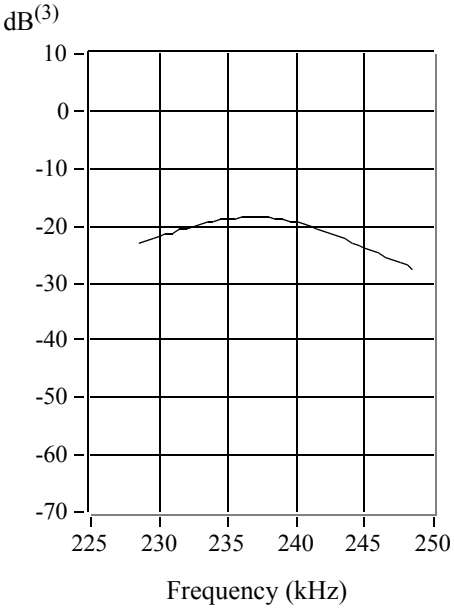


Figure of Merit

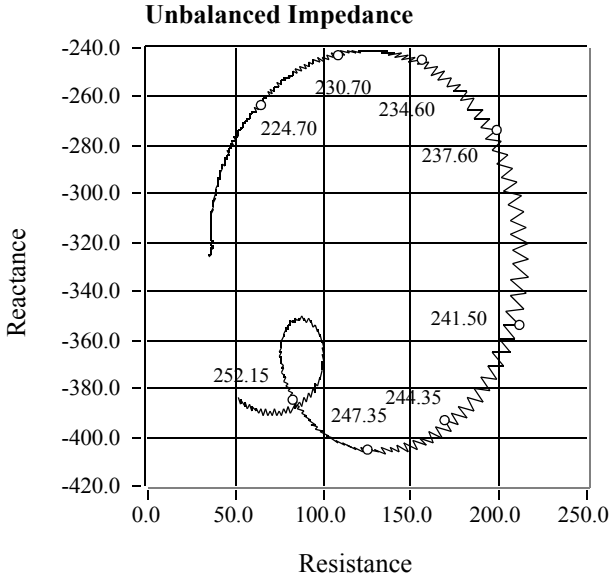


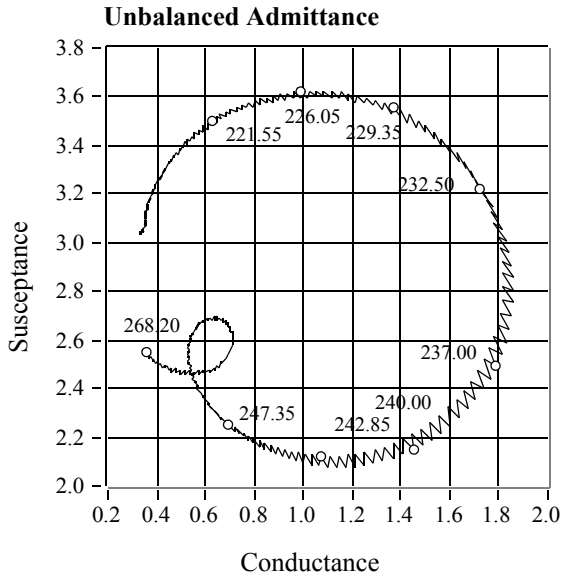
235 kHz-A

51mm (2.0") PZT

Cable Type: C2
Cable Length: 7.6m (25.0')

Impedance Data	
	Unbalanced
Parallel: Rp.	540ohms-20%,+40%
Parallel: Cp. (nominal)	1910pF
Series [R – jX] (nominal)	170 – j250 ohms
1 kHz Capacitance	3140pF±20%





235 kHz-A

Power rating: 600 Wrms @ 2% duty cycle
51mm (2.0") PZT
Active Area: 20cm²
Layered Plastic Urethane Window

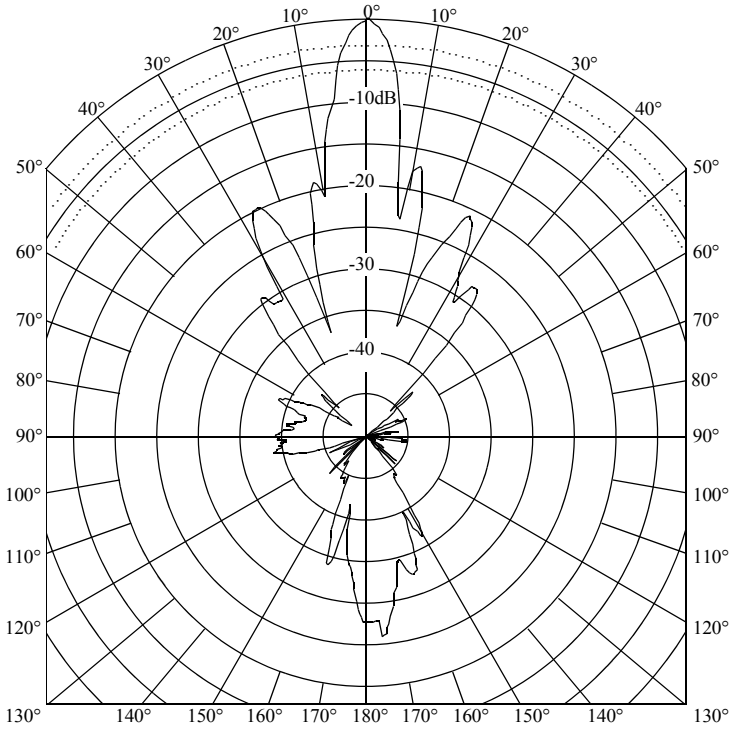
Beamwidth:

-3dB:	6°
-6dB:	9°
-10dB:	12°

Directivity Index:	28.2
Frequency Tolerance:	±5kHz
Peak TVR(1), nominal:	171dB
Peak TVR(1), minimum:	168dB
Q (transmit):	22
Peak Source Level(4):	221dB
Peak RVR(2), nominal:	-184dB
Peak Figure of Merit(3):	-15dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

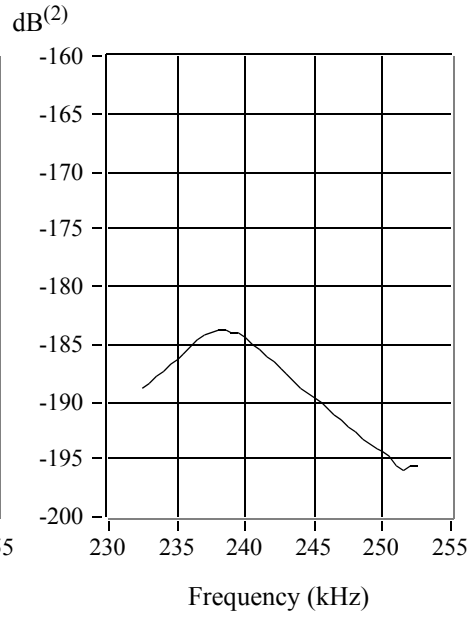
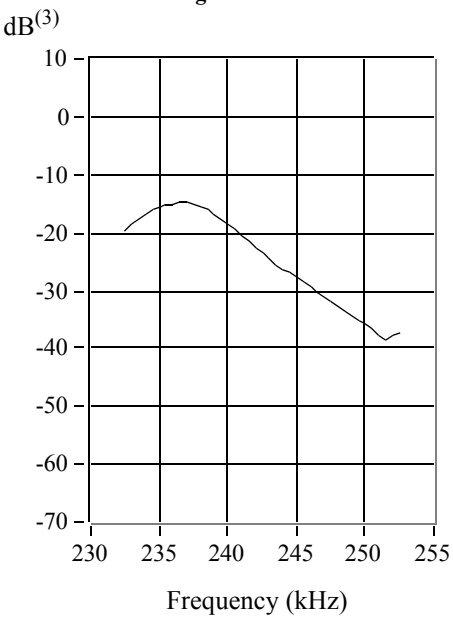


Figure of Merit



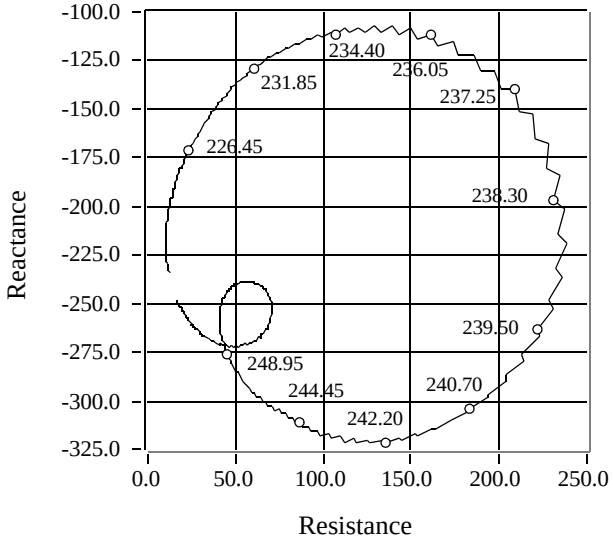
235 kHz-A

51mm (2.0") PZT

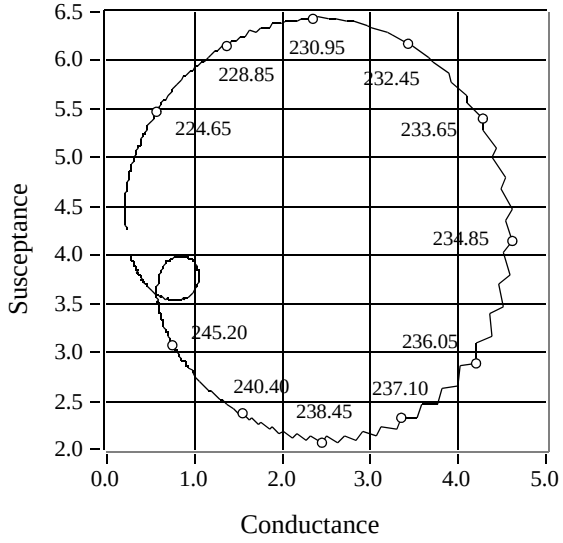
Cable Type: C2
Cable Length: 7.6m (25.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	220ohms-20%,+40%	220ohms-20%,+40%
Parallel: Cp. (nominal)	1400pF	3150pF
Series [R – jX] (nominal)	180 – j80 ohms	110 – j110 ohms
1 kHz Capacitance	1780pF±20%	3100pF±20%

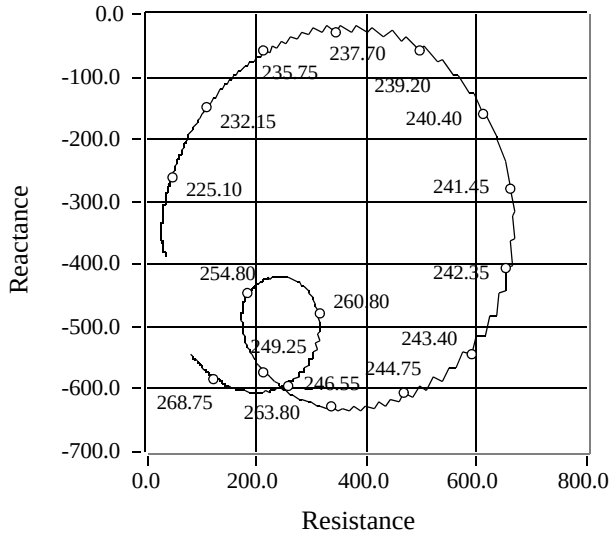
Unbalanced Impedance



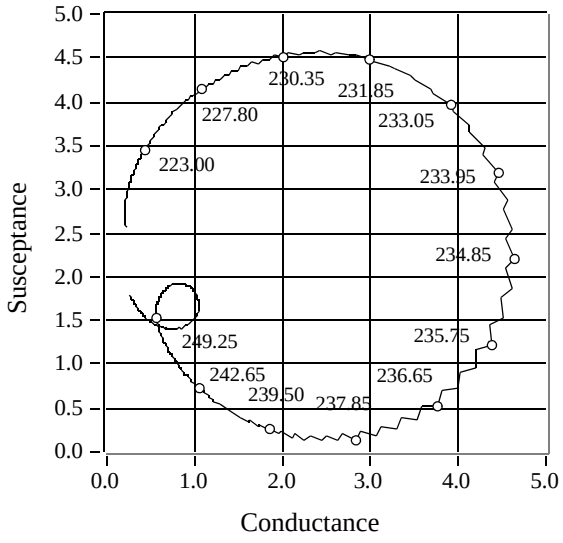
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



235 kHz-B

Power rating: 350 Wrms @ 2% duty cycle
36mm (1.4") PZT
Active Area: 10cm²
Layered Plastic Epoxy Window

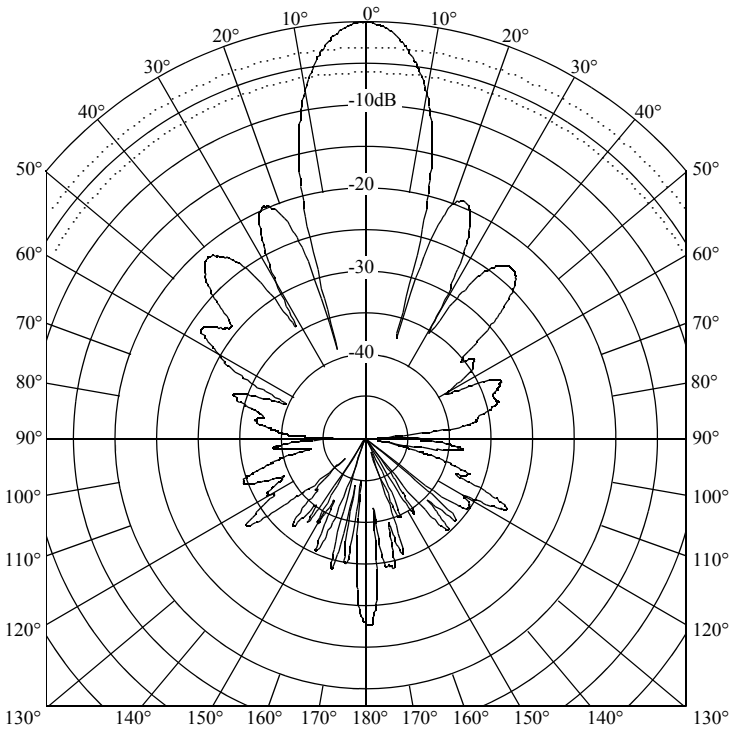
Beamwidth:

-3dB:	11°
-6dB:	17°
-10dB:	22°

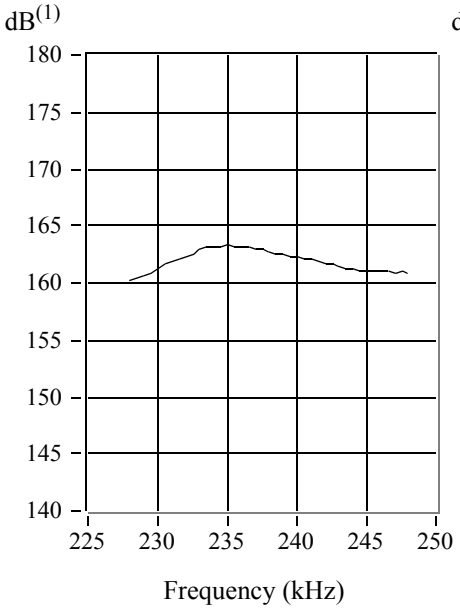
Directivity Index:	25.1
Frequency Tolerance:	±5kHz
Peak TVR(1), nominal:	163dB
Peak TVR(1), minimum:	161dB
Q (transmit):	12
Peak Source Level(4):	216dB
Peak RVR(2), nominal:	-187dB
Peak Figure of Merit(3):	-24dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

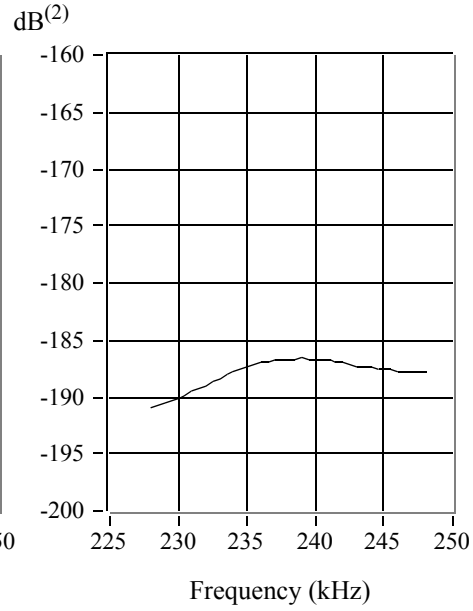
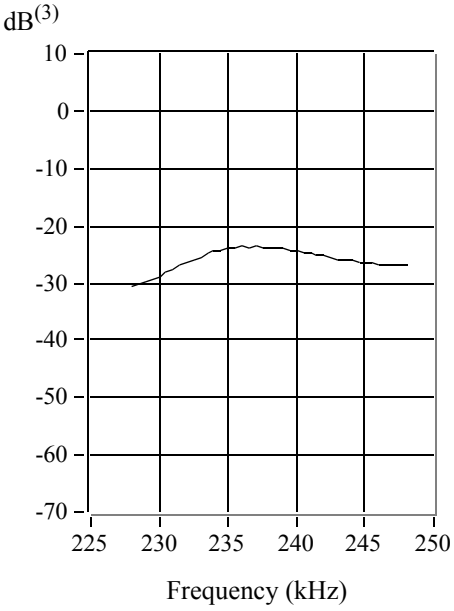


Figure of Merit



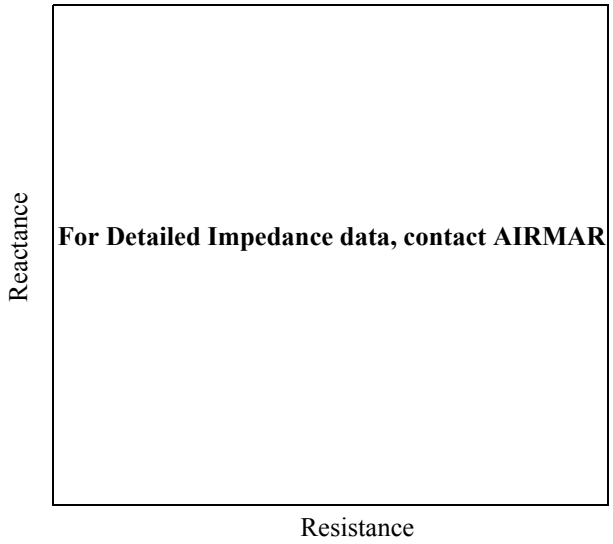
235 kHz-B

36mm (1.4") PZT

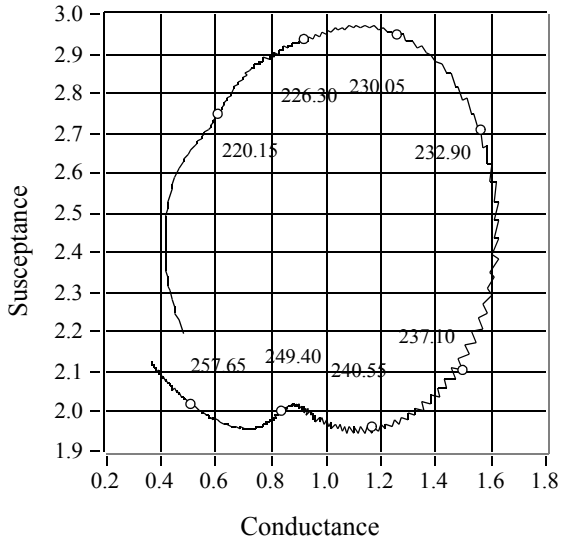
Cable Type: C2
Cable Length: 6.1 m (20.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	610 ohms -20%, +40%	610 ohms -20%, +40%
Parallel: Cp. (nominal)	640 pF	1660 pF
Series [R – jX] (nominal)	460 – j270 ohms	190 – j280 ohms
1 kHz Capacitance	1370 pF ±20%	2400 pF ±20%

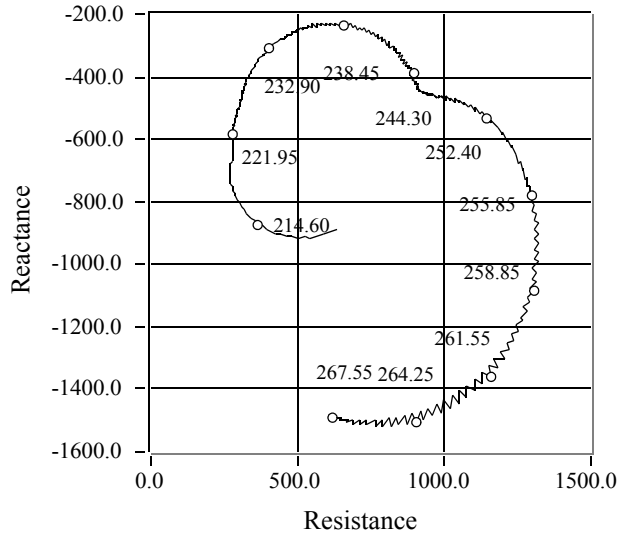
Unbalanced Impedance



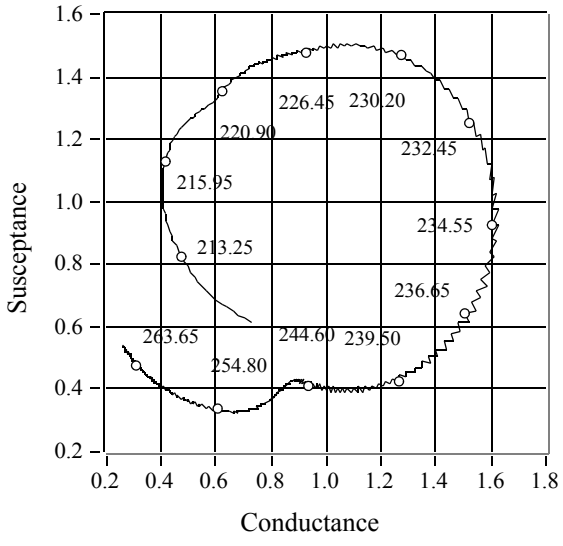
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



235 kHz-B

Power rating: 350 Wrms @ 2% duty cycle 36mm (1.4") PZT
Active Area: 10cm²
Layered Plastic Urethane Window

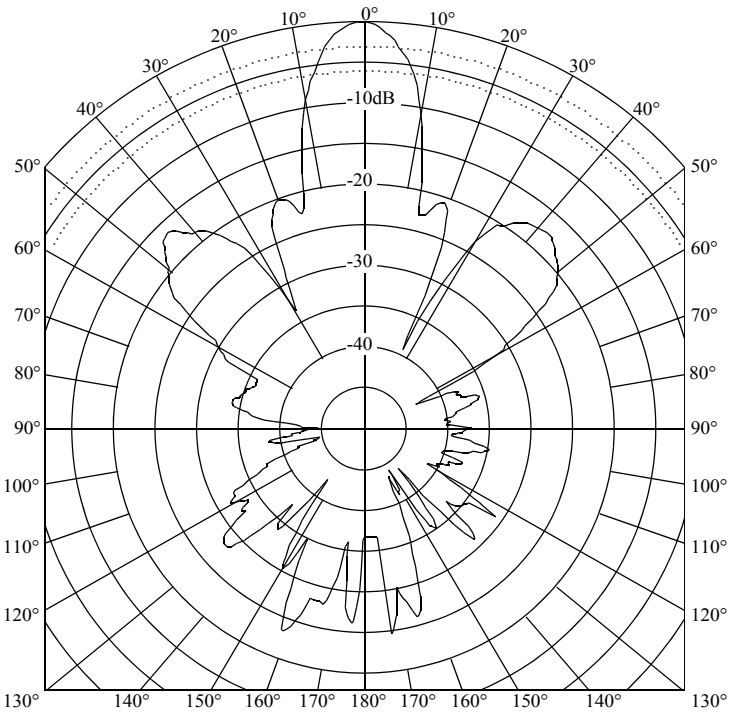
Beamwidth:

-3dB:	11°
-6dB:	15°
-10dB:	20°

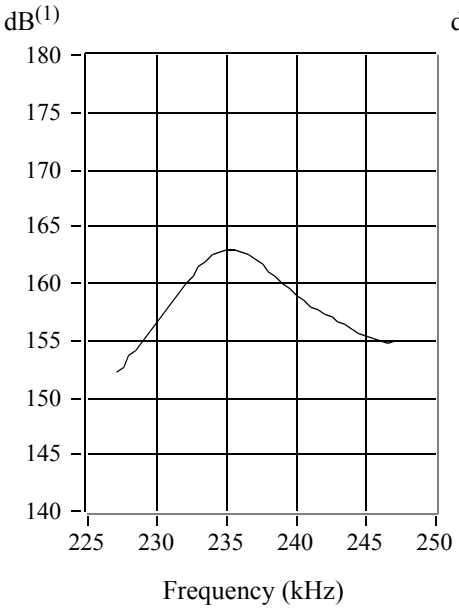
Directivity Index:	25.1
Frequency Tolerance:	234 +3/-4kHz
Peak TVR (1), nominal:	163 dB
Peak TVR (1), minimum:	161 dB
Q (transmit):	34
Peak Source Level (4):	216dB
Peak RVR (2), nominal:	-187dB
Peak Figure of Merit (3):	-26dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

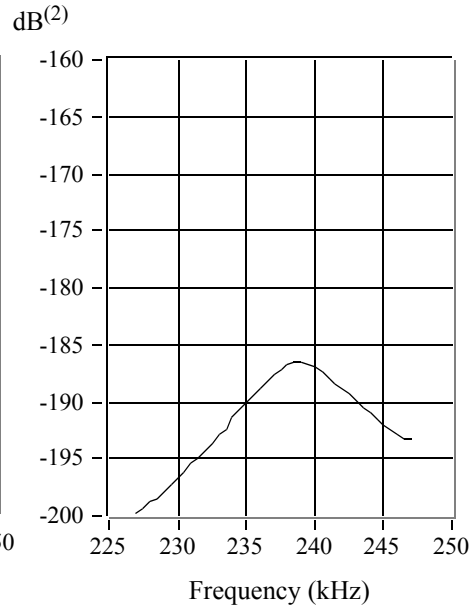
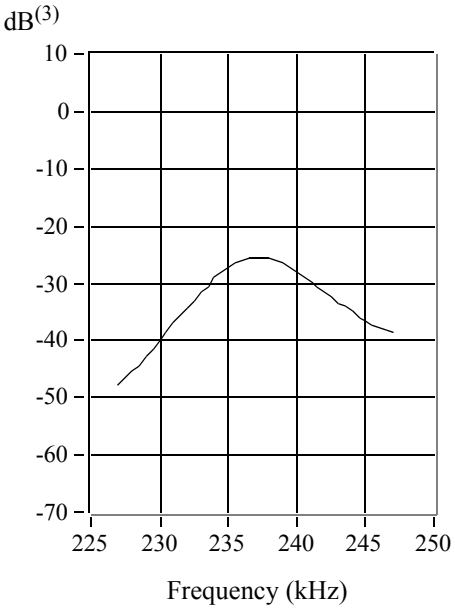


Figure of Merit



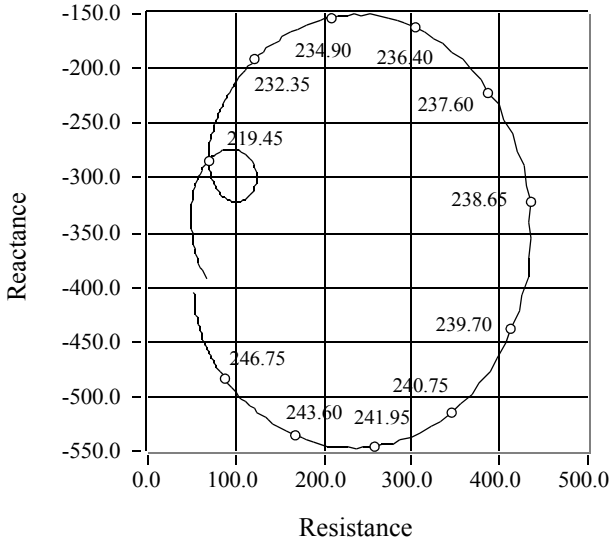
235 kHz-B

36mm (1.4") PZT

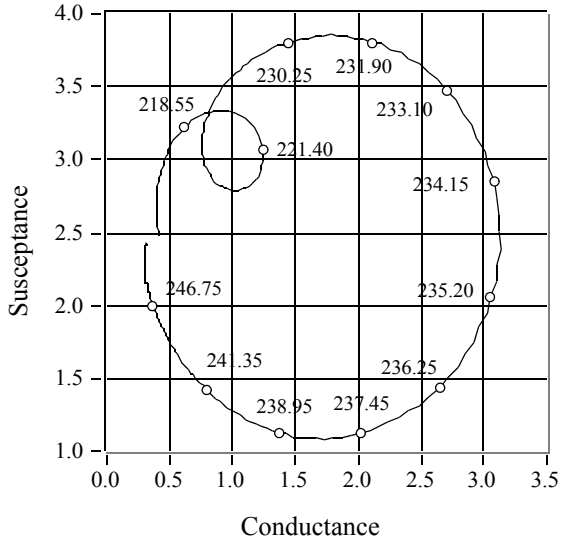
Cable Type: C2
Cable Length: 7.6m (25.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	320ohms-20%,+40%	320ohms-20%,+40%
Parallel: Cp. (nominal)	500pF	1730pF
Series [R – jX] (nominal)	300 – j70 ohms	190 – j160 ohms
1 kHz Capacitance	1380pF±20%	2620 pF±20%

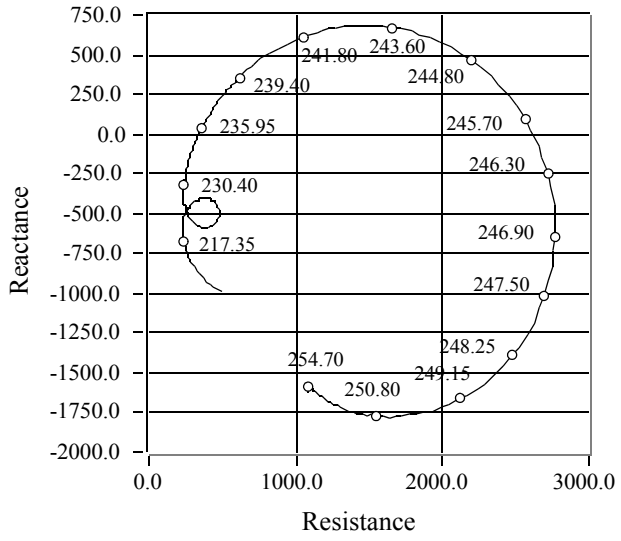
Unbalanced Impedance



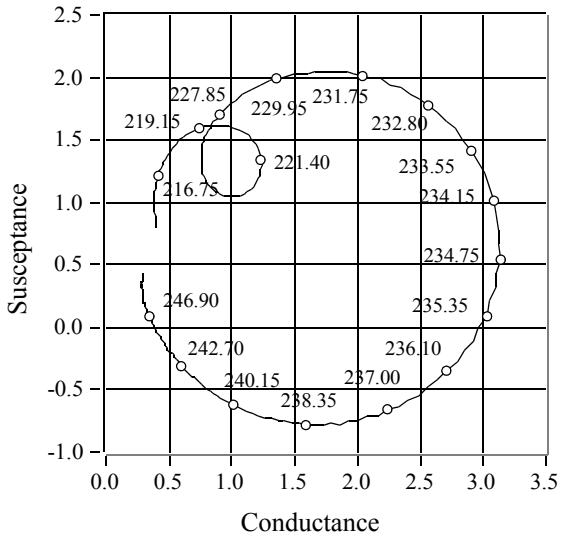
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



235 kHz-B

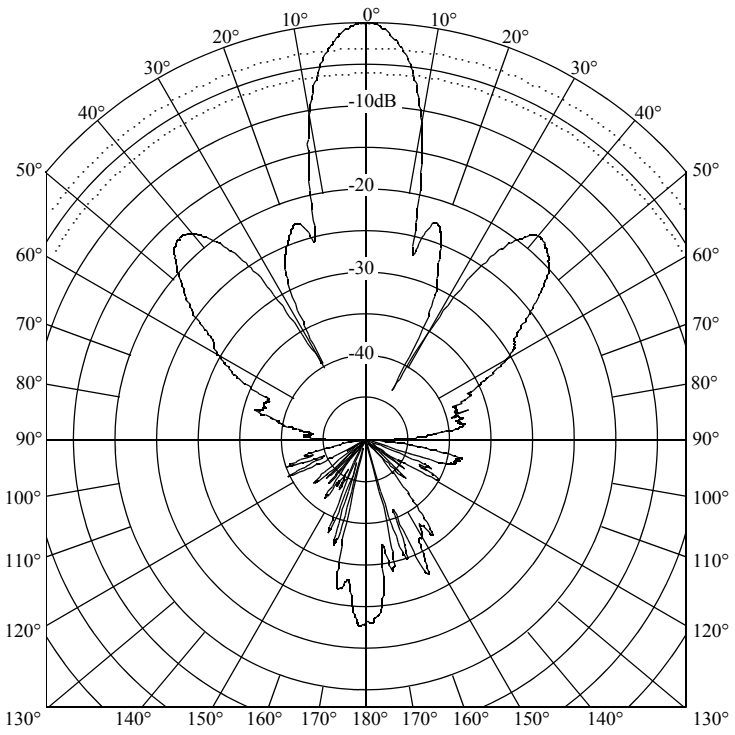
Power rating: 350 Wrms @ 2% duty cycle
36mm (1.4") PZT
Active Area: 10cm^2
Urethane Window

Beamwidth:
-3dB: 11°
-6dB: 15°
-10dB: 19°

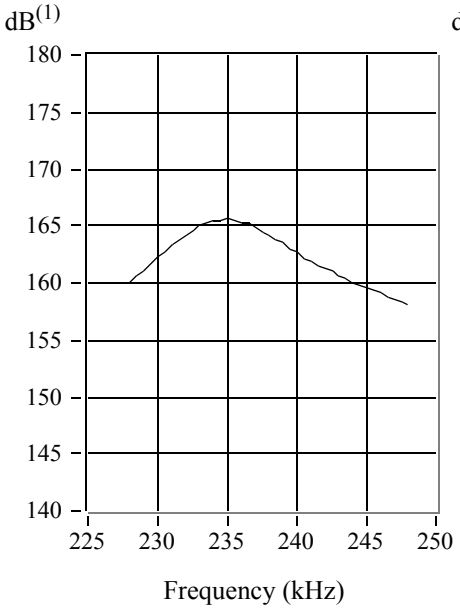
Directivity Index:	25.1
Frequency Tolerance:	234 +3/-4kHz
Peak TVR(1), nominal:	165dB
Peak TVR(1), minimum:	163 dB
Q (transmit):	25
Peak Source Level(4):	216dB
Peak RVR(2), nominal:	-185dB
Peak Figure of Merit(3):	-21 dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

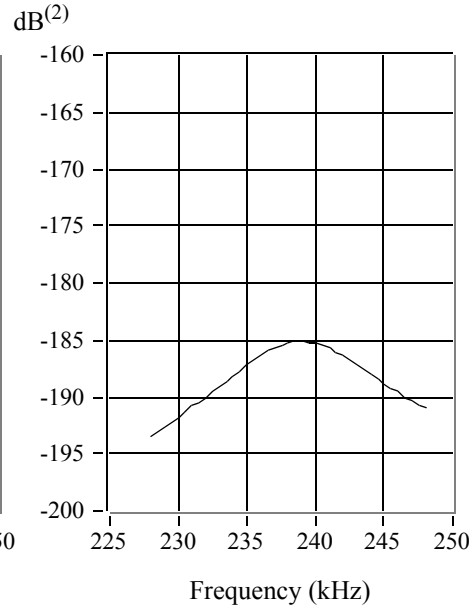
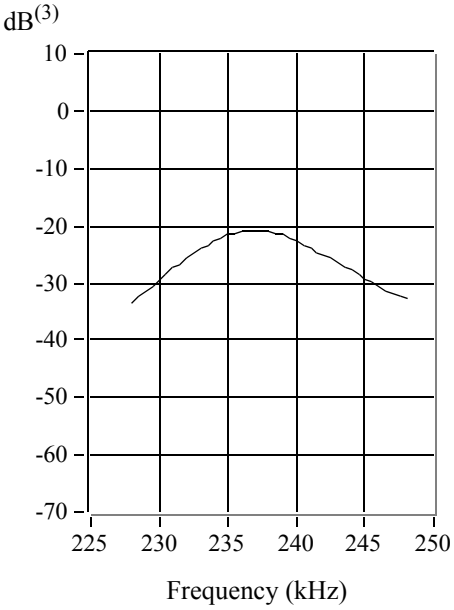


Figure of Merit



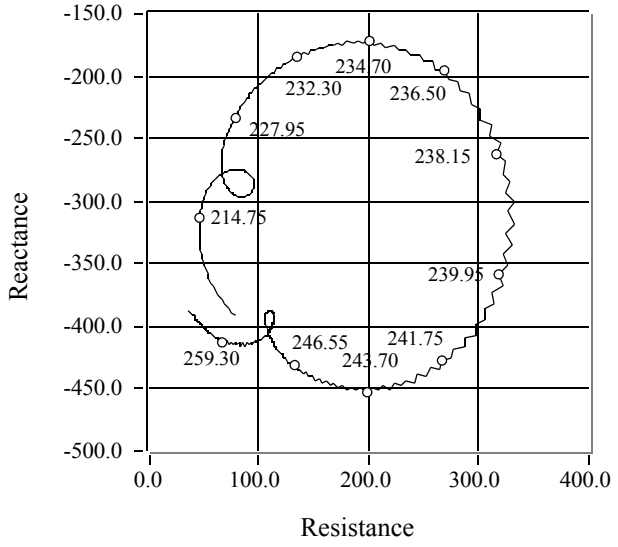
235 kHz-B

36mm (1.4") PZT

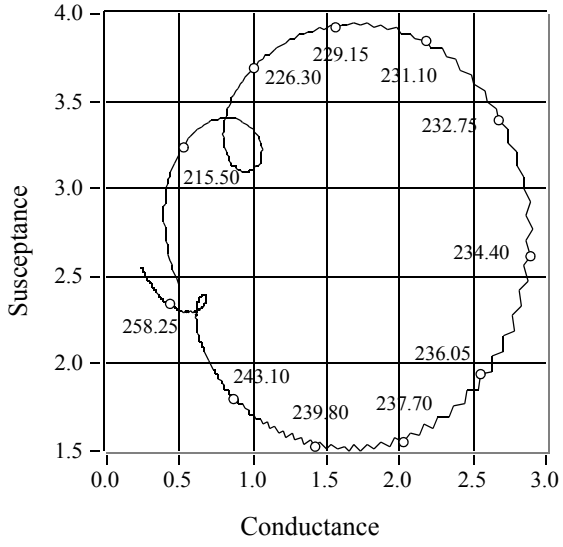
Cable Type: C2
Cable Length: 7.6m (25.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	350ohms-20%,+40%	350ohms-20%,+40%
Parallel: Cp. (nominal)	410pF	1730pF
Series [R – jX] (nominal)	330 – j70 ohms	190 – j170 ohms
1 kHz Capacitance	1440pF±20%	2770pF±20%

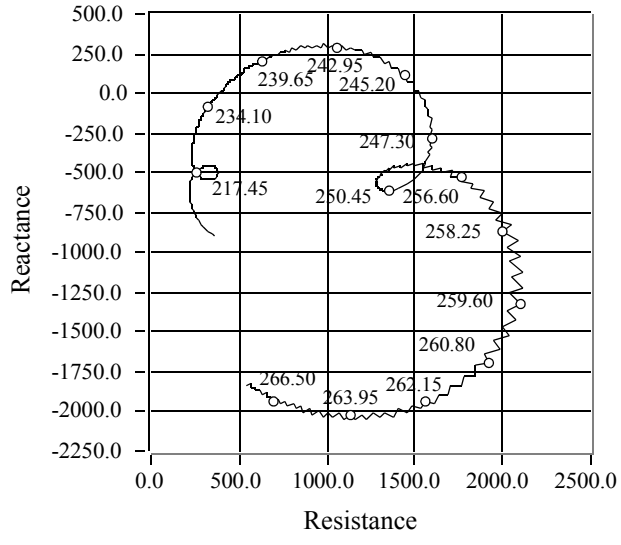
Unbalanced Impedance



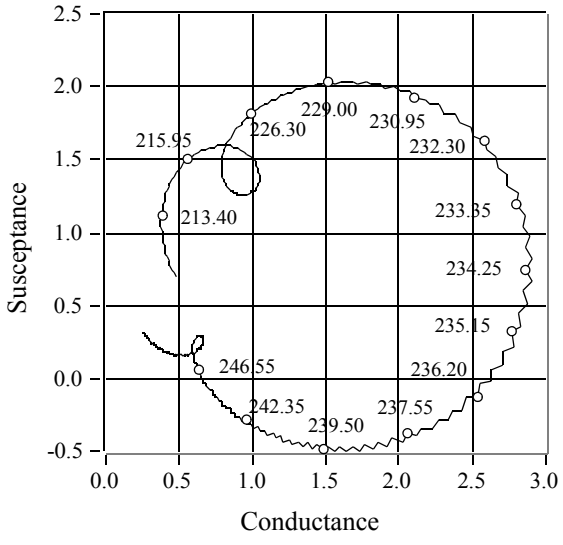
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



235 kHz-D

Power rating: 600 Wrms @ 2% duty cycle
51mm (2.0") BT
Active Area: 20cm²
Layered Plastic Urethane Window

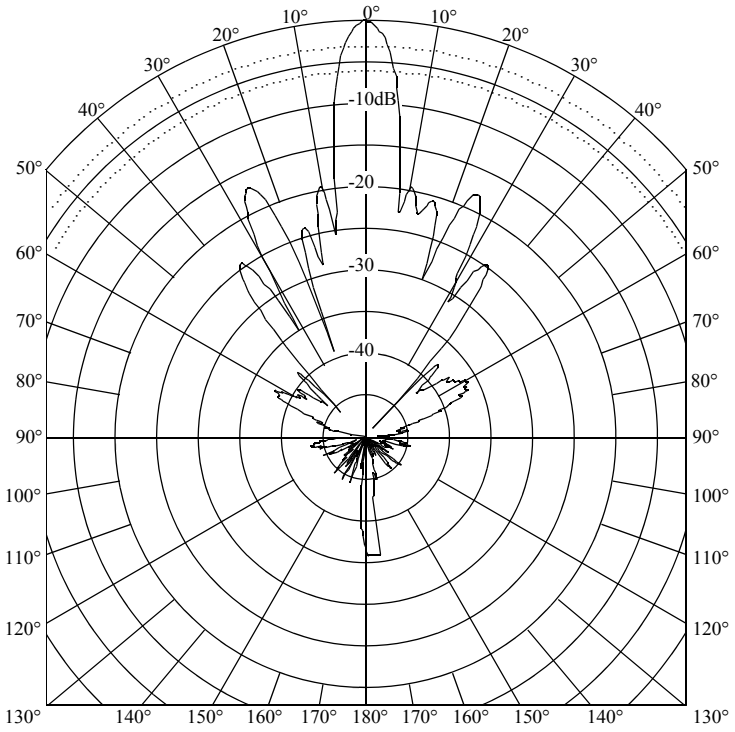
Beamwidth:

-3dB:	6°
-6dB:	9°
-10dB:	11°

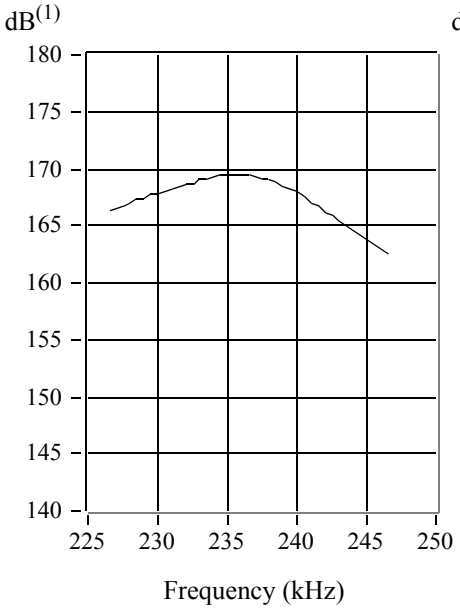
Directivity Index:	28.2
Frequency Tolerance:	±5kHz
Peak TVR(1), nominal:	169dB
Peak TVR(1), minimum:	167dB
Q (transmit):	16
Peak Source Level(4):	223dB
Peak RVR(2), nominal:	-185dB
Peak Figure of Merit(3):	-16dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

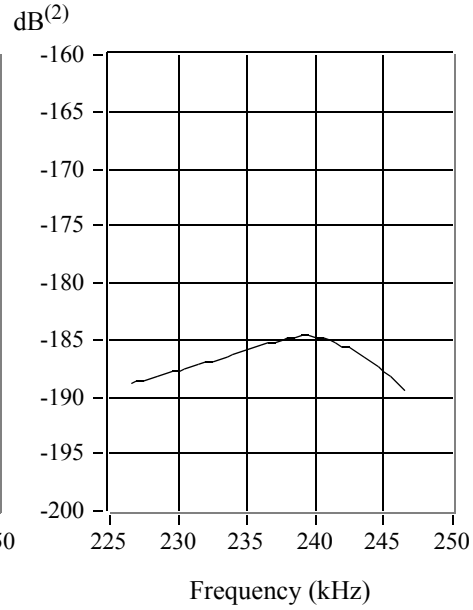
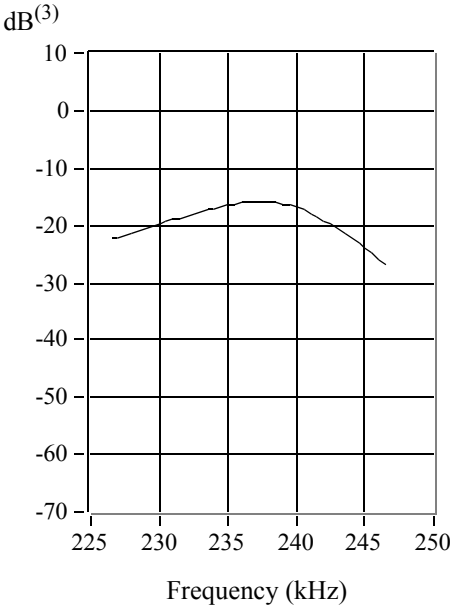


Figure of Merit



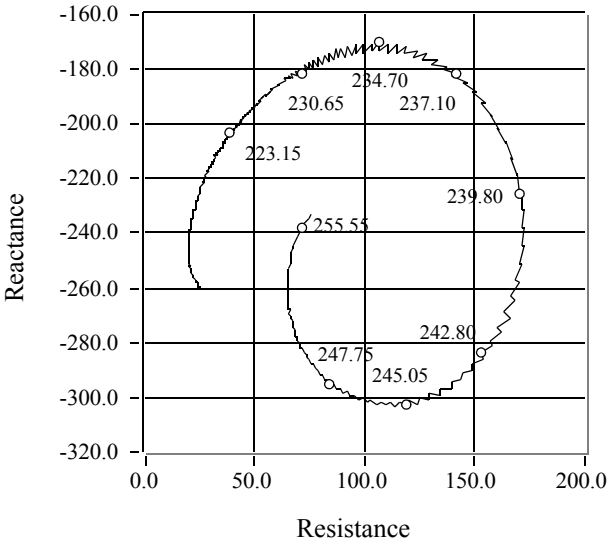
235 kHz-D

51mm (2.0") BT

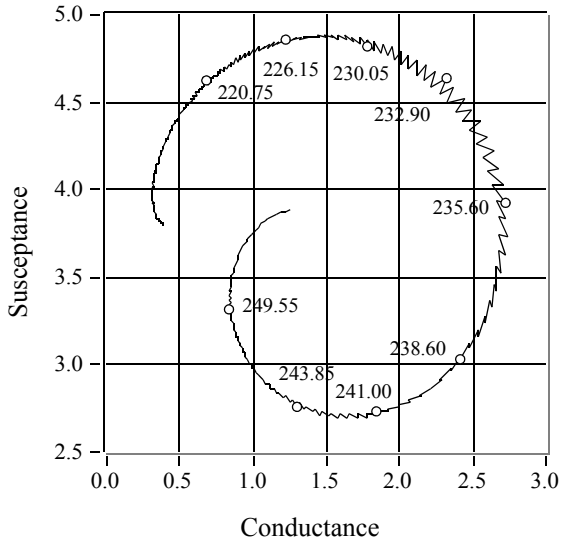
Cable Type: C47
Cable Length: 6.1 m (20.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	370 ohms -20%, +40%	370 ohms -20%, +40%
Parallel: Cp. (nominal)	1440 pF	2440 pF
Series [R – jX] (nominal)	220 – j180 ohms	130 – j180 ohms
1 kHz Capacitance	1790 pF ±20%	2790 pF ±20%

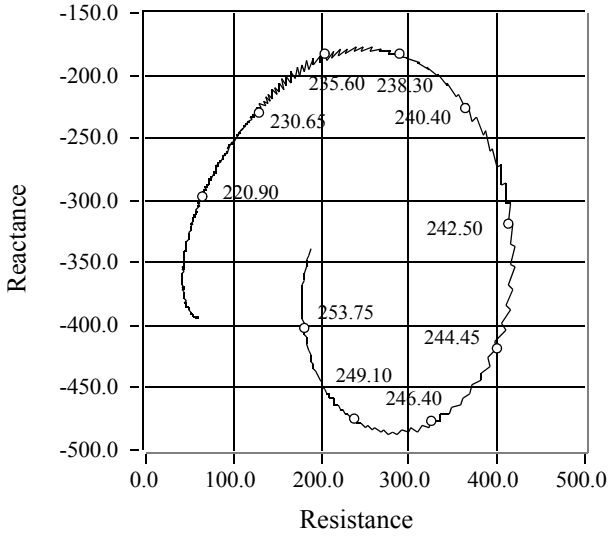
Unbalanced Impedance



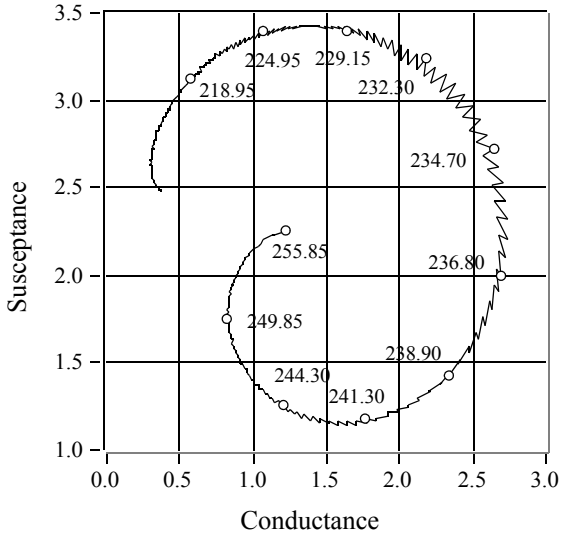
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



235 kHz-D

Power rating: 600 Wrms @ 2% duty cycle
51mm (2.0") BT
Active Area: 20cm²
Urethane Window

Beamwidth:

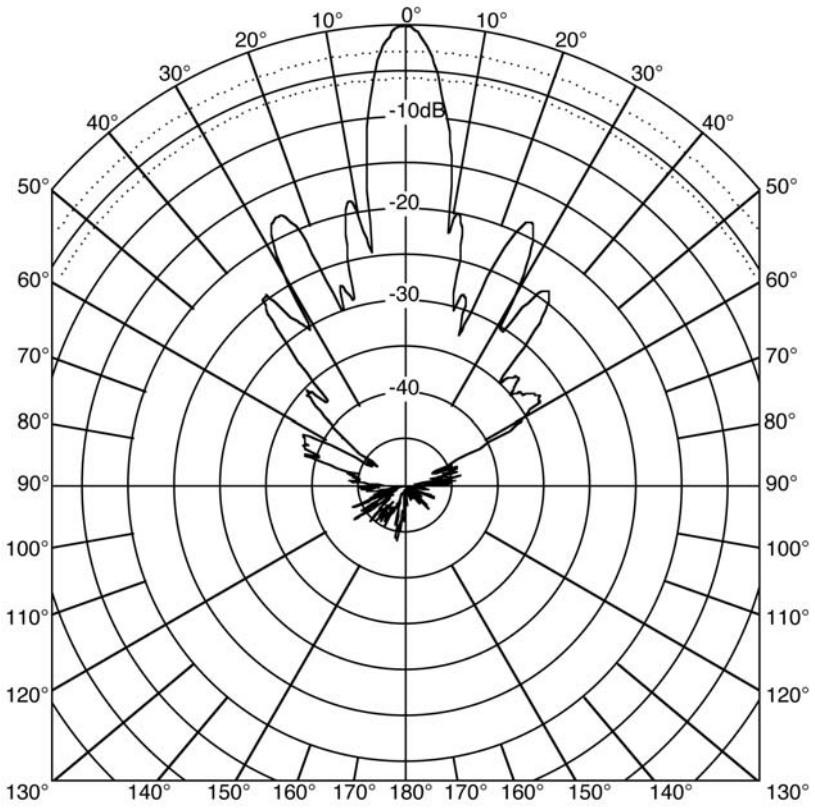
-3dB: 7°
-6dB: 9°
-10dB: 12°

Directivity Index:	28.2
Frequency Tolerance:	±5kHz
Peak TVR(1), nominal:	169dB
Peak TVR(1), minimum:	167dB
Q (transmit):	28
Peak Source Level(4):	223dB
Peak RVR(2), nominal:	-182dB
Peak Figure of Merit(3):	-15dB

Notes:

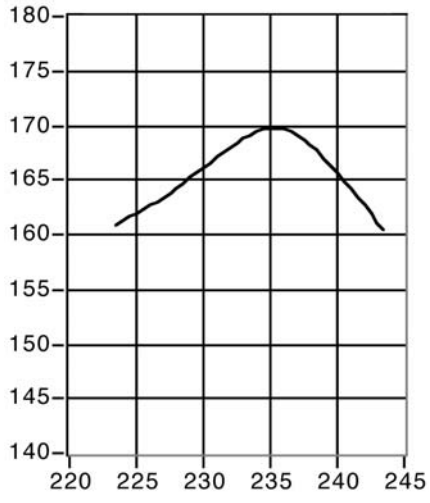
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR

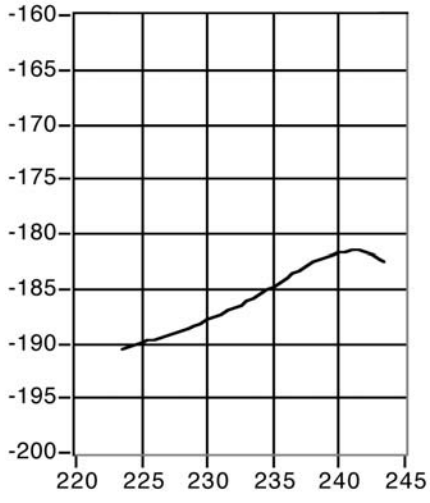
dB(1)



Frequency (kHz)

RVR

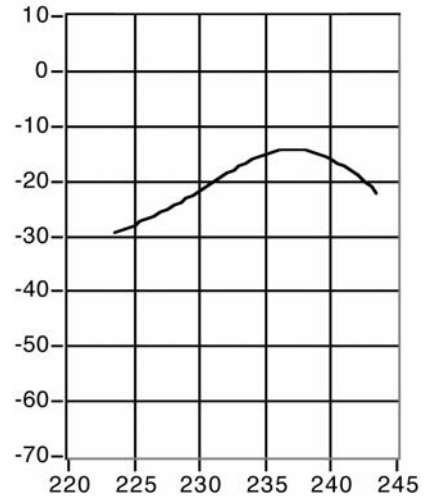
dB(2)



Frequency (kHz)

Figure of Merit

dB(3)



Frequency (kHz)

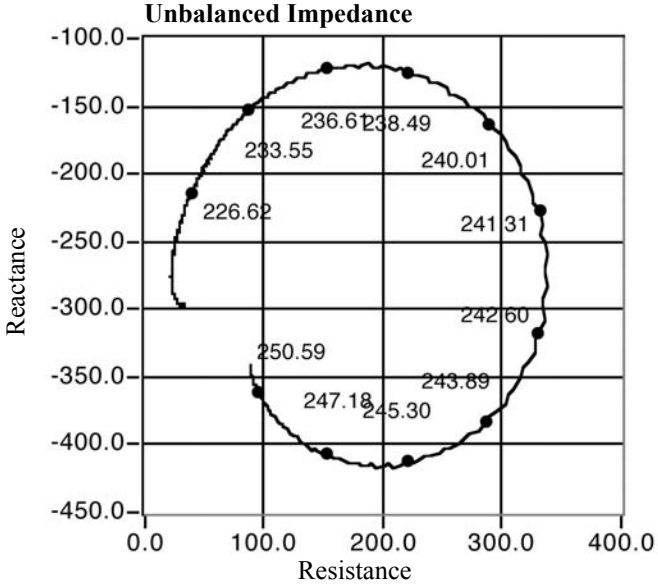
235 kHz-D

51mm (2.0") BT

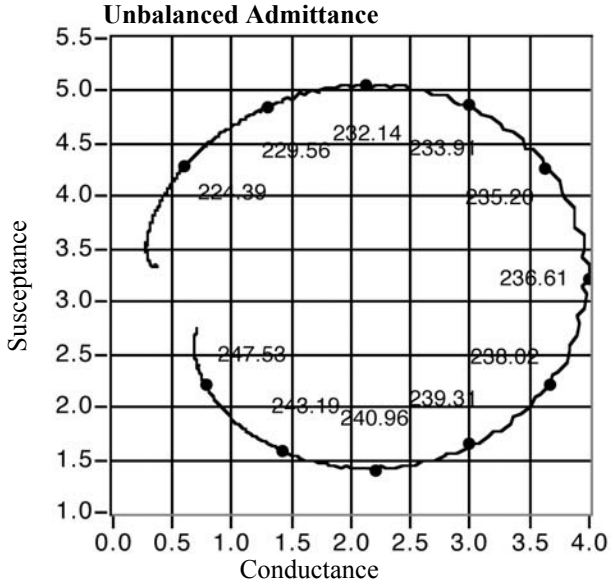
Cable Type: C13
Cable Length: 9.1 m (30.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	255 ohms -20%, +40%	250 ohms -20%, +40%
Parallel: Cp. (nominal)	2270 pF	3000 pF
Series [R – jX] (nominal)	150 – j145 ohms	120 – j130 ohms
1 kHz Capacitance	1590 pF ±20%	2350 pF ±20%

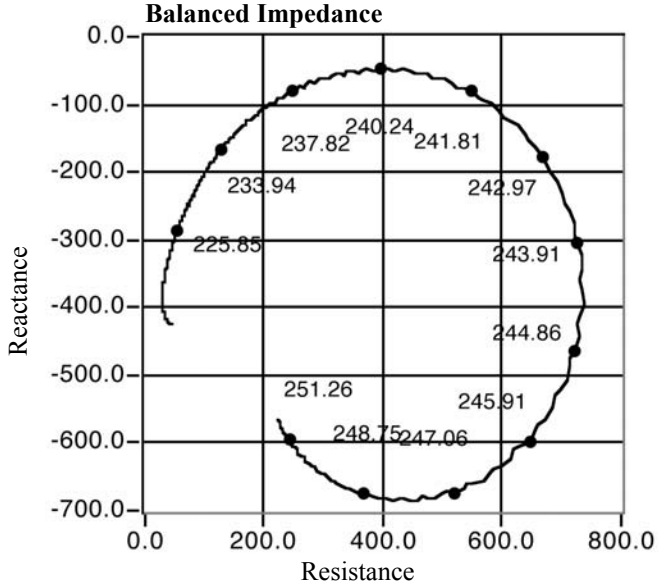
Unbalanced Impedance



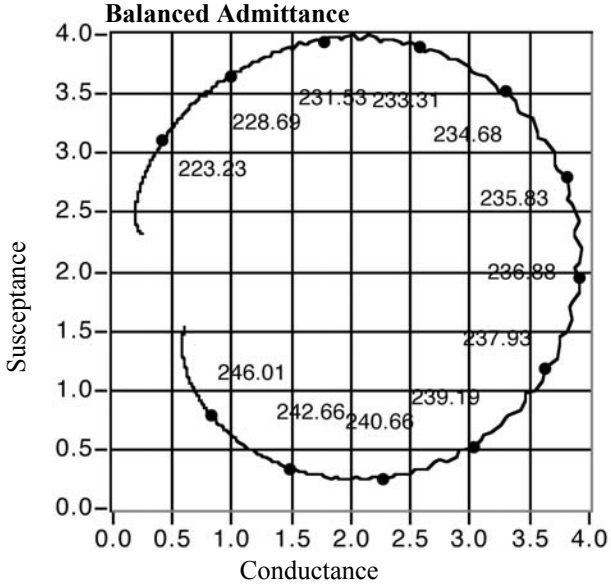
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



235 kHz-F

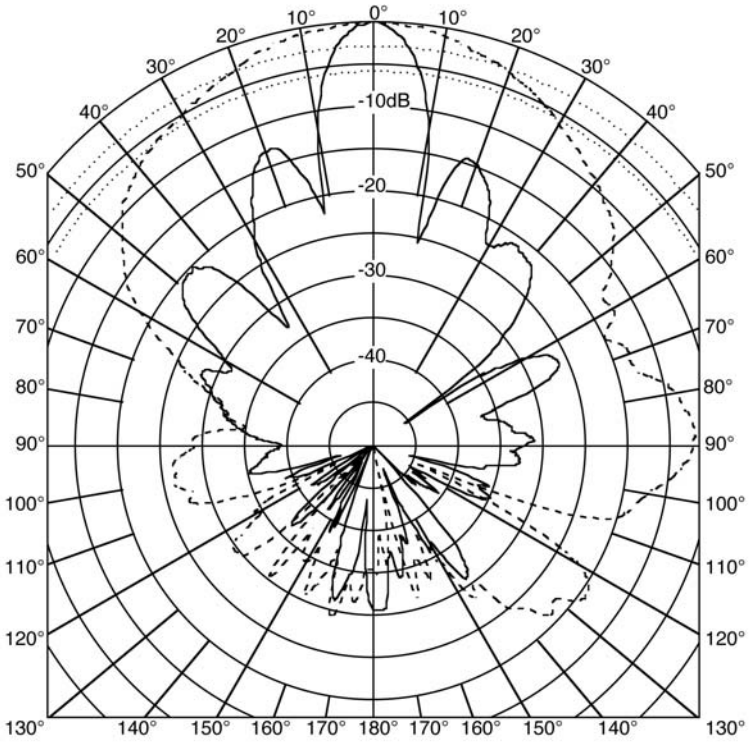
Power rating: 100 Wrms @ 2% duty cycle
5.6mm (.22") x 32mm (1.25") PZT
Active Area: 18cm²
Urethane Window

Beamwidth:
-3dB: 10° x 44°
-6dB: 16° x 60°
-10dB: 20° x 89°

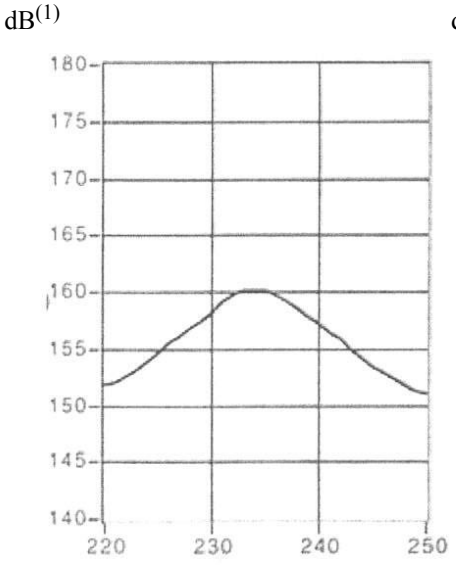
Directivity Index:	18.1
Frequency Tolerance:	±-6kHz/+4kHz
Peak TVR(1), nominal:	160dB
Peak TVR(1), minimum:	157dB
Q (transmit):	20
Peak Source Level(4):	207dB
Peak RVR(2), nominal:	-189dB
Peak Figure of Merit(3):	-32dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

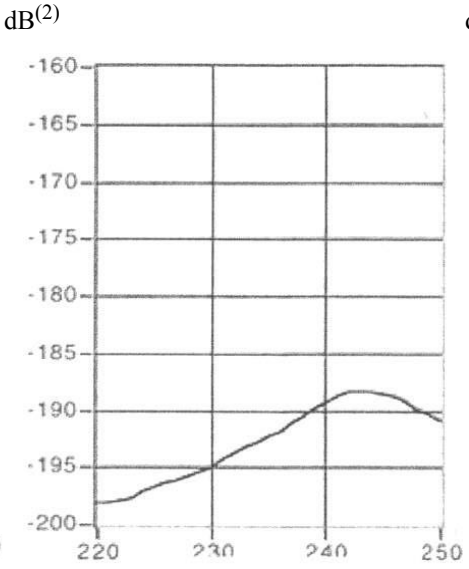
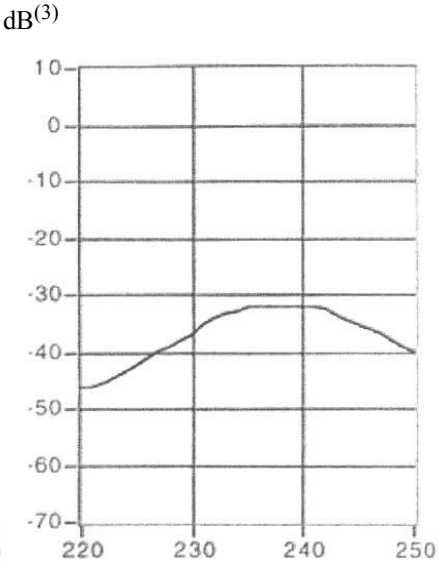


Figure of Merit



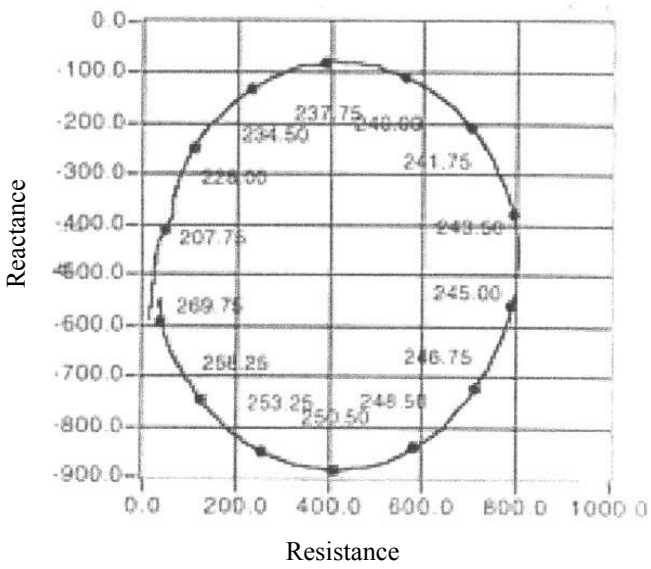
235 kHz-F

5.6mm (.22") x 32mm (1.25") PZT

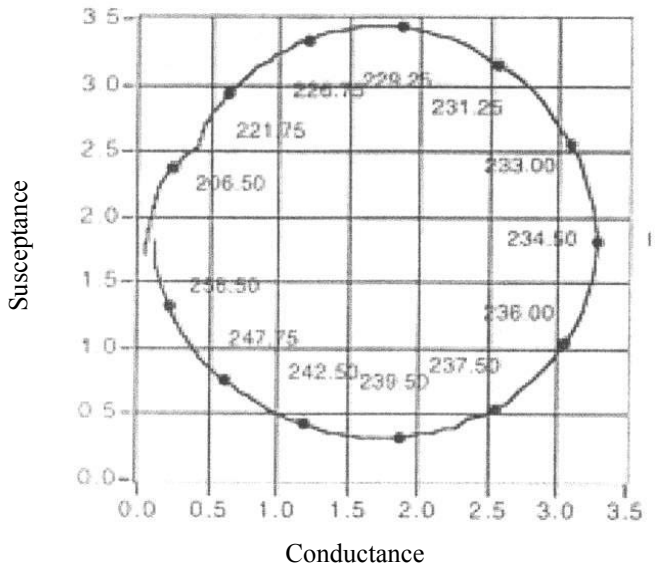
Cable Type: C47
Cable Length: 20’

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	300ohms-20%,+40%	300ohms 20%,+40%
Parallel: Cp. (nominal)	600pF	1250pF
Series [R – jX] (nominal)	300– j15ohms	265– j30 ohms
1 kHz Capacitance	810pF±20%	1440pF±20%

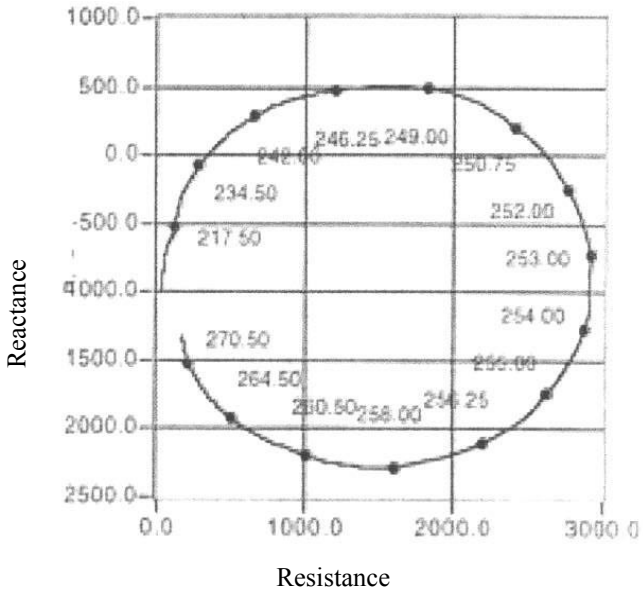
Unbalanced Impedance



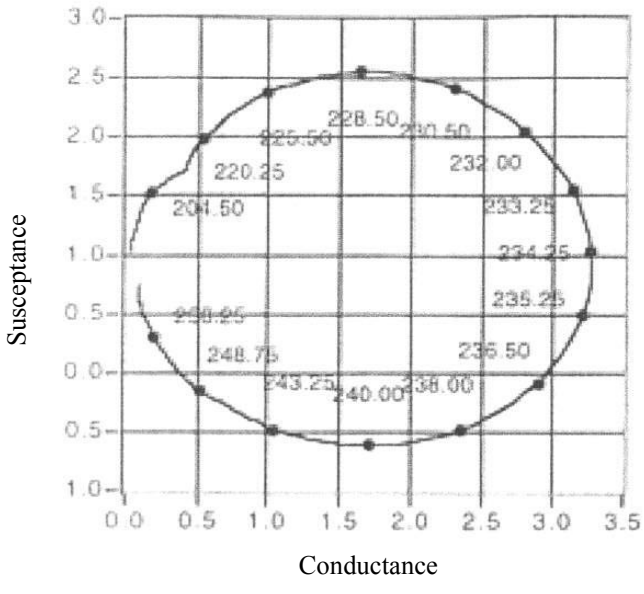
Unbalanced Admittance



Balanced Impedance



Balanced Admittance



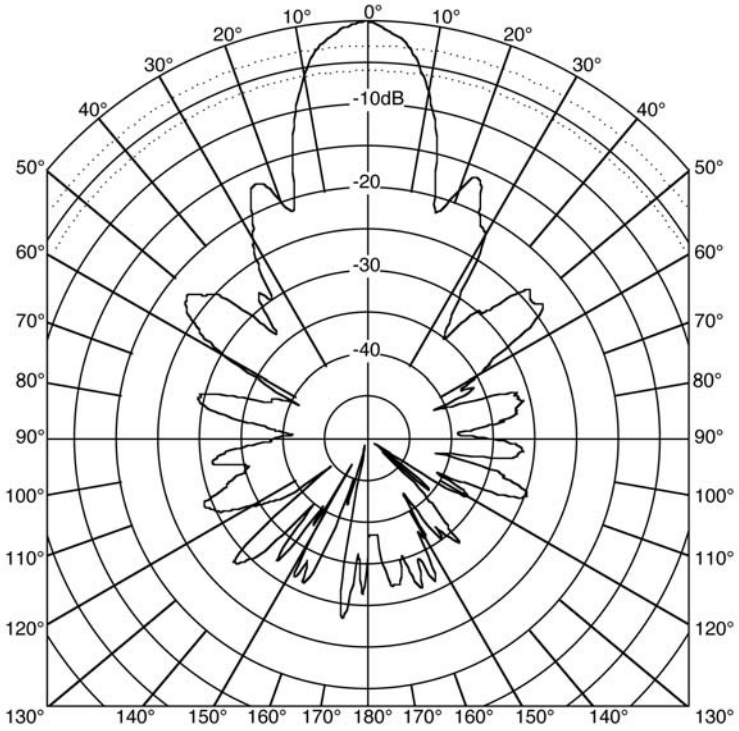
235 kHz-G

Power rating: 200 W
23mm (.92") PZT
Active Area: 4.2cm^2
Layered Plastic Epoxy Window
Beamwidth:
-3dB: 14°
-6dB: 19°
-10dB: 24°

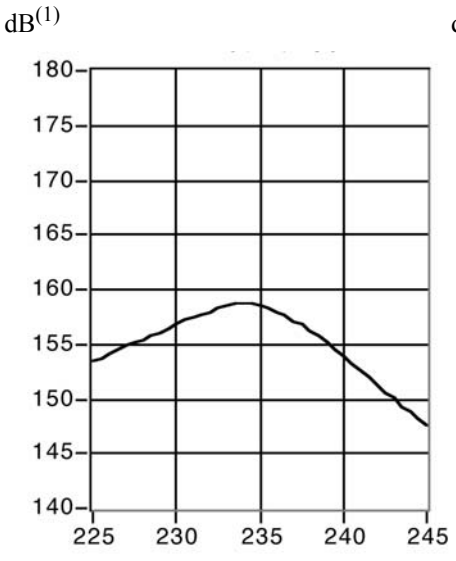
Directivity Index:	21.4
Frequency Tolerance:	±5kHz
Peak TVR(1), nominal:	159dB
Peak TVR(1), minimum:	157dB
Q (transmit):	23
Peak Source Level(4):	211dB
Peak RVR(2), nominal:	-192dB
Peak Figure of Merit(3):	-33dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

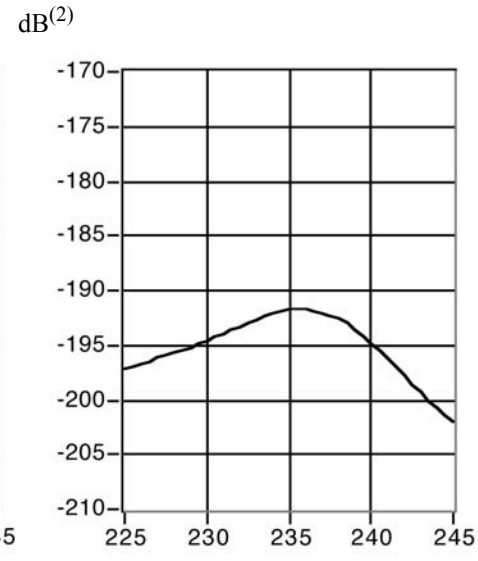
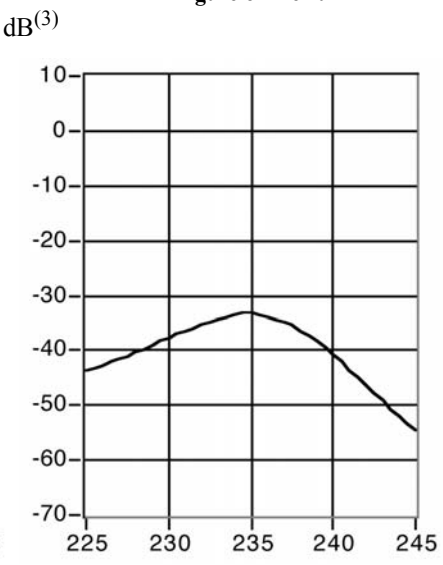


Figure of Merit



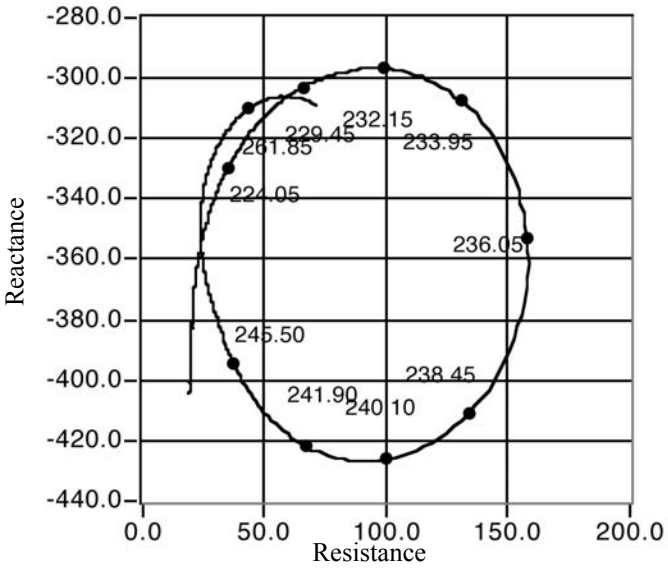
235 kHz-G

23mm (.92") PZT

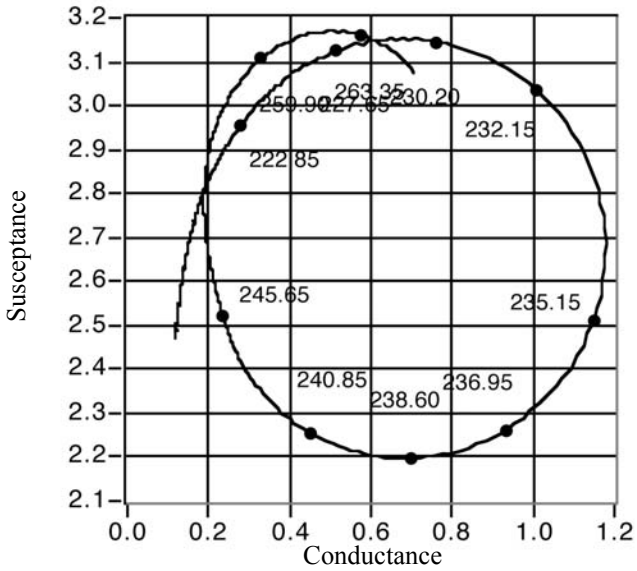
Cable Type: C2
Cable Length: 7.6m (25.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	860ohms-20%,+40%	850ohms-20%,+40%
Parallel: Cp. (nominal)	855pF	1720pF
Series [R – jX] (nominal)	395 – j435 ohms	150 – j325 ohms
1 kHz Capacitance	1300pF±20%	2170pF±20%

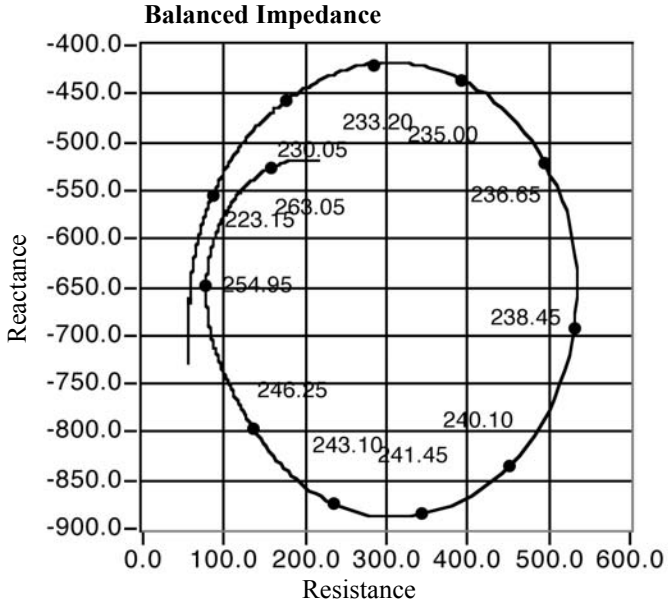
Unbalanced Impedance



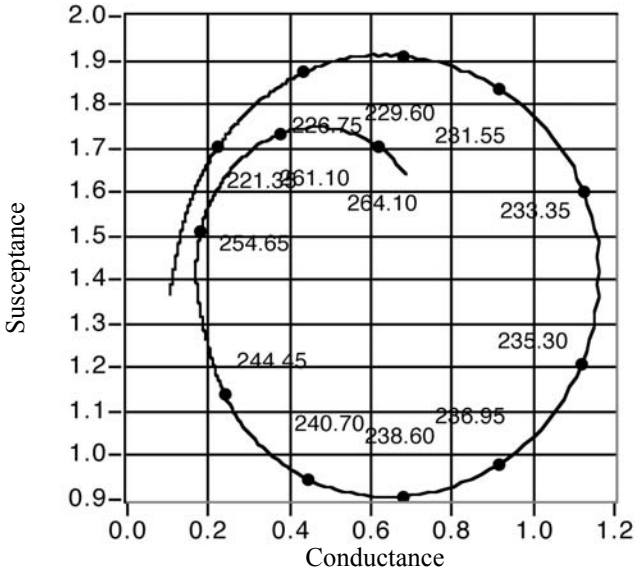
Unbalanced Admittance



Balanced Impedance



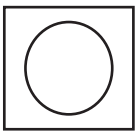
Balanced Admittance



235 kHz-G
P692 Housing

Power Rating: 200 W rms @ 1% duty cycle
23 mm (0.92") PZT
Active Area: 4.2 cm² (0.65 in²)
Radiating Surface: Plastic

Array

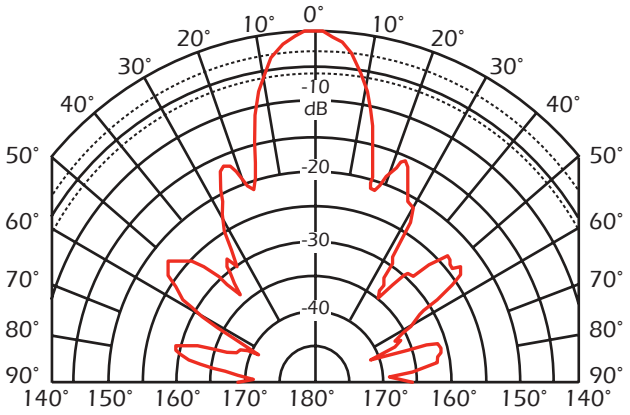


Beamwidth:

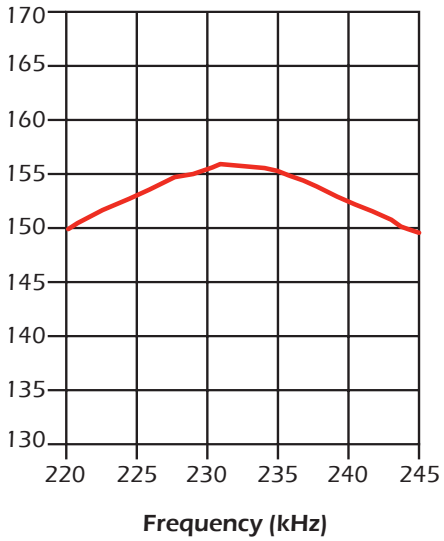
-3 dB:	14°
-6 dB:	19°
-10 dB:	24°

Directivity Index:	21
Frequency Tolerance:	-7 kHz/+3 kHz
Peak TVR(1), nominal:	156 dB
Peak TVR(1), minimum:	154 dB
Q (transmit):	16
Peak Source Level(4):	209 dB
Peak RVR(2), nominal:	-194 dB
Peak Figure of Merit(3):	-38 dB

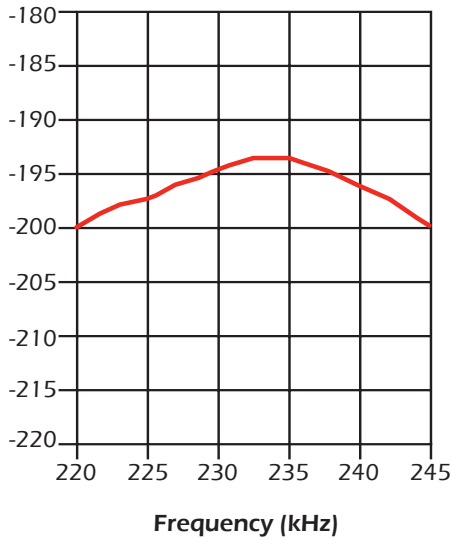
Transmit Radiation Pattern



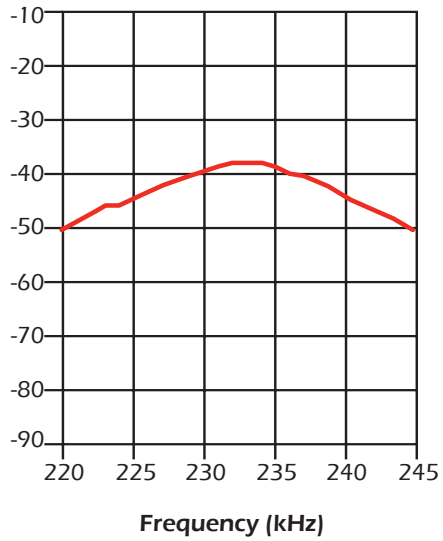
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

235 kHz-G
P692 Housing

23 mm (0.92”) PZT

Cable Type: C2
Cable Length: 8 m (27’)

Note:
Impedance data includes cable

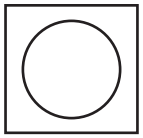
Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	1,040 Ω: -20%, +40%	1,070 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,770 pF	1,750 pF
Series [R - jX]: (nominal)	130 - j340 Ω	130 - j350 Ω
1 kHz capacitance: (nominal)	1,295 pF	2,050 pF

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
220.00	351.34	-82.62	45.12	-348.43	0.37	2.82	2735.71	2041.99
221.00	347.42	-81.89	48.99	-343.95	0.41	2.85	2463.93	2052.15
222.00	344.02	-81.05	53.50	-339.83	0.45	2.87	2211.96	2058.59
223.00	340.88	-80.12	58.48	-335.82	0.50	2.89	1986.91	2062.67
224.00	338.35	-79.03	64.38	-332.17	0.56	2.90	1778.33	2061.58
225.00	336.60	-77.80	71.12	-329.00	0.63	2.90	1593.15	2054.04
226.00	335.71	-76.42	78.81	-326.33	0.70	2.90	1430.04	2039.12
227.00	336.67	-74.87	87.90	-324.99	0.78	2.87	1289.52	2010.31
228.00	339.89	-73.26	97.90	-325.49	0.85	2.82	1180.12	1966.70
229.00	345.34	-71.69	108.49	-327.85	0.91	2.75	1099.29	1910.65
230.00	354.05	-70.42	118.64	-333.58	0.95	2.66	1056.55	1841.49
231.00	364.83	-69.46	128.01	-341.64	0.96	2.57	1039.80	1768.42
232.00	377.22	-68.92	135.65	-351.98	0.95	2.47	1048.97	1696.96
233.00	390.84	-68.94	140.45	-364.74	0.92	2.39	1087.63	1630.94
234.00	404.15	-69.45	141.88	-378.42	0.87	2.32	1151.18	1575.81
235.00	416.34	-70.45	139.34	-392.33	0.80	2.26	1244.02	1532.87
236.00	425.48	-71.83	132.68	-404.26	0.73	2.23	1364.41	1505.97
237.00	433.01	-73.24	124.84	-414.62	0.67	2.21	1501.86	1485.02
238.00	437.01	-74.85	114.20	-421.83	0.60	2.21	1672.37	1477.04
239.00	438.03	-76.34	103.43	-425.64	0.54	2.22	1855.13	1477.28
240.00	437.72	-77.70	93.25	-427.67	0.49	2.23	2054.61	1480.22
241.00	435.56	-78.93	83.62	-427.46	0.44	2.25	2268.71	1487.99
242.00	432.74	-80.08	74.58	-426.26	0.40	2.28	2510.74	1497.04
243.00	429.05	-81.08	66.55	-423.86	0.36	2.30	2766.03	1508.04
244.00	424.68	-81.99	59.20	-420.54	0.33	2.33	3046.75	1520.91
245.00	419.97	-82.74	53.08	-416.61	0.30	2.36	3322.99	1534.39

235 kHz-J

Array

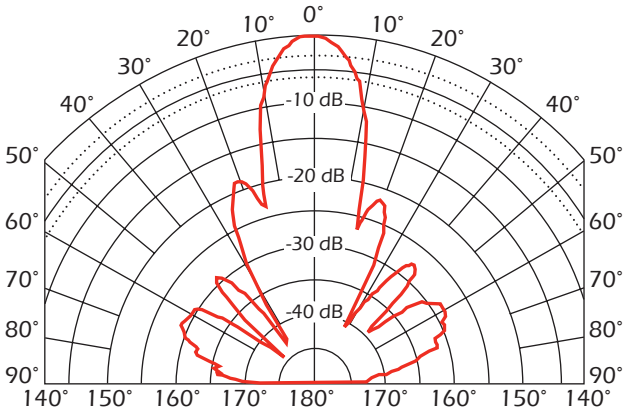


Power Rating: 250 W rms @ 2% duty cycle
33 mm (1.30") PZT
Active Area: 8.5 cm^2
Radiating Suface: Urethane

Beamwidth:
-3 dB: 11°
-6 dB: 16°
-10 dB: 21°

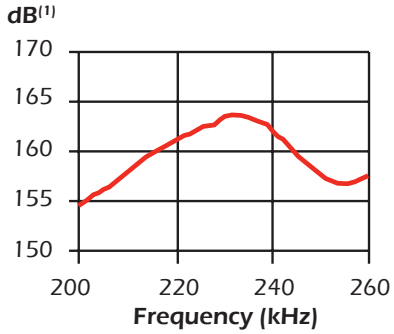
Directivity Index:	24.4
Frequency Tolerance:	± 8 kHz
Peak TVR(1), nominal:	163 dB
Peak TVR(1), minimum:	161 dB
Q (transmit):	9
Peak Source Level(4):	224 dB
Peak RVR(2), nominal:	-188 dB
Peak Figure of Merit(3):	-26 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

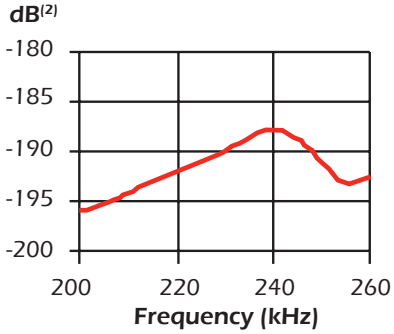
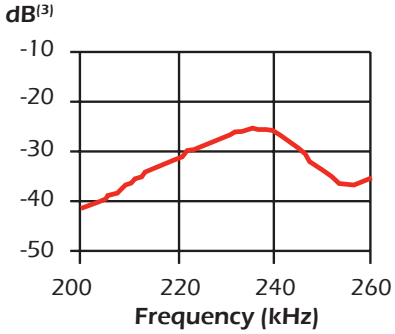


Figure of Merit



235 kHz-J

33 mm (1.30”) PZT

Cable Type: C332
Cable Length: 10 m (33’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	290 Ω: -20%, +40%	290 Ω: -20%, +40%
Parallel: Cp. (nominal)	2030 pF	2960 pF
Series [R - jX]: (nominal)	170 - j140 Ω	120 - j140 Ω
1 kHz capacitance: (nominal)	2650 pF	3750 pF

Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	203.71	-81.29	30.86	-201.36	0.74	4.85	1344.71	4064.59
193.00	197.56	-80.61	32.22	-194.91	0.83	4.99	1211.29	4118.22
196.00	191.42	-79.74	34.11	-188.36	0.93	5.14	1074.31	4174.16
199.00	185.44	-78.50	36.96	-181.72	1.08	5.28	930.27	4226.33
202.00	180.19	-76.94	40.72	-175.53	1.25	5.41	797.35	4259.42
205.00	175.48	-74.95	45.56	-169.46	1.48	5.50	675.81	4272.49
208.00	172.15	-72.68	51.24	-164.35	1.73	5.55	578.39	4243.42
211.00	170.40	-70.44	57.04	-160.57	1.96	5.53	509.03	4171.11
214.00	168.90	-68.47	61.98	-157.12	2.17	5.51	460.25	4095.99
217.00	166.49	-66.29	66.95	-152.43	2.42	5.50	414.00	4033.47
220.00	164.23	-63.19	74.08	-146.58	2.75	5.43	364.11	3931.40
223.00	164.76	-59.19	84.39	-141.51	3.11	5.21	321.69	3720.40
226.00	170.10	-54.67	98.37	-138.77	3.40	4.80	294.12	3377.47
229.00	181.72	-50.70	115.09	-140.63	3.49	4.26	286.93	2959.75
232.00	200.40	-48.29	133.33	-149.61	3.32	3.73	301.20	2555.68
235.00	223.72	-48.55	148.09	-167.69	2.96	3.35	337.97	2269.15
238.00	246.01	-51.65	152.64	-192.92	2.52	3.19	396.48	2131.74
241.00	258.84	-56.31	143.56	-215.38	2.14	3.21	466.68	2123.01
244.00	260.42	-60.84	126.87	-227.43	1.87	3.35	534.55	2187.32
247.00	255.00	-63.72	112.91	-228.64	1.74	3.52	575.90	2265.62
250.00	248.94	-64.90	105.60	-225.44	1.70	3.64	586.87	2315.79
253.00	246.37	-64.46	106.20	-222.30	1.75	3.66	571.51	2303.96
256.00	256.02	-63.89	112.66	-229.89	1.72	3.51	581.78	2180.60
259.00	269.73	-66.41	107.94	-247.19	1.48	3.40	674.02	2087.79
262.00	273.52	-70.47	91.44	-257.78	1.22	3.45	818.14	2093.15
265.00	269.21	-73.96	74.38	-258.73	1.03	3.57	974.43	2144.08
268.00	262.19	-76.56	60.95	-255.01	0.89	3.71	1127.90	2202.94
271.00	255.28	-78.56	50.65	-250.20	0.78	3.84	1286.75	2254.84
274.00	247.22	-80.17	42.22	-243.59	0.69	3.99	1447.68	2315.04
277.00	240.22	-81.15	36.95	-237.36	0.64	4.11	1561.54	2363.35
280.00	235.02	-82.02	32.63	-232.74	0.59	4.21	1692.71	2395.13

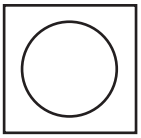
235 kHz-Jlq

Power Rating: 250 W rms @ 1% duty cycle
33 mm (1.30") PZT
Active Area: 8.6 cm^2
Radiating Surface: HPC/Urethane

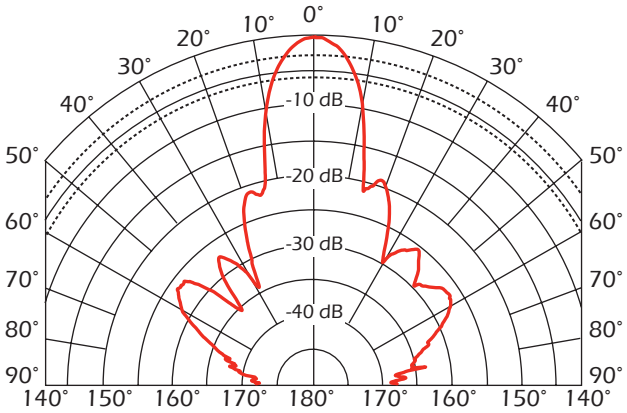
Beamwidth:
-3 dB: 11°
-6 dB: 16°
-10 dB: 20°

Directivity Index:	24.4
Frequency Tolerance:	± 8 kHz
Peak TVR(1), nominal:	163 dB
Peak TVR(1), minimum:	161 dB
Q (transmit):	4
Peak Source Level(4):	214 dB
Peak RVR(2), nominal:	-192 dB
Peak Figure of Merit(3):	-29 dB

Array

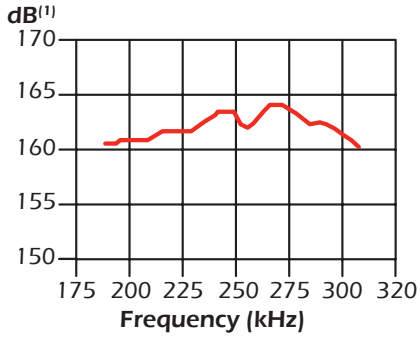


Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

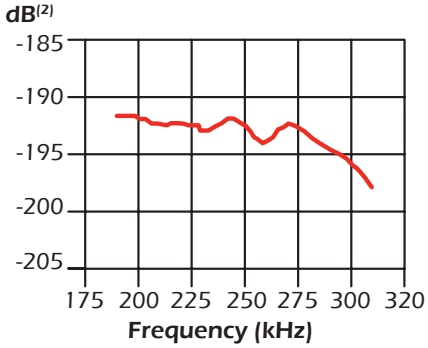
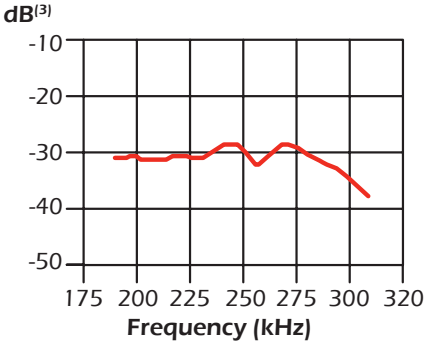


Figure of Merit



235 kHz-Jlq

33 mm (1.30”) PZT

Cable Type: C332
Cable Length: 10 m (33’)

Note:
Impedance data includes cable

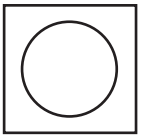
Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	865 Ω: -20%, +40%	850 Ω: -20%, +40%
Parallel: Cp. (nominal)	2000 pF	3150 pF
Series [R - jX]: (nominal)	115 - j295 Ω	50 - j200 Ω
1 kHz capacitance: (nominal)	2550 pF	3750 pF

Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
190.00	233.12	-73.14	67.61	-223.09	1.24	4.11	803.74	3438.87
194.00	235.99	-72.82	69.71	-225.45	1.25	4.05	798.89	3321.30
198.00	237.67	-73.38	67.98	-227.74	1.20	4.03	830.95	3240.79
202.00	237.89	-74.27	64.51	-228.98	1.14	4.05	877.29	3187.94
206.00	234.64	-75.33	59.43	-226.99	1.08	4.12	926.42	3185.36
210.00	228.69	-75.79	56.14	-221.69	1.07	4.24	931.49	3212.61
214.00	223.87	-75.38	56.49	-216.62	1.13	4.32	887.21	3214.66
218.00	222.03	-74.91	57.80	-214.37	1.17	4.35	852.84	3174.77
222.00	221.00	-74.87	57.67	-213.34	1.18	4.37	846.86	3131.58
226.00	220.03	-75.45	55.29	-212.97	1.14	4.40	875.60	3097.86
230.00	215.78	-76.24	51.32	-209.59	1.10	4.50	907.38	3114.83
234.00	209.52	-76.06	50.47	-203.35	1.15	4.63	869.82	3150.69
235.00	208.28	-75.82	51.03	-201.94	1.18	4.65	850.19	3152.54
236.00	207.04	-75.53	51.74	-200.47	1.21	4.68	828.53	3153.98
240.00	204.66	-74.38	55.10	-197.10	1.32	4.71	760.18	3120.67
244.00	205.90	-73.32	59.11	-197.23	1.39	4.65	717.23	3034.54
248.00	209.49	-73.11	60.86	-200.45	1.39	4.57	721.09	2931.36
252.00	212.61	-74.33	57.44	-204.71	1.27	4.53	786.99	2860.06
256.00	209.20	-76.30	49.54	-203.25	1.13	4.64	883.52	2887.26
260.00	200.53	-76.37	47.24	-194.88	1.17	4.85	851.14	2966.71
264.00	196.69	-74.81	51.54	-189.82	1.33	4.91	750.57	2957.89
268.00	198.71	-73.11	57.72	-190.15	1.46	4.82	684.11	2859.69
272.00	205.23	-72.81	60.67	-196.06	1.44	4.65	694.29	2723.62
276.00	209.92	-74.33	56.71	-202.11	1.29	4.59	777.02	2644.86
280.00	210.41	-76.03	50.78	-204.19	1.15	4.61	871.82	2621.55
284.00	208.85	-77.48	45.26	-203.88	1.04	4.67	963.71	2619.56
288.00	205.88	-78.55	40.86	-201.78	0.96	4.76	1037.44	2630.85
292.00	203.71	-79.27	37.91	-200.15	0.91	4.82	1094.56	2628.85
296.00	202.92	-80.01	35.21	-199.85	0.86	4.85	1169.38	2609.49
300.00	201.73	-81.30	30.51	-199.41	0.75	4.90	1333.82	2599.57
304.00	198.70	-82.68	25.31	-197.08	0.64	4.99	1559.75	2613.35
308.00	194.60	-83.77	21.11	-193.45	0.56	5.11	1794.36	2639.69

235 kHz-K

Array

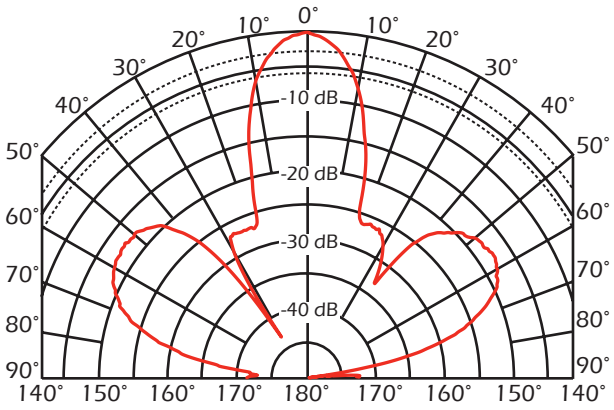


Power Rating: 250 W rms @ 1% duty cycle
33 mm (1.30") PZT
Active Area: 8.6 cm^2
Radiating Surface: Urethane

Beamwidth:
-3 dB: 12°
-6 dB: 17°
-10 dB: 21°

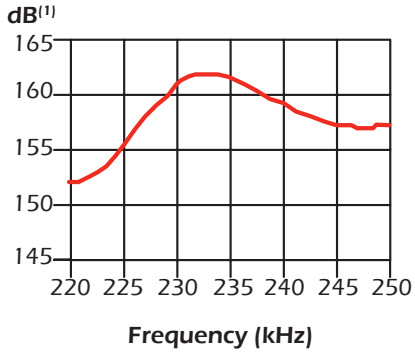
Directivity Index:	24
Frequency Tolerance:	± 8 kHz
Peak TVR(1), nominal:	162 dB
Peak TVR(1), minimum:	160 dB
Q (transmit):	19
Peak Source Level(4):	212 dB
Peak RVR(2), nominal:	-191 dB
Peak Figure of Merit(3):	-29.9 dB

Transmit Radiation Pattern



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

TVR



RVR

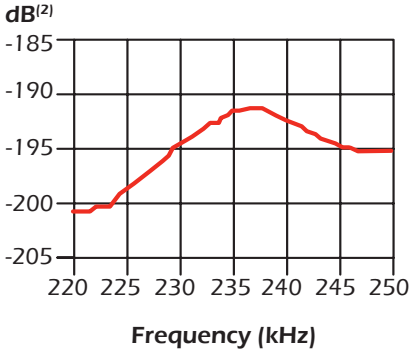
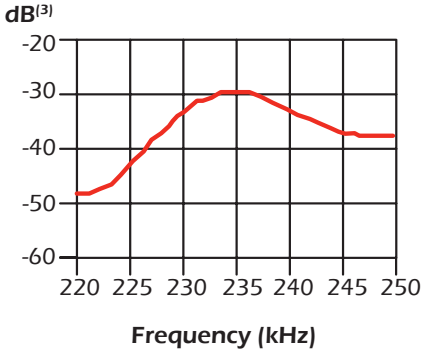


Figure of Merit



235 kHz-K

33 mm (1.30”) PZT

Cable Type: C47
Cable Length: 9 m (30’)

Note:
Impedance data includes cable

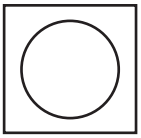
Impedance Data	
	Balanced
Parallel: Rp.	390 Ω: -20%, +40%
Parallel: Cp. (nominal)	980 pF
Series [R - jX]: (nominal)	230 - j190 Ω
1 kHz capacitance: (nominal)	2,490 pF: ±20%

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
220.00	387.35	-75.00	100.26	-374.14	0.67	2.49	1496.45	1804.02
221.00	380.56	-75.77	93.57	-368.88	0.65	2.55	1547.78	1834.25
222.00	370.61	-76.29	87.82	-360.06	0.64	2.62	1564.07	1879.31
223.00	358.19	-76.41	84.17	-348.16	0.66	2.71	1524.22	1936.73
224.00	344.58	-76.12	82.67	-334.52	0.70	2.82	1436.26	2001.72
225.00	330.21	-75.35	83.50	-319.48	0.77	2.93	1305.77	2072.52
226.00	315.41	-73.99	87.00	-303.18	0.87	3.05	1143.50	2146.10
227.00	300.95	-71.93	93.36	-286.10	1.03	3.16	970.11	2214.77
228.00	287.50	-68.91	103.47	-268.24	1.25	3.25	798.88	2265.29
229.00	275.91	-64.90	117.04	-249.85	1.54	3.28	650.42	2281.10
230.00	268.55	-59.66	135.63	-231.78	1.88	3.21	531.71	2223.93
231.00	268.17	-53.45	159.72	-215.42	2.22	3.00	450.27	2063.79
232.00	276.94	-46.81	189.54	-201.91	2.47	2.63	404.63	1806.04
233.00	298.17	-40.53	226.64	-193.75	2.55	2.18	392.28	1488.65
234.00	331.11	-35.80	268.57	-193.66	2.45	1.77	408.22	1201.47
235.00	375.78	-32.95	315.35	-204.36	2.23	1.45	447.79	980.14
236.00	428.64	-32.62	361.02	-231.09	1.96	1.26	508.94	848.18
237.00	484.62	-34.10	401.28	-271.72	1.71	1.16	585.27	776.94
238.00	536.28	-37.32	426.48	-325.14	1.48	1.13	674.35	755.99
239.00	578.31	-41.59	432.54	-383.87	1.29	1.15	773.21	764.34
240.00	608.23	-46.09	421.86	-438.16	1.14	1.18	876.96	785.42
241.00	623.10	-50.49	396.44	-480.72	1.02	1.24	979.37	817.67
242.00	627.94	-54.65	363.28	-512.20	0.92	1.30	1085.44	854.28
243.00	624.77	-57.82	332.71	-528.82	0.85	1.35	1173.22	887.31
244.00	616.93	-60.40	304.77	-536.40	0.80	1.41	1248.82	919.26
245.00	607.96	-62.36	282.05	-538.57	0.76	1.46	1310.45	946.57
246.00	599.53	-63.76	265.11	-537.73	0.74	1.50	1355.82	967.89
247.00	593.57	-64.72	253.48	-536.73	0.72	1.52	1389.96	981.59
248.00	591.47	-65.40	246.23	-537.78	0.70	1.54	1420.78	986.52
249.00	593.84	-65.92	242.29	-542.16	0.69	1.54	1455.49	982.68
250.00	600.77	-66.75	237.17	-551.97	0.66	1.53	1521.75	973.61

240 kHz-DIq

Array

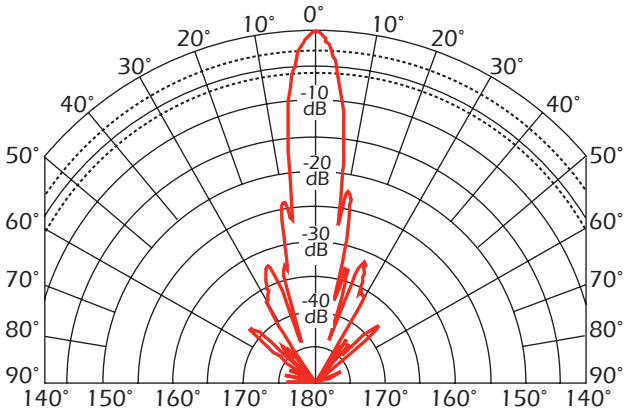


Power Rating: 1 kW rms @ 1% duty cycle
77 mm (3.0") PZT
Active Area: 45 cm²
Epoxy/Urethane Window

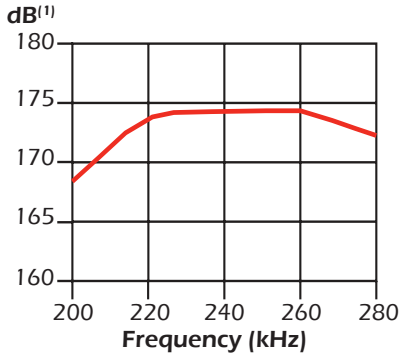
Beamwidth:
-3 dB: 6°
-6 dB: 8°
-10 dB: 11°

Directivity Index:	31.9
Frequency Tolerance:	± 10 kHz
Peak TVR(1), nominal:	174 dB
Peak TVR(1), minimum:	171 dB
Q (transmit):	4
Peak Source Level(4):	227 dB
Peak RVR(2), nominal:	-188 dB
Peak Figure of Merit(3):	-13 dB

Transmit Radiation Pattern



TVR



RVR

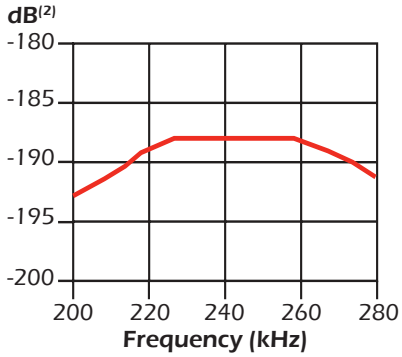
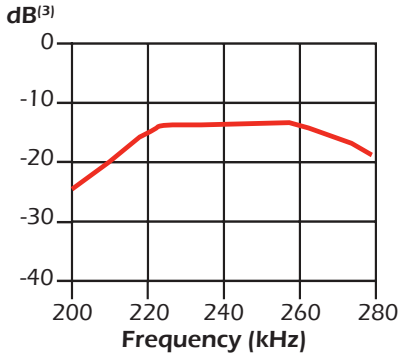


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

240 kHz-Dlq

77 mm (3.0”) PZT

Cable Type: C247
Cable Length: 25.6 m (84’)

Note:
Impedance data includes cable

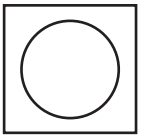
Impedance Data	
	Unbalanced
Parallel: Rp.	222 Ω: -20%, +40%
Parallel: Cp. (nominal)	6,900 pF
Series [R - jX]: (nominal)	35 - j66 Ω
1 kHz capacitance: (nominal)	9,500pF ± 20%

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
200.00	84.94	-80.16	14.51	-83.69	2.01	11.60	497.13	9230.67
203.00	83.46	-79.09	15.79	-81.95	2.27	11.77	441.00	9224.69
206.00	81.71	-77.49	17.70	-79.77	2.65	11.95	377.10	9231.08
209.00	79.85	-75.85	19.53	-77.42	3.06	12.14	326.54	9247.48
212.00	77.97	-73.90	21.62	-74.91	3.56	12.32	281.16	9250.67
215.00	78.14	-71.46	24.84	-74.09	4.07	12.13	245.81	8981.94
218.00	79.61	-69.86	27.42	-74.74	4.33	11.79	231.16	8609.70
221.00	80.89	-68.54	29.59	-75.28	4.52	11.51	221.08	8286.01
224.00	82.56	-67.24	31.94	-76.13	4.69	11.17	213.40	7935.84
227.00	84.08	-66.42	33.64	-77.06	4.76	10.90	210.19	7642.40
230.00	85.16	-66.04	34.59	-77.82	4.77	10.73	209.67	7424.79
233.00	86.08	-66.22	34.71	-78.78	4.68	10.63	213.51	7261.40
236.00	87.27	-66.62	34.63	-80.11	4.55	10.52	219.95	7093.42
239.00	88.71	-66.81	34.93	-81.55	4.44	10.36	225.31	6900.37
240.00	88.27	-66.59	35.08	-81.01	4.50	10.40	222.15	6893.72
241.00	89.06	-66.23	35.90	-81.51	4.53	10.28	220.97	6786.17
244.00	89.34	-66.70	35.33	-82.06	4.43	10.28	225.91	6705.85
247.00	89.94	-67.27	34.76	-82.96	4.30	10.25	232.75	6607.38
250.00	90.91	-67.71	34.48	-84.12	4.17	10.18	239.72	6479.36
253.00	92.09	-68.03	34.45	-85.41	4.06	10.07	246.16	6334.69
256.00	93.52	-68.32	34.56	-86.90	3.95	9.94	253.11	6177.12
259.00	94.33	-68.82	34.08	-87.96	3.83	9.88	261.13	6074.20
262.00	94.91	-69.88	32.65	-89.12	3.62	9.89	275.89	6009.89
265.00	95.44	-71.19	30.77	-90.34	3.38	9.92	296.03	5957.06
268.00	95.91	-72.47	28.90	-91.45	3.14	9.94	318.33	5904.14
271.00	96.08	-74.01	26.47	-92.36	2.87	10.01	348.73	5875.91
274.00	95.81	-75.65	23.75	-92.82	2.59	10.11	386.50	5873.05
277.00	94.85	-77.27	20.89	-92.52	2.32	10.28	430.60	5908.78
280.00	93.08	-78.66	18.31	-91.26	2.11	10.53	473.21	5987.67

240 kHz-Dlq

Array

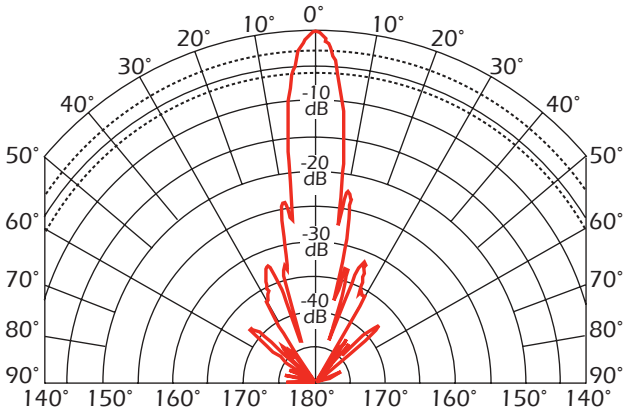


Power Rating: 1 kW rms @ 1% duty cycle
77 mm (3.0") PZT
Active Area: 45 cm²
Epoxy/Urethane Window

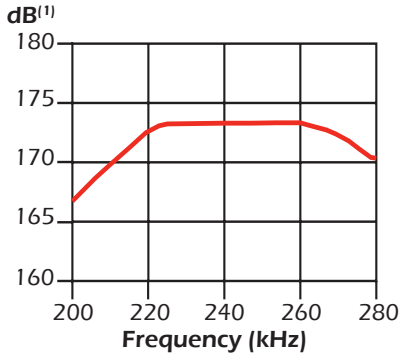
Beamwidth:
-3 dB: 6°
-6 dB: 8°
-10 dB: 11°

Directivity Index:	31.9
Frequency Tolerance:	± 10 kHz
Peak TVR(1), nominal:	173 dB
Peak TVR(1), minimum:	171 dB
Q (transmit):	4
Peak Source Level(4):	227 dB
Peak RVR(2), nominal:	-181 dB
Peak Figure of Merit(3):	-8 dB

Transmit Radiation Pattern



TVR



RVR

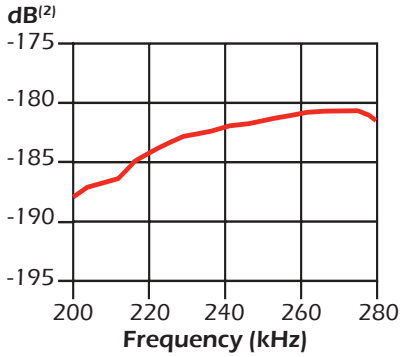
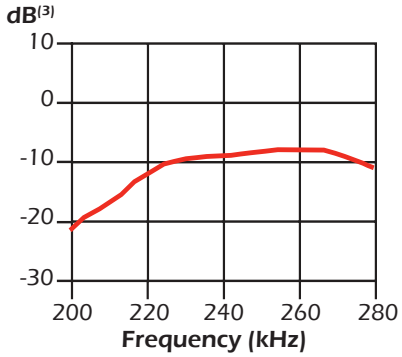


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

240 kHz-Dlq

77 mm (3.0”) PZT

Cable Type: Test Cable (18 AWG)
Cable Length: 3 m (10’)

Note:
Impedance data includes cable

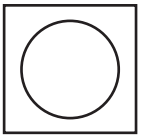
Impedance Data	
	Unbalanced
Parallel: Rp.	270 Ω: -20%, +40%
Parallel: Cp. (nominal)	2,000 pF
Series [R - jX]: (nominal)	150 - j40 Ω
1 kHz capacitance: (nominal)	4,920pF ± 20%

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
200.00	179.07	-74.85	46.79	-172.85	1.46	5.39	685.37	4289.57
203.00	173.65	-72.65	51.80	-165.74	1.72	5.50	582.17	4309.44
206.00	167.69	-70.61	55.66	-158.19	1.98	5.63	505.20	4346.00
209.00	161.75	-68.31	59.78	-150.29	2.29	5.74	437.63	4374.61
212.00	155.86	-65.32	65.09	-141.62	2.68	5.83	373.23	4376.50
215.00	153.34	-60.91	74.55	-134.00	3.17	5.70	315.40	4218.47
218.00	157.32	-57.19	85.26	-132.22	3.44	5.34	290.31	3900.05
221.00	160.75	-53.76	95.03	-129.66	3.68	5.02	271.93	3613.23
224.00	165.21	-50.57	104.93	-127.61	3.84	4.68	260.12	3321.86
227.00	171.36	-48.10	114.45	-127.54	3.90	4.34	256.58	3045.23
230.00	178.13	-45.68	124.46	-127.43	3.92	4.02	254.94	2779.09
233.00	184.56	-43.91	132.95	-128.00	3.90	3.76	256.19	2566.99
236.00	190.47	-42.56	140.29	-128.83	3.87	3.55	258.60	2394.83
239.00	196.03	-41.62	146.55	-130.21	3.81	3.39	262.23	2256.27
240.00	201.45	-41.70	150.41	-134.02	3.71	3.30	269.82	2189.93
241.00	201.63	-42.70	148.19	-136.72	3.65	3.36	274.33	2221.00
244.00	208.87	-42.03	155.14	-139.84	3.56	3.21	281.19	2090.91
247.00	217.06	-41.62	162.27	-144.15	3.44	3.06	290.33	1971.57
250.00	222.71	-40.76	168.70	-145.39	3.40	2.93	294.01	1866.11
253.00	229.38	-39.55	176.87	-146.05	3.36	2.78	297.47	1746.21
256.00	238.03	-38.61	185.99	-148.55	3.28	2.62	304.63	1629.94
259.00	248.16	-38.21	194.98	-153.51	3.17	2.49	315.85	1531.77
262.00	260.39	-38.35	204.20	-161.57	3.01	2.38	332.05	1447.54
265.00	273.54	-39.34	211.55	-173.41	2.83	2.32	353.69	1391.90
268.00	288.91	-40.39	220.05	-187.21	2.64	2.24	379.33	1331.95
271.00	307.34	-42.12	227.96	-206.14	2.41	2.18	414.36	1281.61
274.00	326.38	-45.01	230.73	-230.84	2.17	2.17	461.68	1258.73
277.00	341.83	-48.93	224.56	-257.72	1.92	2.21	520.34	1267.25
280.00	350.56	-53.54	208.34	-281.93	1.70	2.29	589.84	1304.02

270 kHz-Blq

Array

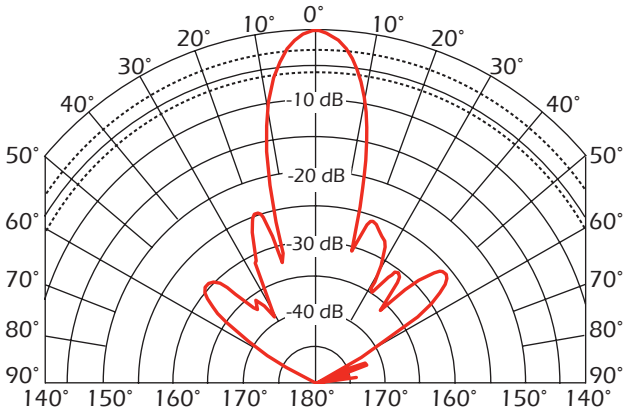


Power Rating: 300 W rms @ 2% duty cycle
32 mm (1.25") PZT
Active Area: 8 cm^2
Urethane/Epoxy Window

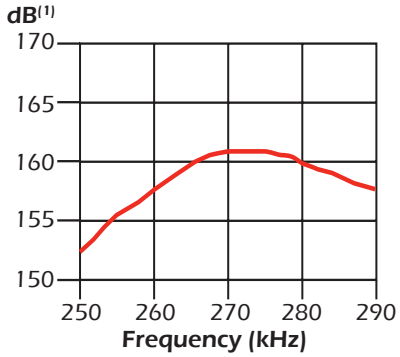
Beamwidth:
-3 dB: 10°
-6 dB: 14°
-10 dB: 18°

Directivity Index:	25.3
Frequency Tolerance:	± 10 kHz
Peak TVR(1), nominal:	161 dB
Peak TVR(1), minimum:	159 dB
Q (transmit):	10
Peak Source Level(4):	216 dB
Peak RVR(2), nominal:	-186 dB
Peak Figure of Merit(3):	-25 dB

Transmit Radiation Pattern



TVR



RVR

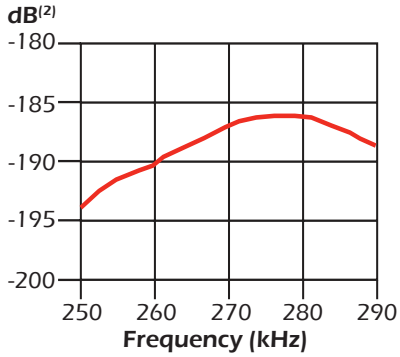
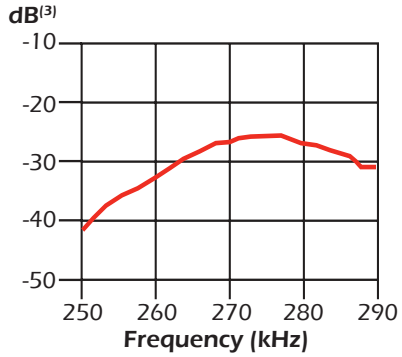


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

270 kHz-Blq

32 mm (1.25”) PZT

Cable Type: C2
Cable Length: 2.4 m (8’)

Note:
Impedance data includes cable

Impedance Data	
	Unbalanced
Parallel: Rp.	1,055 Ω: -20%, +40%
Parallel: Cp. (nominal)	900 pF
Series [R - jX]: (nominal)	300 - j60 Ω
1 kHz capacitance: (nominal)	1,560 pF ± 20%

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
250.00	625.57	-74.35	168.72	-602.39	0.43	1.54	2319.39	979.95
251.00	604.08	-73.80	168.55	-580.09	0.46	1.59	2165.04	1007.97
252.00	588.90	-72.94	172.75	-563.00	0.50	1.62	2007.53	1025.26
253.00	578.96	-72.02	178.68	-550.70	0.53	1.64	1875.98	1033.51
255.00	567.87	-70.63	188.36	-535.72	0.58	1.66	1712.01	1036.87
256.00	563.26	-70.15	191.28	-529.78	0.60	1.67	1658.57	1038.16
257.00	558.94	-69.75	193.48	-524.38	0.62	1.68	1614.68	1039.46
258.00	553.80	-69.35	195.27	-518.23	0.64	1.69	1570.63	1042.36
260.00	542.13	-68.28	200.62	-503.64	0.68	1.71	1464.93	1048.97
261.00	536.62	-67.52	205.22	-495.83	0.71	1.72	1403.18	1049.98
262.00	532.04	-66.57	211.55	-488.18	0.75	1.72	1338.09	1047.62
263.00	529.21	-65.51	219.39	-481.60	0.78	1.72	1276.57	1040.60
265.00	528.78	-63.29	237.67	-472.36	0.85	1.69	1176.45	1014.59
266.00	531.32	-62.13	248.39	-469.68	0.88	1.66	1136.51	995.48
267.00	535.35	-61.09	258.83	-468.62	0.90	1.64	1107.28	974.66
268.00	541.12	-60.05	270.18	-468.84	0.92	1.60	1083.74	950.88
270.00	555.42	-58.34	291.51	-472.77	0.95	1.53	1058.23	903.37
271.00	564.87	-57.62	302.47	-477.07	0.95	1.50	1054.92	878.07
272.00	575.49	-57.02	313.26	-482.76	0.95	1.46	1057.22	852.92
273.00	587.35	-56.64	322.95	-490.60	0.94	1.42	1068.23	829.06
275.00	613.30	-56.15	341.61	-509.35	0.91	1.35	1101.07	783.71
276.00	627.26	-56.19	349.00	-521.20	0.89	1.32	1127.37	763.88
277.00	641.01	-56.43	354.47	-534.08	0.86	1.30	1159.16	746.82
278.00	655.49	-56.85	358.39	-548.83	0.83	1.28	1198.85	731.29
280.00	681.97	-58.16	359.78	-579.34	0.77	1.25	1292.67	708.06
281.00	693.76	-59.03	357.05	-594.83	0.74	1.24	1348.02	699.98
282.00	704.33	-60.00	352.17	-609.97	0.71	1.23	1408.64	693.94
283.00	712.80	-61.13	344.15	-624.22	0.68	1.23	1476.35	690.93
285.00	723.38	-63.50	322.79	-647.37	0.62	1.24	1621.10	690.86
286.00	725.25	-64.69	310.05	-655.63	0.59	1.25	1696.45	693.66
287.00	725.09	-65.87	296.42	-661.74	0.56	1.26	1773.68	697.97
288.00	722.67	-66.92	283.28	-664.84	0.54	1.27	1843.63	703.49
290.00	713.68	-68.74	258.77	-665.11	0.51	1.31	1968.33	716.66

270 kHz-Blq

Transformed to 50 ohms

Power rating: 300 Wrms @ 2% duty cycle
32mm (1.25") PZT
Active Area: 8cm²
Urethane Window

Beamwidth:

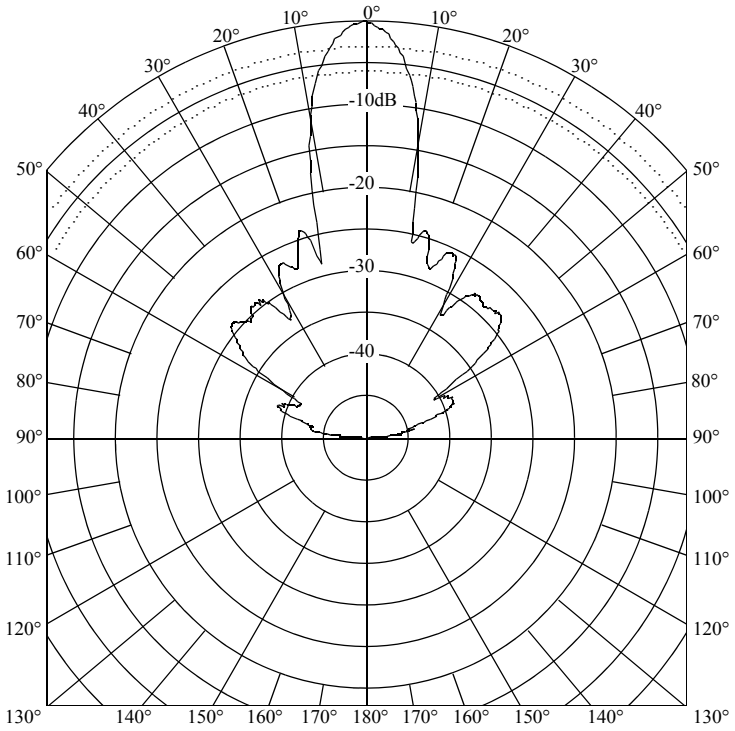
-3dB:	10°
-6dB:	14°
-10dB:	18°

Directivity Index:	25.3
Frequency Tolerance:	±10kHz
Peak TVR (1), nominal:	175dB
Peak TVR (1), minimum:	172dB
Q (transmit):	5
Peak Source Level (4):	217dB
Peak RVR (2), nominal:	-191dB
Peak Figure of Merit (3):	-18dB

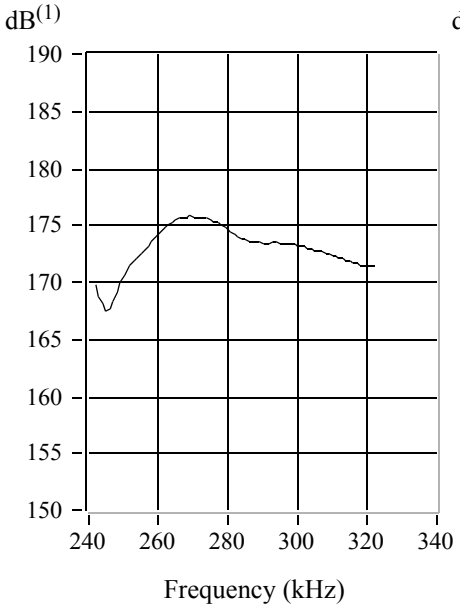
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

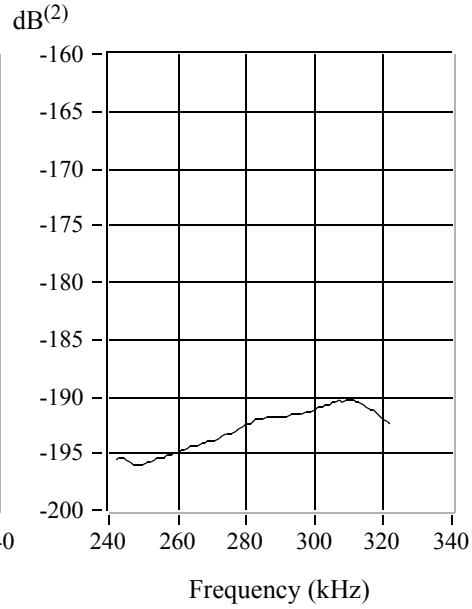
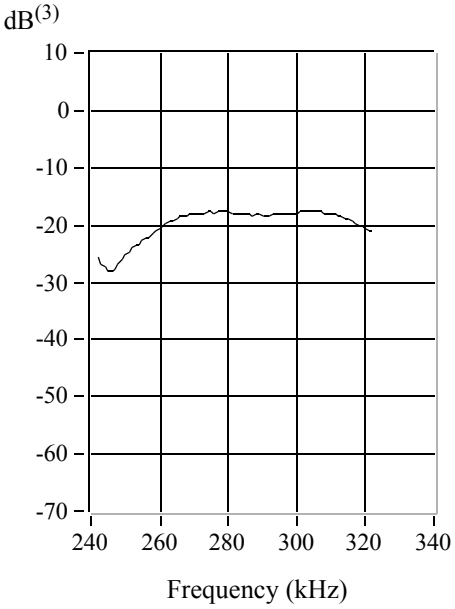


Figure of Merit



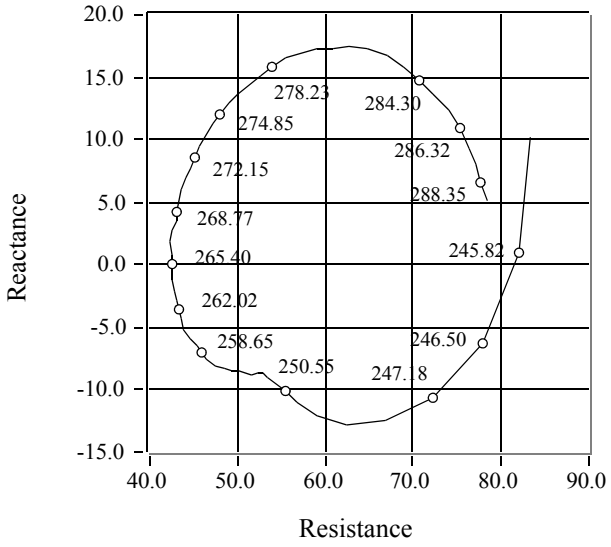
270 kHz-Blq

32mm (1.25") PZT

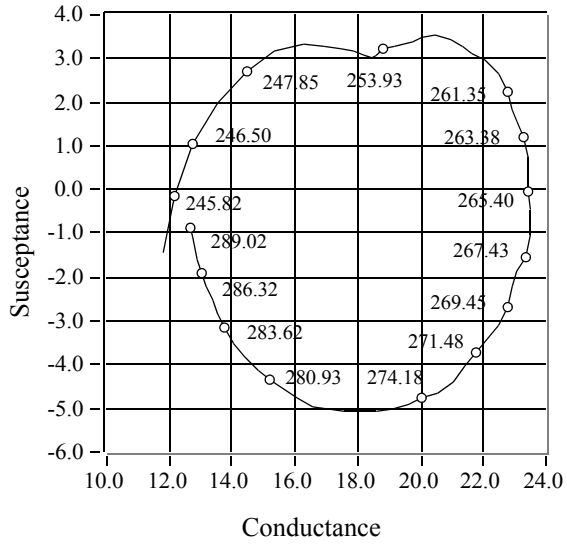
Cable Type: Test Cable
Cable Length: 3.0 m (10.0')

Impedance Data	
	Unbalanced
Parallel: Rp.	50 ohms -20%,+40%
Parallel: Cp. (nominal)	0 pF
Series [R – jX] (nominal)	50 – j0 ohms
1 kHz Capacitance	n/a

Unbalanced Impedance



Unbalanced Admittance



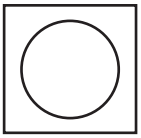
270 kHz-Blq

Transformed to 90 ohms
Power Rating: 300 W rms @ 2% duty cycle
32 mm (1.25") PZT
Active Area: 8 cm^2
Urethane/Epoxy Window

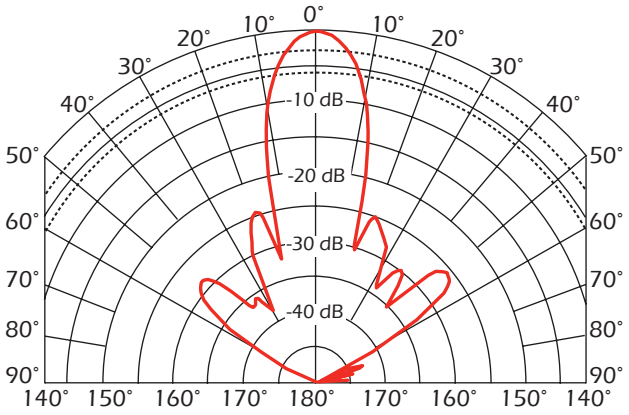
Beamwidth:
-3 dB: 10°
-6 dB: 14°
-10 dB: 18°

Directivity Index:	25.3
Frequency Tolerance:	± 10 kHz
Peak TVR(1), nominal:	174 dB
Peak TVR(1), minimum:	171 dB
Q (transmit):	8
Peak Source Level(4):	218 dB
Peak RVR(2), nominal:	-189 dB
Peak Figure of Merit(3):	-18 dB

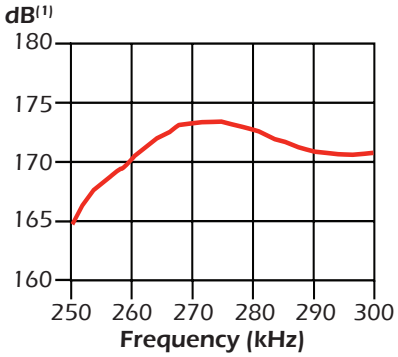
Array



Transmit Radiation Pattern



TVR



RVR

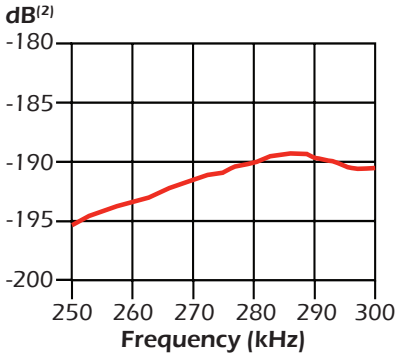
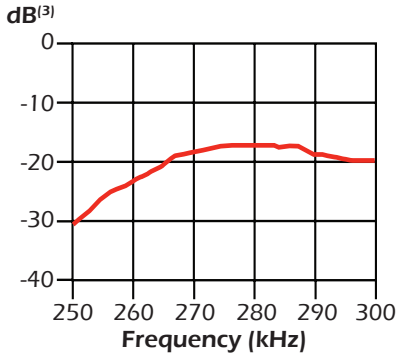


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

270 kHz-Blq

32 mm (1.25”) PZT

Cable Type: C2
Cable Length: 2.4 m (8’)

Note:
Impedance data includes cable

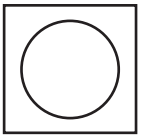
Impedance Data	
	Unbalanced
Parallel: Rp.	90 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF
Series [R - jX]: (nominal)	90 - j0 Ω
1 kHz capacitance: (nominal)	n/a pF

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
250.00	124.28	-46.53	85.50	-90.20	5.54	5.84	180.66	3717.60
251.00	113.89	-47.61	76.78	-84.12	5.92	6.49	168.93	4112.16
254.00	97.13	-45.67	67.87	-69.48	7.19	7.37	139.00	4615.04
256.00	92.06	-44.35	65.84	-64.35	7.77	7.59	128.74	4720.37
257.00	89.90	-43.88	64.80	-62.31	8.02	7.71	124.72	4775.00
259.00	85.69	-42.98	62.69	-58.42	8.54	7.96	117.13	4888.86
260.00	83.52	-42.48	61.60	-56.40	8.83	8.09	113.24	4949.20
262.00	79.13	-40.64	60.04	-51.54	9.59	8.23	104.28	5000.00
263.00	77.04	-39.25	59.66	-48.75	10.05	8.21	99.49	4970.21
265.00	74.17	-35.53	60.36	-43.10	10.97	7.83	91.13	4705.51
266.00	73.60	-33.40	61.44	-40.51	11.34	7.48	88.16	4475.11
268.00	73.80	-29.03	64.53	-35.81	11.85	6.58	84.41	3904.84
269.00	74.60	-27.09	66.42	-33.97	11.93	6.10	83.79	3611.11
270.00	75.73	-25.20	68.52	-32.24	11.95	5.62	83.69	3313.90
271.00	77.21	-23.62	70.74	-30.93	11.87	5.19	84.27	3047.01
272.00	78.96	-22.22	73.10	-29.86	11.72	4.79	85.29	2802.12
274.00	82.83	-20.02	77.83	-28.35	11.34	4.13	88.16	2400.44
275.00	84.94	-19.02	80.30	-27.68	11.13	3.84	89.85	2220.67
277.00	89.44	-17.31	85.39	-26.61	10.67	3.33	93.68	1911.34
278.00	92.38	-16.53	88.56	-26.29	10.38	3.08	96.36	1763.52
280.00	99.64	-15.36	96.09	-26.39	9.68	2.66	103.33	1510.65
281.00	103.85	-15.28	100.18	-27.36	9.29	2.54	107.65	1436.99
283.00	113.85	-16.33	109.26	-32.01	8.43	2.47	118.64	1388.74
284.00	118.83	-17.58	113.28	-35.89	8.02	2.54	124.65	1424.24
286.00	127.74	-21.17	119.11	-46.14	7.30	2.83	136.99	1573.61
287.00	131.36	-23.54	120.43	-52.46	6.98	3.04	143.28	1685.91
289.00	134.92	-28.24	118.86	-63.84	6.53	3.51	153.15	1931.32
290.00	135.50	-30.36	116.91	-68.49	6.37	3.73	157.04	2047.40
292.00	134.74	-34.09	111.59	-75.52	6.15	4.16	162.70	2267.21
293.00	133.98	-35.61	108.92	-78.02	6.07	4.35	164.81	2360.86
295.00	132.18	-38.21	103.86	-81.76	5.94	4.68	168.22	2524.75
298.00	128.55	-41.01	97.01	-84.35	5.87	5.10	170.35	2725.94
299.00	127.38	-41.65	95.18	-84.66	5.87	5.22	170.49	2777.24
300.00	126.50	-42.06	93.92	-84.74	5.87	5.30	170.37	2809.33

270 kHz-Clq

Array

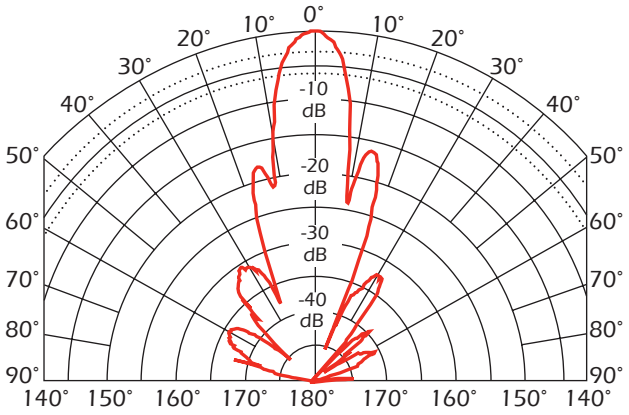


Power Rating: 500 W rms @ 2% duty cycle
37 mm (1.46”) PZT
Active Area: 10.75 cm^2
Urethane Window

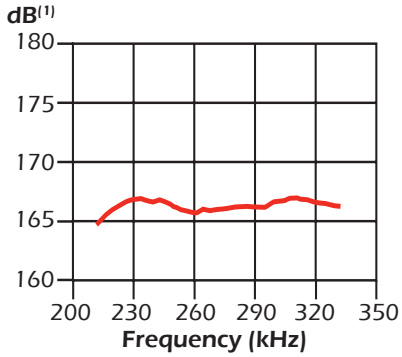
Beamwidth:
-3 dB: 9°
-6 dB: 12°
-10 dB: 15°

Directivity Index:	26
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	167 dB
Peak TVR(1), minimum:	164 dB
Q (transmit):	2
Peak Source Level(4):	222 dB
Peak RVR(2), nominal:	-187 dB
Peak Figure of Merit(3):	-20 dB

Transmit Radiation Pattern



TVR



RVR

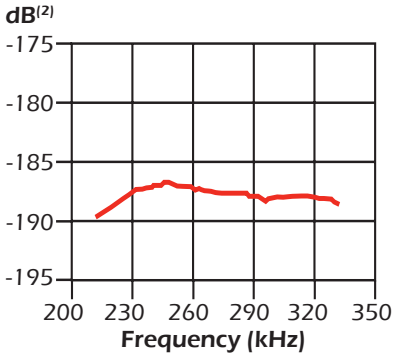
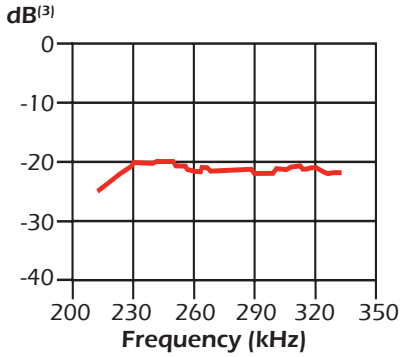


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

270 kHz-Clq

33 mm (1.46”) PZT

Cable Type: C33
Cable Length: 15.2 m (50’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	506 Ω: -20%, +40%	506 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,688 pF	1,688 pF
Series [R - jX]: (nominal)	160 - j236 Ω	160 - j236 Ω
1 kHz capacitance: (nominal)	3,030 pF	3,030 pF

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
220.00	210.91	-60.47	103.96	-183.51	2.34	4.13	427.88	2984.47
223.00	208.78	-57.85	111.11	-176.76	2.55	4.06	392.30	2894.17
226.00	212.57	-55.53	120.30	-175.25	2.66	3.88	375.59	2731.30
229.00	215.93	-53.93	127.13	-174.53	2.73	3.74	366.75	2601.71
232.00	218.06	-52.03	134.17	-171.89	2.82	3.62	354.39	2480.00
235.00	222.22	-49.55	144.18	-169.10	2.92	3.42	342.50	2319.12
238.00	233.72	-46.67	160.39	-170.01	2.94	3.11	340.59	2081.17
241.00	246.13	-46.36	169.87	-178.12	2.80	2.94	356.64	1941.66
244.00	256.09	-47.48	173.09	-188.74	2.64	2.88	378.89	1877.13
247.00	259.36	-48.00	173.56	-192.73	2.58	2.87	387.58	1846.13
250.00	265.26	-46.97	181.01	-193.91	2.57	2.76	388.74	1754.40
253.00	278.46	-46.83	190.50	-203.09	2.46	2.62	407.01	1647.69
256.00	288.00	-48.35	191.39	-215.21	2.31	2.59	433.38	1613.04
259.00	296.76	-51.59	184.37	-232.54	2.09	2.64	477.66	1622.57
262.00	291.39	-54.40	169.64	-236.91	2.00	2.79	500.50	1694.99
265.00	283.27	-54.88	162.96	-231.69	2.03	2.89	492.37	1734.20
268.00	280.19	-54.20	163.91	-227.25	2.09	2.89	478.98	1718.97
271.00	282.37	-54.00	165.97	-228.45	2.08	2.87	480.40	1682.61
274.00	284.98	-54.87	164.00	-233.05	2.02	2.87	495.18	1666.91
277.00	283.07	-56.13	157.76	-235.04	1.97	2.93	507.92	1685.30
280.00	277.51	-56.16	154.53	-230.51	2.01	2.99	498.38	1701.30
283.00	277.63	-54.98	159.33	-227.37	2.07	2.95	483.78	1658.86
286.00	281.82	-54.98	161.72	-230.80	2.04	2.91	491.11	1617.13
289.00	284.35	-55.94	159.27	-235.56	1.97	2.91	507.67	1604.39
292.00	281.42	-57.34	151.87	-236.92	1.92	2.99	521.48	1630.58
295.00	266.58	-56.31	147.87	-221.81	2.08	3.12	480.60	1683.93
298.00	271.80	-56.34	150.66	-226.22	2.04	3.06	490.32	1635.46
301.00	272.72	-54.25	159.36	-221.32	2.14	2.98	466.73	1573.38
304.00	284.75	-53.40	169.76	-228.62	2.09	2.82	477.64	1476.11
307.00	292.74	-54.41	170.39	-238.05	1.99	2.78	502.96	1440.04
310.00	295.24	-56.25	164.02	-245.49	1.88	2.82	531.44	1445.89
313.00	293.01	-56.97	159.72	-245.65	1.86	2.86	537.53	1454.89
316.00	292.63	-56.54	161.33	-244.14	1.88	2.85	530.80	1435.94
319.00	296.31	-56.44	163.81	-246.92	1.87	2.81	536.00	1403.08
320.00	292.69	-57.94	155.36	-248.05	1.81	2.90	551.41	1440.10

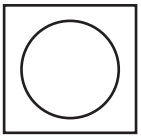
270 kHz-Clq

Transformed to 90 ohms
Power Rating: 500 W rms @ 2% duty cycle
37 mm (1.46") PZT
Active Area: 10.75 cm²
Epoxy/Urethane Window

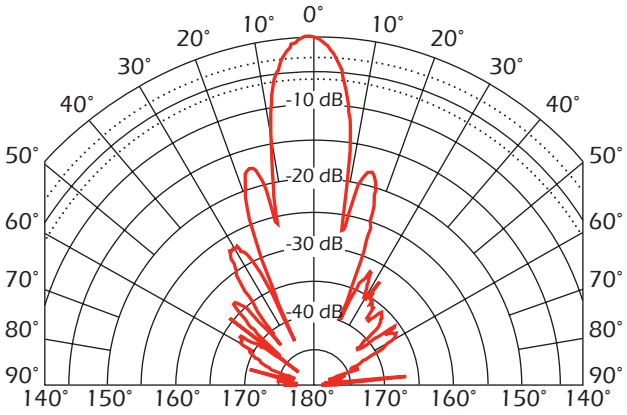
Beamwidth:
-3 dB: 9°
-6 dB: 13°
-10 dB: 16°

Directivity Index:	26
Frequency Tolerance:	± 2 kHz
Peak TVR(1), nominal:	173 dB
Peak TVR(1), minimum:	170 dB
Q (transmit):	2.5
Peak Source Level(4):	219 dB
Peak RVR(2), nominal:	-189 dB
Peak Figure of Merit(3):	-17 dB

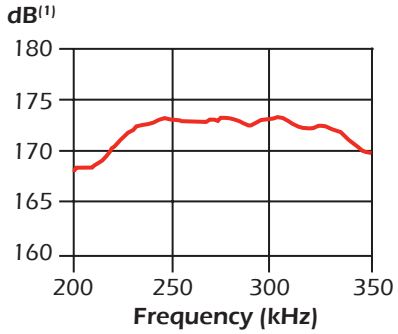
Array



Transmit Radiation Pattern



TVR



RVR

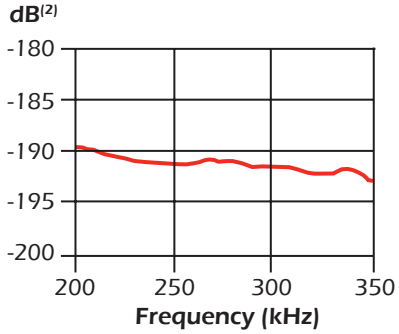
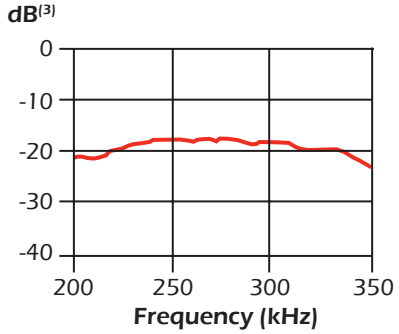


Figure of Merit



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

270 kHz-Clq

37 mm (1.46”) PZT

Cable Type: Test
Cable Length: 3 m (10’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	90 Ω: -20%, +40%	90 Ω: -20%, +40%
Parallel: Cp. (nominal)	0 pF	0 pF
Series [R - jX]: (nominal)	90 - j10 Ω	90 - j10 Ω
1 kHz capacitance: (nominal)	n/a	n/a

Unbalance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
200.00	127.48	36.16	102.92	75.23	6.33	-4.63	157.91	-3683.49
205.00	126.03	27.16	112.13	57.52	7.06	-3.62	141.64	-2811.67
210.00	120.47	17.99	114.57	37.21	7.90	-2.56	126.66	-1943.21
215.00	108.65	10.58	106.81	19.94	9.05	-1.69	110.53	-1250.47
220.00	97.72	6.60	97.07	11.23	10.17	-1.18	98.37	-850.82
225.00	87.03	4.89	86.71	7.42	11.45	-0.98	87.35	-693.29
230.00	80.35	6.00	79.91	8.40	12.38	-1.30	80.80	-899.71
235.00	76.89	7.72	76.19	10.33	12.89	-1.75	77.59	-1183.60
240.00	75.46	8.70	74.59	11.42	13.10	-2.01	76.34	-1329.83
245.00	74.71	10.10	73.55	13.10	13.18	-2.35	75.88	-1524.10
250.00	75.82	11.50	74.30	15.12	12.92	-2.63	77.38	-1673.81
255.00	78.84	12.05	77.10	16.47	12.40	-2.65	80.62	-1653.28
260.00	82.83	11.11	81.28	15.96	11.85	-2.33	84.42	-1424.30
265.00	85.73	8.34	84.82	12.44	11.54	-1.69	86.65	-1016.69
270.00	85.35	5.35	84.98	7.95	11.67	-1.09	85.72	-643.59
275.00	84.42	4.33	84.18	6.38	11.81	-0.89	84.67	-517.66
280.00	85.36	3.69	85.19	5.49	11.69	-0.75	85.54	-428.21
285.00	88.88	2.41	88.81	3.74	11.24	-0.47	88.96	-264.49
290.00	90.95	-1.43	90.92	-2.27	10.99	0.27	90.98	150.72
295.00	89.01	-4.07	88.79	-6.31	11.21	0.80	89.24	429.69
300.00	86.42	-4.42	86.16	-6.67	11.54	0.89	86.68	473.54
305.00	87.76	-3.35	87.61	-5.13	11.38	0.67	87.91	347.64
310.00	93.38	-4.28	93.12	-6.97	10.68	0.80	93.64	410.47
315.00	96.85	-8.04	95.89	-13.55	10.22	1.44	97.81	729.92
320.00	95.95	-10.93	94.21	-18.19	10.23	1.98	97.72	982.70
325.00	95.44	-11.33	93.58	-18.75	10.27	2.06	97.33	1007.89
330.00	99.69	-10.29	98.09	-17.80	9.87	1.79	101.32	863.95
335.00	109.93	-11.87	107.58	-22.62	8.90	1.87	112.33	889.23
340.00	122.21	-17.32	116.67	-36.39	7.81	2.44	128.02	1140.38
345.00	129.07	-25.63	116.37	-55.84	6.99	3.35	143.16	1546.23
350.00	128.58	-33.55	107.16	-71.06	6.48	4.30	154.28	1954.33

300 kHz-Blq

Power rating: 250 Wrms @ 2% duty cycle
30mm (1.2") PZT
Active Area: 7.3cm²
Epoxy Window

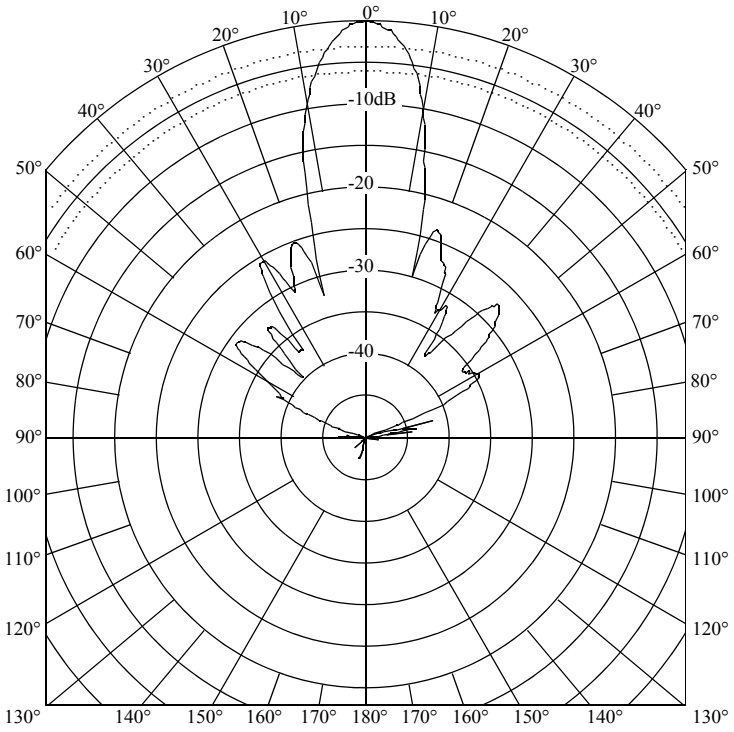
Beamwidth:

-3dB:	11°
-6dB:	16°
-10dB:	20°

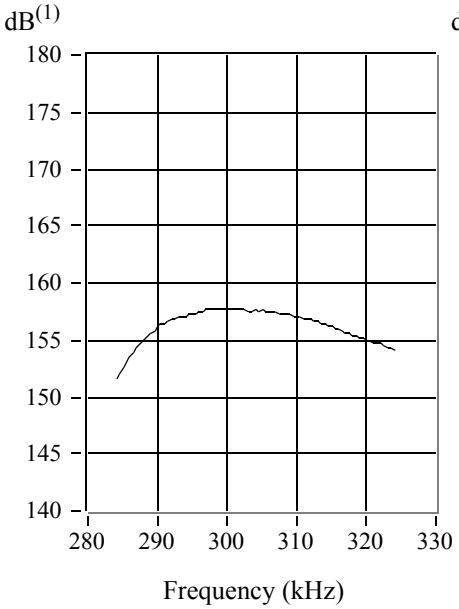
Directivity Index:	25.9
Frequency Tolerance:	±12kHz
Peak TVR(1), nominal:	157dB
Peak TVR(1), minimum:	155dB
Q (transmit):	9
Peak Source Level(4):	213dB
Peak RVR(2), nominal:	-187dB
Peak Figure of Merit(3):	-29dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

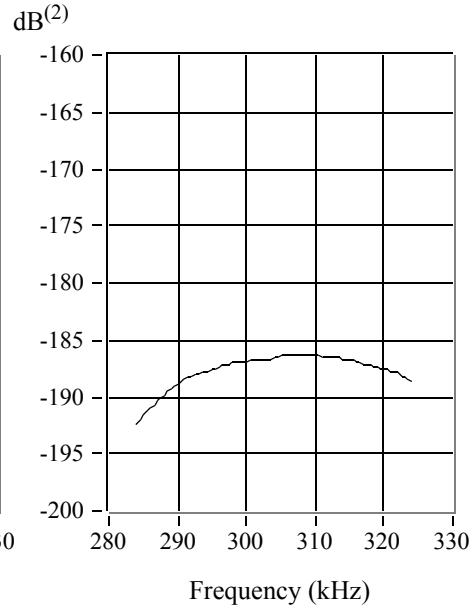
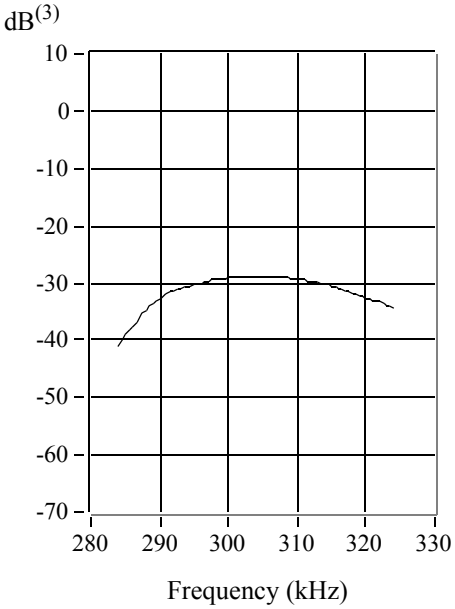


Figure of Merit



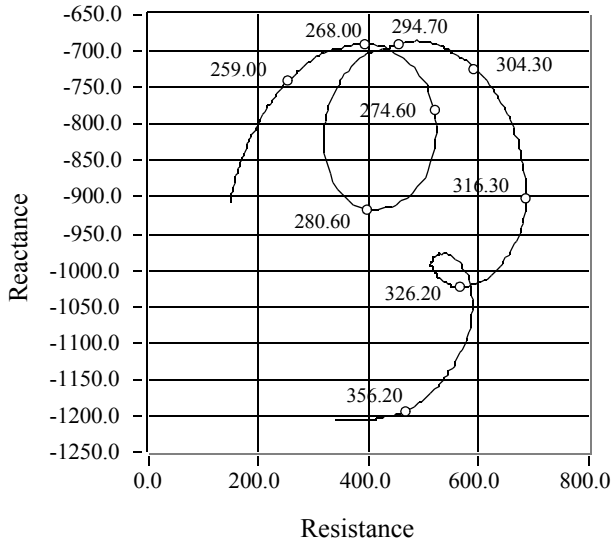
300 kHz-Blq

30mm (1.2") PZT

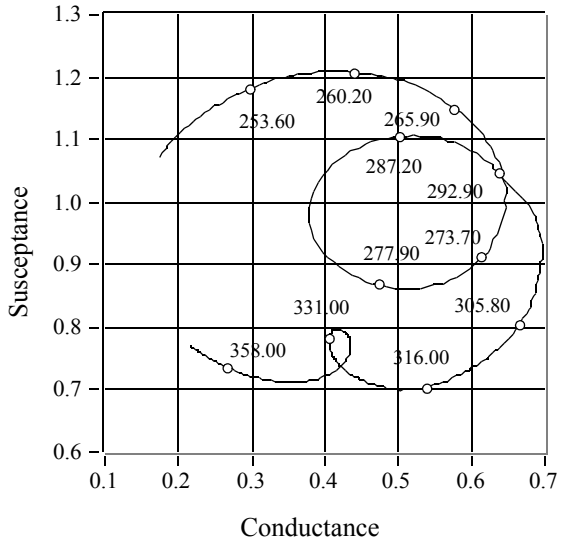
Cable Type: Test Cable
Cable Length: 2.4m (8.0')

Impedance Data	
	Unbalanced
Parallel: Rp.	1440ohms -20%,+40%
Parallel: Cp. (nominal)	490pF
Series [R – jX] (nominal)	540 – j700 ohms
1 kHz Capacitance	790pF±20%

Unbalanced Impedance



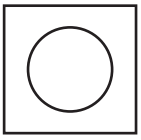
Unbalanced Admittance



360 kHz-Alq

Power Rating: 80 W rms @ 1% duty cycle
19 mm (0.75") PZT
Active Area: 2.84 cm² (0.44 in²)
Radiating Surface: Urethane

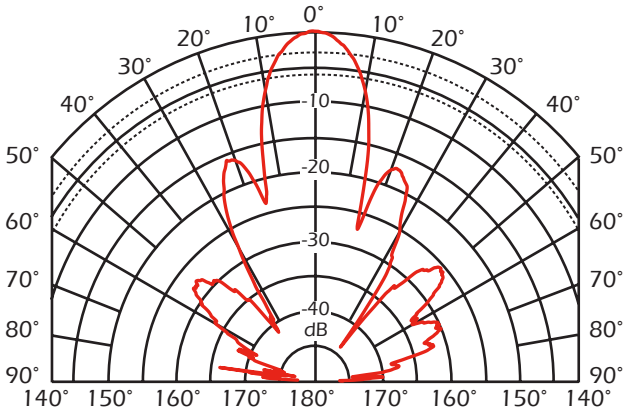
Array



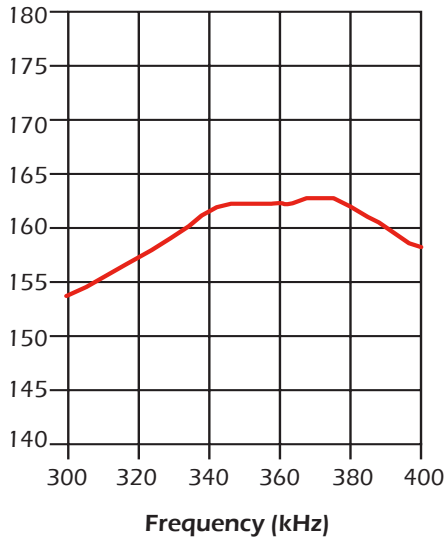
Beamwidth:
-3 dB: 13°
-6 dB: 18°
-10 dB: 22°

Directivity Index:	22
Frequency Tolerance:	+/-20kHz
Peak TVR(1), nominal:	163 dB
Peak TVR(1), minimum:	161 dB
Q (transmit):	6.5
Peak Source Level(4):	207 dB
Peak RVR(2), nominal:	-191 dB
Peak Figure of Merit(3):	-30 dB

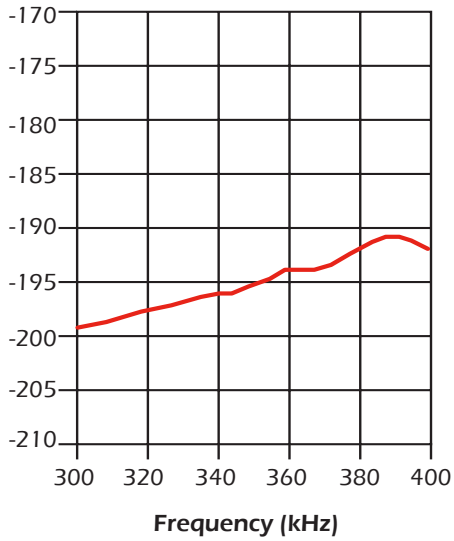
Transmit Radiation Pattern



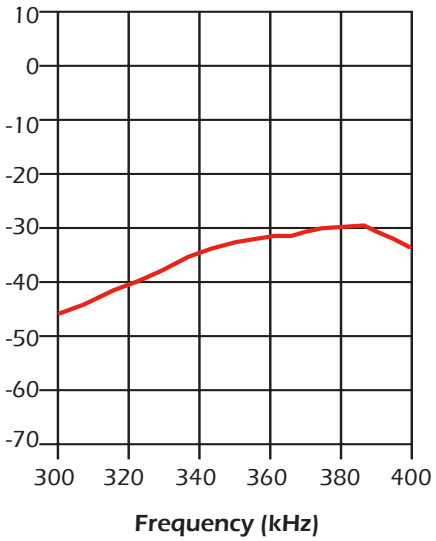
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

360 kHz-Alq

19 mm (0.75”) PZT

Cable Type: C189-02
Cable Length: 2.4m (8’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	320 Ω: -20%, +40%	330 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,030 pF	1,360 pF
Series [R - jX]: (nominal)	210-j160 Ω	170-j163 Ω
1 kHz capacitance: (nominal)	1,070 pF	1,420 pF

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
300.00	432.24	-76.59	100.24	-420.46	0.54	2.25	1863.82	1193.89
308.00	401.13	-76.23	95.50	-389.59	0.59	2.42	1684.83	1251.17
312.00	384.18	-75.75	94.55	-372.36	0.64	2.52	1561.01	1286.97
314.00	376.52	-75.34	95.28	-364.27	0.67	2.57	1487.86	1302.36
318.00	359.82	-74.37	96.97	-346.51	0.75	2.68	1335.16	1339.48
320.00	351.17	-73.87	97.55	-337.35	0.79	2.74	1264.11	1360.55
324.00	333.66	-72.38	101.03	-318.00	0.91	2.86	1102.00	1403.11
326.00	324.35	-71.50	102.93	-307.58	0.98	2.92	1022.03	1427.38
330.00	306.22	-69.21	108.67	-286.29	1.16	3.05	862.86	1472.47
332.00	297.09	-67.85	112.00	-275.17	1.27	3.12	788.04	1494.55
336.00	278.99	-64.44	120.38	-251.68	1.55	3.23	646.55	1531.64
338.00	270.21	-62.19	126.06	-239.00	1.73	3.27	579.19	1541.37
342.00	254.90	-56.54	140.53	-212.67	2.16	3.27	462.36	1523.14
344.00	249.44	-53.09	149.82	-199.44	2.41	3.21	415.31	1482.98
348.00	247.56	-44.74	175.83	-174.27	2.87	2.84	348.55	1300.46
350.00	252.12	-40.49	191.73	-163.72	3.02	2.58	331.53	1171.23
354.00	274.25	-33.30	229.22	-150.56	3.05	2.00	328.12	900.02
356.00	290.26	-31.47	247.56	-151.54	2.94	1.80	340.32	804.15
358.00	305.45	-30.76	262.47	-156.24	2.81	1.67	355.47	744.47
360.00	315.59	-31.01	270.48	-162.60	2.72	1.63	368.22	721.74
362.00	318.83	-31.28	272.47	-165.56	2.68	1.63	373.07	716.07
364.00	316.28	-30.91	271.36	-162.46	2.71	1.62	368.62	710.13
366.00	310.90	-29.37	270.94	-152.47	2.80	1.58	356.75	685.95
370.00	306.57	-22.99	282.22	-119.73	3.00	1.27	333.02	548.00
372.00	312.46	-18.75	295.88	-100.43	3.03	1.03	329.97	440.07
376.00	342.96	-10.75	336.95	-63.94	2.86	0.54	349.08	230.11
378.00	366.62	-7.36	363.60	-46.98	2.71	0.35	369.67	147.15
382.00	434.09	-2.72	433.60	-20.60	2.30	0.11	434.58	45.55
384.00	473.08	-1.53	472.91	-12.60	2.11	0.06	473.25	23.34
388.00	567.61	-1.19	567.49	-11.76	1.76	0.04	567.73	14.97
390.00	621.36	-1.98	620.99	-21.45	1.61	0.06	621.73	22.67
396.00	799.70	-8.55	790.81	-118.90	1.24	0.19	808.68	74.72
400.00	907.19	-16.58	869.47	-258.87	1.06	0.31	946.55	125.16

455 kHz-A

Power rating: 300 Wrms @ 2% duty cycle
27mm (1.08") PZT
Active Area: 5.4cm²
Layered Plastic Epoxy Window

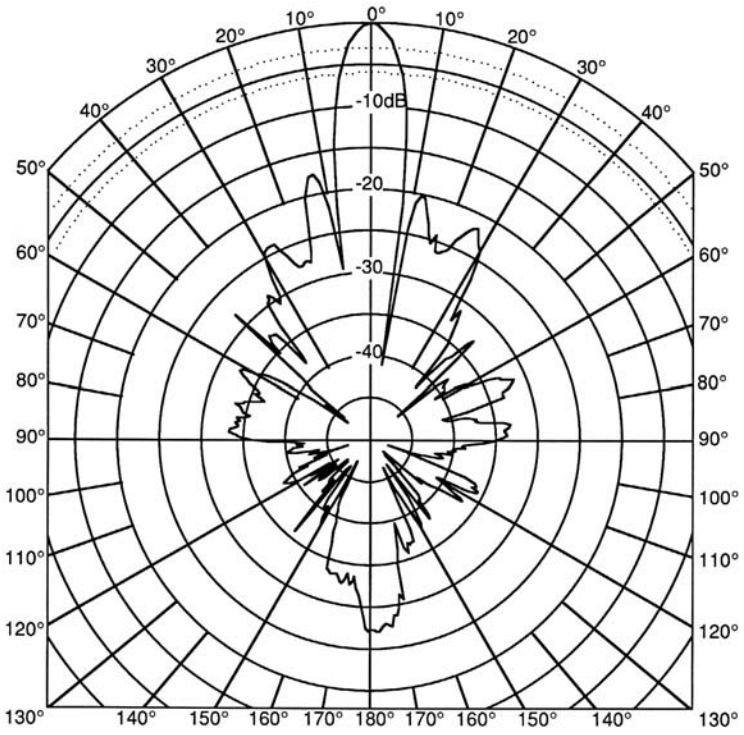
Beamwidth:

-3dB:	7°
-6dB:	10°
-10dB:	12°

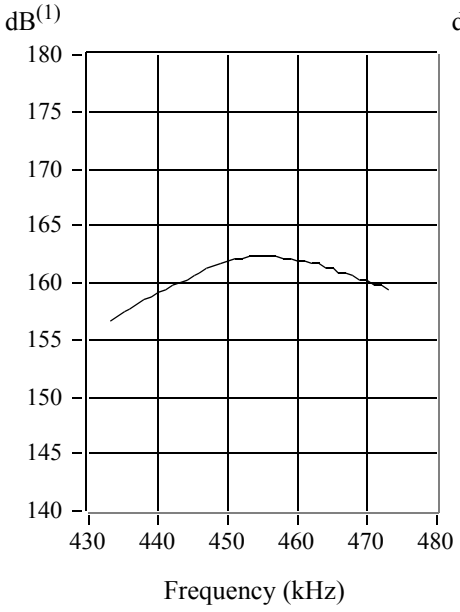
Directivity Index:	28.6
Frequency Tolerance:	±12kHz
Peak TVR(1), nominal:	162dB
Peak TVR(1), minimum:	160dB
Q (transmit):	14
Peak Source Level(4):	214dB
Peak RVR(2), nominal:	-192dB
Peak Figure of Merit(3):	-31dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

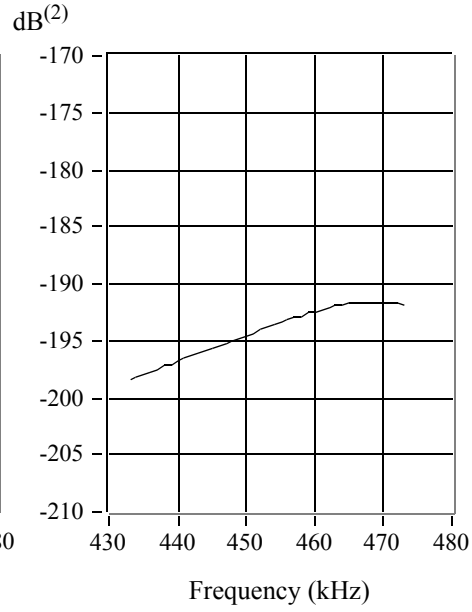
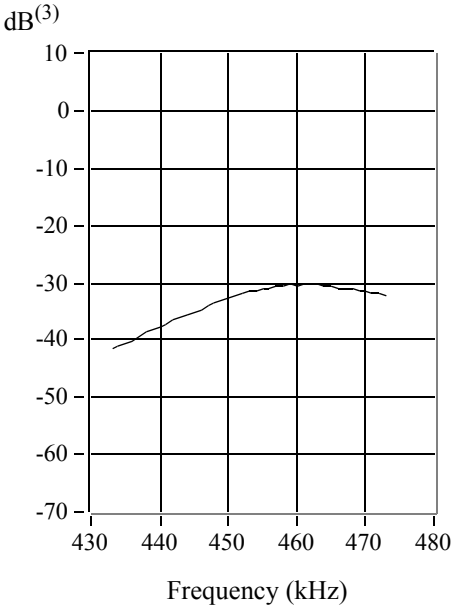


Figure of Merit



455 kHz-A

27mm (1.08") PZT

Cable Type: C13
Cable Length: 1.5m (5.0')

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	540ohms-20%,+40%	550ohms-20%,+40%
Parallel: Cp. (nominal)	510pF	680pF
Series [R – jX] (nominal)	330 – j260 ohms	260 – j280 ohms
1 kHz Capacitance	680pF±20%	810 pF±20%

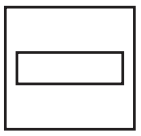
Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (ohms)	Phase Angle (°)	Series Resistance (ohms)	Series Reactance (ohms)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (ohms)	Parallel Capacitance (pF)
430.00	376.60	-76.29	89.26	-365.87	0.6293	2.5797	1588.98	954.81
431.00	372.50	-75.71	91.94	-360.97	0.6626	2.6015	1509.14	960.65
432.00	369.20	-75.10	94.93	-356.79	0.6965	2.6175	1435.83	964.32
433.00	365.00	-74.46	97.79	-351.66	0.7340	2.6396	1362.39	970.21
434.00	361.90	-73.68	101.69	-347.32	0.7765	2.6519	1287.89	972.48
435.00	358.40	-72.99	104.85	-342.72	0.8162	2.6681	1225.14	976.19
436.00	354.50	-72.13	108.78	-337.40	0.8656	2.6848	1155.26	980.04
437.00	351.30	-71.18	113.33	-332.52	0.9183	2.6944	1088.98	981.29
438.00	348.30	-70.23	117.81	-327.77	0.9711	2.7019	1029.73	981.77
439.00	345.10	-69.18	122.66	-322.57	1.0299	2.7085	970.93	981.94
440.00	342.20	-68.00	128.19	-317.28	1.0947	2.7095	913.49	980.06
441.00	340.10	-66.72	134.42	-312.41	1.1621	2.7009	860.52	974.75
442.00	337.70	-65.41	140.52	-307.07	1.2322	2.6927	811.54	969.57
443.00	336.00	-63.89	147.87	-301.71	1.3098	2.6725	763.47	960.13
444.00	335.50	-62.33	155.80	-297.13	1.3841	2.6398	722.47	946.24
445.00	335.10	-60.71	163.94	-292.26	1.4600	2.6027	684.95	930.85
446.00	335.90	-58.89	173.55	-287.59	1.5382	2.5489	650.11	909.58
447.00	338.20	-57.12	183.60	-284.02	1.6052	2.4832	622.97	884.14
448.00	341.10	-55.33	194.03	-280.53	1.6677	2.4111	599.63	856.58
449.00	345.50	-53.45	205.75	-277.55	1.7237	2.3251	580.16	824.18
450.00	351.20	-51.65	217.91	-275.42	1.7667	2.2330	566.03	789.77
451.00	359.10	-49.94	231.11	-274.84	1.7922	2.1314	557.96	752.14
452.00	367.60	-48.42	243.96	-274.98	1.8054	2.0349	553.89	716.51
453.00	377.80	-46.90	258.14	-275.86	1.8086	1.9327	552.93	679.01
454.00	389.50	-45.58	272.62	-278.19	1.7970	1.8337	556.50	642.83
455.00	402.50	-44.54	286.89	-282.32	1.7708	1.7426	564.71	609.56
456.00	416.10	-43.64	301.13	-287.16	1.7392	1.6586	574.97	578.88
457.00	431.90	-42.86	316.59	-293.78	1.6972	1.5749	589.21	548.48
458.00	448.10	-42.45	330.64	-302.44	1.6467	1.5062	607.29	523.42
459.00	464.40	-42.17	344.19	-311.77	1.5959	1.4456	626.59	501.25
460.00	481.90	-42.06	357.78	-322.83	1.5407	1.3901	649.07	480.97
461.00	500.30	-42.17	370.80	-335.87	1.4814	1.3419	675.03	463.26
462.00	518.40	-42.56	381.84	-350.63	1.4209	1.3047	703.80	449.46
463.00	536.20	-43.13	391.32	-366.58	1.3611	1.2750	734.72	438.28
464.00	553.80	-43.74	400.11	-382.89	1.3046	1.2484	766.52	428.22
465.00	572.10	-44.65	407.00	-402.06	1.2435	1.2284	804.17	420.45
466.00	587.40	-45.68	410.40	-420.25	1.1894	1.2180	840.75	415.99
467.00	602.50	-46.65	413.59	-438.12	1.1393	1.2069	877.70	411.32
468.00	617.70	-47.91	414.04	-458.39	1.0851	1.2014	921.53	408.56
469.00	629.70	-49.09	412.37	-475.89	1.0400	1.2002	961.56	407.27
470.00	641.90	-50.35	409.59	-494.24	0.9941	1.1995	1005.96	406.18

455/800 kHz-D (455kHz)

Ceramics Wired in Parallel with 50/200 kHz-A
Power Rating: 25 W rms @ 1% duty cycle
60mm x 3.07 mm (2.36" x 0.121") PZT
Active Area: 1.8 cm^2 (0.285 in^2)
Radiating Surface: Urethane

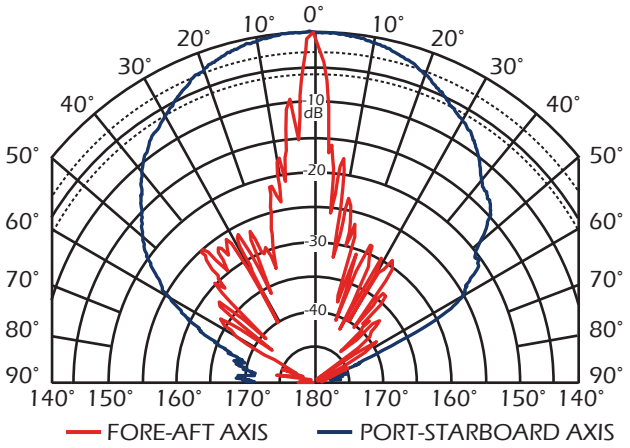
Array



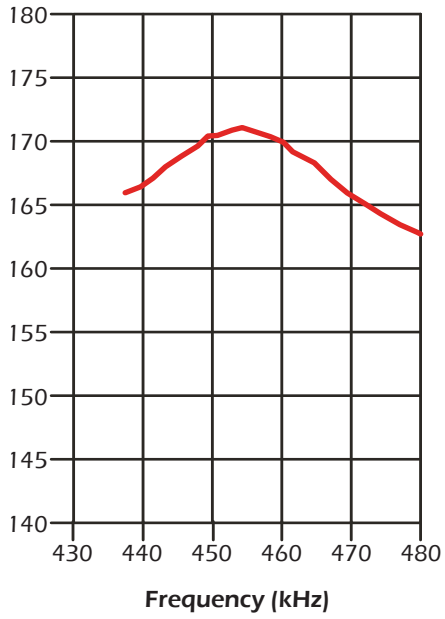
Beamwidth:
-3 dB: 4°/ 40°
-6 dB: 6°/ 56°
-10 dB: 8°/ 75°

Directivity Index:	22
Frequency Tolerance:	+/-23kHz
Peak TVR(1), nominal:	171 dB
Peak TVR(1), minimum:	169 dB
Q (transmit):	21
Peak Source Level(4):	204 dB
Peak RVR(2), nominal:	-194 dB
Peak Figure of Merit(3):	-27 dB

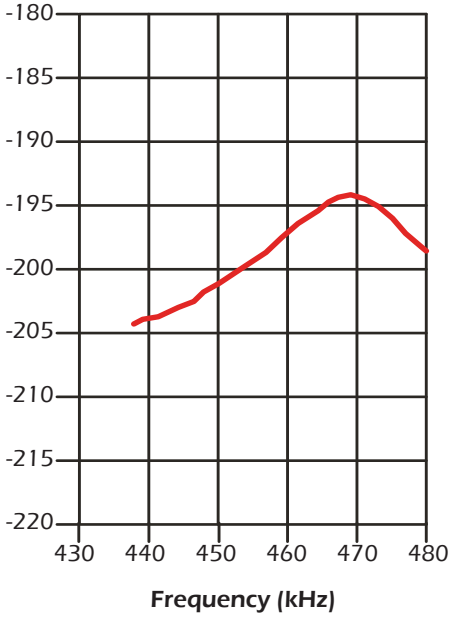
Transmit Radiation Pattern



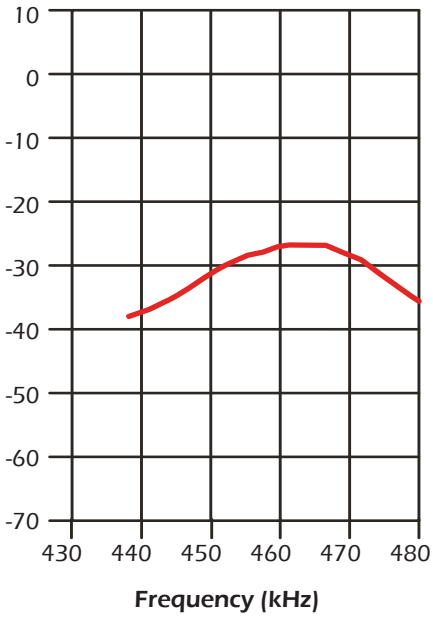
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

455/800 kHz-D (455kHz)

60mm x 3.07mm (2.36” x 0.121”) PZT

Cable Type: C315
Cable Length: 10m (33’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	75 Ω: -20%, +40%	72 Ω: -20%, +40%
Parallel: Cp. (nominal)	1,140 pF	3,100 pF
Series [R - jX]: (nominal)	70-j17 Ω	50-j30 Ω
1 kHz capacitance: (nominal)	2,610	6,280

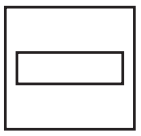
Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
437.00	82.67	-74.77	21.72	-79.77	3.18	11.67	314.71	4370.52
438.00	81.11	-73.91	22.49	-77.93	3.42	11.85	292.58	4425.62
440.00	95.48	-67.66	36.30	-88.31	3.98	9.69	251.15	3585.56
442.00	90.19	-63.61	40.08	-80.79	4.93	9.93	202.94	3659.30
444.00	84.97	-59.00	43.76	-72.84	6.06	10.09	165.00	3699.55
446.00	79.84	-53.14	47.90	-63.88	7.51	10.02	133.08	3657.85
448.00	75.95	-45.89	52.86	-54.54	9.16	9.45	109.12	3435.11
449.00	74.47	-42.01	55.33	-49.84	9.98	8.99	100.22	3258.19
450.00	73.12	-37.80	57.77	-44.82	10.81	8.38	92.54	3032.32
451.00	72.09	-33.51	60.10	-39.80	11.57	7.66	86.46	2764.11
452.00	71.50	-28.78	62.67	-34.43	12.26	6.73	81.58	2424.98
453.00	71.42	-23.75	65.37	-28.76	12.82	5.64	78.03	2026.11
454.00	71.69	-18.70	67.91	-22.98	13.21	4.47	75.69	1602.94
455.00	72.58	-13.41	70.60	-16.83	13.40	3.19	74.61	1142.51
456.00	74.07	-8.05	73.34	-10.37	13.37	1.89	74.81	674.56
457.00	76.08	-2.63	76.00	-3.49	13.13	0.60	76.16	214.77
458.00	78.83	2.70	78.74	3.71	12.67	-0.60	78.92	-212.03
459.00	82.14	8.04	81.33	11.49	12.06	-1.70	82.95	-603.68
460.00	86.56	13.22	84.27	19.79	11.25	-2.64	88.91	-934.24
461.00	91.83	18.31	87.18	28.86	10.34	-3.42	96.73	-1207.47
462.00	97.90	23.15	90.02	38.49	9.39	-4.02	106.48	-1413.84
463.00	105.12	27.64	93.13	48.76	8.43	-4.41	118.66	-1550.31
464.00	113.16	31.88	96.09	59.76	7.50	-4.67	133.26	-1636.00
465.00	122.59	35.93	99.27	71.93	6.61	-4.79	151.39	-1674.19
466.00	132.91	39.60	102.40	84.73	5.80	-4.80	172.50	-1674.10
467.00	144.42	43.15	105.36	98.77	5.05	-4.74	197.95	-1649.24
468.00	157.24	46.56	108.11	114.17	4.37	-4.62	228.68	-1604.76
470.00	188.29	52.64	114.25	149.67	3.22	-4.22	310.31	-1460.65
472.00	224.39	58.14	118.43	190.59	2.35	-3.79	425.15	-1304.01
474.00	269.10	63.75	119.02	241.35	1.64	-3.33	608.43	-1143.21
476.00	325.26	69.14	115.82	303.94	1.09	-2.87	913.45	-981.22
478.00	395.66	74.77	103.96	381.75	0.66	-2.44	1505.86	-829.32
480.00	483.78	81.21	73.91	478.10	0.32	-2.04	3166.62	-691.75

455/800 kHz-D (800kHz)

Ceramics Wired in Parallel with 50/200 kHz-A
Power Rating: 25 W rms @ 1% duty cycle
60mm x 3.07 mm (2.36" x 0.121") PZT
Active Area: 1.8 cm² (0.285 in²)
Radiating Surface: Urethane

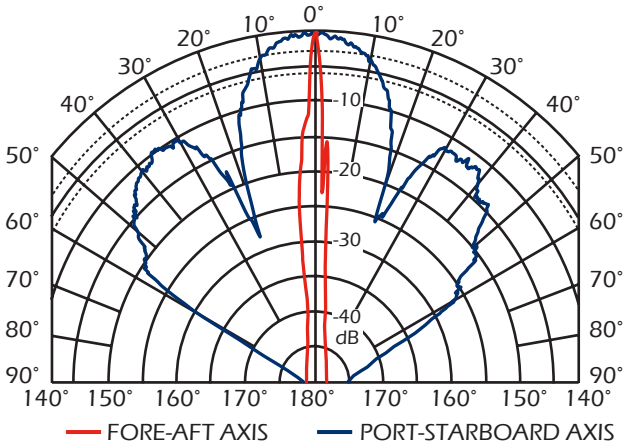
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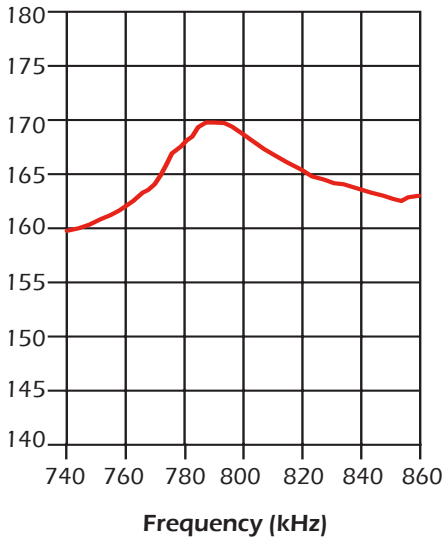
Beamwidth:
-3 dB: 1°/ 19°
-6 dB: 2°/ 26°
-10 dB: 3°/ 32°

Directivity Index:	32
Frequency Tolerance:	+/-40kHz
Peak TVR(1), nominal:	170 dB
Peak TVR(1), minimum:	168 dB
Q (transmit):	22
Peak Source Level(4):	207 dB
Peak RVR(2), nominal:	-206 dB
Peak Figure of Merit(3):	-36 dB

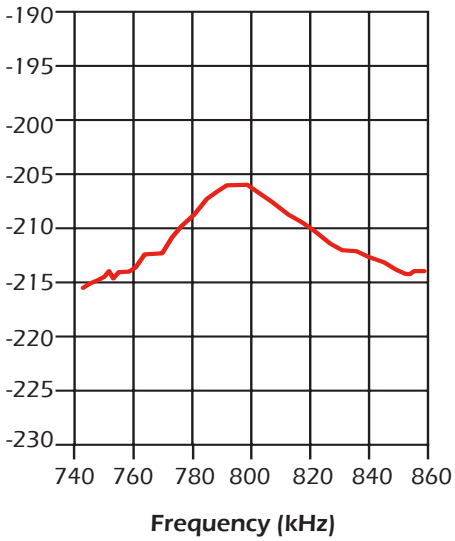
Transmit Radiation Pattern



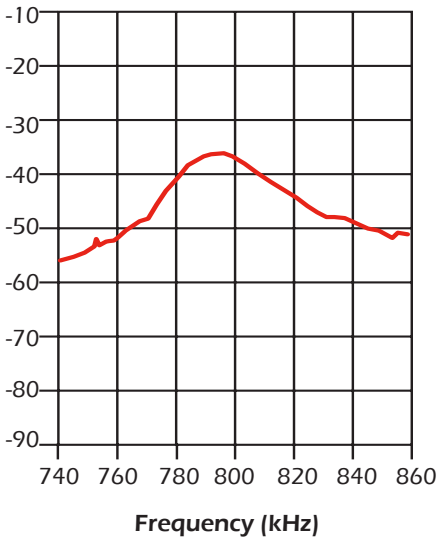
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

455/800 kHz-D (800kHz)

60mm x 3.07mm (2.36” x 0.121”) PZT

Cable Type: C315
Cable Length: 10m (33’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	190 Ω: -20%, +40%	190 Ω: -20%, +40%
Parallel: Cp. (nominal)	2,200 pF	3,230 pF
Series [R - jX]: (nominal)	34-j73 Ω	20-j60 Ω
1 kHz capacitance: (nominal)	3,350	4,260

Balance Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
740.00	87.55	-84.84	7.87	-87.19	1.03	11.38	973.67	2446.70
744.00	85.99	-84.54	8.18	-85.60	1.11	11.58	903.79	2476.33
748.00	84.42	-84.15	8.60	-83.98	1.21	11.78	828.37	2507.34
752.00	82.88	-83.64	9.19	-82.37	1.34	11.99	747.75	2537.83
756.00	81.34	-83.01	9.89	-80.74	1.50	12.20	668.66	2568.97
760.00	79.85	-82.14	10.91	-79.10	1.71	12.41	584.22	2598.13
764.00	78.48	-81.35	11.81	-77.58	1.92	12.60	521.65	2624.32
768.00	76.94	-79.98	13.38	-75.77	2.26	12.80	442.33	2652.27
772.00	75.71	-78.81	14.70	-74.27	2.56	12.96	390.06	2671.20
776.00	74.23	-76.85	16.89	-72.28	3.07	13.12	326.23	2690.43
780.00	73.41	-74.10	20.11	-70.60	3.73	13.10	267.93	2673.32
784.00	73.97	-70.65	24.51	-69.79	4.48	12.76	223.20	2589.31
788.00	76.91	-67.12	29.91	-70.86	5.06	11.98	197.81	2419.37
792.00	82.57	-64.86	35.08	-74.75	5.15	10.96	194.36	2203.16
796.00	89.74	-64.98	37.96	-81.31	4.71	10.10	212.15	2018.98
799.00	94.66	-66.57	37.64	-86.85	4.20	9.69	238.06	1930.86
800.00	96.12	-67.34	37.03	-88.71	4.01	9.60	249.54	1909.96
801.00	97.20	-68.13	36.20	-90.21	3.83	9.55	260.98	1897.03
804.00	99.36	-70.70	32.85	-93.78	3.33	9.50	300.60	1880.23
808.00	100.32	-73.69	28.18	-96.28	2.80	9.57	357.13	1884.48
812.00	99.84	-76.51	23.29	-97.09	2.34	9.74	427.94	1908.99
816.00	98.15	-78.59	19.42	-96.21	2.02	9.99	496.10	1947.89
820.00	96.24	-80.09	16.57	-94.80	1.79	10.24	558.91	1986.69
824.00	94.36	-81.27	14.32	-93.27	1.61	10.47	621.85	2023.15
828.00	92.46	-82.16	12.62	-91.60	1.48	10.71	677.52	2059.45
832.00	90.68	-82.77	11.40	-89.96	1.39	10.94	720.97	2092.87
836.00	89.02	-83.25	10.46	-88.40	1.32	11.16	757.21	2123.84
840.00	87.50	-83.62	9.72	-86.95	1.27	11.36	787.54	2152.06
844.00	86.07	-83.90	9.15	-85.58	1.24	11.55	809.50	2178.49
848.00	84.67	-84.06	8.76	-84.21	1.22	11.75	818.28	2204.78
852.00	83.41	-84.10	8.58	-82.97	1.23	11.93	811.10	2227.73
856.00	82.58	-84.03	8.59	-82.14	1.26	12.04	794.28	2239.20
860.00	81.73	-84.41	7.96	-81.35	1.19	12.18	839.49	2253.44

500 kHz-A

Power rating: 200 Wrms @ 2% duty cycle
30mm (1.18") PZT
Active Area: 7cm²
Urethane Window

Beamwidth:

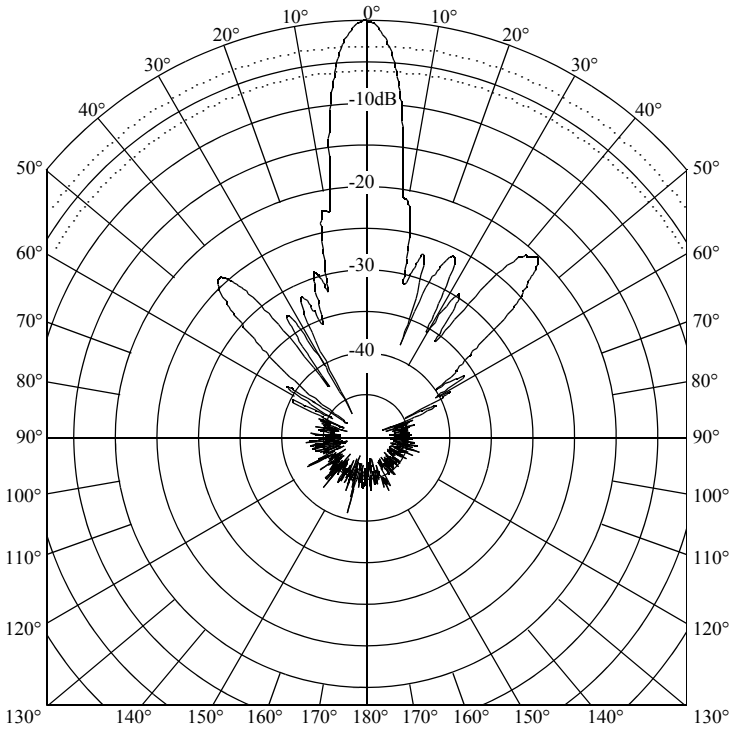
-3dB:	7°
-6dB:	10°
-10dB:	12°

Directivity Index:	30.1
Frequency Tolerance:	±15kHz
Peak TVR(1), nominal:	173dB
Peak TVR(1), minimum:	171dB
Q (transmit):	10
Peak Source Level(4):	218dB
Peak RVR(2), nominal:	-187dB
Peak Figure of Merit(3):	-17dB

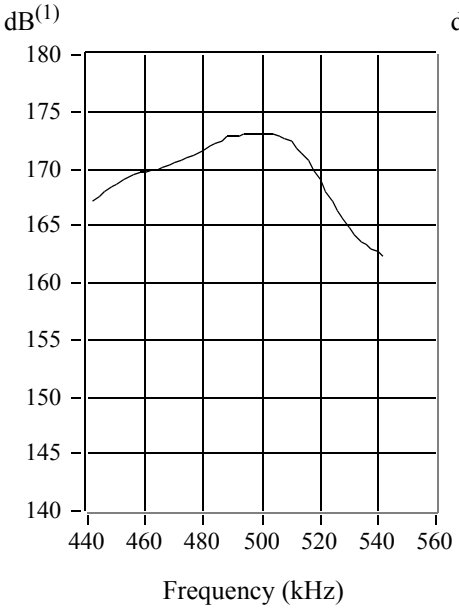
Notes:

(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

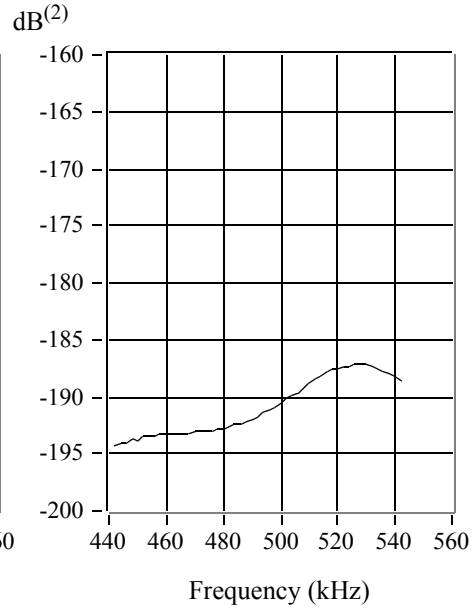
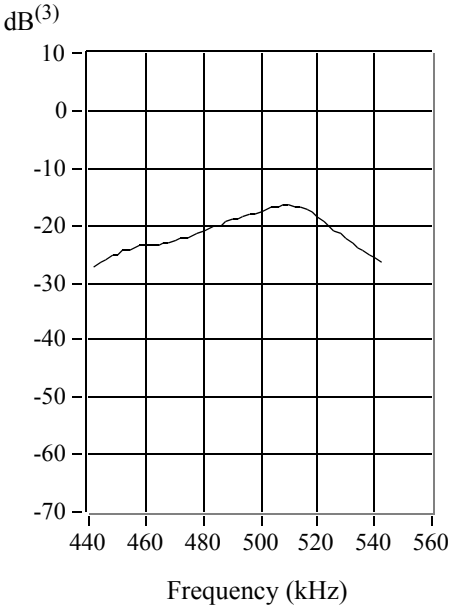


Figure of Merit



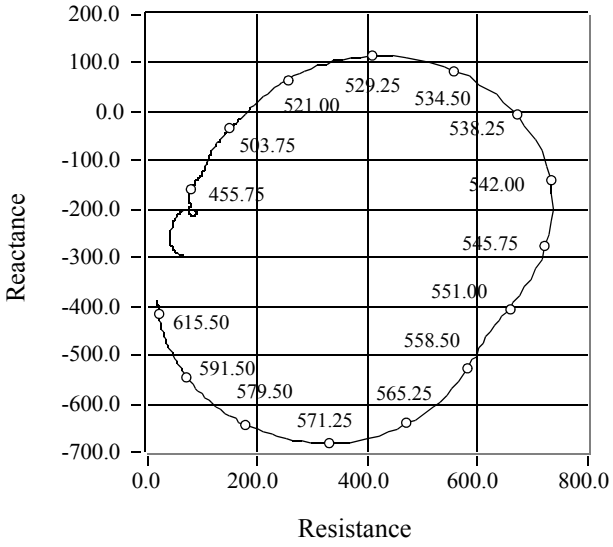
500 kHz-A

30mm (1.18") PZT

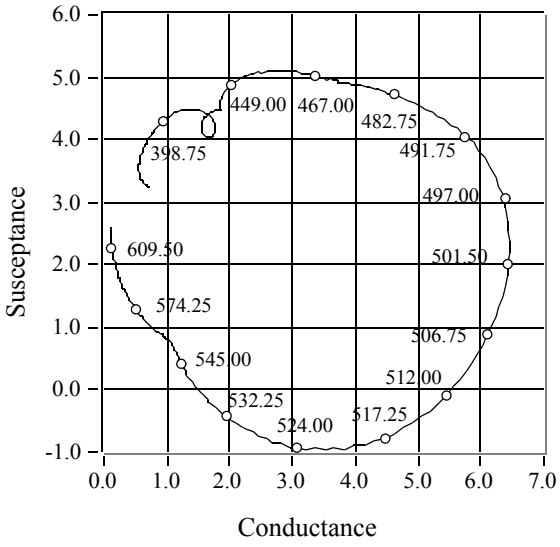
Cable Type: Test
Cable Length: 3.0 m (10.0')

Impedance Data	
	Unbalanced
Parallel: Rp.	150 ohms -20%, +40%
Parallel: Cp. (nominal)	750 pF
Series [R – jX] (nominal)	140 – j50 ohms
1 kHz Capacitance	1810 pF ±20%

Unbalanced Impedance



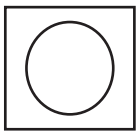
Unbalanced Admittance



500 kHz-Dlq

Power Rating: 150 W rms @ 1% duty cycle
42 mm (1.65") PZT
Active Area: 138.5 cm² (21.5 in²)
Radiating Surface: CPVC

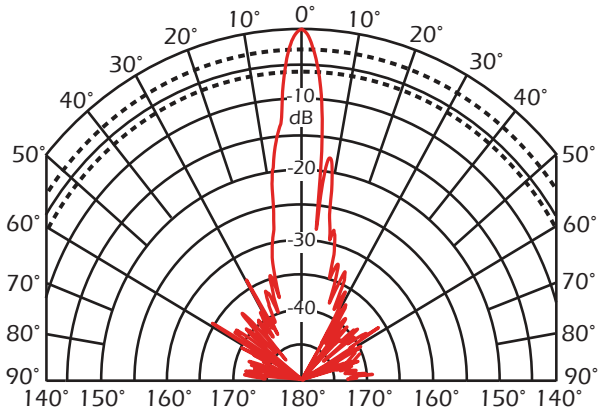
Array



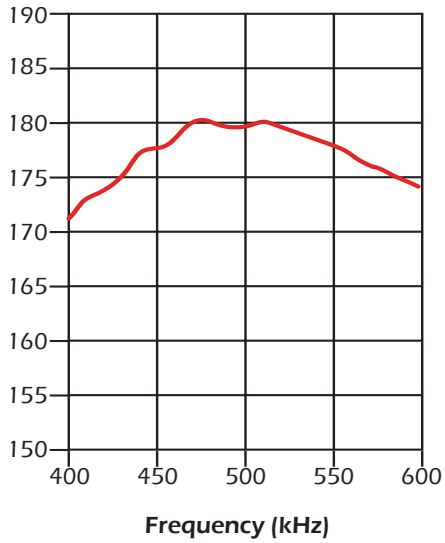
Beamwidth:
-3 dB: 4°
-6 dB: 6°
-10 dB: 8°

Directivity Index:	59
Frequency Tolerance:	± 40 kHz
Peak TVR(1), nominal:	180 dB
Peak TVR(1), minimum:	177 dB
Q (transmit):	4
Peak Source Level(4):	219 dB
Peak RVR(2), nominal:	-193 dB
Peak Figure of Merit(3):	-14 dB

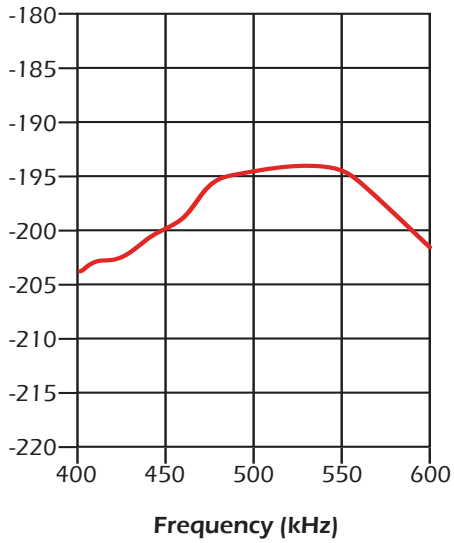
Transmit Radiation Pattern



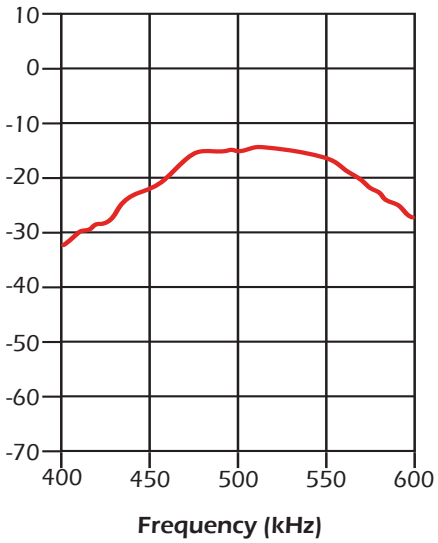
TVR



RVR



FOM



Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

500 kHz-Dlq

42 mm (1.65”) PZT

Cable Type: C33
Cable Length: 20 m (66’)

Note:
Impedance data includes cable

Impedance Data		
	Balanced	*Unbalanced*
Parallel: Rp.	40 Ω: -20%, +40%	40 Ω: -20%, +40%
Parallel: Cp. (nominal)	4,570 pF	6,760 pF
Series [R - jX]: (nominal)	30 - j16 Ω	25 - j20 Ω
1 kHz capacitance: (nominal)	7,240 pF	9,320 pF

Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
400.00	35.60	-74.29	9.64	-34.26	7.61	27.04	131.44	10760.45
405.00	34.10	-71.75	10.68	-32.38	9.19	27.85	108.86	10945.40
410.00	33.17	-68.81	11.99	-30.93	10.90	28.11	91.78	10910.87
415.00	32.60	-66.32	13.09	-29.86	12.32	28.09	81.19	10772.95
420.00	32.06	-64.00	14.05	-28.82	13.67	28.04	73.14	10624.09
425.00	31.67	-62.03	14.85	-27.97	14.81	27.89	67.52	10444.43
430.00	30.79	-60.78	15.03	-26.88	15.85	28.34	63.09	10490.70
440.00	28.06	-52.02	17.27	-22.12	21.93	28.08	45.60	10158.64
445.00	28.86	-45.81	20.12	-20.69	24.15	24.85	41.40	8886.58
450.00	30.62	-42.50	22.58	-20.69	24.08	22.06	41.53	7803.11
455.00	31.54	-40.98	23.81	-20.68	23.94	20.79	41.78	7273.20
460.00	31.78	-38.38	24.92	-19.73	24.66	19.53	40.55	6758.55
475.00	38.25	-27.73	33.85	-17.80	23.14	12.17	43.21	4077.06
480.00	41.91	-28.13	36.96	-19.76	21.04	11.25	47.52	3729.97
490.00	46.29	-31.41	39.50	-24.12	18.44	11.26	54.23	3657.23
495.00	47.67	-32.52	40.20	-25.62	17.69	11.28	56.53	3625.82
500.00	48.94	-33.42	40.85	-26.96	17.05	11.25	58.64	3582.33
505.00	50.17	-34.08	41.56	-28.11	16.51	11.17	60.58	3519.36
510.00	51.53	-34.55	42.44	-29.22	15.98	11.01	62.56	3434.99
515.00	53.27	-35.04	43.61	-30.58	15.37	10.78	65.06	3331.20
520.00	55.32	-35.88	44.82	-32.42	14.65	10.59	68.27	3242.55
525.00	57.37	-37.19	45.70	-34.68	13.89	10.54	72.01	3194.52
530.00	59.51	-38.78	46.40	-37.27	13.10	10.52	76.34	3160.02
535.00	61.60	-40.80	46.64	-40.25	12.29	10.61	81.38	3155.22
540.00	63.63	-43.28	46.32	-43.62	11.44	10.78	87.40	3175.82
545.00	65.49	-46.16	45.36	-47.23	10.58	11.01	94.54	3216.37
550.00	66.73	-49.51	43.33	-50.75	9.73	11.40	102.77	3297.94
555.00	67.35	-53.23	40.32	-53.94	8.89	11.89	112.50	3410.70
560.00	67.08	-57.08	36.46	-56.31	8.10	12.51	123.43	3556.45
570.00	64.14	-64.04	28.08	-57.67	6.82	14.02	146.52	3913.64
575.00	61.98	-66.86	24.36	-56.99	6.34	14.84	157.69	4106.47
580.00	59.72	-69.28	21.13	-55.86	5.92	15.66	168.81	4297.83
585.00	57.44	-71.39	18.34	-54.44	5.56	16.50	179.96	4488.47
590.00	55.16	-73.25	15.90	-52.82	5.22	17.36	191.41	4682.99
595.00	52.81	-74.80	13.84	-50.96	4.96	18.27	201.42	4888.20
600.00	50.54	-76.07	12.17	-49.05	4.76	19.21	209.90	5094.31

545 kHz-Blq

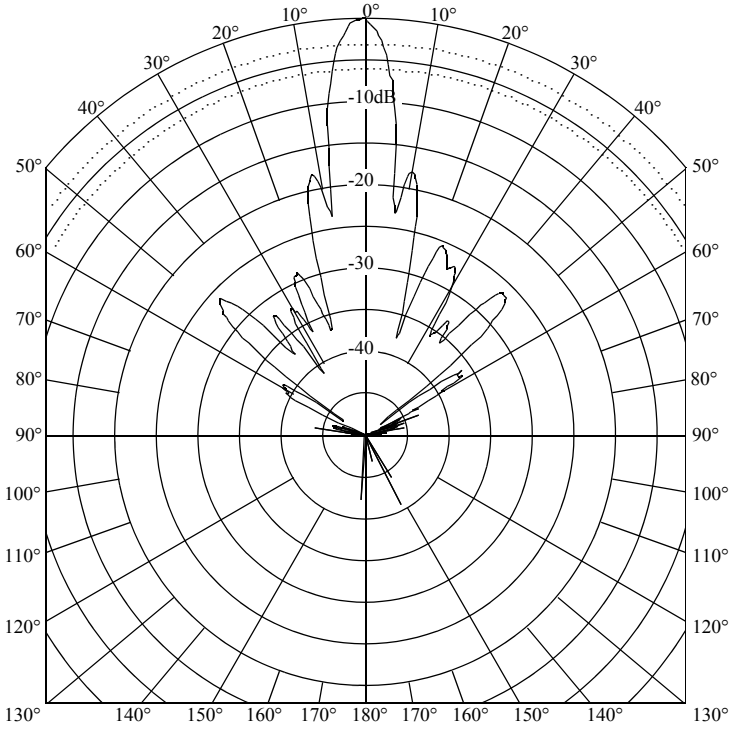
Transformed to 70 ohms
Power rating: 300 Wrms @ 2% duty cycle
25mm (1.0") PZT
Active Area: 6.2cm²
Urethane Window

Beamwidth:
-3dB: 6°
-6dB: 9°
-10dB: 11°

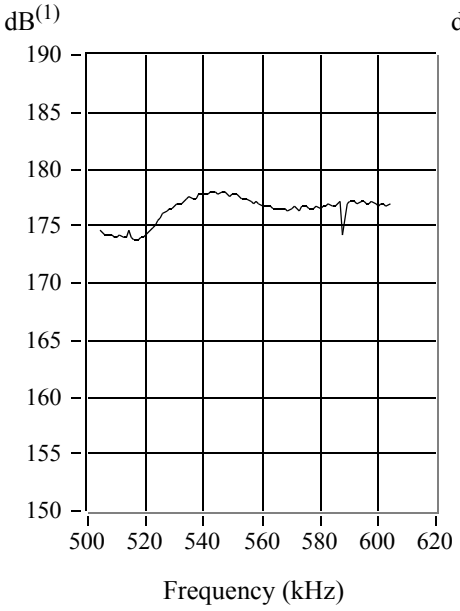
Directivity Index:	29.5
Frequency Tolerance:	±20kHz
Peak TVR(1), nominal:	178dB
Peak TVR(1), minimum:	176dB
Q (transmit):	5
Peak Source Level(4):	221dB
Peak RVR(2), nominal:	-193dB
Peak Figure of Merit(3):	-16dB

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) sum of transmitting voltage response and receiving voltage response
(4) Nominal peak TVR, rated power, and no cavitation

Transmit Radiation Pattern



TVR



RVR

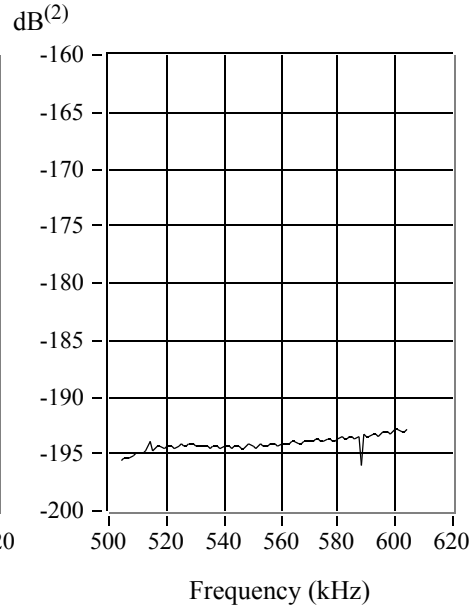
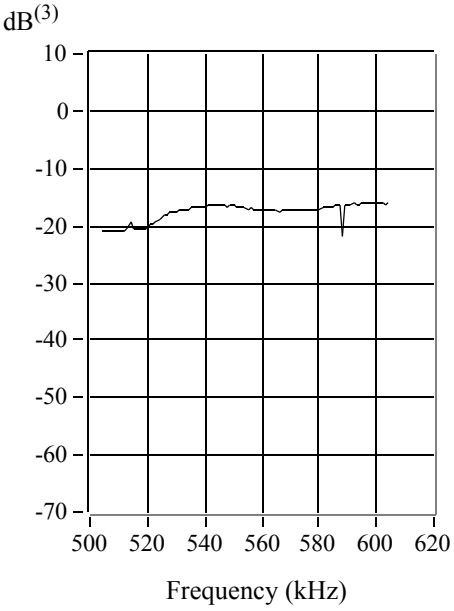


Figure of Merit



545 kHz-Blq

25mm (1.0") PZT

Cable Type: Test
Cable Length: 3.0m (10.0')

Impedance Data w/ transformer	
	Unbalanced
Parallel: Rp.	70ohms -20%,+40%
Parallel: Cp. (nominal)	0pF
Series [R – jX] (nominal)	70 – j0 ohms
1 kHz Capacitance	n/a

Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (ohms)	Phase Angle (°)	Series Resistance (ohms)	Series Reactance (ohms)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (ohms)	Parallel Capacitance (pF)
530.00	68.49	-1.96	68.45	-2.35	14.5924	0.5003	68.53	150.23
531.00	66.54	-2.17	66.49	-2.52	15.0186	0.5698	66.58	170.79
532.00	68.38	-2.73	68.30	-3.25	14.6079	0.6954	68.46	208.04
533.00	68.96	-0.55	68.96	-0.66	14.5002	0.1381	68.96	41.23
534.00	66.06	2.04	66.02	2.35	15.1283	-0.5378	66.10	-160.29
535.00	64.53	1.27	64.51	1.43	15.4937	-0.3429	64.54	-102.02
536.00	66.35	1.25	66.33	1.44	15.0687	-0.3281	66.36	-97.43
537.00	67.51	3.83	67.36	4.51	14.7799	-0.9895	67.66	-293.26
538.00	65.31	6.47	64.89	7.36	15.2151	-1.7249	65.72	-510.26
539.00	63.54	6.01	63.20	6.65	15.6504	-1.6480	63.90	-486.63
540.00	65.67	5.55	65.36	6.35	15.1558	-1.4731	65.98	-434.17
541.00	67.69	8.24	66.99	9.70	14.6208	-2.1180	68.40	-623.10
542.00	65.32	10.79	64.17	12.22	15.0377	-2.8645	66.50	-841.16
543.00	64.61	10.08	63.62	11.31	15.2374	-2.7096	65.63	-794.19
544.00	67.23	9.87	66.23	11.52	14.6552	-2.5495	68.24	-745.88
545.00	69.49	12.32	67.89	14.83	14.0581	-3.0712	71.13	-896.88
546.00	67.99	14.86	65.71	17.44	14.2165	-3.7734	70.34	-1099.92
547.00	66.93	14.04	64.93	16.24	14.4947	-3.6255	68.99	-1054.88
548.00	69.66	13.31	67.78	16.04	13.9707	-3.3050	71.58	-959.86
549.00	72.54	15.87	69.78	19.84	13.2599	-3.7700	75.42	-1092.91
550.00	71.07	17.58	67.75	21.47	13.4128	-4.2502	74.56	-1229.89
551.00	70.86	16.31	68.01	19.90	13.5443	-3.9628	73.83	-1144.66
552.00	74.24	15.67	71.48	20.06	12.9682	-3.6389	77.11	-1049.17
553.00	77.01	17.44	73.47	23.08	12.3888	-3.8924	80.72	-1120.26
554.00	75.73	19.25	71.50	24.96	12.4668	-4.3527	80.21	-1250.46
555.00	74.88	17.72	71.33	22.79	12.7215	-4.0646	78.61	-1165.58
556.00	78.23	16.56	74.98	22.30	12.2527	-3.6440	81.61	-1043.10
557.00	81.20	18.23	77.12	25.40	11.6973	-3.8531	85.49	-1100.96
558.00	79.35	19.48	74.81	26.46	11.8817	-4.2022	84.16	-1198.58
559.00	79.49	17.35	75.87	23.70	12.0084	-3.7513	83.28	-1068.04
560.00	83.03	16.82	79.48	24.02	11.5286	-3.4842	86.74	-990.22
561.00	84.58	18.35	80.28	26.63	11.2222	-3.7219	89.11	-1055.90
562.00	82.34	18.87	77.92	26.63	11.4918	-3.9273	87.02	-1112.17
563.00	82.55	16.76	79.04	23.80	11.5996	-3.4925	86.21	-987.29
564.00	85.77	16.06	82.43	23.72	11.2038	-3.2245	89.26	-909.92
565.00	87.13	17.65	83.03	26.42	10.9362	-3.4802	91.44	-980.35
566.00	84.48	18.09	80.30	26.23	11.2524	-3.6760	88.87	-1033.67

22 to 40 kHz-A (Broadband)

All 4 Quadrants Transformed to 12 ohms minimum (B5)

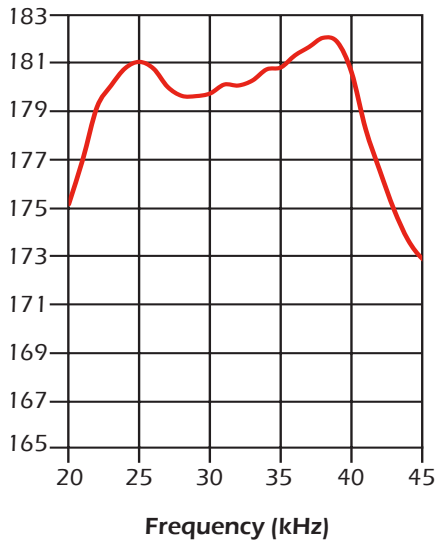
Power Rating:
- 2 kW @ 1% duty cycle
- CW(4): TBD in M438

52 x 42 mm x 42 mm
(1.65 in x 1.65 in) PZT
Active Area: 913 cm^2 (141 in^2)
Radiating Surface: Urethane

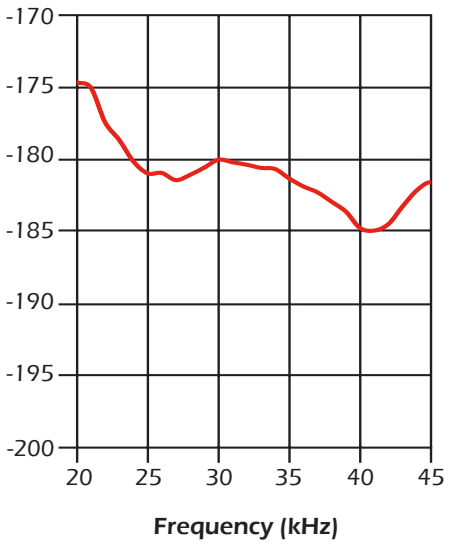
Q ≈ 2
Cable Type: C247
Cable Length: 26 m (87 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

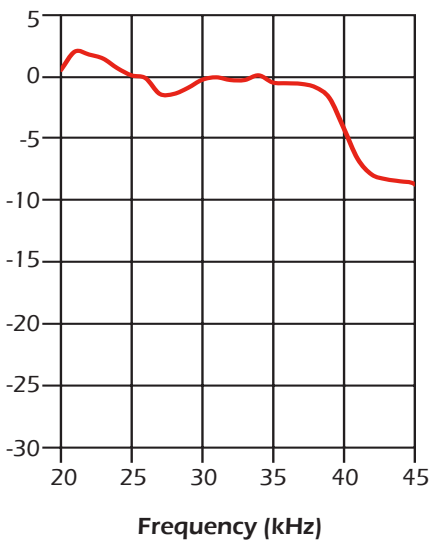
TVR



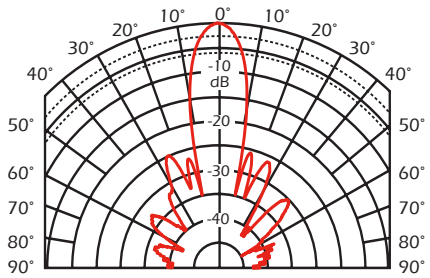
RVR



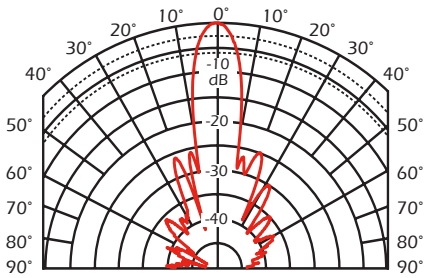
FOM



Transmit Radiation Pattern



Beamwidth	@ 32 kHz
-3 dB	9°
-6 dB	13°
-10 dB	16°



Beamwidth	@ 38 kHz
-3 dB	8°
-6 dB	11°
-10 dB	14°

22 to 40 kHz-A (Broadband) All 4 Quadrants Transformed to 12 ohms minimum (B5)

Note: Impedance data includes cable

Unbalanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
20.00	32.28	37.50	25.61	19.65	24.58	-18.86	40.69	-150073
20.50	29.81	14.28	28.89	7.35	32.51	-8.27	30.76	-64240
21.00	26.18	3.10	26.14	1.42	38.14	-2.07	26.22	-15655
21.50	20.69	-7.40	20.52	-2.66	47.93	6.23	20.86	46081
22.00	16.26	-7.02	16.14	-1.99	61.04	7.52	16.38	54376
22.50	14.96	-4.74	14.91	-1.24	66.62	5.52	15.01	39072
23.00	13.29	-6.19	13.21	-1.43	74.81	8.11	13.37	56142
23.50	11.00	1.42	11.00	0.27	90.88	-2.25	11.00	-15257
24.00	10.76	1.90	10.75	0.36	92.89	-3.08	10.77	-20434
25.00	9.87	13.62	9.59	2.32	98.47	-23.86	10.16	-151887
25.50	10.43	17.14	9.97	3.07	91.62	-28.26	10.91	-176355
26.00	10.65	18.31	10.11	3.35	89.14	-29.50	11.22	-180570
26.50	10.72	21.18	10.00	3.87	86.98	-33.70	11.50	-202417
27.00	11.40	24.68	10.36	4.76	79.71	-36.63	12.55	-215904
27.50	12.44	24.39	11.33	5.14	73.21	-33.19	13.66	-192114
28.00	12.85	22.32	11.89	4.88	71.99	-29.55	13.89	-167993
28.50	13.11	22.88	12.08	5.10	70.28	-29.66	14.23	-165616
29.00	14.12	23.27	12.97	5.58	65.06	-27.98	15.37	-153552
30.00	15.38	13.54	14.95	3.60	63.21	-15.22	15.82	-80759
30.50	14.62	11.86	14.31	3.00	66.94	-14.06	14.94	-73355
31.00	14.92	12.87	14.55	3.32	65.34	-14.93	15.30	-76646
31.50	15.62	9.48	15.41	2.57	63.15	-10.54	15.84	-53276
32.00	15.17	5.20	15.11	1.37	65.65	-5.97	15.23	-29715
32.50	14.50	5.14	14.44	1.30	68.69	-6.18	14.56	-30257
33.00	14.89	5.52	14.82	1.43	66.85	-6.46	14.96	-31157
33.50	15.29	1.52	15.28	0.41	65.38	-1.73	15.30	-8242
34.00	14.41	-2.50	14.40	-0.63	69.33	3.03	14.42	14170
35.00	13.62	-0.93	13.62	-0.22	73.41	1.19	13.62	5419
35.50	13.54	-4.09	13.51	-0.97	73.67	5.27	13.57	23616
36.00	12.42	-5.86	12.36	-1.27	80.09	8.22	12.49	36342
36.50	11.58	-2.66	11.57	-0.54	86.26	4.01	11.59	17475
37.00	11.69	0.27	11.69	0.06	85.54	-0.40	11.69	-1734
37.50	11.66	-0.96	11.66	-0.20	85.75	1.44	11.66	6098
38.00	10.65	-0.59	10.65	-0.11	93.89	0.97	10.65	4050
38.50	9.97	6.10	9.91	1.06	99.73	-10.66	10.03	-44061
39.00	10.32	12.43	10.08	2.22	94.63	-20.86	10.57	-85116
40.00	10.72	22.86	9.88	4.16	85.96	-36.24	11.63	-144190
40.50	11.99	30.67	10.31	6.12	71.74	-42.54	13.94	-167184
41.00	14.15	34.06	11.72	7.92	58.55	-39.58	17.08	-153644
41.50	16.34	34.30	13.50	9.21	50.56	-34.49	19.78	-132262
42.00	18.61	34.56	15.33	10.56	44.25	-30.48	22.60	-115508

22 to 40 kHz-A (Broadband) 1 Quadrant Transformed to 50 ohms minimum

Note: Impedance data includes cable

Unbalanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
20.00	118.55	36.33	95.51	70.23	6.80	-5.00	147.15	-39768
20.50	113.98	20.95	106.45	40.75	8.19	-3.14	122.05	-24354
21.00	98.83	9.54	97.46	16.38	9.98	-1.68	100.22	-12710
21.50	82.50	2.02	82.45	2.91	12.11	-0.43	82.55	-3163
22.00	69.20	0.12	69.20	0.14	14.45	-0.03	69.20	-219
22.50	61.19	-0.16	61.19	-0.17	16.34	0.05	61.19	323
23.00	54.01	-0.24	54.01	-0.23	18.51	0.08	54.01	537
23.50	47.47	2.16	47.44	1.79	21.05	-0.79	47.50	-5377
24.00	43.23	7.25	42.88	5.46	22.95	-2.92	43.58	-19359
25.00	41.27	19.47	38.91	13.76	22.85	-8.08	43.77	-51416
25.50	43.67	24.63	39.70	18.20	20.82	-9.54	48.04	-59563
26.00	46.90	26.50	41.97	20.93	19.08	-9.51	52.41	-58237
26.50	50.41	27.86	44.57	23.56	17.54	-9.27	57.02	-55676
27.00	54.44	27.01	48.50	24.72	16.37	-8.34	61.10	-49174
27.50	56.88	24.88	51.60	23.93	15.95	-7.40	62.70	-42808
28.00	59.17	23.86	54.11	23.93	15.46	-6.84	64.70	-38858
28.50	62.21	21.15	58.02	22.45	14.99	-5.80	66.70	-32389
29.00	64.35	18.02	61.19	19.91	14.78	-4.81	67.67	-26383
30.00	63.01	11.82	61.67	12.91	15.53	-3.25	64.38	-17246
30.50	63.03	10.17	62.04	11.13	15.62	-2.80	64.04	-14618
31.00	62.91	7.32	62.40	8.02	15.77	-2.03	63.43	-10398
31.50	60.63	4.94	60.40	5.22	16.43	-1.42	60.86	-7176
32.00	58.61	4.61	58.42	4.71	17.01	-1.37	58.80	-6820
32.50	58.10	4.30	57.94	4.36	17.16	-1.29	58.26	-6320
33.00	57.33	3.39	57.23	3.39	17.41	-1.03	57.43	-4974
33.50	56.23	3.22	56.14	3.16	17.76	-1.00	56.32	-4746
34.00	56.29	3.47	56.19	3.41	17.73	-1.08	56.39	-5033
35.00	55.92	0.10	55.92	0.10	17.88	-0.03	55.92	-142
35.50	53.76	-0.43	53.76	-0.40	18.60	0.14	53.76	626
36.00	52.81	-0.23	52.81	-0.21	18.94	0.08	52.81	336
36.50	51.66	-0.70	51.66	-0.63	19.36	0.24	51.66	1031
37.00	49.89	-1.01	49.88	-0.88	20.04	0.35	49.90	1520
37.50	48.00	-0.76	48.00	-0.64	20.83	0.28	48.00	1173
38.00	45.08	0.63	45.08	0.50	22.18	-0.24	45.08	-1022
38.50	42.67	4.06	42.56	3.02	23.38	-1.66	42.78	-6859
39.00	41.02	10.04	40.39	7.15	24.01	-4.25	41.66	-17344
40.00	43.71	23.35	40.13	17.32	21.00	-9.07	47.61	-36079
40.50	47.17	29.91	40.89	23.52	18.38	-10.57	54.42	-41542
41.00	53.92	35.87	43.69	31.59	15.03	-10.87	66.54	-42184
41.50	63.49	38.34	49.80	39.38	12.35	-9.77	80.95	-37470
42.00	75.21	38.68	58.71	47.00	10.38	-8.31	96.34	-31489

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25 to 45 kHz-A (Broadband)

Ceramics wired in parallel

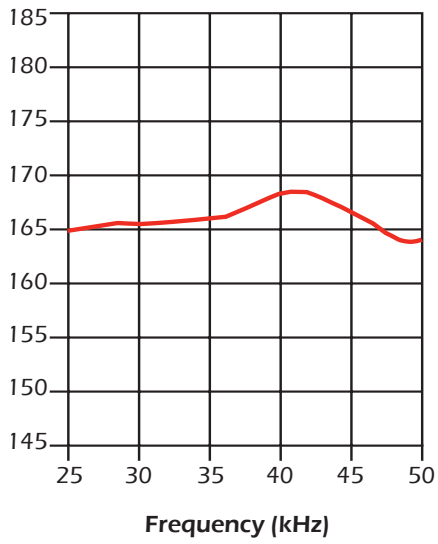
Power Rating:
- 3 kW @ 1% duty cycle
- CW(4): 60W in R609

15 x 44.4 mm (1.7") PZT4
Active Area: 232.8 cm²
Radiating Surface: Epoxy

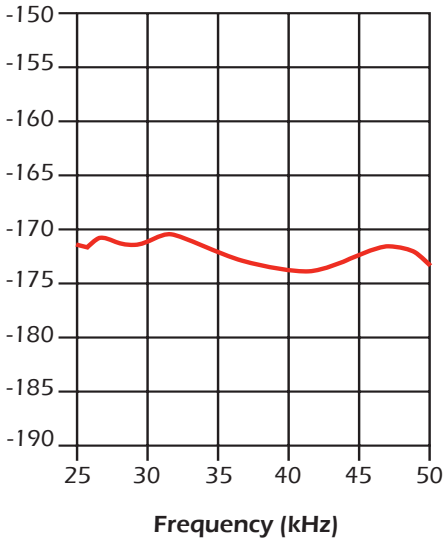
Q ≈ 2
Cable Type: C44
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

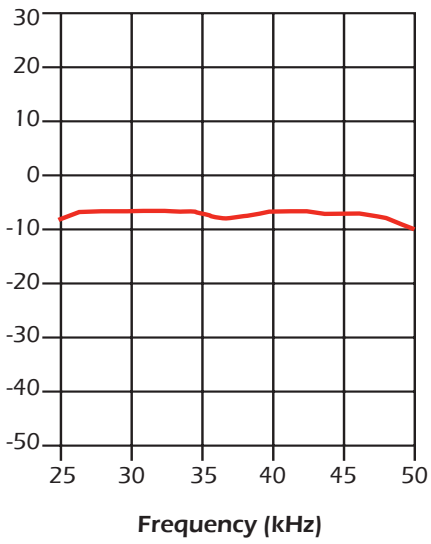
TVR



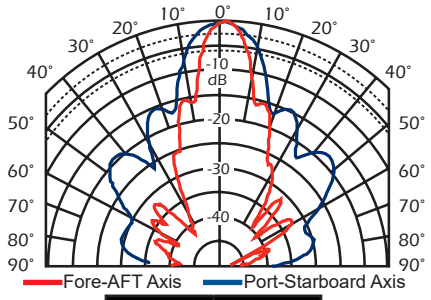
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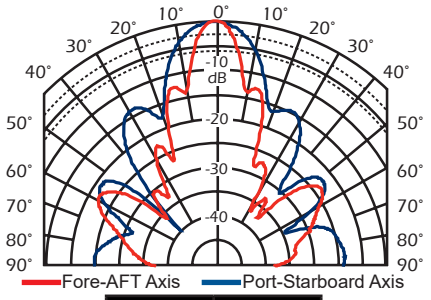
FOM



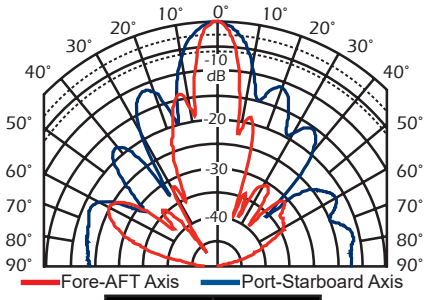
Transmit Radiation Pattern



Beamwidth	@ 28 kHz
-3 dB	10°/17°
-6 dB	13°/22°
-10 dB	16°/29°



Beamwidth	@ 38 kHz
-3 dB	8°/16°
-6 dB	12°/23°
-10 dB	15°/29°



Beamwidth	@ 45 kHz
-3 dB	7°/13°
-6 dB	10°/18°
-10 dB	13°/22°

25 to 45 kHz-A (Broadband)

Note: Impedance data includes cable

1 kHz Capacitance: 38,275 pF: ± 20%

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
25.00	197.22	-4.87	196.51	-16.73	5.0521	0.4300	197.94	2737.72
25.50	202.12	1.96	202.00	6.91	4.9447	-0.1692	202.24	-1056.28
26.00	176.40	8.02	174.68	24.60	5.6135	-0.7906	178.14	-4839.29
26.50	186.13	6.46	184.95	20.95	5.3385	-0.6047	187.32	-3631.79
27.00	218.58	9.16	215.79	34.81	4.5165	-0.7285	221.41	-4294.20
27.50	191.32	10.55	188.09	35.03	5.1384	-0.9569	194.61	-5537.84
28.00	186.11	7.12	184.67	23.08	5.3317	-0.6664	187.56	-3787.93
28.50	215.63	7.33	213.87	27.50	4.5997	-0.5915	217.40	-3303.38
29.00	203.33	13.97	197.31	49.08	4.7728	-1.1871	209.52	-6515.01
29.50	198.65	10.03	195.61	34.60	4.9570	-0.8767	201.73	-4729.88
30.00	212.67	7.84	210.68	29.01	4.6582	-0.6413	214.68	-3402.38
30.50	240.79	13.00	234.61	54.17	4.0466	-0.9343	247.12	-4875.43
31.00	220.33	6.27	219.01	24.05	4.5115	-0.4954	221.65	-2543.30
31.50	259.13	-2.09	258.96	-9.46	3.8565	0.1409	259.30	711.66
32.00	264.80	3.56	264.29	16.46	3.7691	-0.2347	265.31	-1167.52
32.50	231.01	-1.04	230.97	-4.19	4.3281	0.0785	231.05	384.48
33.00	246.18	-11.15	241.53	-47.61	3.9854	0.7856	250.92	3788.90
33.50	249.38	-6.23	247.91	-27.05	3.9864	0.4349	250.86	2066.16
34.00	217.24	-7.92	215.17	-29.95	4.5592	0.6345	219.34	2970.26
34.50	209.45	-16.39	200.95	-59.09	4.5804	1.3468	218.32	6213.06
35.00	221.39	-13.08	215.64	-50.11	4.3997	1.0225	227.29	4649.37
35.50	197.45	-10.33	194.25	-35.40	4.9824	0.9081	200.70	4071.25
36.00	192.32	-16.14	184.75	-53.46	4.9946	1.4453	200.22	6389.62
36.50	203.19	-14.72	196.52	-51.62	4.7602	1.2503	210.08	5451.70
37.00	183.67	-14.07	178.16	-44.66	5.2811	1.3240	189.36	5695.05
37.50	179.23	-19.06	169.41	-58.53	5.2736	1.8219	189.63	7732.24
38.00	178.93	-15.83	172.14	-48.81	5.3769	1.5246	185.98	6385.31
38.50	159.26	-11.67	155.96	-32.22	6.1493	1.2704	162.62	5251.72
39.00	160.04	-15.55	154.18	-42.90	6.0197	1.6750	166.12	6835.64
39.50	170.26	-11.73	166.70	-34.60	5.7509	1.1936	173.89	4809.48
40.00	155.21	-6.55	154.20	-17.71	6.4007	0.7349	156.23	2924.27
40.50	148.58	-9.87	146.38	-25.46	6.6310	1.1533	150.81	4532.37
41.00	159.37	-5.11	158.74	-14.21	6.2497	0.5594	160.01	2171.44
41.50	146.81	3.17	146.58	8.13	6.8013	-0.3771	147.03	-1446.18
42.00	147.22	2.74	147.05	7.03	6.7848	-0.3245	147.39	-1229.76
42.50	177.17	4.78	176.55	14.75	5.6248	-0.4700	177.78	-1760.25
43.00	174.34	13.22	169.72	39.88	5.5839	-1.3121	179.09	-4856.37
43.50	177.82	10.52	174.83	32.47	5.5291	-1.0269	180.86	-3757.27
44.00	221.38	8.59	218.89	33.05	4.4666	-0.6743	223.88	-2439.15
44.50	232.27	14.01	225.36	56.22	4.1774	-1.0421	239.38	-3727.23
45.00	225.05	9.41	222.02	36.78	4.3837	-0.7261	228.12	-2568.20

25 to 45 kHz-B (Broadband)

Transformed to 60 ohms minimum (B3)
Ceramics wired in parallel

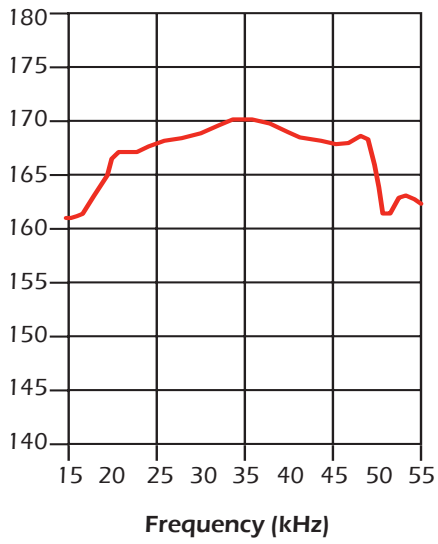
Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 12W in M563

7 x 44.4 mm (1.7") PZT4
Active Area: 140.6 cm² (21.8 in²)
Radiating Surface: Urethane

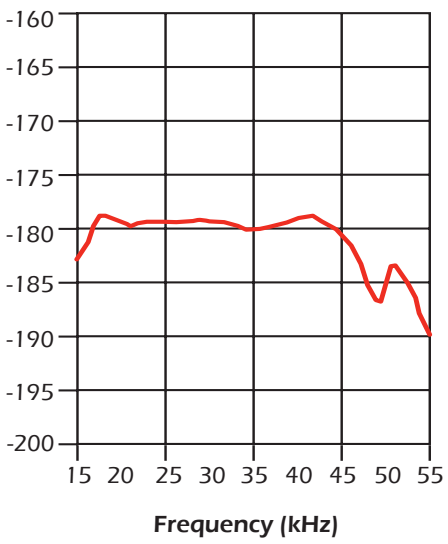
Q ≈ 2
Cable Type: C44-02
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

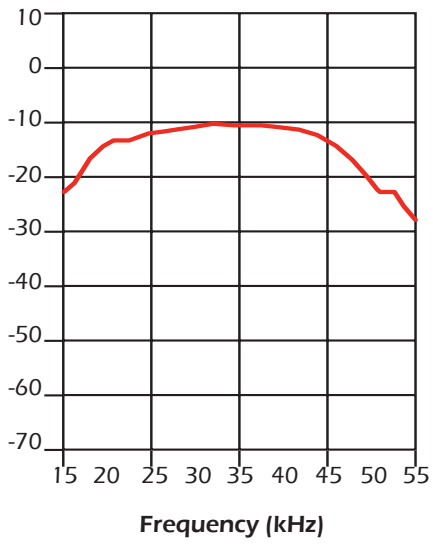
TVR



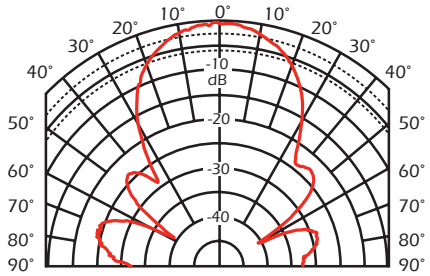
RVR



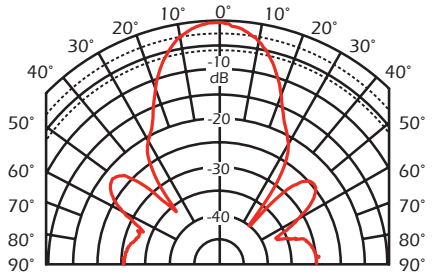
FOM



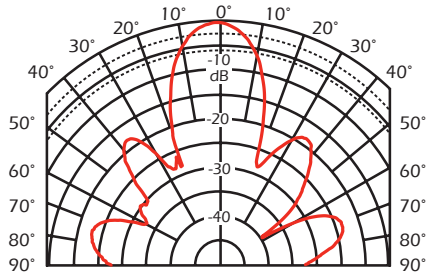
Transmit Radiation Pattern



Beamwidth	@ 25 kHz
-3 dB	24°
-6 dB	35°
-10 dB	45°



Beamwidth	@ 35 kHz
-3 dB	19°
-6 dB	26°
-10 dB	33°



Beamwidth	@ 45 kHz
-3 dB	14°
-6 dB	19°
-10 dB	24°

25 to 45 kHz-B (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
10.00	16.39	86.99	0.86	16.37	3.20	-60.94	312.48	-969813.28
11.00	18.53	87.25	0.89	18.51	2.59	-53.91	386.78	-779954.91
12.00	20.87	87.41	0.94	20.85	2.16	-47.87	462.37	-634881.04
13.00	23.41	87.44	1.05	23.38	1.91	-42.68	524.24	-522529.37
15.00	29.62	87.35	1.37	29.59	1.56	-33.73	640.92	-357854.09
16.00	33.57	87.17	1.66	33.53	1.47	-29.75	679.60	-295970.30
17.00	38.49	86.75	2.18	38.43	1.47	-25.94	678.16	-242853.40
18.00	44.90	85.75	3.33	44.78	1.65	-22.21	605.69	-196371.50
20.00	65.99	78.17	13.53	64.59	3.11	-14.83	321.78	-118020.46
21.00	80.91	66.91	31.73	74.43	4.85	-11.37	206.30	-86167.46
22.00	87.64	49.07	57.41	66.21	7.48	-8.62	133.77	-62367.39
23.00	78.17	34.22	64.64	43.96	10.58	-7.19	94.54	-49778.52
25.00	58.31	30.41	50.29	29.52	14.79	-8.68	67.61	-55265.18
26.00	57.15	34.35	47.18	32.24	14.45	-9.87	69.22	-60437.85
27.00	60.15	37.44	47.76	36.57	13.20	-10.11	75.76	-59574.99
28.00	66.42	37.19	52.91	40.15	11.99	-9.10	83.38	-51729.17
30.00	78.67	25.49	71.01	33.86	11.47	-5.47	87.16	-29023.24
31.00	76.68	19.39	72.33	25.45	12.30	-4.33	81.29	-22226.55
32.00	74.65	14.99	72.11	19.31	12.94	-3.46	77.28	-17230.49
33.00	73.18	12.20	71.53	15.46	13.36	-2.89	74.87	-13926.30
35.00	68.36	5.70	68.02	6.79	14.56	-1.45	68.70	-6611.38
36.00	64.43	4.77	64.21	5.35	15.47	-1.29	64.66	-5701.87
37.00	62.25	4.59	62.05	4.99	16.01	-1.29	62.45	-5534.68
38.00	60.96	5.63	60.67	5.98	16.32	-1.61	61.26	-6739.93
40.00	59.61	10.49	58.61	10.85	16.50	-3.05	60.62	-12153.91
41.00	62.93	13.09	61.29	14.26	15.48	-3.60	64.61	-13973.12
42.00	67.80	15.49	65.34	18.11	14.21	-3.94	70.36	-14926.10
43.00	74.30	15.75	71.51	20.16	12.95	-3.65	77.20	-13517.55
45.00	92.23	9.02	91.09	14.47	10.71	-1.70	93.38	-6015.46
46.00	100.89	4.55	100.57	7.99	9.88	-0.79	101.21	-2717.60
47.00	109.72	-3.23	109.54	-6.17	9.10	0.51	109.89	1737.04
48.00	110.73	-13.39	107.72	-25.64	8.79	2.09	113.82	6932.55
50.00	102.64	-28.86	89.89	-49.54	8.53	4.70	117.19	14968.74
51.00	91.60	-35.58	74.49	-53.30	8.88	6.35	112.63	19825.15
52.00	78.85	-39.43	60.90	-50.09	9.80	8.06	102.09	24655.30
53.00	63.79	-38.56	49.88	-39.76	12.26	9.77	81.57	29343.21
55.00	75.46	9.45	74.43	12.39	13.07	-2.18	76.49	-6298.48
56.00	158.69	-9.27	156.62	-25.57	6.22	1.02	160.79	2885.96
57.00	152.65	-44.83	108.26	-107.62	4.65	4.62	215.24	12895.09
58.00	122.05	-59.78	61.42	-105.47	4.12	7.08	242.52	19428.28
60.00	86.51	-73.53	24.52	-82.96	3.28	11.08	305.20	29403.65

25 to 45 kHz-B (Broadband)

Transformed to 100 ohms minimum (B1)
Ceramics wired in parallel

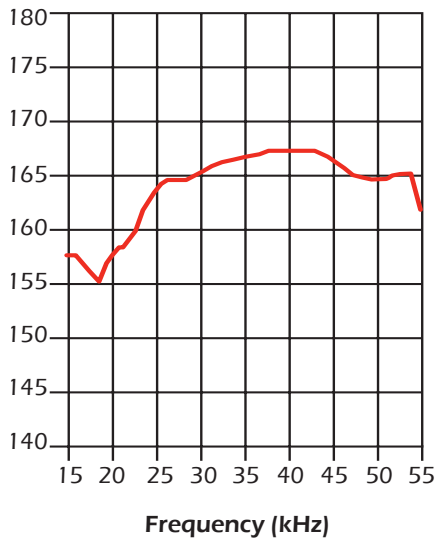
Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 12W in M563

7 x 44.4 mm (1.7") PZT4
Active Area: 140.6 cm²
Radiating Surface: Urethane

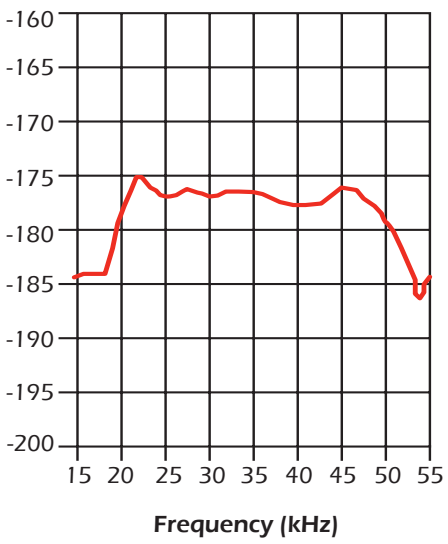
Q ≈ 2
Cable Type: C44-02
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

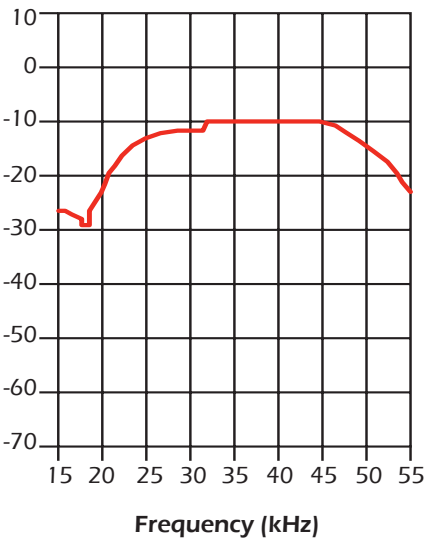
TVR



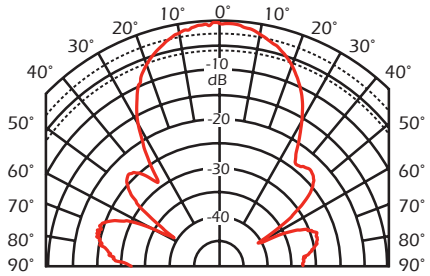
RVR



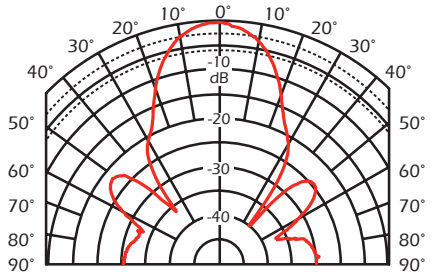
FOM



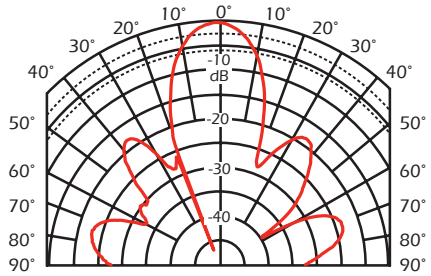
Transmit Radiation Pattern



Beamwidth	@ 25 kHz
-3 dB	24°
-6 dB	35°
-10 dB	45°



Beamwidth	@ 35 kHz
-3 dB	19°
-6 dB	26°
-10 dB	33°



Beamwidth	@ 45 kHz
-3 dB	14°
-6 dB	19°
-10 dB	24°

25 to 45 kHz-B (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
15.00	60.70	88.10	2.02	60.66	0.55	-16.47	1828.23	-174717.25
16.00	69.30	87.79	2.67	69.24	0.56	-14.42	1795.86	-143438.97
17.00	80.23	87.07	4.09	80.12	0.64	-12.45	1571.85	-116540.43
18.00	94.33	85.77	6.96	94.07	0.78	-10.57	1278.60	-93480.89
19.00	114.03	83.00	13.89	113.18	1.07	-8.70	935.80	-72913.30
20.00	142.61	77.40	31.12	139.18	1.53	-6.84	653.62	-54455.16
21.00	179.03	65.84	73.28	163.35	2.29	-5.10	437.41	-38624.78
22.00	202.11	47.29	137.08	148.52	3.36	-3.64	298.00	-26303.12
23.00	189.48	27.16	168.60	86.48	4.70	-2.41	212.96	-16667.73
24.00	151.42	15.73	145.75	41.06	6.36	-1.79	157.32	-11876.27
25.00	122.90	17.00	117.52	35.94	7.78	-2.38	128.51	-15148.02
26.00	115.12	21.20	107.33	41.62	8.10	-3.14	123.47	-19224.98
27.00	120.52	24.01	110.09	49.04	7.58	-3.38	131.94	-19901.32
28.00	131.13	20.71	122.65	46.37	7.13	-2.70	140.18	-15328.66
29.00	128.40	15.46	123.75	34.22	7.51	-2.08	133.22	-11391.71
30.00	123.50	12.33	120.65	26.38	7.91	-1.73	126.42	-9176.01
31.00	121.11	13.37	117.83	28.01	8.03	-1.91	124.49	-9802.42
32.00	122.84	13.16	119.61	27.96	7.93	-1.85	126.15	-9214.81
33.00	125.15	11.35	122.70	24.62	7.83	-1.57	127.64	-7581.86
34.00	127.46	9.87	125.57	21.85	7.73	-1.35	129.37	-6296.08
35.00	129.85	6.61	128.99	14.95	7.65	-0.89	130.72	-4031.61
36.00	127.51	3.71	127.24	8.26	7.83	-0.51	127.78	-2244.76
37.00	123.80	1.83	123.73	3.96	8.07	-0.26	123.86	-1112.31
38.00	119.79	1.02	119.77	2.14	8.35	-0.15	119.81	-624.79
39.00	118.31	1.63	118.26	3.37	8.45	-0.24	118.36	-982.90
40.00	117.98	3.78	117.72	7.78	8.46	-0.56	118.24	-2222.66
41.00	120.99	4.03	120.69	8.51	8.24	-0.58	121.29	-2256.64
42.00	123.81	5.46	123.25	11.79	8.04	-0.77	124.37	-2913.93
43.00	131.25	7.79	130.04	17.79	7.55	-1.03	132.47	-3823.15
44.00	147.09	8.82	145.35	22.55	6.72	-1.04	148.85	-3769.22
45.00	170.89	5.57	170.08	16.58	5.82	-0.57	171.70	-2007.94
46.00	195.05	-1.80	194.96	-6.11	5.12	0.16	195.15	555.98
47.00	201.26	-11.38	197.31	-39.69	4.87	0.98	205.29	3318.47
48.00	200.72	-20.04	188.57	-68.79	4.68	1.71	213.66	5661.59
49.00	194.54	-27.91	171.90	-91.07	4.54	2.41	220.15	7816.63
50.00	183.96	-36.13	148.57	-108.48	4.39	3.21	227.77	10203.26
51.00	163.93	-42.50	120.87	-110.74	4.50	4.12	222.34	12860.21
52.00	138.75	-46.90	94.80	-101.31	4.92	5.26	203.07	16107.68
53.00	109.09	-45.78	76.08	-78.18	6.39	6.57	156.42	19728.44
54.00	79.22	-28.14	69.86	-37.36	11.13	5.95	89.84	17544.01
55.00	127.68	23.09	117.45	50.06	7.21	-3.07	138.79	-8887.22

25 to 50 kHz | 3 kW / 60 W

25 to 50 kHz-A (Broadband)

Ceramics wired in parallel

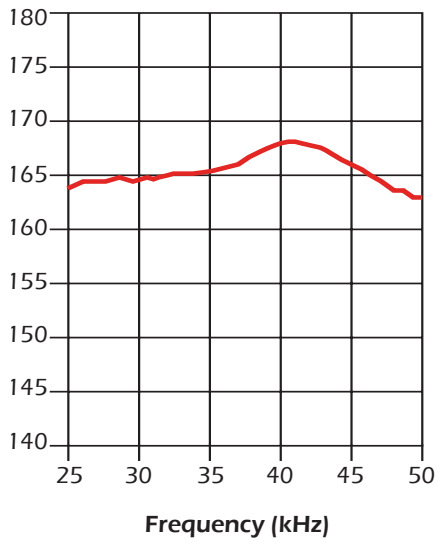
Power Rating:
- 3 kW @ 1% duty cycle
- CW(4): 60W in CM510

15 x 44.4 mm (1.7") PZT4
Active Area: 232.8 cm²
Radiating Surface: Epoxy

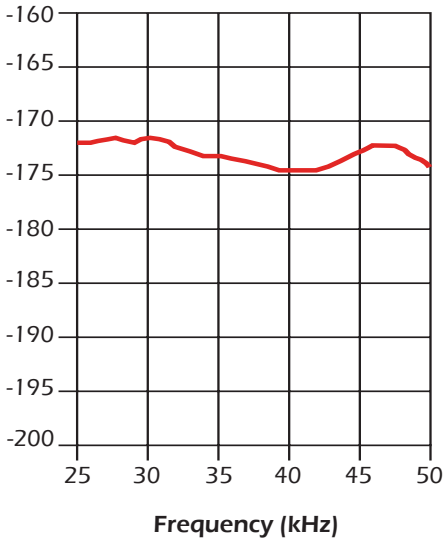
Q ≈ 2
Cable Type: C421
Cable Length: 25 m (82 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

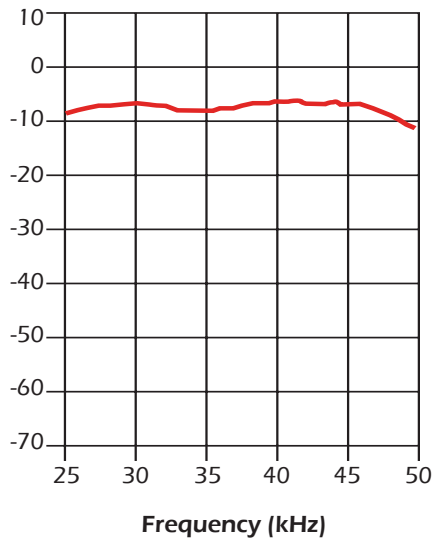
TVR



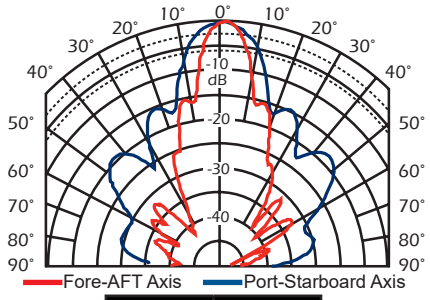
RVR



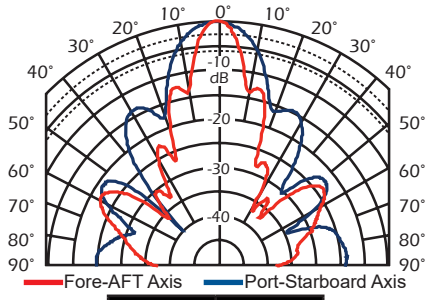
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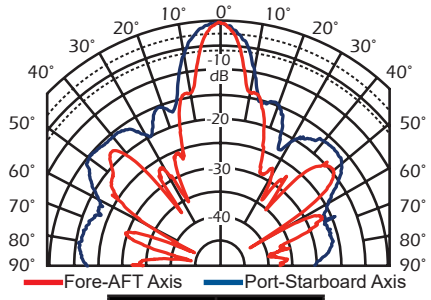
Transmit Radiation Pattern



Beamwidth	@ 28 kHz
-3 dB	10°/17°
-6 dB	13°/22°
-10 dB	16°/29°



Beamwidth	@ 38 kHz
-3 dB	8°/16°
-6 dB	12°/23°
-10 dB	15°/29°



Beamwidth	@ 50 kHz
-3 dB	7°/13°
-6 dB	10°/18°
-10 dB	13°/23°

25 to 50 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
25.00	204.48	8.46	202.26	30.07	4.84	-0.72	206.73	-4577.78
25.50	195.97	10.97	192.39	37.31	5.01	-0.97	199.62	-6063.12
26.00	192.67	17.19	184.06	56.94	4.96	-1.53	201.68	-9390.20
26.50	199.86	22.04	185.25	75.00	4.64	-1.88	215.61	-11276.45
27.00	209.10	18.57	198.22	66.58	4.53	-1.52	220.58	-8975.95
28.00	210.07	16.26	201.67	58.83	4.57	-1.33	218.83	-7577.40
28.50	202.19	17.87	192.44	62.04	4.71	-1.52	212.44	-8473.82
29.00	212.25	15.73	204.31	57.53	4.54	-1.28	220.51	-7008.87
29.50	224.39	14.48	217.26	56.12	4.31	-1.11	231.75	-6013.24
30.50	228.40	11.39	223.90	45.10	4.29	-0.86	232.99	-4511.72
31.00	236.65	6.20	235.27	25.54	4.20	-0.46	238.04	-2341.58
31.50	233.39	2.21	233.21	8.99	4.28	-0.17	233.56	-833.92
32.00	216.19	1.07	216.16	4.03	4.62	-0.09	216.23	-428.71
33.00	208.57	-0.50	208.56	-1.82	4.79	0.04	208.58	201.37
34.00	198.24	0.22	198.24	0.77	5.04	-0.02	198.24	-91.99
34.50	201.02	-0.54	201.01	-1.89	4.97	0.05	201.02	215.73
35.50	203.64	-2.28	203.48	-8.09	4.91	0.20	203.80	874.38
36.00	198.24	-4.95	197.50	-17.10	5.03	0.44	198.98	1923.65
36.50	195.59	-6.10	194.48	-20.79	5.08	0.54	196.70	2370.07
37.00	190.47	-8.08	188.58	-26.77	5.20	0.74	192.38	3174.51
38.00	170.45	-8.92	168.39	-26.43	5.80	0.91	172.54	3810.61
38.50	166.59	-7.45	165.19	-21.61	5.95	0.78	168.01	3218.92
39.00	159.62	-6.58	158.57	-18.29	6.22	0.72	160.68	2929.06
39.50	153.34	-4.54	152.86	-12.14	6.50	0.52	153.82	2080.21
40.50	151.89	1.47	151.84	3.90	6.58	-0.17	151.94	-664.98
41.00	149.94	3.98	149.58	10.41	6.65	-0.46	150.31	-1796.82
41.50	151.76	7.92	150.31	20.92	6.53	-0.91	153.22	-3483.44
42.00	159.42	11.74	156.09	32.43	6.14	-1.28	162.83	-4834.73
43.50	192.63	19.57	181.50	64.53	4.89	-1.74	204.44	-6362.93
44.00	217.59	21.08	203.03	78.25	4.29	-1.65	233.19	-5978.35
44.50	234.40	19.19	221.37	77.06	4.03	-1.40	248.19	-5016.41
45.50	273.66	17.13	261.53	80.58	3.49	-1.08	286.36	-3763.79
46.00	298.70	15.37	288.02	79.16	3.23	-0.89	309.78	-3069.79
46.50	317.74	8.74	314.06	48.26	3.11	-0.48	321.47	-1636.04
47.00	341.20	3.25	340.65	19.33	2.93	-0.17	341.75	-562.38
47.50	368.18	0.74	368.15	4.78	2.72	-0.04	368.21	-118.22
48.00	385.12	-4.19	384.09	-28.15	2.59	0.19	386.15	629.24
48.50	379.52	-11.89	371.38	-78.18	2.58	0.54	387.84	1781.22
49.00	384.40	-17.39	366.84	-114.87	2.48	0.78	402.81	2524.96
49.50	390.08	-21.15	363.81	-140.72	2.39	0.92	418.24	2973.55
50.00	386.45	-28.74	338.86	-185.80	2.27	1.24	440.74	3960.14

28 to 60 kHz-A (Broadband)

Transformed to 100 ohms minimum (B2)
Ceramics wired in parallel

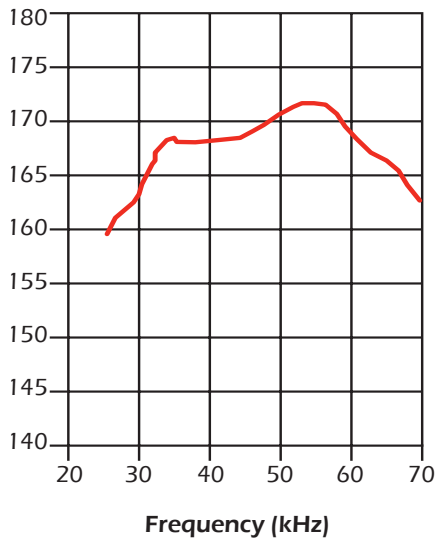
Power Rating:
- 3 kW @ 1% duty cycle
- CW(4): 60W in R509
  40W in CM599, R599

24 x 35.1 mm (1.4 in) PZT
Active Area: 229.9 cm^2 (35.63 in^2)
Radiating Surface: Epoxy

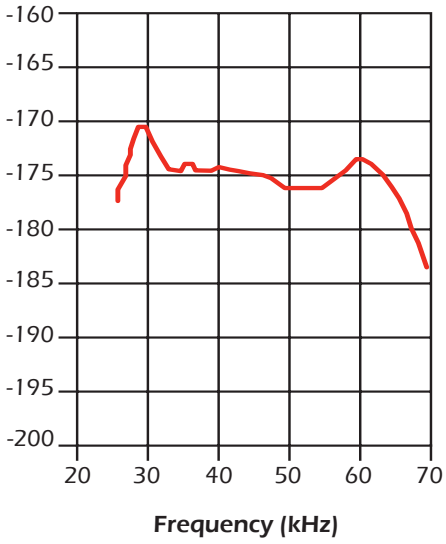
Q ≈ 2
Cable Type: C44
Cable Length: 15 m (50 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

TVR



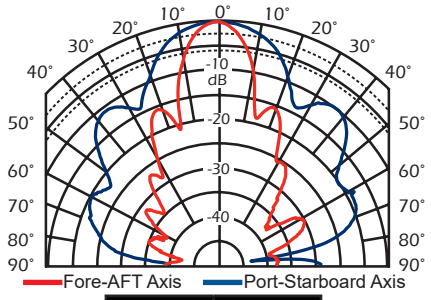
RVR



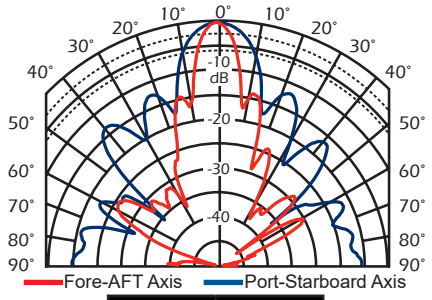
FOM



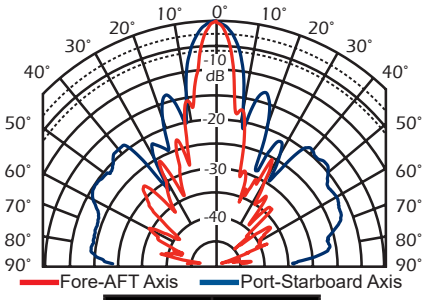
Transmit Radiation Pattern



Beamwidth	@ 28 kHz
-3 dB	11°/23°
-6 dB	15°/31°
-10 dB	20°/39°



Beamwidth	@ 45 kHz
-3 dB	7°/13°
-6 dB	10°/18°
-10 dB	12°/22°



Beamwidth	@ 60 kHz
-3 dB	5°/9°
-6 dB	7°/12°
-10 dB	10°/15°

28 to 60 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
28.00	308.55	41.79	230.06	205.61	2.42	-2.16	413.81	-12276.03
29.00	318.78	20.93	297.74	113.90	2.93	-1.12	341.31	-6150.87
30.00	241.28	0.87	241.25	3.68	4.14	-0.06	241.31	-335.76
31.00	193.73	-7.41	192.12	-24.97	5.12	0.67	195.36	3416.12
32.00	145.29	-8.06	143.85	-20.37	6.82	0.96	146.74	4798.72
33.00	128.57	-0.01	128.57	-0.01	7.78	0.00	128.57	3.43
34.00	120.78	8.12	119.58	17.05	8.20	-1.17	122.01	-5471.06
35.00	135.55	12.11	132.54	28.44	7.21	-1.55	138.64	-7037.17
36.00	133.81	6.89	132.85	16.04	7.42	-0.90	134.78	-3960.88
37.00	133.31	7.74	132.09	17.95	7.43	-1.01	134.53	-4345.42
38.00	134.75	7.40	133.63	17.35	7.36	-0.96	135.88	-4001.46
39.00	142.01	9.12	140.22	22.52	6.95	-1.12	143.84	-4557.01
40.00	150.97	3.48	150.69	9.16	6.61	-0.40	151.25	-1599.99
41.00	149.39	2.52	149.25	6.58	6.69	-0.29	149.54	-1143.87
42.00	150.47	-1.08	150.45	-2.85	6.64	0.13	150.50	476.71
43.00	148.40	-2.06	148.31	-5.34	6.73	0.24	148.50	897.42
44.00	150.01	-6.28	149.11	-16.40	6.63	0.73	150.92	2636.57
45.00	144.71	-8.59	143.08	-21.61	6.83	1.03	146.35	3650.59
46.00	144.44	-11.83	141.37	-29.62	6.78	1.42	147.57	4912.27
47.00	142.31	-14.82	137.58	-36.40	6.79	1.80	147.21	6085.48
48.00	132.05	-18.07	125.54	-40.97	7.20	2.35	138.91	7789.92
49.00	119.22	-17.44	113.74	-35.74	8.00	2.51	124.97	8165.83
50.00	112.06	-15.52	107.98	-29.99	8.60	2.39	116.31	7601.44
51.00	109.67	-11.32	107.53	-21.53	8.94	1.79	111.84	5586.70
52.00	108.55	-9.99	106.90	-18.82	9.07	1.60	110.22	4889.39
53.00	109.23	-7.10	108.39	-13.50	9.08	1.13	110.07	3397.43
54.00	108.61	-3.96	108.35	-7.50	9.19	0.64	108.87	1872.96
55.00	113.56	2.37	113.46	4.69	8.80	-0.36	113.66	-1053.14
56.00	125.63	6.09	124.92	13.33	7.92	-0.84	126.34	-2399.70
57.00	136.85	9.33	135.04	22.18	7.21	-1.18	138.68	-3306.52
58.00	162.06	10.90	159.14	30.65	6.06	-1.17	165.04	-3202.70
59.00	190.57	7.57	188.91	25.09	5.20	-0.69	192.24	-1863.70
60.00	220.91	1.96	220.79	7.54	4.52	-0.15	221.04	-409.63

30 to 60 kHz-A (Broadband)

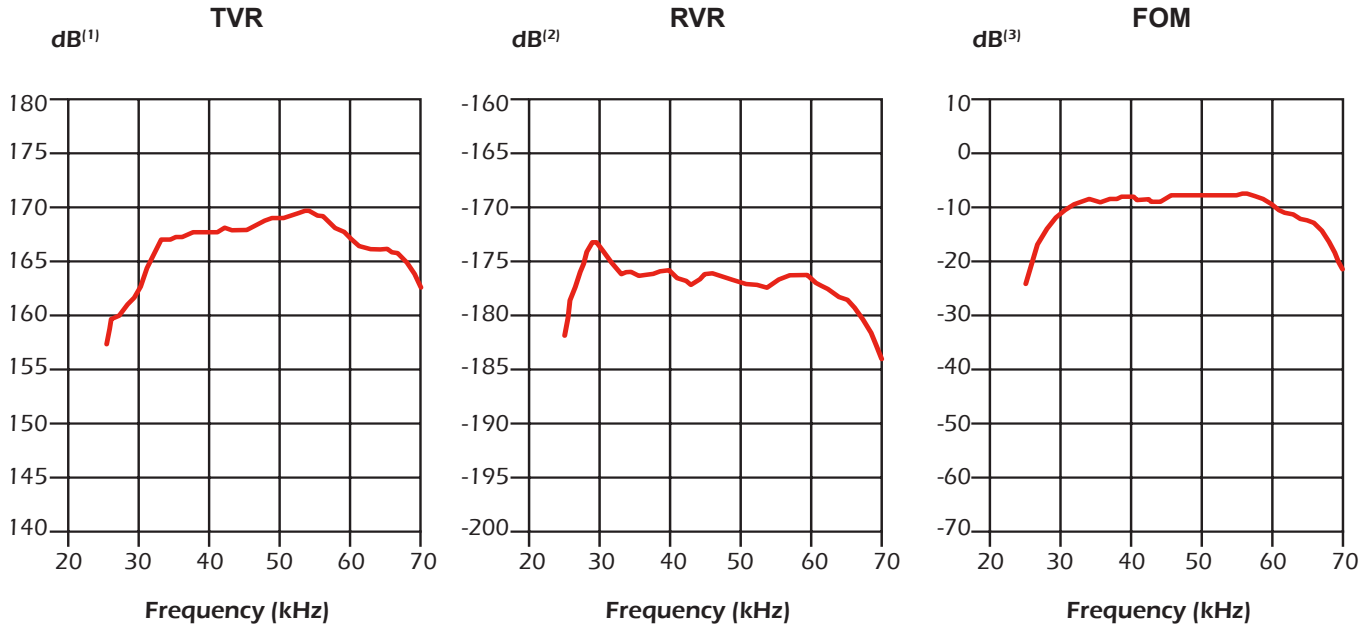
Transformed to 125 ohms minimum (B1)

Power Rating:
- 2 kW @ 2% duty cycle
- CW(2): 65W IN M188

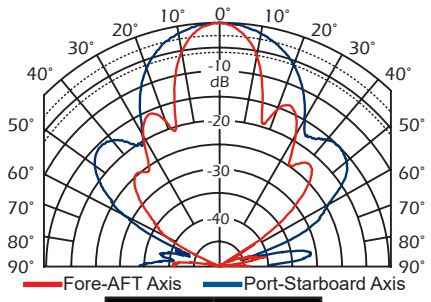
15 x 35 mm (1.38”) PZT
Active Area: 143.7 cm² (22.37 in²)
Radiating Surface: Urethane

Q ≈ 2
Cable Type: C44-02
Cable Length: 15 m (50 ft)

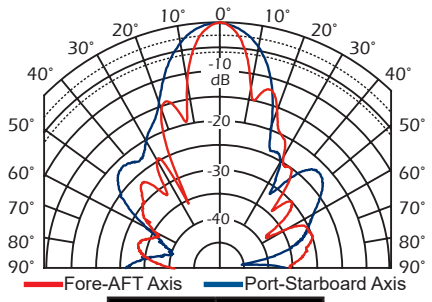
Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.



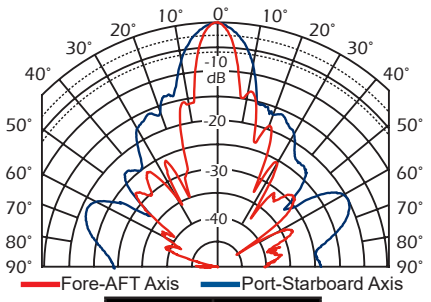
Transmit Radiation Pattern



Beamwidth	@ 30 kHz
-3 dB	13°/25°
-6 dB	18°/35°
-10 dB	23°/44°



Beamwidth	@ 45 kHz
-3 dB	10°/18°
-6 dB	14°/25°
-10 dB	18°/32°



Beamwidth	@ 60 kHz
-3 dB	7°/12°
-6 dB	10°/18°
-10 dB	13°/23°

30 to 60 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value)

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
30.00	231.03	10.20	227.37	40.93	4.26	-0.77	234.74	-4068.40
32.00	139.16	-0.28	139.16	-0.68	7.19	0.04	139.17	175.23
33.00	117.30	6.75	116.49	13.78	8.47	-1.00	118.12	-4830.57
34.00	121.68	9.89	119.87	20.91	8.10	-1.41	123.52	-6609.90
35.00	118.09	10.08	116.27	20.66	8.34	-1.48	119.94	-6736.76
36.00	119.27	12.48	116.45	25.78	8.19	-1.81	122.16	-8010.61
37.00	124.29	11.75	121.68	25.31	7.88	-1.64	126.95	-7049.02
38.00	124.46	11.60	121.92	25.02	7.87	-1.61	127.06	-6763.63
39.00	129.85	10.59	127.64	23.87	7.57	-1.42	132.11	-5776.81
40.00	133.11	6.41	132.28	14.85	7.47	-0.84	133.94	-3335.44
41.00	127.72	2.30	127.62	5.12	7.82	-0.31	127.82	-1218.05
42.00	119.60	2.25	119.51	4.69	8.35	-0.33	119.69	-1242.46
43.00	119.54	6.71	118.72	13.98	8.31	-0.98	120.37	-3620.16
44.00	131.06	7.85	129.83	17.90	7.56	-1.04	132.30	-3770.19
45.00	142.25	3.65	141.96	9.05	7.02	-0.45	142.54	-1581.17
46.00	141.49	-3.02	141.29	-7.45	7.06	0.37	141.68	1286.95
47.00	134.63	-5.54	134.00	-12.99	7.39	0.72	135.26	2427.70
48.00	130.06	-6.90	129.12	-15.62	7.63	0.92	131.01	3062.26
49.00	126.39	-8.53	124.99	-18.76	7.82	1.17	127.81	3813.49
50.00	124.42	-8.00	123.21	-17.32	7.96	1.12	125.64	3560.88
51.00	123.33	-7.16	122.37	-15.38	8.04	1.01	124.30	3155.55
52.00	121.18	-7.36	120.18	-15.52	8.18	1.06	122.18	3235.53
53.00	120.12	-4.07	119.81	-8.52	8.30	0.59	120.42	1773.34
54.00	124.34	-2.98	124.17	-6.47	8.03	0.42	124.51	1233.12
55.00	133.62	-1.52	133.58	-3.54	7.48	0.20	133.67	574.22
56.00	145.00	0.44	145.00	1.12	6.90	-0.05	145.00	-151.27
57.00	163.49	-2.87	163.28	-8.18	6.11	0.31	163.69	854.94
58.00	176.17	-6.72	174.96	-20.61	5.64	0.66	177.39	1821.81
59.00	187.86	-10.89	184.48	-35.50	5.23	1.01	191.31	2713.33
60.00	198.99	-17.62	189.65	-60.23	4.79	1.52	208.78	4035.03
61.00	201.76	-24.56	183.51	-83.85	4.51	2.06	221.82	5374.07
62.00	201.51	-30.19	174.18	-101.33	4.29	2.50	233.13	6405.40
63.00	202.79	-36.94	162.07	-121.88	3.94	2.96	253.73	7487.57
64.00	191.45	-42.11	142.02	-128.39	3.87	3.50	258.09	8710.53
65.00	185.87	-46.32	128.36	-134.43	3.72	3.89	269.15	9527.27
66.00	182.57	-49.62	118.28	-139.08	3.55	4.17	281.83	10061.71
67.00	174.71	-52.76	105.72	-139.09	3.46	4.56	288.72	10824.60
68.00	171.83	-55.78	96.63	-142.08	3.27	4.81	305.54	11263.38
70.00	164.10	-63.93	72.12	-147.41	2.68	5.47	373.41	12445.30

33 to 60 kHz-A (Broadband)

Ceramics wired in parallel

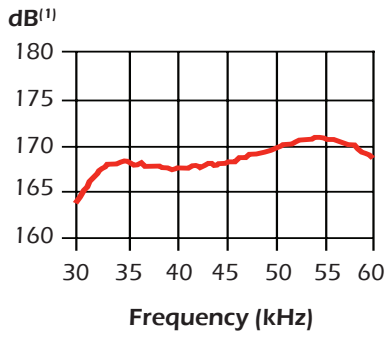
Power Rating:
- 3 kW @ 2% duty cycle

24 x 35.1 mm (1.4”) PZT4
Active Area: 60.8 cm²
Radiating Surface: Epoxy

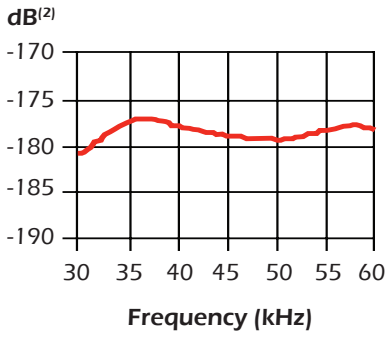
Cable Type: C44
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

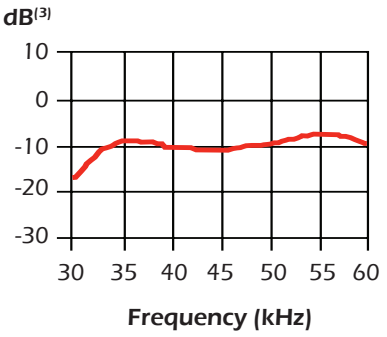
TVR



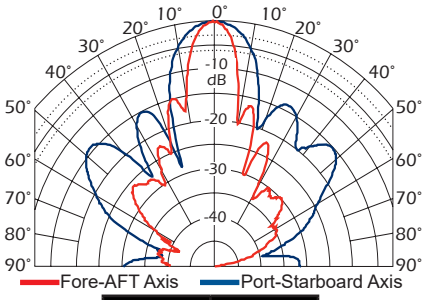
RVR



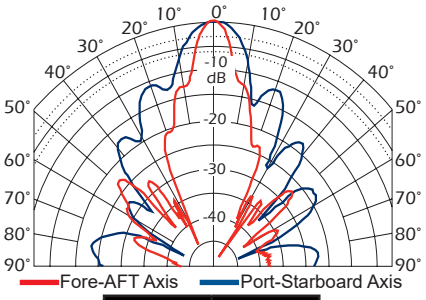
FOM



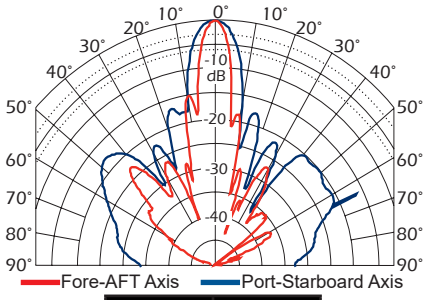
Transmit Radiation Pattern



Beamwidth	@ 38 kHz
-3 dB	7°/13°
-6 dB	10°/18°
-10 dB	12°/22°



Beamwidth	@ 50 kHz
-3 dB	9°/16°
-6 dB	12°/22°
-10 dB	15°/27°



Beamwidth	@ 60 kHz
-3 dB	6°/10°
-6 dB	8°/13°
-10 dB	10°/17°

33 to 60 kHz-A (Broadband)

Note: Impedance data includes cable

Impedance Data	
1 kHz capacitance: 48,675 pF: ±20%	Impedance @ 38 kHz = 115 ohms: -20%, +40%
Impedance Range: 120 to 190 ohms: -20%, +40%	Impedance @ 50 kHz = 130 ohms: -20%, +40%

Balanced Impedance Table (Nominal Value)

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
33.00	78.67	-56.74	43.15	-65.78	6.9717	10.6282	143.44	51258.38
34.00	82.48	-52.46	50.26	-65.40	7.3878	9.6132	135.36	44999.67
35.00	87.96	-47.23	59.73	-64.57	7.7197	8.3452	129.54	37947.94
36.00	99.09	-47.40	67.07	-72.94	6.8310	7.4290	146.39	32843.25
37.00	102.46	-50.44	65.26	-78.99	6.2163	7.5243	160.87	32365.53
38.00	104.75	-50.60	66.48	-80.95	6.0586	7.3771	165.05	30897.28
39.00	106.12	-51.93	65.44	-83.54	5.8107	7.4183	172.10	30273.32
40.00	106.38	-54.62	61.59	-86.74	5.4424	7.6648	183.74	30497.13
41.00	104.04	-55.87	58.38	-86.12	5.3930	7.9558	185.43	30883.08
42.00	102.37	-56.18	56.98	-85.04	5.4376	8.1153	183.90	30752.04
43.00	100.80	-55.93	56.46	-83.50	5.5573	8.2184	179.94	30418.40
44.00	99.68	-57.40	53.70	-83.97	5.4052	8.4516	185.01	30570.88
45.00	97.78	-56.49	53.98	-81.53	5.6454	8.5272	177.13	30158.72
46.00	96.60	-56.24	53.69	-80.31	5.7532	8.6055	173.82	29774.07
47.00	93.82	-56.61	51.63	-78.34	5.8651	8.8996	170.50	30136.64
48.00	91.07	-56.15	50.73	-75.64	6.1160	9.1193	163.51	30237.10
49.00	89.85	-55.08	51.44	-73.67	6.3712	9.1254	156.96	29639.92
50.00	87.73	-53.72	51.91	-70.73	6.7445	9.1885	148.27	29248.01
51.00	86.06	-51.46	53.61	-67.32	7.2391	9.0894	138.14	28365.23
52.00	85.23	-48.72	56.23	-64.05	7.7404	8.8172	129.19	26986.63
53.00	86.85	-45.40	60.98	-61.83	8.0855	8.1984	123.68	24619.11
54.00	91.07	-43.12	66.47	-62.25	8.0145	7.5057	124.77	22121.70
55.00	94.83	-40.81	71.78	-61.98	7.9810	6.8916	125.30	19942.46
56.00	101.20	-39.28	78.33	-64.08	7.6483	6.2564	130.75	17720.92
57.00	109.99	-38.58	85.98	-68.59	7.1076	5.6697	140.69	15830.89
58.00	120.98	-40.70	91.71	-78.89	6.2665	5.3905	159.58	14791.89
59.00	128.98	-43.84	93.04	-89.33	5.5925	5.3697	178.81	14484.95
60.00	136.62	-48.96	89.70	-103.05	4.8059	5.5210	208.08	14644.90

33 to 60 kHz-Blq (Broadband)

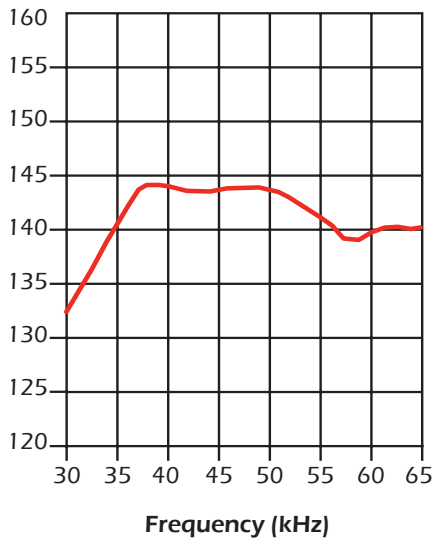
Power Rating:
- 150 W @ 1% duty cycle

35 mm (1.38 in) PZT
Active Area: 9.6 cm^2 (1.5 in^2)
Radiating Surface: HPC/Urethane

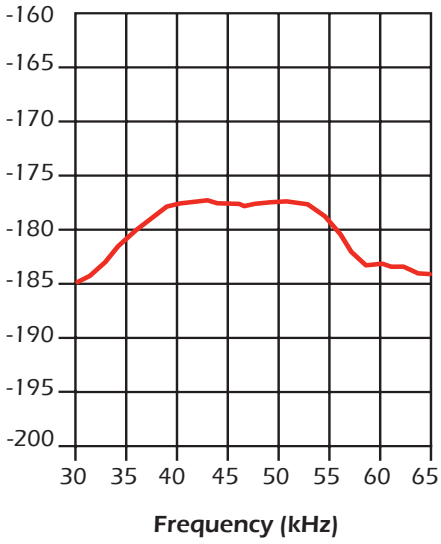
Q ≈ 2
Cable Type: C189-02
Cable Length: 4.9 m (16 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response

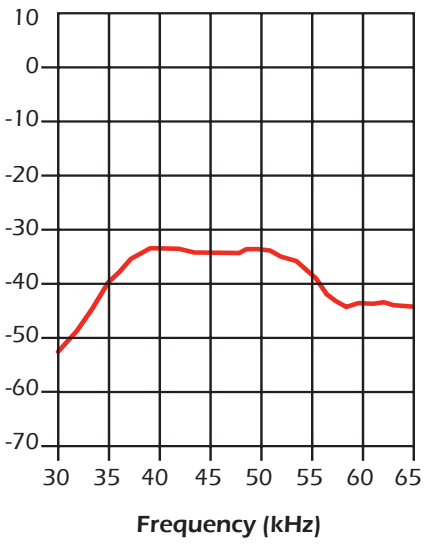
TVR



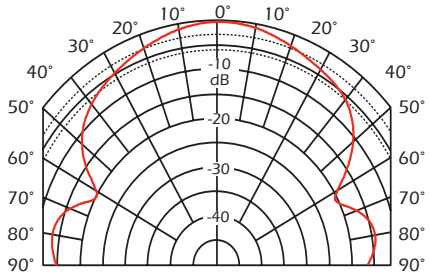
RVR



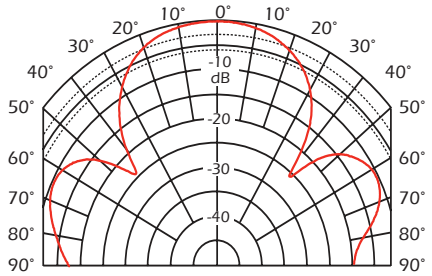
FOM



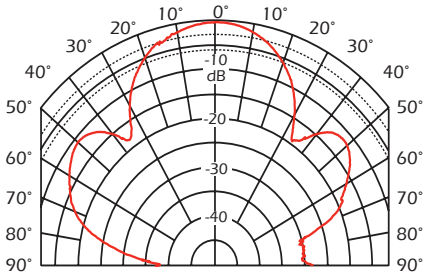
Transmit Radiation Pattern



Beamwidth	@ 35 kHz
-3 dB	46°
-6 dB	76°
-10 dB	96°



Beamwidth	@ 50 kHz
-3 dB	40°
-6 dB	53°
-10 dB	63°



Beamwidth	@ 60 kHz
-3 dB	30°
-6 dB	42°
-10 dB	53°

33 to 60 kHz-Blq (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
30.00	2172.90	-82.18	295.66	-2152.69	0.06	0.46	15969.59	2418.81
31.00	2009.08	-80.94	316.34	-1984.02	0.08	0.49	12759.86	2523.54
32.00	1850.27	-78.74	361.44	-1814.62	0.11	0.53	9471.79	2636.25
33.00	1707.99	-75.47	428.39	-1653.39	0.15	0.57	6809.69	2733.45
34.00	1597.95	-70.97	521.09	-1510.60	0.20	0.59	4900.22	2769.26
35.00	1519.04	-65.82	622.19	-1385.77	0.27	0.60	3708.67	2730.90
36.00	1472.70	-59.93	737.82	-1274.55	0.34	0.59	2939.53	2598.03
37.00	1451.51	-53.58	861.83	-1167.96	0.41	0.55	2444.67	2384.55
38.00	1495.65	-46.31	1033.14	-1081.48	0.46	0.48	2165.21	2024.85
39.00	1631.90	-40.54	1240.09	-1060.79	0.47	0.40	2147.50	1625.54
40.00	1801.68	-38.39	1412.07	-1118.98	0.44	0.34	2298.79	1371.60
41.00	1946.96	-38.45	1524.78	-1210.66	0.40	0.32	2486.04	1239.78
42.00	2059.82	-39.70	1584.79	-1315.79	0.37	0.31	2677.24	1175.17
43.00	2123.81	-41.00	1602.85	-1393.35	0.36	0.31	2814.09	1143.36
44.00	2146.33	-42.01	1594.81	-1436.42	0.35	0.31	2888.58	1127.86
45.00	2147.63	-41.97	1596.75	-1436.21	0.35	0.31	2888.56	1101.30
46.00	2150.65	-41.47	1611.43	-1424.29	0.35	0.31	2870.31	1065.42
47.00	2175.15	-40.20	1661.34	-1404.00	0.35	0.30	2847.86	1004.87
48.00	2242.04	-38.21	1761.73	-1386.74	0.35	0.28	2853.29	914.72
49.00	2349.64	-36.69	1884.16	-1403.84	0.34	0.25	2930.12	825.92
50.00	2507.31	-36.14	2024.84	-1478.72	0.32	0.24	3104.73	748.72
51.00	2681.53	-36.91	2144.13	-1610.38	0.30	0.22	3353.63	698.90
52.00	2875.50	-37.92	2268.47	-1767.08	0.27	0.21	3644.98	654.10
53.00	3108.60	-40.62	2359.55	-2023.83	0.24	0.21	4095.43	628.91
54.00	3328.24	-44.84	2359.94	-2346.88	0.21	0.21	4693.83	624.44
55.00	3460.65	-50.91	2182.08	-2686.01	0.18	0.22	5488.39	649.01
56.00	3440.98	-57.77	1835.39	-2910.61	0.16	0.25	6451.11	698.64
57.00	3282.41	-63.38	1470.94	-2934.37	0.14	0.27	7324.70	760.46
58.00	3087.70	-66.80	1216.15	-2838.11	0.13	0.30	7839.43	816.87
59.00	2908.90	-68.80	1052.10	-2711.97	0.12	0.32	8042.67	864.56
60.00	2762.15	-69.55	965.09	-2588.06	0.13	0.34	7905.45	899.81
61.00	2659.38	-69.68	923.62	-2493.84	0.13	0.35	7657.18	920.02
62.00	2602.20	-69.57	908.38	-2438.50	0.13	0.36	7454.40	924.42
63.00	2578.90	-69.87	887.64	-2421.33	0.13	0.36	7492.58	919.74
64.00	2574.86	-70.75	848.96	-2430.88	0.13	0.37	7809.46	911.79
65.00	2545.33	-72.27	775.18	-2424.42	0.12	0.37	8357.72	916.28

35 to 65 kHz-A (Broadband)

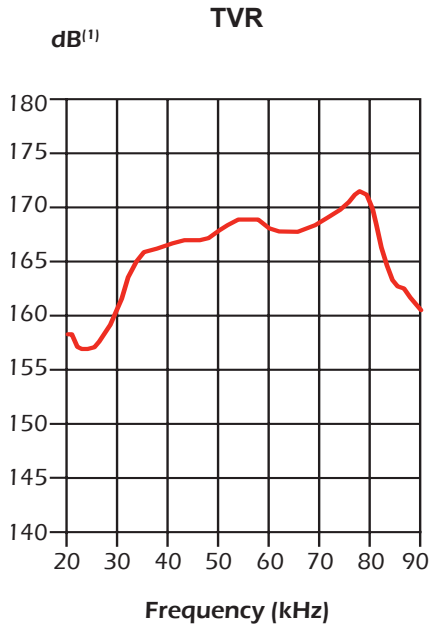
Transformed to 100 ohms minimum

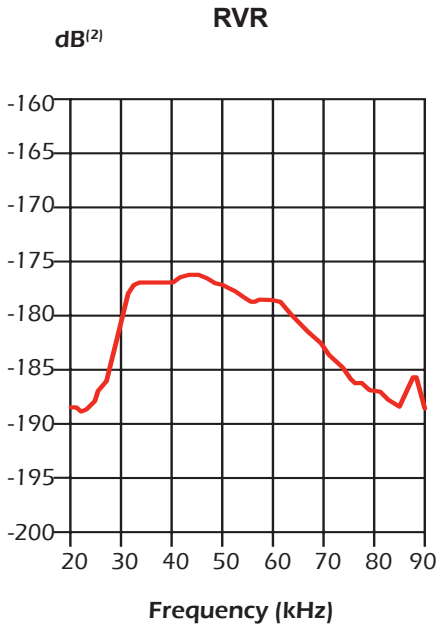
Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 12W in CM365

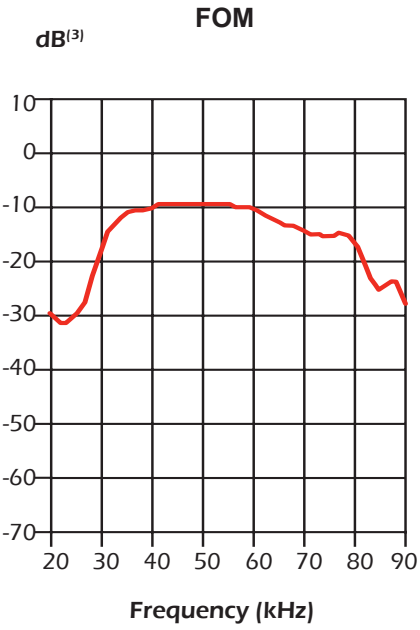
10 x 35 mm (1.38 in) PZT
Active Area: 96.2 cm² (14.95 in²)
Radiating Surface: Urethane

Q ≈ 2.6
Cable Type: C332/C338
Cable Length: 15 m (50 ft)

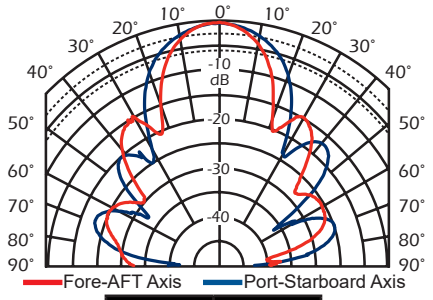
Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.



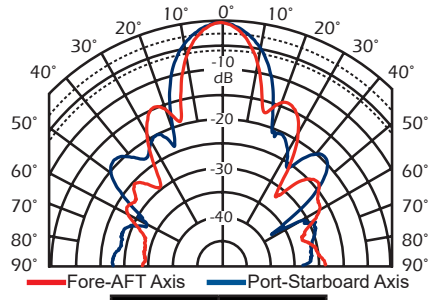




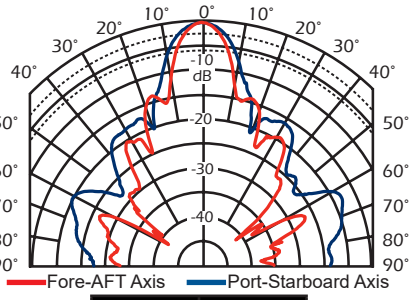
Transmit Radiation Pattern



Beamwidth	@ 35 kHz
-3 dB	17°/22°
-6 dB	24°/31°
-10 dB	30°/39°



Beamwidth	@ 50 kHz
-3 dB	12°/15°
-6 dB	16°/21°
-10 dB	21°/27°



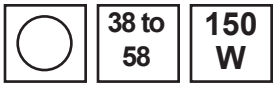
Beamwidth	@ 65 kHz
-3 dB	9°/12°
-6 dB	13°/17°
-10 dB	17°/22°

35 to 65 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
20.00	45.14	86.94	2.41	45.07	1.18	-22.12	846.17	-176044.03
22.00	53.53	86.73	3.05	53.45	1.07	-18.65	938.54	-134914.71
24.00	64.46	86.13	4.35	64.32	1.05	-15.48	956.08	-102639.47
26.00	79.65	84.17	8.09	79.24	1.28	-12.49	784.33	-76456.21
28.00	101.12	79.05	19.20	99.28	1.88	-9.71	532.58	-55187.82
30.00	128.97	67.44	49.49	119.10	2.98	-7.16	336.10	-37986.54
32.00	139.69	50.23	89.35	107.38	4.58	-5.50	218.39	-27367.51
34.00	127.25	39.07	98.79	80.21	6.10	-4.95	163.92	-23186.96
36.00	122.58	36.32	98.77	72.60	6.57	-4.83	152.14	-21360.34
38.00	123.77	32.36	104.55	66.26	6.82	-4.32	146.54	-18113.75
40.00	129.98	31.32	111.04	67.56	6.57	-4.00	152.14	-15911.67
42.00	139.36	26.19	125.05	61.51	6.44	-3.17	155.31	-12001.53
44.00	147.10	20.97	137.36	52.65	6.35	-2.43	157.54	-8800.31
46.00	157.17	12.71	153.32	34.58	6.21	-1.40	161.12	-4843.35
48.00	151.69	2.27	151.57	6.01	6.59	-0.26	151.81	-866.01
50.00	138.87	-3.62	138.60	-8.76	7.19	0.45	139.15	1445.49
52.00	132.57	-7.62	131.40	-17.57	7.48	1.00	133.75	3059.41
54.00	120.22	-9.37	118.61	-19.58	8.21	1.35	121.84	3993.18
56.00	118.08	-5.74	117.49	-11.80	8.43	0.85	118.67	2406.33
58.00	131.08	-6.93	130.12	-15.81	7.57	0.92	132.04	2524.41
60.00	140.87	-11.87	137.85	-28.99	6.95	1.46	143.95	3874.52
62.00	145.03	-21.28	135.14	-52.63	6.43	2.50	155.64	6423.56
64.00	137.89	-29.92	119.52	-68.77	6.29	3.62	159.09	8994.72
66.00	127.75	-37.40	101.48	-77.60	6.22	4.76	160.81	11466.45
68.00	115.45	-42.91	84.55	-78.61	6.34	5.90	157.64	13803.70
70.00	101.73	-48.79	67.02	-76.54	6.48	7.40	154.43	16814.77
72.00	84.18	-51.57	52.32	-65.95	7.38	9.31	135.44	20570.24
74.00	68.90	-49.94	44.34	-52.73	9.34	11.11	107.05	23890.92
76.00	56.32	-42.44	41.57	-38.01	13.10	11.98	76.32	25090.37
78.00	49.96	-27.69	44.23	-23.22	17.72	9.30	56.42	18982.95
80.00	53.96	-7.13	53.54	-6.70	18.39	2.30	54.38	4575.17
82.00	77.45	3.60	77.30	4.87	12.89	-0.81	77.60	-1574.74
84.00	106.75	-0.87	106.74	-1.61	9.37	0.14	106.77	267.95
86.00	137.12	-6.35	136.27	-15.17	7.25	0.81	137.96	1493.31
88.00	214.27	-22.95	197.32	-83.54	4.30	1.82	232.68	3290.55
90.00	189.72	-68.63	69.13	-176.67	1.92	4.91	520.64	8680.41



38 to 58 kHz-A (Broadband)

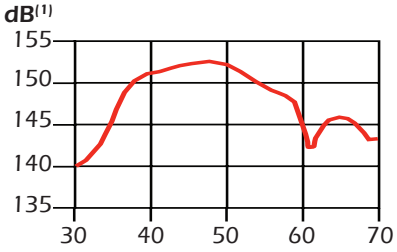
Power Rating:
- 150 W @ 2% duty cycle

35.05 mm (1.38”) PZT4-L
Active Area: 11 cm^2
Radiating Surface: Epoxy/Urethane

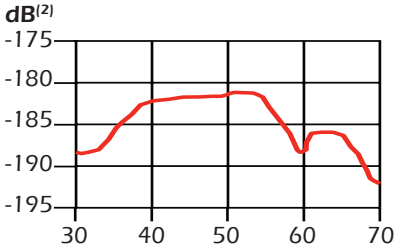
Cable Type: Custom
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

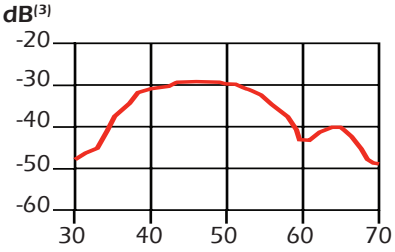
TVR



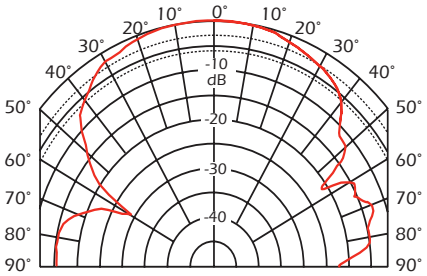
RVR



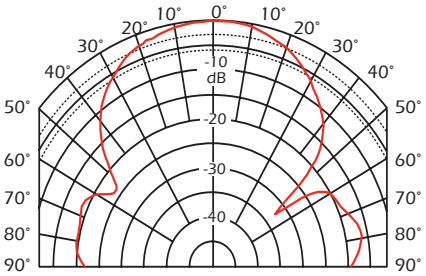
FOM



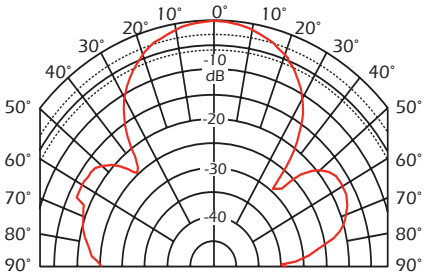
Transmit Radiation Pattern



Beamwidth	@ 40 kHz
-3 dB	46°
-6 dB	69°
-10 dB	82°



Beamwidth	@ 44 kHz
-3 dB	37°
-6 dB	59°
-10 dB	74°



Beamwidth	@ 50 kHz
-3 dB	33°
-6 dB	46°
-10 dB	57°

38 to 58 kHz-A (Broadband)

Note: Impedance data includes cable

1 kHz capacitance: 7400 pF: ±20%
Parallel Resistance @ 48 kHz = 592 Ω: -20%, +40%

Unbalanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
30.00	576.03	-82.72	73.01	-571.38	0.22	1.72	4544.80	9135.63
31.00	543.52	-81.69	78.55	-537.82	0.27	1.82	3760.95	9346.71
32.00	510.73	-80.43	84.87	-503.62	0.33	1.93	3073.35	9602.89
33.00	478.64	-78.75	93.42	-469.44	0.41	2.05	2452.42	9882.44
34.00	447.28	-76.32	105.76	-434.60	0.53	2.17	1891.63	10168.75
35.00	419.84	-72.84	123.84	-401.16	0.70	2.28	1423.27	10349.12
36.00	399.01	-68.39	146.98	-370.96	0.92	2.33	1083.25	10300.70
37.00	388.86	-62.91	177.06	-346.21	1.17	2.29	854.00	9848.64
38.00	393.06	-57.62	210.48	-331.96	1.36	2.15	734.03	8999.15
39.00	410.97	-53.72	243.21	-331.29	1.44	1.96	694.47	8004.41
40.00	427.59	-52.15	262.34	-337.65	1.43	1.85	696.92	7348.10
41.00	438.05	-51.69	271.57	-343.71	1.42	1.79	706.59	6953.14
42.00	437.36	-51.37	273.02	-341.67	1.43	1.79	700.61	6768.80
43.00	434.43	-49.74	280.77	-331.51	1.49	1.76	672.18	6501.30
44.00	432.60	-47.69	291.22	-319.90	1.56	1.71	642.62	6182.98
45.00	436.43	-45.44	306.22	-310.96	1.61	1.63	621.99	5774.19
46.00	443.21	-43.30	322.55	-303.97	1.64	1.55	609.01	5353.86
47.00	452.66	-40.92	342.02	-296.52	1.67	1.45	599.09	4900.38
48.00	463.45	-38.44	363.03	-288.10	1.69	1.34	591.66	4447.39
49.00	484.26	-35.25	395.45	-279.51	1.69	1.19	593.01	3871.43
50.00	523.64	-32.84	439.97	-283.95	1.60	1.04	623.22	3296.22
51.00	580.27	-32.29	490.53	-310.00	1.46	0.92	686.43	2873.07
52.00	646.35	-34.49	532.75	-365.98	1.28	0.88	784.16	2681.28
53.00	697.12	-39.33	539.27	-441.78	1.11	0.91	901.18	2729.82
54.00	714.07	-45.22	502.96	-506.88	0.99	0.99	1013.79	2929.90
55.00	694.49	-50.52	441.56	-536.04	0.92	1.11	1092.29	3216.06
56.00	653.83	-53.96	384.68	-528.69	0.90	1.24	1111.29	3514.85
57.00	603.33	-54.72	348.48	-492.51	0.96	1.35	1044.55	3777.95
58.00	545.72	-52.45	332.62	-432.64	1.12	1.45	895.36	3986.34
59.00	492.64	-41.72	367.73	-327.82	1.52	1.35	659.97	3643.73
60.00	664.89	-16.24	638.35	-185.97	1.44	0.42	692.53	1115.88
61.00	1183.83	-44.10	850.07	-823.91	0.61	0.59	1648.63	1533.89
62.00	971.95	-62.28	452.10	-860.40	0.48	0.91	2089.54	2337.98
63.00	865.73	-66.90	339.66	-796.31	0.45	1.06	2206.58	2684.13
64.00	814.86	-69.74	282.12	-764.46	0.42	1.15	2353.59	2863.07
65.00	777.25	-72.59	232.57	-741.63	0.39	1.23	2597.49	3005.94

38 to 75 kHz-A (Broadband)

Transformed to 100 ohms minimum (B1)

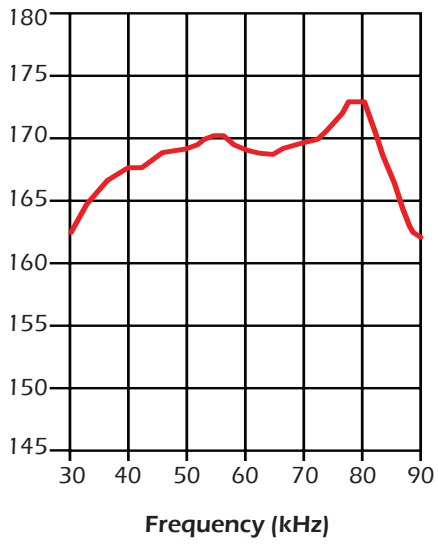
Power Rating:
- 2 kW @ 1% duty cycle
- CW(4): 30W in CM199, PM111, R109
  25W in R111

15 x 35 mm (1.38 in) PZT
Active Area: 144.6 cm^2 (22.4 in^2)
Radiating Surface: Urethane

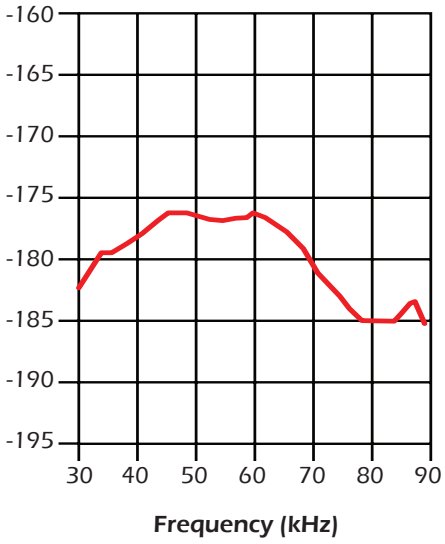
Q ≈ 2.5
Cable Type: C44
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

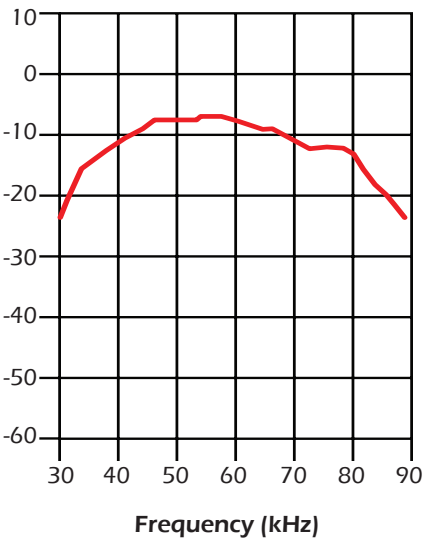
TVR



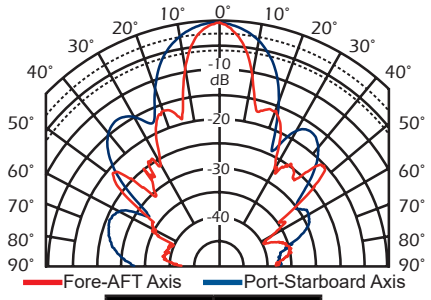
RVR



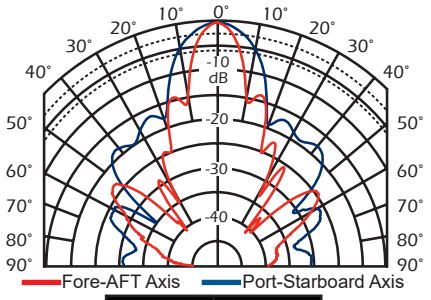
FOM



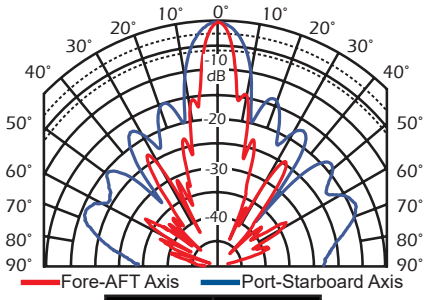
Transmit Radiation Pattern



Beamwidth	@ 38 kHz
-3 dB	10°/19°
-6 dB	14°/27°
-10 dB	18°/32°



Beamwidth	@ 50 kHz
-3 dB	8°/14°
-6 dB	12°/20°
-10 dB	15°/26°



Beamwidth	@ 75 kHz
-3 dB	5°/10°
-6 dB	7°/14°
-10 dB	9°/18°

38 to 75 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
30.00	73.63	79.09	13.94	72.30	2.57	-13.34	388.89	-70751.87
32.00	83.84	71.66	26.38	79.59	3.75	-11.32	266.51	-56308.40
33.00	86.52	66.26	34.83	79.20	4.65	-10.58	214.93	-51027.89
34.00	87.92	64.05	38.48	79.06	4.98	-10.23	200.91	-47870.63
35.00	87.72	60.49	43.21	76.34	5.62	-9.92	178.09	-45112.33
37.00	91.45	56.84	50.02	76.56	5.98	-9.15	167.20	-39379.39
38.00	93.70	56.32	51.96	77.97	5.92	-8.88	168.96	-37195.20
39.00	95.09	55.19	54.27	78.07	6.00	-8.64	166.59	-35239.96
40.00	100.06	55.99	55.97	82.95	5.59	-8.28	178.90	-32961.94
42.00	111.74	52.29	68.34	88.40	5.47	-7.08	182.69	-26829.75
43.00	115.80	48.05	77.41	86.13	5.77	-6.42	173.24	-23771.53
44.00	120.86	45.22	85.13	85.78	5.83	-5.87	171.57	-21244.19
45.00	121.59	40.54	92.40	79.04	6.25	-5.35	160.01	-18906.98
47.00	125.64	34.58	103.45	71.30	6.55	-4.52	152.59	-15295.70
48.00	127.75	32.83	107.34	69.26	6.58	-4.24	152.03	-14071.62
49.00	126.59	29.64	110.03	62.60	6.87	-3.91	145.65	-12689.05
50.00	129.39	27.71	114.55	60.18	6.84	-3.59	146.16	-11440.62
52.00	125.13	22.81	115.35	48.51	7.37	-3.10	135.75	-9481.56
53.00	121.69	20.84	113.74	43.29	7.68	-2.92	130.21	-8777.16
54.00	120.95	21.36	112.64	44.05	7.70	-3.01	129.87	-8875.86
55.00	119.93	21.17	111.84	43.30	7.78	-3.01	128.61	-8711.94
57.00	131.50	21.90	122.01	49.04	7.06	-2.84	141.72	-7919.07
58.00	140.42	20.79	131.28	49.84	6.66	-2.53	150.20	-6935.86
59.00	147.88	17.71	140.87	44.98	6.44	-2.06	155.23	-5548.44
60.00	156.98	14.36	152.07	38.94	6.17	-1.58	162.04	-4191.94
62.00	168.17	4.78	167.59	14.03	5.93	-0.50	168.76	-1273.03
63.00	168.00	-1.26	167.96	-3.69	5.95	0.13	168.04	330.64
64.00	166.64	-6.26	165.65	-18.18	5.97	0.65	167.64	1627.73
65.00	163.04	-11.77	159.61	-33.26	6.00	1.25	166.55	3063.86
67.00	153.01	-21.93	141.93	-57.16	6.06	2.44	164.95	5799.39
68.00	145.19	-26.24	130.23	-64.21	6.18	3.05	161.88	7128.34
69.00	135.53	-30.73	116.50	-69.25	6.34	3.77	157.66	8696.56
70.00	125.37	-34.40	103.44	-70.83	6.58	4.51	151.95	10246.24
72.00	104.21	-39.11	80.87	-65.73	7.45	6.05	134.30	13379.47
73.00	94.65	-40.41	72.07	-61.36	8.04	6.85	124.32	14932.33
74.00	85.81	-40.46	65.29	-55.68	8.87	7.56	112.77	16263.93
75.00	77.42	-39.96	59.34	-49.72	9.90	8.30	101.00	17602.69
77.00	62.05	-35.05	50.80	-35.64	13.19	9.26	75.80	19130.99
78.00	56.05	-29.11	48.97	-27.27	15.59	8.68	64.15	17709.11
79.00	52.08	-20.92	48.64	-18.59	17.94	6.86	55.75	13812.91
80.00	51.11	-10.83	50.20	-9.60	19.22	3.68	52.03	7312.83

40 to 60 kHz-A (Broadband)

Transformed to 100 ohms minimum (B2)

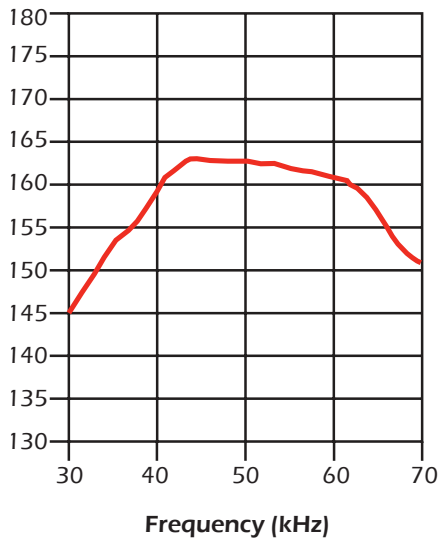
Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 15W in B175

7 x 20.3 mm (0.80”) PZT4
Active Area: 23 cm^2 (3.5 in^2)
Radiating Surface: Urethane

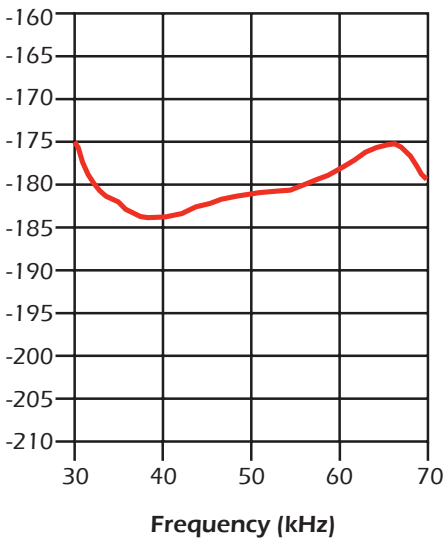
Q ≈ 2.5
Cable Type: C335
Cable Length: 10 m (33’)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

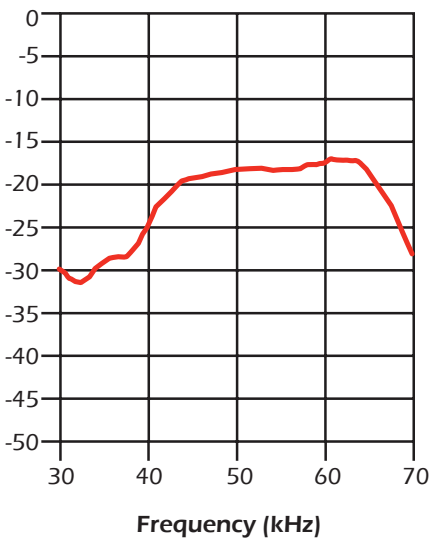
TVR



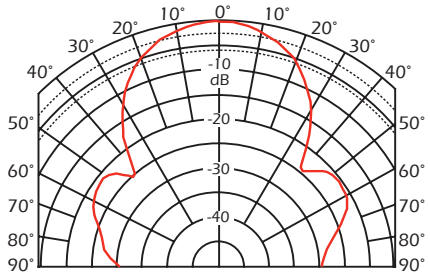
RVR



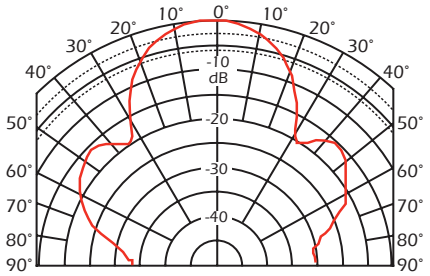
FOM



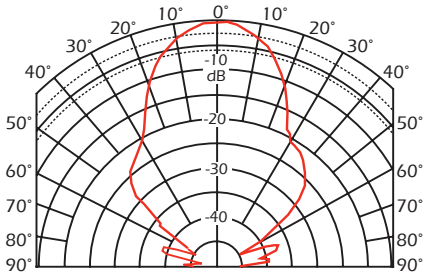
Transmit Radiation Pattern



Beamwidth	@ 40 kHz
-3 dB	31°
-6 dB	43°
-10 dB	51°



Beamwidth	@ 50 kHz
-3 dB	27°
-6 dB	38°
-10 dB	47°



Beamwidth	@ 60 kHz
-3 dB	21°
-6 dB	30°
-10 dB	39°

40 to 60 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
30.00	1566.74	-52.71	949.12	-1246.54	0.39	0.51	2586.28	2694.08
32.00	659.12	-67.32	254.12	-608.16	0.58	1.40	1709.58	6962.49
33.00	493.15	-68.47	180.98	-458.74	0.74	1.89	1343.79	9097.42
34.00	386.75	-67.72	146.65	-357.86	0.98	2.39	1019.94	11199.70
35.00	313.94	-66.40	125.69	-287.68	1.28	2.92	784.12	13272.91
36.00	264.23	-63.55	117.70	-236.57	1.69	3.39	593.18	14979.78
37.00	225.64	-61.22	108.64	-197.76	2.13	3.88	468.64	16708.54
38.00	191.83	-58.14	101.25	-162.93	2.75	4.43	363.44	18544.10
39.00	163.59	-53.89	96.42	-132.15	3.60	4.94	277.55	20152.19
40.00	141.47	-47.14	96.24	-103.70	4.81	5.18	207.98	20615.15
41.00	127.09	-38.97	98.81	-79.93	6.12	4.95	163.47	19209.71
42.00	117.05	-29.39	101.99	-57.45	7.44	4.19	134.35	15888.54
43.00	114.17	-19.82	107.41	-38.71	8.24	2.97	121.36	10991.74
44.00	116.41	-10.49	114.47	-21.19	8.45	1.56	118.39	5655.50
45.00	124.14	-3.65	123.89	-7.91	8.04	0.51	124.39	1815.47
46.00	132.21	1.87	132.14	4.32	7.56	-0.25	132.28	-856.05
47.00	142.79	4.84	142.28	12.05	6.98	-0.59	143.30	-2001.25
48.00	148.70	7.28	147.50	18.83	6.67	-0.85	149.90	-2823.74
49.00	155.74	9.70	153.52	26.23	6.33	-1.08	158.00	-3513.14
50.00	162.24	12.43	158.43	34.93	6.02	-1.33	166.13	-4224.56
51.00	169.58	14.95	163.84	43.76	5.70	-1.52	175.53	-4748.29
52.00	174.96	17.38	166.97	52.25	5.45	-1.71	183.32	-5224.76
53.00	182.36	19.88	171.49	62.03	5.16	-1.87	193.93	-5600.86
54.00	193.16	24.54	175.70	80.24	4.71	-2.15	212.35	-6338.45
55.00	212.47	27.32	188.77	97.52	4.18	-2.16	239.14	-6250.85
56.00	229.11	28.58	201.19	109.62	3.83	-2.09	260.91	-5934.84
57.00	248.37	30.03	215.02	124.31	3.49	-2.02	286.88	-5626.80
58.00	267.37	32.03	226.67	141.80	3.17	-1.98	315.38	-5442.88
59.00	295.20	33.89	245.06	164.59	2.81	-1.89	355.60	-5094.99
60.00	330.19	35.77	267.91	193.01	2.46	-1.77	406.96	-4695.73
61.00	375.74	37.29	298.91	227.66	2.12	-1.61	472.31	-4207.37
62.00	435.78	38.13	342.81	269.05	1.81	-1.42	553.97	-3636.77
63.00	527.40	37.50	418.43	321.05	1.50	-1.15	664.76	-2915.87
64.00	637.87	34.62	524.95	362.37	1.29	-0.89	775.10	-2214.76
65.00	800.21	28.90	700.55	386.72	1.09	-0.60	914.03	-1478.77
66.00	1001.17	18.83	947.61	323.09	0.95	-0.32	1057.76	-777.28
67.00	1212.72	3.05	1211.00	64.58	0.82	-0.04	1214.44	-104.30
68.00	1295.75	-15.77	1246.99	-352.10	0.74	0.21	1346.41	490.84
70.00	1088.53	-48.17	725.98	-811.08	0.61	0.68	1632.14	1556.34

40 to 60 kHz | 1 kW / 15 W

40 to 60 kHz-A (Broadband)

Transformed to 200 ohms minimum

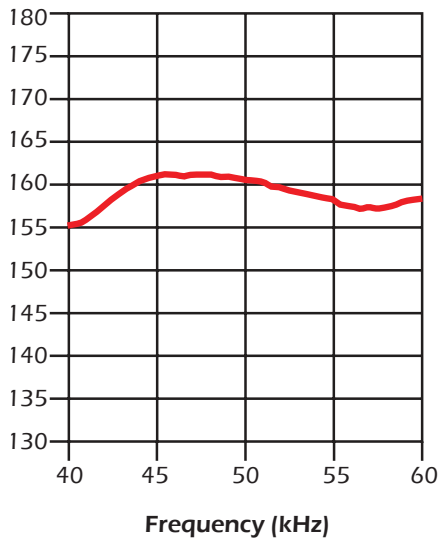
Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 15W in B175

7 x 20.3 mm (0.80”) PZT4
Active Area: 23 cm² (3.5 in²)
Radiating Surface: Urethane

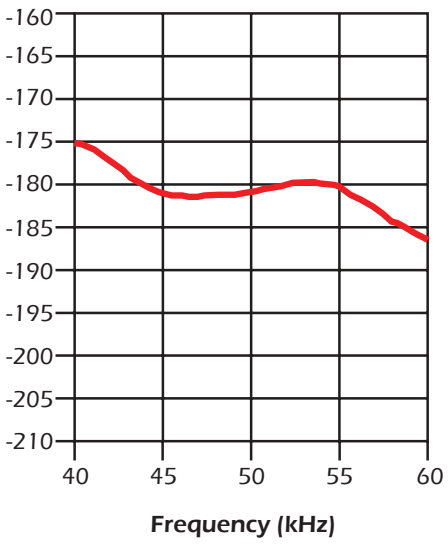
Q ≈ 2.5
Cable Type: C335
Cable Length: 10 m (33’)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

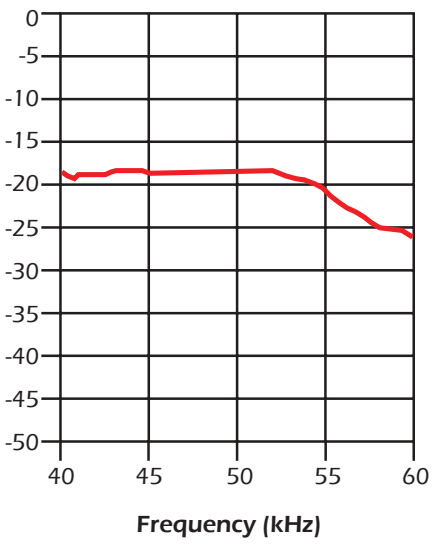
TVR



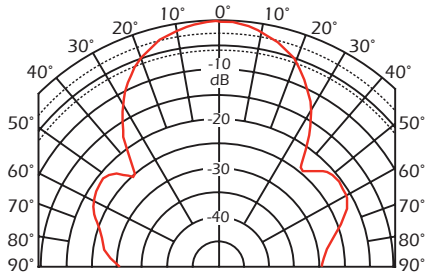
RVR



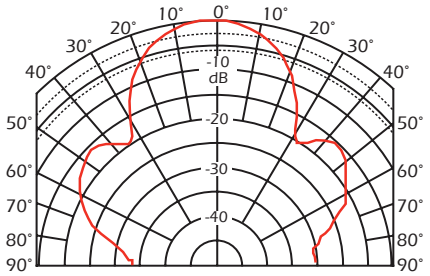
FOM



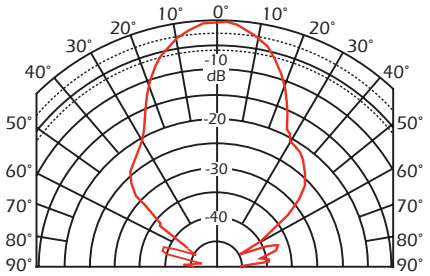
Transmit Radiation Pattern



Beamwidth	@ 40 kHz
-3 dB	31°
-6 dB	43°
-10 dB	51°



Beamwidth	@ 50 kHz
-3 dB	27°
-6 dB	38°
-10 dB	47°



Beamwidth	@ 60 kHz
-3 dB	21°
-6 dB	30°
-10 dB	39°

40 to 60 kHz-A (Broadband)

Note: Impedance data includes cable

Unbalanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
40.00	418.98	-34.21	346.49	-235.56	1.9738	1.3419	506.63	5339.18
41.00	339.61	-34.34	280.41	-191.59	2.4312	1.6611	411.31	6448.24
42.00	287.92	-31.89	244.46	-152.12	2.9488	1.8350	339.12	6953.62
43.00	242.44	-27.10	215.82	-110.45	3.6718	1.8791	272.35	6954.97
44.00	217.38	-21.04	202.89	-78.03	4.2937	1.6512	232.90	5972.68
45.00	205.36	-14.98	198.39	-53.07	4.7041	1.2583	212.58	4450.40
46.00	199.17	-8.79	196.83	-30.43	4.9619	0.7670	201.53	2653.90
47.00	201.44	-4.78	200.74	-16.79	4.9469	0.4138	202.15	1401.15
48.00	200.73	-1.22	200.69	-4.28	4.9806	0.1062	200.78	352.12
49.00	198.34	2.41	198.17	8.33	5.0373	-0.2118	198.52	-687.80
50.00	201.95	8.64	199.66	30.35	4.8954	-0.7442	204.27	-2368.94
51.00	207.39	12.71	202.31	45.63	4.7037	-1.0609	212.60	-3310.78
52.00	221.17	17.41	211.04	66.18	4.3142	-1.3530	231.79	-4141.13
53.00	240.15	21.20	223.90	86.83	3.8824	-1.5056	257.57	-4521.31
54.00	271.57	22.83	250.29	105.38	3.3937	-1.4289	294.67	-4211.38
55.00	306.70	25.43	276.99	131.69	2.9446	-1.4000	339.60	-4051.16
56.00	351.87	24.75	319.56	147.29	2.5810	-1.1897	387.45	-3381.07
57.00	406.37	21.82	377.26	151.04	2.2845	-0.9147	437.73	-2553.90
58.00	456.66	19.17	431.34	149.96	2.0684	-0.7191	483.47	-1973.26
59.00	515.06	10.82	505.90	96.68	1.9070	-0.3644	524.38	-983.09
60.00	559.21	4.13	557.76	40.28	1.7836	-0.1288	560.67	-341.62

40 to 60 kHz-B (Broadband)

Transformed to 120 ohms minimum (B2)

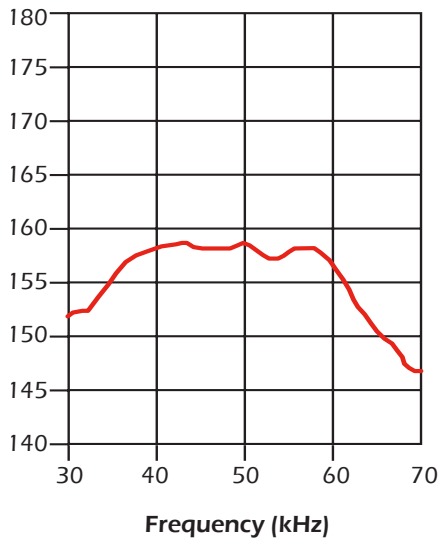
Power Rating:
- 2 kW @ 1% duty cycle
- CW(4): 20W in PM411

14 x 20 mm (0.80”) PZT
Active Area: 45.4 cm² (7.04 in²)
Radiating Surface: Epoxy/Urethane

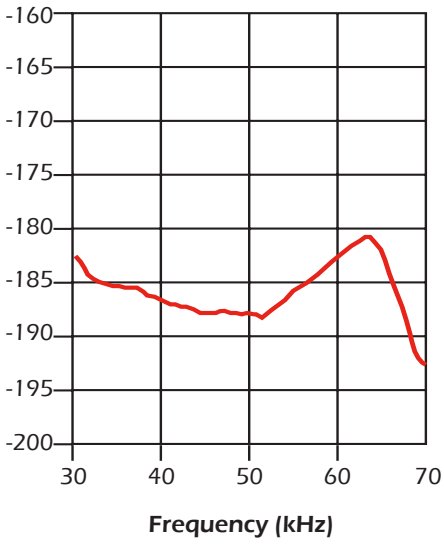
Q ≈ 2.0
Cable Type: C44-02
Cable Length: 15 m (50’)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

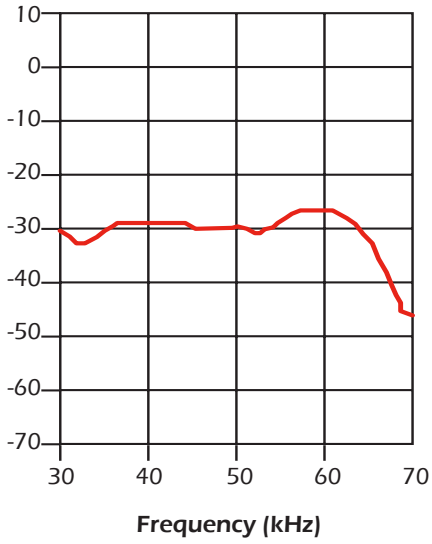
TVR



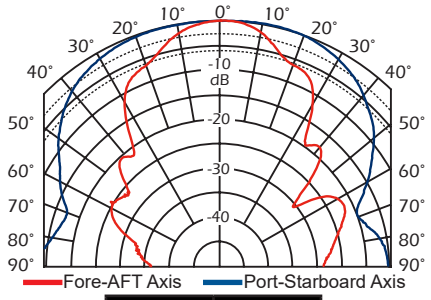
RVR



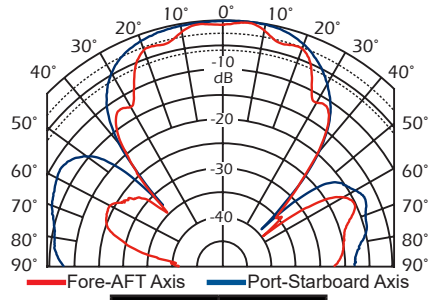
FOM



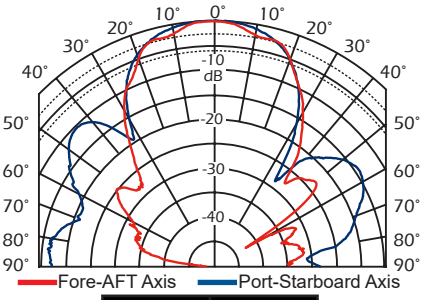
Transmit Radiation Pattern



Beamwidth	@ 40 kHz
-3 dB	25°/75°
-6 dB	37°/91°
-10 dB	57°/107°



Beamwidth	@ 50 kHz
-3 dB	29°/50°
-6 dB	48°/60°
-10 dB	54°/70°



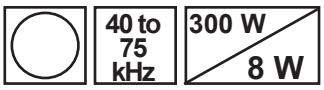
Beamwidth	@ 60 kHz
-3 dB	35°/34°
-6 dB	42°/44°
-10 dB	53°/52°

40 to 60 kHz-B (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
30.00	280.74	-63.35	125.91	-250.92	1.60	3.18	625.94	16890.12
31.00	249.26	-62.50	115.08	-221.10	1.85	3.56	539.85	18270.53
32.00	223.17	-60.64	109.41	-194.51	2.20	3.91	455.24	19424.23
33.00	199.48	-58.84	103.23	-170.69	2.59	4.29	385.47	20687.73
34.00	179.03	-57.84	95.29	-151.57	2.97	4.73	336.39	22135.21
35.00	159.38	-55.83	89.52	-131.87	3.52	5.19	283.77	23605.08
36.00	144.70	-52.68	87.72	-115.08	4.19	5.50	238.70	24298.75
37.00	132.41	-47.87	88.83	-98.19	5.07	5.60	197.37	24091.34
39.00	115.61	-37.91	91.22	-71.03	6.82	5.31	146.53	21687.24
40.00	111.25	-32.62	93.70	-59.97	7.57	4.85	132.08	19280.78
41.00	109.09	-26.92	97.27	-49.39	8.17	4.15	122.35	16108.30
42.00	107.85	-20.99	100.69	-38.64	8.66	3.32	115.52	12587.73
43.00	109.46	-15.16	105.65	-28.63	8.82	2.39	113.41	8844.48
44.00	114.00	-10.81	111.98	-21.38	8.62	1.64	116.06	5949.53
45.00	118.90	-7.31	117.94	-15.13	8.34	1.07	119.88	3785.32
46.00	123.43	-5.32	122.90	-11.44	8.07	0.75	123.96	2598.37
47.00	125.31	-3.40	125.09	-7.42	7.97	0.47	125.53	1600.84
48.00	125.58	-0.62	125.57	-1.36	7.96	0.09	125.59	285.85
49.00	125.53	3.67	125.27	8.04	7.95	-0.51	125.79	-1657.83
50.00	130.69	10.18	128.64	23.09	7.53	-1.35	132.78	-4303.12
51.00	144.99	15.35	139.82	38.38	6.65	-1.83	150.35	-5697.03
52.00	162.91	17.24	155.59	48.30	5.86	-1.82	170.58	-5569.35
54.00	189.84	16.45	182.07	53.76	5.05	-1.49	197.94	-4396.39
55.00	198.09	17.58	188.84	59.83	4.81	-1.52	207.80	-4412.23
56.00	207.59	20.23	194.79	71.77	4.52	-1.67	221.23	-4733.32
57.00	225.98	23.67	206.97	90.71	4.05	-1.78	246.72	-4959.63
58.00	254.92	26.71	227.73	114.57	3.50	-1.76	285.37	-4837.61
59.00	295.21	29.32	257.38	144.57	2.95	-1.66	338.59	-4475.12
60.00	356.07	29.89	308.72	177.42	2.44	-1.40	410.68	-3711.96
61.00	437.21	28.53	384.11	208.85	2.01	-1.09	497.66	-2850.54
62.00	552.41	23.96	504.81	224.33	1.65	-0.74	604.50	-1887.10
63.00	712.56	15.22	687.55	187.11	1.35	-0.37	738.47	-930.95
64.00	888.50	-0.04	888.50	-0.64	1.13	0.00	888.50	2.03
65.00	994.66	-21.35	926.43	-362.04	0.94	0.37	1067.92	896.02
66.00	929.16	-42.10	689.45	-622.89	0.80	0.72	1252.21	1739.83
67.00	795.98	-56.95	434.05	-667.23	0.69	1.05	1459.72	2501.56
68.00	668.42	-66.52	266.32	-613.08	0.60	1.37	1677.63	3211.60
69.00	570.40	-72.64	170.15	-544.43	0.52	1.67	1912.23	3859.72
70.00	495.75	-76.68	114.19	-482.42	0.46	1.96	2152.30	4462.91



40 to 75 kHz-A (Broadband)

Transformed to 100 ohms minimum (B1)

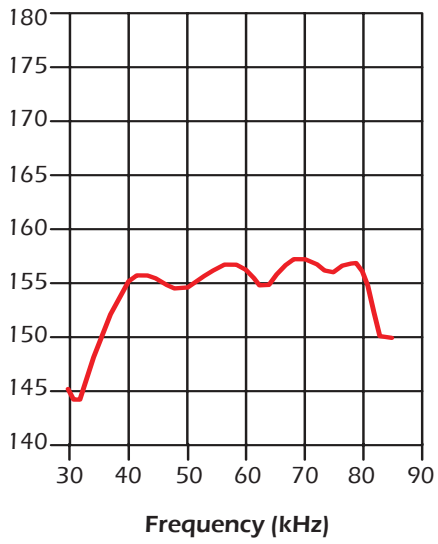
Power Rating:
- 300 W @ 1% duty cycle
- CW(4): 8W in B75, B765

34.9 mm (1.37 in) PZT
Active Area: 9.6 cm^2 (1.49 in^2)
Radiating Surface: Urethane

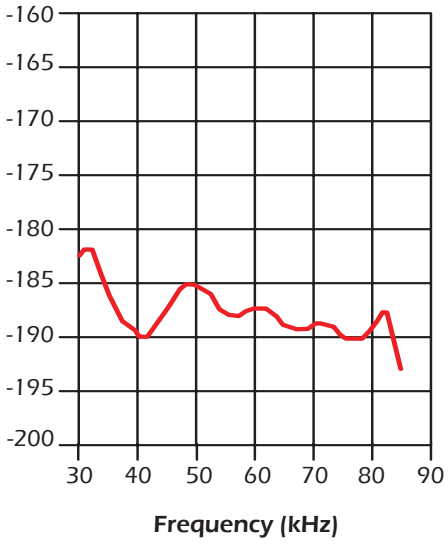
Q ≈ 2
Cable Type: C335
Cable Length: 12 m (40 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

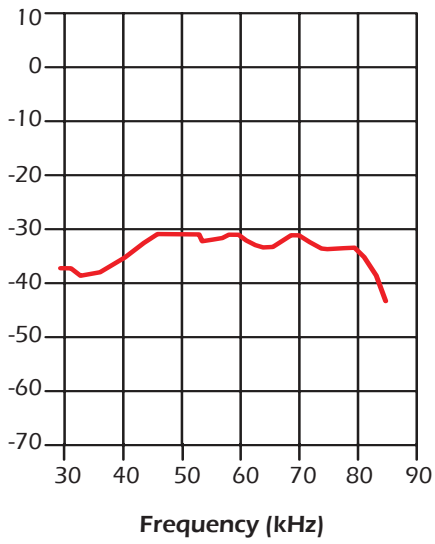
TVR



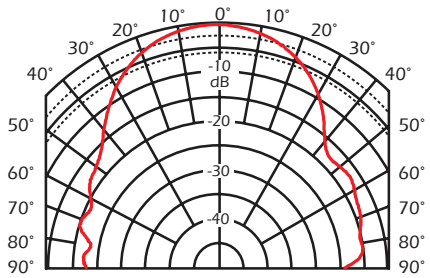
RVR



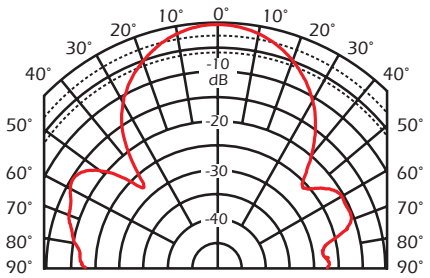
FOM



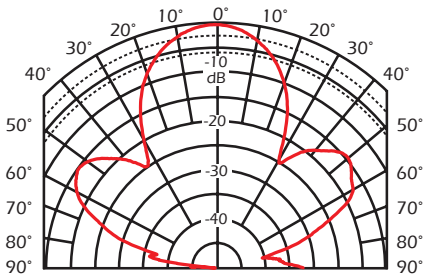
Transmit Radiation Pattern



Beamwidth	@ 50 kHz
-3 dB	32°
-6 dB	45°
-10 dB	59°



Beamwidth	@ 65 kHz
-3 dB	28°
-6 dB	40°
-10 dB	51°



Beamwidth	@ 75 kHz
-3 dB	21°
-6 dB	30°
-10 dB	39°

40 to 75 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
35.00	280.50	-39.59	216.15	-178.77	2.75	2.27	364.01	10331.93
36.00	222.38	-39.14	172.49	-140.36	3.49	2.84	286.70	12547.90
37.00	180.38	-37.05	143.97	-108.67	4.43	3.34	225.99	14366.86
38.00	150.31	-32.91	126.19	-81.67	5.59	3.61	179.04	15138.44
39.00	127.79	-26.20	114.66	-56.43	7.02	3.46	142.43	14100.23
41.00	108.82	-5.65	108.29	-10.70	9.15	0.90	109.35	3509.24
42.00	113.47	5.35	112.97	10.58	8.77	-0.82	113.96	-3115.06
43.00	126.37	13.74	122.76	30.01	7.69	-1.88	130.09	-6955.52
44.00	147.36	18.83	139.47	47.56	6.42	-2.19	155.69	-7921.99
46.00	202.86	17.06	193.94	59.50	4.71	-1.45	212.19	-5002.56
47.00	229.26	12.23	224.06	48.55	4.26	-0.92	234.58	-3127.95
48.00	249.49	4.80	248.61	20.89	3.99	-0.34	250.36	-1112.68
49.00	256.38	-3.36	255.94	-15.04	3.89	0.23	256.82	743.36
50.00	250.77	-10.57	246.52	-45.99	3.92	0.73	255.10	2327.82
51.00	237.78	-16.19	228.35	-66.30	4.04	1.17	247.60	3659.50
52.00	220.06	-19.99	206.80	-75.22	4.27	1.55	234.16	4754.44
53.00	203.43	-22.29	188.23	-77.15	4.55	1.86	219.85	5598.31
54.00	187.81	-22.26	173.81	-71.15	4.93	2.02	202.94	5945.49
56.00	169.55	-17.81	161.42	-51.87	5.62	1.80	178.09	5127.84
57.00	168.88	-14.34	163.62	-41.84	5.74	1.47	174.32	4095.67
58.00	174.92	-11.10	171.65	-33.68	5.61	1.10	178.26	3020.46
59.00	188.53	-9.55	185.91	-31.29	5.23	0.88	191.18	2374.60
60.00	206.18	-10.63	202.64	-38.04	4.77	0.89	209.78	2373.91
61.00	222.89	-14.16	216.12	-54.52	4.35	1.10	229.87	2863.11
62.00	230.76	-20.17	216.61	-79.57	4.07	1.49	245.84	3835.96
63.00	228.53	-26.46	204.58	-101.84	3.92	1.95	255.28	4926.37
64.00	214.52	-31.41	183.08	-111.81	3.98	2.43	251.36	6042.07
66.00	181.62	-34.16	150.29	-101.98	4.56	3.09	219.49	7455.22
67.00	170.54	-32.39	144.01	-91.36	4.95	3.14	201.97	7461.74
68.00	165.26	-29.46	143.90	-81.27	5.27	2.98	189.80	6964.78
69.00	165.84	-26.13	148.89	-73.03	5.41	2.66	184.71	6124.87
71.00	180.27	-23.16	165.75	-70.89	5.10	2.18	196.07	4889.82
72.00	189.42	-24.51	172.35	-78.57	4.80	2.19	208.17	4840.84
73.00	194.65	-26.45	174.28	-86.69	4.60	2.29	217.40	4988.39
74.00	195.93	-29.00	171.35	-95.00	4.46	2.47	224.02	5322.78
76.00	187.10	-31.10	160.20	-96.65	4.58	2.76	218.52	5782.00
77.00	181.70	-29.38	158.33	-89.15	4.80	2.70	208.53	5581.27
78.00	180.79	-25.42	163.28	-77.60	5.00	2.37	200.16	4844.68
79.00	189.84	-19.05	179.44	-61.98	4.98	1.72	200.85	3464.48
80.00	223.57	-12.15	218.56	-47.07	4.37	0.94	228.70	1873.50

42 to 65 kHz-A (Broadband)

Transformed to 100 ohms minimum (B1)

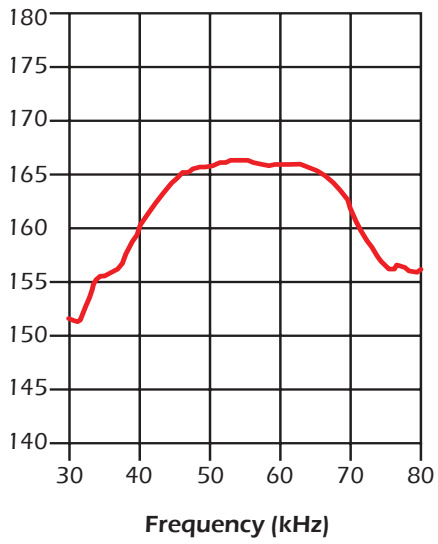
Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 25W in B265, PM265
  15W in M265, TM265

7 x 28.6 mm (1.13 in) PZT
Active Area: 45 cm^2 (6.9 in^2)
Radiating Surface: Urethane

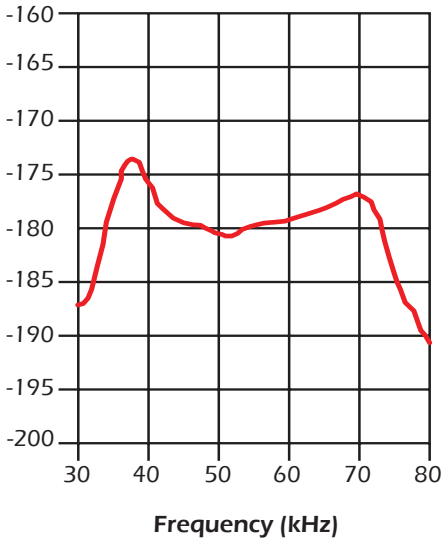
Q ≈ 2
Cable Type: C335
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

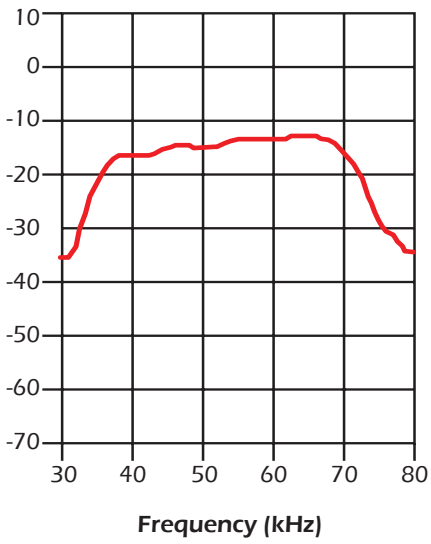
TVR



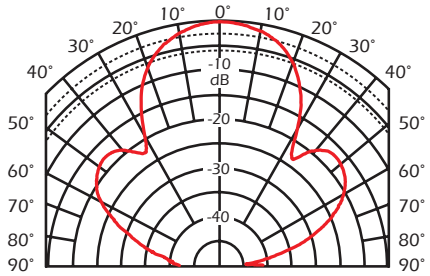
RVR



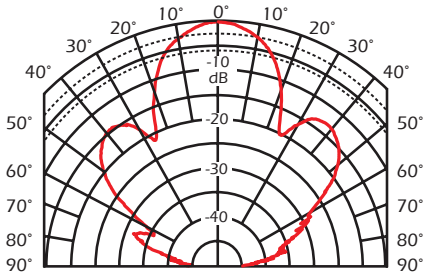
FOM



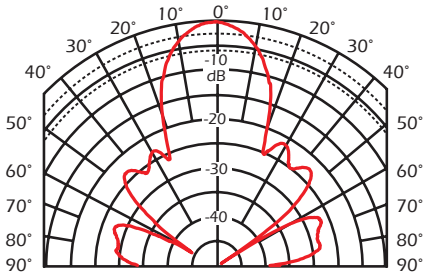
Transmit Radiation Pattern



Beamwidth	@ 42 kHz
-3 dB	25°
-6 dB	35°
-10 dB	43°



Beamwidth	@ 50 kHz
-3 dB	20°
-6 dB	28°
-10 dB	34°



Beamwidth	@ 65 kHz
-3 dB	16°
-6 dB	22°
-10 dB	28°

42 to 65 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
40.00	305.87	-15.48	294.78	-81.62	3.15	0.87	317.38	3470.98
41.00	247.24	-19.88	232.50	-84.08	3.80	1.38	262.91	5339.42
42.00	203.32	-20.42	190.54	-70.94	4.61	1.72	216.95	6502.90
43.00	173.62	-19.56	163.60	-58.14	5.43	1.93	184.26	7138.63
44.00	152.61	-16.64	146.22	-43.70	6.28	1.88	159.28	6786.59
45.00	140.30	-12.05	137.20	-29.29	6.97	1.49	143.46	5262.71
46.00	134.39	-8.36	132.96	-19.55	7.36	1.08	135.83	3745.19
47.00	129.98	-5.84	129.31	-13.23	7.65	0.78	130.66	2651.98
48.00	126.28	-3.80	126.00	-8.37	7.90	0.53	126.55	1740.80
49.00	123.64	-1.69	123.58	-3.64	8.08	0.24	123.69	773.95
50.00	119.60	0.02	119.60	0.03	8.36	0.00	119.60	-7.13
51.00	115.87	3.54	115.65	7.15	8.61	-0.53	116.09	-1661.96
52.00	116.85	7.67	115.81	15.59	8.48	-1.14	117.91	-3495.61
53.00	120.09	11.08	117.86	23.07	8.17	-1.60	122.37	-4803.73
54.00	125.09	13.76	121.50	29.74	7.77	-1.90	128.78	-5602.29
55.00	131.10	15.44	126.37	34.90	7.35	-2.03	136.01	-5875.61
56.00	138.17	16.25	132.65	38.67	6.95	-2.03	143.92	-5757.18
57.00	144.18	16.30	138.39	40.46	6.66	-1.95	150.22	-5434.31
58.00	147.81	16.55	141.69	42.11	6.48	-1.93	154.20	-5288.48
59.00	154.64	17.23	147.70	45.81	6.18	-1.92	161.91	-5167.01
60.00	159.67	16.88	152.79	46.36	5.99	-1.82	166.86	-4823.14
61.00	164.96	17.59	157.25	49.84	5.78	-1.83	173.05	-4778.87
62.00	171.78	18.35	163.05	54.08	5.53	-1.83	180.99	-4704.40
63.00	182.10	18.89	172.28	58.97	5.20	-1.78	192.47	-4492.47
64.00	190.26	19.35	179.52	63.03	4.96	-1.74	201.65	-4330.09
65.00	203.20	20.59	190.22	71.47	4.61	-1.73	217.07	-4238.17
66.00	220.23	21.49	204.92	80.67	4.23	-1.66	236.68	-4010.94
67.00	244.22	21.86	226.65	90.94	3.80	-1.52	263.14	-3622.18
68.00	275.19	21.56	255.95	101.11	3.38	-1.34	295.89	-3124.79
69.00	319.03	20.17	299.48	109.98	2.94	-1.08	339.87	-2492.40
70.00	381.73	15.34	368.12	101.01	2.53	-0.69	395.84	-1576.06

42 to 65 kHz-A (Broadband)

Transformed to 100 ohms minimum with internal diplexer (B1)

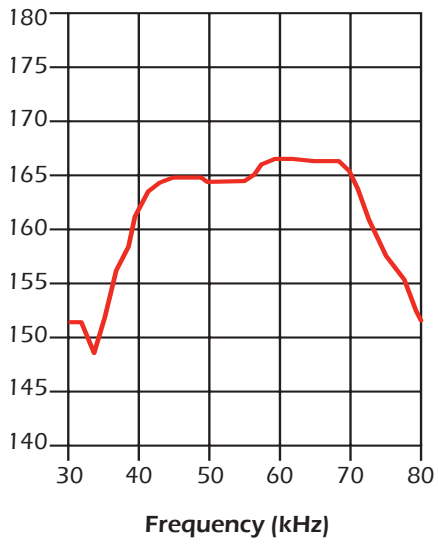
Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 25W in B265, PM265
  15W in M265, TM265

7 x 28.6 mm (1.13 in) PZT
Active Area: 45 cm^2 (6.9 in^2)
Radiating Surface: Urethane

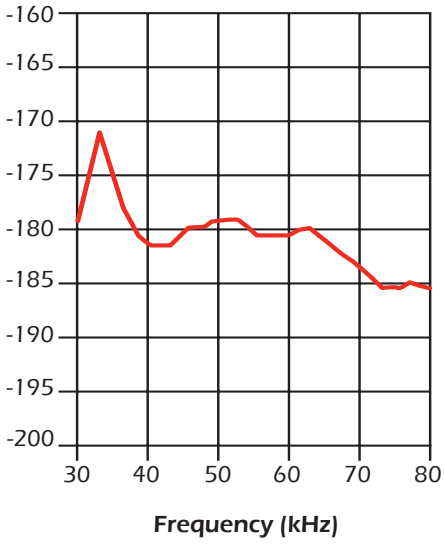
Q ≈ 2
Cable Type: C332
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

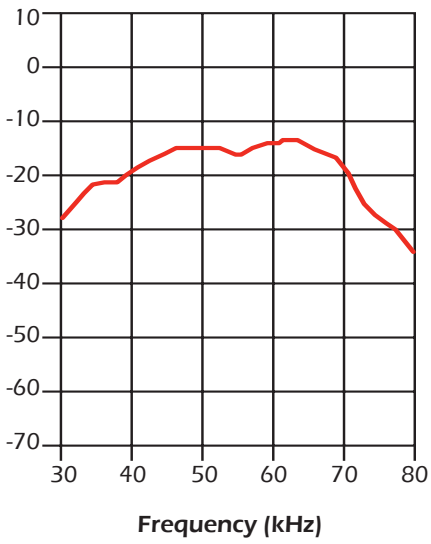
TVR



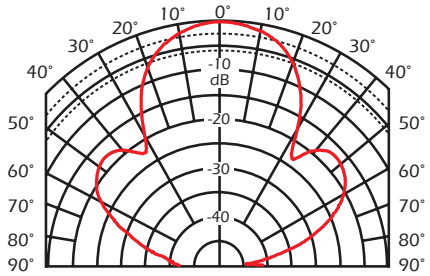
RVR



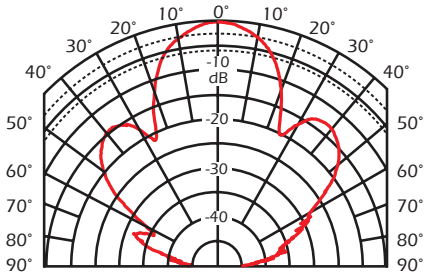
FOM



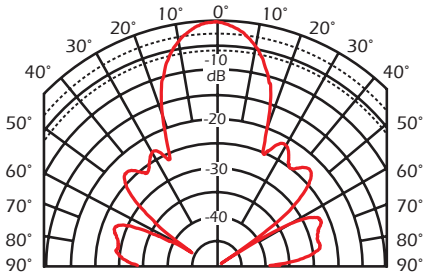
Transmit Radiation Pattern



Beamwidth	@ 42 kHz
-3 dB	25°
-6 dB	35°
-10 dB	43°



Beamwidth	@ 50 kHz
-3 dB	20°
-6 dB	28°
-10 dB	34°



Beamwidth	@ 65 kHz
-3 dB	16°
-6 dB	22°
-10 dB	28°

42 to 65 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
30.00	369.73	83.91	39.20	367.64	0.29	-2.69	3487.58	-14268.01
31.00	458.23	80.95	72.10	452.52	0.34	-2.16	2912.20	-11064.50
32.00	612.89	75.00	158.64	592.00	0.42	-1.58	2367.81	-7838.46
34.00	1307.23	21.62	1215.29	481.58	0.71	-0.28	1406.12	-1319.17
35.00	895.70	-24.50	815.05	-371.44	1.02	0.46	984.32	2105.29
36.00	521.51	-39.81	400.58	-333.93	1.47	1.23	678.95	5428.02
38.00	236.80	-41.41	177.59	-156.64	3.17	2.79	315.76	11699.57
39.00	179.20	-35.91	145.14	-105.10	4.52	3.27	221.25	13357.34
40.00	142.39	-27.65	126.13	-66.07	6.22	3.26	160.74	12967.03
42.00	113.37	-4.79	112.98	-9.46	8.79	0.74	113.77	2790.29
43.00	112.00	5.56	111.47	10.86	8.89	-0.87	112.53	-3204.41
44.00	118.72	12.92	115.71	26.54	8.21	-1.88	121.80	-6812.68
46.00	132.25	19.33	124.79	43.78	7.14	-2.50	140.15	-8660.73
47.00	135.14	22.06	125.24	50.76	6.86	-2.78	145.81	-9412.51
48.00	140.50	24.34	128.01	57.91	6.48	-2.93	154.21	-9726.54
50.00	156.97	25.32	141.89	67.14	5.76	-2.73	173.66	-8673.82
51.00	162.23	23.71	148.53	65.24	5.64	-2.48	177.19	-7736.13
52.00	164.41	22.36	152.06	62.54	5.63	-2.31	177.77	-7080.60
54.00	162.16	17.95	154.26	49.98	5.87	-1.90	170.45	-5602.39
55.00	154.93	16.29	148.71	43.45	6.20	-1.81	161.40	-5239.04
56.00	145.43	16.49	139.45	41.28	6.59	-1.95	151.67	-5547.28
58.00	129.54	21.14	120.83	46.72	7.20	-2.78	138.89	-7639.77
59.00	126.81	25.10	114.84	53.79	7.14	-3.34	140.04	-9023.02
60.00	128.44	29.21	112.10	62.68	6.80	-3.80	147.15	-10079.31
62.00	136.41	33.56	113.67	75.41	6.11	-4.05	163.70	-10403.53
63.00	139.81	34.06	115.82	78.31	5.93	-4.01	168.77	-10120.97
64.00	140.07	33.41	116.92	77.13	5.96	-3.93	167.80	-9776.78
66.00	128.22	34.77	105.32	73.13	6.41	-4.45	156.10	-10726.58
67.00	120.52	38.43	94.41	74.91	6.50	-5.16	153.84	-12251.04
68.00	114.92	44.40	82.11	80.40	6.22	-6.09	160.84	-14249.97
70.00	120.19	60.97	58.32	105.09	4.04	-7.28	247.70	-16541.12
71.00	131.74	67.88	49.62	122.04	2.86	-7.03	349.82	-15762.33
72.00	147.83	72.91	43.45	141.30	1.99	-6.47	502.95	-14291.97
74.00	187.22	77.96	39.06	183.10	1.11	-5.22	897.37	-11234.73
75.00	208.62	79.19	39.12	204.92	0.90	-4.71	1112.62	-9991.31
76.00	231.26	79.96	40.31	227.72	0.75	-4.26	1326.69	-8916.77
78.00	283.38	80.75	45.57	279.69	0.57	-3.48	1762.21	-7106.74
79.00	314.90	80.70	50.89	310.76	0.51	-3.13	1948.60	-6313.52
80.00	351.93	79.83	62.14	346.40	0.50	-2.80	1993.06	-5564.04

58 to 110 kHz-A (Broadband)

All 4 Quadrants wired in Parallel

Transformed to 12.5 ohms minimum (B5)

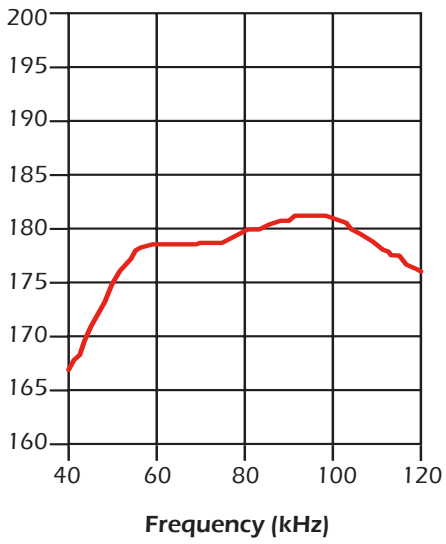
Power Rating:
- 1,000 kW @ 1% duty cycle
- CW(4): 15W in M475

171 mm (6.75 in) PZT
Active Area: 59.2 cm^2 (20.9 in^2)
Radiating Surface: Urethane

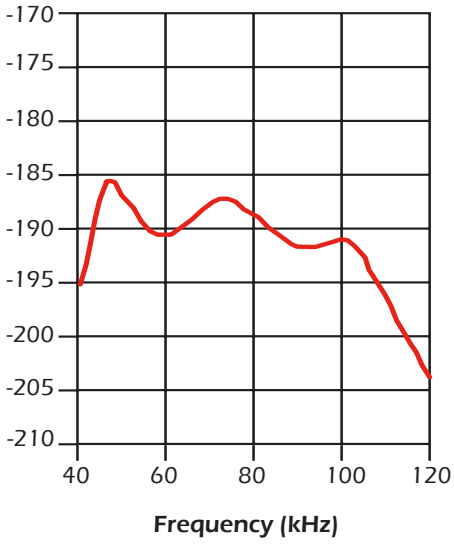
Q ≈ 2
Cable Type: C247
Cable Length: 26 m (87 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

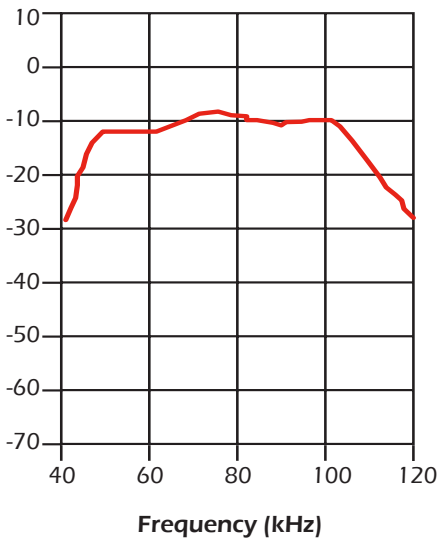
TVR



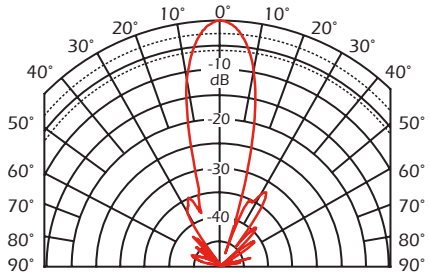
RVR



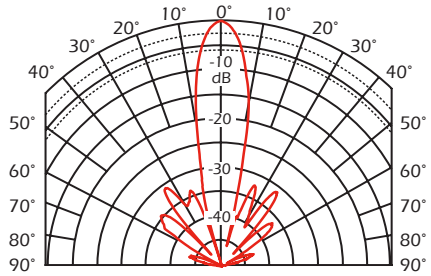
FOM



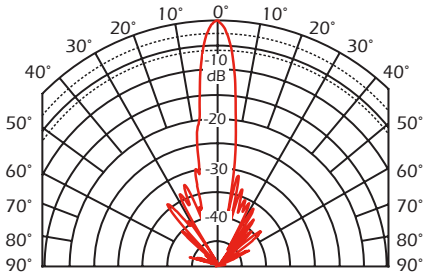
Transmit Radiation Pattern



Beamwidth	@ 60 kHz
-3 dB	10°
-6 dB	15°
-10 dB	19°



Beamwidth	@ 80 kHz
-3 dB	8°
-6 dB	11°
-10 dB	14°



Beamwidth	@ 110 kHz
-3 dB	5°
-6 dB	8°
-10 dB	10°

58 to 110 kHz-A (Broadband) All 4 Quadrants Transformed to 12.5 ohms minimum (B5)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
40.00	14.11	79.43	2.59	13.87	13.00	-69.66	76.95	-277185.61
42.00	17.73	73.54	5.02	17.00	15.98	-54.10	62.58	-204989.26
44.00	22.43	61.82	10.59	19.77	21.06	-39.30	47.49	-142165.71
46.00	26.69	40.93	20.16	17.49	28.31	-24.55	35.33	-84943.75
48.00	25.54	17.72	24.33	7.78	37.29	-11.92	26.82	-39511.77
50.00	19.82	1.77	19.81	0.61	50.42	-1.55	19.83	-4947.26
52.00	15.48	-3.20	15.46	-0.86	64.49	3.60	15.51	11028.67
54.00	12.36	-4.01	12.33	-0.86	80.73	5.65	12.39	16660.75
56.00	10.40	1.49	10.39	0.27	96.14	-2.51	10.40	-7123.35
58.00	9.99	8.63	9.88	1.50	98.93	-15.01	10.11	-41179.51
60.00	9.89	15.37	9.54	2.62	97.45	-26.79	10.26	-71065.63
62.00	10.48	21.01	9.78	3.76	89.07	-34.21	11.23	-87816.51
64.00	11.48	23.11	10.56	4.51	80.10	-34.17	12.48	-84983.84
66.00	12.98	23.75	11.88	5.23	70.53	-31.04	14.18	-74849.91
68.00	14.54	23.13	13.37	5.71	63.25	-27.02	15.81	-63234.65
70.00	16.16	19.55	15.23	5.41	58.32	-20.70	17.15	-47075.41
72.00	17.73	12.40	17.32	3.81	55.07	-12.11	18.16	-26769.15
74.00	19.27	4.81	19.20	1.62	51.71	-4.35	19.34	-9357.53
76.00	19.55	-3.71	19.51	-1.27	51.03	3.31	19.60	6937.06
78.00	18.78	-11.67	18.39	-3.80	52.16	10.77	19.17	21973.67
80.00	17.61	-18.91	16.66	-5.71	53.71	18.40	18.62	36614.85
82.00	16.81	-23.16	15.46	-6.61	54.69	23.39	18.29	45402.95
84.00	15.81	-27.65	14.00	-7.34	56.04	29.37	17.84	55638.05
86.00	14.38	-31.19	12.30	-7.44	59.51	36.02	16.80	66660.82
88.00	13.14	-33.43	10.97	-7.24	63.49	41.92	15.75	75813.47
90.00	12.43	-32.92	10.43	-6.75	67.54	43.72	14.81	77320.37
92.00	12.06	-30.93	10.35	-6.20	71.10	42.61	14.06	73710.56
94.00	11.97	-29.52	10.41	-5.90	72.72	41.17	13.75	69702.30
96.00	12.19	-30.40	10.51	-6.17	70.76	41.51	14.13	68824.83
98.00	12.79	-32.71	10.76	-6.91	65.81	42.26	15.20	68635.61
100.00	13.38	-36.25	10.79	-7.91	60.27	44.19	16.59	70326.44
102.00	13.75	-43.29	10.01	-9.43	52.94	49.88	18.89	77824.09
104.00	13.27	-51.22	8.31	-10.35	47.18	58.73	21.19	89876.81
106.00	12.16	-57.73	6.49	-10.28	43.91	69.53	22.77	104390.79
108.00	10.99	-62.36	5.10	-9.74	42.21	80.60	23.69	118775.06
110.00	9.91	-65.42	4.12	-9.01	41.96	91.74	23.83	132727.94
112.00	8.95	-67.54	3.42	-8.27	42.70	103.29	23.42	146781.97
114.00	8.12	-68.64	2.96	-7.56	44.87	114.76	22.28	160221.14
116.00	7.40	-69.30	2.62	-6.93	47.75	126.36	20.94	173367.55
118.00	6.82	-69.63	2.37	-6.39	51.05	137.51	19.59	185464.39
120.00	6.31	-69.69	2.19	-5.91	55.05	148.72	18.17	197244.63

58 to 110 kHz-A (Broadband) 1 Quadrant Transformed to 50 ohms minimum

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
40.00	56.92	78.80	11.06	55.84	3.41	-17.23	293.02	-68569.84
42.00	71.44	73.02	20.87	68.33	4.09	-13.39	244.59	-50729.20
44.00	90.76	61.38	43.47	79.67	5.28	-9.67	189.49	-34984.88
46.00	107.66	41.70	80.38	71.62	6.94	-6.18	144.19	-21378.75
48.00	104.27	18.47	98.90	33.03	9.10	-3.04	109.93	-10073.82
50.00	84.09	1.54	84.06	2.26	11.89	-0.32	84.12	-1016.00
52.00	64.81	-6.15	64.44	-6.94	15.34	1.65	65.18	5056.56
54.00	50.77	-6.63	50.43	-5.86	19.57	2.27	51.11	6701.89
56.00	43.29	-1.59	43.27	-1.20	23.09	0.64	43.31	1820.35
58.00	40.13	5.11	39.97	3.57	24.82	-2.22	40.29	-6088.16
60.00	39.96	10.90	39.23	7.56	24.58	-4.73	40.69	-12558.05
62.00	41.44	15.56	39.92	11.11	23.25	-6.47	43.01	-16613.05
64.00	45.18	18.76	42.78	14.53	20.96	-7.12	47.71	-17703.43
66.00	50.29	19.48	47.41	16.77	18.75	-6.63	53.34	-15990.55
68.00	55.39	17.73	52.76	16.87	17.20	-5.50	58.15	-12866.97
70.00	61.06	13.86	59.28	14.63	15.90	-3.92	62.89	-8922.66
72.00	66.72	7.40	66.17	8.59	14.86	-1.93	67.28	-4266.34
74.00	69.56	-0.10	69.56	-0.12	14.38	0.03	69.56	53.83
76.00	69.25	-8.51	68.49	-10.24	14.28	2.14	70.02	4472.23
78.00	66.45	-16.56	63.70	-18.94	14.42	4.29	69.33	8749.11
80.00	61.17	-22.22	56.62	-23.13	15.13	6.18	66.07	12298.76
82.00	56.67	-24.98	51.37	-23.94	15.99	7.45	62.52	14464.62
84.00	52.83	-28.59	46.39	-25.28	16.62	9.06	60.17	17162.31
86.00	48.58	-31.37	41.48	-25.29	17.58	10.72	56.90	19830.13
88.00	44.57	-31.74	37.90	-23.45	19.08	11.80	52.41	21350.09
90.00	41.49	-29.70	36.04	-20.56	20.94	11.94	47.76	21119.75
92.00	39.71	-27.07	35.36	-18.07	22.43	11.46	44.59	19822.77
94.00	39.65	-24.99	35.94	-16.75	22.86	10.65	43.75	18037.44
96.00	41.16	-23.73	37.68	-16.56	22.24	9.78	44.96	16206.48
98.00	44.02	-23.01	40.52	-17.21	20.91	8.88	47.83	14418.01
100.00	47.28	-25.49	42.68	-20.35	19.09	9.10	52.38	14487.71
102.00	51.10	-30.32	44.11	-25.79	16.89	9.88	59.19	15412.91
104.00	52.83	-39.69	40.65	-33.74	14.56	12.09	68.66	18499.50
106.00	50.54	-49.05	33.13	-38.17	12.97	14.94	77.11	22435.62
108.00	46.03	-55.86	25.83	-38.10	12.19	17.98	82.03	26498.39
110.00	40.99	-61.02	19.86	-35.86	11.82	21.34	84.61	30876.87
112.00	36.44	-64.19	15.87	-32.81	11.95	24.70	83.70	35104.16
114.00	32.61	-66.24	13.14	-29.85	12.35	28.06	80.95	39178.47
116.00	29.41	-67.12	11.43	-27.10	13.22	31.33	75.65	42978.99
118.00	26.74	-67.47	10.25	-24.70	14.33	34.54	69.77	46587.29
120.00	24.45	-67.67	9.29	-22.61	15.54	37.84	64.34	50182.15

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60 to 100 kHz-A (Broadband)

Transformed to 100 ohms minimum (B1)

Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 12W in B175

7 Bars, PZT

Active Area: 23 cm^2 (3.57 in^2)

Radiating Surface: Urethane

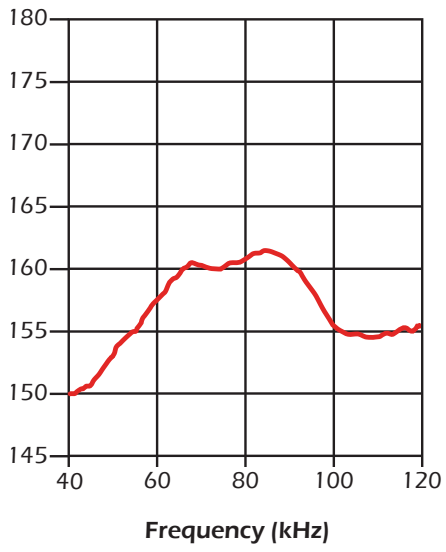
Q ≈ 2.5

Cable Type: C315

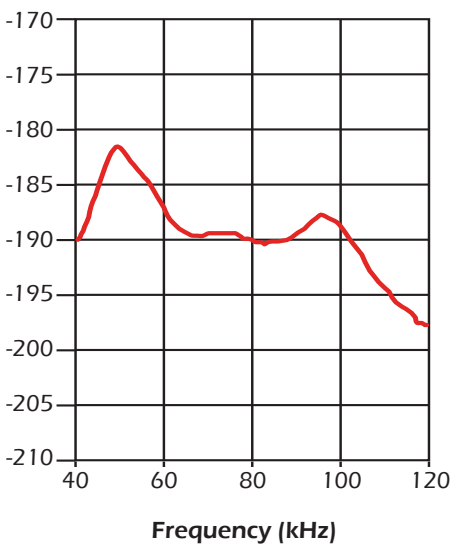
Cable Length: 12 m (39 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

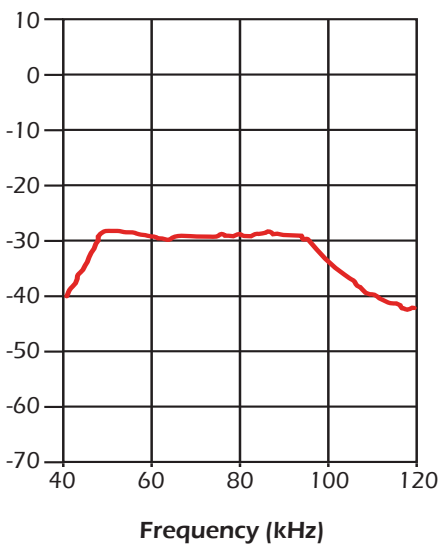
TVR



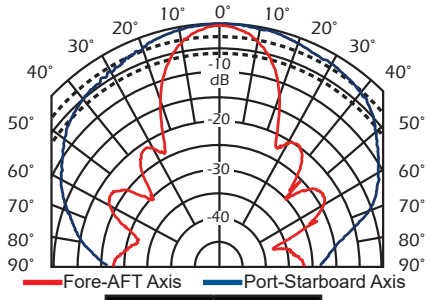
RVR



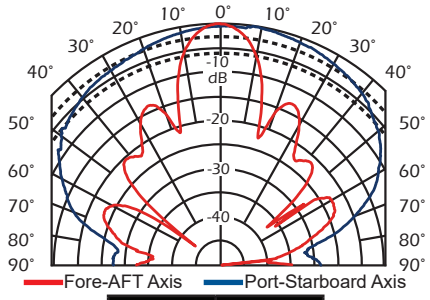
FOM



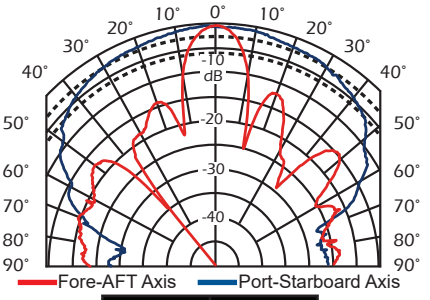
Transmit Radiation Pattern



Beamwidth	@ 60 kHz
-3 dB	20°/ 60°
-6 dB	28°/ 91°
-10 dB	35°/ 112°



Beamwidth	@ 80 kHz
-3 dB	15°/ 60°
-6 dB	20°/ 92°
-10 dB	25°/ 114°



Beamwidth	@ 100 kHz
-3 dB	12°/ 65°
-6 dB	16°/ 92°
-10 dB	20°/ 107°

60 to 100 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
40.00	180.14	79.43	33.06	177.08	1.02	-5.46	981.69	-21712.37
41.00	199.37	77.46	43.30	194.61	1.09	-4.90	917.99	-19005.83
45.00	310.86	61.86	146.61	274.12	1.52	-2.84	659.14	-10032.59
47.00	378.62	46.29	261.61	273.70	1.82	-1.91	547.96	-6465.46
49.00	412.99	26.01	371.16	181.11	2.18	-1.06	459.53	-3448.92
50.00	409.82	15.06	395.75	106.47	2.36	-0.63	424.39	-2017.75
51.00	383.91	5.99	381.81	40.10	2.59	-0.27	386.02	-848.96
53.00	340.21	-6.86	337.78	-40.66	2.92	0.35	342.67	1054.95
55.00	302.05	-19.81	284.17	-102.37	3.11	1.12	321.05	3247.03
56.00	273.39	-25.80	246.13	-119.01	3.29	1.59	303.67	4525.09
59.00	192.49	-35.11	157.47	-110.70	4.25	2.99	235.29	8059.95
60.00	171.65	-35.69	139.42	-100.14	4.73	3.40	211.34	9014.62
61.00	153.79	-35.65	124.96	-89.65	5.28	3.79	189.27	9888.84
62.00	139.71	-34.74	114.81	-79.61	5.88	4.08	170.01	10470.22
63.00	127.26	-32.20	107.69	-67.80	6.65	4.19	150.38	10577.19
65.00	110.79	-26.05	99.54	-48.65	8.11	3.96	123.32	9705.21
69.00	108.16	-10.69	106.28	-20.06	9.09	1.72	110.07	3955.93
70.00	112.18	-8.97	110.81	-17.50	8.80	1.39	113.57	3161.73
75.00	121.91	-10.00	120.05	-21.16	8.08	1.42	123.79	3022.18
78.00	118.23	-11.48	115.86	-23.53	8.29	1.68	120.64	3434.76
79.00	116.25	-11.48	113.92	-23.13	8.43	1.71	118.62	3448.39
80.00	113.44	-10.85	111.41	-21.35	8.66	1.66	115.50	3300.69
81.00	110.49	-9.61	108.94	-18.44	8.92	1.51	112.07	2968.54
84.00	106.04	-3.06	105.89	-5.65	9.42	0.50	106.19	952.39
85.00	107.27	0.12	107.27	0.23	9.32	-0.02	107.27	-37.93
87.00	113.77	5.64	113.22	11.17	8.75	-0.86	114.32	-1579.14
89.00	125.47	11.03	123.16	24.00	7.82	-1.52	127.83	-2726.56
90.00	133.35	13.50	129.67	31.13	7.29	-1.75	137.14	-3095.32
91.00	144.28	15.35	139.14	38.20	6.68	-1.83	149.62	-3209.24
95.00	217.38	14.21	210.73	53.36	4.46	-1.13	224.24	-1891.96
97.00	267.51	7.33	265.32	34.15	3.71	-0.48	269.72	-782.99
99.00	313.62	-3.60	313.00	-19.67	3.18	0.20	314.24	321.46
100.00	335.62	-10.08	330.44	-58.72	2.93	0.52	340.88	829.68
101.00	350.22	-17.70	333.63	-106.50	2.72	0.87	367.63	1368.24
102.00	359.92	-25.55	324.72	-155.23	2.51	1.20	398.93	1869.84
105.00	332.46	-47.09	226.35	-243.51	2.05	2.20	488.32	3339.30
109.00	257.78	-64.36	111.56	-232.39	1.68	3.50	595.65	5106.46
110.00	242.32	-66.81	95.40	-222.75	1.62	3.79	615.46	5488.68
111.00	228.22	-69.06	81.58	-213.15	1.57	4.09	638.47	5867.43
114.00	193.97	-73.52	55.04	-186.00	1.46	4.94	683.65	6901.66
115.00	184.76	-74.60	49.06	-178.13	1.44	5.22	695.84	7221.48
119.00	156.00	-77.74	33.12	-152.45	1.36	6.26	734.72	8377.66
120.00	150.35	-78.27	30.55	-147.21	1.35	6.51	739.83	8637.46

80 to 130 kHz | 600 W / 6 W

80 to 130 kHz-A (Broadband)

Transformed to 100 ohms minimum (B1)

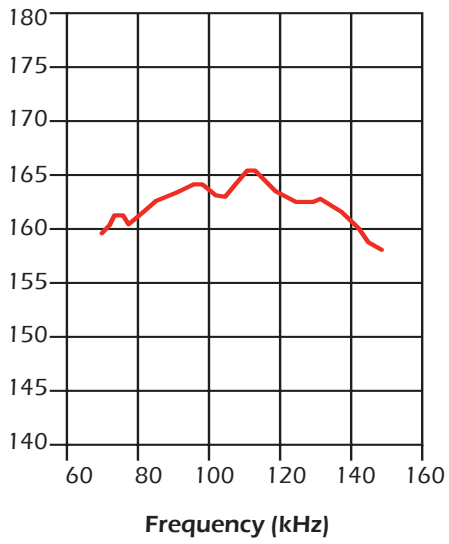
Power Rating:
- 600 W @ 1% duty cycle
- CW(4): 6W in B75, B765, B785

43 mm (1.7 in) PZT
Active Area: 15 cm^2 (2.3 in^2)
Radiating Surface: Urethane

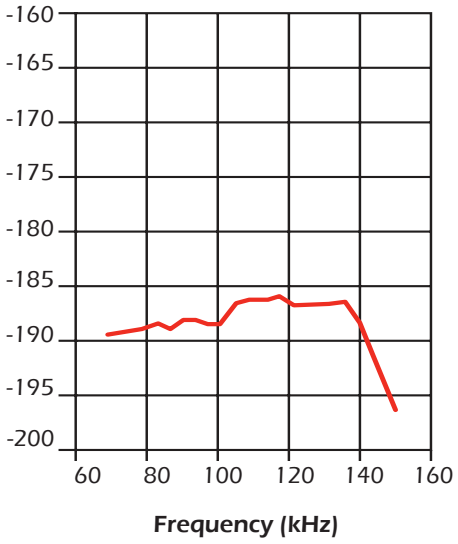
Q ≈ 2.5
Cable Type: C334
Cable Length: 12 m (40 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

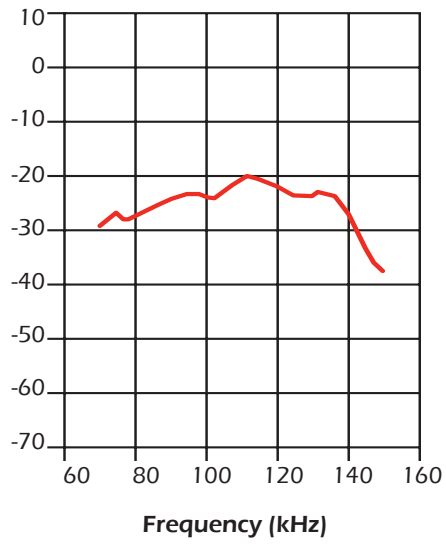
TVR



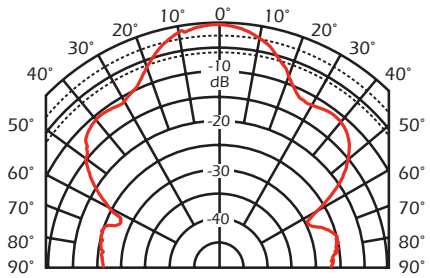
RVR



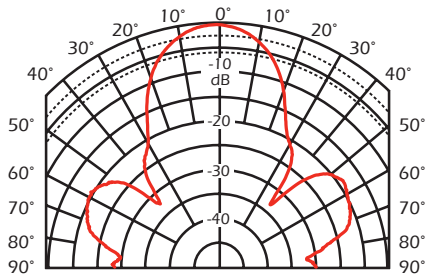
FOM



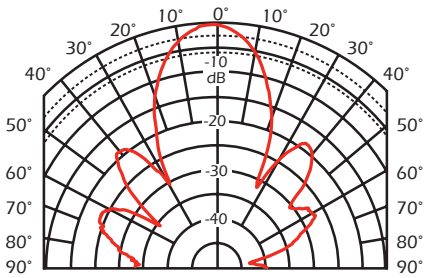
Transmit Radiation Pattern



Beamwidth	@ 80 kHz
-3 dB	24°
-6 dB	33°
-10 dB	43°



Beamwidth	@ 100 kHz
-3 dB	20°
-6 dB	29°
-10 dB	36°



Beamwidth	@ 130 kHz
-3 dB	16°
-6 dB	23°
-10 dB	29°

80 to 130 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
70.00	112.82	57.74	60.22	95.40	4.73	-7.50	211.35	-17042.10
72.00	109.93	52.61	66.76	87.33	5.52	-7.23	181.01	-15975.96
74.00	106.06	51.34	66.25	82.82	5.89	-7.36	169.77	-15835.37
76.00	109.80	51.58	68.24	86.02	5.66	-7.14	176.67	-14942.55
78.00	117.91	48.81	77.66	88.72	5.59	-6.38	179.03	-13022.05
80.00	122.20	43.56	88.55	84.21	5.93	-5.64	168.63	-11219.11
82.00	121.09	38.46	94.82	75.31	6.47	-5.14	154.64	-9968.67
84.00	116.51	35.29	95.10	67.31	7.01	-4.96	142.74	-9394.42
86.00	112.35	34.52	92.57	63.67	7.33	-5.04	136.35	-9334.78
88.00	112.53	34.68	92.54	64.02	7.31	-5.06	136.83	-9144.45
90.00	115.22	33.69	95.86	63.91	7.22	-4.81	138.48	-8514.20
92.00	115.97	31.52	98.85	60.63	7.35	-4.51	136.04	-7799.69
94.00	114.40	29.63	99.44	56.57	7.60	-4.32	131.62	-7317.73
96.00	111.06	29.59	96.58	54.84	7.83	-4.45	127.72	-7370.08
98.00	109.88	32.16	93.01	58.49	7.70	-4.84	129.79	-7868.17
100.00	114.43	35.31	93.38	66.14	7.13	-5.05	140.22	-8038.96
102.00	126.23	37.76	99.81	77.29	6.26	-4.85	159.66	-7568.24
104.00	144.84	36.21	116.86	85.57	5.57	-4.08	179.51	-6242.24
106.00	162.27	27.60	143.81	75.17	5.46	-2.85	183.10	-4286.33
108.00	156.07	19.63	147.00	52.42	6.04	-2.15	165.69	-3171.62
110.00	143.31	17.48	136.69	43.05	6.66	-2.10	150.25	-3033.01
112.00	137.74	19.31	129.99	45.55	6.85	-2.40	145.95	-3411.58
114.00	139.98	23.09	128.77	54.89	6.57	-2.80	152.17	-3911.20
116.00	153.87	25.36	139.04	65.91	5.87	-2.78	170.28	-3819.54
118.00	175.82	23.36	161.41	69.73	5.22	-2.26	191.53	-3042.09
120.00	185.83	18.33	176.40	58.44	5.11	-1.69	195.76	-2244.56
122.00	195.12	15.64	187.90	52.59	4.94	-1.38	202.62	-1801.91
124.00	208.10	11.62	203.84	41.91	4.71	-0.97	212.45	-1242.15
126.00	217.11	7.58	215.22	28.63	4.57	-0.61	219.03	-767.19
128.00	226.43	3.49	226.01	13.77	4.41	-0.27	226.85	-333.95
130.00	234.00	-1.13	233.96	-4.60	4.27	0.08	234.05	102.84
132.00	238.43	-4.07	237.83	-16.93	4.18	0.30	239.03	359.03
134.00	257.22	-5.81	255.90	-26.02	3.87	0.39	258.55	467.17
136.00	294.93	-11.35	289.16	-58.06	3.32	0.67	300.82	781.14
138.00	327.05	-22.37	302.44	-124.46	2.83	1.16	353.66	1342.03
140.00	331.62	-36.85	265.37	-198.88	2.41	1.81	414.42	2055.87

80 to 130 kHz | 2 kW / 30 W

80 to 130 kHz-B (Broadband)

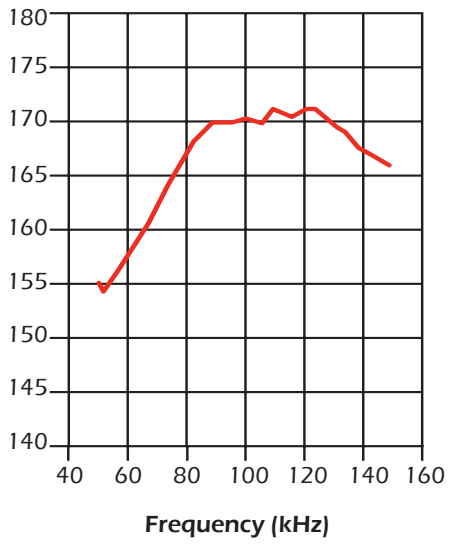
Transformed to 100 ohms minimum (B1)

Power Rating:
- 2 kW @ 1% duty cycle
- CW(4): 30W in R509, R609
  25W in CM199, CM599, PM111, R109, R111, R599

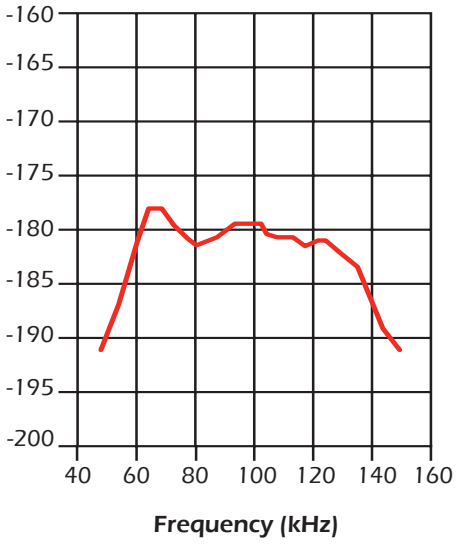
88 mm (3.46 in) PZT
Active Area: 61 cm^2 (9.4 in^2)
Radiating Surface:
Cast Resin/Urethane
Q ≈ 2
Cable Type: C44-02
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

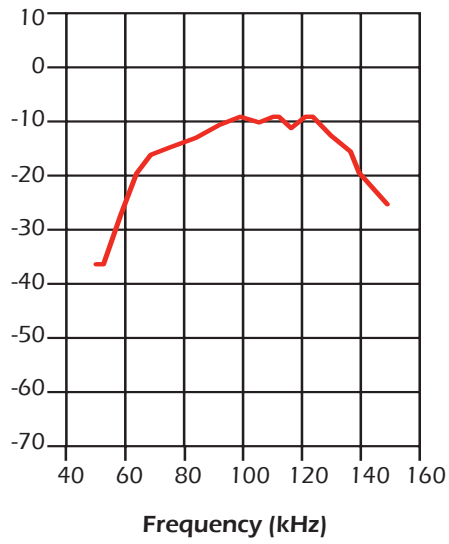
TVR



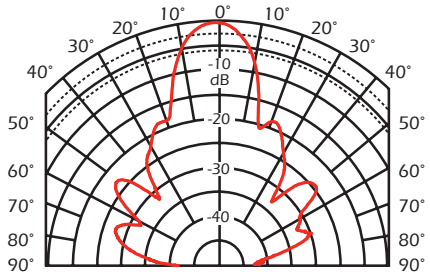
RVR



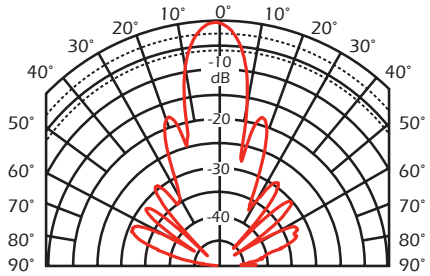
FOM



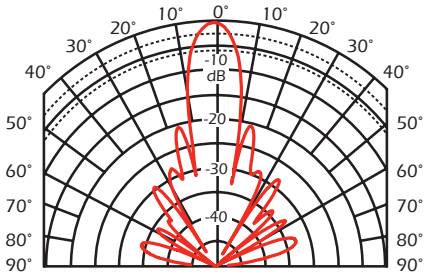
Transmit Radiation Pattern



Beamwidth	@ 80 kHz
-3 dB	13°
-6 dB	18°
-10 dB	23°



Beamwidth	@ 100 kHz
-3 dB	10°
-6 dB	13°
-10 dB	17°



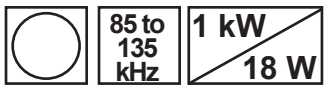
Beamwidth	@ 130 kHz
-3 dB	8°
-6 dB	11°
-10 dB	14°

80 to 130 kHz-B (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
70.00	352.49	9.16	348.00	56.10	2.80	-0.45	357.04	-1026.46
72.00	300.17	-7.39	297.68	-38.61	3.30	0.43	302.69	947.26
74.00	238.95	-15.07	230.73	-62.12	4.04	1.09	247.46	2339.85
76.00	193.20	-16.98	184.78	-56.41	4.95	1.51	202.00	3164.75
78.00	166.77	-14.88	161.18	-42.84	5.80	1.54	172.56	3142.75
80.00	152.62	-12.33	149.10	-32.60	6.40	1.40	156.22	2784.39
82.00	142.34	-10.22	140.08	-25.24	6.91	1.25	144.63	2418.34
84.00	136.54	-7.89	135.24	-18.75	7.25	1.01	137.84	1905.72
86.00	131.32	-5.61	130.69	-12.84	7.58	0.74	131.95	1377.97
88.00	128.21	-1.96	128.13	-4.39	7.80	0.27	128.28	483.53
90.00	131.64	1.95	131.56	4.48	7.59	-0.26	131.72	-456.88
92.00	141.65	3.79	141.34	9.37	7.04	-0.47	141.96	-807.72
94.00	150.64	2.53	150.50	6.66	6.63	-0.29	150.79	-497.04
96.00	156.64	-0.07	156.64	-0.19	6.38	0.01	156.64	12.52
98.00	159.32	-2.17	159.21	-6.05	6.27	0.24	159.44	386.78
100.00	162.35	-3.34	162.07	-9.46	6.15	0.36	162.62	571.22
102.00	169.56	-5.60	168.75	-16.56	5.87	0.58	170.38	898.66
104.00	174.55	-10.39	171.69	-31.47	5.64	1.03	177.45	1580.69
106.00	167.56	-15.14	161.74	-43.75	5.76	1.56	173.58	2339.90
108.00	157.16	-16.91	150.36	-45.72	6.09	1.85	164.27	2728.03
110.00	150.50	-15.71	144.88	-40.76	6.40	1.80	156.35	2603.83
112.00	153.63	-14.00	149.07	-37.18	6.32	1.58	158.34	2238.26
114.00	161.95	-15.32	156.20	-42.78	5.96	1.63	167.92	2277.07
116.00	163.62	-19.19	154.53	-53.78	5.77	2.01	173.25	2756.23
118.00	155.05	-21.19	144.57	-56.04	6.01	2.33	166.29	3144.16
120.00	152.02	-18.69	144.00	-48.73	6.23	2.11	160.49	2796.22
122.00	162.34	-17.10	155.16	-47.74	5.89	1.81	169.85	2363.38
124.00	175.29	-18.48	166.25	-55.57	5.41	1.81	184.83	2321.15
126.00	188.46	-22.04	174.69	-70.72	4.92	1.99	203.32	2515.12
128.00	197.94	-27.87	174.99	-92.52	4.47	2.36	223.91	2936.16
130.00	199.27	-34.00	165.20	-111.43	4.16	2.81	240.36	3435.51
132.00	197.51	-38.56	154.43	-123.13	3.96	3.16	252.60	3805.58
134.00	200.38	-43.53	145.29	-138.00	3.62	3.44	276.36	4082.07
136.00	199.95	-50.19	128.01	-153.60	3.20	3.84	312.32	4496.08
138.00	190.44	-57.56	102.16	-160.71	2.82	4.43	354.99	5110.90
140.00	174.34	-63.38	78.12	-155.86	2.57	5.13	389.06	5829.30



85 to 135 kHz-B (Broadband)

Transformed to 100 ohms minimum (B1)

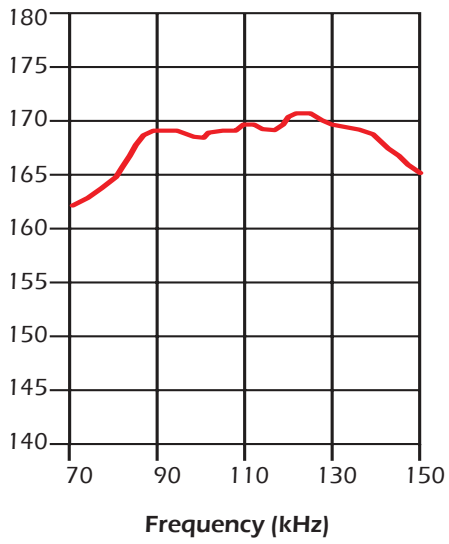
Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 18W in B175, B265, B285, PM265
  12W in M265, TM185, TM265

65 mm (2.56 in) PZT
Active Area: 33 cm² (5.1 in²)

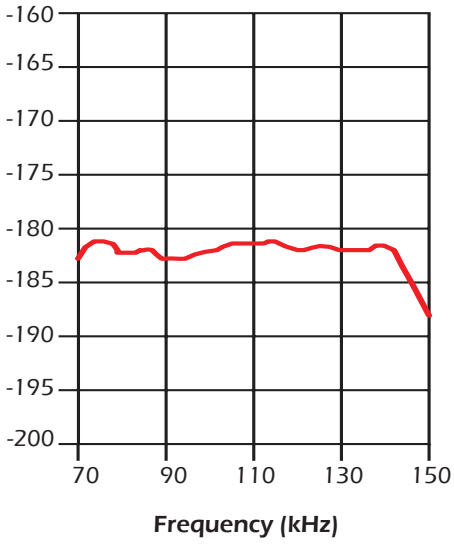
Radiating Surface: Urethane
Q ≈ 2
Cable Type: C335
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

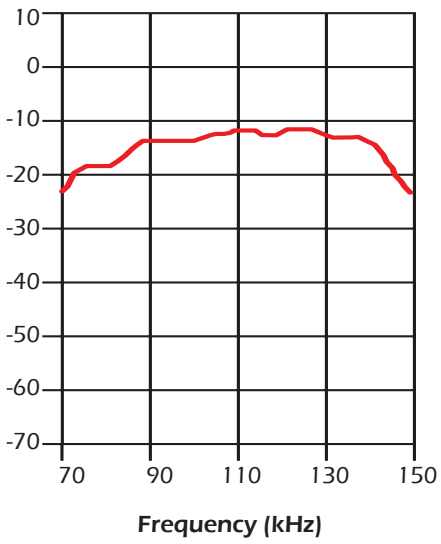
TVR



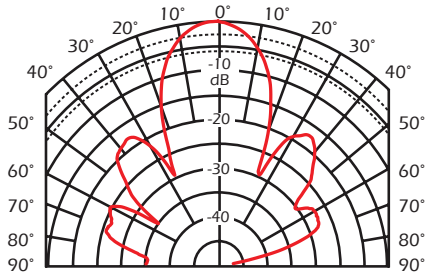
RVR



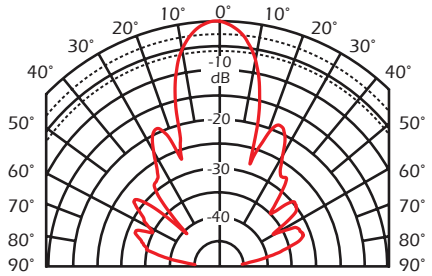
FOM



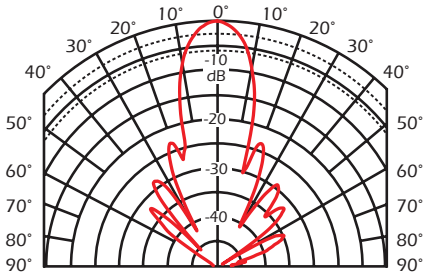
Transmit Radiation Pattern



Beamwidth	@ 85 kHz
-3 dB	16°
-6 dB	22°
-10 dB	29°



Beamwidth	@ 105 kHz
-3 dB	13°
-6 dB	18°
-10 dB	22°



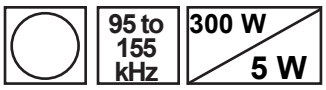
Beamwidth	@ 135 kHz
-3 dB	11°
-6 dB	15°
-10 dB	19°

85 to 135 kHz-B (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
75.00	240.21	29.30	209.48	117.57	3.63	-2.04	275.46	-4323.59
77.00	231.70	16.69	221.94	66.54	4.13	-1.24	241.89	-2561.81
79.00	204.27	7.58	202.48	26.95	4.85	-0.65	206.07	-1301.08
81.00	183.32	3.40	182.99	10.87	5.45	-0.32	183.64	-635.29
83.00	170.03	-1.06	170.00	-3.14	5.88	0.11	170.06	208.32
85.00	150.91	-5.20	150.29	-13.67	6.60	0.60	151.54	1123.61
87.00	130.38	-5.70	129.74	-12.96	7.63	0.76	131.03	1394.63
89.00	117.20	-2.52	117.09	-5.15	8.52	0.38	117.31	670.63
91.00	111.64	3.07	111.48	5.97	8.94	-0.48	111.79	-837.83
93.00	114.06	8.14	112.91	16.15	8.68	-1.24	115.22	-2124.79
95.00	120.70	10.90	118.52	22.83	8.14	-1.57	122.92	-2625.71
97.00	130.07	12.03	127.22	27.11	7.52	-1.60	133.00	-2629.03
99.00	142.17	10.29	139.88	25.39	6.92	-1.26	144.49	-2019.20
101.00	148.32	6.09	147.49	15.73	6.70	-0.71	149.16	-1126.55
103.00	149.11	3.53	148.82	9.19	6.69	-0.41	149.39	-638.51
105.00	152.85	1.70	152.78	4.52	6.54	-0.19	152.92	-293.52
107.00	156.36	-1.39	156.31	-3.80	6.39	0.16	156.40	230.91
109.00	155.91	-3.97	155.54	-10.80	6.40	0.44	156.29	648.58
111.00	156.14	-4.98	155.55	-13.55	6.38	0.56	156.73	797.02
113.00	164.32	-5.79	163.48	-16.59	6.05	0.61	165.16	865.42
115.00	174.54	-11.92	170.77	-36.06	5.61	1.18	178.39	1638.25
117.00	164.75	-19.34	155.45	-54.57	5.73	2.01	174.60	2734.69
119.00	148.66	-20.46	139.28	-51.96	6.30	2.35	158.67	3144.64
121.00	142.19	-17.38	135.70	-42.47	6.71	2.10	148.99	2762.55
123.00	147.06	-14.66	142.28	-37.23	6.58	1.72	152.02	2227.19
125.00	157.33	-15.05	151.93	-40.86	6.14	1.65	162.92	2101.98
127.00	165.42	-17.43	157.83	-49.55	5.77	1.81	173.39	2269.18
129.00	170.32	-20.27	159.77	-59.00	5.51	2.03	181.56	2509.22
131.00	173.62	-22.89	159.96	-67.53	5.31	2.24	188.46	2721.46
133.00	177.00	-24.58	160.96	-73.63	5.14	2.35	194.64	2812.33
135.00	185.77	-25.74	167.34	-80.67	4.85	2.34	206.23	2755.77
137.00	201.62	-28.69	176.86	-96.81	4.35	2.38	229.85	2766.43
139.00	219.05	-34.90	179.66	-125.31	3.74	2.61	267.06	2990.37
141.00	229.49	-43.85	165.50	-158.98	3.14	3.02	318.22	3407.39
143.00	224.57	-54.12	131.63	-181.95	2.61	3.61	383.13	4015.33
145.00	206.22	-62.51	95.20	-182.93	2.24	4.30	446.71	4721.54



95 to 155 kHz-A (Broadband)

Transformed to 100 ohms minimum (B1)

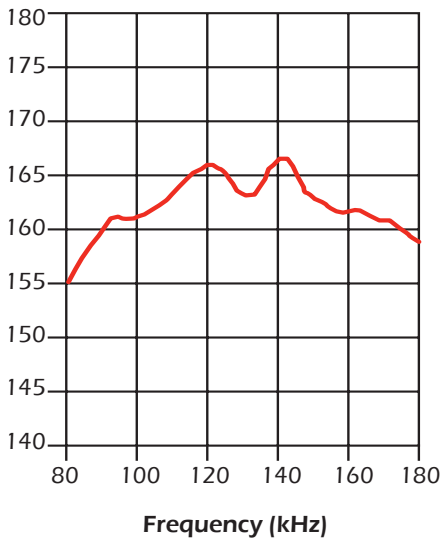
Power Rating:
- 300 W @ 1% duty cycle
- CW(4): 5W in TM150

33 mm (1.3 in) PZT
Active Area: 8.6 cm² (1.33 in²)
Radiating Surface: Plastic/Urethane

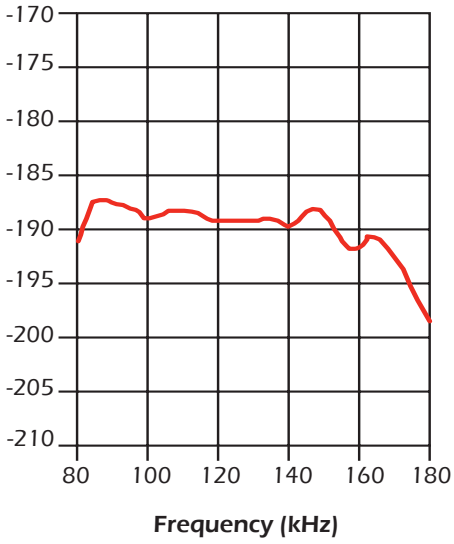
Q ≈ 2
Cable Type: C332
Cable Length: 12.2 m (40 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

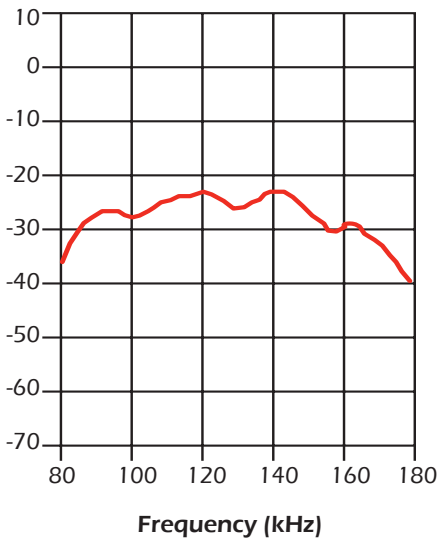
TVR



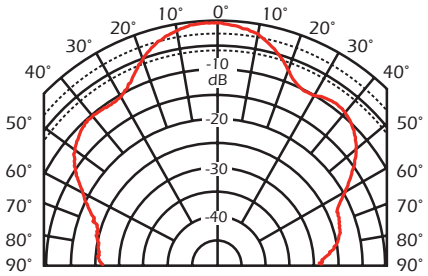
RVR



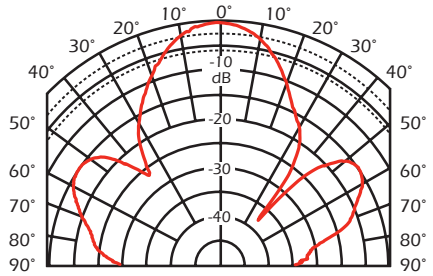
FOM



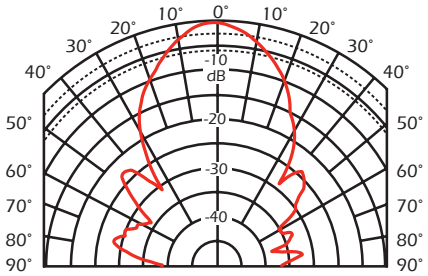
Transmit Radiation Pattern



Beamwidth	@ 100 kHz
-3 dB	26°
-6 dB	36°
-10 dB	48°



Beamwidth	@ 130 kHz
-3 dB	20°
-6 dB	28°
-10 dB	38°



Beamwidth	@ 155 kHz
-3 dB	17°
-6 dB	27°
-10 dB	37°

95 to 155 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
80.00	178.44	67.21	69.11	164.52	2.17	-5.17	460.73	-10278.73
82.00	199.11	58.75	103.28	170.23	2.61	-4.29	383.86	-8333.88
84.00	211.58	48.29	140.78	157.95	3.14	-3.53	317.99	-6684.97
86.00	210.94	37.52	167.30	128.47	3.76	-2.89	265.95	-5343.30
90.00	180.92	23.09	166.43	70.94	5.08	-2.17	196.67	-3832.67
92.00	167.53	21.50	155.88	61.40	5.55	-2.19	180.06	-3784.37
94.00	164.56	20.99	153.64	58.93	5.67	-2.18	176.25	-3684.85
96.00	166.98	17.95	158.85	51.45	5.70	-1.85	175.52	-3059.46
100.00	154.41	11.97	151.05	32.04	6.34	-1.34	157.85	-2138.58
102.00	153.02	11.81	149.78	31.33	6.40	-1.34	156.33	-2087.81
104.00	156.97	9.20	154.95	25.10	6.29	-1.02	159.02	-1558.93
106.00	156.66	5.33	155.98	14.54	6.36	-0.59	157.34	-889.60
110.00	145.30	-1.52	145.25	-3.85	6.88	0.18	145.35	263.51
112.00	136.73	-3.95	136.40	-9.42	7.30	0.50	137.06	716.22
114.00	128.11	-5.04	127.61	-11.25	7.78	0.69	128.60	956.61
116.00	119.12	-4.37	118.77	-9.07	8.37	0.64	119.47	877.47
120.00	108.19	0.96	108.18	1.81	9.24	-0.15	108.21	-205.08
122.00	109.22	5.42	108.74	10.31	9.11	-0.86	109.72	-1127.90
124.00	114.75	9.90	113.05	19.73	8.58	-1.50	116.49	-1923.29
126.00	125.70	12.08	122.92	26.30	7.78	-1.66	128.55	-2102.27
130.00	151.43	6.81	150.36	17.96	6.56	-0.78	152.51	-958.67
132.00	162.04	2.38	161.90	6.73	6.17	-0.26	162.18	-309.14
134.00	167.14	-5.39	166.40	-15.71	5.96	0.56	167.88	667.81
136.00	152.99	-14.45	148.15	-38.17	6.33	1.63	157.99	1908.51
140.00	114.09	-9.14	112.64	-18.13	8.65	1.39	115.56	1583.09
142.00	114.08	0.71	114.07	1.41	8.77	-0.11	114.08	-121.62
144.00	130.50	8.12	129.19	18.43	7.59	-1.08	131.82	-1196.05
146.00	159.78	8.97	157.83	24.91	6.18	-0.98	161.76	-1063.50
150.00	206.57	-5.14	205.74	-18.50	4.82	0.43	207.41	459.90
152.00	207.79	-13.71	201.87	-49.26	4.68	1.14	213.89	1194.55
154.00	198.87	-19.31	187.68	-65.78	4.75	1.66	210.73	1718.79
156.00	193.00	-21.28	179.84	-70.03	4.83	1.88	207.12	1918.21
160.00	192.88	-23.41	177.01	-76.63	4.76	2.06	210.18	2048.87
162.00	208.47	-23.87	190.63	-84.37	4.39	1.94	227.98	1907.37
164.00	230.93	-28.91	202.15	-111.64	3.79	2.09	263.81	2031.57
166.00	244.13	-37.53	193.60	-148.72	3.25	2.50	307.85	2392.46
170.00	232.28	-55.00	133.22	-190.28	2.47	3.53	404.99	3301.68
172.00	216.30	-62.14	101.09	-191.22	2.16	4.09	462.79	3782.00
174.00	198.16	-67.77	74.96	-183.43	1.91	4.67	523.85	4272.92
176.00	180.20	-71.90	55.97	-171.28	1.72	5.28	580.14	4770.12
180.00	150.66	-76.77	34.47	-146.66	1.52	6.46	658.53	5713.23

95 to 155 kHz | 300 W / 5 W

95 to 155 kHz-A (Broadband)

Transformed to 650 ohms minimum (B4)

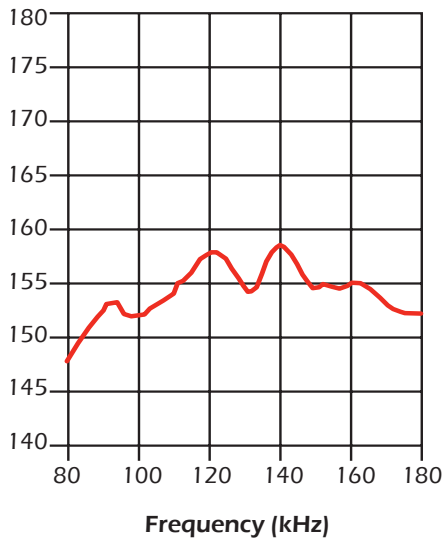
Power Rating:
- 300 W @ 1% duty cycle
- CW(4): 5W in TM150

33 mm (1.3 in) PZT
Active Area: 8.6 cm^2 (1.33 in^2)
Radiating Surface: Plastic/Urethane

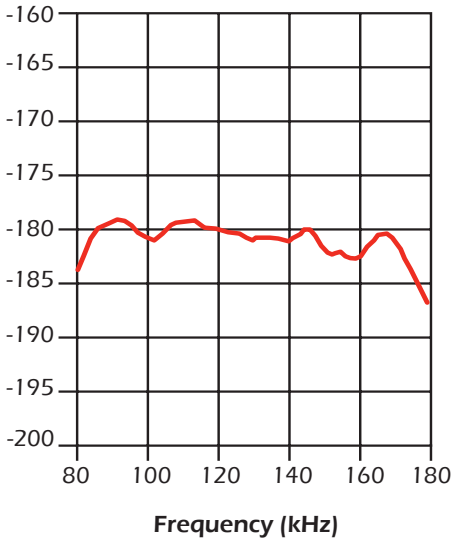
Q ≈ 2
Cable Type: C315
Cable Length: 12.2 m (40 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

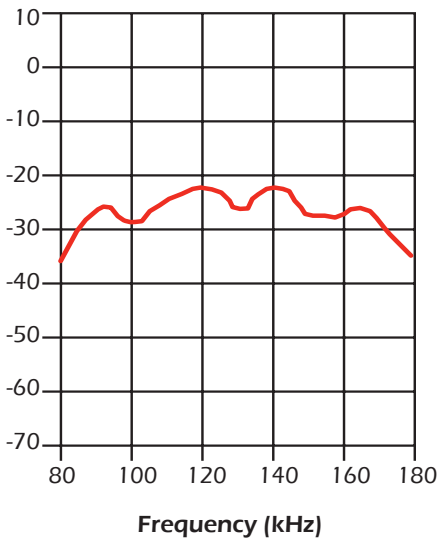
TVR



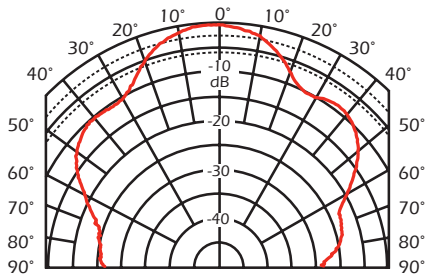
RVR



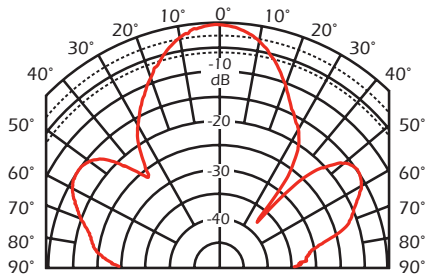
FOM



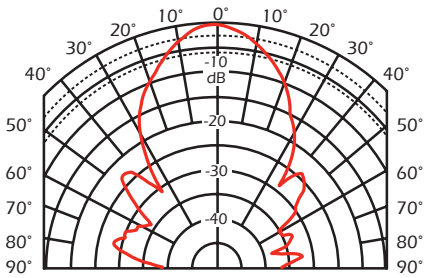
Transmit Radiation Pattern



Beamwidth	@ 100 kHz
-3 dB	26°
-6 dB	36°
-10 dB	48°



Beamwidth	@ 130 kHz
-3 dB	20°
-6 dB	28°
-10 dB	38°



Beamwidth	@ 155 kHz
-3 dB	17°
-6 dB	27°
-10 dB	37°

95 to 155 kHz-A (Broadband) Transformed to 650 ohms minimum (B4)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
80.00	916.49	70.00	313.42	861.23	0.37	-1.03	2679.93	-2039.83
82.00	997.24	62.38	462.34	883.59	0.46	-0.89	2151.00	-1724.48
84.00	1041.05	53.67	616.71	838.72	0.57	-0.77	1757.38	-1466.28
86.00	1037.49	45.50	727.24	739.94	0.68	-0.69	1480.10	-1272.18
90.00	923.15	34.64	759.51	524.75	0.89	-0.62	1122.06	-1088.88
92.00	874.76	34.23	723.19	492.13	0.95	-0.64	1058.08	-1112.59
94.00	880.40	35.21	719.29	507.67	0.93	-0.66	1077.60	-1108.96
96.00	937.96	33.87	778.79	522.73	0.89	-0.59	1129.65	-985.06
100.00	945.48	24.77	858.50	396.11	0.96	-0.44	1041.27	-705.24
102.00	927.80	23.46	851.10	369.38	0.99	-0.43	1011.41	-669.55
104.00	947.77	22.24	877.26	358.74	0.98	-0.40	1023.96	-611.17
106.00	977.01	19.68	919.96	328.97	0.96	-0.34	1037.60	-517.46
110.00	1020.93	9.61	1006.59	170.52	0.97	-0.16	1035.48	-236.71
112.00	969.61	3.07	968.22	51.90	1.03	-0.06	971.01	-78.45
114.00	884.17	-1.33	883.93	-20.54	1.13	0.03	884.41	36.68
116.00	787.44	-2.88	786.44	-39.62	1.27	0.06	788.44	87.67
120.00	641.63	3.70	640.29	41.42	1.56	-0.10	642.97	-133.43
122.00	629.35	11.42	616.89	124.61	1.56	-0.31	642.07	-410.43
124.00	674.02	18.66	638.59	215.64	1.41	-0.47	711.41	-609.24
126.00	769.04	22.06	712.75	288.81	1.21	-0.49	829.78	-616.84
130.00	978.48	18.95	925.45	317.76	0.97	-0.33	1034.56	-406.32
132.00	1110.97	13.31	1081.13	255.77	0.88	-0.21	1141.64	-249.85
134.00	1152.81	0.89	1152.67	17.81	0.87	-0.01	1152.95	-15.91
136.00	987.85	-7.62	979.13	-131.01	1.00	0.13	996.66	157.11
140.00	748.89	0.97	748.78	12.74	1.34	-0.02	748.99	-25.82
142.00	760.08	11.01	746.10	145.11	1.29	-0.25	774.32	-281.53
144.00	868.55	19.58	818.32	291.06	1.08	-0.39	921.85	-426.44
146.00	1077.20	23.04	991.29	421.56	0.85	-0.36	1170.56	-396.03
150.00	1572.14	4.28	1567.75	117.38	0.63	-0.05	1576.54	-50.39
152.00	1428.87	-5.47	1422.36	-136.22	0.70	0.07	1435.41	69.86
154.00	1342.47	-4.58	1338.19	-107.14	0.74	0.06	1346.77	61.44
156.00	1389.17	-5.03	1383.82	-121.85	0.72	0.06	1394.54	64.42
160.00	1392.87	1.12	1392.61	27.12	0.72	-0.01	1393.13	-13.90
162.00	1697.04	7.69	1681.80	226.94	0.58	-0.08	1712.42	-77.42
164.00	2306.70	7.02	2289.40	282.00	0.43	-0.05	2324.13	-51.43
166.00	3240.10	-2.33	3237.41	-131.89	0.31	0.01	3242.79	12.04
170.00	4658.03	-59.88	2337.78	-4028.90	0.11	0.19	9281.12	173.84
172.00	3392.88	-82.65	434.08	-3365.00	0.04	0.29	26519.55	270.48
174.00	2531.45	-91.55	-68.63	-2530.52	-0.01	0.39	-93375.72	361.20
176.00	2038.93	-95.74	-203.98	-2028.70	-0.05	0.49	-20381.06	441.29
180.00	1489.48	-100.18	-263.18	-1466.05	-0.12	0.66	-8429.92	584.29

120 to 220 kHz-A (Broadband)

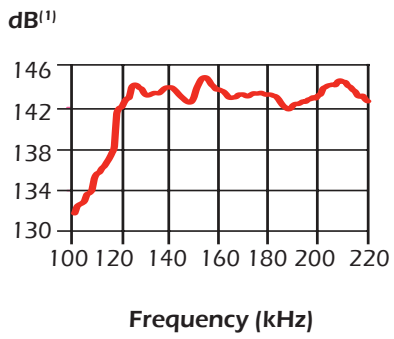
Power Rating:
- 250 W @ 1% duty cycle

21 mm (0.85”) PZT
Active Area: 3.5 cm²
Radiating Surface: Epoxy/Urethane

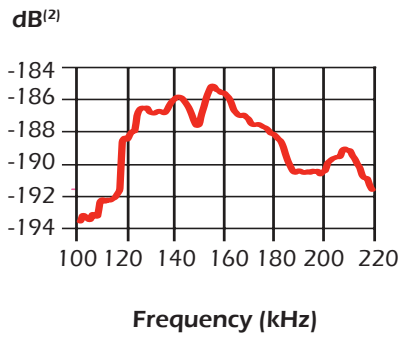
Cable Type: Custom
Cable Length: 9 m (30 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

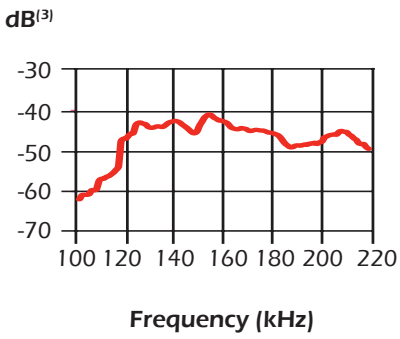
TVR



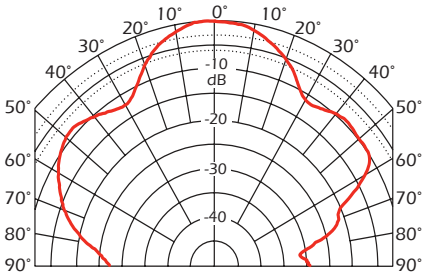
RVR



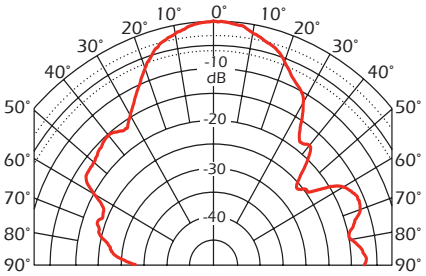
FOM



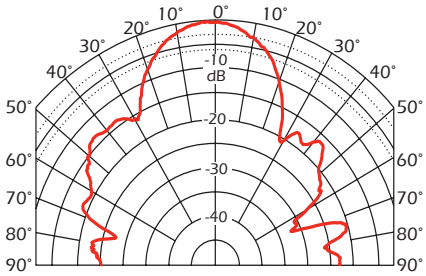
Transmit Radiation Pattern



Beamwidth	@ 125 kHz
-3 dB	26°
-6 dB	37°
-10 dB	47°



Beamwidth	@ 160 kHz
-3 dB	24°
-6 dB	35°
-10 dB	46°



Beamwidth	@ 200 kHz
-3 dB	22°
-6 dB	31°
-10 dB	31°

120 to 220 kHz-A (Broadband)

Note: Impedance data includes cable

Impedance Data	
1 kHz capacitance: 620 pF: ±20%	Rp @ 160 kHz = 5500 Ω: -20%, +40%
Rp Range: 3500 to 10,000 Ω: -20%, +40%	Rp @ 200 kHz = 7000 Ω: -20%, +40%

Unbalanced Impedance Table (Nominal Value)

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
100.00	2805.63	-84.30	278.51	-2791.77	0.04	0.35	28262.79	564.47
104.00	2577.26	-83.90	273.72	-2562.68	0.04	0.39	24266.43	590.43
108.00	2357.68	-82.67	300.83	-2338.41	0.05	0.42	18477.94	619.94
112.00	2163.10	-80.59	353.84	-2133.96	0.08	0.46	13223.43	648.09
116.00	1976.58	-77.54	426.33	-1930.05	0.11	0.49	9163.92	677.80
120.00	1803.78	-71.15	582.77	-1707.04	0.18	0.52	5582.99	695.85
124.00	1785.28	-62.13	834.67	-1578.15	0.26	0.50	3818.56	635.53
128.00	1977.57	-56.23	1099.14	-1643.98	0.28	0.42	3558.03	522.69
132.00	2096.53	-56.93	1144.01	-1756.89	0.26	0.40	3842.13	481.94
136.00	2118.37	-54.84	1219.96	-1731.81	0.27	0.39	3678.38	451.63
140.00	2293.24	-52.79	1386.73	-1826.46	0.26	0.35	3792.35	394.82
144.00	2490.09	-56.58	1371.32	-2078.47	0.22	0.34	4521.58	370.48
148.00	2319.19	-61.20	1117.44	-2032.23	0.21	0.38	4813.37	406.31
152.00	2267.27	-54.16	1327.62	-1837.91	0.26	0.36	3871.97	374.37
156.00	2601.61	-54.01	1528.72	-2105.09	0.23	0.31	4427.47	317.31
160.00	2751.53	-59.96	1377.29	-2382.02	0.18	0.31	5496.98	312.97
164.00	2694.37	-64.87	1144.17	-2439.37	0.16	0.34	6344.90	326.09
168.00	2584.06	-67.36	994.86	-2384.87	0.15	0.36	6711.86	338.35
172.00	2507.60	-68.58	915.65	-2334.45	0.15	0.37	6867.29	343.53
176.00	2458.34	-69.75	851.04	-2306.33	0.14	0.38	7101.25	345.10
180.00	2420.31	-70.84	794.55	-2286.17	0.14	0.39	7372.56	345.08
184.00	2373.34	-72.75	703.95	-2266.54	0.13	0.40	8001.60	348.05
188.00	2265.23	-74.24	615.42	-2180.03	0.12	0.42	8337.89	359.67
192.00	2175.57	-73.56	615.77	-2086.61	0.13	0.44	7686.50	365.44
196.00	2144.00	-73.48	609.61	-2055.51	0.13	0.45	7540.40	363.11
200.00	2092.22	-72.53	628.08	-1995.72	0.14	0.46	6969.50	362.81
204.00	2114.02	-70.97	689.42	-1998.44	0.15	0.45	6482.38	348.87
208.00	2186.45	-71.31	700.71	-2071.13	0.15	0.43	6822.48	331.50
212.00	2225.15	-73.72	623.62	-2135.98	0.13	0.43	7939.60	323.86
216.00	2198.87	-76.29	521.31	-2136.18	0.11	0.44	9274.84	325.54
220.00	2147.10	-77.85	452.08	-2098.97	0.10	0.46	10197.40	329.38

120 to 220 kHz-A (Broadband)

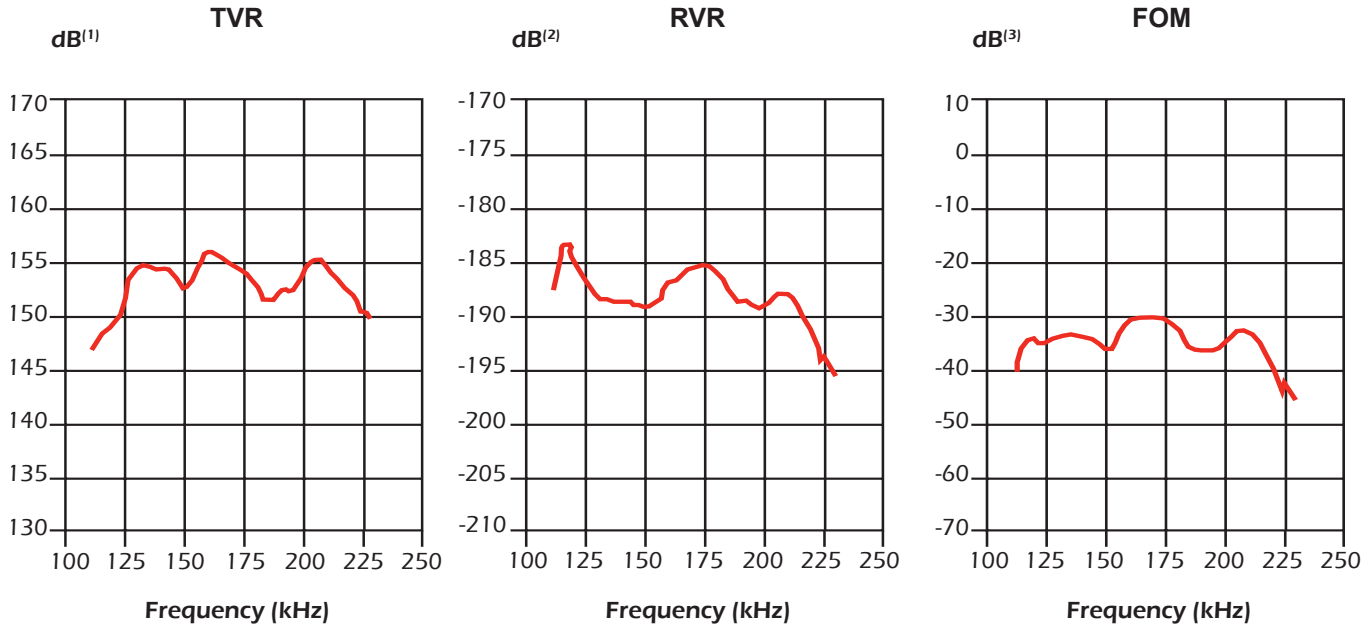
Transformed to 500 ohms minimum

Power Rating:
- 250 W @ 1% duty cycle

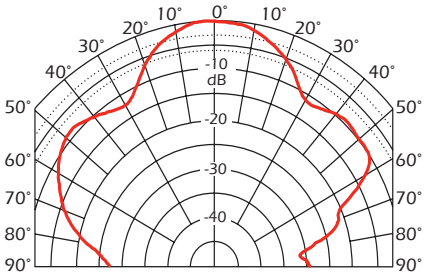
21 mm (0.85”) PZT
Active Area: 3.5 cm² (0.54 in²)
Radiating Surface: Urethane

Q ≈ 3
Cable Type: RG178
Cable Length: 0.15 m (6 in)

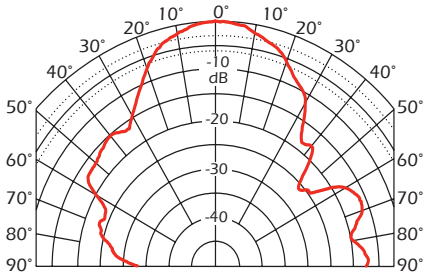
Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response



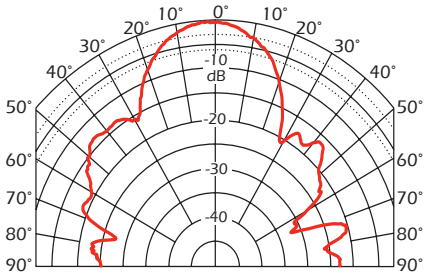
Transmit Radiation Pattern



Beamwidth	@ 125 kHz
-3 dB	26°
-6 dB	37°
-10 dB	47°



Beamwidth	@ 160 kHz
-3 dB	24°
-6 dB	35°
-10 dB	46°



Beamwidth	@ 200 kHz
-3 dB	22°
-6 dB	31°
-10 dB	31°

120 to 220 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
110.00	853.24	71.53	270.30	809.30	0.37	-1.11	2693.36	-1608.38
113.00	1049.63	60.52	516.56	913.72	0.47	-0.83	2132.79	-1168.11
116.00	1193.12	43.23	869.28	817.24	0.61	-0.57	1637.60	-787.67
120.00	1145.44	15.64	1103.05	308.73	0.84	-0.24	1189.46	-312.09
121.00	1070.94	9.10	1057.47	169.34	0.92	-0.15	1084.58	-194.21
124.00	798.00	-3.43	796.57	-47.73	1.25	0.08	799.43	96.21
127.00	586.39	-3.87	585.06	-39.55	1.70	0.12	587.73	144.15
130.00	488.91	3.54	487.97	30.21	2.04	-0.13	489.84	-154.72
133.00	465.09	10.68	457.03	86.21	2.11	-0.40	473.30	-476.90
136.00	466.14	15.35	449.51	123.40	2.07	-0.57	483.39	-664.61
139.00	476.41	18.06	452.93	147.73	2.00	-0.65	501.11	-745.25
142.00	485.87	20.17	456.08	167.50	1.93	-0.71	517.60	-795.27
145.00	504.58	22.34	466.72	191.76	1.83	-0.75	545.51	-826.71
148.00	542.31	23.31	498.05	214.61	1.69	-0.73	590.52	-784.69
151.00	584.04	19.81	549.47	197.95	1.61	-0.58	620.78	-611.67
154.00	564.35	15.72	543.24	152.90	1.71	-0.48	586.28	-496.16
157.00	533.93	17.60	508.93	161.46	1.79	-0.57	560.15	-574.15
160.00	542.95	22.14	502.90	204.65	1.71	-0.69	586.18	-690.55
163.00	587.83	25.43	530.86	252.46	1.54	-0.73	650.92	-713.38
166.00	654.23	26.74	584.24	294.40	1.37	-0.69	732.59	-659.48
169.00	736.87	25.68	664.10	319.29	1.22	-0.59	817.61	-553.78
172.00	822.49	22.33	760.82	312.48	1.12	-0.46	889.16	-427.42
175.00	893.57	17.85	850.57	273.87	1.07	-0.34	938.75	-311.93
178.00	961.69	13.69	934.35	227.65	1.01	-0.25	989.82	-220.09
181.00	1052.38	8.65	1040.42	158.22	0.94	-0.14	1064.48	-125.62
184.00	1145.19	-0.02	1145.19	-0.34	0.87	0.00	1145.19	0.22
187.00	1126.32	-10.84	1106.23	-211.76	0.87	0.17	1146.77	142.07
190.00	1032.24	-15.93	992.59	-283.35	0.93	0.27	1073.48	222.76
193.00	1032.84	-17.53	984.90	-311.02	0.92	0.29	1083.12	240.43
196.00	1041.32	-25.26	941.71	-444.43	0.87	0.41	1151.46	332.82
199.00	931.23	-30.92	798.88	-478.52	0.92	0.55	1085.50	441.32
202.00	842.82	-29.79	731.41	-418.79	1.03	0.59	971.21	464.51
205.00	837.65	-26.12	752.12	-368.74	1.07	0.53	932.90	408.00
208.00	908.18	-24.54	826.14	-377.22	1.00	0.46	998.38	349.95
211.00	1020.17	-27.99	900.81	-478.85	0.87	0.46	1155.35	347.05
214.00	1096.79	-36.32	883.67	-649.68	0.73	0.54	1361.32	401.66
217.00	1086.30	-45.72	758.43	-777.71	0.64	0.66	1555.91	483.37
219.00	1041.55	-50.82	658.05	-807.34	0.61	0.74	1648.56	540.85
220.00	1014.64	-52.83	613.09	-808.47	0.60	0.79	1679.20	568.12
224.00	920.17	-57.84	489.78	-778.99	0.58	0.92	1728.76	653.68
227.00	891.17	-60.25	442.26	-773.69	0.56	0.97	1795.75	683.03
230.00	873.70	-64.72	373.16	-790.00	0.49	1.03	2045.64	716.13

130 to 210 kHz-B (Broadband)

Transformed to 60 ohms minimum (B3)

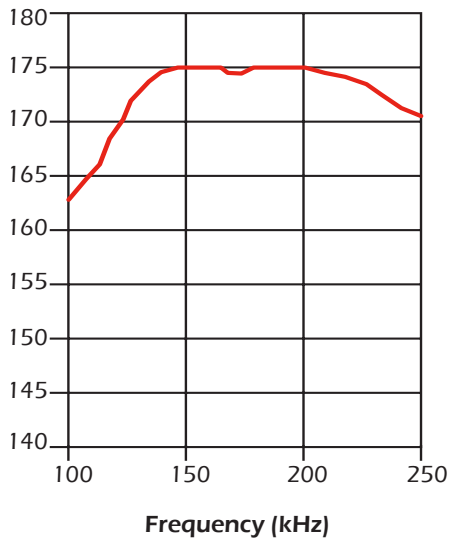
Power Rating:
- 2 kW @ 1% duty cycle
- CW(4): 25W in M563

88 mm (3.46 in) PZT
Active Area: 61 cm² (9.4 in²)
Radiating Surface:
Cast Resin/Urethane

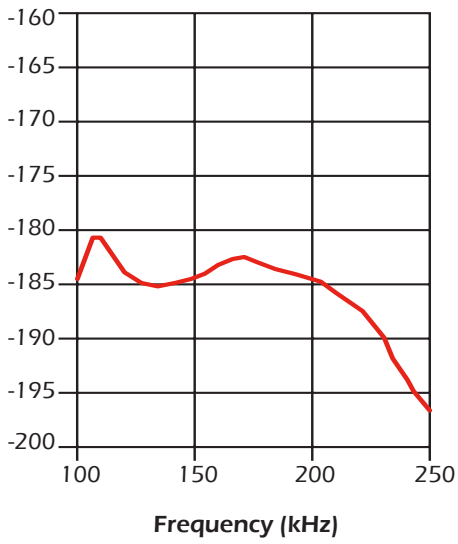
Q ≈ 2
Cable Type: C44-02
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

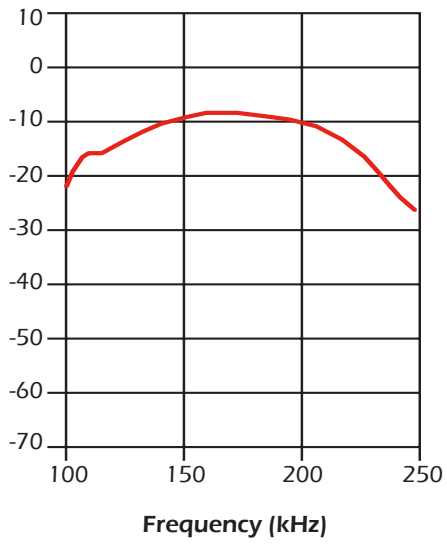
TVR



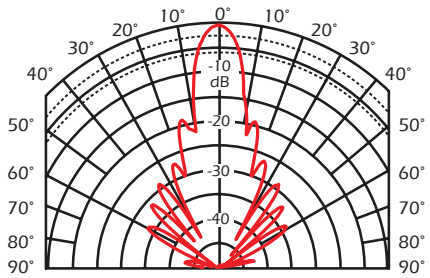
RVR



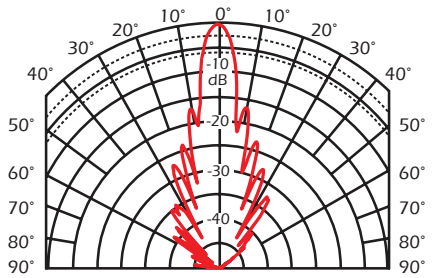
FOM



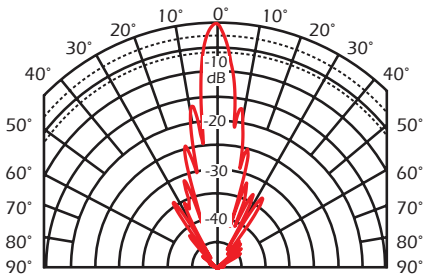
Transmit Radiation Pattern



Beamwidth	@ 130 kHz
-3 dB	8°
-6 dB	11°
-10 dB	13°



Beamwidth	@ 170 kHz
-3 dB	5°
-6 dB	7°
-10 dB	10°



Beamwidth	@ 210 kHz
-3 dB	4°
-6 dB	6°
-10 dB	8°

130 to 210 kHz-B (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
100.00	220.47	53.26	131.89	176.67	2.71	-3.63	368.55	-5784.85
104.00	281.46	32.21	238.15	150.01	3.01	-1.89	332.64	-2897.86
108.00	269.04	2.00	268.88	9.40	3.71	-0.13	269.21	-191.34
112.00	205.58	-15.71	197.90	-55.68	4.68	1.32	213.57	1871.96
116.00	158.45	-25.23	143.33	-67.55	5.71	2.69	175.17	3691.53
120.00	124.84	-28.56	109.65	-59.69	7.04	3.83	142.14	5079.26
124.00	105.15	-28.78	92.16	-50.62	8.34	4.58	119.96	5876.99
125.00	101.53	-28.85	88.93	-48.98	8.63	4.75	115.91	6050.44
129.00	87.41	-29.03	76.43	-42.42	10.00	5.55	99.97	6849.70
130.00	84.11	-28.68	73.79	-40.36	10.43	5.70	95.87	6984.37
134.00	72.78	-26.05	65.39	-31.96	12.34	6.03	81.01	7166.26
138.00	65.13	-20.82	60.88	-23.15	14.35	5.46	69.68	6293.52
142.00	61.40	-13.57	59.69	-14.40	15.83	3.82	63.16	4281.84
146.00	61.79	-6.64	61.37	-7.14	16.08	1.87	62.21	2040.09
150.00	65.20	-1.05	65.19	-1.20	15.34	0.28	65.21	298.40
154.00	72.93	1.80	72.89	2.29	13.71	-0.43	72.96	-444.21
158.00	80.79	-0.64	80.79	-0.90	12.38	0.14	80.80	138.50
162.00	82.93	-4.26	82.70	-6.15	12.03	0.89	83.16	879.13
166.00	84.39	-6.46	83.86	-9.50	11.77	1.33	84.93	1278.85
170.00	84.51	-9.62	83.32	-14.13	11.67	1.98	85.72	1852.18
174.00	80.51	-10.18	79.25	-14.23	12.22	2.20	81.80	2007.81
178.00	81.72	-7.19	81.08	-10.22	12.14	1.53	82.36	1368.63
182.00	86.70	-6.73	86.10	-10.16	11.45	1.35	87.30	1181.50
186.00	92.43	-6.38	91.86	-10.27	10.75	1.20	93.01	1028.71
190.00	103.88	-8.52	102.74	-15.40	9.52	1.43	105.04	1194.99
194.00	112.01	-14.97	108.20	-28.94	8.63	2.31	115.94	1892.20
198.00	114.96	-19.80	108.16	-38.94	8.18	2.95	122.18	2368.63
202.00	120.70	-25.52	108.92	-52.00	7.48	3.57	133.75	2812.27
206.00	122.04	-33.29	102.02	-66.99	6.85	4.50	146.00	3474.63
210.00	120.11	-39.54	92.63	-76.46	6.42	5.30	155.75	4016.89
214.00	119.09	-46.43	82.08	-86.29	5.79	6.08	172.80	4524.73
218.00	114.08	-54.55	66.17	-92.93	5.08	7.14	196.70	5213.17
222.00	104.38	-61.42	49.94	-91.66	4.58	8.41	218.20	6031.16
226.00	94.34	-66.66	37.37	-86.62	4.20	9.73	238.14	6853.89
230.00	84.93	-70.63	28.17	-80.13	3.90	11.11	256.11	7686.08

130 to 210 kHz | 2 kW / 30 W

130 to 210 kHz-B (Broadband)

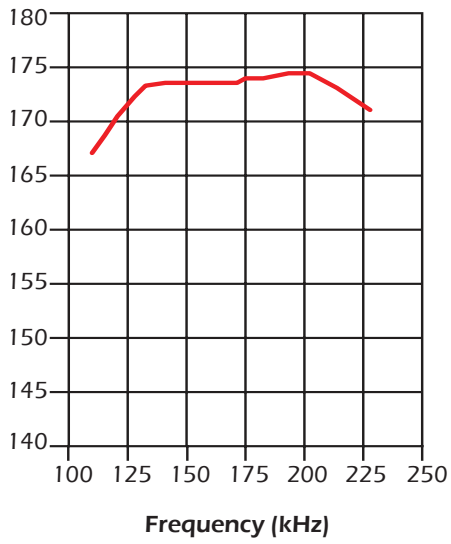
Transformed to 100 ohms minimum (B1)

Power Rating:
- 2 kW @ 1% duty cycle
- CW(4): 30W in R509, R609
  25W in CM199, CM599, PM111, R109, R111, R599

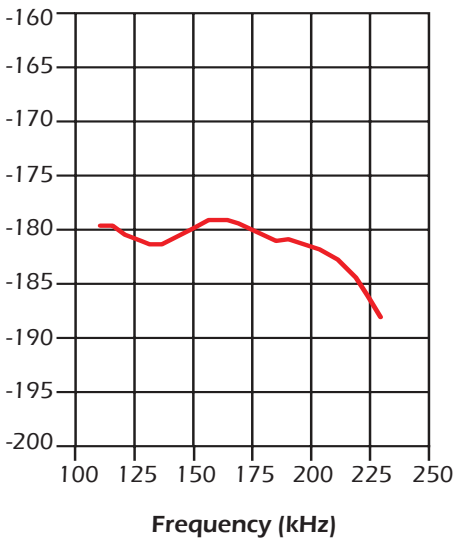
88 mm (3.46 in) PZT
Active Area: 61 cm^2 (9.4 in^2)
Radiating Surface:
Cast Resin/Urethane
Q ≈ 2
Cable Type: C44-02
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

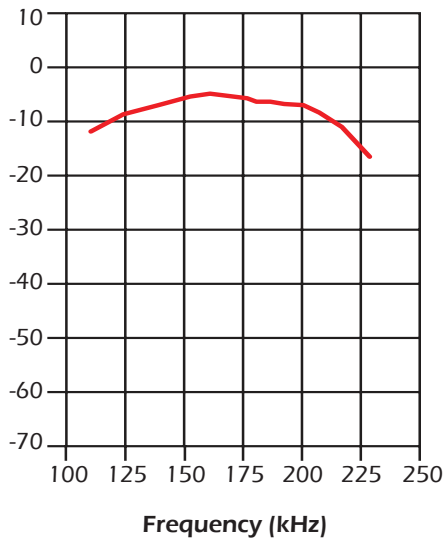
TVR



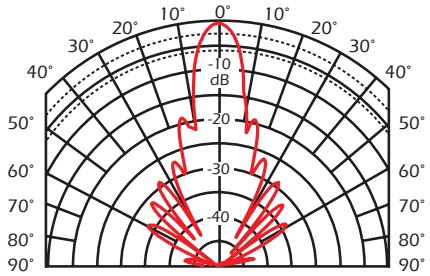
RVR



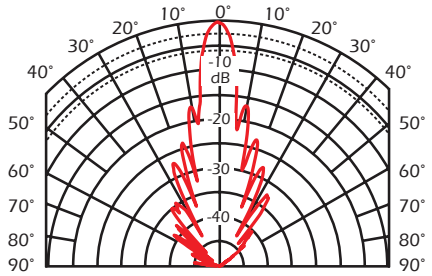
FOM



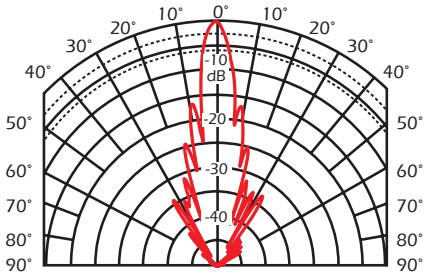
Transmit Radiation Pattern



Beamwidth	@ 130 kHz
-3 dB	8°
-6 dB	11°
-10 dB	13°



Beamwidth	@ 170 kHz
-3 dB	5°
-6 dB	7°
-10 dB	10°



Beamwidth	@ 210 kHz
-3 dB	4°
-6 dB	6°
-10 dB	8°

130 to 210 kHz-B (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
130.00	127.94	8.78	126.44	19.53	7.72	-1.19	129.46	-1460.93
132.00	123.02	10.90	120.80	23.26	7.98	-1.54	125.28	-1853.13
134.00	121.05	13.32	117.79	27.89	8.04	-1.90	124.39	-2260.49
136.00	120.96	15.92	116.32	33.18	7.95	-2.27	125.79	-2653.65
138.00	123.25	17.77	117.37	37.60	7.73	-2.48	129.42	-2855.27
140.00	126.15	19.31	119.05	41.71	7.48	-2.62	133.67	-2979.87
142.00	130.22	20.36	122.08	45.31	7.20	-2.67	138.90	-2994.68
144.00	134.62	20.96	125.71	48.16	6.94	-2.66	144.16	-2937.23
146.00	140.58	21.15	131.11	50.73	6.63	-2.57	150.73	-2798.26
148.00	146.38	20.82	136.82	52.04	6.39	-2.43	156.61	-2611.53
150.00	151.99	20.04	142.78	52.09	6.18	-2.26	161.79	-2392.65
152.00	158.03	19.08	149.35	51.66	5.98	-2.07	167.22	-2165.81
154.00	164.22	17.90	156.28	50.47	5.79	-1.87	172.57	-1933.80
156.00	171.29	16.51	164.23	48.67	5.60	-1.66	178.65	-1692.44
158.00	178.40	14.26	172.90	43.94	5.43	-1.38	184.07	-1390.72
160.00	184.28	11.31	180.71	36.14	5.32	-1.06	187.93	-1058.56
162.00	188.06	8.40	186.04	27.46	5.26	-0.78	190.09	-762.74
164.00	189.88	6.01	188.84	19.89	5.24	-0.55	190.93	-535.42
166.00	192.52	3.49	192.16	11.73	5.18	-0.32	192.88	-303.52
168.00	195.06	1.24	195.02	4.22	5.13	-0.11	195.11	-105.03
170.00	197.94	-1.87	197.84	-6.45	5.05	0.16	198.05	154.07
172.00	198.12	-5.23	197.30	-18.05	5.03	0.46	198.95	425.59
174.00	194.54	-8.52	192.39	-28.82	5.08	0.76	196.71	696.49
176.00	190.16	-10.57	186.94	-34.87	5.17	0.96	193.44	872.03
178.00	186.73	-11.85	182.76	-38.33	5.24	1.10	190.80	982.98
180.00	184.49	-12.89	179.83	-41.17	5.28	1.21	189.26	1069.46
182.00	185.09	-14.50	179.20	-46.33	5.23	1.35	191.18	1182.68
184.00	183.65	-16.45	176.13	-52.01	5.22	1.54	191.49	1333.73
186.00	180.37	-18.38	171.17	-56.88	5.26	1.75	190.07	1496.00
188.00	176.24	-19.05	166.59	-57.53	5.36	1.85	186.45	1567.92
190.00	174.66	-19.31	164.83	-57.77	5.40	1.89	185.08	1586.24
192.00	176.38	-19.83	165.92	-59.85	5.33	1.92	187.50	1594.63
194.00	178.00	-20.95	166.23	-63.65	5.25	2.01	190.60	1648.06
196.00	178.44	-22.22	165.18	-67.48	5.19	2.12	192.75	1721.01
198.00	178.66	-23.43	163.93	-71.03	5.14	2.23	194.71	1788.71
200.00	179.18	-24.11	163.55	-73.19	5.09	2.28	196.30	1814.16
202.00	182.61	-24.65	165.96	-76.18	4.98	2.28	200.93	1799.86
204.00	188.44	-25.97	169.42	-82.51	4.77	2.32	209.60	1812.81
206.00	195.13	-28.35	171.73	-92.67	4.51	2.43	221.73	1880.22
208.00	198.99	-31.52	169.64	-104.03	4.28	2.63	233.43	2010.11
210.00	200.43	-34.90	164.38	-114.68	4.09	2.85	244.39	2163.56

130 to 210 kHz-BRlq (Broadband)

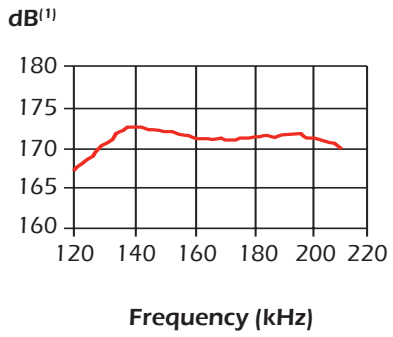
Power Rating:
- 2 kW @ 1% duty cycle

88 mm (3.5”) PZT
Active Area: 60.8 cm^2
Radiating Surface: Urethane

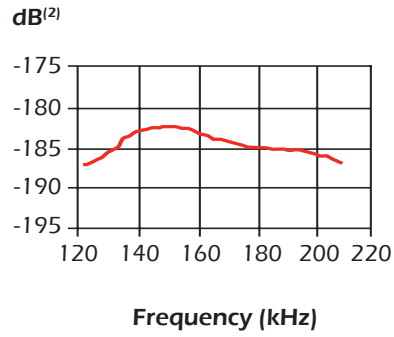
Cable Type: C44
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

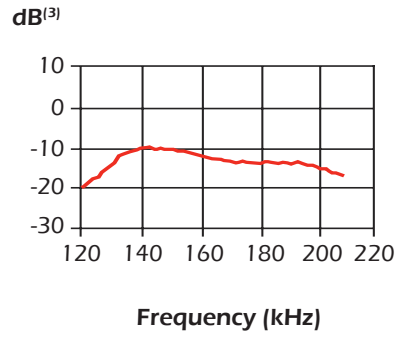
TVR



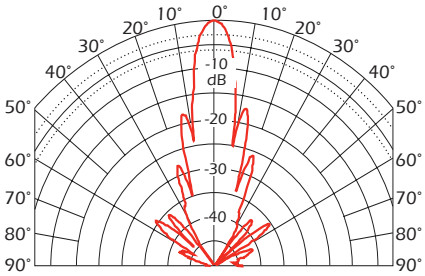
RVR



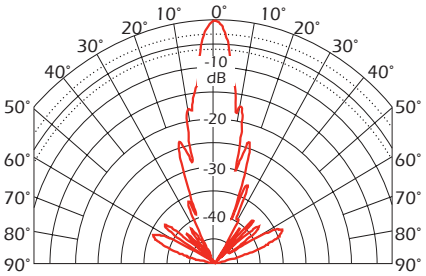
FOM



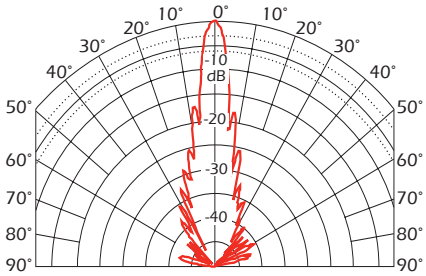
Transmit Radiation Pattern



Beamwidth	@ 140 kHz
-3 dB	7°
-6 dB	10°
-10 dB	12°



Beamwidth	@ 160 kHz
-3 dB	6°
-6 dB	8°
-10 dB	10°



Beamwidth	@ 200 kHz
-3 dB	5°
-6 dB	7°
-10 dB	9°

130 to 210 kHz-BRlq (Broadband)

Note: Impedance data includes cable

1 kHz Capacitance: 10,250 pF: ± 20%

Balanced Impedance Table

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
130.00	100.71	-61.50	48.05	-88.51	4.7377	8.7262	211.07	10683.23
132.00	99.99	-58.17	52.74	-84.95	5.2748	8.4964	189.58	10244.26
134.00	101.54	-55.01	58.23	-83.19	5.6474	8.0683	177.07	9582.96
136.00	104.14	-52.38	63.57	-82.49	5.8616	7.6056	170.60	8900.51
138.00	107.58	-50.06	69.06	-82.48	5.9680	7.1271	167.56	8219.66
140.00	112.86	-48.24	75.17	-84.18	5.9015	6.6092	169.45	7513.51
142.00	118.39	-47.84	79.47	-87.76	5.6692	6.2610	176.39	7017.37
144.00	122.94	-47.79	82.60	-91.06	5.4651	6.0245	182.98	6658.54
146.00	127.68	-48.01	85.43	-94.89	5.2401	5.8208	190.83	6345.25
148.00	131.93	-48.71	87.06	-99.12	5.0021	5.6951	199.92	6124.33
150.00	135.54	-49.79	87.51	-103.50	4.7636	5.6341	209.93	5977.96
152.00	138.23	-50.77	87.43	-107.07	4.5757	5.6035	218.54	5867.22
154.00	140.86	-51.82	87.08	-110.72	4.3886	5.5802	227.86	5767.00
156.00	143.19	-53.07	86.04	-114.46	4.1964	5.5822	238.30	5695.14
158.00	144.96	-54.55	84.07	-118.09	4.0009	5.6197	249.95	5660.73
160.00	145.87	-56.27	81.01	-121.31	3.8070	5.7010	262.67	5670.91
162.00	144.93	-57.96	76.88	-122.86	3.6601	5.8493	273.22	5746.61
164.00	143.05	-59.01	73.66	-122.63	3.5997	5.9925	277.80	5815.44
166.00	141.96	-59.65	71.74	-122.50	3.5596	6.0786	280.93	5827.93
168.00	140.87	-60.30	69.80	-122.36	3.5175	6.1660	284.29	5841.38
170.00	140.22	-60.95	68.10	-122.58	3.4633	6.2341	288.74	5836.40
172.00	139.51	-61.76	66.02	-122.90	3.3920	6.3145	294.81	5842.89
174.00	138.31	-62.64	63.57	-122.83	3.3232	6.4215	300.92	5873.61
176.00	135.85	-63.37	60.89	-121.44	3.2993	6.5800	303.10	5950.20
178.00	133.53	-63.39	59.81	-119.39	3.3542	6.6956	298.14	5986.70
180.00	132.11	-63.11	59.75	-117.83	3.4235	6.7510	292.10	5969.23
182.00	131.78	-62.79	60.26	-117.19	3.4703	6.7487	288.16	5901.60
184.00	132.25	-62.82	60.41	-117.64	3.4540	6.7267	289.52	5818.40
186.00	132.12	-63.18	59.61	-117.91	3.4146	6.7547	292.86	5779.84
188.00	131.92	-63.45	58.96	-118.02	3.3877	6.7810	295.18	5740.56
190.00	131.25	-63.81	57.92	-117.78	3.3624	6.8371	297.41	5727.16
192.00	130.47	-63.57	58.06	-116.84	3.4109	6.8637	293.17	5689.50
194.00	131.07	-63.30	58.90	-117.09	3.4286	6.8157	291.66	5591.53
196.00	132.34	-63.33	59.41	-118.25	3.3923	6.7522	294.79	5482.86
198.00	134.00	-63.65	59.47	-120.08	3.3120	6.6874	301.93	5375.39
200.00	135.41	-64.46	58.38	-122.18	3.1838	6.6633	314.09	5302.48
202.00	136.11	-64.97	57.59	-123.33	3.1085	6.6569	321.70	5244.98
204.00	137.31	-65.83	56.22	-125.28	2.9816	6.6442	335.39	5183.61
206.00	137.95	-66.68	54.62	-126.68	2.8701	6.6564	348.42	5142.71
208.00	139.58	-67.63	53.13	-129.07	2.7269	6.6250	366.71	5069.26
210.00	140.76	-69.27	49.82	-131.65	2.5142	6.6443	397.74	5035.59

130 to 210 kHz | 1 kW / 18 W

130 to 210 kHz-C (Broadband)

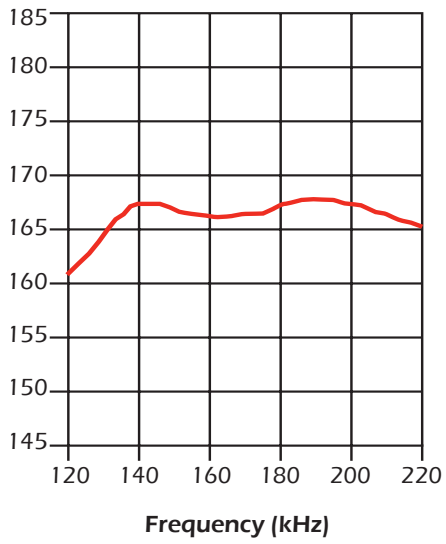
Power Rating:
- 1 kW @ 1% duty cycle
- CW[4]: 18W in B175, B265, PM265
  12W in M265, TM265

65 mm (2.5”) PZT
Active Area: 33 cm²
Radiating Surface: Epoxy/Urethane

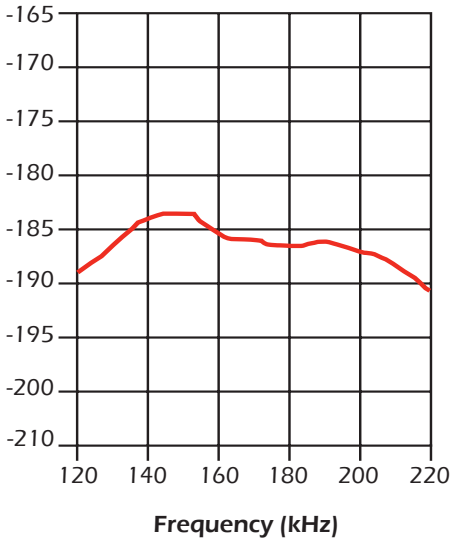
Q ≈ 2.5
Cable Type: C44
Cable Length: 10 m (50 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

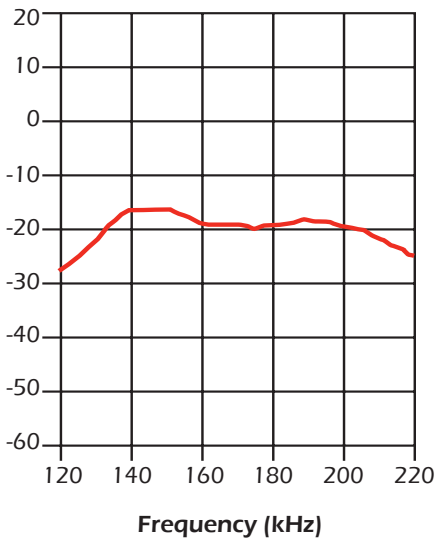
TVR



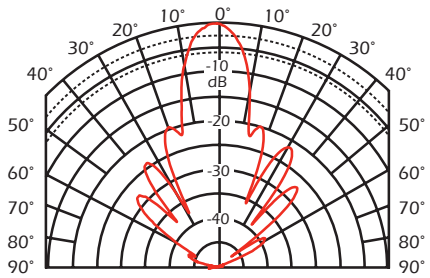
RVR



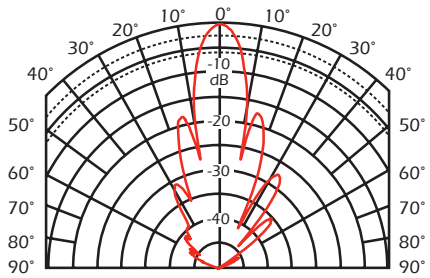
FOM



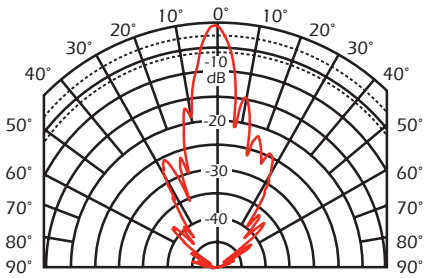
Transmit Radiation Pattern



Beamwidth	@ 130 kHz
-3 dB	11°
-6 dB	15°
-10 dB	20°



Beamwidth	@ 160 kHz
-3 dB	8°
-6 dB	12°
-10 dB	15°



Beamwidth	@ 210 kHz
-3 dB	6°
-6 dB	9°
-10 dB	12°

130 to 210 kHz-C (Broadband)

Note: Impedance data includes cable

1 kHz Capacitance: 5,310 pF: ± 20%

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
130.00	196.88	-65.77	80.79	-179.54	2.08	4.63	479.80	5670.82
133.00	195.76	-61.72	92.74	-172.39	2.42	4.50	413.19	5383.41
136.00	200.56	-57.84	106.75	-169.79	2.65	4.22	376.80	4939.84
139.00	207.35	-54.27	121.09	-168.31	2.82	3.92	355.04	4482.63
142.00	221.76	-52.05	136.37	-174.88	2.77	3.56	360.64	3985.61
145.00	239.78	-51.61	148.89	-187.95	2.59	3.27	386.14	3588.16
148.00	247.57	-54.71	143.02	-202.09	2.33	3.30	428.57	3545.53
151.00	271.21	-56.98	147.81	-227.39	2.01	3.09	497.63	3258.44
154.00	265.60	-61.32	127.45	-233.02	1.81	3.30	553.50	3413.90
157.00	258.21	-62.92	117.54	-229.91	1.76	3.45	567.27	3495.61
160.00	253.64	-63.37	113.68	-226.74	1.77	3.52	565.92	3505.84
163.00	251.25	-63.83	110.79	-225.50	1.76	3.57	569.76	3488.02
166.00	249.38	-64.41	107.71	-224.92	1.73	3.62	577.38	3467.41
169.00	248.51	-65.25	104.02	-225.69	1.68	3.65	593.69	3441.57
172.00	245.28	-67.40	94.25	-226.44	1.57	3.76	638.29	3482.91
175.00	233.69	-67.78	88.37	-216.34	1.62	3.96	618.01	3602.69
178.00	228.21	-66.22	92.02	-208.84	1.77	4.01	565.97	3585.41
181.00	228.89	-64.67	97.93	-206.89	1.87	3.95	535.02	3472.26
184.00	232.15	-64.28	100.74	-209.15	1.87	3.88	534.98	3356.89
187.00	235.99	-64.38	102.03	-212.80	1.83	3.82	545.87	3251.98
190.00	240.10	-65.84	98.26	-219.07	1.70	3.80	586.66	3183.28
193.00	235.70	-67.51	90.18	-217.76	1.62	3.92	616.04	3232.53
196.00	231.73	-66.55	92.21	-212.60	1.72	3.96	582.38	3214.73
199.00	236.46	-65.56	97.83	-215.27	1.75	3.85	571.54	3079.22
202.00	246.62	-66.44	98.56	-226.07	1.62	3.72	617.11	2928.50
205.00	251.39	-68.64	91.58	-234.11	1.45	3.70	690.08	2876.09
208.00	252.69	-71.85	78.71	-240.12	1.23	3.76	811.28	2877.46
210.00	247.95	-73.95	68.56	-238.28	1.12	3.88	896.75	2937.42

130 to 210 kHz | 1 kW / 18 W

130 to 210 kHz-C (Broadband)

Transformed to 100 ohms minimum (B1)

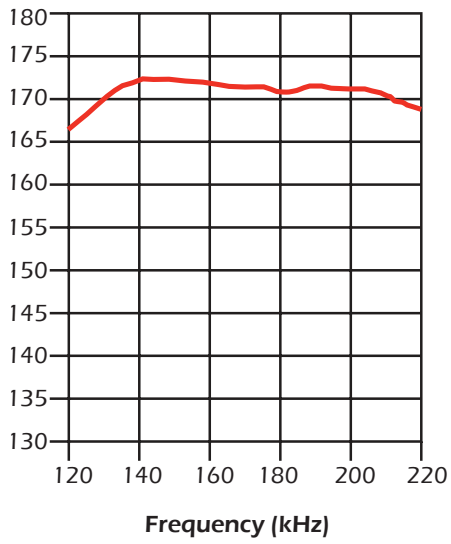
Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 18W in B175, B265, PM265
  12W in M265, TM265

65 mm (2.56 in) PZT
Active Area: 33 cm^2 (5.1 in^2)
Radiating Surface: Urethane

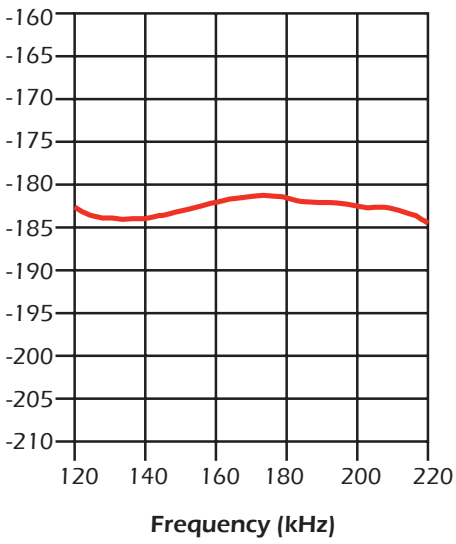
Q ≈ 2
Cable Type: C335
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

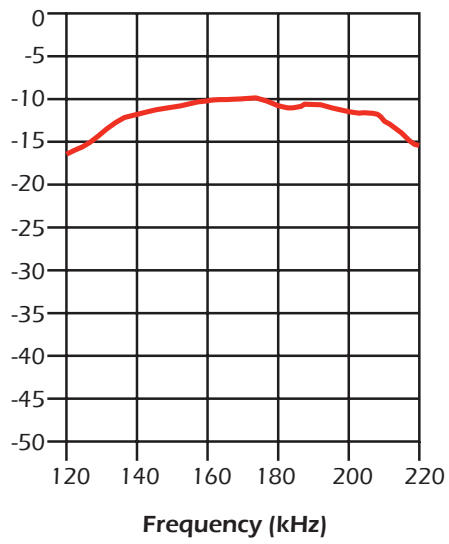
TVR



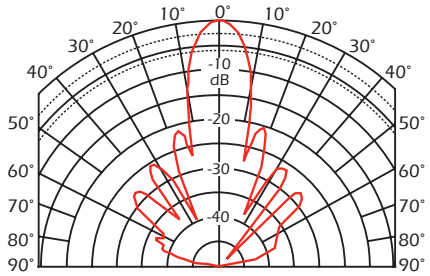
RVR



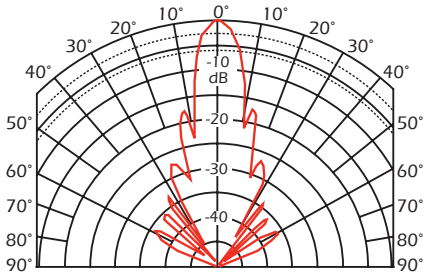
FOM



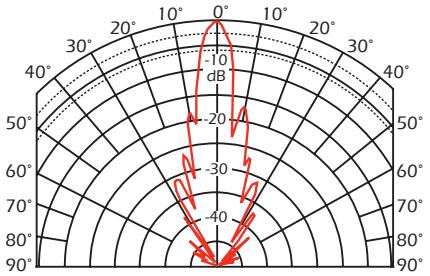
Transmit Radiation Pattern



Beamwidth	@ 130 kHz
-3 dB	10°
-6 dB	14°
-10 dB	18°



Beamwidth	@ 160 kHz
-3 dB	8°
-6 dB	12°
-10 dB	15°



Beamwidth	@ 210 kHz
-3 dB	6°
-6 dB	8°
-10 dB	11°

130 to 210 kHz-C (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
120.00	208.31	-17.43	198.75	-62.39	4.58	1.44	218.33	1906.87
123.00	177.31	-19.75	166.89	-59.91	5.31	1.91	188.39	2465.59
126.00	152.23	-18.99	143.95	-49.52	6.21	2.14	160.99	2699.47
129.00	133.22	-16.34	127.84	-37.48	7.20	2.11	138.83	2605.27
132.00	120.55	-12.05	117.89	-25.17	8.11	1.73	123.27	2088.34
135.00	112.76	-6.38	112.06	-12.54	8.81	0.99	113.46	1162.56
138.00	109.48	-0.54	109.48	-1.04	9.13	0.09	109.49	99.87
141.00	109.94	4.87	109.55	9.33	9.06	-0.77	110.34	-871.61
144.00	114.62	9.71	112.98	19.33	8.60	-1.47	116.29	-1626.25
147.00	121.20	13.15	118.02	27.58	8.03	-1.88	124.47	-2032.96
150.00	129.57	15.12	125.09	33.80	7.45	-2.01	134.22	-2135.96
153.00	138.30	15.64	133.18	37.28	6.96	-1.95	143.61	-2027.51
156.00	146.78	16.08	141.05	40.65	6.55	-1.89	152.76	-1924.61
159.00	157.83	16.02	151.70	43.56	6.09	-1.75	164.21	-1750.40
162.00	170.16	14.70	164.60	43.17	5.68	-1.49	175.92	-1464.75
165.00	181.46	12.13	177.41	38.14	5.39	-1.16	185.61	-1117.37
168.00	189.54	9.04	187.18	29.80	5.21	-0.83	191.93	-785.73
171.00	196.75	5.79	195.75	19.86	5.06	-0.51	197.76	-477.60
174.00	203.68	3.22	203.35	11.45	4.90	-0.28	204.00	-252.53
177.00	210.86	-0.59	210.84	-2.18	4.74	0.05	210.87	44.16
180.00	215.04	-4.94	214.24	-18.53	4.63	0.40	215.85	354.23
183.00	211.15	-9.70	208.13	-35.56	4.67	0.80	214.21	693.78
186.00	203.43	-11.87	199.07	-41.86	4.81	1.01	207.87	865.47
189.00	200.71	-12.44	195.99	-43.24	4.87	1.07	205.53	903.98
192.00	203.60	-13.26	198.17	-46.70	4.78	1.13	209.18	933.89
195.00	208.49	-15.13	201.27	-54.40	4.63	1.25	215.97	1021.47
198.00	211.19	-18.13	200.70	-65.71	4.50	1.47	222.22	1184.30
201.00	209.20	-20.47	195.99	-73.17	4.48	1.67	223.31	1323.75
204.00	210.75	-21.44	196.17	-77.03	4.42	1.73	226.42	1353.04
207.00	217.91	-22.49	201.34	-83.35	4.24	1.76	235.85	1349.54
210.00	229.47	-25.57	207.00	-99.03	3.93	1.88	254.38	1425.29
213.00	240.32	-30.09	207.94	-120.48	3.60	2.09	277.74	1558.76
216.00	244.20	-35.87	197.88	-143.09	3.32	2.40	301.36	1768.05
219.00	244.10	-41.77	182.06	-162.59	3.06	2.73	327.26	1983.11
220.00	242.56	-43.83	174.98	-167.99	2.97	2.86	336.26	2065.48

130 to 210 kHz | 1 kW / 18 W

130 to 210 kHz-C (Broadband)

Transformed to 100 ohms minimum with internal diplexer (B2)

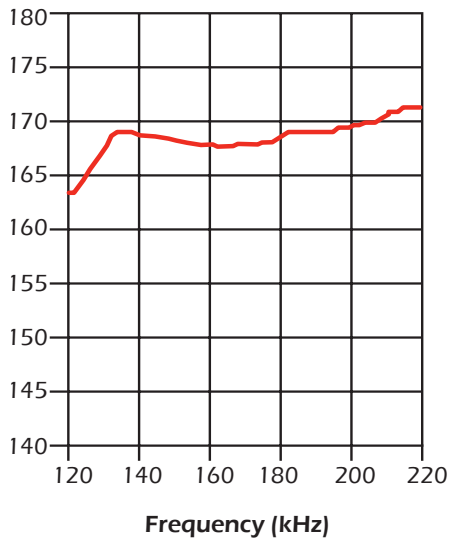
Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 18W in B175, B265, PM265
  12W in M265, TM265

65 mm (2.56 in) PZT
Active Area: 33 cm^2 (5.1 in^2)
Radiating Surface: Urethane

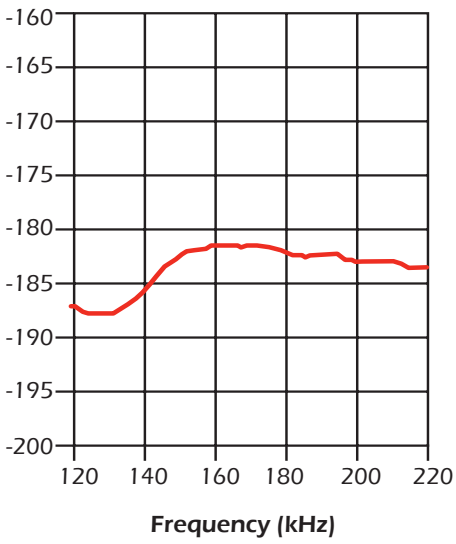
Q ≈ 2
Cable Type: C332
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

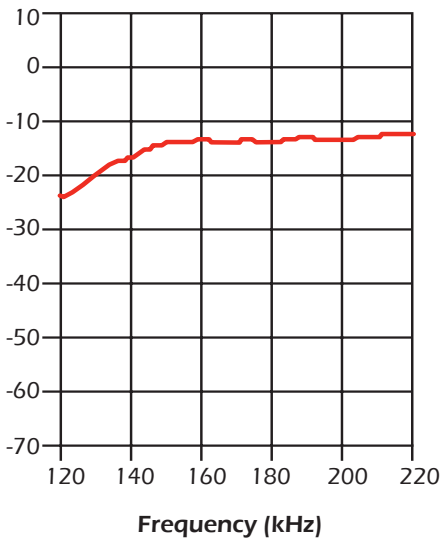
TVR



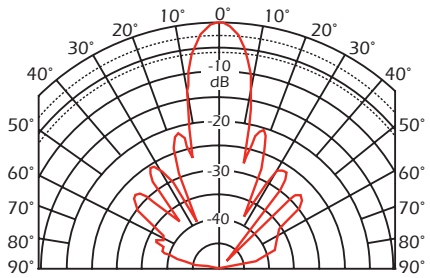
RVR



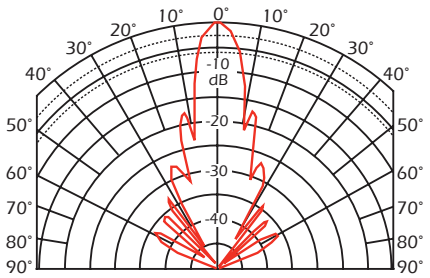
FOM



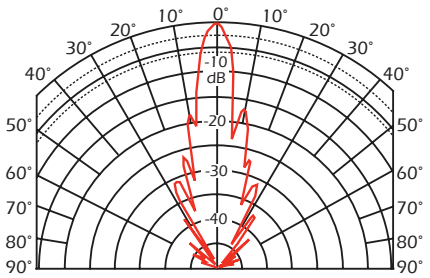
Transmit Radiation Pattern



Beamwidth	@ 130 kHz
-3 dB	10°
-6 dB	14°
-10 dB	18°



Beamwidth	@ 160 kHz
-3 dB	8°
-6 dB	12°
-10 dB	15°



Beamwidth	@ 210 kHz
-3 dB	6°
-6 dB	8°
-10 dB	11°

130 to 210 kHz-C (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
117.00	190.30	-31.19	162.79	-98.55	4.50	2.72	222.45	3701.83
120.00	174.84	-30.44	150.74	-88.59	4.93	2.90	202.80	3843.36
123.00	149.11	-29.58	129.67	-73.61	5.83	3.31	171.46	4283.90
126.00	125.94	-24.42	114.67	-52.07	7.23	3.28	138.32	4146.95
129.00	109.04	-15.17	105.24	-28.54	8.85	2.40	112.98	2961.73
132.00	100.47	-1.63	100.43	-2.86	9.95	0.28	100.51	341.44
135.00	103.22	13.01	100.57	23.24	9.44	-2.18	105.94	-2571.09
138.00	116.39	24.67	105.76	48.58	7.81	-3.59	128.08	-4136.54
141.00	137.80	32.11	116.72	73.25	6.15	-3.86	162.69	-4354.48
144.00	163.58	35.65	132.93	95.34	4.97	-3.56	201.31	-3937.89
147.00	190.50	35.69	154.71	111.14	4.26	-3.06	234.56	-3316.05
150.00	213.60	33.42	178.29	117.64	3.91	-2.58	255.91	-2735.71
153.00	230.31	30.05	199.37	115.31	3.76	-2.17	266.06	-2261.39
156.00	245.48	27.11	218.52	111.85	3.63	-1.86	275.77	-1893.62
159.00	264.12	25.25	238.89	112.67	3.42	-1.62	292.02	-1616.63
162.00	278.88	22.66	257.35	107.44	3.31	-1.38	302.20	-1357.15
165.00	281.76	17.75	268.34	85.91	3.38	-1.08	295.85	-1043.79
168.00	274.63	15.83	264.22	74.90	3.50	-0.99	285.45	-940.79
171.00	278.01	12.91	270.98	62.14	3.51	-0.80	285.23	-748.23
174.00	281.95	10.34	277.37	50.62	3.49	-0.64	286.60	-582.48
177.00	279.81	8.71	276.58	42.37	3.53	-0.54	283.07	-486.59
180.00	262.62	6.80	260.77	31.09	3.78	-0.45	264.48	-398.63
183.00	240.25	7.17	238.37	29.99	4.13	-0.52	242.15	-451.93
186.00	230.51	10.43	226.70	41.75	4.27	-0.79	234.39	-672.31
189.00	239.40	11.78	234.35	48.87	4.09	-0.85	244.55	-718.13
192.00	250.69	12.45	244.80	54.03	3.90	-0.86	256.72	-712.65
195.00	249.22	12.29	243.51	53.05	3.92	-0.85	255.07	-697.14
198.00	237.16	12.40	231.63	50.91	4.12	-0.91	242.82	-727.63
201.00	226.56	13.62	220.19	53.36	4.29	-1.04	233.12	-823.17
204.00	229.61	14.70	222.09	58.25	4.21	-1.10	237.37	-862.00
207.00	231.44	14.83	223.73	59.24	4.18	-1.11	239.41	-850.33
210.00	222.21	16.17	213.42	61.88	4.32	-1.25	231.37	-949.76
213.00	204.87	19.50	193.12	68.40	4.60	-1.63	217.34	-1217.62
216.00	189.92	25.16	171.91	80.73	4.77	-2.24	209.82	-1649.12
219.00	189.19	32.17	160.14	100.74	4.47	-2.81	223.51	-2045.44
222.00	198.09	39.18	153.56	125.14	3.91	-3.19	255.54	-2286.33
225.00	208.35	45.51	146.01	148.63	3.36	-3.42	297.32	-2421.93
228.00	218.55	51.80	135.15	171.75	2.83	-3.60	353.41	-2510.12



130 to 210 kHz-D (Broadband)

Transformed to 100 ohms minimum (B2)

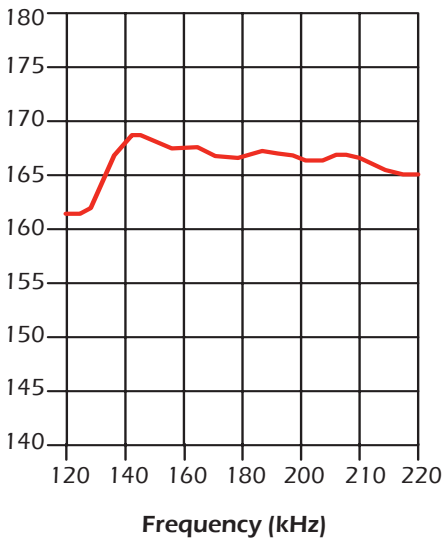
Power Rating:
- 600 W @ 1% duty cycle
- CW(4): 6W in B75, B765

43 mm (1.7 in) PZT
Active Area: 14.5 cm^2 (2.25 in^2)
Radiating Surface: Urethane

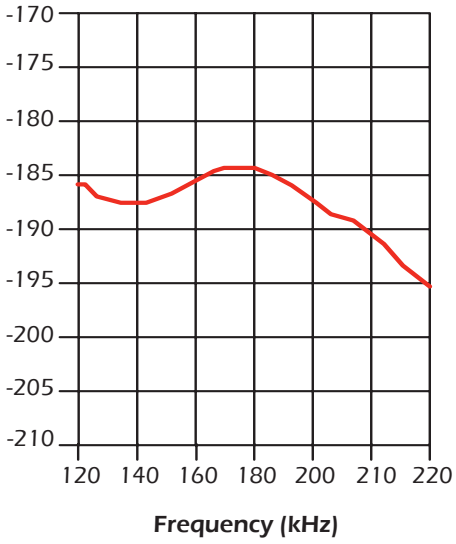
Q ≈ 2
Cable Type: C334
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

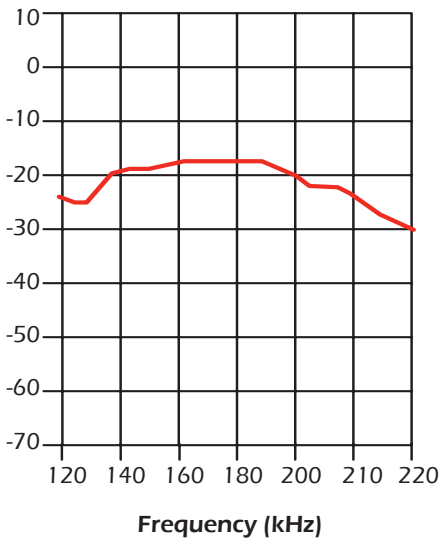
TVR



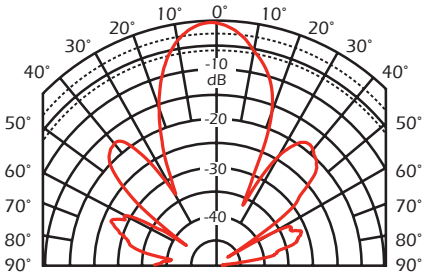
RVR



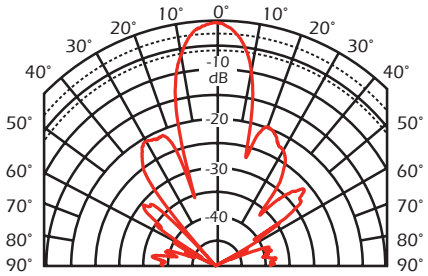
FOM



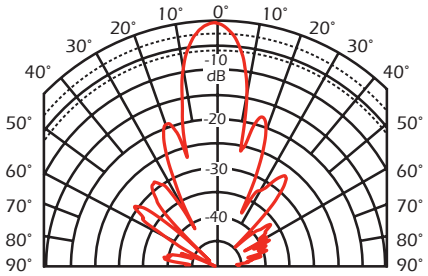
Transmit Radiation Pattern



Beamwidth	@ 130 kHz
-3 dB	15°
-6 dB	22°
-10 dB	29°



Beamwidth	@ 170 kHz
-3 dB	12°
-6 dB	16°
-10 dB	20°



Beamwidth	@ 210 kHz
-3 dB	9°
-6 dB	13°
-10 dB	17°

130 to 210 kHz-D (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
120.00	269.48	3.01	269.11	14.13	3.71	-0.19	269.85	-258.06
122.00	260.47	0.21	260.47	0.96	3.84	-0.01	260.47	-18.49
124.00	253.05	-4.36	252.32	-19.26	3.94	0.30	253.79	386.00
128.00	220.57	-14.96	213.09	-56.94	4.38	1.17	228.31	1455.39
130.00	197.24	-19.13	186.35	-64.63	4.79	1.66	208.76	2033.87
132.00	172.07	-21.41	160.19	-62.82	5.41	2.12	184.82	2558.24
136.00	131.39	-17.93	125.01	-40.46	7.24	2.34	138.10	2742.70
138.00	118.92	-13.01	115.86	-26.78	8.19	1.89	122.05	2183.97
140.00	112.08	-7.32	111.16	-14.27	8.85	1.14	113.00	1291.57
144.00	110.27	4.60	109.91	8.85	9.04	-0.73	110.63	-804.01
146.00	114.52	9.74	112.87	19.37	8.61	-1.48	116.19	-1610.33
148.00	120.86	13.64	117.45	28.50	8.04	-1.95	124.37	-2098.09
152.00	139.10	17.26	132.84	41.26	6.87	-2.13	145.65	-2233.16
154.00	147.85	17.35	141.13	44.09	6.46	-2.02	154.90	-2084.22
156.00	154.97	17.03	148.17	45.40	6.17	-1.89	162.08	-1928.57
160.00	169.60	17.72	161.56	51.62	5.62	-1.79	178.05	-1785.02
162.00	180.74	17.78	172.11	55.19	5.27	-1.69	189.81	-1659.67
164.00	193.67	17.24	184.96	57.40	4.93	-1.53	202.78	-1485.21
168.00	223.00	13.60	216.75	52.42	4.36	-1.05	229.42	-998.59
170.00	237.88	10.71	233.73	44.21	4.13	-0.78	242.10	-731.48
172.00	250.60	6.98	248.74	30.44	3.96	-0.48	252.47	-448.53
176.00	269.52	-1.57	269.42	-7.40	3.71	0.10	269.62	92.15
178.00	273.26	-5.90	271.81	-28.09	3.64	0.38	274.71	336.36
180.00	273.40	-9.79	269.42	-46.50	3.60	0.62	277.44	550.02
184.00	272.28	-16.01	261.72	-75.09	3.53	1.01	283.27	876.14
186.00	272.80	-18.78	258.28	-87.82	3.47	1.18	288.14	1009.74
188.00	273.66	-21.49	254.64	-100.25	3.40	1.34	294.11	1133.27
192.00	276.17	-27.67	244.59	-128.23	3.21	1.68	311.82	1393.72
194.00	275.28	-31.30	235.23	-143.00	3.10	1.89	322.16	1548.08
196.00	272.18	-34.76	223.59	-155.19	3.02	2.10	331.31	1701.13
200.00	262.43	-41.20	197.46	-172.86	2.87	2.51	348.78	1997.36
202.00	256.31	-44.32	183.37	-179.08	2.79	2.73	358.26	2147.77
204.00	248.41	-47.22	168.72	-182.32	2.73	2.95	365.74	2305.12
208.00	230.57	-51.51	143.50	-180.47	2.70	3.39	370.46	2597.56
210.00	223.74	-52.91	134.93	-178.47	2.70	3.57	370.98	2702.02
212.00	218.46	-54.19	127.82	-177.16	2.68	3.71	373.35	2786.83
216.00	211.99	-57.22	114.79	-178.22	2.55	3.97	391.49	2922.17
218.00	208.53	-59.11	107.04	-178.96	2.46	4.12	406.24	3004.54
220.00	204.66	-61.23	98.51	-179.40	2.35	4.28	425.22	3098.41

130 to 210 kHz | 1.5 kW / 5 W

130 to 210 kHz-E (Broadband)

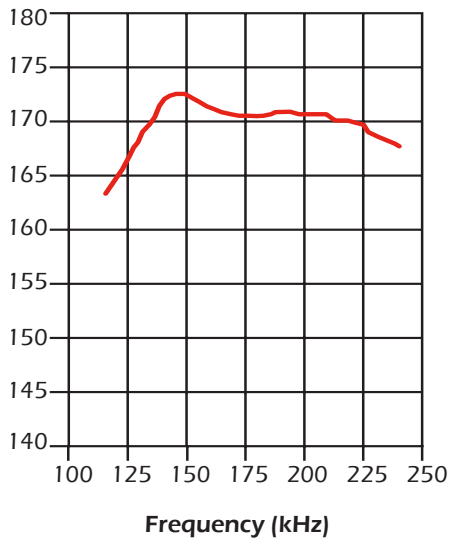
Power Rating:
- 1.5 kW @ 1% duty cycle
- CW(4): 5W in P836

80 mm (3.15 in) PZT
Active Area: 50.3 cm² (7.8 in²)
Radiating Surface: Epoxy

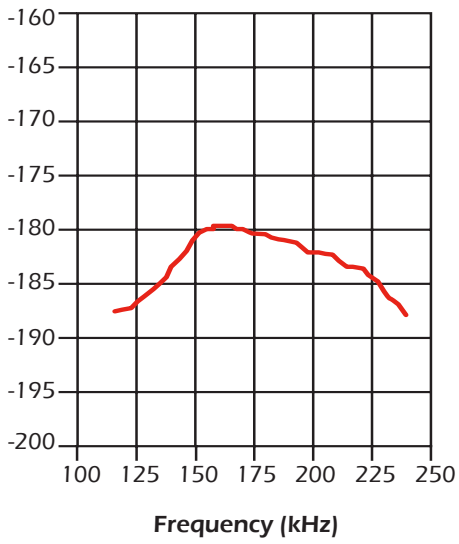
Q ≈ 2
Cable Type: Test Leads
Cable Length: 0.3 m (1 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

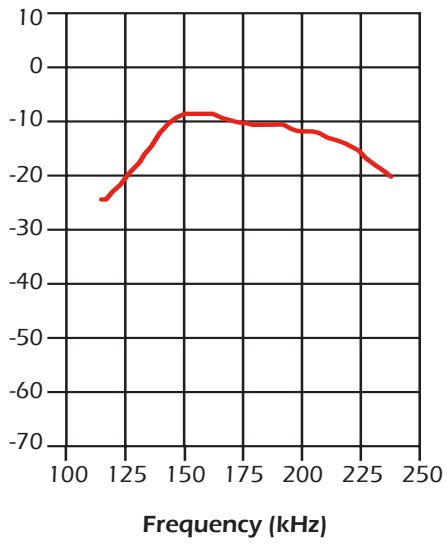
TVR



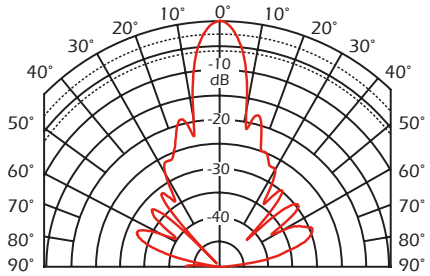
RVR



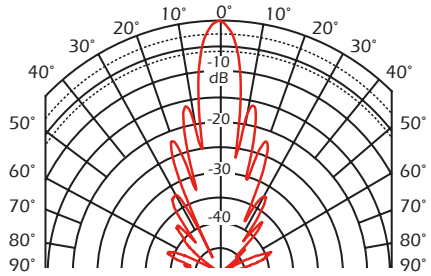
FOM



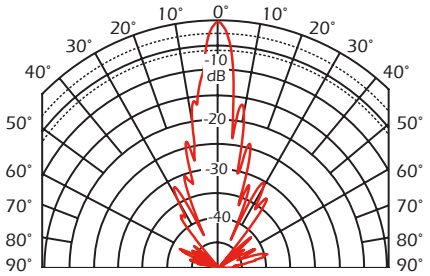
Transmit Radiation Pattern



Beamwidth	@ 130 kHz
-3 dB	8°
-6 dB	12°
-10 dB	15°



Beamwidth	@ 160 kHz
-3 dB	7°
-6 dB	9°
-10 dB	12°



Beamwidth	@ 210 kHz
-3 dB	5°
-6 dB	7°
-10 dB	10°

130 to 210 kHz-E (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
116.00	164.00	-74.68	43.33	-158.17	1.61	5.88	620.68	8068.80
120.00	153.44	-71.84	47.82	-145.80	2.03	6.19	492.41	8213.05
124.00	141.18	-69.13	50.30	-131.92	2.52	6.62	396.30	8494.68
126.00	136.46	-65.97	55.56	-124.63	2.98	6.69	335.15	8454.74
128.00	134.61	-63.23	60.63	-120.18	3.35	6.63	298.87	8247.10
130.00	131.53	-61.26	63.25	-115.32	3.66	6.67	273.51	8160.73
132.00	127.62	-58.09	67.46	-108.33	4.14	6.65	241.41	8020.00
134.00	126.98	-54.20	74.28	-102.99	4.61	6.39	217.07	7586.27
136.00	126.38	-51.80	78.15	-99.31	4.89	6.22	204.36	7277.26
140.00	125.00	-43.16	91.18	-85.50	5.84	5.47	171.36	6221.17
144.00	135.42	-34.79	111.22	-77.26	6.06	4.21	164.89	4656.49
148.00	153.99	-28.22	135.69	-72.81	5.72	3.07	174.76	3301.76
152.00	182.89	-26.45	163.74	-81.46	4.90	2.44	204.27	2550.18
156.00	209.79	-29.07	183.36	-101.94	4.17	2.32	240.03	2363.03
160.00	229.49	-32.38	193.81	-122.90	3.68	2.33	271.74	2321.23
164.00	246.88	-36.47	198.53	-146.75	3.26	2.41	307.00	2336.66
168.00	257.59	-41.42	193.17	-170.41	2.91	2.57	343.50	2433.03
172.00	258.01	-46.76	176.73	-187.97	2.66	2.82	376.65	2612.87
176.00	256.44	-48.87	168.68	-193.16	2.57	2.94	389.87	2656.08
180.00	258.86	-52.19	158.70	-204.51	2.37	3.05	422.24	2698.53
184.00	253.00	-55.57	143.06	-208.66	2.24	3.26	447.41	2819.83
188.00	244.69	-57.33	132.08	-205.98	2.21	3.44	453.29	2912.46
192.00	243.04	-57.73	129.75	-205.51	2.20	3.48	455.24	2883.98
196.00	243.78	-59.84	122.47	-210.78	2.06	3.55	485.22	2880.11
200.00	238.94	-61.30	114.75	-209.58	2.01	3.67	497.55	2921.26
204.00	236.01	-62.52	108.92	-209.38	1.96	3.76	511.40	2932.55
206.00	235.15	-62.65	108.05	-208.86	1.95	3.78	511.78	2918.13
208.00	236.47	-63.15	106.82	-210.97	1.91	3.77	523.49	2886.87
210.00	238.13	-64.18	103.70	-214.37	1.83	3.78	546.84	2865.00
212.00	237.87	-65.32	99.34	-216.13	1.76	3.82	569.57	2867.70
214.00	235.99	-66.22	95.16	-215.95	1.71	3.88	585.21	2883.92
216.00	235.49	-66.95	92.20	-216.69	1.66	3.91	601.45	2879.14
220.00	234.71	-68.95	84.31	-219.05	1.53	3.98	653.43	2876.51
224.00	233.98	-71.42	74.57	-221.78	1.36	4.05	734.20	2878.28
228.00	228.59	-74.15	62.42	-219.90	1.19	4.21	837.09	2937.66
232.00	222.17	-76.26	52.77	-215.81	1.07	4.37	935.29	2999.40
236.00	215.93	-78.01	44.86	-211.22	0.96	4.53	1039.36	3055.02
240.00	210.04	-79.92	36.74	-206.80	0.83	4.69	1200.62	3108.58

130 to 210 kHz | 1.5 kW / 5 W

130 to 210 kHz-E (Broadband)

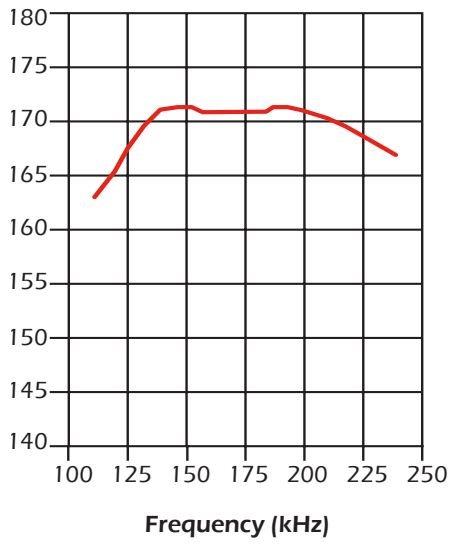
Power Rating:
- 1.5 kW @ 1% duty cycle
- CW(4): 5W in P836

80 mm (3.15 in) PZT
Active Area: 50.25 cm^2 (7.79 in^2)
Radiating Surface: Urethane

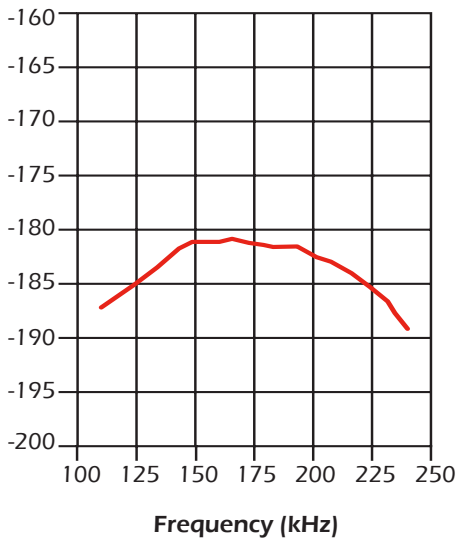
Q ≈ 2
Cable Type: Test Leads
Cable Length: 0.3 m (1 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

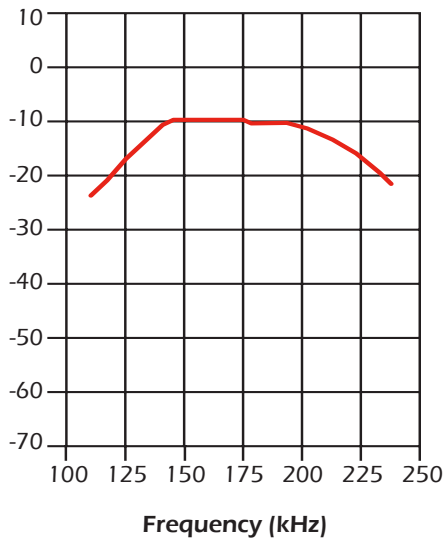
TVR



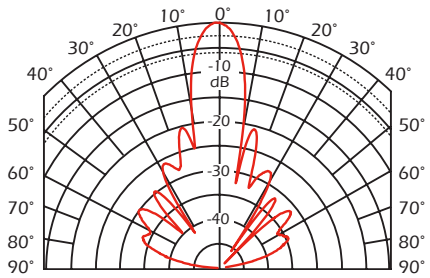
RVR



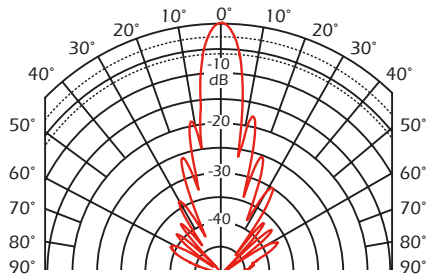
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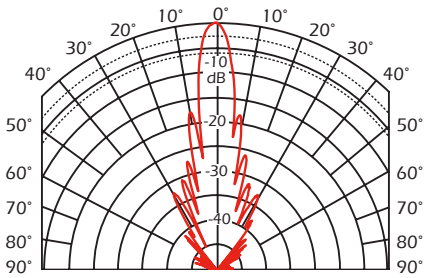
Transmit Radiation Pattern



Beamwidth	@ 130 kHz
-3 dB	9°
-6 dB	12°
-10 dB	15°



Beamwidth	@ 160 kHz
-3 dB	7°
-6 dB	10°
-10 dB	12°



Beamwidth	@ 210 kHz
-3 dB	6°
-6 dB	8°
-10 dB	10°

130 to 210 kHz-E (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
130.00	138.87	-56.44	76.78	-115.71	3.98	6.00	251.17	7346.23
132.00	139.06	-53.99	81.75	-112.50	4.23	5.82	236.56	7013.93
134.00	140.34	-51.80	86.78	-110.29	4.41	5.60	226.94	6651.12
136.00	141.82	-49.75	91.64	-108.23	4.56	5.38	219.47	6297.82
138.00	143.63	-47.34	97.32	-105.62	4.72	5.12	211.96	5905.28
140.00	146.75	-44.85	104.05	-103.50	4.83	4.81	206.99	5463.04
142.00	152.00	-42.90	111.34	-103.48	4.82	4.48	207.51	5019.74
144.00	157.81	-41.56	118.08	-104.69	4.74	4.20	210.90	4646.35
146.00	164.26	-40.80	124.35	-107.33	4.61	3.98	216.99	4336.30
148.00	171.12	-40.23	130.64	-110.52	4.46	3.77	224.14	4058.82
150.00	177.82	-40.21	135.81	-114.79	4.29	3.63	232.84	3851.78
152.00	184.35	-40.64	139.88	-120.08	4.12	3.53	242.96	3699.56
154.00	190.15	-41.55	142.30	-126.13	3.94	3.49	254.10	3605.06
156.00	194.23	-42.49	143.22	-131.19	3.80	3.48	263.40	3547.96
158.00	197.47	-43.45	143.36	-135.80	3.68	3.48	271.99	3507.98
160.00	199.81	-44.24	143.16	-139.39	3.59	3.49	278.88	3472.96
162.00	202.32	-44.92	143.25	-142.87	3.50	3.49	285.73	3428.98
164.00	205.45	-45.62	143.69	-146.84	3.40	3.48	293.75	3376.05
166.00	208.10	-46.39	143.53	-150.67	3.31	3.48	301.70	3335.94
168.00	210.60	-47.50	142.28	-155.27	3.21	3.50	311.73	3316.52
170.00	212.03	-48.77	139.75	-159.46	3.11	3.55	321.70	3320.71
172.00	211.93	-49.82	136.74	-161.91	3.04	3.60	328.46	3335.69
174.00	210.96	-50.55	134.06	-162.89	3.01	3.66	331.97	3347.85
176.00	211.03	-51.05	132.67	-164.10	2.98	3.69	335.65	3332.37
178.00	212.34	-51.60	131.91	-166.40	2.93	3.69	341.82	3299.73
180.00	213.62	-52.39	130.39	-169.22	2.86	3.71	350.00	3278.65
182.00	214.09	-53.39	127.67	-171.86	2.79	3.75	359.01	3278.79
184.00	212.98	-54.32	124.21	-173.01	2.74	3.81	365.20	3299.07
186.00	211.44	-54.82	121.82	-172.82	2.72	3.87	366.99	3307.75
188.00	210.63	-55.10	120.51	-172.74	2.72	3.89	368.12	3296.37
190.00	211.45	-55.19	120.71	-173.60	2.70	3.88	370.38	3252.56
192.00	213.35	-55.46	120.97	-175.74	2.66	3.86	376.26	3200.35
194.00	215.18	-56.27	119.48	-178.96	2.58	3.87	387.51	3170.80
196.00	216.15	-57.33	116.67	-181.96	2.50	3.89	400.45	3162.41
198.00	216.03	-58.17	113.93	-183.54	2.44	3.93	409.63	3161.41
200.00	215.67	-58.77	111.81	-184.42	2.40	3.97	416.00	3155.22
202.00	216.41	-59.30	110.50	-186.08	2.36	3.97	423.86	3130.40
204.00	217.86	-59.92	109.20	-188.52	2.30	3.97	434.66	3098.76
206.00	219.54	-60.74	107.30	-191.54	2.23	3.97	449.20	3070.17
208.00	221.03	-61.87	104.22	-194.91	2.13	3.99	468.75	3052.90
210.00	221.82	-63.30	99.68	-198.16	2.03	4.03	493.62	3052.24

150 to 250 kHz | 1 kW / 18 W

150 to 250 kHz-A (Broadband)

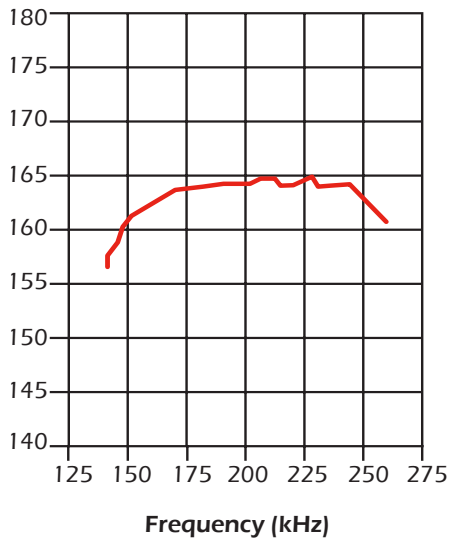
Transformed to 100 ohms minimum (B1)

Power Rating:
- 1 kW @ 1% duty cycle
- CW(4): 18 W in B175, B275, B285, CM599, PM111, PM275,R109, R509
  12W in CM275, TM185, TM275

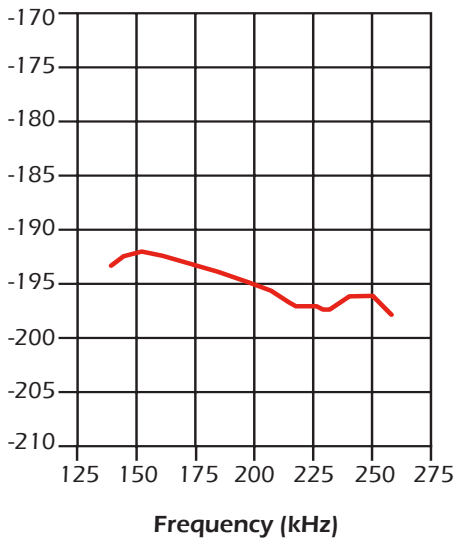
65 mm (2.56 in) PZT
Active Area: 34.4 cm^2 (5.3 in^2)
Radiating Surface: HPC/Urethane
Q ≈ 2.3
Cable Type: C334
Cable Length: 12 m (40 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

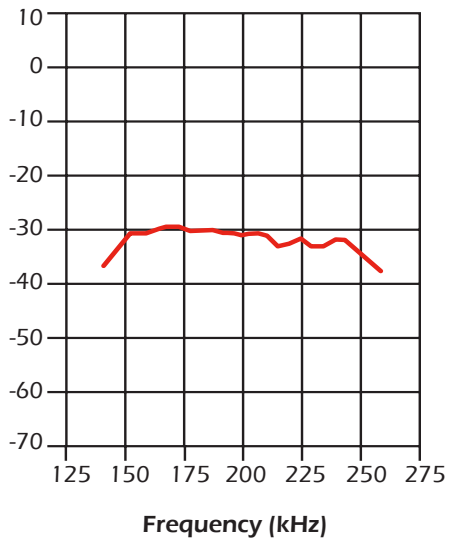
TVR



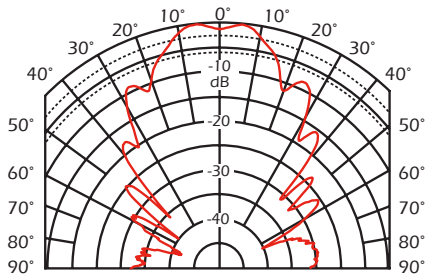
RVR



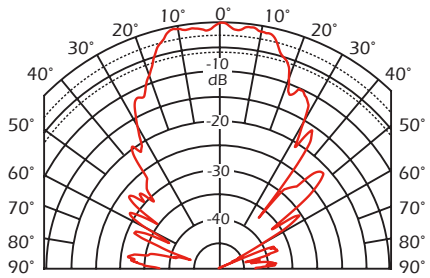
FOM



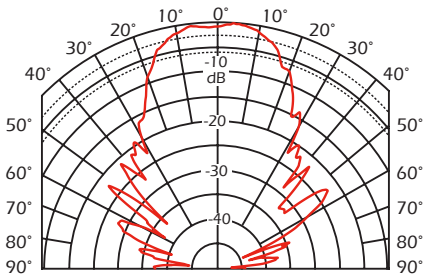
Transmit Radiation Pattern



Beamwidth	@ 160 kHz
-3 dB	24°
-6 dB	32°
-10 dB	39°



Beamwidth	@ 200 kHz
-3 dB	30°
-6 dB	38°
-10 dB	44°



Beamwidth	@ 235 kHz
-3 dB	26°
-6 dB	33°
-10 dB	43°

150 to 250 kHz-A (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
140.00	213.73	23.07	196.63	83.76	4.30	-1.83	232.31	-2084.55
142.00	210.53	18.00	200.22	65.07	4.52	-1.47	221.36	-1645.47
146.00	193.34	9.57	190.65	32.13	5.10	-0.86	196.06	-937.09
148.00	182.66	6.91	181.33	21.98	5.43	-0.66	184.00	-708.56
152.00	168.28	4.38	167.78	12.85	5.93	-0.45	168.77	-475.15
154.00	162.84	3.22	162.58	9.15	6.13	-0.35	163.09	-356.77
158.00	154.21	1.38	154.16	3.71	6.48	-0.16	154.25	-156.98
160.00	150.70	0.74	150.69	1.94	6.64	-0.09	150.72	-85.05
164.00	146.19	-0.85	146.17	-2.16	6.84	0.10	146.20	98.16
166.00	142.90	-2.10	142.80	-5.24	6.99	0.26	142.99	246.27
170.00	134.45	-3.02	134.26	-7.08	7.43	0.39	134.64	366.64
172.00	131.48	-2.92	131.31	-6.70	7.60	0.39	131.65	358.37
176.00	128.39	-2.48	128.27	-5.55	7.78	0.34	128.51	304.44
178.00	127.87	-2.35	127.76	-5.25	7.81	0.32	127.98	287.00
182.00	129.72	-1.93	129.64	-4.38	7.70	0.26	129.79	227.58
184.00	131.65	-3.45	131.41	-7.92	7.58	0.46	131.89	395.40
188.00	126.92	-6.72	126.04	-14.85	7.83	0.92	127.80	780.66
190.00	123.22	-6.96	122.31	-14.94	8.06	0.98	124.14	824.33
194.00	119.44	-5.67	118.86	-11.80	8.33	0.83	120.03	678.49
196.00	120.32	-4.77	119.91	-10.00	8.28	0.69	120.74	560.88
200.00	124.52	-5.54	123.93	-12.02	7.99	0.78	125.10	617.12
202.00	125.98	-7.40	124.93	-16.24	7.87	1.02	127.04	805.97
206.00	119.49	-11.90	116.92	-24.64	8.19	1.73	122.11	1333.10
208.00	113.53	-11.49	111.25	-22.61	8.63	1.75	115.85	1342.41
212.00	110.69	-8.53	109.46	-16.42	8.93	1.34	111.92	1006.20
214.00	111.72	-7.92	110.66	-15.40	8.87	1.23	112.80	917.63
218.00	111.18	-8.27	110.02	-16.00	8.90	1.29	112.35	944.92
220.00	110.57	-8.17	109.44	-15.71	8.95	1.28	111.70	929.56
224.00	106.52	-8.15	105.44	-15.10	9.29	1.33	107.61	945.73
226.00	103.16	-6.65	102.47	-11.94	9.63	1.12	103.86	790.09
230.00	104.24	-0.17	104.24	-0.30	9.59	0.03	104.24	19.23
232.00	109.08	2.09	109.01	3.98	9.16	-0.33	109.16	-229.43
236.00	119.52	2.97	119.36	6.19	8.36	-0.43	119.68	-292.38
238.00	122.98	2.87	122.83	6.15	8.12	-0.41	123.14	-271.84
242.00	129.46	3.52	129.21	7.95	7.71	-0.47	129.70	-312.09
244.00	134.32	4.59	133.89	10.75	7.42	-0.60	134.75	-388.72
248.00	151.36	6.37	150.43	16.79	6.57	-0.73	152.30	-470.39
250.00	165.02	6.14	164.07	17.64	6.03	-0.65	165.97	-412.42
254.00	197.22	1.17	197.18	4.01	5.07	-0.10	197.26	-64.62
256.00	210.94	-3.31	210.59	-12.18	4.73	0.27	211.29	170.16
260.00	228.00	-13.43	221.77	-52.95	4.27	1.02	234.41	623.51

150 to 250 kHz | 600 W / 6 W

150 to 250 kHz-B (Broadband)

Transformed to 125 ohms minimum (B1)

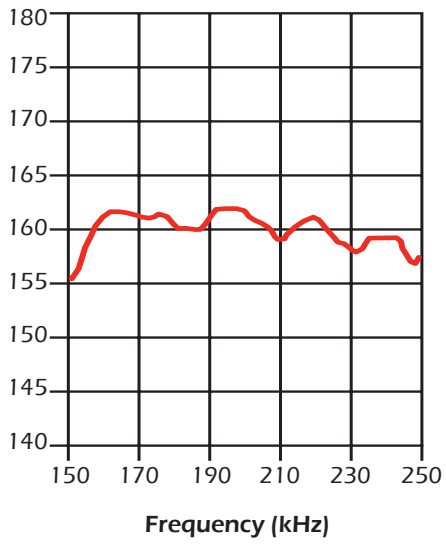
Power Rating:
- 600 W @ 1% duty cycle
- CW(4): 6 W in TM165

51 mm (2.0”) PZT
Active Area: 20.3 cm² (3.14 in²)
Radiating Surface: Urethane

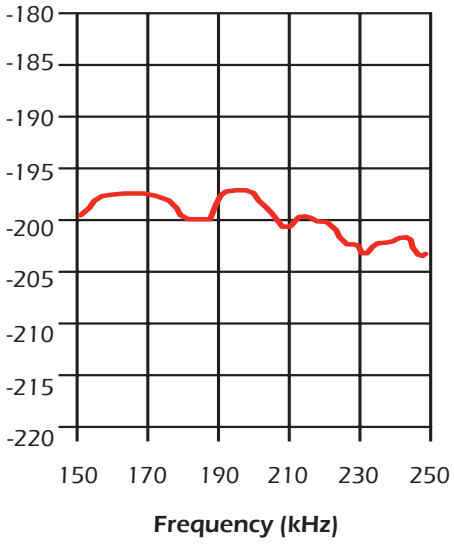
Q ≈ 3
Cable Type: C315
Cable Length: 9.1 m (30 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

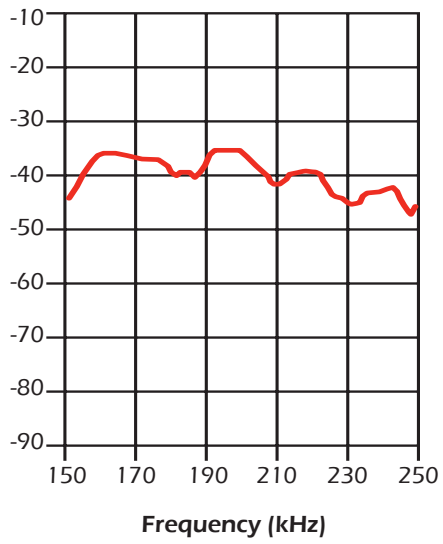
TVR



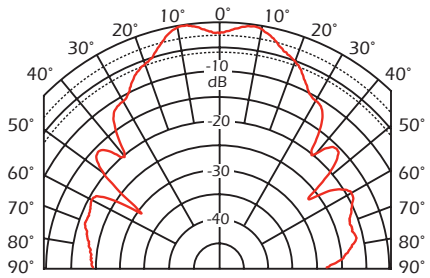
RVR



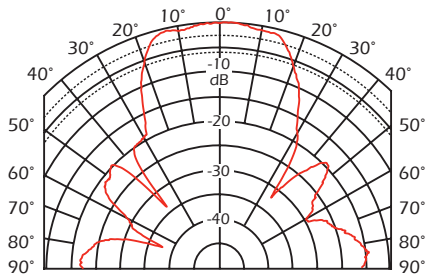
FOM



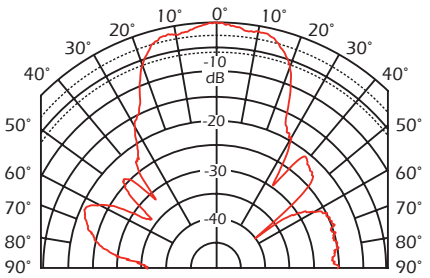
Transmit Radiation Pattern



Beamwidth	@ 150 kHz
-3 dB	30°
-6 dB	43°
-10 dB	55°



Beamwidth	@ 210 kHz
-3 dB	34°
-6 dB	40°
-10 dB	46°



Beamwidth	@ 235 kHz
-3 dB	32°
-6 dB	39°
-10 dB	45°

150 to 250 kHz-B (Broadband)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value) in 20°C Water

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
150.00	142.50	-41.43	106.83	-94.30	5.26	4.64	190.06	4927.44
154.00	119.94	-45.02	84.79	-84.84	5.89	5.90	169.67	6094.58
158.00	98.19	-39.10	76.20	-61.92	7.90	6.42	126.52	6469.74
162.00	90.89	-30.48	78.33	-46.10	9.48	5.58	105.47	5483.03
166.00	91.65	-23.27	84.19	-36.21	10.02	4.31	99.77	4132.93
170.00	99.35	-20.58	93.01	-34.93	9.42	3.54	106.13	3312.81
174.00	99.30	-24.18	90.58	-40.68	9.19	4.13	108.85	3773.65
178.00	92.08	-21.18	85.86	-33.27	10.13	3.92	98.75	3508.21
182.00	92.97	-18.05	88.40	-28.80	10.23	3.33	97.78	2914.02
186.00	95.99	-13.75	93.23	-22.82	10.12	2.48	98.82	2119.57
188.00	101.38	-12.85	98.84	-22.54	9.62	2.19	103.98	1856.94
190.00	106.12	-14.01	102.97	-25.70	9.14	2.28	109.38	1911.16
192.00	108.16	-15.46	104.25	-28.83	8.91	2.46	112.22	2042.56
194.00	109.65	-16.31	105.24	-30.80	8.75	2.56	114.25	2101.55
196.00	112.21	-17.35	107.11	-33.47	8.51	2.66	117.56	2158.43
198.00	114.06	-19.20	107.72	-37.51	8.28	2.88	120.78	2317.33
200.00	113.59	-21.46	105.71	-41.55	8.19	3.22	122.05	2562.87
202.00	111.25	-23.08	102.34	-43.62	8.27	3.52	120.93	2776.86
206.00	106.52	-22.20	98.62	-40.24	8.69	3.55	115.04	2740.35
208.00	108.64	-20.78	101.57	-38.54	8.61	3.27	116.19	2498.45
210.00	114.34	-21.14	106.64	-41.24	8.16	3.15	122.59	2390.96
212.00	118.62	-24.67	107.80	-49.51	7.66	3.52	130.54	2641.20
214.00	115.83	-29.01	101.29	-56.17	7.55	4.19	132.44	3113.97
216.00	108.10	-31.01	92.65	-55.69	7.93	4.77	126.13	3511.71
218.00	102.01	-29.68	88.63	-50.51	8.52	4.85	117.41	3543.74
220.00	100.49	-27.32	89.28	-46.12	8.84	4.57	113.11	3304.19
222.00	101.66	-25.92	91.43	-44.43	8.85	4.30	113.03	3082.37
226.00	103.52	-25.45	93.47	-44.48	8.72	4.15	114.64	2923.29
228.00	104.57	-25.17	94.64	-44.48	8.65	4.07	115.54	2839.04
230.00	106.22	-25.37	95.97	-45.52	8.51	4.03	117.56	2791.55
232.00	107.15	-26.36	96.01	-47.58	8.36	4.14	119.59	2842.71
234.00	105.62	-27.17	93.97	-48.23	8.42	4.32	118.72	2940.27
236.00	103.24	-26.24	92.60	-45.65	8.69	4.28	115.10	2888.04
238.00	103.79	-23.92	94.87	-42.08	8.81	3.91	113.54	2612.58
240.00	108.39	-22.34	100.25	-41.21	8.53	3.51	117.19	2325.83
242.00	113.72	-22.58	105.00	-43.66	8.12	3.38	123.15	2220.31
244.00	117.84	-23.32	108.21	-46.65	7.79	3.36	128.32	2191.24
246.00	122.64	-24.27	111.80	-50.41	7.43	3.35	134.53	2168.59
248.00	127.93	-26.46	114.53	-56.99	7.00	3.48	142.90	2234.84
250.00	129.77	-29.67	112.76	-64.23	6.70	3.81	149.35	2428.03

400 to 600 kHz-A (Broadband)

Transformed to 60 ohms minimum (B3)

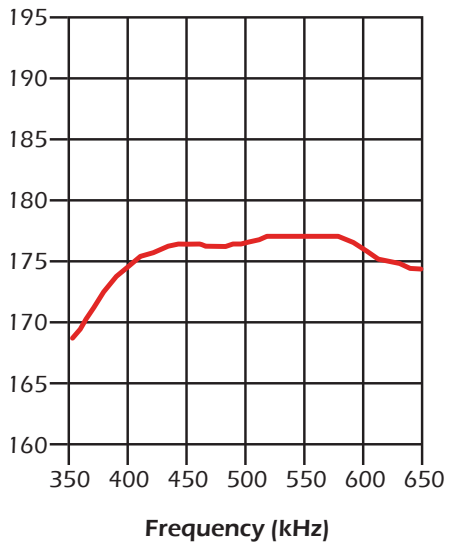
Power Rating:
- 500 W @ 1% duty cycle
- CW(4): 2 W in SS510

51 mm (2.01 in) PZT
Active Area: 20.26 cm^2 (3.14 in^2)
Radiating Surface: Urethane

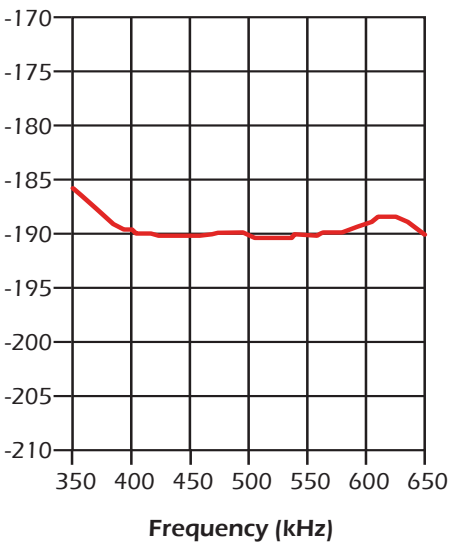
Q ≈ 2
Cable Type: C33
Cable Length: 10 m (33 ft)

Notes:
(1) dB re 1 µPa per volt at 1 meter
(2) dB re 1 volt per µPa
(3) Sum of transmitting voltage response and receiving voltage response
(4) CW Power ratings is for 20°C seawater temperature. Consult Airmar for different housing CW ratings.

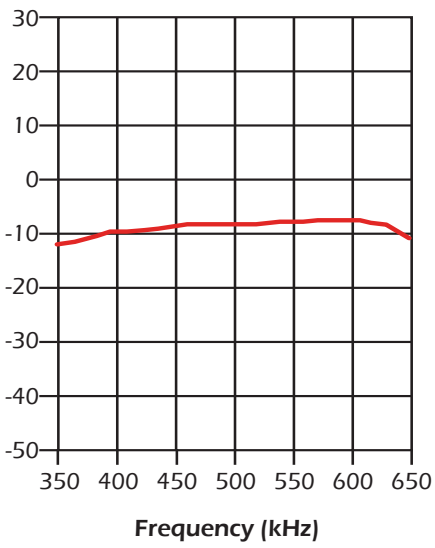
TVR



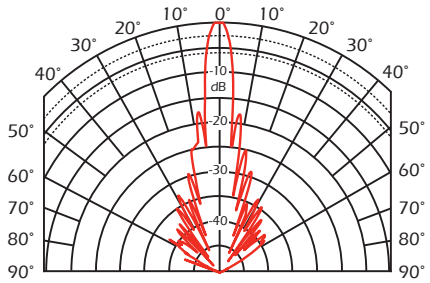
RVR



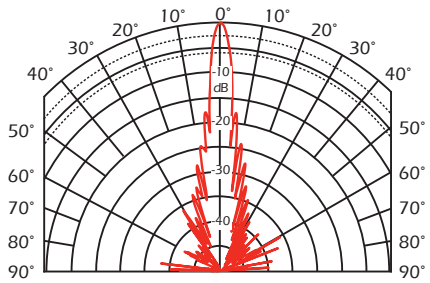
FOM



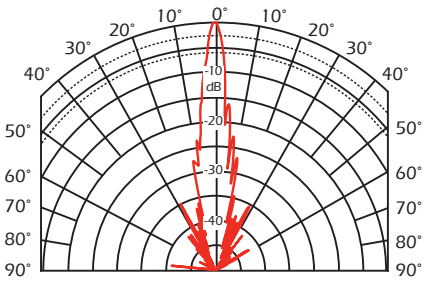
Transmit Radiation Pattern



Beamwidth	@ 400 kHz
-3 dB	5°
-6 dB	7°
-10 dB	8°



Beamwidth	@ 500 kHz
-3 dB	3°
-6 dB	5°
-10 dB	6°



Beamwidth	@ 600 kHz
-3 dB	3°
-6 dB	4°
-10 dB	6°

400 to 600 kHz-A (Broadband) Transformed to 60 ohms minimum (B3)

Note: Impedance data includes cable

Balanced Impedance Table (Nominal Value)

Test Frequency (kHz)	Impedance Magnitude (Ω)	Phase Angle (°)	Series Resistance (Ω)	Series Reactance (Ω)	Parallel Conductance (mS)	Parallel Susceptance (mS)	Parallel Resistance (Ω)	Parallel Capacitance (pF)
350.00	166.79	24.85	151.35	70.09	5.44	-2.52	183.81	-1145.73
360.00	147.20	7.16	146.05	18.36	6.74	-0.85	148.36	-374.58
370.00	116.42	-4.25	116.10	-8.62	8.57	0.64	116.74	273.56
380.00	90.32	-7.49	89.55	-11.77	10.98	1.44	91.10	604.53
390.00	75.33	-5.58	74.97	-7.33	13.21	1.29	75.69	526.87
400.00	67.16	-1.50	67.13	-1.76	14.89	0.39	67.18	155.53
410.00	63.06	1.19	63.04	1.31	15.86	-0.33	63.07	-128.24
420.00	59.75	3.37	59.64	3.51	16.71	-0.98	59.85	-372.74
430.00	56.86	6.34	56.52	6.28	17.48	-1.94	57.21	-718.37
440.00	55.35	9.80	54.54	9.42	17.80	-3.08	56.17	-1112.62
450.00	55.47	13.74	53.89	13.18	17.51	-4.28	57.11	-1514.82
460.00	58.10	16.21	55.79	16.22	16.53	-4.80	60.50	-1662.29
470.00	61.36	16.58	58.81	17.51	15.62	-4.65	64.03	-1574.96
480.00	63.66	14.81	61.55	16.27	15.19	-4.01	65.85	-1331.20
490.00	64.03	11.96	62.64	13.27	15.28	-3.24	65.45	-1050.94
500.00	62.07	10.82	60.96	11.65	15.82	-3.02	63.19	-962.84
510.00	60.44	10.79	59.37	11.32	16.25	-3.10	61.52	-966.80
520.00	59.16	12.94	57.65	13.25	16.48	-3.79	60.70	-1158.81
530.00	60.58	14.94	58.53	15.62	15.95	-4.26	62.70	-1278.12
540.00	62.40	15.58	60.11	16.76	15.44	-4.30	64.78	-1268.57
550.00	63.93	16.01	61.45	17.63	15.04	-4.31	66.51	-1248.43
560.00	66.51	16.18	63.88	18.53	14.44	-4.19	69.25	-1190.61
570.00	67.28	16.27	64.58	18.85	14.27	-4.16	70.08	-1162.59
580.00	69.80	18.75	66.10	22.44	13.57	-4.61	73.71	-1263.72
590.00	76.19	20.82	71.21	27.07	12.27	-4.66	81.51	-1258.32
600.00	86.29	21.36	80.36	31.44	10.79	-4.22	92.66	-1119.83
610.00	100.88	18.26	95.80	31.60	9.41	-3.11	106.23	-810.23
620.00	116.60	12.24	113.95	24.73	8.38	-1.82	119.32	-466.91
630.00	131.51	2.62	131.37	6.01	7.60	-0.35	131.64	-87.82
640.00	141.38	-9.34	139.51	-22.95	6.98	1.15	143.28	285.48
650.00	142.98	-21.96	132.61	-53.47	6.49	2.62	154.17	640.34

Sensor Design Fundamentals

Piezoelectric Transducer Design for Marine Use

The Sonar Transducer

A sonar *transducer* is an underwater antenna; its sensitivity, radiation pattern and operating frequency will prescribe the information available to an echosounder for signal processing. An echosounder can perform no better than the transducer allows it to perform. Marine transducers are electromechanical devices, and by definition, convert electrical energy to mechanical energy (sound pressure) and reciprocally, mechanical energy to electrical energy.

In a given underwater sonar system, a transducer may be employed as a transmitting device, a listening device, or both. When transmitting, the transducer is referred to as a *projector.* When listening, the transducer is referred to as a *hydrophone*.

In a typical sonar system, the transducer converts a high voltage electrical pulse at a given frequency into mechanical vibration. This creates a sound wave that is transmitted through the water in the desired direction according to the characteristic radiation pattern of the transducer. The sound wave intercepts one or more targets within its path (such as fish or the bottom) and a portion of the energy is reflected back to the transducer as an echo.

The received echo mechanically deflects the transducer, producing a low voltage return signal that is then amplified and processed by the receiver electronics (Figure 1). Since the speed of sound remains relatively fixed (at approximately 4800 feet per second in water), it is possible to determine the distance to the target by accurately measuring the time difference between the transmitted pulse and the received echo.

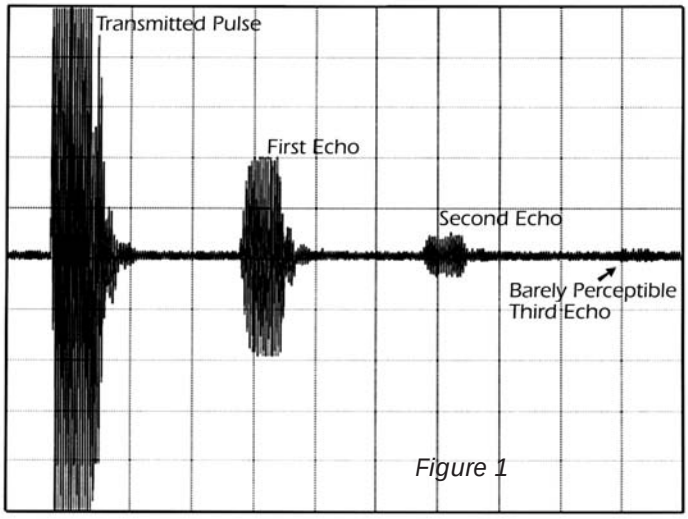


Figure 1

Piezoelectric Transducers

For most underwater applications, *piezoelectric* transducers present the best combination of efficiency, design flexibility and economy. Discovery of the piezoelectric effect in 1880 is credited to Jacques and Pierre Curie. This phenomenon is exhibited by certain materials which develop an electrostatic potential when subjected to pressure and, reciprocally, mechanically deform when subjected to an electrostatic potential. Certain naturally-occurring crystalline substances (for example, quartz) inherently exhibit the piezoelectric property. Synthetic piezoelectric materials can be manufactured using polycrystalline ceramics, or certain synthetic polymers.

Piezoceramics are manufactured by pressing a powder of a selected polycrystalline material to a desired shape (usually circular or rectangular) and then firing the parts in a kiln at a high temperature. Grinding and lapping usually is required to achieve desired mechanical or frequency tolerances. Electrodes typically of silver are applied next to allow the application of electrostatic potential. At this point, the ceramic is isotropic (uniform in all directions) and is composed of many crystals, in a random orientation, with each crystal cell behaving like a dipole. By applying a strong DC field at a high temperature, the dipoles are aligned parallel to the field thus making the ceramic anisotropic. This process is called *poling* and makes the ceramic piezoelectric.[1]

Applying an alternating current across the electrodes will cause the transducer to alternate in size at the applied frequency. Likewise, vibrating the ceramic mechanically will cause an AC voltage to appear at its electrodes.

In its simplest form shown in Figure 2, a marine transducer is fabricated by wrapping a resonant piezoceramic in a suitable pressure release material such as cork or foam, placing the ceramic in a suitable housing, connecting a shielded cable to the silvered electrodes on the ceramic, and filling the housing with an appropriate encapsulation material(s). Usually, the surfaces with electrodes are parallel to the water. (As a low-cost alternative, the ceramic may be bonded to the housing with encapsulated material applied as a backfill.)

Simplified Model

All piezoceramics have at least one series resonant frequency at which they vibrate most easily. This is dependent on the ceramic material, shape and dimensions. Around a given resonant

Sensor Design Fundamentals

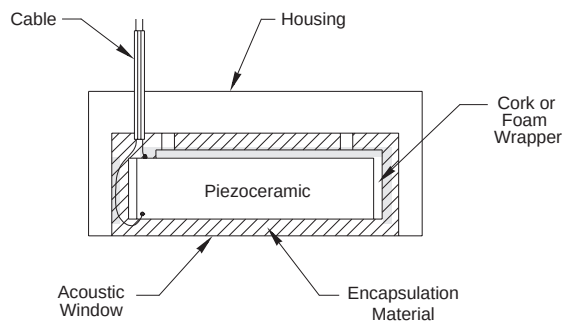


Figure 2
Encapsulation of Piezoceramic

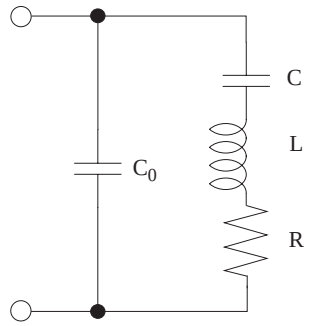


Figure 3

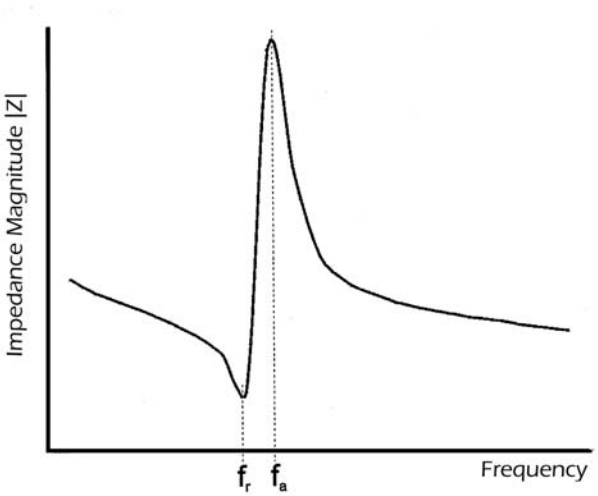


Figure 4

frequency f_r, a piezoelectric transducer may be modeled by the equivalent circuit shown in Figure 3.

In this model, R, C, and L represent the mechanical resonance of the transducer. In particular, R represents the transfer of energy into the water, as well as mechanical losses of the transducer. At resonance, the energy stored in the transducer is being transferred back and forth between C and L, and the magnitude of the impedance is at a minimum determined by R. It is at a point very near this resonant frequency that the transducer is most efficient as a projector (that is, converting electrical energy to acoustic energy).

The equivalent parallel capacitor C_o represents the dielectric capacitance of the transducer. The combination of C_o, C, and L yields a parallel *antiresonance* at a frequency f_a, which for a piezoceramic is always above f_r (usually by a few kHz), and where impedance magnitude is near maximum. Near f_a, the transducer is most efficient as a hydrophone (that is, converting acoustic energy to electrical energy). The parallel antiresonant frequency is greatly influenced by external factors such as cable capacitance and acoustic window material, which serve to affect the total parallel capacitance in the system. For a piezoceramic, impedance magnitude vs. frequency is graphically presented in Figure 4.

The *quality factor*, or Q of the transducer at resonance, is defined as

$$Q = 2\pi f_r \cdot \left(\frac{\text{maximum energy stored in transducer at } f_r}{\text{power dissipated in transducer}} \right)$$

The Q of a transducer is related to its frequency response near resonance. It can be shown that $Q = \frac{f_r}{\Delta f}$

where Δf is the -3dB (half power) bandwidth of the transducer, centered on the resonant frequency f_r. Transducers with a higher Q therefore have a narrower bandwidth around the resonant frequency. They also have a higher tendency towards ringing when transmitting.

Radiation Pattern and Beamwidth

The transducer *directivity*, or *radiation pattern*, is a function of the dimensions of the active transducer surface area and the transducer operating frequency. Piezoceramics have the property of *reciprocity*; therefore the transmitting radiation pattern of a given transducer is identical to its receiving radiation pattern.

Sensor Design Fundamentals

For a disc shaped element, the directivity of the element at a given angle α is

$$D(\alpha) = \frac{2CJ_1\left(\frac{2\pi rf\sin\alpha}{C}\right)}{\pi fd\sin\alpha}$$

where

$D(\alpha)$ = sound pressure at angle α

C = sound speed of water

J_1 = first order Bessel function of the first kind

f = frequency

d = piezoceramic diameter

The *beamwidth* θ of the transducer at -3dB (half power points) can be computed by letting $D(\alpha) = 1/\sqrt{2}$ and solving for α (= θ / 2). This reduces to the approximation $\theta \approx 1.02 \times \frac{C}{fd}$

From this formula, we can see that transducer beamwidth is inversely proportional to both frequency and ceramic diameter. The -3dB beamwidth as a function of element diameter and frequency is shown in Figure 5. To increase beamwidth, it is obvious that the operating frequency and/or ceramic diameter must be decreased (and conversely). When piezoceramic diameter is reduced transducer sensitivity is also reduced.

Performance Measurement of Transducers

Various methods of transducer measurement are used by transducer manufacturers, instrument OEM's and marine electronics dealers. To further confuse this issue, various units are used by different manufacturers. Comparison of transducers measured in different units is difficult, but is still possible.

Of most significant interest is the measurement of transmitting voltage response, receiving voltage response, radiation pattern, and impedance. There are several methods for measuring acoustic response, but the easiest to use is the comparative method, whereby an unknown transducer is compared with a hydrophone of known and reliable calibration. A large number of calibrated hydrophones are available. Most measurements are performed at a distance of one meter between the unknown transducer and the hydrophone.

The *transmitting voltage response* (TVR) of the unknown transducer is the sound pressure produced in the center of the radiated beam pattern at a given distance from the transducer per unit voltage into a hydrophone. Commonly, TVR is reported in decibels (dB) above 1 micropascal (μPa) per volt at 1 meter.

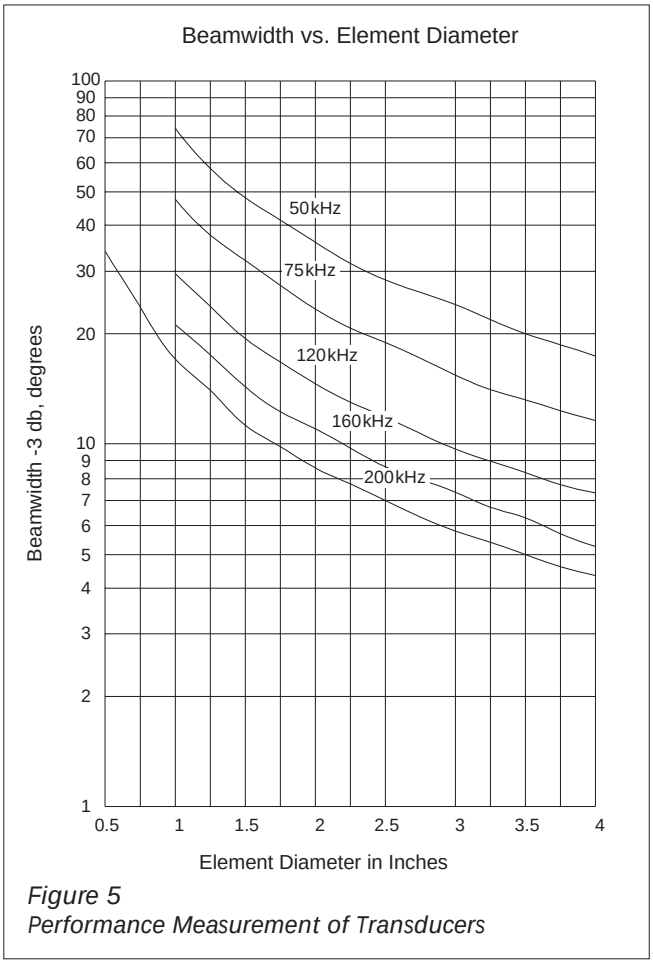


Figure 5
Performance Measurement of Transducers

The *receiving voltage response* (RVR) of the measured transducer is the voltage generated across its leads by a plane wave of unit acoustic pressure. When the measured transducer works into a very high impedance, this measurement is called *open circuit voltage* (OCV) response. Common units are dB relative to 1 volt per μPa.

Both TVR and RVR are measured as a function of frequency to determine the peak responses (transmit and receive). A *figure of merit* (the sum of TVR and RVR) is useful in providing a relative gauge of the performance of various piezoceramics. Figures 6, 7, 8 show TVR, RVR and Figure of Merit, respectively, for an Airmar 200 kHz 1.75" diameter PZT-4 piezoceramic which is commonly used in recreational echosounders. Note that peak TVR is at 198 kHz while peak RVR occurs at 202 kHz. Peak TVR occurs approximately at the resonant frequency of the ceramic (f_r, the

Sensor Design Fundamentals

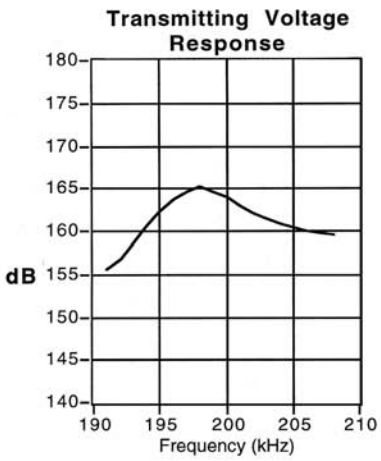


FIgure 6

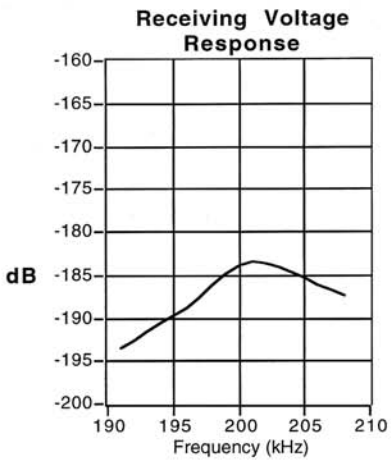


FIgure 7

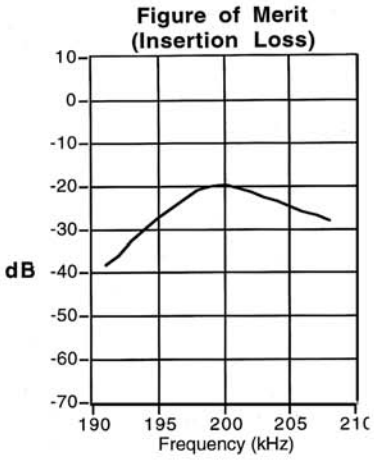


FIgure 8

minimum impedance point; refer to Figure 4) whereas peak RVR occurs approximately at the anti resonant frequency (f_a, the maximum impedance point). The figure of merit (Figure 8) provides a good representation of transducer bandwidth and the best operating frequency for the transducer (when not tuned).

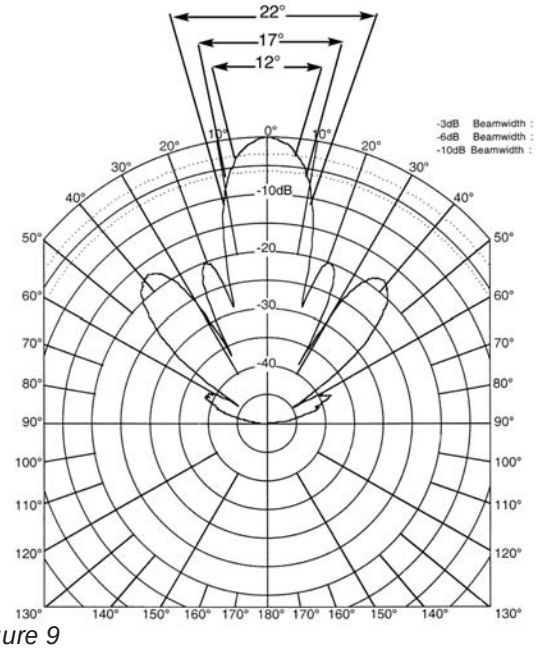


Figure 9

The *transmit radiation pattern* is normally measured at the best transmitting frequency by applying a signal to the transducer and measuring the signal received with a hydrophone as the transducer is being rotated. Measurements can be made continuously or in finite increments of 1˚ or so. The measured data is normalized relative to the peak response and usually plotted on a polar grid such as shown in Figure 9. The beam angles at -3dB, -6dB, and -10dB are highlighted. Note that the first sidelobe is at -20dB and the second sidelobe is well suppressed as well at -17dB. Spurious radiation is negligible and this is mainly attributable to the the fact that this ceramic was mounted in a bronze housing.

Impedance data is measured while the transducer is immersed in water. No echo should be received by the transducer during this measurement which, in theory, would require an infinitely large tank. Depending on the equipment used, impedance is measured as a function of frequency in one of the representations of impedance: impedance magnitude and angle ($|Z|$ and Θ), series resistance and reactance ($R_s + jX_s$), equivalent parallel resistance and capacitance (R_p and C_p), or conductance and susceptance ($G + jB$). These are mathematically related by the following formulas:

$$|Z| = \sqrt{R_s^2 + X_s^2} \qquad \Theta = \text{atan}(X_s/R_s)$$

$$R_p = |Z|^2/R_s \qquad C_p = X_s/2\pi f_r|Z|^2$$

$$G = R_s/|Z|^2 \qquad B = -X_s/|Z|^2$$

Sensor Design Fundamentals

While the theory of transducer measurement is simple, it is relatively difficult and expensive to make accurate absolute measurements. A water tank of sufficient size must be used. Tank sizing is dependent on the frequency to be measured. Detailed recommendations on tank design and measurement equipment systems are outside the scope of this article, but valuable information may be obtained by referring to literature published by Bruel & Kjaer Instruments, 2364 Park Central Blvd., Decatur, GA 30035-3987.

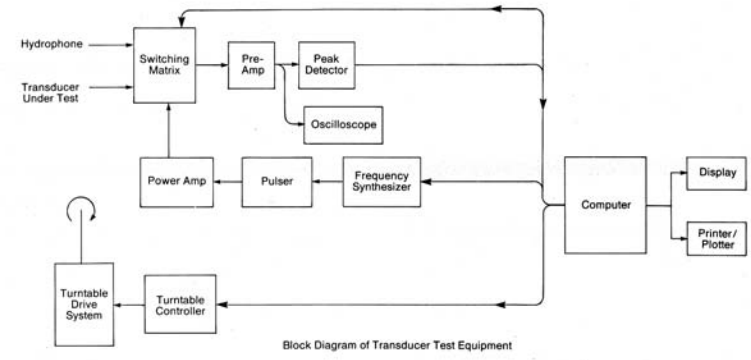


Figure 10

A block diagram of the equipment used for transducer measurement is shown in Figure 10. A good comparative evaluation of small transducers in the 50 kHz to 200 kHz frequency range can be performed with less sophisticated equipment, but still must be done in a tank of adequate size. As a general recommendation, the hydrophone and transducer should be 1 meter apart to avoid being in the Fresnel zone. The tank should be at least 4 feet deep to control surface reflections, and the transducer and hydrophone should be at least 1 foot from the tank walls. Wood tanks work well; the high reflectivity of steel (unless lined) makes for a poor tank. Small diameter tubes are not suitable measurement tanks because of standing wave reflections. Measurement in air of marine transducers is not recommended for many reasons. Most basic is that marine transducers are designed to couple the maximum amount of energy to water. For any specific design, the transducer may or may not exhibit good coupling to air depending on a number of factors.



Piezoceramic Resonance Modes

Piezoceramics are usually used at one specific resonant frequency. However, all ceramics contain multiple resonances and the resonant frequencies are a function of the geometry and type of piezoceramic material. Because piezoceramics are three dimensional solids, they can resonate in elongation in several planes and also resonate in shear. These different resonances are called *modes*. For each mode of resonance and each material type, there is a specific *frequency constant* and *coupling coefficient.*

The frequency constant is usually given in kHz/mm and is the product of frequency and the dimension in millimeters at which a piezoceramic resonates in a certain mode. For example, for a specified frequency constant of 2MHz/mm, a ceramic resonating in the thickness mode at 200 kHz would be about 10mm thick.

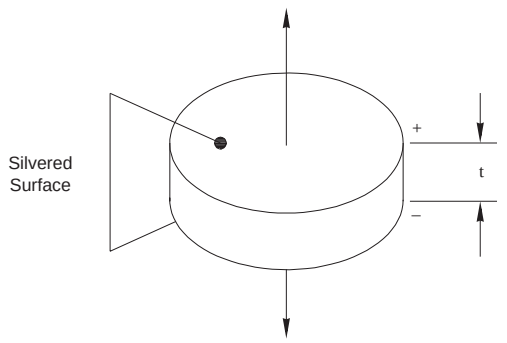
The *coupling coefficient*, k, is a dimensionless measure of piezoceramic performance and is defined by

$$k = \sqrt{\frac{\text{energy stored mechanically}}{\text{total energy stored electrically}}}$$

The coupling coefficient is not to be confused with transducer efficiency, but higher coupling coefficients yield higher efficiency transducers.

Sensor Design Fundamentals

Axial (Thickness) Mode



$f_r \propto 1/t$
$t \leq 0.3$ diameter (optimal)
$R_p \propto 1/t$
$R_p \propto 1/f_r$

Thickness Mode

The *thickness mode* is the most commonly used resonance mode above 100 kHz.

Advantages:

- Resonates in the direction of the water
- Piezoceramic can be manufactured at low relative cost
- Simple transducer construction
- Generally low spurious radiation if properly constructed
- Low to moderate impedance if $t \leq 0.35d$

Disadvantages:

- Less than desirable characteristics if $t \geq 0.4d$ (typical of 1.0" to 1.3" diameter piezoceramics at 150 kHz to 200 kHz)
- High impedance
- Low to moderate sensitivity
- Unwanted resonance modes often near desired resonant frequency

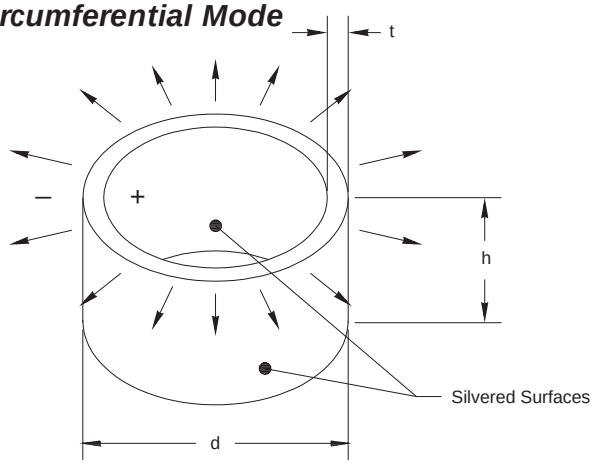
Circumferential Mode

The *circumferential mode* is primarily used in applications below 75 kHz. Piezoelectric rings resonating in circumferential mode are commonly used to generate quasi-omnidirectional radiation patterns. A typical application is underwater communications.

Transverse Wall Mode

The primary application of the *transverse wall mode* is from 100 kHz to 300 kHz. By controlling t, impedance can be, by design, low to moderate allowing low impedance transducers in a wide range of diameters, d.

Circumferential Mode



$f_r \propto 1/\text{mean diameter}$
$d \geq 3h + 3t$

Advantages:

- Good sensitivity
- Allows narrow and wide beam, high frequency transducers at low to moderate impedance
- Moderate cost

Disadvantages:

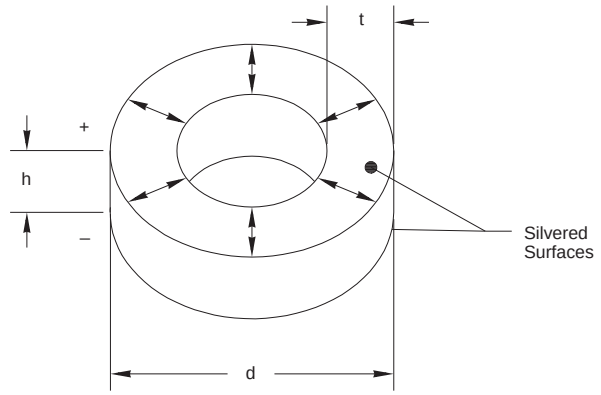
- Higher sidelobes in some cases
- Higher spurious radiation requires more expensive construction

Planar (Radial) Mode

The *planar mode* in circular disks typically exhibits very high coupling, high Q and high ringing. The principal application of the planar mode is for dual mode, dual frequency transducers, and mass loaded low frequency assemblies of ≤120 kHz. This can be most easily demonstrated with an example. In the planar mode, lead zirconate titanate (PZT) resonates at 50 kHz, when the diameter is about 1.75". PZT cannot be poled easily when thicker than 0.8", precluding the thickness mode. (Even if it could be, its impedance would be quite high!) So metal wafers are bonded to both sides of the piezoceramic disk to lower its resonant frequency. When wafers of approximately $\lambda/4$ thickness are bonded to a thin ceramic, it becomes a thickness mode resonant assembly.[2] In our 50 kHz example, when 1.75" diameter steel wafers and aluminum approximately 0.75" thick are bonded to a 1.75" diameter thin PZT wafer, an assembly is created which resonates simultaneously in the thickness and planar modes. Such an assembly is said to be *mode coupled* and tends to be very efficient.

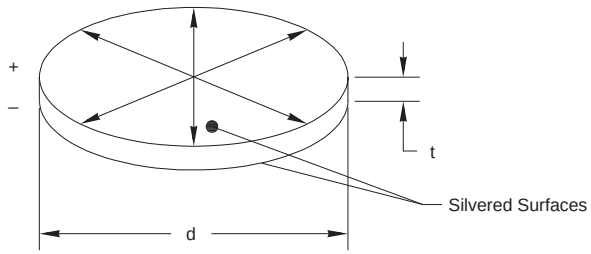
Sensor Design Fundamentals

Transverse Wall Mode



$f_r \propto 1/t$
$R_p \propto 1/t$

Planar (Radial) Mode



$f_r \propto 1/d$
$d \geq 5t$ (optimal)

Various material combinations and shapes can be used for the radiating head (wafer closest to the water) and tailpiece (wafer away from the water). The principal application of coupled planar/thickness mode assemblies is in the range from 24kHz to 120kHz. Cost is moderate considering the available alternatives at lower frequencies.

Piezoceramic Material Comparison

There are many piezoceramic materials that could be used for marine transducers, but the trade-off of ceramic cost and performance have dictated the use of two material families, barium titanate and lead zirconate titanate (PZT). Comparison of barium and the most commonly used variant of lead zirconate titanate, PZT-4, is shown below.[3]

Resonance Mode	*Coupling Coefficient*	
	Barium	PZT-4
Axial (Thickness)	.46	.71
Circumferential	-.19	-.36
Transverse Wall		-.54
Planar (Radial)	-.32	-.60

Resonance Mode	*Frequency Constant, kHz/in.*	
	Barium	PZT-4
Axial (Thickness)	106	79
Circumferential	58	41
Transverse Wall	91	65
Planar (Radial)	124	87

As can be seen, PZT-4 exhibits superior coupling in all modes and generally yields superior transducers. Barium is desirable in certain situations where its higher frequency constant can yield a more desirable beamwidth and better thickness to diameter ratio. Consider a 75kHz mode coupled transducer of laminated construction. Barium titanate is resonant in the planar mode at 1.65" diameter whereas PZT-4 is resonant at a diameter of 1.16". For most applications, barium is used because it yields a larger assembly, narrower beamwidth and better absolute sensitivity despite its lower coupling coefficient.

Other forms of PZT are used in marine transducers. PZT-5 is used primarily in receive only applications whereas PZT-8 has high transmit power capabilities.

Use of Various Modes

In marine applications, how does one decide when to use one resonance mode over another? At a given frequency, there may exist a market need for a selection of radiation patterns. Table 1 shows a good example of using different resonance modes to achieve a family of transducers of varying beamwidths at 120 kHz.

Use of these resonance modes can create a selection of transducers which are reasonably impedance compatible. If a single mode were used, the impedance variation would be much greater and transducer sensitivity compromised. Radiation patterns shown in Figure 11 graphically illustrate the great variation in beam patterns that can be achieved.

Sensor Design Fundamentals

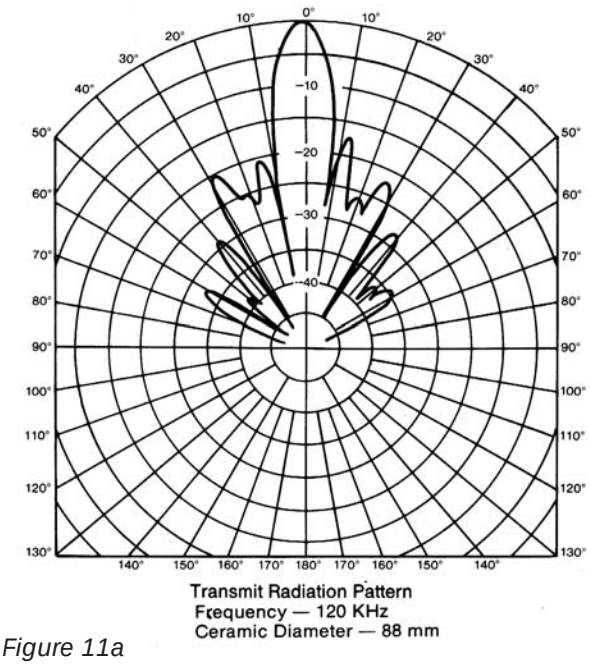


Figure 11a

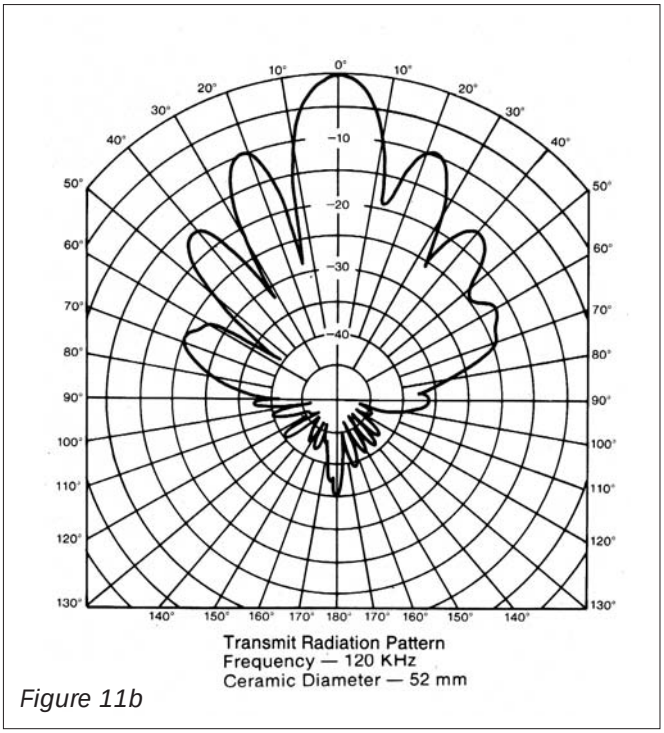


Figure 11b

Multi-Beamwidth Transducers

Table 1: Various Modes at 120 kHz				
Piezoceramic Diameter	3.5"	2.1"	1.45"	0.75"
Beamwidth @ -3dB	9	15	20	40
Material	Barium	PZT	PZT	PZT
Resonance Mode	Thickness	Transverse	Thickness	Coupled Planar/ Thickness
Power Capability Watts, RMS	1000+	600	350	56
Transmitting Voltage	1000+	600	350	200
Response dB	71	66	62	56
Impedance, Rp, ohms	320	200	200	500

By creating an impedance compatible family of transducers at one frequency, it is obvious that two or more of these piezoceramics can be packaged in one housing allowing different characteristics to be obtained. For example, at 120 kHz a 2.1”/15 degree beamwidth can be used for bottom detection to 1000 feet and medium depth fishfinding whereas a 0.75" diameter/40 degree beamwidth is an excellent choice for shallow water fishfinding and will present fish targets as “arches”. A multi-beamwidth transducer allows the fisherman to select the beamwidth best suited to the situation. For a discernible difference to be obtained on the echosounder screen, there must be a significant difference in beamwidth and transducer characteristics. For example, a 9/17 degree, 200 kHz dual beamwidth transducer, while easy to construct, does not present a significantly different picture to the fisherman viewing the echosounder.

Multifrequency Transducers

All ceramics have multiple resonances of varying strengths. A circular disc with a center hole might have the resonance modes shown in Figure 12. Depending on its various dimensions, a given ceramic can exhibit virtually any combination of thickness, circumferential, transverse wall, and/or planar modes.

In single frequency piezoceramic applications, the ceramic is designed for one strong resonance with other resonances as far away in frequency and as weak as possible.

Sensor Design Fundamentals

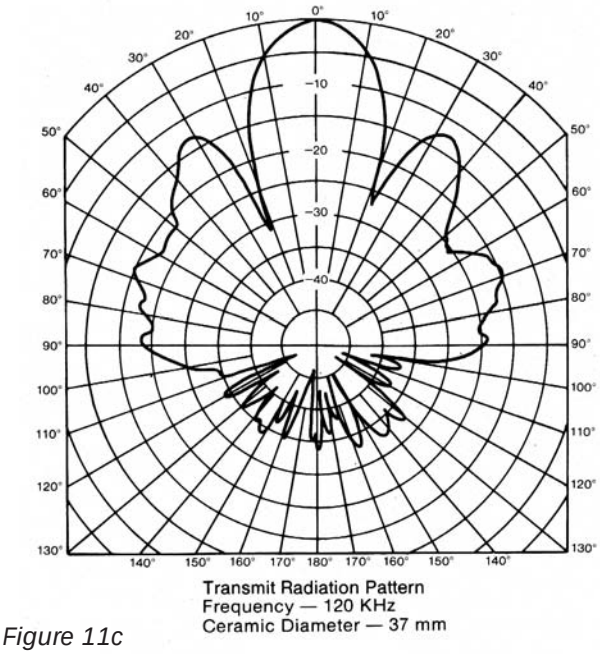


Figure 11c

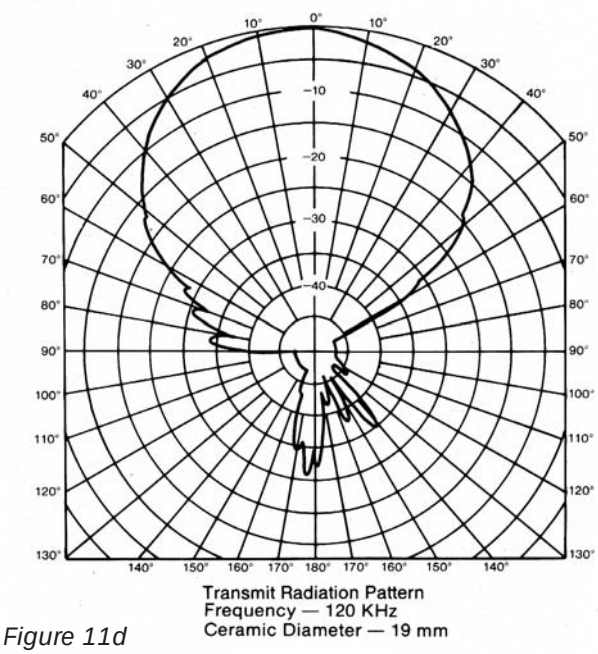


Figure 11d

Unwanted resonances that are close in frequency to the desired resonance are parasitic and tend to diminish the strength of the desired resonance. Rather than separate resonances, another approach sometimes used is to cross couple (in frequency) the two resonances to achieve greater piezoelectric activity.

Since all ceramics have a number of resonance modes, a multifrequency transducer can be created using a single ceramic. The optimization of a multifrequency transducer is a difficult process, and involves compromises since good sensitivity is desired at two or more frequencies. Usually, the relative performance at one frequency will be better than at the others. Multifrequency transducers are often desirable for applications where transducer size (and therefore housing drag) is an important consideration. For commercial fishing, multifrequency transducers are certainly desirable but since size is not usually a dominant consideration, optimum performance can best be achieved using specialized piezoceramics for each frequency. In this way sensitivity, beamwidth, impedance, and sidelobes can be tailored to the intended application.

Acoustic Window

There are many construction variables which affect transducer performance and reliability but the most important is the material used for the *acoustic window*. Referring to Figure 2, the window material occupies the space between the piezoceramic and the water.

When an acoustic wave encounters an interface between two materials, some energy propagates through the interface, and some is reflected back. As acoustic energy is transferred from piezoceramic to the acoustic window material and into the water (and back again as an echo), it passes through several interfaces.

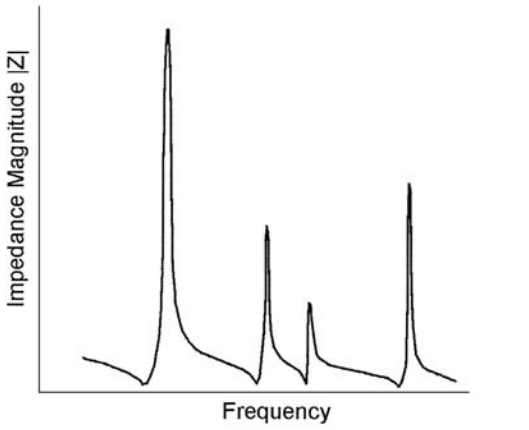


Figure 12

Sensor Design Fundamentals

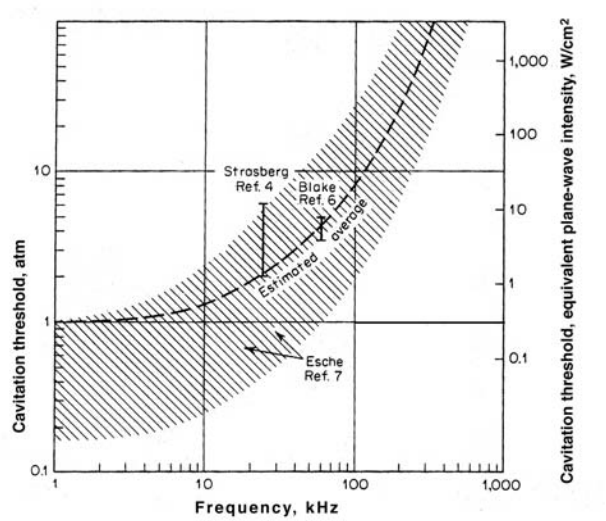


Figure 13

Used with permission of The McGraw-Hill Companies, from "Principles of Underwater Sound," by Robert J. Urick, 3rd edition, McGraw Hill, 1983.

At a given frequency, a given material has a characteristic *acoustic impedance*. A good window material will provide an efficient matching layer between the ceramic and the water. In addition, an impedance mismatch may be effectively "tuned out" by controlling the thickness of the acoustic window relative to the wavelength at the frequency of interest.

Most marine transducers use one of the following materials for the acoustic window:

1. Urethane - Flexible material generally with good adhesion, excellent hydrolytic stability and soundspeed close to that of water. Low impedance. Low acoustic transmission losses. Medium to high cost material.
2. Neoprene - Flexible material usually used in conjunction with vulcanized housing construction. Relatively expensive. Other characteristics similar to urethane.
3. Epoxy - Usually a hard material with fillers. Varying hydrolytic stability. High soundspeed relative to water. Good adhesion characteristics. Low material cost. Often used to form a $\lambda/4$ wave matching layer which results in lower Q, lower ringing, and higher impedance.
4. Plastic - Typically, ABS, polycarbonate, or polyester. High soundspeed relative to water. Usually yields a transducer with higher impedance. Generally used for 150-200kHz. Very low cost and smooth. Repeatable, but compromised performance relative to other materials.

Neoprene and urethane can be used in the frequency range from very low frequencies to 2MHz. Because the soundspeed of the window is close to that of water, thickness is not critical generally, affording design flexibility. Urethanes are relatively expensive and difficult to handle, being toxic and hydroscopic and often requiring a high temperature cure cycle. Maximum acoustic performance and maximum power ratings are achieved using neoprene and urethanes. The flexibility of urethanes is especially important in bronze housings since urethanes are less likely to separate from housing walls during thermal cycling.

Epoxies are inexpensive and their process control is relatively simple. Acoustic window thickness is somewhat critical when constructing a matching layer. Epoxy windows are susceptible to delamination at high power and separation from bronze housings during cold cycling due to the inherent rigidity of the material. Epoxies are not often used in low frequency commercial transducers. They are also not very suitable for multifrequency or multibeam-width transducers. However, cast epoxy housings with integral matching layer can provide excellent performance (low Q, low sidelobes) in 1-3 kW transducers.

Plastic windows are confined to low cost, high frequency transducers; this construction is especially suited to in-hull transducers since the relatively hard plastic window provides an excellent bonding surface to the relatively hard hull material. Plastic windows are also commonly used on transom mount transducers because the smooth plastic surface can provide very good high speed performance.

Power Rating

Most transducers are rated for a maximum input power usually stated in watts, RMS. Maximum power input is constrained by cavitation of the transducer and by catastrophic failure of the transducer.

Cavitation occurs on the surface of a projecting transducer as transmitting power is increased. As the transducer vibrates, the acoustic pressure generated alternates between a positive and a negative pressure. When the pressure on the negative portion of the cycle exceeds a certain *cavitation threshold*, bubbles begin to form on the face and just in front of the transducer. As the transducer is driven harder, various detrimental effects begin to occur, including a loss of acoustic power as the energy is scattered by the cavitated bubble cloud, a deterioration in the transmitting radiation pattern, and a mismatch of acoustic impedance between the transducer face and the water.

Sensor Design Fundamentals

Cavitation is a limiting factor usually at lower frequencies (<50 kHz) (see Figure 13). The cavitation threshold may be raised, thus allowing more acoustic power to be radiated, by increasing the frequency, decreasing the transmit pulse length, increasing the active surface area and/or increasing the depth (hydrostatic pressure) of the transducer.[4] As shown in Figure 13, the cavitation threshold in watts/cm^2 is not precisely defined at each frequency since the onset of cavitation is dependent on the presence of bubbles, particles and biomass in the water, water temperature and dissolved oxygen. For example, the data in Figure 13 shows that the cavitation threshold at 50 kHz can vary from 0.4 to 40 watts/cm^2 with the estimated average being 6 watts/cm^2. Typical sportfishing transducers are operated at power densities as high as 43 watts/cm^2. Commercial fishing transducers operate in the range of 6 to 23 watts/cm^2. While transducers (especially those used in sportfishing) are often operated above the cavitation threshold, the effect is seldom noticed since water flowing over the transducer carries the cavitated bubbles away.

The other limiting factor in determining the power rating of a transducer is the catastrophic failure of the device. Failure modes include

- Piezoceramic fracture
- Silver electrode failure
- Excessive heat, causing depoling
- Delamination of loading wafers
- Separation of acoustic window from resonant assembly

The most common failure modes at high power are delamination or acoustic window separation.

A transducer with a power rating of 500 watts will accept a 500 watt input and survive. It is not necessarily the best transducer for a 500 watt echosounder. There is no direct correlation between power rating and transducer acoustic response or overall acoustic efficiency. Unfortunately, power rating is frequently the selection criterion for matching a transducer to an echosounder. This is analogous to selecting the smallest available propulsion unit for a vessel and yet expecting maximum performance.

Frequency Selection

A recurring trade-off is the optimum operating frequency for a variety of applications. Higher freqencies have narrower beam-widths yielding greater bottom definition but detecting fewer midwater targets. Attenuation of sound in water increases with frequency according to the graph shown in Figure 14. Note that attenuation in saltwater is significantly greater below 500 kHz than freshwater primarily due to the presence of magnesium sulfate. Because there is lower roundtrip attenuation of lower frequency signals, lower frequencies must be used to achieve greater working depths. However, lower frequencies have the disadvantage of greater beam angle and spreading losses for a given transducer size. Also, there is increasing ambient noise at the lower end of the frequency spectrum and this reduces the signal to noise ratio when using lower frequencies. Due to the longer wavelength inherent with lower frequencies, smaller targets such as feedfish may not be detected. This can be an advantage or disadvantage. Finally, the lower the transducer frequency, generally the higher the transducer cost.

The fact that different size targets and different bottom compositions have a different appearance on an echosounder display at different frequencies, has precipitated the transition to multifrequency echosounders especially for commercial fishing.

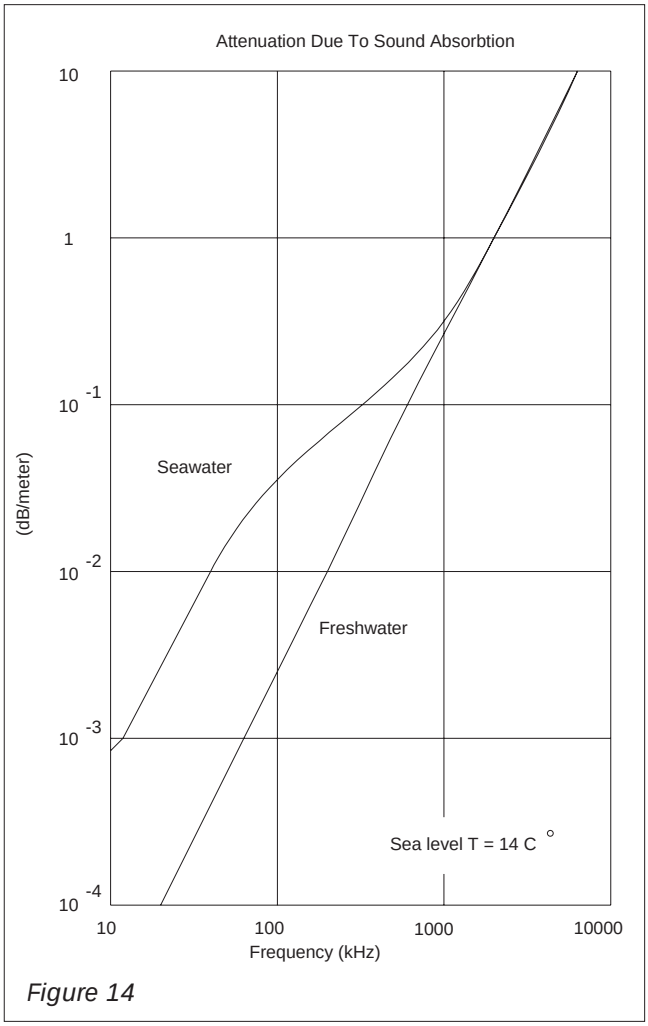


Figure 14

Sensor Design Fundamentals

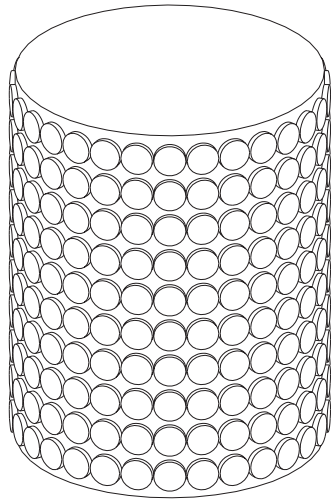


Figure 15

Ringing

A bell, when struck, resounds at its resonant frequency, decaying over time. A transducer exhibits this behavior as well, in both transmit and receive modes of operation. The amplitude of ring is generally much lower than the amplitude of the causative "strike." In a system with one transducer acting as both projector and hydrophone, the ringing occurring as a result of the transmit pulse can prevent the receiver from "seeing" near-range echoes. Various methods may be used to counteract the effects of ringing:

- To reduce ringing of the transmitted pulse, use a transducer with a lower Q.
- To reduce the ringing of received echoes, use a transducer with a lower figure of merit.
- Use separate transducer elements for transmit and receive. If the elements are well isolated from each other, the ringing of the transmit element will not affect the received signal.
- If using a single element for both transmitting and receiving, apply a low impedance load across the transducer immediately after the transmit pulse to dissipate the ringing energy. This is analogous to grabbing the bell with your hand immediately after it is struck.
- If the ringing profile of the transducer immediately after transmit is measured and stored in the signal processing module of the receiver, the expected amplitude of the ringing at each point in time can be subtracted from the total signal detected, thus resulting in only the external signal of interest. The dynamic range of the receiver in this case would need to be wide enough such that the total amplitude of ringing + signal would not saturate the receiver.

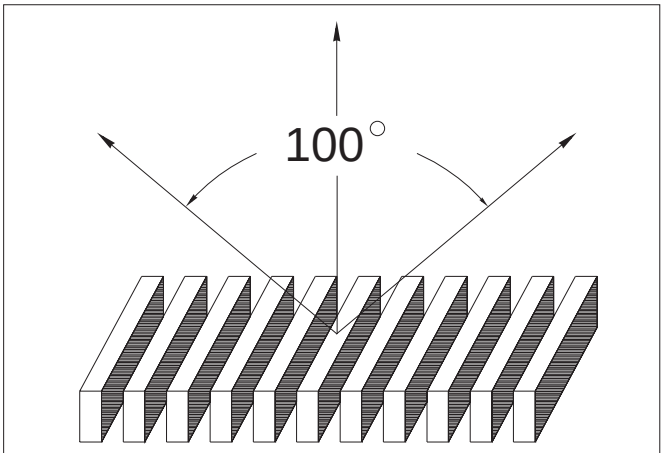


Figure 16

System Losses

Many articles and books cover the system losses in echosounders. Prediction of system losses can be determined using the sonar equation and its application is well documented in several texts and papers.[4, 5] This paper focuses on transducer performance, but this is only one component in the sonar equation. Others include water path attenuation along the soundpath (Figure 14), reflection loss of the target, acoustic noise, and electrical noise on board the vessel. Because of these variables, it is very difficult to evaluate initially a transducer in the field environment. Too many other variables can mask subtle differences among transducers. While transducers ultimately must work in the field environment, there is no substitute for the controlled environment of a test tank.

Transducer Selection Criteria

In most echosounder systems sold today, the transducer represents less than 10% of the system cost. It should be obvious that an optimal transducer can markedly enhance echosounder performance; a minimal transducer can severely limit performance. Believing that all transducers of similar power rating are the same can lead to unhappy customers. Various manufacturers produce transducers with different impedance and using different piezoceramic materials and different acoustic window materials.

In commercial fishing applications, the operating frequency(s) will be determined by intended use. Once the frequency(s) is determined, transducer selection criteria should be maximum acoustic response (figure of merit), an impedance which matches the echosounder, and a beam angle compatible with the intended application. Usually, the optional, more expensive transducer is the better choice because of its better acoustic response and narrower beam angle.

Sensor Design Fundamentals

For recreational fishing, the selection criteria are slightly different. Since most pleasure fishing is done in shallow waters, beam pattern can be a dominant factor along with operating frequency. Once these are determined, the transducer offering best acoustic response and compatible impedance should be selected. For recreational navigation, narrow beam angle transducers are preferred. Maximum required depth will determine the operating frequency. Again, acoustic response should be maximum. Post transmission ring and pulse width will affect minimum depth capability. Spurious radiation and transducer sidelobes should be evaluated carefully for digital depth sounder applications.

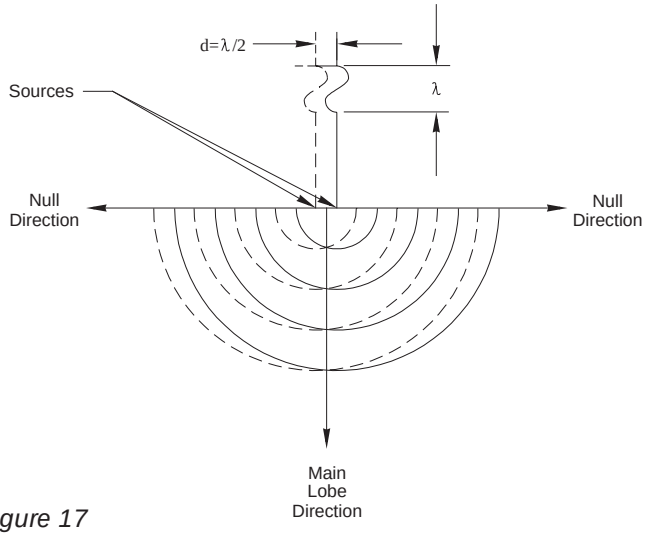


Figure 17

PVDF

The piezoelectric homopolymer *PVDF* (polyvinylidene fluoride) is emerging as a low cost alternative to piezoceramics in certain applications. A sheet of isotropic PVDF is poled by stretching it while being exposed to heat and a high electrostatic field. It is then plated with copper on both sides. The copper is selectively etched using the same method as for printed-circuit boards, yielding a pair of electrodes. The shape of the electrodes determines the transducer's radiation pattern, and is designed using the principles of antenna theory. This approach presents the opportunity to design a transducer with a unique radiation pattern, such as an elliptical shape or one with very low sidelobes. PVDF has a broader frequency response than do piezoceramics, and is therefore not limited for use at a specific frequency. PVDF can be shaped to conform to unusual requirements. Multiple elements may be etched onto a single sheet, taking advantage of the intrinsic uniformity of the sheet, yielding arrays of elements well matched in amplitude and phase.

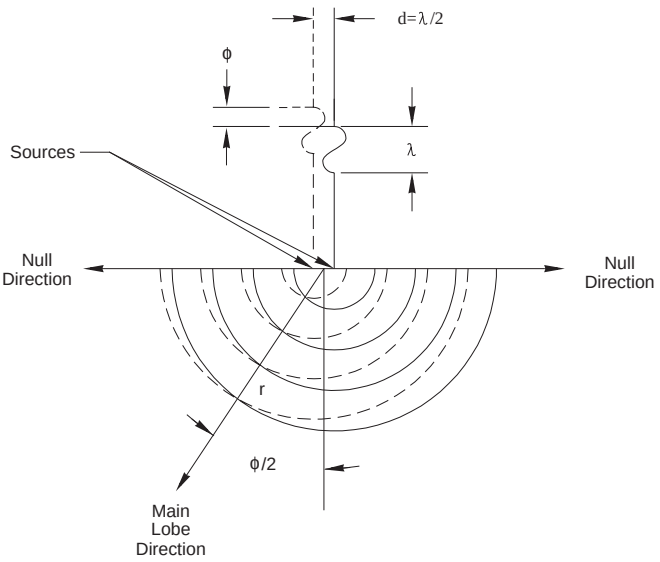


Figure 18

Phased-Array Systems

Single frequency, single beam transducers limit the information available to the echosounder to the underwater volume within the transducer beam pattern. A wide beam transducer can cover an increased volume in shallow water, but provides less resolution and sensitivity. Multifrequency and multi-beamwidth transducers are becoming popular because they can provide significantly more information on the echosounder display. But these transducers generally use a vertically directed soundbeam and provide no acoustic information on targets lying in front of and to the side of the vessel.

Ideally, an echosounder would cover a very large area fore, aft, port, and starboard of the vessel, and have good resolution, sensitivity and discrimination. These characteristics are provided by *phased-array* systems.

The unique characteristic of the phased-array system is the ability to electronically and rapidly steer the acoustic beam in a selected direction. This allows the echosounder to display near-real-time images of targets in their actual locations, and accurate, to-scale bottom contours, rather than a historical graph of objects that have been passed over.

A phased-array system consists of a transducer containing multiple elements, and a beam former, which consists of multiple

transmitters and receivers and the phase delay circuitry required to steer the beam.

The complexity of the system is determined by the application. Some military systems use very large cylindrical or spherical arrays to obtain 360-degree steering capabilities with very high resolution and sensitivity. Some large commercial systems use larger planar or curvilinear arrays for beam steering on either one or two axes.

Curvilinear arrays such as the one shown in Figure 15 are used in omni-sonars on large fishing vessels. Phase shifting is used to tilt the beam on the vertical (elevation) axis. (These arrays also can form a single or multiple beams on the horizontal (azimuth) axis.)

Planar arrays (Figure 16) can steer a beam on one or two axes through plus or minus 50 degrees from an axis normal to the planar surface. The concept can work at any ultrasonic frequency commonly in use, but some frequency bands present greater transducer fabrication difficulties and result in higher cost.

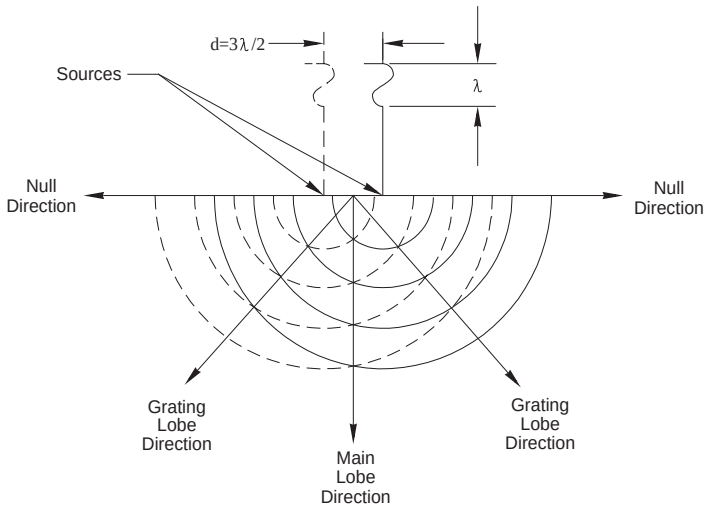


Figure 19

The principle of beam steering may be illustrated by considering the simple case of two point sources, each radiating hemispherically, driven synchronously by a sinusoid of wavelength λ, and separated from each other by a distance of $\lambda / 2$, as shown in Figure 17. The sound waves emanated from each will also be synchronous and sinusoidal, and are represented by concentric semicircles one wavelength (λ) apart, corresponding to the same point on each wave. Where the dotted and solid lines cross, the sound waves are in phase, adding to produce a main lobe; when the two lines are $\lambda / 2$ apart, or 180 degrees out of phase, the sound waves cancel, creating a null. For Figure 17, the main lobe is directed perpendicular to the plane of the two sources.

To steer the beam, we create a time delay, or phase shift ϕ, between the input signal to each source, which in turn produces a phase shift between the sound waves as shown in Figure 18. Now the sound waves add along a line at an angle $\phi / 2$ from the perpendicular. In phased-array technology, this basic principle is extended to the different array types discussed earlier.

What happens if we change the spacing between sources? Figure 19 demonstrates that if the spacing is greater than $\lambda / 2$, there will be more than one line along which the sound waves add. These "grating lobes" are unacceptable in a scanning sonar system because actual positions of targets become uncertain. If the spacing is less than $\lambda / 2$, then the waves are never 180 degrees out of phase, so there is no null along the plane of the sources as there is in Figure 17. This is also undesirable.

Having chosen $\lambda / 2$ as the best spacing, we accept that each element must be less than $\lambda / 2$ in width for ease of manufacture. To construct a transducer of reasonable sensitivity, the width of each element should be at least $\lambda / 4$. The number of elements used is based on the overall beamwidth desired.

Due to the complexity of the transducer and the need for multiple receivers, transmitters, and a beam former, a phased-array echosounder is understandably more expensive to produce than a fixed-beam echosounder. The prevailing trend is to design and use transducers which will acquire more underwater information. As more features are added to new echosounders, phased-array systems will inevitably become more prevalent in the sportfishing and other recreational markets.■

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3 Channel Industries, "Piezoelectric Materials and their Properties."
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Sensor Design Fundamentals

Comparison of Urethane vs. Plastic for Acoustic Window Material

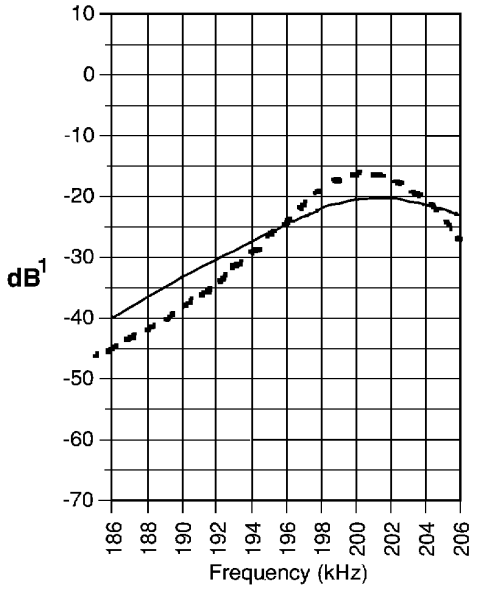
For 120, 150, 200, and 235 kHz transducers, Airmar offers two different acoustic window materials: a soft, low durometer urethane window, and a harder plastic window. Each has advantages. A transducer with the urethane window will have maximum sensitivity and lower impedance. The plastic window will have a broader frequency response, higher impedance, and typically less sensitivity. The low durometer urethane offers superior hydrolytic stability which translates to lower water absorption and longer life for thru-hull transducers. The flexibility of the softer material also reduces the window separation from the housing, which can occur due to the temperature extremes transducers may be subjected to in northern climates. Transducers with plastic windows wet more quickly and generate less acoustic noise at high boat speeds. Plastic windows are more desirable for in-hull mounting and for use on trolling motors, trailered boats, and high speed boats.■

Performance Comparison of Window Material

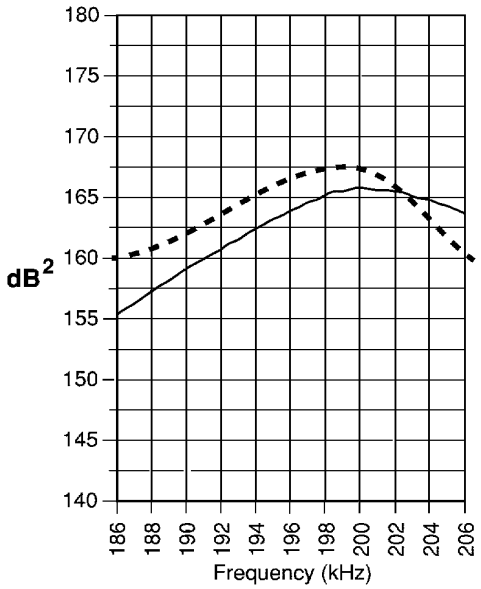
Urethane Window - - - - - - -

Plastic Window ———

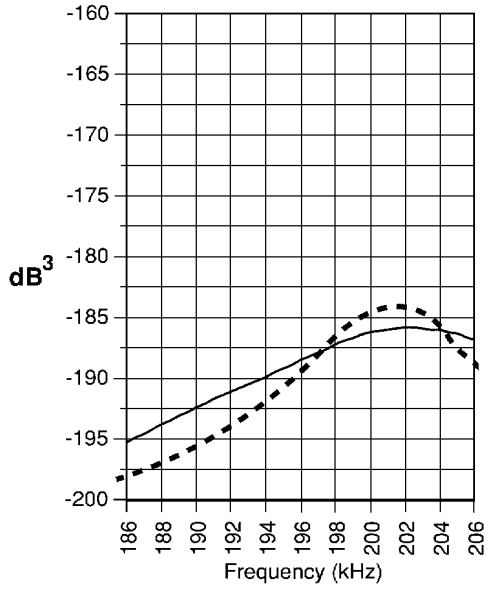
Figure of Merit
(Insertion Loss)



Transmitting Voltage Response



Receiving Voltage Response



1. Sum of transmitting voltage response and receiving voltage response.
2. dB re 1µPa per volt at 1 meter, subtract 100 dB for µbars
3. dB re 1 volt per µPa, add 100 dB for µbars

Sensor Design Fundamentals

Impedance of Piezoceramic Transducers

Review of Impedance Concepts

In DC circuits, Ohm's Law states that the resistance R of a device is the ratio of the DC voltage V across its terminals to the current I flowing into the device: $R = \frac{V}{I}$

where R is measured in ohms, V is in volts, and I is in amperes.

In AC circuits, we broaden this concept of resistance to include information regarding the phase relationship between the time-varying voltage and current. Impedance Z is the AC equivalent of resistance, and is the ratio of voltage to current: $Z = \frac{V(t)}{I(t)}$

where voltage V(t) and current I(t) both vary as a function of time. Like resistance, impedance is measured in ohms. Unlike resistance, impedance is described using complex numbers. A complex number is any number of the form A+jB. It has two components: a real component A, and an imaginary component jB. By definition, $j = \sqrt{-1}$. That is, j is that number which, when multiplied by itself, results in negative one. The term imaginary is sometimes misleading: it does not mean that the quantity being described is any less physical or tangible than a real quantity; only that it is mathematically represented in a different geometric dimension than a real value. While ordinary real numbers may be plotted on a number line in a single dimension, complex numbers are plotted on a 2-dimensional complex plane.

Impedance is represented in the complex plane by the vector

$$Z = R + jX$$

where R (resistance) is the real component of impedance, X is the imaginary component of impedance, known as reactance, both of which are measured in ohms, and j is the complex operator $\sqrt{-1}$. Impedance of a device in the complex plane is shown in Figure 1.

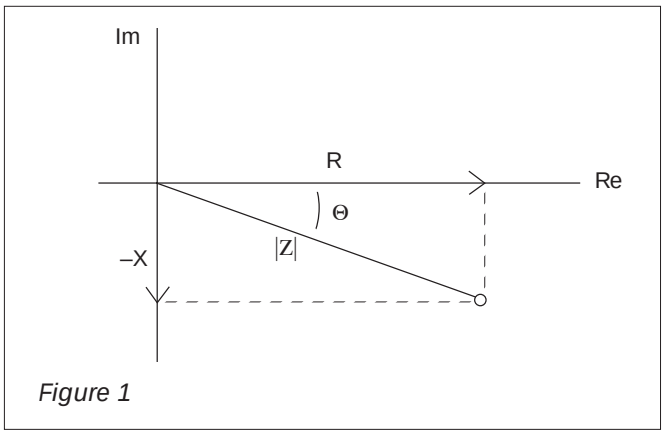


Figure 1

An ideal capacitor has the capacitive reactance $X_C = \frac{-1}{2\pi fC}$

and an ideal inductor has the inductive reactance $X_L = 2\pi fL$

where f is the frequency in hertz, C is the capacitance in farads, and L is the inductance in henrys. Noting the sign in the above two equations, we see that positive reactances are inductive, and negative reactances are capacitive.

The magnitude of impedance Z is $|Z| = \sqrt{R^2 + X^2}$

and its phase angle is $\Theta = \text{atan}\frac{X}{R}$

Impedances connected in series are additive, that is

$$Z_{series} = Z_1 + Z_2$$

and impedances connected in parallel are combined according to

$$\frac{1}{Z_{parallel}} = \frac{1}{Z_1} + \frac{1}{Z_2} \quad \text{or} \quad Z_{parallel} = \frac{Z_1 Z_2}{Z_1 + Z_2}$$

Admittance Y is the reciprocal of impedance: Y = 1 / Z, and is measured in siemens (S, also known as mhos, the reciprocal of ohms). As with impedance, admittance is represented as a complex value: $Y = G + jB$

The real and imaginary components of admittance are conductance G, and susceptance B, respectively, where

$$G = \frac{R}{|Z|^2} \quad \text{and} \quad B = \frac{-X}{|Z|^2}$$

Both conductance G and susceptance B are measured in siemens.

Sensor Design Fundamentals

Transducer Equivalent Circuit

Over a relatively narrow frequency range, a piezoelectric transducer can be modeled by the equivalent circuit shown in Figure 2.

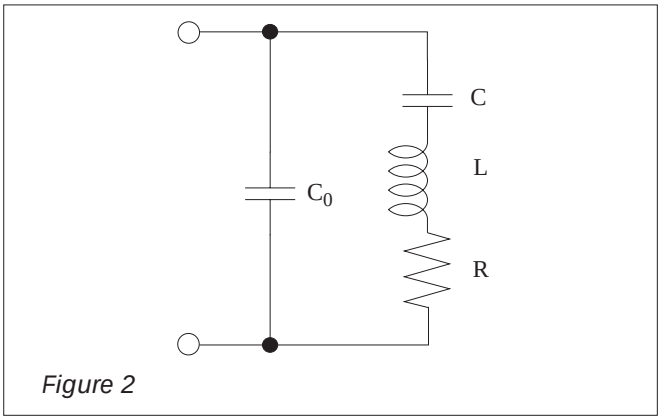


Figure 2

The series elements L and C yield a natural resonance at a specific series resonant frequency f_r of the transducer. This frequency may be expressed in terms of the equivalent values of L and C:

$$f_r = \frac{1}{2\pi} \cdot \sqrt{\frac{1}{LC}}$$

At this frequency, the capacitive reactance X_C of equivalent series capacitor C exactly cancels the inductive reactance X_L of inductor L, and the magnitude of the transducer impedance |Z| is therefore at a minimum determined by R. Near f_r, the transducer is most efficient as a projector (transmitting device).

Parallel capacitor C_0 combines with C and L to produce a second resonance known as the parallel antiresonant frequency f_a, which for a piezoceramic is usually a few kHz above f_r. f_a is related to the equivalent circuit elements by

$$f_a = \frac{1}{2\pi} \cdot \sqrt{\frac{C + C_0}{LC_0C}}$$

At this antiresonant frequency, the impedance magnitude is at a maximum. It is near this frequency that the transducer is generally most efficient as a hydrophone (listening device). Note that the parallel capacitance of the entire system, including the cable, connectors, and echosounder driver circuitry, serve to add to the total parallel capacitance, and so tends to shift the antiresonant frequency. Note also that this total parallel capacitance acts as an AC load, reducing the amplitude of the received signal, and/or requiring the transmitter driver amplifier to provide more current. (The effect of this total shunt capacitance may be minimized at a given frequency by proper selection of a suitable series or parallel inductor.) External parallel capacitance has no effect on the series resonant frequency f_r.

Quality Factor

The quality factor, or Q of a transducer, is a measure of its energy storage property relative to its energy dissipation property. Q is measured at resonance, where the total stored energy in the transducer is constant. Q may be expressed in terms of our equivalent circuit elements:

$$Q = \frac{X_L}{R} = \frac{2\pi f_r L}{R} \quad \text{and} \quad Q = \frac{-X_C}{R} = \frac{1}{2\pi f_r CR}$$

The Q of a transducer is related to its frequency response near resonance. It can be shown that $Q = \frac{f_r}{\Delta f}$

where Δf is the -3dB (half power) bandwidth of the transducer, centered on the resonant frequency f_r. Note from this equation that a transducer with a higher Q at a given frequency will have a narrower bandwidth.

Net Impedance of a Transducer at its Terminals

It is often required to characterize the net impedance vs. frequency of a transducer at its terminals. For this purpose, our equivalent circuit may be simplified further. At a given frequency (except at resonance), either C or L is predominant. Therefore, at that frequency the transducer will appear at its electrodes to be either capacitive or inductive, and may be represented by either Figure 3 or Figure 4.

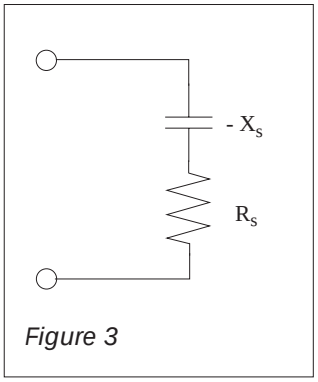


Figure 3

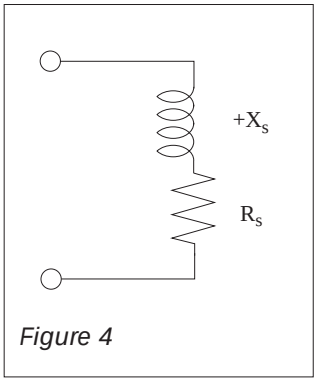


Figure 4

where R_s = series resistance
X_s = series reactance

Note that the values of both R_s and X_s are highly frequency dependent.

Sensor Design Fundamentals

The series model does not conveniently lend itself to calculations involving parallel tuned matching circuits. Therefore, it is often more convenient to convert the circuits of Figure 3 and Figure 4 to their exactly equivalent parallel circuits, Figure 5 and Figure 6.

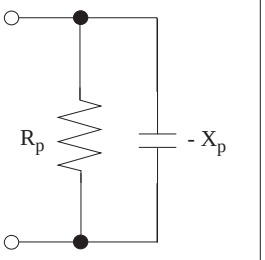


Figure 5

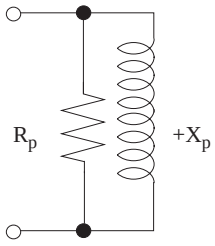


Figure 6

where R_p = parallel resistance
X_p = parallel reactance

The values of R_p and X_p are related to R_s and X_s by the equations

$$R_p = \frac{R_s^2 + X_s^2}{R_s} = \frac{|Z|^2}{R_s} \quad \text{and} \quad X_p = \frac{R_s^2 + X_s^2}{X_s} = \frac{|Z|^2}{X_s}$$

As with R_s and X_s, R_p and X_p vary with frequency.

If X_p is assumed to be capacitive, the value of the corresponding equivalent parallel capacitance would be $C_p = \frac{1}{2\pi f X_p}$

The above equation can be used even if X_p is in fact inductive; in this case the value computed for C_p will be a negative number.

The impedance vs. frequency characteristic of a given transducer may be represented using the units most convenient to the task: impedance magnitude and angle ($|Z|$ and Θ), series resistance and reactance ($R_s + jX_s$), equivalent parallel resistance and capacitance (R_p and C_p), or conductance and susceptance ($G + jB$). Airmar provides impedance data for sample transducers in tabular form showing all of these pairs of values as a function of frequency.

Note that the impedance of a transducer in air is significantly different than in water; therefore when characterizing the impedance of a marine transducer, the device must be immersed in water.

Sensor Design Fundamentals

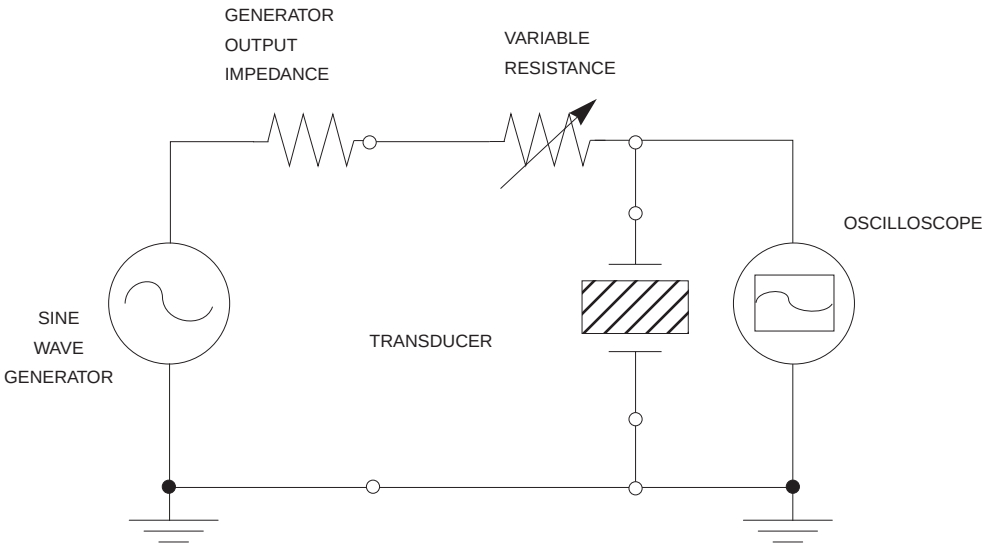


Figure 7

Finding Transducer Resistance at Resonance

The following procedure will allow you to determine the approximate resistance R of a transducer at its resonant frequency (note that at resonance, $R = R_s = R_p$). Though limited, this procedure will produce sufficiently accurate results for field use. Note the following:

- With this procedure a transducer can only be measured unbalanced (i.e. having one side of the transducer grounded).
- If the transducer does not become resistive at the frequency of minimum voltage, the value obtained will be closer to the impedance magnitude |Z| at that frequency than to R, but no indication is given of the angle (capacitive or inductive).

Equipment required:

- Sine wave generator
- Variable resistor or a selection of fixed resistors between 50 and 5,000 ohms
- Oscilloscope
- Ohmmeter

Procedure:

1. Configure the equipment as shown in Figure 7. Set the variable resistor to approximately 1000 ohms. Immerse the transducer in water.
2. Adjust the frequency of the sine wave generator until the signal across the transducer seen on the oscilloscope is at a minimum. This is the resonant frequency, and should be within a few kHz of the nominal operating frequency of the transducer.
3. Open one connection to the transducer and set the variable resistor to 0 ohms (shorted). Record this “open circuit” voltage measured by the oscilloscope.
4. Re-connect the transducer. Vary the resistor until the voltage measured by the oscilloscope is exactly one-half of the open-circuit voltage.
5. Remove the variable resistor from the circuit and measure its resistance with the ohmmeter. The resistance of the transducer at the chosen frequency is the resistance of the variable resistor plus the output impedance of the sine wave generator.■

Sensor Design Fundamentals

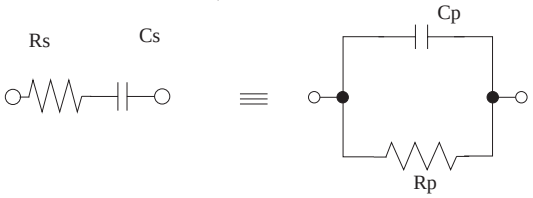
Notes on the Design of Matching Systems for Piezo Elements

These notes describe a simplified approach to match a piezoelectric device to a source of power. The optimum matching circuit will result in maximum transmitted energy which will result in stronger echoes.

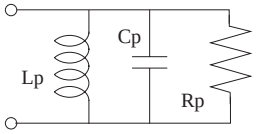
Delivering power to a piezo device, such as a transducer for a depth sounder, is relatively simple in a normal situation. If the fundamentals are understood, then special circumstances can also be accommodated in a straightforward manner.

Like most reactive loads, a piezo device can be represented by a series resistor and capacitor. The values of both these elements will vary with frequency.

By means of the classic transformation, the series values may be transformed to an exactly equivalent parallel resistor and capacitor combination. Unfortunately, the values of these components also vary with frequency (see the separate application note, "Impedance of Piezoelectric Transducers").



The solution to these variations with frequency of operation is to use the values at the desired frequency. In the case of a depth sounder, it is the "Best Echo Frequency". At exactly this frequency, the resistance and capacitance values of the piezo device are obtained either by measurement or from the manufacturer of the device.

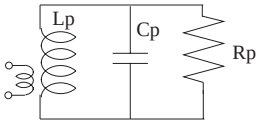


$X_L = X_C$

The simplest matching method is to use an inductor to tune out the reactance of the parallel capacitance, yielding a purely resistive load very nearly equal to the parallel resistance. If the resulting load resistance is too high to directly match the driving source, the inductor may also be used as a tuned transformer to provide a lower, more convenient driving point.

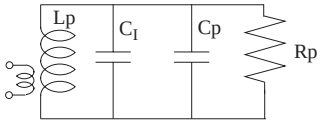
The procedure now follows classic RF matching methods. First, the Q (figure of merit) of the inductor load must be reasonable (5-7 is acceptable).

$$Q = \frac{R_P}{X_L} = \frac{X_L}{R_S}$$

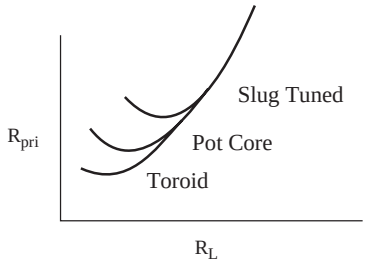


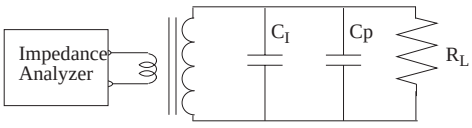
If the Q is too low, place a capacitor C_I across the load and reduce "L" until the load is again resistive.

$$X_L = \frac{X_{CI}(X_{CP})}{X_{CI} + X_{CP}}$$



A low impedance winding may now be added to provide a match to the driving source. The turns ratio is the square root of the impedance ratio. However, there is a limit to how high the turns ratio can be. For the usual universal wound inductor with a ferrite adjustment slug and ferrite shell, a ratio of 22 to 1 is about the maximum that can be achieved. Higher ratios may be achieved if toroidal forms are used for the inductor. This is because tighter coupling is achieved with toroids than is available with other types of inductors. Pot cores are between toroids and slug-tuned coils in coupling.



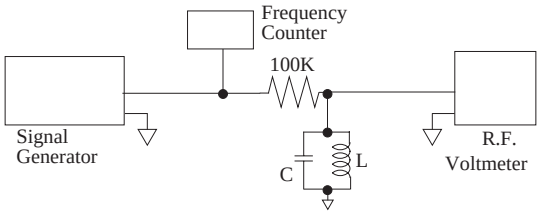


The foregoing discussion of matching assumes that the coil is lossless, at least compared to the R_p of the desired transducer load. Often this is not the case.

Sensor Design Fundamentals

To evaluate whether there is a problem, a sample coil of the calculated inductance must be obtained. If an impedance analyzer is available, the R_p of the coil may be measured by placing the calculated total capacitance across the coil and adjusting the frequency for zero phase angle. The instrument will indicate the R_p directly.

If an impedance analyzer is not available, the same results can be obtained by another technique.



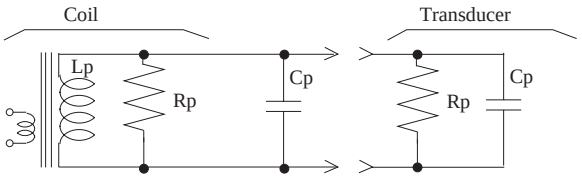
Find the frequencies at which the response of the tuned circuit is down 3dB from peak response.

$$Q = \frac{\left(\frac{F_H + F_L}{2}\right)}{F_H - F_L}$$

F_L= lower -3dB frequency
F_H= higher -3dB frequency

$$R_P = QX_C$$

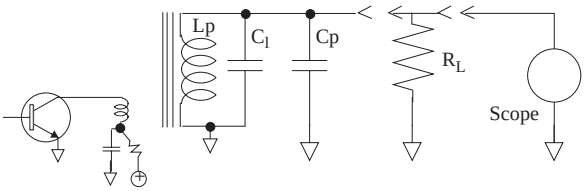
The R_P of the coil should now be considered to be in parallel with R_P of the transducer.



The coil inductance and resonating capacitance must now be recalculated based on the lower load resistance presented by the parallel combination of the R_P of both the coil and transducer.

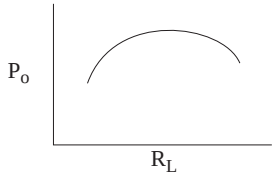
Also, the division of the available output power must be considered. If the two R_P's are equal, only one half the power developed is available to the transducer to put into the water. So it is desirable that the R_P of the coil be as high as possible compared to the R_P of the transducer.

Once the coil is designed and in place, the effectiveness may be checked by placing the equivalent parallel capacitance of the piezo device across the inductor.



$$P_o = \frac{\left(\frac{V_{P-P}}{2.83}\right)^2}{R_L}$$

Then various resistors are placed across the inductor and the power dissipated is then calculated. A broad peak should be achieved at the value of the parallel resistance of the piezo device. If the power peak does not occur at the value of parallel resistance which the piezo device has at the frequency of interest, small adjustments in the turns ratio and/or the Q should be made.

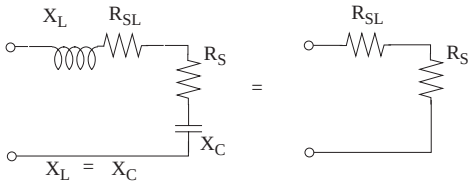


The advantages of this method of matching are:

- Minimum components — minimum cost
- Highest impedance in the connecting cable, hence the lowest I^2R losses
- If the cable must be extended, a simple removal of fixed capacitance is all that is required

Another method which might be considered is using the series equivalent values of the piezo device. To do this, an inductor is placed in series with the piezo device whose reactance is equal to the reactance of the equivalent series capacitance. This method presents the value of series resistance to the driving source. The disadvantage is that a second inductor is required because in the usual case, the series resistance is still higher than the required load impedance of semiconductor power sources. Also, the current through the load must pass through the effective series resistance of this (series) inductor, which increases the I^2R losses, resulting in a net loss of power delivered to the load in the usual case.

Sensor Design Fundamentals



Example:

Assume that a transducer is to be matched whose "Best Echo Frequency" is 196.0 kHz and the series R and X have been measured at that frequency as 151 – j239 (C = 3398pf).

$$R_P = R_S + \frac{X_S^2}{R_S} = 151 + \frac{(239)^2}{151} = 529.3\text{ohms}$$

$$X_P = \frac{R_S R_P}{X_S} = \frac{151(529.3)}{239} = 334.4\text{ohms}$$

$$(C_P) = 2428\text{pf}$$

Since at resonance $X_C = X_L$, the inductor will have a reactance of 334.4 ohms

Calculate Q of this situation

$$Q = \frac{R_P}{X_L} = \frac{529.3}{334.4} = 1.58$$

This is too low so capacitance must be added. Let us calculate on the basis of a loaded Q of 6

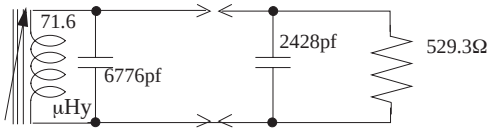
$$X_L = \frac{R_P}{Q} = \frac{529.3}{6} = 88.22\text{ohms}$$

$$L = \frac{X_L}{2\pi f} = \frac{88.22}{6.28(196 \times 10^3)} = 71.6\mu\text{Hy}$$

Total C is now

$$C = \frac{1}{2\pi f X_L} = \frac{1}{6.28(196 \times 10^3)(88.22)} = 9204\text{pf}$$

Added capacitance must then be $9204 - 2428 = 6776\text{pf}$



The required primary impedance is calculated as 3.6 ohms to match the driving transistor

$$N_R = \sqrt{\frac{529.3}{3.6}} = \sqrt{147} = 12.1 \qquad N_R = \sqrt{\frac{529.3}{3.6}} = 12.1$$

This is low enough so a slug tuned coil may be used. If a coil of 71.6μHy required 55 turns, then the primary would use 4.5 turns;

$$T_{PRI} = \frac{\text{Tsec}}{N_R} = \frac{55}{12.1} = 4.55$$

The primary should be wound as tightly over the secondary as possible to obtain the best coupling. Use the start of the secondary coil as the high impedance end.

Power into a piezo device:

If the parallel resistance is known, power calculation is straight-forward:

$$P = \frac{E^2}{R}$$

E is RMS volts
R is the parallel resistance of the piezo device

Of course the voltage across the load will probably be measured with an oscilloscope and read as peak to peak voltage. If the transmitted pulse is a sine wave, then it must be divided by 2.83 to change to RMS voltage.

If parallel resistance is not used in the calculation, series resistance may be used. But the calculation is a bit more involved:

1. Impedance

$$|Z| = \sqrt{R_S^2 + X_S^2}$$

2.

$$I_L = \frac{E}{|Z|}$$

E is RMS voltage across the load as previously shown

3.

$$P = I^2 R_S$$

4. The above equations are combined into a single equation

$$P = \frac{R_S E^2}{R_S^2 + X_S^2}$$

Considerations for Matching Systems During Receive Mode:

Once the matching has been accomplished for transmit, what are the considerations for receiving? If the input impedance of the receiving section is higher by a large margin, then it may be tied directly across the tuned circuit used to match in transmit.

If the receive input impedance margin is not large or is even small, then other methods must be used to achieve the maximum performance of which the piezo device is capable. Also, provisions must be made to prevent the transmit voltage from destroying the input device(s) of the receiver.

If the coupling of the transformer is high, a lower "Q" may operate satisfactorily. Reduce the capacitance added in steps, increasing the inductance of the secondary in steps to maintain resonance. Keep the primary inductance constant. In the extreme it may be possible to resonate with just the capacitance of the transducer without adding any external capacitance. This will yield higher turns ratios and if the coupling is tight enough, will also yield more output voltage (power).

Note, however, that at Q values of 7 or less, the equation $X_L = X_C$ no longer holds. Until such time as an application note describing techniques of calculating such low Q matching systems is developed, proceed carefully, step by step, in developing these matching systems by empirical methods.

Balanced versus Unbalanced

The method of driving transducers is a choice made by the designer of the echo sounder. Unbalanced systems are simpler and easier to make electrical measurements on. An unbalanced configuration requires a higher matching capacitance across the transducer element. Balanced systems often require a third winding on the output transformer to feed an unbalanced signal to the receiver. Balanced lines usually pick up less noise than unbalanced, assuming that the shielding in each case has identical leakage.

Airmar normally uses shielded, twisted pair cable for connection to the piezoceramic element. The transducer may be wired either balanced or unbalanced, as required. The lead designated as transducer "low" is connected to the piezo element surface closest to the water; the transducer "hot" lead is connected to the piezo element surface further from the water.■

Sensor Design Fundamentals

Measurement of Echosounder Power Output as a Function of Transducer Impedance

To determine the optimum transducer impedance value, it is useful to know the power output of an echosounder as a function of impedance. The ability of the echosounder to handle a range of impedances is best approached by modeling the transducer as a parallel equivalent circuit comprised of a resistor and capacitor.

The data is obtained by using ordinary 5% carbon resistors and an oscilloscope. The steps are as follows:

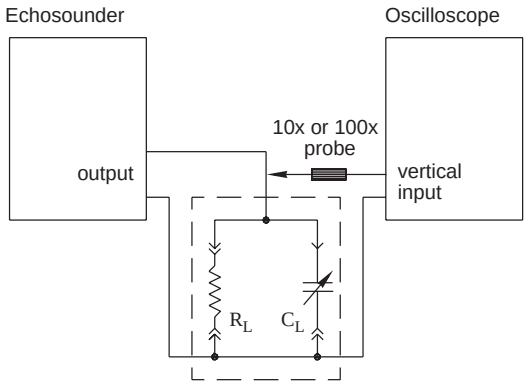
1. Connect equipment as shown in Figure 1.
2. With nominal R_L connected, vary C_L for a maximum voltage transmit pulse on the oscilloscope.
3. Connect various values of resistors at R_L. Record volts peak to peak as read from the oscilloscope. (Select a range of values of R_L so as to find maximum power and several data points on either side.)
4. Calculate RMS power during the transmit pulse.
5. Plot on a graph the Output Power (RMS watts) vs. Parallel Load Resistance (ohms).
6. Set R_L to the value yielding maximum output power. Vary the capacitance, C_L, and record volts peak-to-peak.
7. Calculate RMS power out during the transmit pulse and plot Output Power (RMS watts) vs. Parallel capacitance (pf).

Figures 2 and 3 show the power output curves for a typical echosounder.

With these graphs, the optimum values of parallel load resistance and capacitance are determined and the sensitivity of the echosounder to changes in load may be determined easily.

The transducer data sheets provided by Airmar list the equivalent parallel resistance R_p and capacitance C_p for each model at best transmit frequency. Upon request, we also can provide a table showing R_p and C_p as a function of frequency.■

Figure 1



Equivalent Parallel Circuit of Transducer

Figure 2

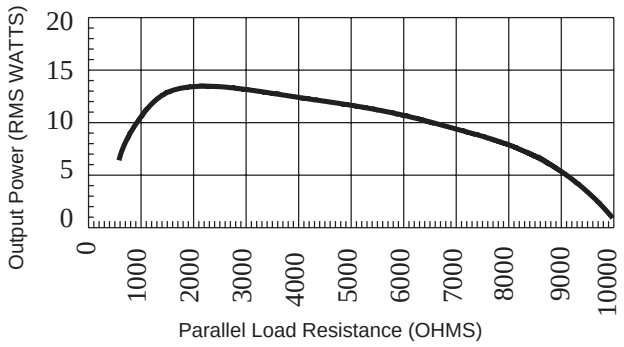
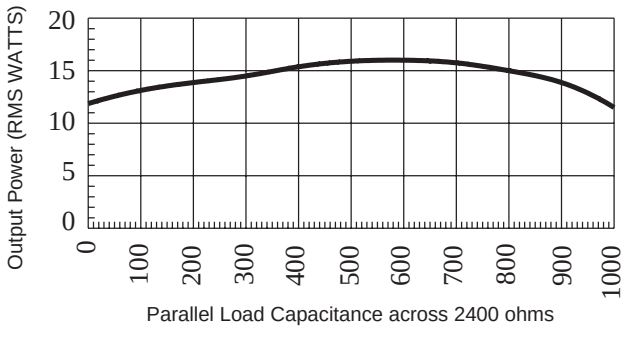


Figure 3



Sensor Design Fundamentals

Bench Testing of Marine Transducers

Without a large tank and sophisticated test equipment, it is difficult, if not impossible, to make measurements that yield absolute sensitivities of marine transducers. However, it is not too difficult to make a comparison between a "known good" transducer and a suspected/questionable unit. Note that this is a comparative test and is valid only for transducers having the same element size and sensitivity.

The equipment requirements are; a test tank, frequency source, pulse generator, a transmit/receive (T-R) switch and an oscilloscope.

Test tank:

A plastic cylindrical tank is recommended, the larger the better. As an absolute minimum, use a 55 gallon steel drum. The drum should have a very flat bottom. This can be done in either of two ways. In the steel drum, about 1" of epoxy will provide a satisfactorily flat bottom. Alternatively, in either the steel or plastic drum, a metal plate can be cut and placed in the bottom of the drum. A 1/8" plate of stainless steel is ideal; aluminum or steel is less so because of corrosion. In addition, the walls of the drum should be lined with a sound absorbing material to reduce reflections. The material we have used is single skin, closed cell neoprene foam fastened with contact cement.

Frequency Source:

A sine wave generator with a range of 50 to 220 kHz and supplying 10 Volts peak-to-peak from a source impedance of 600 ohms or less is adequate. It is desirable to have a frequency counter to provide an accurate frequency readout.

Pulser:

This unit is connected to the frequency source and forms the transmit pulses. If a commercial model is not available, then a pulser may be constructed. A schematic for a fairly simple unit is shown in Figure 1.

Oscilloscope:

Almost any scope will be satisfactory. A dual channel, 15 or 20MHz bandwidth with external trigger input, is satisfactory. Among similar oscilloscopes a unit which has higher accelerating potential on the cathode ray tube will give a brighter, more visible presentation.

Figure 1. gives the schematic of the T-R switch and indicates the connections to the other components of the test set-up.

Test Procedure

1. The transducer should be connected to the T-R switch grounding the wire attached to the ceramic surface closest to the water. (Usually the black wire in shielded twisted pair cable or the braid in coax cables).
2. The transmit pulse voltage should be set to a reference level, say 10 Volts peak-to-peak.
3. Wet the transducer face, place in the tank, and aim at the tank bottom. Adjust the position and direction of the transducer to maximize the echo amplitude. Adjust the frequency for the best echo considering both amplitude and echo pulse shape. Readjust the aim to obtain maximum echo.
4. Recheck transmit pulse amplitude to ensure that changes in transducer impedance have not changed transmit pulse amplitude.
5. The amplitude of the echo is now measured on the oscilloscope display and recorded.

Using this method, comparison of echo amplitude can be made between two similar transducers.

The frequency at peak echo is neither the frequency of maximum transmit source level nor the frequency of maximum receive sensitivity, but is the best composite transmit/receive frequency and corresponds to the Figure of Merit curve presented for each ceramic in the Technical Data Catalog.

When judging what is "good" vs. not acceptable, the following procedure meets good engineering standards.

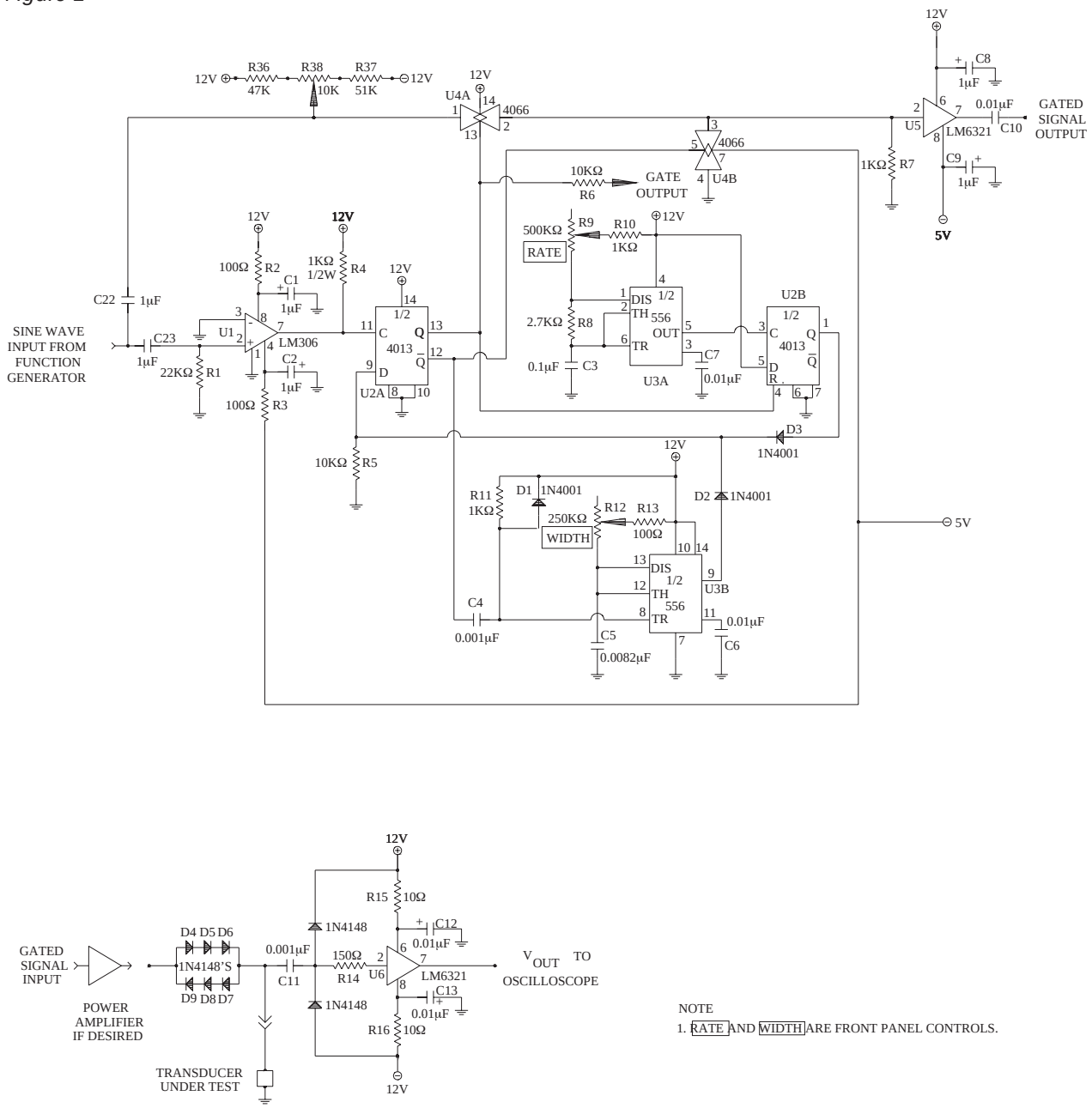
1. Select a sample of each type/model of transducer which is to be routinely tested.
2. Record echo strength and carefully note all parameters of the test equipment. Repeat these tests over a period of time to establish a firm benchmark for that transducer.
3. As transducers are compared to the standards, keep a record of the results noting particularly the echo strength of any units that give a better echo than the standard.
4. An acceptable transducer would be one which produces 1/2 or more echo voltage of that measured for your 'standard' transducer.

Note:

This is based on -3dB transmit and -3dB receive sensitivity difference. Transducer sensitivity can vary considerably in a normal production run. You may measure a voltage variation between the very best transducer and a passable unit of 3 to 1. Bad transducers are usually those having a voltage of 33% or less (usually much less) than that measured for a known "good" unit. In other words, bad transducers are usually very bad. Be careful with regard to transducer ceramic size. A small diameter ceramic will produce only 10% to 25% of the voltage of a large diameter (2") ceramic. Make sure you are comparing similar diameters and frequencies.■

Sensor Design Fundamentals

Figure 1



NOTE
1. RATE AND WIDTH ARE FRONT PANEL CONTROLS.

Sensor Design Fundamentals

Circuit Interfaces to Hall-Effect Speed Sensors

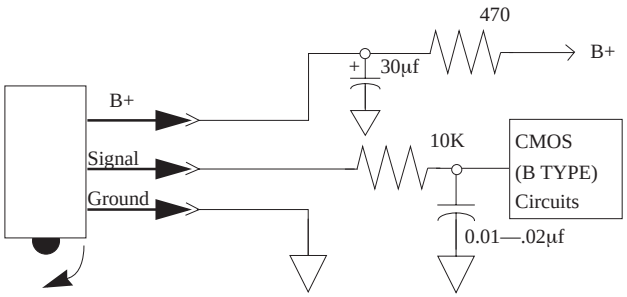
Interfacing to CMOS Logic

When interfacing a Hall-effect sensor to a CMOS input, two filters are recommended, one in the line supplying power to the transducer, the other in the signal line from the Hall-effect circuit.

The supply line filter is recommended mostly as a matter of good engineering practice, being comprised of a series resistor of 470 to 1000 ohms and a capacitor of 0.1 µf to 33 µf. This prevents noise pickup in the speed sensor cable from entering the electronic circuitry of the knotmeter as well as protecting the circuitry from short circuits in the external wiring.

The signal line filter helps prevent noise picked up on the cable from being counted as a pulse from the transducer. A series resistor of 10K ohms and a 0.01 µf or 0.02 µf capacitor should be adequate.

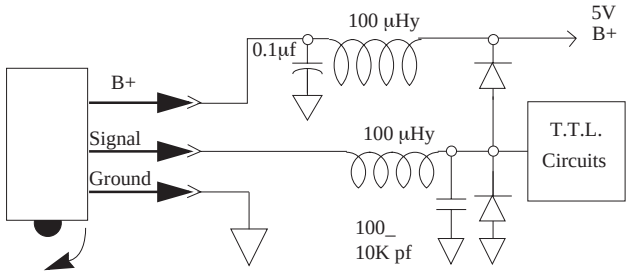
Further, it is recommended that the first electronic circuit encountered by the signal be arranged as a buffer or squaring circuit so that any rounding of the input signal caused by the cable, input filter, etc., is removed and further signal processing circuits are driven by a full CMOS signal.



Interfacing to TTL Logic Systems

When interfacing a Hall-effect sensor to a TTL input, the power filter should be an L-C type to prevent dropping the supply voltage below the 5 volt TTL level. Current limiting in case of a short circuit in the external wiring will have to be accomplished by the 5 volt regulator.

The input filter should, for the same reasons, be an L-C type. In addition, diodes should be used between the signal input and ground and signal input and the 5 volt bus so that any noise pulses cannot drive the signal line above 5 volts or below ground.



Two-Wire Systems

For retrofitting to certain systems, a two-wire system is available which operates through a coaxial cable. Typically, the Hall device operates at 5 volts and the output pulse amplitude is from 5.6 to 12VDC.

"Bullet Proof" Models

If the ultimate in impulse protection is a requirement, Airmar can provide designs which use proven types of circuit protection. Note that these protection circuits will not fit into the S21 and S63 "Snap-In" assemblies.

Calibration

The need for instrument calibration is attributed to the variations in the speed of water past the speed sensor caused by the flow characteristics of the hull design.

Consideration should also be given to whether the knotmeter is to be calibrated at the factory in statute miles per hour, or nautical miles per hour. Statute miles are in common use on inland charts in the United States; nautical miles are prevalent on ocean charts worldwide. A statute mile is 5,280 feet, a nautical mile is approximately 6,076 feet (note that there is also an "Admiralty" mile of 6,070 feet).

The traditional methods of calibrating knotmeters by traversing a known distance in both directions, recording the elapsed time, calculating speed in each direction and averaging should be used with Airmar speed sensors. While Airmar speed sensors have good linearity, maximum accuracy will be obtained if the calibration run is performed at the most used vessel cruising speed.

Instruments with greatest customer acceptance are those with adjustable speed calibration accessed via a display menu. Some models have an adjustment located on the back panel or via an access hole in the back panel.

Sensor Design Fundamentals

This allows the end user to calibrate the instrument and minimizes complaints concerning accuracy. Typically, the calibration range on most instruments is wide enough to accommodate the changeover from nautical to statute miles, and vice versa.

Pulse Rates

The nominal rates listed in Airmar literature are for the standard paddlewheel magnetization. Electronic dividers can be built into most models of the speed sensors to provide lower pulse rates to assist in matching the requirements of existing equipment. Divide-by-2, divide-by-4 and divide-by-100 circuits have been most popular, but others are available. By using a divide-by-100 circuit it is possible to provide approximately 200 pulses per nautical mile for use with most types of ARPA and satellite navigation systems. ■

Paddlewheel Calibration Data

Causes of non-linearity

Paddlewheel speed sensors are inherently non-linear devices. The causes of non-linearity are several:

- The boundary layer becomes thicker as speed decreases and as the distance from the 'leading edge' increases. The boundary layer effect causes significant errors at low boat speeds.
- The drag induced by fluid recirculation in the paddlewheel cavity is not linear with speed.
- Rotational friction from the shaft bearings supporting the paddlewheel is not linear with speed.
- The angle of attack of the hull changes with speed and this causes errors in speed detection.
- The shape of the paddlewheel cavity determines the amount of fluid recirculation and the linearity.

Calibration units

Speed calibration of paddlewheels can be stated in several ways:

- Pulses per nautical mile
- Pulses per statute mile
- Hz/knot

All of these calibration constants are mathematically related. Originally, Airmar published all paddlewheel calibration constants in pulses per nautical mile. Of late, we have chosen to present the data in Hz/knot.

Test Methodology used to acquire calibration data

To better assist knotmeter and fishfinder designers, we have measured paddlewheel pulse output as a function of speed. The data we present in the range from 0.5 knots to 5.8 knots was taken in a tow tank at the University of New Hampshire. The paddlewheel sensor is mounted to a towed body [sled] and the sled traverses the tank at a constant speed. About 10-20 sets of data were recorded over the speed range. In the speed range from 3 knots to 50 knots, a planing hull powerboat with a low deadrise angle [relatively flat bottomed] hull was used. A multi-channel data logger was used to simultaneously capture data output from up to three paddlewheel sensors and a differential GPS. In our test procedure the boat runs at a constant speed for a period of time and then speed is increased in 3 to 5 knot increments. The tests are repeated, running in the opposite direction to cancel out the effects of running upwind vs. downwind and with vs. against the current.

Data interpretation

The information we present in the following pages is essentially raw data. No attempt was made to smooth the data. You will note that the tow tank data does not always merge perfectly with boat data in the areas where the data overlaps. This is due to the following:

- The sled used in the tow tank is much smaller than the boat hull and the effective distance from the leading edge of the sensor is shorter for the sled.
- The flow characteristics of the boat hull and the sled are different.
- There are edge effects caused by the tow tank.

Notwithstanding the limitations in the tow tank and boat speed data, the following graphs present much better data than we have had available previously.

As you review the data, you may notice significant non-linearity in the speed range from 6 to 12 knots. This is due to the very high angle of attack of the boat hull as it transitions from displacement to planing speeds. This transition has the greatest effect on transom mounted speed sensors. Because this is a very inefficient mode in which to operate a boat, we generally recommend that non-linearity in this range be ignored.

All thru-hull paddlewheel speed sensors have a cavitation speed limitation. With the onset of cavitation, the pulse rate no longer increases with increasing boat speed. As it approaches the cavitation threshold, first the pulse rate levels off and then it decreases with increasing speed. Transom mounted speed sensors do not cavitate since the paddlewheel cavity in Airmar sensors is open to the atmosphere. Transom mount designs become non-linear above 50 knots whereby the paddlewheel will indicate higher than true speed.

Do Airmar's high speed fairings provide better speed sensor linearity?

We have recorded data for thru-hull mounted speed sensors mounted in high speed fairings and mounted directly to the hull. The calibration data is somewhat different as is expected. The sensor mounted in a high speed fairing projects usually beyond the boundary layer and we would expect it to have better low speed accuracy. In effect, the fairing presents a new leading edge. The fairing alters the flow under the hull and usually results in a slightly lower pulse rate.

How should the calibration data be used?

Using the data herein, one can select a calibration constant which will represent the best linear fit. If one knows the speed at which the boat cruises or the speed of primary interest, the most appropriate calibration constant can be selected. It is also possible to use the data to construct a calibration table as function of speed. In this way it is possible to compensate for the effects of the boundary layer and the anomalies of the particular speed sensor. Keep in mind that the data presented herein is hull dependent and may not be representative for all hull shapes.

Computation of boundary layer thickness

The following formula is provided to illustrate how boundary layer varies with distance from the leading edge and boat speed. Listed below are four specific examples:

A. The distance from the leading edge to the paddle wheel is 2 meters and the speed is 3 knots
B. Same as A. above except the speed is 20 knots
C. Use of a projecting fairing where the distance from the leading edge to the paddlewheel is 20cm and the speed is 3 knots
D. Same as C. above except the speed is 20 knots

In a turbulent flow regime which is characteristic of most boating conditions, the equation for boundary layer thickness is:

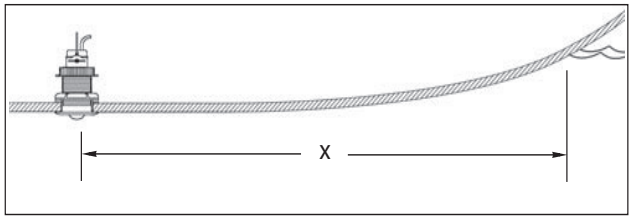
$$\delta = 0.376\ Rex^{-1/5}$$

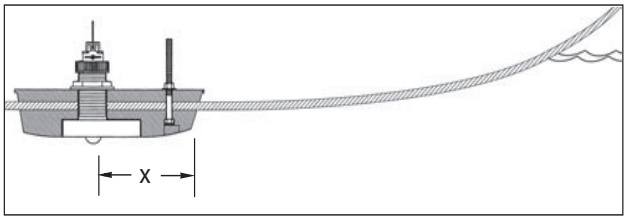
The terms are defined as follows:
δ = Boundary layer thickness
x = distance from the leading edge of the hull or fairing to the paddlewheel
Re = Reynolds number (Re=ρVx/μ)
ρ = density of water
V = boat speed
μ = viscosity of water

The computational results show:

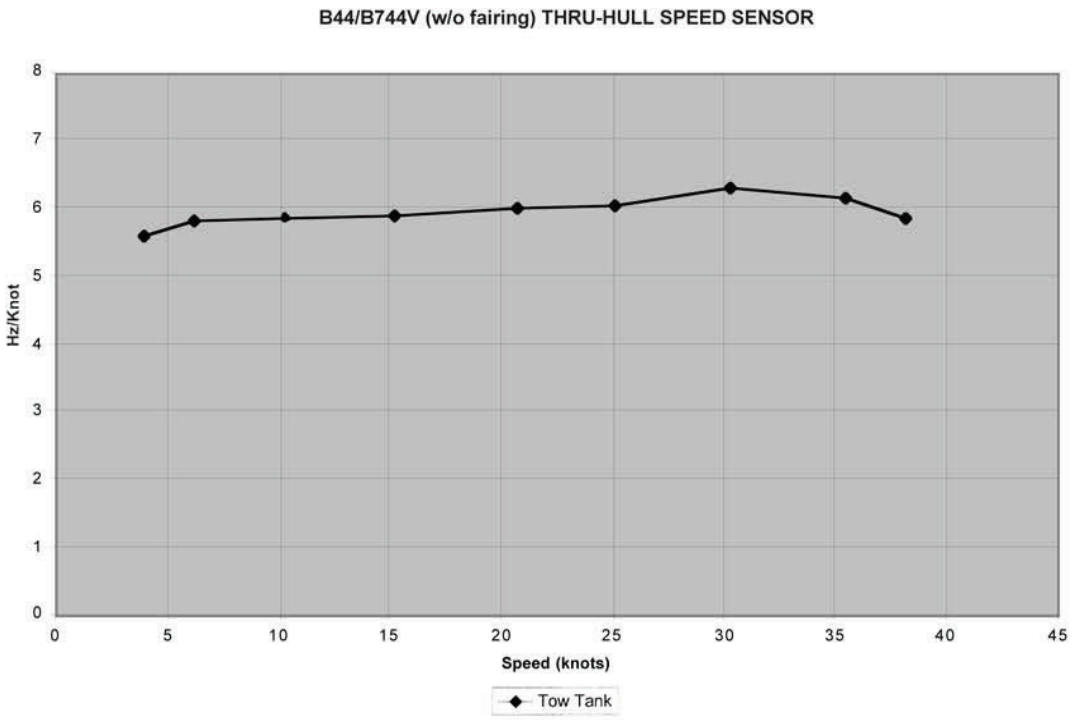
Ex.	Boat Speed (V)	Distance from the leading edge (x)	Boundary layer thickness (δ)
A	3 knots	2 m [79”]	38 mm [1.5”]
B	20 knots	2 m [79”]	25.8 mm [1”]
C	3 knots	20 cm [8”]	5.8 mm [0.23”]
D	20 knots	20 cm [8”]	4 mm [0.16”]

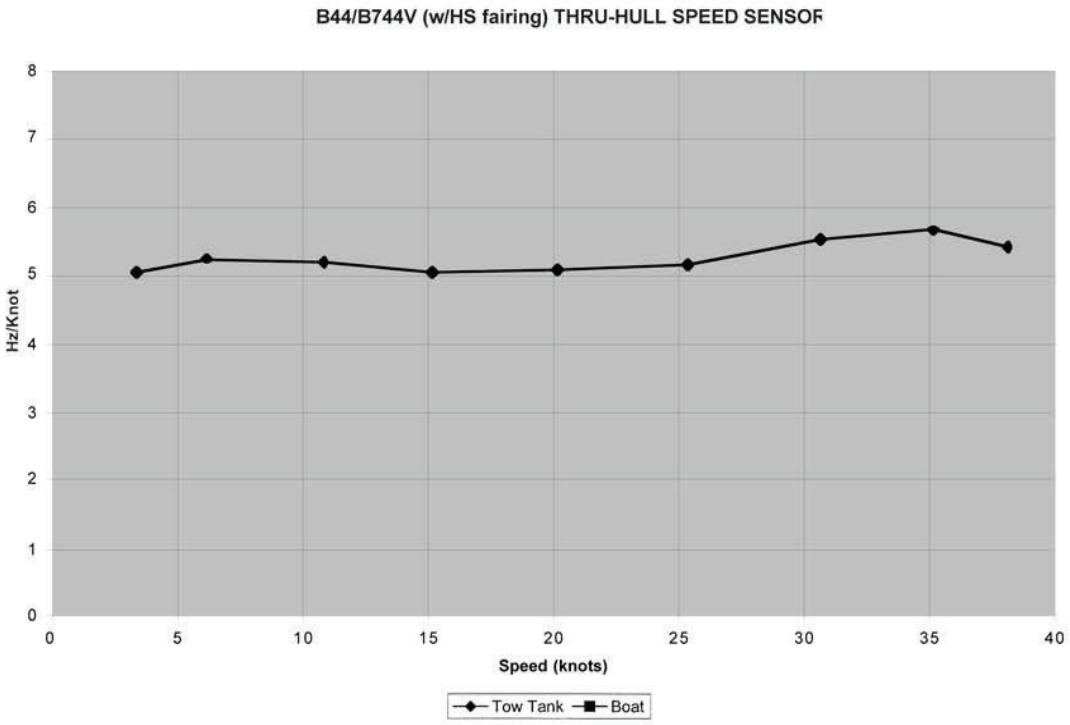
As the data shows, the boundary layer decreases in thickness with increasing speed. The data also shows that the boundary layer thickness increases substantially with increased distance from the leading edge. Keep in mind that the distance, x is not constant and x usually is significantly less when a boat is planing. Therefore, at planing speeds both increasing V and decreasing x contribute to a thinner boundary layer. The distance from the leading edge can be reduced by the use of a projecting fairing or mounting the paddlewheel sensor well forward. When the paddlewheel blades do not project beyond the boundary layer, the paddlewheel will typically measure less than the true speed of the boat.





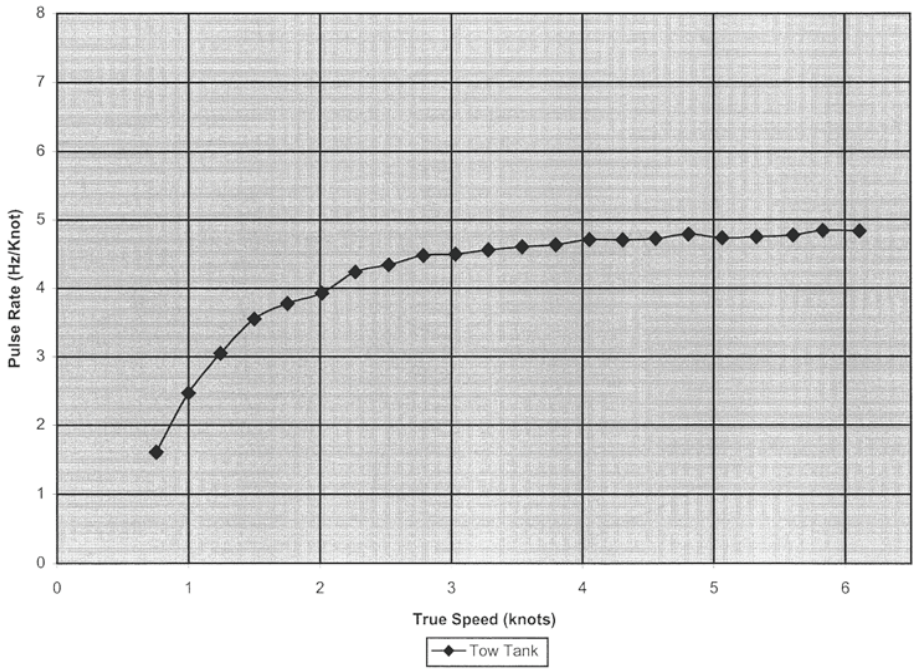
Paddlewheel Chart



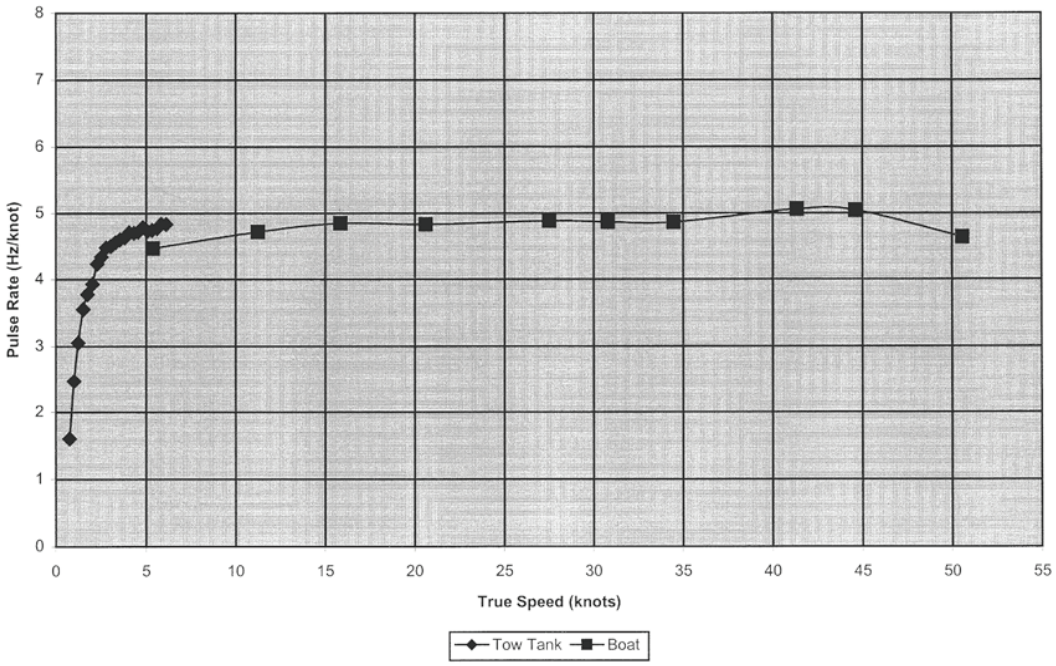


Paddlewheel Chart

DST800 RETRACTABLE TRIDUCER MULTISENSOR - LOW PROFILE THRU-HULL HOUSING

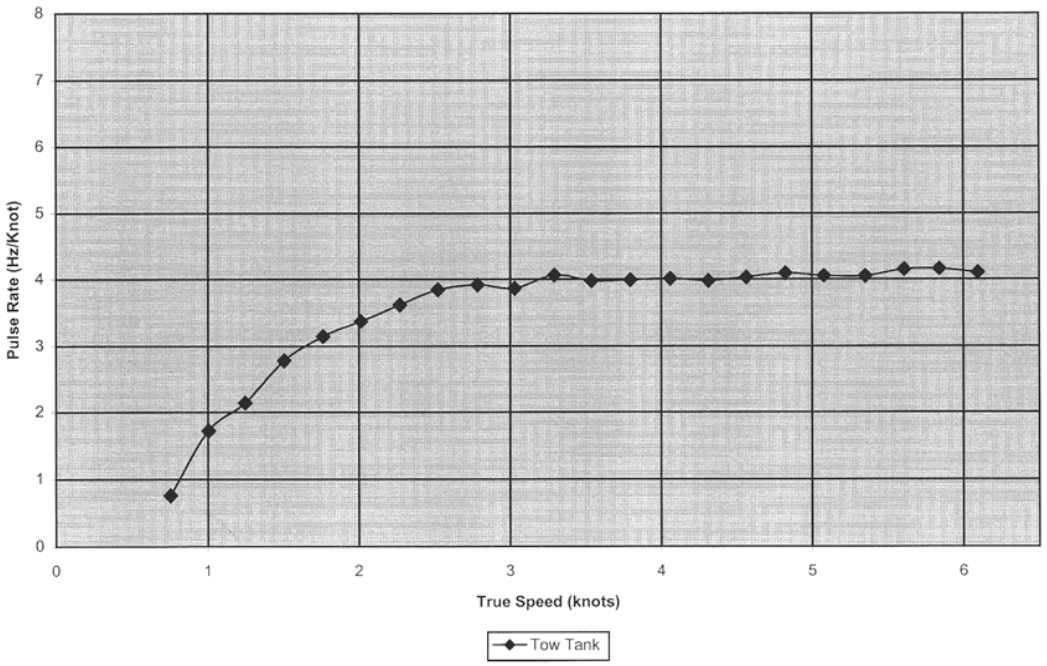


DST800 RETRACTABLE TRIDUCER MULTISENSOR - LOW PROFILE THRU-HULL HOUSING

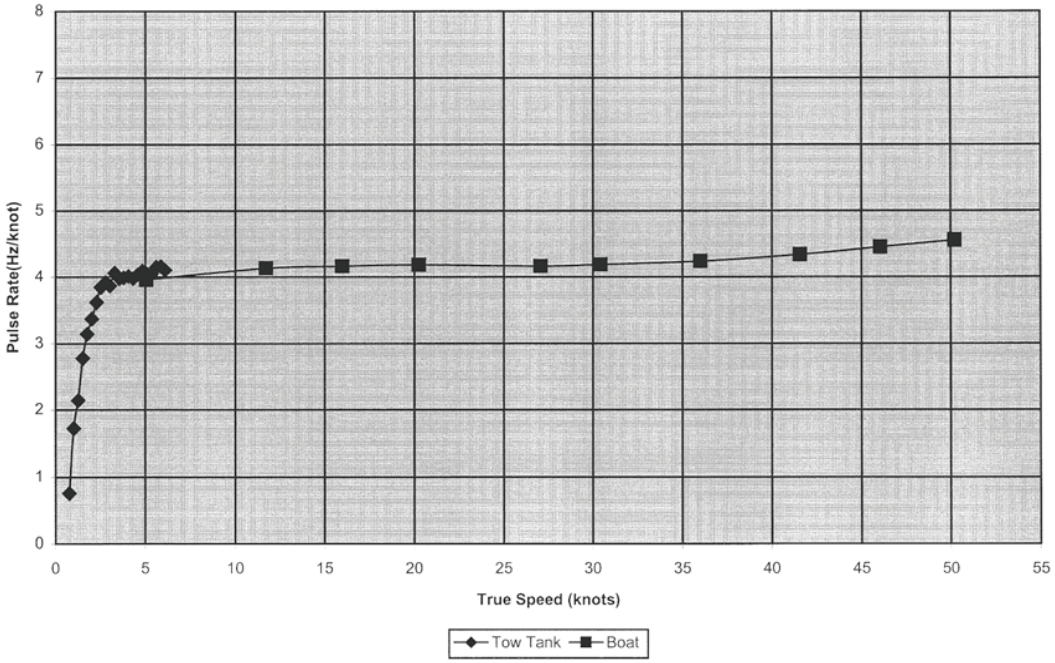


Paddlewheel Chart

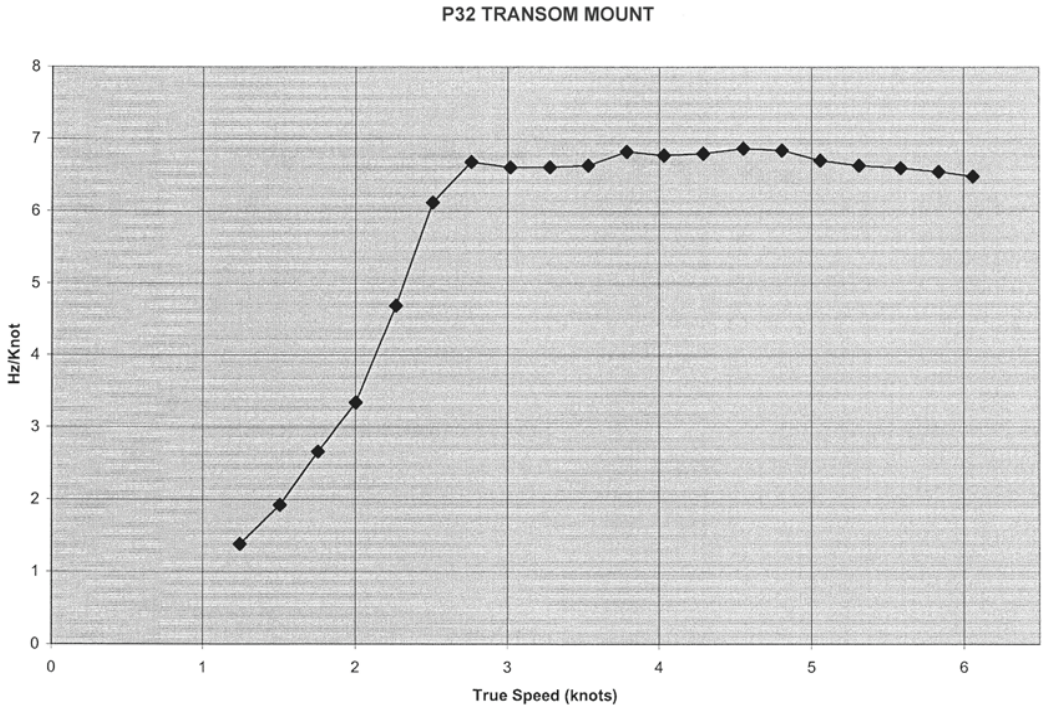
DST800 RETRACTABLE TRIDUCER MULTISENSOR - FLUSH THRU-HULL HOUSING

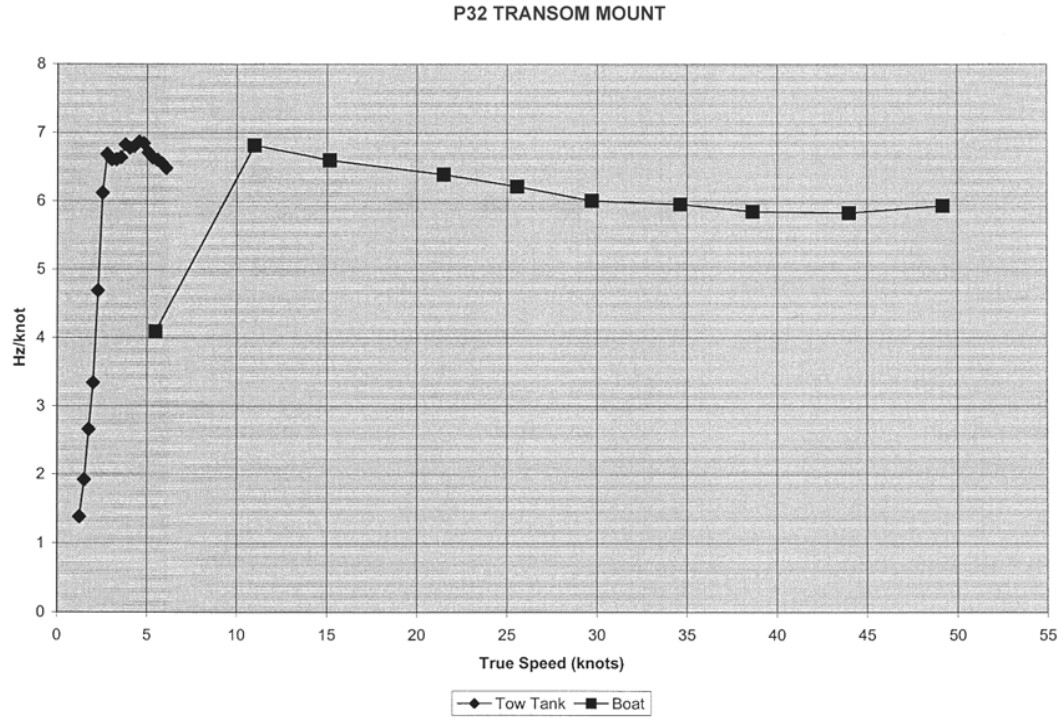


DST800 RETRACTABLE TRIDUCER MULTISENSOR - FLUSH THRU-HULL HOUSING

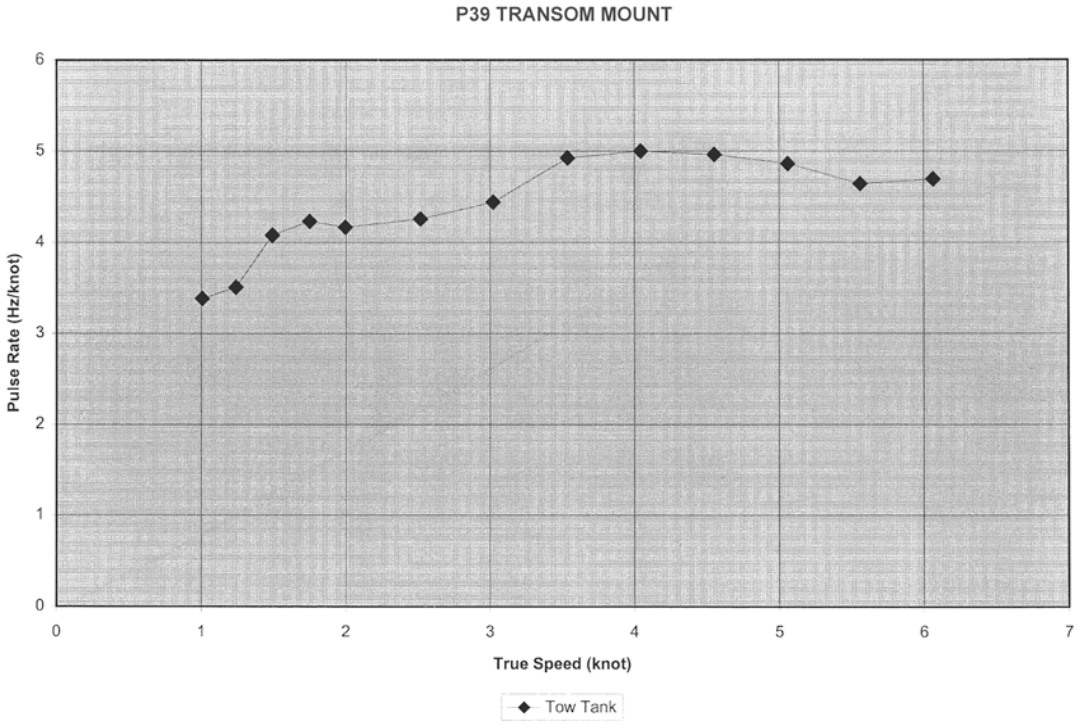


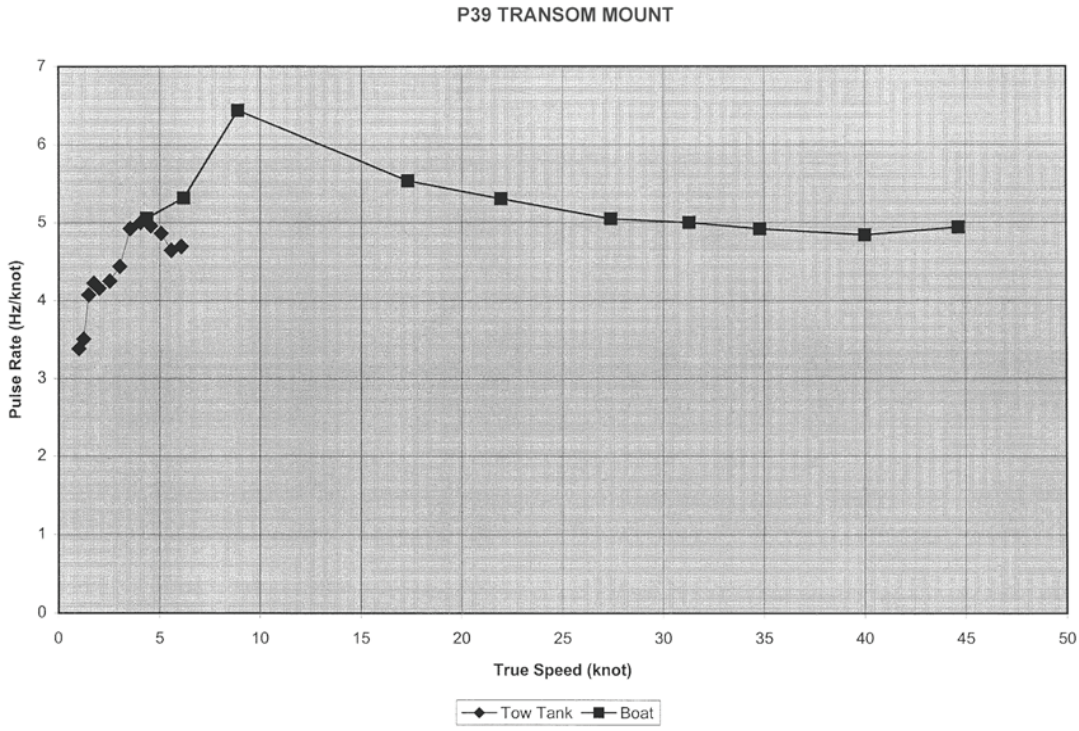
Paddlewheel Chart



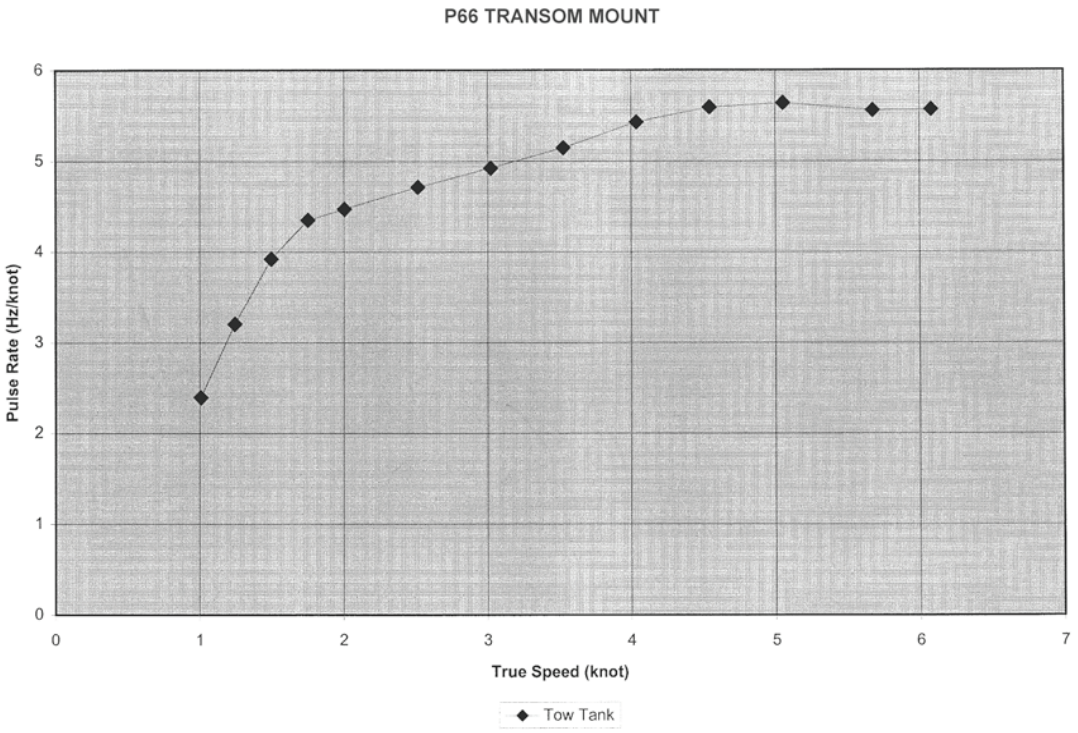


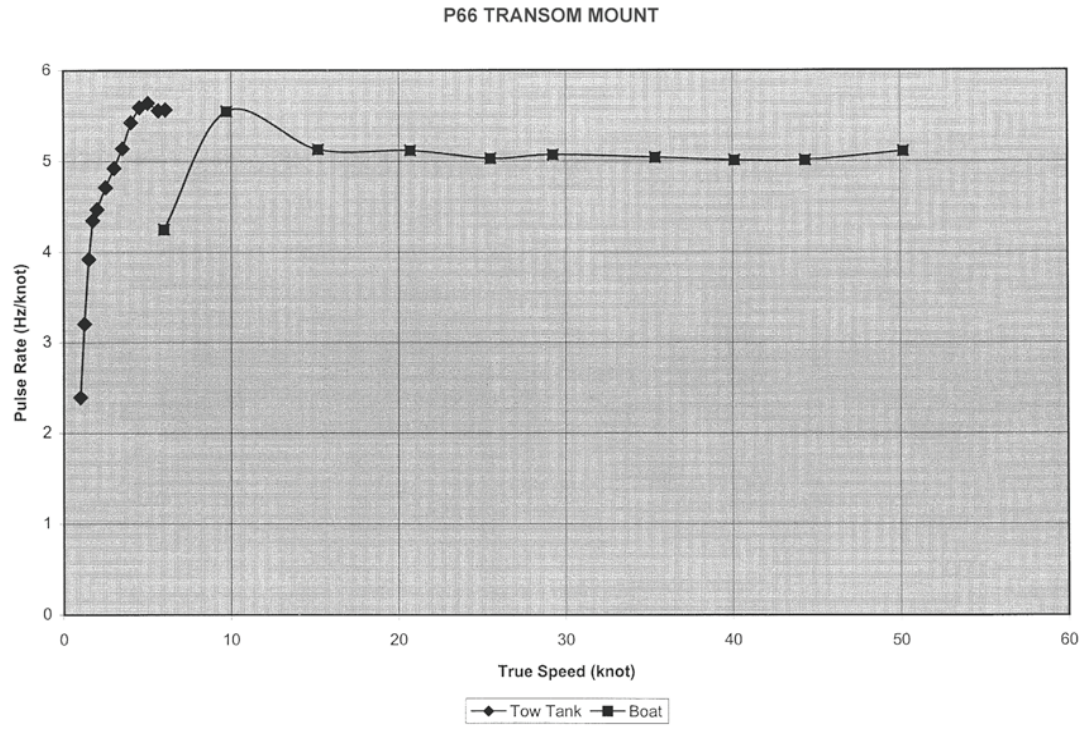
Paddlewheel Chart





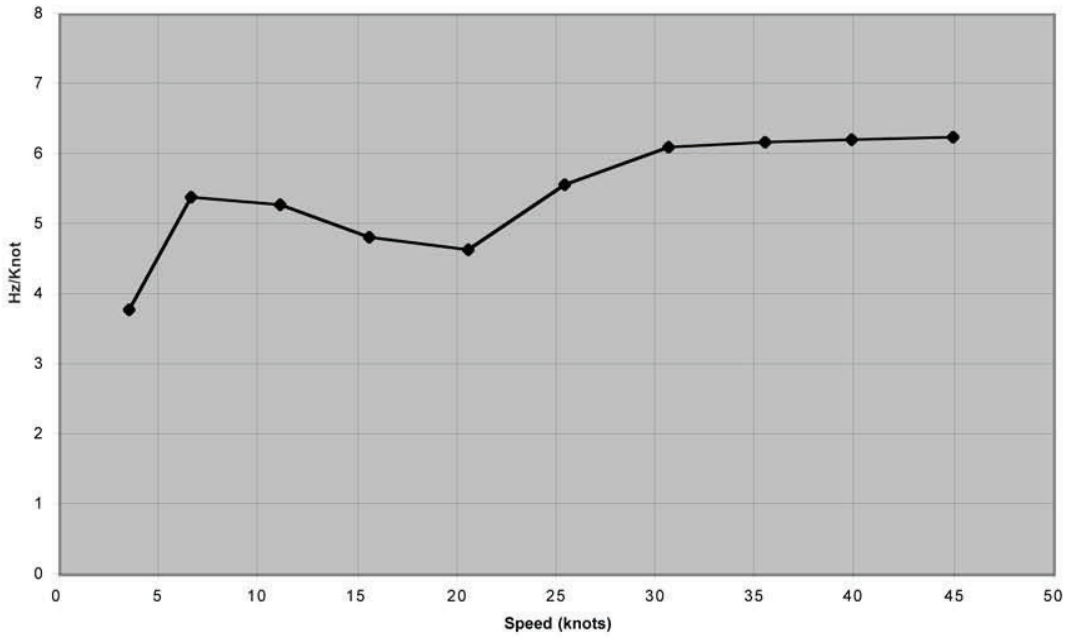
Paddlewheel Chart



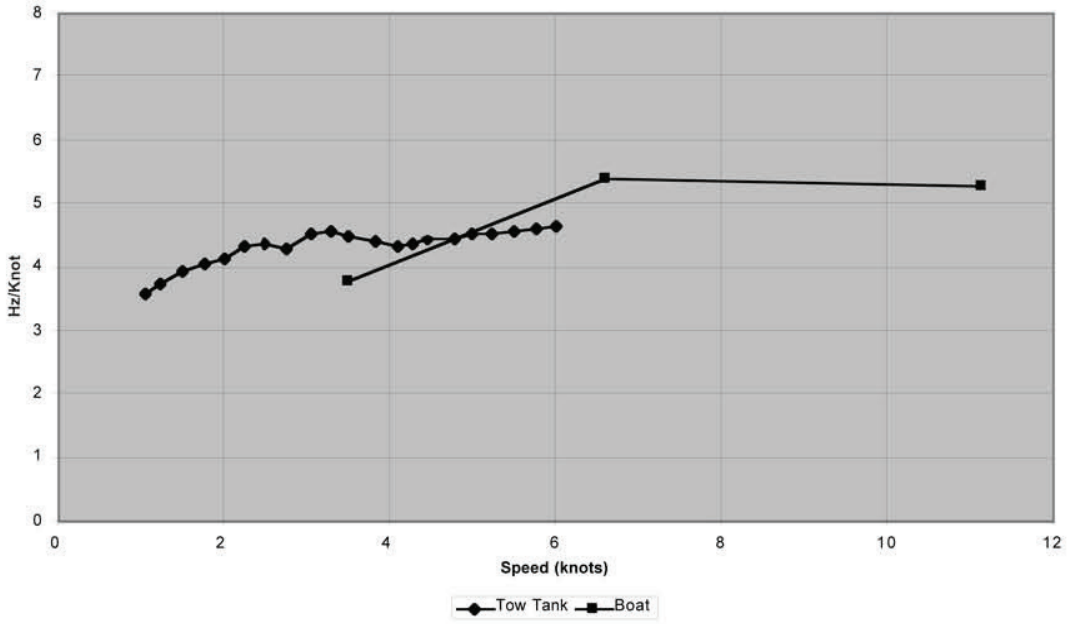


Paddlewheel Chart

S61 TRANSOM MOUNT SPEED SENSOR

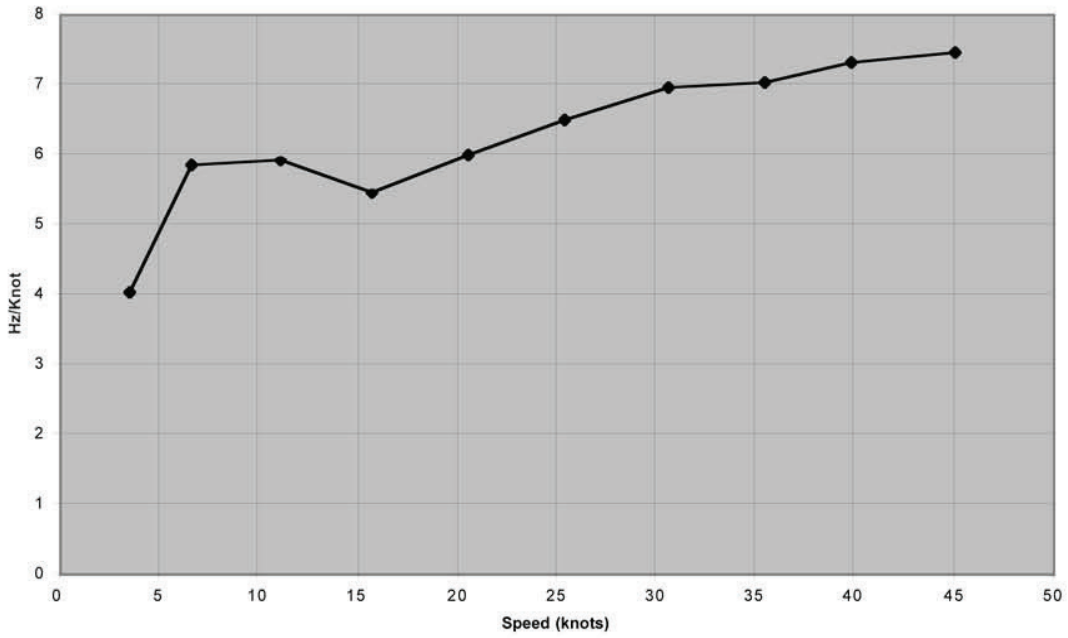


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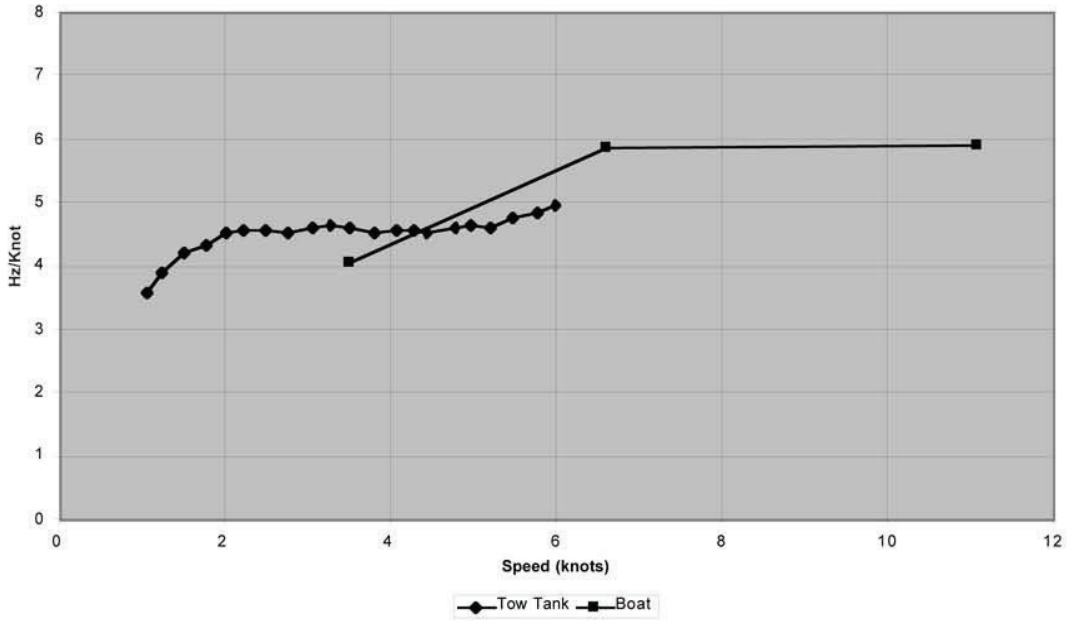


Paddlewheel Chart

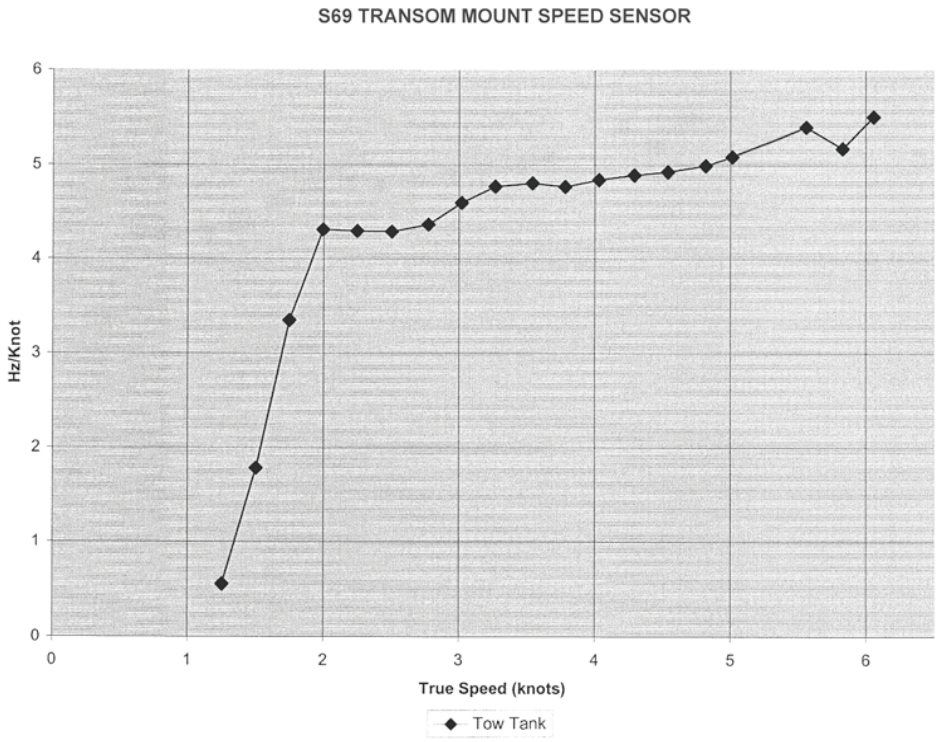
S63 TRANSOM MOUNT SPEED SENSOR

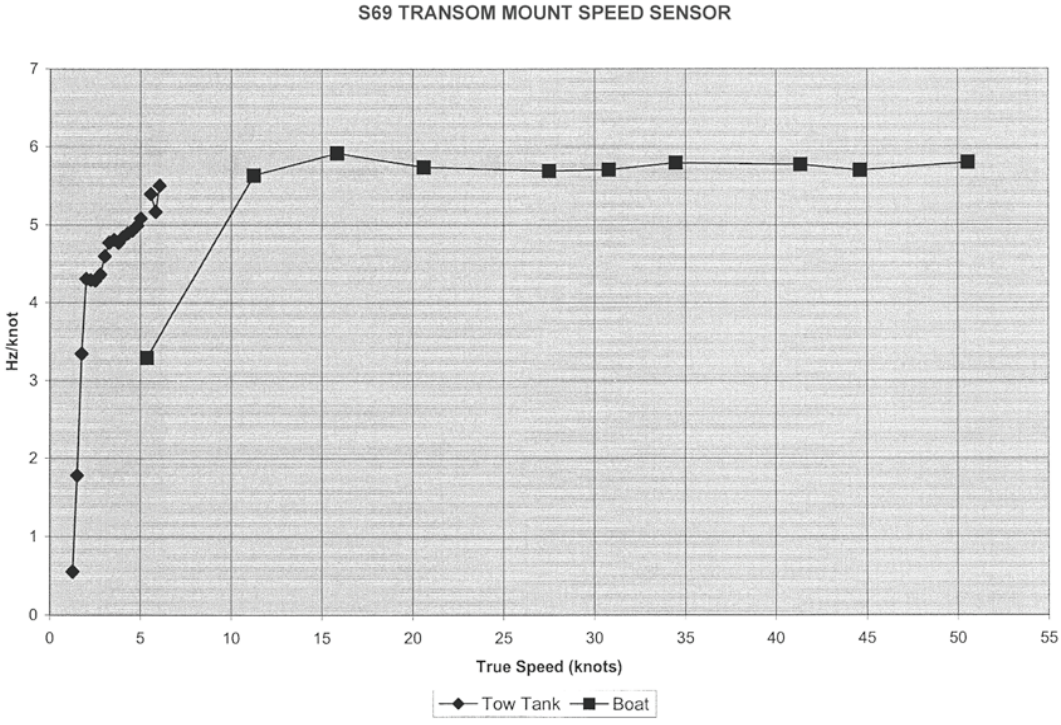


S63 TRANSOM MOUNT SPEED SENSOR



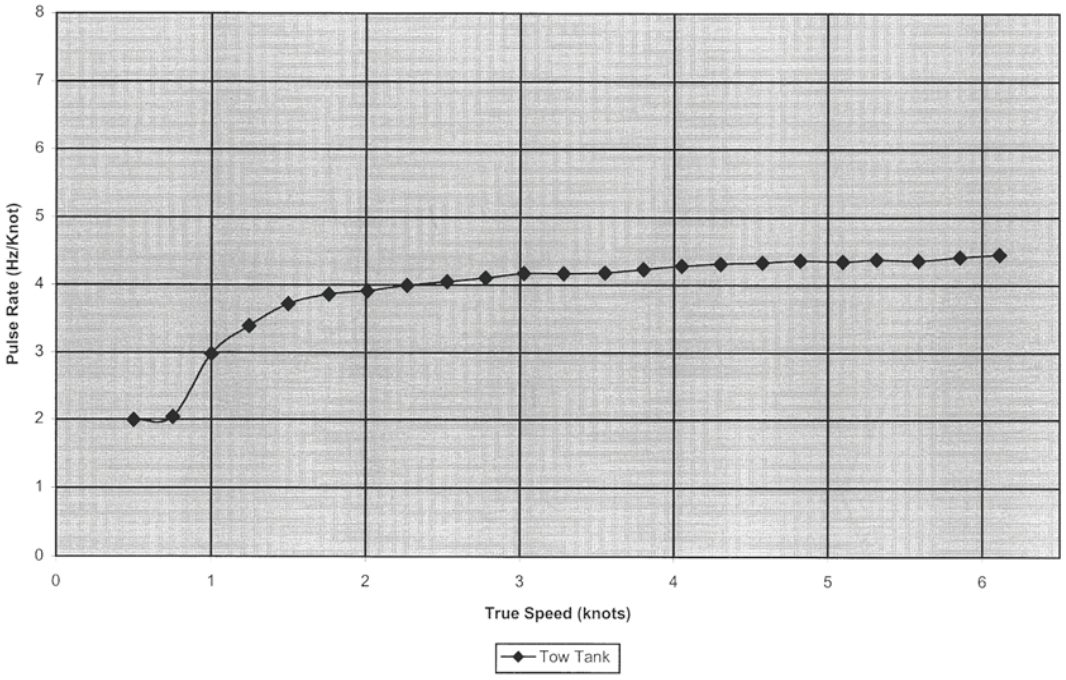
Paddlewheel Chart



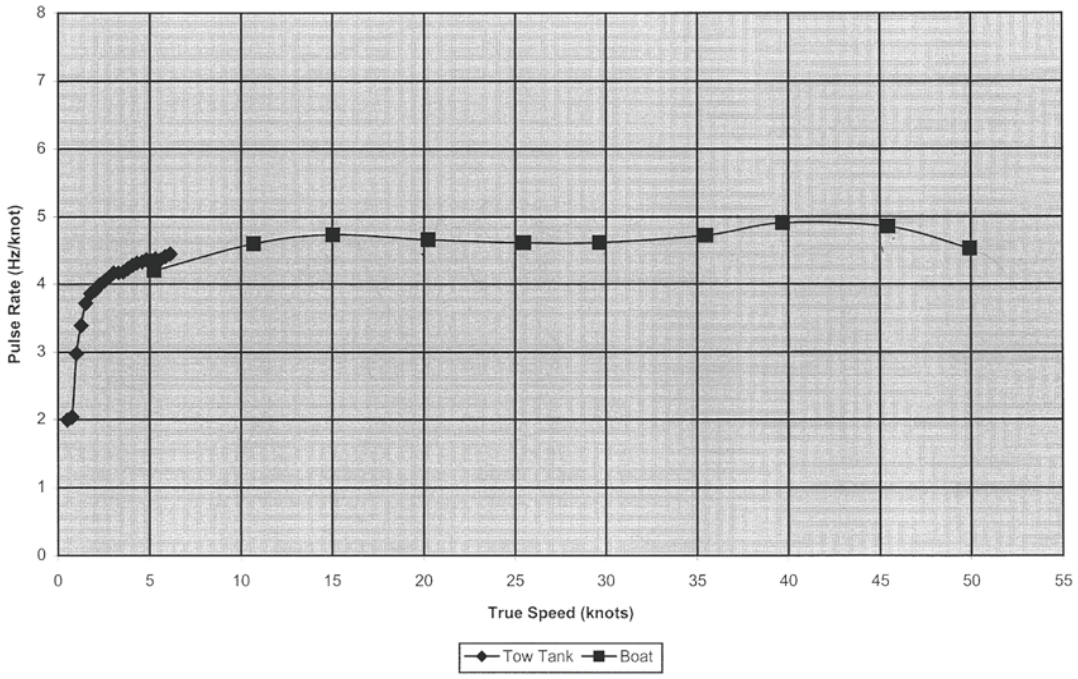


Paddlewheel Chart

ST300 / ST600 / ST620 / ST650 / ST700 / ST800 / ST850 — LOW PROFILE THRU-HULL HOUSING

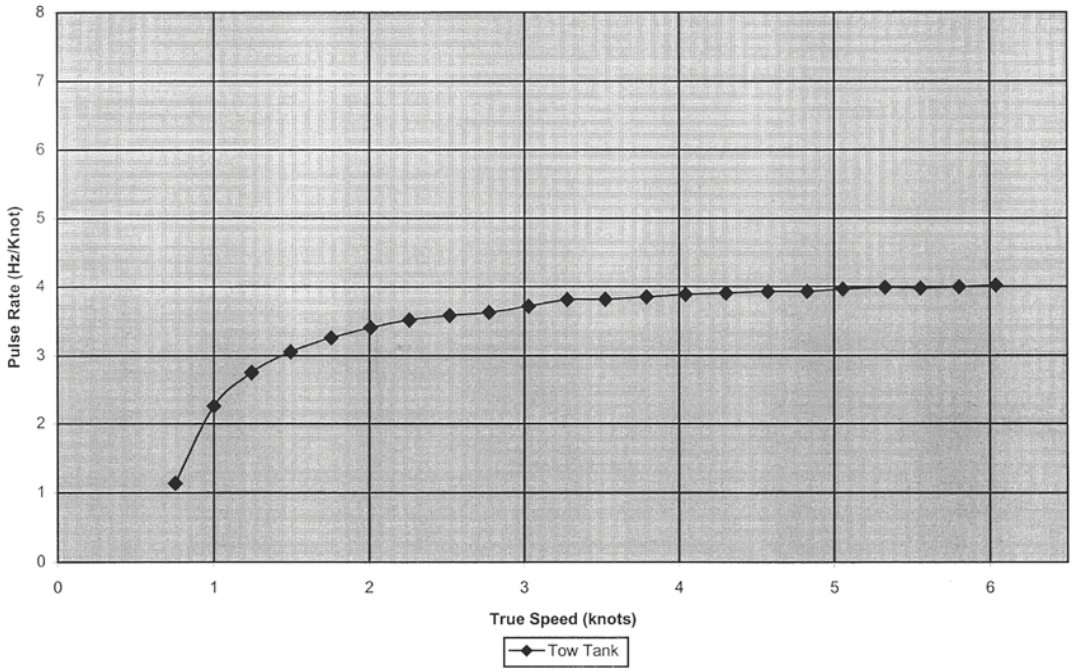


ST300 / ST600 / ST620 / ST650 / ST700 / ST800 / ST850 — LOW PROFILE THRU-HULL HOUSING

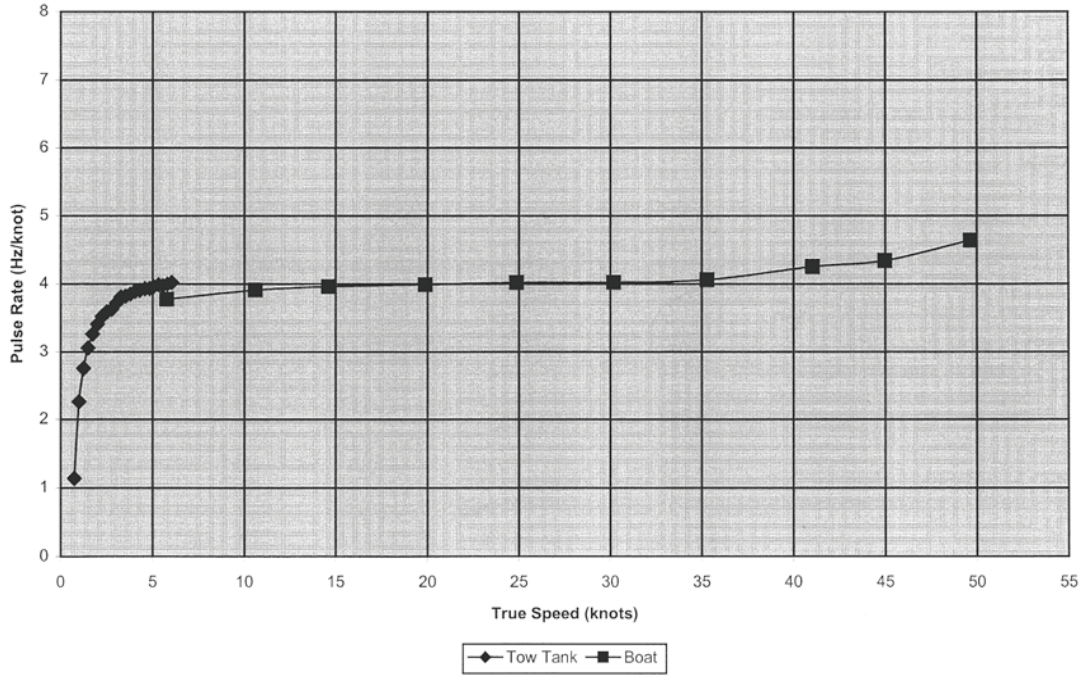


Paddlewheel Chart

ST300 / ST600 / ST620 / ST650 / ST700 / ST800 / ST850 — FLUSH THRU-HULL HOUSING

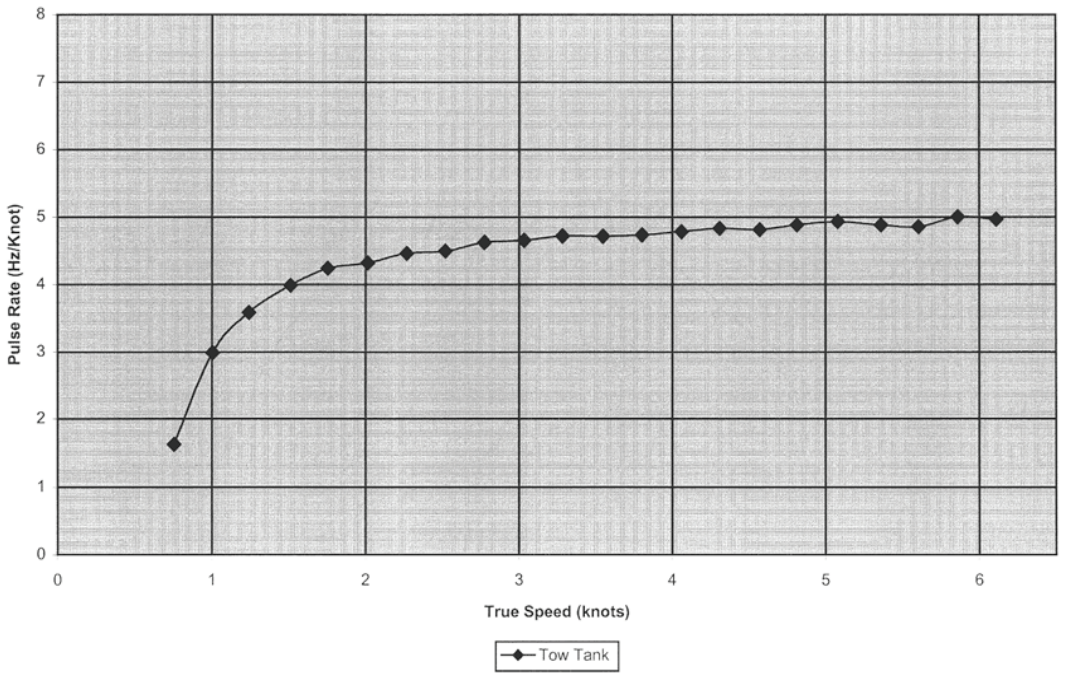


ST300 / ST600 / ST620 / ST650 / ST700 / ST800 / ST850 — FLUSH THRU-HULL HOUSING

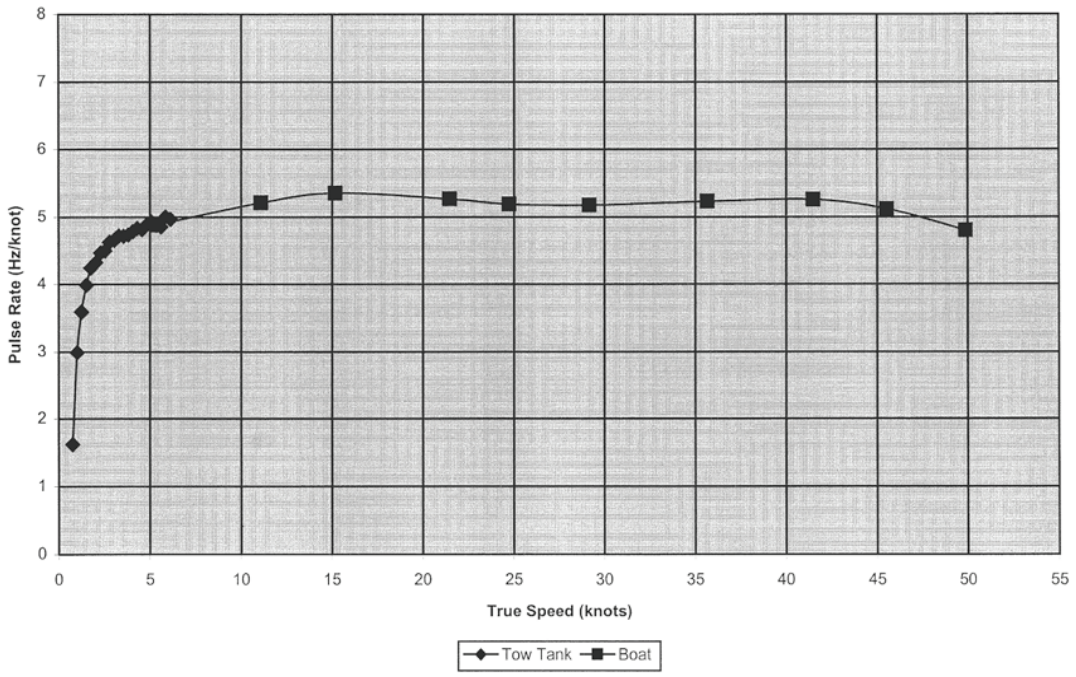


Paddlewheel Chart

ST300 / ST600 / ST620 / ST650 / ST700 / ST800 / ST850 WITHOUT FINS — LOW PROFILE THRU-HULL HOUSING

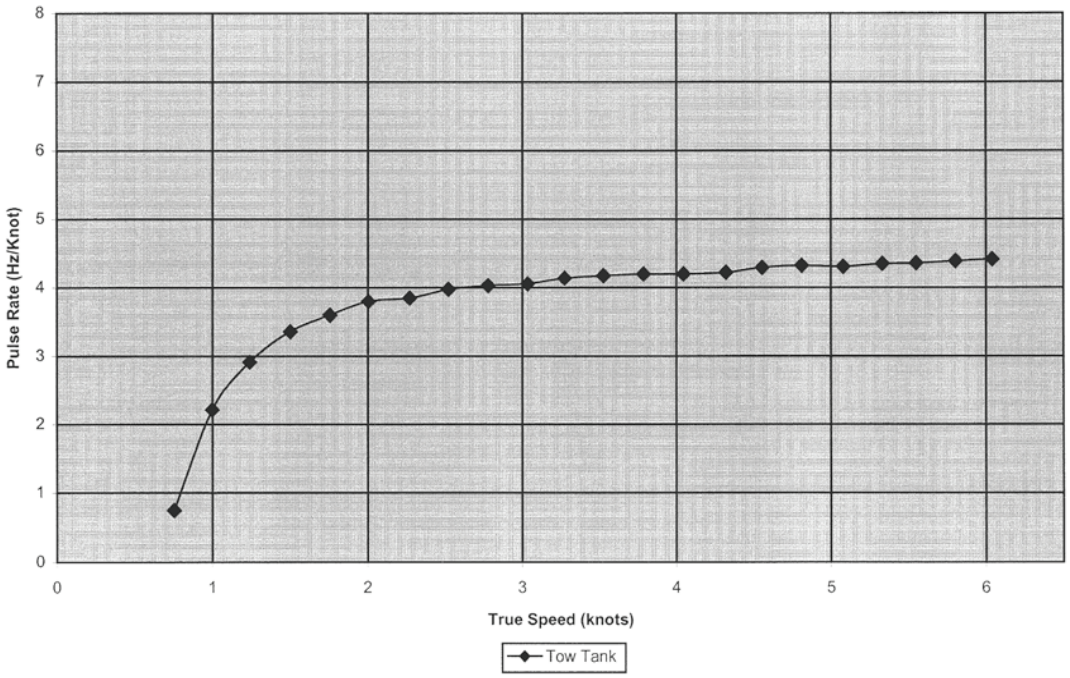


ST300 / ST600 / ST620 / ST650 / ST700 / ST800 / ST850 WITHOUT FINS — LOW PROFILE THRU-HULL HOUSING



Paddlewheel Chart

ST300 / ST600 / ST620 / ST650 / ST700 / ST800 / ST850 WITHOUT FINS — FLUSH THRU-HULL HOUSING



ST300 / ST600 / ST620 / ST650 / ST700 / ST800 / ST850 WITHOUT FINS — FLUSH THRU-HULL HOUSING

