



**Krautkramer**  
Ultrasonic Systems

# Ultrasonic Transducers

July 2002 Edition

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# General Information

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## Krautkramer— The World Leader

Krautkramer is the world's largest designer, manufacturer, and marketer of high technology instruments and transducers for ultrasonic nondestructive testing (UT). Our products include flaw detectors, thickness gauges, hardness testers, inspection systems, UT software, ultrasonic transducers, and eddy current instruments and probes. Krautkramer is a division of Emerson Electric and has worldwide manufacturing and product support bases. Our main manufacturing centers are in Lewistown, Pennsylvania, USA, and Cologne, Germany. We also have direct facilities in Japan, United Kingdom, France, and Italy, as well as worldwide representatives. All of our direct facilities and many of our representative facilities have full service capabilities. A full list of worldwide representatives is available from Krautkramer or on the Internet at [www.krautkramer.com](http://www.krautkramer.com).

## Ultrasonic Transducers for Every Application

Krautkramer offers over 4000 standard and special ultrasonic transducers and accessories for virtually every application. This catalog describes our extensive range of standard transducers and related accessories. For applications that require a non-standard product, we proudly offer the most comprehensive special probe and applications services available anywhere. Refer to the Special Probes and Applications section of this catalog for more information.

## Fast Delivery

Because we know that fast delivery is a must for most of our customers, we stock over 500 of the commonly used products in this catalog. If your first choice is not available from stock, a product specialist can often recommend a suitable substitute. When not available from stock, most standard products in this catalog can be shipped in less than two weeks. As a certified Class A MRPII manufacturer, Krautkramer employs state-of-the-art control systems and manufacturing methods to assure timely delivery of a reliable product.

## The Best Quality and Service

Our quality program is certified to the international quality standard ISO-9001. This enables Krautkramer to quickly serve the marketplace with products of exceptional quality and value. Krautkramer's commitment to providing the very best customer service is evidenced by ongoing investments in manufacturing technology and productivity enhancing capital equipment.



## New Products

Numerous products are included in this catalog for the first time. Below are a few of the most important ones:

- Look for new **Benchmark Series** probes throughout the catalog. Made with proprietary **BENCHMARK COMPOSITE®** active elements, they offer incredible penetration and excellent resolution. Refer to the Transducer Performance section of the catalog for more information.
- Use new **XLC** Extended Life Contact probes for long service life in the most abusive applications.
- Try the new **K-PEN** 20 MHz pencil type probe on parts with sharp curves or limited access.
- Use the **HT400A** high temperature probe to test materials at temperatures to 1000 °F.
- Save time and money with **FAST™** probes, designed for high speed, manual weld scanning.



# Table of Contents

	Page		Page
<b>How to Order</b> .....	1	<b>Fingertip Dual Element Transducers</b>	
<b>Transducer Performance</b>		ADP Style (Potted Cable) .....	15
Alpha Series Features .....	2	RC Dual Style (Replaceable Cable) .	15
Benchmark Series Features .....	2	FDU Style (Replaceable Cable) .....	15
Gamma Series Features .....	2	<b>High Temperature Dual Element Transducers</b>	
Frequency Color Coding .....	2	HT400A (to 1000° F) .....	15
<b>Contact Transducers</b>		KBA560V (to 750° F) .....	15
RHP Style Standard .....	3	<b>Standard Dual Element Transducers</b>	
XLC Style Extended Life .....	3	DU Style (Replaceable Delay) .....	16
F Style Fingertip .....	4	DU-F Style, Benchmark Series .....	16
<b>Delay Line Contact Transducers</b>		FAST™ Probes .....	16
DFR Style Removable Delay .....	4	<b>Immersion Transducers</b>	
K-PEN Pencil Type Probe .....	5	ISS/IS Styles .....	17
ZIP Probes .....	5	IPS/IR Styles .....	18
<b>Protective Face Contact Transducers</b>		Velocity System Transducers .....	19
PFCR/PFCS Combination Styles .....	6	Near Field and Focusing Information .	19
PMCR/PMCS Membrane Styles .....	7	<b>Thickness Gauging Transducers</b>	
PWCCR/PWCCS Styles .....	8	Precision Gauging.....	20
<b>Angle Beam Transducers</b>		Dual Element Corrosion Gauging ....	21
SWS/AWS Styles, Gamma .....	9	<b>Special Probes and Applications Laboratory</b>	
SWS/AWS Styles, Benchmark .....	10	Special Probes & Applications .....	22
<b>Miniature Angle Beam Transducers</b>		Phased Array Transducers .....	23
MSW-QC Quick Change, Gamma ....	11	Inquiry Form.....	24
MSW-QC, Alpha & Benchmark .....	12	<b>Accessories</b>	
MSWS Style (Captive Screws) .....	13	Cables/Adaptors/Search Tubes ....	25
ABFP Style (Potted Wedge) .....	14	Couplants .....	26
SMSWS Style (Subminiature) .....	14	Test Blocks .....	27
		<b>Transducer Certification</b> .....	29
		<b>Tables and Formulas</b> .....	30
		<b>Transducer Kits</b> .....	Inside Back Cover

## How To Order

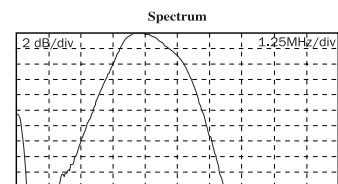
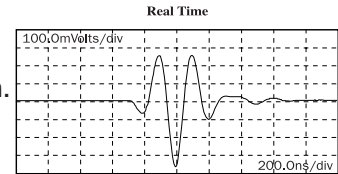
- **Order by Product Code:** Tables on each page give Product Codes by frequency, size, and style.
- **Phone:** (717) 242-0327. Ask for the Sales Department. After hours, use our voice mail system.
- **Fax:** (717) 242-2606
- **Mail:** Sales Department, Krautkramer, 50 Industrial Park Road, Lewistown, PA 17044
- **Contact your local Sales Representative:** See our site on the web at [www.krautkramer.com](http://www.krautkramer.com) or call our Sales Department
- **If you need assistance:** Call (717) 242-0327 and ask for a Transducer Product Specialist.
- **VISA** and **MasterCard** accepted in North America when you order through our Lewistown, PA office.



# Transducer Performance

Krautkramer offers three series of transducers: **Alpha**, **Gamma**, and new **Benchmark**. To determine which of these series is best for your application, please read the technical information on this page. If you need assistance, contact one of our Transducer Product Specialists (717-242-0327) or your local sales representative. Real time waveform and frequency certification is included with every transducer at no charge (refer to the Technical Information section for details).

- Recommended for applications where resolution is the primary consideration.
- Suitable for applications such as thickness measurement and near-surface flaw detection.
- Very short pulse— mechanically damped to the limit of current technology.
- Gain is usually lower than that of the Gamma and Benchmark Series.
- Broadband— typical 6 dB bandwidths range from 50% to 100%.
- Typical Alpha waveforms (right) exhibit one to two full ring cycles, depending on frequency, size and other parameters.



- Proprietary **BENCHMARK COMPOSITE**<sup>®</sup> (piezocomposite) active elements.
- Penetration in attenuative materials is far superior to conventional transducers.
- High signal to noise on coarse grain metals, fiber reinforced composites, et al.
- Short pulse— resolution usually superior to Gamma Series.
- Gain is usually higher than that of the Gamma and Alpha Series.
- Very broadband— typical 6 dB bandwidths range from 60% to 120%.
- Low acoustic impedance element improves performance of angle beam, delay line, and immersion probes— excellent match to plastic and water.

- General purpose transducers, recommended for the majority of applications.
- Medium pulse, medium damping— best combination of gain and resolution
- Matching electrical network ensures maximum gain and optimum waveform for general use.
- Medium bandwidth— typical 6 dB bandwidths range from 30% to 50%.
- Typical Gamma waveform exhibits three to four full ring cycles, depending on frequency, size and other parameters.

For easy identification of frequency, most Krautkramer transducers are color coded as follows:

Frequency (MHz)	.50	1.0	2.25	3.50	5.00	10.00
Color	Gray	Red	Yellow	Blue	Green	Black

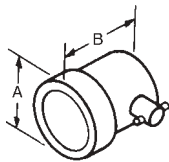


# Contact Transducers

Single Element Contact Transducers are longitudinal wave transducers designed for general purpose manual ultrasonic inspection where test materials are relatively flat and smooth. Contact transducers provide high sensitivity for better penetration and are ruggedly constructed for extended service life under the roughest testing conditions.

## RHP and XLC Style Contacts

Standard Contact Transducers are designed for abusive “scrubbing” applications. Gamma series are for applications where sensitivity and penetration are essential. Alpha series have maximum bandwidth for axial resolution. RHP style probes feature ceramic wearplates for the best combination of acoustic matching and durability and stainless steel housings to resist corrosion. New XLC (Extended Life Contact) style probes have special, high durability wearplates for the most abusive applications. Both styles feature an improved comfort grip and color band for frequency identification. CR models have right angle mounted BNC connectors and the CS models have top-mounted BNC connectors.



Element Diameter	A	B
.500	1.15	1.50
.750	1.40	1.50
1.000	1.65	1.50

## Standard Contact Transducers— RHP and XLC Styles

Freq. (MHz)	Size (in.)	PRODUCT CODES			Accessories	Freq. (MHz)	Size (in.)	PRODUCT CODES				
		Style	Alpha Series	Gamma Series				Style	Alpha Series	Gamma Series	Accessories	
.5	.750	RHP RHP		250-043-CR 250-123-CS	<b>Cables</b>  6' BNC C-016  6' LEMO C-018	3.5	.500	RHP RHP XLC XLC		243-043-CR 243-123-CS 243-050-CR 243-150-CS	<b>Cables</b> 6' BNC C-016  6' LEMO C-018	
	1.00	RHP RHP		260-043-CR 260-123-CS				.750	RHP RHP XLC XLC			253-043-CR 253-123-CS 253-050-CR 253-150-CS
1.0	.500	RHP RHP		241-043-CR 241-123-CS			1.00		RHP RHP XLC XLC			263-043-CR 263-123-CS 263-050-CR 263-150-CS
	.750	RHP RHP		251-043-CR 251-123-CS				5.0	.500	RHP RHP		144-043-CR 144-123-CS
	1.00	RHP RHP XLC XLC		261-043-CR 261-123-CS 261-050-CR 261-150-CS			.750		RHP RHP	154-043-CR 154-123-CS		254-043-CR 254-123-CS
	2.25	.500	RHP RHP XLC XLC	142-043-CR 142-123-CS			242-043-CR 242-123-CS 242-050-CR 242-150-CS	1.00	RHP RHP	164-043-CR 164-123-CS		264-043-CR 264-123-CS
.750		RHP RHP XLC XLC	152-043-CR 152-123-CS	252-043-CR 252-123-CS 252-050-CR 252-150-CS		10.0	.500	RHP RHP		246-043-CR 246-123-CS		
		1.00	RHP RHP XLC XLC	162-043-CR 162-123-CS				262-043-CR 262-123-CS 262-050-CR 262-150-CS				



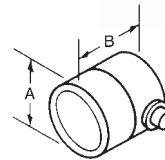
# Contact Transducers

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## F Style Contact

F Style Contact transducers are small diameter fingertip probes with a right angle mounted Microdot connector. Gamma Series are recommended for applications where high sensitivity and penetration are essential. Alpha Series are designed for optimum damping and resolution. Benchmark Series, with Benchmark Composite® elements, are best for punching through highly attenuative materials.



Element Diameter	A	B
.250	.50	.66
.375	.63	.66
.500	.75	.66

## Fingertip Contact Transducers— F Style

Freq. (MHz)	Size (in.)	PRODUCT CODES				Freq. (MHz)	Size (in.)	PRODUCT CODES			
		Benchmark Series	Alpha Series	Gamma Series	Accessories			Benchmark Series	Alpha Series	Gamma Series	Accessories
2.25	.250	822-000	122-000	222-000	Cables 6' BNC C-012	5.0	.250	824-000	124-000	224-000	Cables 6' BNC C-012
	.375	832-000	132-000	232-000			.375	834-000	134-000	234-000	
	.500	842-000	142-000	242-000			.500	844-000	144-000	244-000	
3.5	.250		123-000	223-000	6' LEMO C-022	10.0	.250		126-000	226-000	6' LEMO C-022
	.375		133-000	233-000			.375		136-000	236-000	
	.500		143-000	243-000			.500		146-000	246-000	

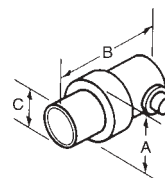
## DFR Style Removable Delay Line Contact

DFR Style Removable Delay Line Fingertip Transducers are specifically designed for thickness gauging and flaw detection of thin materials. High frequency and critical damping results in a high performance transducer, which exhibits excellent resolution capability. All DFR Style Transducers have right angle mounted Microdot connectors.



## Removable Delay Line— DFR Style

Freq. (MHz)	Size (in.)	PRODUCT CODES			Accessories
		Alpha Series	Delay Line 10-PK .38" Lg	Delay Line 10-PK .5" Lg	
2.25	.250	122-660	D-050	D-051	Cables 6' BNC C-012
	.500	140-500		D-052	
3.5	.250	123-660	D-050	D-051	6' LEMO C-022
	.500	144-660		D-052	
5.0	.250	124-660	D-050	D-051	Delay Line Couplant XD-740
	.500	140-602		D-052	
10.0	.250	126-660	D-050	D-051	Spring Loaded VEE Block H-007*
.500	140-602		D-052		
15.0	.250	127-660	D-050	D-051	
22.0	.125	118-660	D-050	D-051	
25.0	.250	129-660	D-050	D-051	
Mini-DFR 20.0	.125	518-650	MD-502		



Element Diameter	A	B	C
.125 or .250	.51	.835	.30
.500	.875	1.375	.595
Mini-DFR			
.125	.41	.765	.19

\*H-007 fits .125<sup>2</sup> and .25<sup>2</sup> units only with exception of Mini DFR.



# Contact Transducers

Single Element Contact Transducers are longitudinal wave transducers designed for general purpose manual ultrasonic inspection where test materials are relatively flat and smooth. Contact transducers provide high sensitivity for better penetration and are ruggedly constructed for extended service life under the roughest testing conditions.

## K-PEN Replaceable Delay Line Pencil Probe

K-PEN's are high resolution pencil type probes. They are designed for applications requiring an extremely small contact area, such as tightly curved surfaces of turbine blades or remaining wall thickness measurements from a pit bottom. They can be used with most flaw detectors, precision thickness gauges, and general pulser / receiver units. Probes come with interchangeable delay tips that are tapered to a .065" and .090" contact diameter. Replacement delays are available in packs of 10. The straight model features a removable handle, which also allows it to be used as a fingertip probe. All models have Microdot connectors.



### K-PEN Probes

Freq. (MHz)	PRODUCT CODES					
	Straight K-PEN	45° K-PEN	Right Angle K-PEN	.065" Tip Delay 10-PK	.090" Tip Delay 10-PK	6' BNC Cable
7.5	389-042-200	389-042-880	389-042-870	387-003-109	387-003-110	C-012
20.0	389-030-290	389-041-270	389-040-660			

## ZIP Probes for Testing Composite and Other Attenuative Plastics

Zero Interface (ZIP) Probes are highly damped, low frequency delay line transducers designed for composite inspection. ZIP delay lines are acoustically matched to most composite and other plastic materials. This eliminates or minimizes the delay line interface echo, significantly improving near surface resolution. The low frequency characteristics of ZIPs make them excellent for penetrating thick or highly attenuative cross-sections. ZIPs can also be used on many smooth surfaced materials without couplant.



### Zero Interface Probes (ZIP)

Freq. (MHz)	Size (in.)	PRODUCT CODES	PRODUCT CODES	
			Cables	Delay Line
0.45	1.00	560-130	6' BNC C-016	D-071
1.5	.500	560-131	6' BNC C-012	D-072
2.25	.375	560-132		D-073



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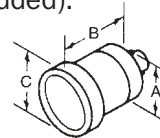


## PFCR and PFCS Style Contacts

The Protective Face Combination transducers are designed to allow one basic transducer to be used with three different types of protective face: membrane, wear cap, or delay line. All models have BNC connectors, PFCR are right angle mount and PFCS are top-mount.

Style PM Kit includes a knurled ring, gland nut, wrench, 12 membranes, and a 2 oz. bottle of couplant (transducer not included).

Style PWC Kit includes a knurled ring, three wear caps, and a 2 oz. bottle of couplant (transducer not included). This option may not be usable if near surface resolution is critical.



Element Diameter	A	B	C
.500	.75	1.20	.94
.750	1.00	1.20	1.19
1.000	1.25	1.20	1.44
1.125	1.38	1.35	1.57

Style PHTD Kit includes a knurled ring, either 1" or 1.5" long high temperature delay line, and a 2 oz. bottle of couplant (transducer not included).

## Protective Face Combination Transducers— PFCR / PFCS Style

Freq. (MHz)	Size (in.)	PRODUCT CODES		Freq. (MHz)	Size (in.)	PRODUCT CODES	
		Gamma Series PFCR Style	Gamma Series PFCS Style			Gamma Series PFCR Style	Gamma Series PFCS Style
1.0	.500	241-240	241-260	3.5	.500	243-240	243-260
	.750	251-240	251-260		.750	253-240	253-260
	1.00	261-240	261-260		1.00	263-240	263-260
	1.125	271-240	271-260				
2.25	.500	242-240	242-260	5.0	.500	244-240	244-260
	.750	252-240	252-260		.750	254-240	254-260
	1.00	262-240	262-260		1.00	264-240	264-260
	1.125	272-240	272-260				

## Accessories— PFCR / PFCS

	PRODUCT CODES			
	Transducer Element Diameter			
	.500"	.750"	1.00"	1.125"
Spare Membranes Pkg. of 12 pcs.	PM-020	PM-021	PM-022	PM-023
Spare Wear caps Pkg. of 12 pcs.	PC-123	PC-122	PC-121	PC-120
Hi-Temp. Delay Line* 1.0" Long	PD-027	PD-031	PD-035	PD-039
Hi-Temp. Delay Line* 1.5" Long	PD-029	PD-033	PD-037	PD-041
6' BNC Cable	C-016			
Membrane, Wear Cap & Delay Line Couplant	XD-740			

## Protective Face Option Kits— PFCR / PFCS

Kit Style	PRODUCT CODES			
	Transducer Element Diameter			
	.500"	.750"	1.00"	1.125"
PM	PK-120	PK-140	PK-160	PK-180
PWC	PK-220	PK-240	PK-260	PK-280
PHTD (1" Delay)*	PK-320	PK-340	PK-360	PK-380
PHTD (1.5" Delay)*	PK-420	PK-440	PK-460	PK-480

\* High Temp (PHTD) delay line: maximum temperature 400 °F, maximum contact time 10 seconds; cool to ambient before reuse.



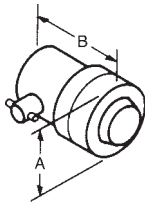


# Contact Transducers

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## PMCR and PMCS Style Contacts

Protective Membrane Contact Transducers are excellent for coupling to rough or uneven surfaces. The membrane will conform to surface irregularities providing better coupling to the test material. PMCR and PMCS Style contacts are designed for quick, easy membrane replacement and have color-coded grips identifying transducer frequency. The PMCR Style has right angle BNC connectors while the PMCS Style has straight top-mount BNC connectors.



Element Diameter	A	B
.500	1.13	1.75
.750	1.41	1.75
1.000	1.63	1.75
1.125	1.63	1.75

## Protective Membrane Transducers— PMCR/PMCS Style

Freq. (MHz)	Size (in.)	PRODUCT CODES			Freq. (MHz)	Size (in.)	PRODUCT CODES		
		Gamma Series	Membranes 1 dozen	Accessories			Gamma Series	Membranes 1 dozen	Accessories
1.0	.500	241-241-PMCR 241-261-PMCS	PM-020	<b>Cables</b> 6' BNC C-016  6' LEMO C-018  <b>Membrane Couplant</b> XD-740	3.5	.500	243-241-PMCR 243-261-PMCS	PM-020	<b>Cables</b> 6' BNC C-016  6' LEMO C-018  <b>Membrane Couplant</b> XD-740
	.750	251-241-PMCR 251-261-PMCS	PM-021			.750	253-241-PMCR 253-261-PMCS	PM-021	
	1.00	261-241-PMCR 261-261-PMCS	PM-022			1.00	263-241-PMCR 263-261-PMCS	PM-022	
	1.125	271-241-PMCR 271-261-PMCS	PM-023						
2.25	.500	242-241-PMCR 242-261-PMCS	PM-020		5.0	.500	244-241-PMCR 244-261-PMCS	PM-020	
	.750	252-241-PMCR 252-261-PMCS	PM-021			.750	254-241-PMCR 254-261-PMCS	PM-021	
	1.00	262-241-PMCR 262-261-PMCS	PM-022			1.00	264-241-PMCR 264-261-PMCS	PM-022	
	1.125	272-241-PMCR 272-261-PMCS	PM-023						

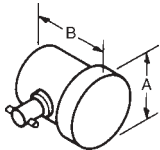


# Contact Transducers

Single Element Contact Transducers are longitudinal wave transducers designed for general purpose manual ultrasonic inspection where test materials are relatively flat and smooth. Contact transducers provide high sensitivity for better penetration and are ruggedly constructed for extended service life under the roughest testing conditions.

## PWCCR and PWCCS Style Contacts

Protective Wear Cap Contact Transducers have expendable wear caps which are easily replaced when worn. This means unlimited economy when the job calls for “scrubbing” which would normally destroy a standard contact probe. The PWCCR Style has right angle mounted BNC connectors while the PWCCS Style has straight top-mount BNC connectors. High temperature delay lines are also available for applications to 400 °F.



Element Diameter	A	B
.500	1.0	1.12
.750	1.25	1.12
1.000	1.50	1.12



## Protective Wear Cap/Delay Line Transducers— PWCCR/PWCCS

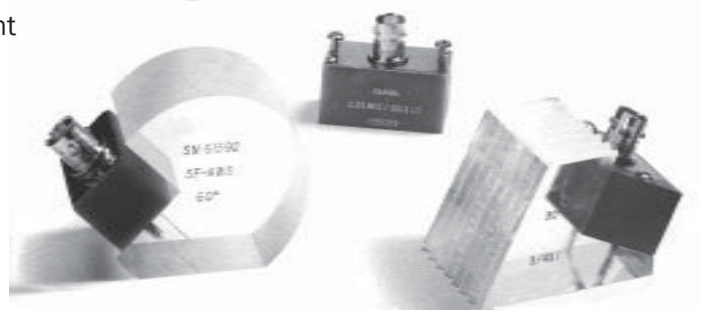
Freq. (MHz)	Size (in.)	PRODUCT CODES				Accessories	Freq. (MHz)	Size (in.)	PRODUCT CODES				Accessories
		Gamma Series	Wear Cap 10 pc. Kit	HT Delay Line Kit*					Gamma Series	Wear Cap 10 pc. Kit	HT Delay Line Kit*		
1.0	.500	241-250-PWCCR 241-270-PWCCS	PC-221	PK-050-1" PK-060-1.5"	Cables 6' BNC C-016 6' LEMO C-018	3.5	.500	243-250-PWCCR 243-270-PWCCS	PC-221	PK-050-1" PK-060-1.5"	Cables 6' BNC C-016 6' LEMO C-018		
	.750	251-250-PWCCR 251-270-PWCCS	PC-241	PK-070-1" PK-080-1.5"			.750	253-250-PWCCR 253-270-PWCCS	PC-241	PK-070-1" PK-080-1.5"			
	1.00	261-250-PWCCR 261-270-PWCCS	PC-261	PK-090-1" PK-100-1.5"			1.00	263-250-PWCCR 263-270-PWCCS	PC-261	PK-090-1" PK-100-1.5"			
2.25	.500	242-250-PWCCR 242-270-PWCCS	PC-221	PK-050-1" PK-060-1.5"	Wear Cap Couplant XD-740	5.0	.500	244-250-PWCCR 244-270-PWCCS	PC-221	PK-050-1" PK-060-1.5"	Wear Cap Couplant XD-740		
	.750	252-250-PWCCR 252-270-PWCCS	PC-241	PK-070-1" PK-080-1.5"			.750	254-250-PWCCR 254-270-PWCCS	PC-241	PK-070-1" PK-080-1.5"			
	1.00	262-250-PWCCR 262-270-PWCCS	PC-261	PK-090-1" PK-100-1.5"			1.00	264-250-PWCCR 264-270-PWCCS	PC-261	PK-090-1" PK-100-1.5"			

\* High Temp (HT) Delay Line: maximum temperature 400 °F, maximum contact time 10 seconds; cool to ambient before reuse.



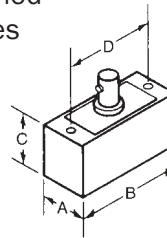
# Angle Beam Transducers

Angle Beam Transducers are single or dual element transducers designed for weld inspection or flaw detection where flaws have an angular orientation with respect to the material surface. Weld inspections are performed using shear waves refracted from a longitudinal wave by means of a lucite wedge. Lucite wedges are designed to produce shear waves of a particular angle in a specified material with minimal wedge noise.



## SWS and AWS Style Angle Beam, Gamma Series

SWS and AWS Style Angle Beam Transducers are designed to fit on removable wedges. Refracted shear wave angles may be specified as required. The AWS series are designed to meet or exceed all of the requirements outlined in AWS Structural Welding Code D1.1. All SWS and AWS transducers utilize captive screws for fastening the probe to the wedge and have top-mount BNC connectors. High temperature wedges are for temperatures up to 400° F.



Element Size	A	B	C	D
.50 dia.	.72	1.0	.75	.81
.50 x 1.0	.725	1.51	.75	1.31
.75 x 1.0	1.00	1.5	.75	1.31
1.0 dia.	1.22	1.65	.75	1.38
.625 x .625	.725	1.25	.75	1.00
.625 x .750	.725	1.25	.75	1.00
.750 x .750	.85	1.25	.75	1.00

## Standard Angle Beam— SWS and AWS Styles, Gamma Series

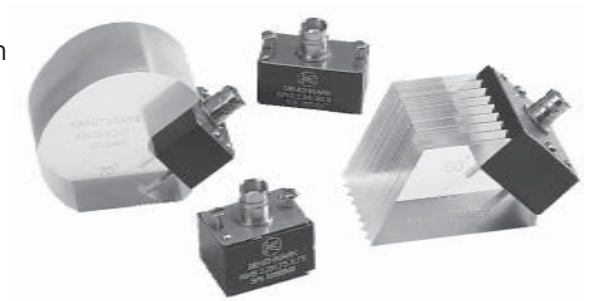
Freq. (MHz)	Size (in.)	PRODUCT CODES				Freq. (MHz)	Size (in.)	PRODUCT CODES			
		Gamma Series	Standard Wedge	Hi-Temp Wedge*	Accessories			Gamma Series	Standard Wedge	Hi-Temp Wedge*	Accessories
.5	1.0 Dia	260-600	W-021 45° W-022 60° W-023 70° W-025 90°	W-081 45° W-082 60° W-083 70°	<b>Cables</b> 6' BNC C-016 6' LEMO C-018 <b>Wedge Couplant</b> XD-740	2.25 AWS Series	.63 x .63	292-603	W-104 45° W-105 60° W-106 70°		<b>Cables</b> 6' BNC C-016 6' LEMO C-018 <b>Wedge Couplant</b> XD-740
	.5 Dia	241-600	W-009 45° W-010 60° W-011 70° W-013 90°	W-076 45° W-077 60° W-078 70°			.63 x .75	292-601	W-104 45° W-105 60° W-106 70°		
.5 x 1	291-600	W-015 45° W-016 60° W-017 70° W-019 90°	W-070 45° W-086 60° W-071 70°	.75 x .75			292-604	W-104 45° W-105 60° W-106 70°			
1.0 Dia	261-600	W-021 45° W-022 60° W-023 70° W-025 90°	W-081 45° W-082 60° W-083 70°	.5 Dia			243-600	W-009 45° W-010 60° W-011 70° W-013 90°	W-076 45° W-077 60° W-078 70°		
1.0	.75 x 1	291-605	W-051 45° W-052 60° W-053 70° W-054 90°				.5 x 1	293-600	W-015 45° W-016 60° W-017 70° W-019 90°	W-070 45° W-086 60° W-071 70°	
	2.25	.5 Dia	242-600	W-009 45° W-010 60° W-011 70° W-013 90°		W-076 45° W-077 60° W-078 70°		.75 x 1	293-605	W-051 45° W-052 60° W-053 70° W-054 90°	
		.5 x 1	292-600	W-015 45° W-016 60° W-017 70° W-019 90°		W-070 45° W-086 60° W-071 70°	1.0 Dia		263-600	W-021 45° W-022 60° W-023 70° W-025 90°	
	2.25	.75 x 1	292-605	W-051 45° W-052 60° W-053 70° W-054 90°			.5 Dia	244-600	W-009 45° W-010 60° W-011 70° W-013 90°	W-076 45° W-077 60° W-078 70°	
5.0		.5 x 1	262-600	W-021 45° W-022 60° W-023 70° W-025 90°		W-081 45° W-082 60° W-083 70°		.5 x 1	294-600	W-015 45° W-016 60° W-017 70° W-019 90°	
		5.0	.75 x 1	294-605		W-051 45° W-052 60° W-053 70° W-054 90°			1.0 Dia	264-600	

\* Duty Cycle: at 400° F, maximum contact time is 10 seconds; cool to ambient before reuse.  
 Note: Standard wedge angles are specified for carbon steel.



# Angle Beam Transducers

Angle Beam Transducers are single or dual element transducers designed for weld inspection or flaw detection where flaws have an angular orientation with respect to the material surface. Weld inspections are performed using shear waves refracted from a longitudinal wave by means of a lucite wedge. Lucite wedges are designed to produce shear waves of a particular angle in a specified material with minimal wedge noise.



## SWS and AWS Style Angle Beam, Benchmark Series

Benchmark series SWS and AWS Style Angle Beam Transducers feature proprietary BENCHMARK COMPOSITE® active elements. They are available in the same range of sizes and fit the same removable wedges as the Gamma series. Benchmark series offer a superior combination of sensitivity, resolution, and penetration for punching through highly attenuative materials. They are especially beneficial when signal to noise ratio is a problem, for example coarse grain materials and fiber reinforced composites. The AWS models meet all requirements of Structural Welding Code D1.1.

**Standard Angle Beam— SWS and AWS Styles, Benchmark Series**

Freq. (MHz)	Size (in.)	PRODUCT CODES			Freq. (MHz)	Size (in.)	PRODUCT CODES		
		Benchmark Series	Standard Wedge	Accessories			Benchmark Series	Standard Wedge	Accessories
1.0	.5 Dia	841-600	W-009 45° W-010 60° W-011 70° W-013 90°		3.5	.5 Dia	843-600	W-009 45° W-010 60° W-011 70° W-013 90°	
	.5 x 1	891-600	W-015 45° W-016 60° W-017 70° W-019 90°			.5 x 1	893-600	W-015 45° W-016 60° W-017 70° W-019 90°	
	.75 x 1	891-605	W-051 45° W-052 60° W-053-70° W-054 90°			.75 x 1	893-605	W-051 45° W-052 60° W-053-70° W-054 90°	
	1.0 Dia	861-600	W-021 45° W-022 60° W-023 70° W-025 90°			1.0 Dia	863-600	W-021 45° W-022 60° W-023 70° W-025 90°	
2.25	.5 Dia	842-600	W-009 45° W-010 60° W-011 70° W-013 90°	Cables 6' BNC C-016 6' LEMO C-018 Wedge Couplant XD-740	5.0	.5 Dia	844-600	W-009 45° W-010 60° W-011 70° W-013 90°	Cables 6' BNC C-016 6' LEMO C-018 Wedge Couplant XD-740
	.5 x 1	892-600	W-015 45° W-016 60° W-017 70° W-019 90°			.5 x 1	894-600	W-015 45° W-016 60° W-017 70° W-019 90°	
	.75 x 1	892-605	W-051 45° W-052 60° W-053 70° W-054 90°			.75 x 1	894-605	W-051 45° W-052 60° W-053 70° W-054 90°	
	1.0 Dia	862-600	W-021 45° W-022 60° W-023 70° W-025 90°			1.0 Dia	864-600	W-021 45° W-022 60° W-033 70° W-025 90°	
2.25 AWS Series	.63 x .63	892-603	W-104 45° W-105 60° W-106 70°		Note: Standard wedge angles are specified for carbon steel.				
	.63 x .75	892-601	W-104 45° W-105 60° W-106 70°						
	.75 x .75	892-604	W-104 45° W-105 60° W-106 70°						



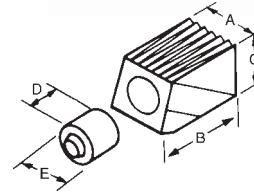
# Angle Beam Transducers

Angle Beam Transducers are single or dual element transducers designed for weld inspection or flaw detection where flaws have an angular orientation with respect to the material surface. Weld inspections are performed using shear waves refracted from a longitudinal wave by means of a lucite wedge. Lucite wedges are designed to produce shear waves of a particular angle in a specified material with minimal wedge noise.



## MSW-QC Style Angle Beam, Gamma Series

MSW-QC Style are miniature angle beam transducers that screw directly into our "Quick Change" Lucite wedges. All MSW-QC transducers have top-mount Microdot connectors. Gamma series utilize conventional monolithic ceramic elements and are recommended for regular inspection of non-attenuative materials. 10.0 MHz MSW-QC transducers are available only in Gamma series.



Replaceable Wedge .25"						Replaceable Wedge .375"					Replaceable Wedge .50"						
Wedge Angle	A	B	C	D	E	Wedge Angle	A	B	C	D	E	Wedge Angle	A	B	C	D	E
45°	.45	.75	.37	.41	.47	45°	.55	.89	.47	.56	.50	45°	.70	1.05	.55	.70	.62
60°	.45	.84	.44	.41	.47	60°	.55	1.04	.55	.56	.50	60°	.70	1.24	.64	.70	.62
70°	.45	1.00	.50	.41	.47	70°	.55	1.19	.58	.56	.50	70°	.70	1.41	.68	.70	.62
90°	.45	.95	.50	.41	.47	90°	.55	1.15	.61	.56	.50	90°	.70	1.39	.73	.70	.62

## Miniature Angle Beam Transducers— MSW-QC Style

Freq. (MHz)	Size (in.)	PRODUCT CODES			Freq. (MHz)	Size (in.)	PRODUCT CODES		
		Gamma Series	Standard Wedge	Accessories			Gamma Series	Standard Wedge	Accessories
1.0	.500	241-590	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°	<b>Cables</b> 6' BNC C-012 6' LEMO C-022  <b>Wedge Couplant</b> XD-740	3.5 cont.	.500	243-590	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°	
	1.5	.375	231-590			W-220 30° W-221 45° W-222 60° W-223 70° W-224 90°	5.0	.250	224-590
.500		241-595	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°		.375	234-590		W-220 30° W-221 45° W-222 60° W-223 70° W-224 90°	
2.25	.250	222-590	W-200 30° W-201 45° W-202 60° W-203 70° W-204 90°		.500	244-590	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°	<b>Cables</b> 6' BNC C-012 6' LEMO C-022  <b>Wedge Couplant</b> XD-740	
	.375	232-590	W-220 30° W-221 45° W-222 60° W-223 70° W-224 90°		10	.250	226-590		W-200 30° W-201 45° W-202 60° W-203 70° W-204 90°
	.500	242-590	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°			.375	236-590		W-220 30° W-221 45° W-222 60° W-223 70° W-224 90°
	3.5	.250	223-590		W-200 30° W-201 45° W-202 60° W-203 70° W-204 90°	.500	246-590		W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°
.375		233-590	W-220 30° W-221 45° W-222 60° W-223 70° W-224 90°						

Note: Standard wedge angles are specified for carbon steel.



# Angle Beam Transducers

Angle Beam Transducers are single or dual element transducers designed for weld inspection or flaw detection where flaws have an angular orientation with respect to the material surface. Weld inspections are performed using shear waves refracted from a longitudinal wave by means of a lucite wedge. Lucite wedges are designed to produce shear waves of a particular angle in a specified material with minimal wedge noise.



## MSW-QC Style Angle Beam, Benchmark and Alpha Series

Benchmark and Alpha series MSW-QC Miniature Angle Beam Transducers are available in the same range of sizes and fit the same standard "Quick Change" wedges as the Gamma series. Their one-piece stainless steel case insures long service life. All MSW-QC probes are color coded by frequency and have top mounted Microdot connectors.

Benchmark series probes feature proprietary BENCHMARK COMPOSITE® active elements. They offer a superior combination of sensitivity, resolution, and penetration for punching through highly attenuative materials. They are especially beneficial when signal to noise ratio is a problem, for example coarse grain materials and fiber reinforced composites. Alpha series MSW-QC probes are made with highly damped monolithic ceramic elements and are recommended when very short pulse lengths are required for axial resolution.

**Miniature Angle Beam Transducers— MSW-QC Style**

Freq. (MHz)	Size (in.)	PRODUCT CODES				Freq. (MHz)	Size (in.)	PRODUCT CODES			
		Benchmark Series	Alpha Series	Standard Wedge	Accessories			Benchmark Series	Alpha Series	Standard Wedge	Accessories
1.0	.500	241-591	141-591	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°	<b>Cables</b> 6' BNC C-012 6' LEMO C-022  <b>Wedge Couplant</b> XD-740	3.5 cont.	.500	243-591	143-591	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°	<b>Cables</b> 6' BNC C-012 6' LEMO C-022  <b>Wedge Couplant</b> XD-740
	1.5	.375	231-596	131-596			W-220 30° W-221 45° W-222 60° W-223 70° W-224 90°	5.0	.250	224-591	
.500		241-596	141-596	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°		.375	234-591		134-591	W-220 30° W-221 45° W-222 60° W-223 70° W-224 90°	
2.25	.250	222-591	122-591	W-200 30° W-201 45° W-202 60° W-203 70° W-204 90°		7.5	.500	244-591	144-591	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°	
	.375	232-591	132-591	W-220 30° W-221 45° W-222 60° W-223 70° W-224 90°			.250	225-591	125-591	W-200 30° W-201 45° W-202 60° W-203 70° W-204 90°	
	.500	242-591	142-591	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°			.375	235-591	135-591	W-220 30° W-221 45° W-222 60° W-223 70° W-224 90°	
3.5	.250	223-591	123-591	W-200 30° W-201 45° W-202 60° W-203 70° W-204 90°		Note: Standard wedge angles are specified for carbon steel.	.500	245-591	145-591	W-210 30° W-211 45° W-212 60° W-213 70° W-214 90°	
	.375	233-591	133-591	W-220 30° W-221 45° W-222 60° W-223 70° W-224 90°							

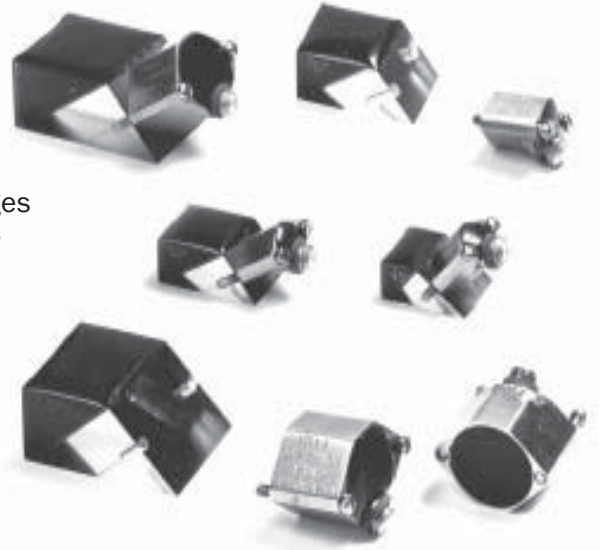


# Angle Beam Transducers

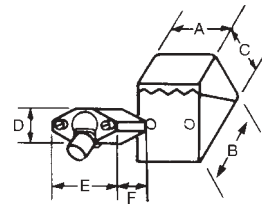
Angle Beam Transducers are single or dual element transducers designed for weld inspection or flaw detection where flaws have an angular orientation with respect to the material surface. Weld inspections are performed using shear waves refracted from a longitudinal wave by means of a lucite wedge. Lucite wedges are designed to produce shear waves of a particular angle in a specified material with minimal wedge noise.

## MSWS Style Angle Beam

MSWS Angle Beam Transducers are designed to fit removable lucite wedges. Refracted shear wave angles may be specified as required. All MSWS transducers have captive screws for fastening the probe to the wedge and are fitted with Microdot connectors. High temperature wedges are for use at temperatures up to 400°F.



Replaceable Wedge .25"						Replaceable Wedge .50"							
Angle	A	B	C	D	E	F	Angle	A	B	C	D	E	F
45°	.47	.60	.30	.31	.48	.34	45°	.73	.96	.42	.56	.73	.50
60°	.47	.65	.35	.31	.48	.34	60°	.73	1.08	.50	.56	.73	.50
70°	.47	.70	.38	.31	.48	.34	70°	.73	1.16	.54	.56	.73	.50
90°	.47	.90	.38	.31	.48	.34	90°	.73	1.56	.58	.56	.73	.50



## Miniature Angle Beam Transducers— MSWS Style

Freq. (MHz)	Size (in.)	PRODUCT CODES				Freq. (MHz)	Size (in.)	PRODUCT CODES			
		Gamma Series	Standard wedge	Hi-Temp Wedge*	Accessories			Gamma Series	Standard Wedge	H-Temp Wedge*	Accessories
1.0	.500	241-580	W-040 45° W-042 60° W-044 70° W-046 80° W-048 90°	W-058 45° W-059 60° W-060 70°		5.0	.250	224-580	W-028 45° W-030 60° W-032 70° W-034 80° W-036 90°	W-055 45° W-056 60° W-057 70°	
	.250		222-580	W-028 45° W-030 60° W-032 70° W-034 80° W-036 90°			W-055 45° W-056 60° W-057 70°				
2.25	.500	242-580	W-040 45° W-042 60° W-044 70° W-046 80° W-048 90°	W-058 45° W-059 60° W-060 70°	Cables 6' BNC C-012  6' LEMO C-022  Wedge Couplant XD-740	10.0	.250	226-580	W-028 45° W-030 60° W-032 70° W-034 80° W-036 90°	W-055 45° W-056 60° W-057 70°	Cables 6' BNC C-012  6' LEMO C-022  Wedge Couplant XD-740
	.250		223-580	W-028 45° W-030 60° W-032 70° W-034 80° W-036 90°			W-055 45° W-056 60° W-057 70°				
3.5	.500	243-580	W-040 45° W-042 60° W-044 70° W-046 80° W-048 90°	W-058 45° W-059 60° W-060 70°			.500	246-580	W-040 45° W-042 60° W-044 70° W-046 80° W-048 90°	W-058 45° W-059 60° W-060 70°	
	.250		223-580	W-028 45° W-030 60° W-032 70° W-034 80° W-036 90°			W-055 45° W-056 60° W-057 70°				



# Angle Beam Transducers

Angle Beam Transducers are single or dual element transducers designed for weld inspection or flaw detection where flaws have an angular orientation with respect to the material surface. Weld inspections are performed using shear waves refracted from a longitudinal wave by means of a lucite wedge. Lucite wedges are designed to produce shear waves of a particular angle in a specified material with minimal wedge noise.

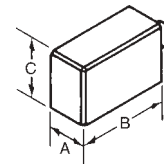


## ABFP Style Angle Beam

ABFP Style, fingertip, fixed angle, shear wave transducers are available in standard angles for inspecting steel and aluminum. Custom angles for other materials may be special ordered. Their small size makes them ideal for weld inspection in restricted access areas. All ABFP Transducers are equipped with right angle Microdot connectors. Top mounted connectors may be special ordered.

### Fingertip Potted Angle Beam Transducers— ABFP Style

Freq. (MHz)	Size (in.)	PRODUCT CODES				Accessories
		45°	60°	70°	90°	
2.25	.187 x .187	292-640	292-641	292-642	292-643	Cables 6' BNC C-012 6' LEMO C-022
	.250 x .250	292-620	292-621	292-622	292-623	
5.0	.187 x .187	294-640	294-641	294-642	294-643	
	.250 x .250	294-620	294-621	294-622	294-623	
10	.187 x .187	296-640	296-641	296-642	296-643	
	.250 x .250	296-620	296-621	296-622	296-623	

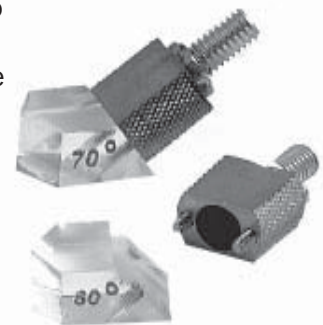


Element Dimensions	A	B	C
.187 x .187	.32	.70	.57
.25 x .25	.50	1.0	.55

Note: Part numbers above are for carbon steel. For aluminum, specify frequency, size, and refracted angle in aluminum.

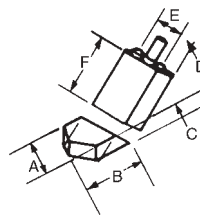
## SMSWS Style Angle Beam

SMSWS Angle Beam Transducers are subminiature transducers designed to fit removable lucite wedges. Refracted shear wave angles may be specified as required. All SMSWS transducers have standard screws for fastening the probe to the wedge and have top-mount miniature Microdot connectors.



### Subminiature Angle Beam— SMSWS Style

Freq. (MHz)	Size (in.)	PRODUCT CODES			Accessories
		Gamma Series	Standard Wedge		
2.25	.125	212-585	W-120 45°	Cable 6' BNC C-047	
			W-121 60°		
			W-122 70°		
			W-123 90°		
5.0	.125	214-585	W-120 45°	Wedge Couplant XD-740	
			W-121 60°		
			W-122 70°		
			W-123 90°		
10.0	.125	216-585	W-120 45°		
			W-121 60°		
			W-122 70°		
			W-123 90°		



Wedge Dimensions						
Angle	A	B	C	D	E	F
45°	.31	.25	.21	.19	.23	.28
60°	.31	.42	.21	.19	.23	.28
70°	.31	.42	.21	.19	.23	.28
90°	.31	.72	.34	.19	.23	.28

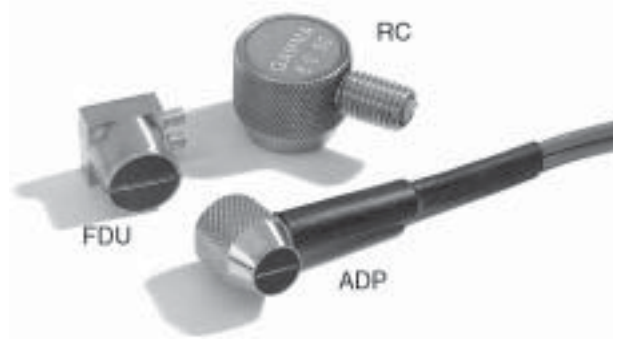
Note: Standard wedge angles are specified for carbon steel.





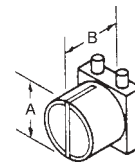
# Dual Element Transducers

Dual Element Contact Transducers are longitudinal wave transducers with a split element; one half functions as a transmitter while the other functions as a receiver. Each half-element is angled slightly toward the other forming the “roof” angle. This “roof” angle effectively focuses the sound beam. These transducers are excellent for thin range flaw detection and thickness gauging. Because they have a discrete transmitter and receiver, better signal to noise ratios are achieved compared to single element transducers.



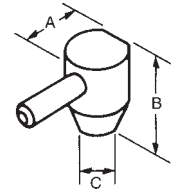
## ADP, RC, and FDU Style Dual Element

Dual Element Transducers are for general flaw detection and thickness gauging on materials with irregular or pitted surfaces. The ADP and RC models are color coded for quick frequency identification. The low profile ADP model has a potted BNC cable. The RC Dual models have a 4-pin LEMO connector which allows for quick and easy cable replacement. All FDU models have mini Microdot threaded connectors. All models may be contoured to fit ID and OD curvatures.



**FDU**

Element Diameter	A	B
.250	.38	.50
.375	.50	.50



**ADP/RC**

Element Diameter	A	B	C
.250	.50	.64	.36
.375	.63	.64	.47
.500	.75	.68	.60

## Fingertip Dual Element Transducers— ADP/RC/FDU Styles

Freq (MHz)	Size (in.)	PRODUCT CODES			Freq (MHz)	Size (in.)	PRODUCT CODES		
		ADP Dual	RC Dual*	FDU Dual†			ADP Dual	RC Dual*	FDU Dual†
2.25	.250	222-700	222-681	222-680	5.0	.250	224-700	224-681	224-680
	.375	232-700	232-681	232-680		.375	234-700	234-681	234-680
	.500	242-700	242-681			.500	244-700	244-681	
3.5	.250	223-700	223-681	223-680	7.5	.375	135-700		
	.375	233-700	233-681	233-680					
	.500	243-700	243-681						

\* Standard BNC Cable (C-088) or Heavy Duty BNC Cable (C-089) sold separately  
 † Standard BNC Cable (C-014) sold separately

## HT400A and KBA560V Style High Temperature Dual Element Transducers

HT400A and KBA560V models are available with replaceable BNC cables and can be used for both flaw detection and thickness gauging applications. Model HT400A can be used intermittently on materials up to 1000° F. Model KBA560V can be used intermittently on materials up to 750° F.



## High Temperature Transducers\*

Freq. (MHz)	Size (in.)	PRODUCT CODES		
		Model	Gamma Series	Accessories
5.0	.250	HT400A	224-760	<b>Cables</b> 6' BNC Standard: C-102 Armored: C-101
	.375	KBA560V	544-230	<b>Cable</b> 6' BNC C-067

\*Duty Cycle: KBA560V— 750°F, maximum contact time is 10 seconds; HT400A— 1000°F, maximum contact time is 5 seconds; cool to ambient before reuse.



# Dual Element Transducers

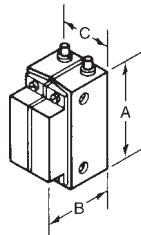
Dual Element Contact Transducers are longitudinal wave transducers with a split element; one half functions as a transmitter while the other functions as a receiver. Each half-element is angled slightly toward the other forming the “roof” angle. This “roof” angle effectively focuses the sound beam. These transducers are excellent for thin range flaw detection and thickness gauging. Because they have a discrete transmitter and receiver, better signal to noise ratios are achieved compared to single element transducers.



## DU Style Dual Element

DU Dual Element Transducers with replaceable delays are excellent general-purpose probes for applications with flat or curved surfaces. High Temperature delays are also available for inspections at temperatures up to 400 °F. All DU transducers have standard Microdot connectors for easy replacement.

Element Size	A	B	C
.500 x .500	.75	.85	.78
.500 x 1.00	1.38	.92	.78



## Standard Dual Element Transducers— DU Style

Freq. (MHz)	Size (in.)	PRODUCT CODES			
		Gamma Series	Delay Set	HT Delay Set*	Accessories
1.0	.5 x .5	291-750	DS-620	DS-720	Cable 6' BNC C-024  Couplant XD-740
	.5 x 1	291-740	DS-640	DS-740	
2.25	.5 x .5	292-750	DS-620	DS-720	
	.5 x 1	292-740	DS-640	DS-740	
5.0	.5 x .5	294-750	DS-620	DS-720	
	.5 x 1	294-740	DS-660	DS-760	

\* Duty Cycle: at 400 °F, maximum contact time is 10 seconds; cool to ambient before reuse.

## DU-F Style Dual Element, Benchmark Series

Benchmark series DU-F Style Dual Element Transducers feature proprietary BENCHMARK COMPOSITE® active elements. Benchmark series offer a superior combination of sensitivity, resolution, and penetration for punching through highly attenuative materials. They are especially beneficial when signal to noise ratio is a problem, for example coarse grain materials and fiber reinforced composites. Close tolerance, integral delays assure consistent performance.

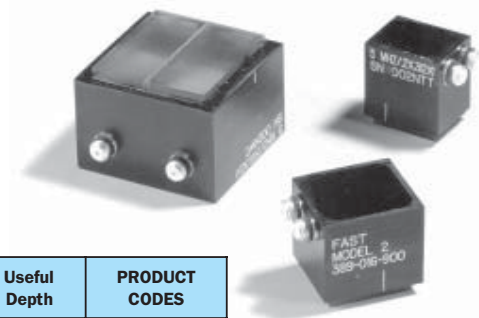


## DU-F Style— Benchmark

Freq. (MHz)	Size (in.)	PRODUCT CODES	
		Benchmark Series	Accessories
2.25	.5 x .5	292-751	Cable 6' BNC C-024
	.5 x 1	292-741	
5.0	.5 x .5	294-751	
	.5 x 1	294-741	

## FAST™ Probes for Rapid Manual Weld Inspection

Benchmark series FAST™ Probes are dual, high angle, longitudinal wave probes with proprietary BENCHMARK COMPOSITE® elements. They are primarily for inspection using the FAST™ method developed by SPIN (LLC). FAST™ high speed, manual weld scanning can reduce inspection costs for fabrication shops, field welding organizations, or any industry that performs in-service NDE of components. For a detailed Product Bulletin, contact our sales department.



## FAST™ Probes

Model	Freq. (MHz)	Useful Depth	PRODUCT CODES
FAST1	5.0	0" to 0.6"	389-016-880
FAST2	5.0	0" to 1.5"	389-016-900
FAST3	5.0	0.5" to 4"	389-016-780



# Immersion Transducers

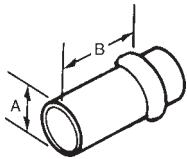
Single Element Immersion Transducers are longitudinal wave transducers typically used in manual, semi-automatic, and automatic scanning systems. Scanning parts with irregular or complex geometries is possible because of the conforming “water path” layer between the probe and the inspected material. Superior near-surface resolution can be achieved when compared to contact transducers. Angle beam inspection is possible by simply angling the probe or search tube in relation to the part surface. Spherical (point) or cylindrical (line) focusing can also be accomplished using acoustically matched lenses. Focal length must be specified.



## ISS and IS Style Immersion

ISS and IS Immersion Transducers are for general ultrasonic immersion inspections requiring element diameters between .25” and 1.0”. Available in Alpha, Gamma, and BENCHMARK COMPOSITE® series, they can be focused for critical applications to improve near-surface resolution or sensitivity to small discontinuities. All ISS and IS Transducers have waterproof UHF connectors. Waterproof BNC connectors may be special ordered. Gamma Series are recommended for applications where high sensitivity and penetration are required. Alpha Series (where available) are designed for optimum damping and resolution. New Benchmark Series (where available), with BENCHMARK COMPOSITE® elements, offer a superior combination of sensitivity, resolution, and penetration for punching through highly attenuative materials.

Gamma Series are recommended for applications where high sensitivity and penetration are required. Alpha Series (where available) are designed for optimum damping and resolution. New Benchmark Series (where available), with BENCHMARK COMPOSITE® elements, offer a superior combination of sensitivity, resolution, and penetration for punching through highly attenuative materials.



Element Diameter	A	B
.250	.63	1.55
.375	.63	1.55
.500	.63	1.55
.750	1.0	1.77
1.00	1.25	1.82

## Immersion Transducers— ISS and IS Styles

Freq. (MHz)	Size (in.)	PRODUCT CODES				Freq. (MHz)	Size (in.)	PRODUCT CODES					
		*Focus	Alpha Series	Gamma Series	Benchmark Series			*Focus	Alpha Series	Gamma Series	Benchmark Series		
1.0	.250	S		221-280		5.0	.250	S	124-280	224-280			
		C		221-290				C	124-290	224-290			
		N		221-300				N	124-300	224-300	824-300		
		S		231-280				S	134-280	234-280	834-280		
		C		231-290				C	134-290	234-290	834-290		
2.25	.375	S		241-280		10	.375	S	134-280	234-280	834-300		
		C		241-290				C	134-290	234-290	834-290		
		N		241-300				N	134-300	234-300	834-300		
		S		251-360				S	154-360	254-360	854-360		
		C		251-370				C	154-370	254-370	854-370		
3.5	.500	S		261-360	861-360	15	.500	S	164-360	264-360	864-360		
		C		261-370	861-370			C	164-370	264-370	864-370		
		N		261-380	861-380			N	164-380	264-380	864-380		
		S		242-280	842-280			S	146-280	246-280			
		C		242-290	842-290			C	146-290	246-290			
5.0	.750	S		242-300	842-300	25	.750	S	156-360	256-360			
		C		252-360	852-360			C	156-370	256-370			
		N		252-380	852-380			N	156-380	256-380			
		S		262-360	862-360			S	127-280				
		C		262-370	862-370			C	127-290				
7.5	1.00	S		262-380	862-380	25	1.00	N	127-300				
		S		222-280				15	.250	1.5"S	127-302 (TTC-100)		
		C		222-290						S	137-280		
		N		222-300	822-300					C	137-290		
		S		232-280	832-280					N	137-300		
C		232-290	832-290	S	147-280								
10	.250	S		242-300	842-300	25	.375	C	147-290				
		C		242-300	842-300			N	147-300				
		S		252-360	852-360			S	147-280				
		C		252-370	852-370			C	147-290				
		N		252-380	852-380			N	147-300				
15	.375	S		262-360	862-360	25	.500	S	129-280				
		C		262-370	862-370			C	129-290				
		N		262-380	862-380			N	129-300				
		S		223-280	823-280			25	.750	S	163-360	263-360	
		C		223-290	823-290					C	163-370	263-370	
N		223-300	823-300	N	163-380	263-380							
S		233-280	833-280	25	1.00	S	163-360			263-360			
C		233-290	833-290			C	163-370			263-370			
N		233-300	833-300			N	163-380	263-380					
S		243-280	843-280			25	1.00	S	153-360	253-360			
C		243-290	843-290					C	153-370	253-370			
N		243-300	843-300	N	153-380			253-380					
S		253-360	853-360	25	1.00			S	163-360	263-360			
C		253-370	853-370					C	163-370	263-370			
N		253-380	853-380			N	163-380	263-380					
S		263-360	863-360			25	1.00	S	163-360	263-360			
C		263-370	863-370					C	163-370	263-370			
N		263-380	863-380	N	163-380			263-380					

Note: Waterproof cables are available in Accessories Section.

\* Focus: S = Spherical; C = Cylindrical, N = Non-focus. Focal length must be specified. For available focal lengths, see table at the end of the Immersion Transducers section.



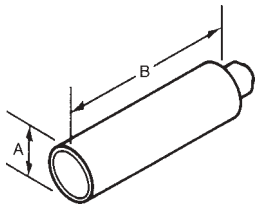
# Immersion Transducers

Single Element Immersion Transducers are longitudinal wave transducers typically used in manual, semi-automatic, and automatic scanning systems. Scanning parts with irregular or complex geometries is possible because of the conforming “water path” layer between the probe and the inspected material. Superior near-surface resolution can be achieved when compared to contact transducers. Angle beam inspection is possible by simply angling the probe or search tube in relation to the part surface. Spherical (point) or cylindrical (line) focusing can also be accomplished using acoustically matched lenses. Focal length must be specified.



## IPS Style Immersion

IPS Immersion Transducers with small diameter cases are designed for immersion applications where transducer size limitations exist. The Alpha series are designed for maximum bandwidth and resolution capabilities. The Gamma series are for increased sensitivity and penetration. All IPS Transducers have Microdot connectors. For best results the connector should be sealed with a non-water soluble grease.



Element Diameter	A	B
.125	.38	1.45
.250	.38	1.45

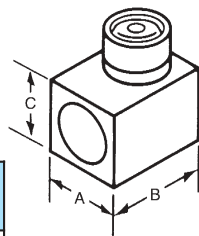
## Immersion Transducers— IPS Style

Freq. (MHz)	Size (in.)	PRODUCT CODES				Freq. (MHz)	Size (in.)	PRODUCT CODES			
		*Focus	Alpha Series	Gamma Series	Accessories			*Focus	Alpha Series	Gamma Series	Accessories
1.0	.250	S		221-320	Cable 6' BNC C-012	10	.250	S	126-320	226-320	Cable 6' BNC C-012
		C		221-330				C	126-330	226-330	
		N		221-340				N	126-340	226-340	
2.25	.250	S	122-320	222-320		15	.125	S	117-320		
		C	122-330	222-330				C	117-330		
		N	122-340	222-340				N	117-340		
3.5	.250	S	123-320	223-320	22	.125	S	127-320			
		C	123-330	223-330			C	127-330			
		N	123-340	223-340			N	127-340			
5.0	.250	S	124-320	224-320	25	.250	S	118-320			
		C	124-330	224-330			C	118-330			
		N	124-340	224-340			N	118-340			

\* Focus: S = Spherical; C = Cylindrical; N = Non-focus. Focal length must be specified. For available focal lengths, see table at the end of the Immersion Transducers section.

## IR Style Immersion

IR Immersion Transducers are used where .25" to .5" diameter probes are desired, but where space constraints exist that prohibit the use of standard ISS Style transducers. IR Style transducers have a right angle mounted UHF connector and will fit into a 1.5 cubic inch area. The IR is available in both the Alpha and Gamma series and can be focused for critical applications to improve near-surface resolution or sensitivity to small discontinuities.



Element Diameter	A	B	C
.250, .375, .500	.75	.94	.75

## Immersion Transducers— IR Style

Freq. (MHz)	Size (in.)	PRODUCT CODES			Freq. (MHz)	Size (in.)	PRODUCT CODES		
		*Focus	Alpha Series	Gamma Series			*Focus	Alpha Series	Gamma Series
1.0	.250	N		221-420	3.5	.250	N	123-420	223-420
		C		221-410			C	123-410	223-410
		S		221-400			S	123-400	223-400
	.375	N		231-420		.375	N	133-420	233-420
		C		231-410			C	133-410	233-410
		S		231-400			S	133-400	233-400
.500	N		241-420	.500	N	143-420	243-420		
	C		241-410		C	143-410	243-410		
	S		241-400		S	143-400	243-400		
2.25	.250	N	122-420	222-420	5.0	.250	N	124-420	224-420
		C	122-410	222-410			C	124-410	224-410
		S	122-400	222-400			S	124-400	224-400
	.375	N	132-420	232-420		.375	N	134-420	234-420
		C	132-410	232-410			C	134-410	234-410
		S	132-400	232-400			S	134-400	234-400
.500	N	142-420	242-420	.500	N	144-420	244-420		
	C	142-410	242-410		C	144-410	244-410		
	S	142-400	242-400		S	144-400	244-400		

\* Focus: S = Spherical; C = Cylindrical; N = Non-focus. Focal length must be specified. For available focal lengths, see table at the end of the Immersion Transducers section. Note: Waterproof cables are available in Accessories Section.



# Immersion Transducers

Single Element Immersion Transducers are longitudinal wave transducers typically used in manual, semi-automatic, and automatic scanning systems. Scanning parts with irregular or complex geometries is possible because of the conforming “water path” layer between the probe and the inspected material. Superior near-surface resolution can be achieved when compared to contact transducers. Angle beam inspection is possible by simply angling the probe or search tube in relation to the part surface. Spherical or cylindrical focusing can also be accomplished using acoustically matched lenses. Focal length must be specified.



## Velocity System Immersion Transducers

These transducers are specifically designed for use with through transmission Krautkramer Velocity Systems. These transducers are available in either the ISS Style or IR Style housing and are provided with standard waterproof UHF connectors.

### Velocity System Immersion Transducers ISS/IR Styles

Freq. (MHz)	PRODUCT CODES	
	Style ISS	Style IR
5.0	144-301	144-421

## Immersion Transducer Focal Lengths

$$N = \frac{(Dia.)^2 \times (Freq.)}{4 \times Velocity}$$

*N* = Near field practical focal length.  
*Min* = Minimum practical focal length.  
*Max* = Maximum practical focal length.

The following table lists the near field lengths and minimum and maximum practical focal lengths in water expressed in inches. To find the approximate near field length in steel, divide all *N* values by 4.

Frequency (MHz)		Element Diameter (Inches)					
		1.0	.75	.50	.375	.25	.125
1.0	N	4.3	2.4	1.1			
	Min	2.0	1.5	1.0			
	Max	3.0	2.0	1.0			
2.25	N	9.6	5.4	2.4	1.4	.6	
	Min	2.0	1.5	1.0	.8	.5	
	Max	6.0	4.0	2.0	.8	.5	
3.5	N	15.0	8.4	3.7	2.1	.9	
	Min	2.0	1.5	1.0	.8	.5	
	Max	8.0	6.0	2.5	.5	.5	
5.0	N	21.0	12.0	5.4	3.0	1.3	.3
	Min	2.0	1.5	1.0	.8	.5	.3
	Max	8.0	8.0	4.0	2.0	.8	.3
10.0	N		24.0	10.7	6.0	2.7	.7
	Min		1.5	1.0	.8	.5	.3
	Max		8.0	6.0	4.5	1.5	.3
15.0	N			16.0	9.0	4.0	1.0
	Min			1.0	.8	.5	.3
	Max			6.0	6.0	2.0	.5
25.0	N					6.7	1.7
	Min					.5	.3
	Max					2.0	1.0



# Single Element Transducers

## For Use With Precision Thickness Gauges

Precision thickness gauging transducers are single element, delay line and contact transducers designed primarily for use with Krautkramer precision thickness gauges. They may also be used with most standard flaw detection instruments. A wide variety is available to satisfy virtually any inspection requirement on most metals and nonmetals with relatively smooth, parallel front and back surfaces. Depending on probe selection and material conditions, most precision gauges can measure from 0.005 to 15.00 inches in steel and plastic.



CL3 and CL3 DL Compatible Transducer Specifications					
Model	Transducer Type	Contact Diameter	Nominal Frequency	Measuring Range (steel unless noted)	Product Code
Alpha 2DFR	Delay, Standard Housing	0.30 in. 7.6 mm	15 MHz	0.010 to 1.0 in. 0.25 to 25 mm	113-527-660
Alpha 2A, Mini DFR	Delay, Small Housing	0.19 in. 4.8 mm	20 MHz	0.010 to 0.200 in. 0.25 to 5 mm	113-518-655
CA211A	Contact, Standard	0.75 in. 19.1 mm	5 MHz	0.080 to 15.0 in. 2 to 381 mm	113-544-000
CA215	Contact, Standard	0.50 in. 12.7 mm	5 MHz	0.080 to 2.0 in. 2 to 51 mm	113-124-011
Alpha 2F	Contact, Fingetip	0.38 in. 9.7 mm	10 MHz	0.80 to 10.0 in. 2 to 254 mm	113-526-000
Alpha DFR-P	Plastics, Delay Line	0.30 in. 7.6 mm	22 MHz	0.005 to 0.150 in. 0.13 to 3.8 mm <i>Plastics only</i>	113-118-661

For instrument and transducer connection use a 022-505-604 cable (Microdot to right angle Lemo connector), or a 022-504-925 (Microdot to straight Lemo connector)

CL 300 and CL 304 Compatible Transducer Specifications					
Model	Transducer Type	Contact Diameter	Nominal Frequency	Measuring Range (steel unless noted)	Product Code
Alpha 2DFR	Delay, Standard Housing	0.30 in. 7.6 mm	15 MHz	0.007 to 1.0 in. 0.25 to 25 mm	113-527-660
Alpha 2A, Mini DFR	Delay, Small Housing	0.19 in. 4.8 mm	20 MHz	0.005 to 0.200 in. .13 to 5 mm	113-518-655
CA211A	Contact, Standard	0.75 in. 19.1 mm	5 MHz	0.060 to 15.0 in. 1.5 to 381 mm	113-544-000
Alpha 2F	Contact, Fingetip	0.38 in. 9.7 mm	10 MHz	0.060 to 10.0 in. 1.5 to 254 mm	113-526-000
KBA125	Plastics, Contact	0.18 in. 4.6 mm	20 MHz	0.010 in. minimum 0.25 mm minimum <i>Plastics only</i>	113-518-006
K-Pen CL304 <i>Only</i>	Pencil Style Transducer	.065 or .090 in. 1.7 or 2.3 mm	20 MHz	Dependent on application and required CL304 special menus setting	389-030-290

For instrument or transducer connection use a 118-140-012 cable (Microdot to BNC)



# Dual Element D-Meter Probes

## Compatible with the D-Meter line of ultrasonic thickness gauges.

Standard probes are readily available to satisfy a wide range of remaining wall thickness applications including: high-temperature, through-coating, erosion/corrosion, thin materials, areas of limited access, tough-to-penetrate materials (coarse-grained/nonmetals), external pitting, wear-resistance, boiler tubing, small diameter piping and tubing, and general-purpose applications.

DIALOG Intelligent Probes are automatically recognized by the DM4 Family of instruments for quick setup, best performance, and test documentation. The model FH2E-D-REM contains a built-in membrane switch with no additional cable lines to send and store readings in the DM4 DL's on-board data logger at a press of the index finger of the probe hand.



Label	Model	Designation	Probe Cable	Contact Diameter	Measuring Range in Steel	Temp Range	Product Code
A.	FH2E	Fingertip	Potted	.380"	.030"-2.0"	< 130°F	113-552-005
B.	FH2E-D**	Fingertip	Potted	.380"	.030" -2.0"	< 130°F	113-552-007
C.	FH2E-D-REM**	Remote Send	Potted	.380"	.030" -2.0"	< 130°F	113-552-009
D.	KB550FH*	Fingertip	Potted	.375"	.060" -2.0"	< 130°F	113-550-001
E.	DA312	Thin Materials	KBA532	.300"	.025" -1.0"	< 130°F	083-056-906
F.	KBA525	5mm Footprint	Potted	.200"	.025" -1.0"	< 130°F	113-516-002
G.	DA312B16*	3mm Footprint	Potted	.120"	.025" -.50"	< 130°F	083-066-934
H.	KBA560	General Purpose	KBA531	.625"	.060" -8.0"	< 450°F	113-544-210
I.	KBA560-D**	General Purpose	KBA531	.625"	.060" -8.0"	< 250°F	083-056-904
J.	DA301	General Purpose	KBA533	.475"	.050" -8.0"	< 140°F	083-056-905
K.	DA303	Penetration	KBA533	.635"	.200" min.	< 140°F	113-561-104
L.	DP-104	High Penetration	KBA532	1.25"	.200" min.	< 130°F	113-552-006
M.	FH2E-WR	Wear Resistant	Potted	.550"	.030" -2.0"	< 130°F	113-544-212
N.	KBA560-WR	Wear Resistant	KBA531	.700"	.060" -8.0"	< 450°F	113-552-005
O.	FH2E-D-WR**	Wear Resistant	Potted	.550"	.030" -2.0"	< 130°F	113-552-008
P.	HT400 HT400A	High Temperature	KBA535 KBA536	.500"	.040" -10.0"	< 1000°F	113-524-760 113-224-760
Q.	KB550BTH*	Studded Boiler Tube	C-BTH	.375"	.060" -2.0"	< 130°F	113-550-003



# Applications and Special Probes Lab

The Krautkramer Applications Lab has a long history of providing a broad spectrum of services to our customers. Experienced Application Engineers and Specialists will work closely with the customer to provide technical assistance and custom designed products to solve challenging ultrasonic testing applications.

## Applications Support Group

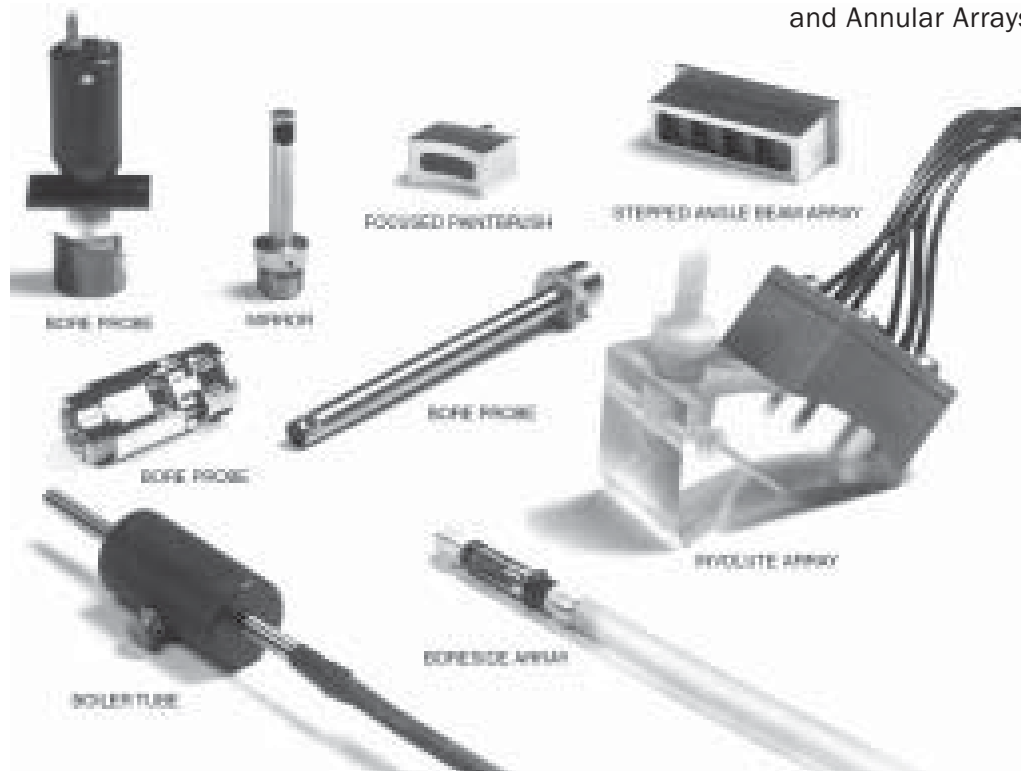
This group specializes in the evaluation of customer supplied samples to provide practical recommendations and solutions for ultrasonic testing problems. Typical applications include thickness and velocity measurements, flaw detection and evaluation and material characterization. This group also provides applications support for small, integrated ultrasonic testing systems. The Applications Lab is fully equipped with a large selection of ultrasonic instrumentation to aid in providing total testing solutions.

## Special Probes Group

The Special Probes Group designs and manufactures custom transducers for specific ultrasonic testing applications. This may include the modification of transducer case design, element size and shape or the connector type and location. The customer may require transducers with custom electrical and acoustic performance including non-standard frequencies, resolution, sensitivity, bandwidth or focusing. Special test fixtures, custom wedges, delay lines and cables are also designed and built to meet customer specifications.

## Examples of Special Probe Types

- I.D. and O.D. Bore Probes
- Special Paintbrush Probes
- Coarse Grain Inspection Probes
- Special Focused Probes
- High Temperature Probes
- Multiple Transducer Probes
- Advanced Flaw Sizing Probes
- Radiation Resistant Probes
- Industrial Linear, Phased, and Annular Arrays



For further assistance from the Applications Lab, please copy and complete the customer inquiry form on the next page and fax it to (717)-242-4170— make extra copies for additional inquiries. You can also phone the Applications Lab at (717)-242-0327 or visit Krautkramer on the Internet at [www.krautkramer.com](http://www.krautkramer.com)





# Phased Array Transducers

## Principles of Phased Array Transducers

By sequentially firing the individual elements of an array transducer at slightly different times, the ultrasonic wavefront can be focused or steered in a specific direction.

Additionally, electronically phasing the order and sequential firing speeds of an array allows for “sweeping” or “panning” through a selection of beam angles or across an area of inspection without manually manipulating the transducer.



**Annular Phased Array**



**Linear Phased Array**



**Curved Phased Array**

### Key Features

- Electronic focal length adjustments
- Electronic linear scanning
- Electronic beam steering / angulation

### Key Benefits

- Reduced manual manipulation
- Reduced scanning surface contact area necessary (footprint)
- Reduced need for multiple inspections with specifically angled or focused probes
- Increased inspection speed and efficiency
- Increased coverage of inspection area

### General Specifications

#### Frequency

1 MHz to 7.5 MHz (10 MHz in some cases)

#### Piezoelectric material

Proprietary BENCHMARK COMPOSITE®

#### Number of elements

16-256 elements (application dependent)

#### Pitch

0.2mm minimum

#### Bandwidth (-6dB)

60% - 80% typical

#### Crosstalk

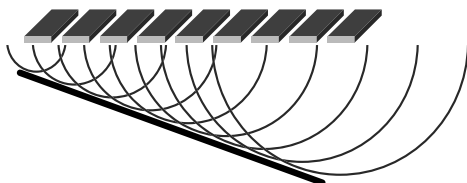
> 30dB

#### Element sensitivity variation

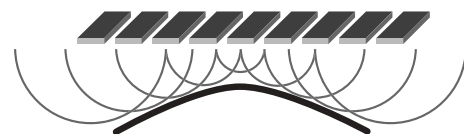
± 2dB

#### Cable options

Detachable connector or potted cable



**Phased Array Steering**



**Phased Array Focusing**



# Applications Lab – Customer Inquiry Form

\*Please complete this form and fax it to the Krautkramer Applications Lab at (717)-242-4170

Name: \_\_\_\_\_ Title: \_\_\_\_\_ Date: \_\_\_\_\_

Company Name: \_\_\_\_\_ Phone: \_\_\_\_\_

Address: \_\_\_\_\_ City: \_\_\_\_\_

State: \_\_\_\_\_ ZIP: \_\_\_\_\_ Fax: \_\_\_\_\_ E-mail: \_\_\_\_\_

**Brief Description of the Ultrasonic Application:**

Material Type: \_\_\_\_\_ Dimensions: \_\_\_\_\_ Shape: \_\_\_\_\_

Test Method: Contact  Immersion  Scan Method: Manual  Mechanical  In-Line

Current Ultrasonic Instrument: \_\_\_\_\_

Test Objective:

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Special Concerns: Restricted Access  Temperature  Radiation  Surface Condition

Flaw Type(s): \_\_\_\_\_ Size: \_\_\_\_\_ Location: \_\_\_\_\_

Please include a sketch of the test part

**I am interested in Special Transducers for this application:**

Type: Single Element  Dual Element  Array  Frequency: \_\_\_\_\_ MHz

Element Size: \_\_\_\_\_ Damping: Alpha(High)  Gamma (Low)  Connector: \_\_\_\_\_

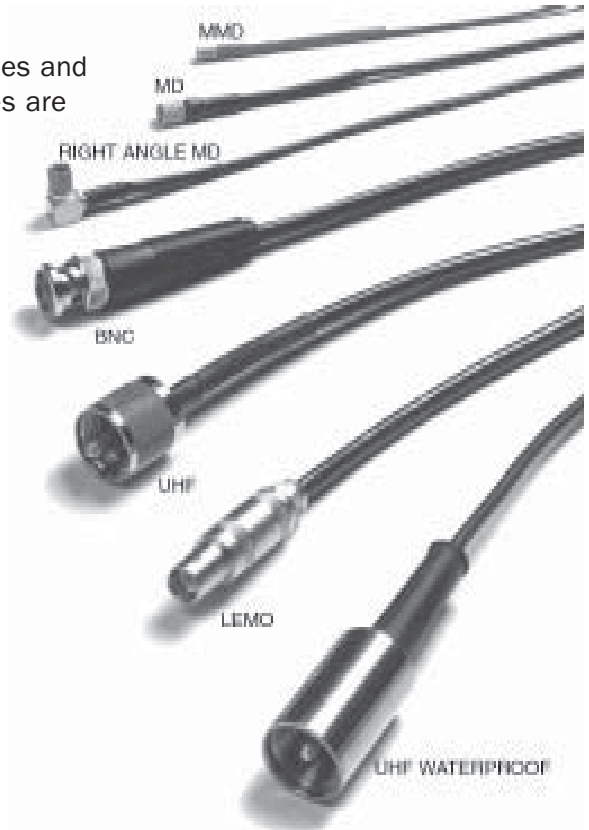
Focus: Flat  Spherical (Spot)  Cylindrical (Line)  Focal Distance: \_\_\_\_\_



# Accessories

## Cables

Krautkramer offers a complete selection of transducer cables and adaptors with the most commonly used connections. Cables are designed with reinforced connector-cable junctions for long service life. Custom transducer cables and adaptors are available upon request. Call or write for price and delivery.



Description	Length (feet)	Cable Type	PRODUCT CODES
BNC to MMD	6.0	RG178	C-047
BNC to MD	6.0	RG174	C-012
BNC to MD	12.0	RG174	C-011
UHF to MD	6.0	RG174	C-030
LEMO to MD	6.0	RG174	C-022
BNC to Right Angle MD	6.0	RG174	C-033
BNC to BNC	6.0	RG58	C-016
BNC to BNC	12.0	RG58	C-021
UHF to BNC	6.0	RG58	C-027
LEMO to BNC	6.0	RG58	C-018
UHF to UHF (non-waterproof)	6.0	RG58	C-020
UHF to UHF (non-waterproof)	12.0	RG58	C-025
LEMO to UHF (non-waterproof)	6.0	RG58	C-035
BNC to Waterproof UHF	6.0	Belden 8218	C-013
UHF to Waterproof UHF	6.0	Belden 8218	C-029
Dual BNC to MMD	6.0	MD 250-3909	C-014
Dual BNC to MD	6.0	RG174	C-024
Dual UHF to MD	6.0	RG174	C-034
RC Dual to BNC	6.0	RG174	C-088
RC Dual to BNC, Heavy Duty	6.0	RG174	C-089
XBA560V to BNC Dual	6.0	RG174	C-067
HT400A to BNC Dual, Armored	6.0	RG174	C-101
HT400A to BNC Dual, Standard	6.0	RG174	C-102

Special cables available on request.

## Adaptors

Type	Description	PRODUCT CODES
BNC-UHF	Adapts transducer or instrument with BNC connector to cable with UHF connector	A-025
UHF-BNC	Adapts transducer or instrument with UHF connector to cable with BNC connector	A-026
LEMO-BNC	Adapts instrument with LEMO #1 connector to BNC cable at instrument	A-030
STUHF-RA	Right angle adaptor for type STUHF, 3/4" diameter search tube	A-032
UHF-STIF	Adapts transducer with UHF connector to 1.375" flange type search tube	A-031
DM-BNC	Adapts LEMO plug on D-meter probe cable to dual BNC connectors	A-045
BNC-BNC	Couples BNC cable to another BNC cable	A-010



Special adaptors available on request.

## Search Tubes

The STUHF stainless steel immersion search tube has an outside diameter of .735" and is for use with all immersion transducers with UHF (threaded) connectors.

Length (in.)	PRODUCT CODES	Length (in.)	PRODUCT CODES
1.5	ST-010	12.0	ST-016
2.0	ST-011	18.0	ST-018
3.0	ST-012	24.0	ST-015
4.5	ST-013	36.0	ST-019
6.0	ST-014		

Special lengths available on request.



# Accessories

## Exosen Couplants (General Purpose)

Krautkramer Exosen ultrasonic couplant is specially formulated for ultrasonic coupling in all general applications. Exosen is available in five standard viscosities and has the following properties:

- Water soluble.
- Low sulphur and halogens.
- Non-toxic and nonflammable.
- Antiseptic— non-irritating— pleasantly scented— safe.
- High viscosity grades ideal for vertical and overhead surfaces.
- Rust preventative added.
- Shelf life of one year when stored between 50°F and 80°F and out of direct sunlight.

Please order by product code from the table.

## XL Couplant (Laboratory and Smooth Surfaces)

Krautkramer XL ultrasonic couplant is specifically made for laboratory testing of transducers and for contact testing of materials having smooth surface finish of 62 microinches RMS or better in both general production and laboratory testing.

Quantity	PRODUCT CODES
8 ounce squeeze bottle	XL-820
16 ounce squeeze bottle	XL-840
1 gallon container	XL-860
5 gallon container	XL-880

*Note:* All couplant, Exosen or XL, shipped in nonreturnable polyethylene containers. Average gross weight per 55 gallon drum is 410 pounds. Not intended for human consumption.

## SLC Couplant (Curved, Rough, Vertical, and Overhead Surfaces)

Krautkramer SLC couplant is a thick highly attenuative couplant ideal for making thickness measurements on very rough surfaces that would not be possible with thinner couplants. Its high viscosity also makes it an excellent couplant for use on vertical and overhead surfaces.

Quantity	PRODUCT CODE
4 ounce container	X-080

Couplant Grade	Equivalent Viscosity	1 gallon*	Case of Four 1 gallon*	5 gallon	55 gallon
Exosen 10	30 Oil	X-220	X-225	X-240	X-260
Exosen 14	40 Oil	X-320	X-325	X-340	X-360
Exosen 20	90 Oil	X-420	X-425	X-440	X-460
Exosen 30	Heavy Pourable	X-520	X-525	X-540	X-560
Exosen 40	Semisolid	—	—	X-640	X-660

*Note:* MSDS included with each Exosen shipment. Letter of certification available upon request. Empty 8 ounce squeeze bottle included with each gallon of Exosen.

## Hitempco Couplant (High Temperature)

Krautkramer Hitempco is an excellent high temperature couplant for inspection on surfaces at temperatures up to 550°F. Its high viscosity (toothpaste consistency) makes it ideal on vertical and overhead surfaces.

Quantity	PRODUCT CODES
2 ounce tube	XH-010
Dozen 2 ounce tubes	XH-015

*Note:* Letter of certification included with each Hitempco shipment.

## Delay Line, Wedge and Protective Face Couplant

This couplant is for use between the face of the transducer and the delay line, wedge, membrane, or wear cap with which it is used.

Quantity	PRODUCT CODE
2 ounce squeeze bottle	XD-740

## ZGM Couplant (High Temperature)

ZGM is a highly viscous, high temperature couplant manufactured by Krautkramer. It is designed for use on surfaces with temperatures of 400°F (minimum) to 1000°F. Primarily intended for wall thickness measurement, ZGM contains a solid filler that melts at high temperature.

Quantity	PRODUCT CODE
100 g. (3.5 oz.) tube	XZ-471



# Accessories

## Test Blocks

### Type DC Block (AWS type)

For shear wave distance calibration. Contains a 1.0" radius overlaying a 2.0" radius on 180° half circle. Dimensions: 2.0" radius section is .50" thick; 1.0" radius section is 1.0" thick. Product Code: 118-540-290.



### Type SC Block (AWS type)

For shear wave sensitivity calibration. Contains two .062" diameter sidedrilled holes. Distance from front surface to center of holes is .178" and .521". Dimensions: 3.000" x 1.250" x .905". Product Code: 118-540-330



### AWS Resolution Block

For checking resolution capabilities of angle beam transducers. Contains three sets of three .062" diameter thru holes for 45°, 60°, and 70°. Dimensions: 6" x 3" x 1" Product Code: 118-540-350



### Angle Beam Block (Miniature Size)

Substitute for DSC Block for general angle beam calibration. Contains 1.0" radius opposite a 2.0" radius, and a 5/64" side-drilled, flat bottom hole .750" deep. Dimensions: 1.0" thick. Product Code: 118-540-260



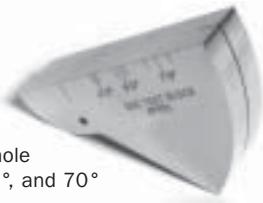
### IOW Beam Profile Block (English or Metric)

For beam profile measurement of angle beam transducers and for measurement of transducer angles. Dimensions: 12" x 3" x 2" Product Code: 118-540-240



### Type DSC Block (AWS type)

For shear wave distance and sensitivity calibration. Contains a 1.0" radius opposite a 3.0" radius. The 3.0" radius includes a radius slot .375" deep x .032" wide. Also contains 0" reference point for checking exit point on wedge, and a .125" diameter side-drilled thru hole and corresponding markings at 45°, 60°, and 70° for measuring actual refracted angle. Dimensions: 1.0" thick Product Code: 118-540-300.



### Step Blocks

For Thickness and linearity calibration. Available in 4-step version with thickness of .250", .500", .750", and 1.00"; or 5-step version, with thickness of .100", .200", .300", .400", and .500". 4-Step Product Code: 118-540-320. 5-Step Product Code: 118-540-310.



### Type DS Block (AWS type)

For longitudinal distance and sensitivity calibration. Contains a 2.0" high section between two 4.0" high sections. Dimensions: 6.0" x 4.0" x 2.0". Product Code: 118-540-340.



### IIW Block Type 1

For calibration of shear and longitudinal transducers, and for verification of shear wedge exit point and refracted angle. Also can be used to check resolution and sensitivity. Dimensions: 12" x 4" x 1". Product Code: 118-540-270.



### IIW Block Type 2

Modified version of original IIW Type 1. Includes a 2.0" radius x .250" deep cut-out and additional side-drilled holes for resolution studies. Dimensions: 12" x 4" x 1". Product Code: 118-540-280.



### NAVSHIPS Test Block

Used in accordance with NAVSHIPS Specification 0900-006-3010. Section 6, for distance amplitude correction, sensitivity levels and flaw depth information. Contains six 3/64" diameter side-drilled holes at distances from 1/4" to 2 3/4". Dimensions: 12" x 3" x 1 1/4". Product Code: 118-540-370



### 30FBH Resolution Block

For determining resolution and sensitivity capabilities and to produce area/amplitude plots for normal beam transducers. Contains ten flat bottom holes each of diameters 3/64", 5/64", and 8/64" at test metal distances from .050" to 1250". Dimensions: 11" x 1 1/2". Product Code: 118-540-230.



### ASME-625 Reference Plate

For longitudinal, shear, and surface wave sensitivity calibrations. Contains six flat bottom holes: three 1/64" diameter holes, one each at a depth of .050", .250", and .500", and one 1/64" hole 1.500" deep, one 8/64" hole 1.625" deep, and one 16/64" hole 1.750" deep. Dimensions: 12" x 6" x 1/2". Product Code: 118-540-360.



# Accessories

## Test Blocks, continued

### Miniature Resolution Block

For checking resolution capabilities and calibrating high resolution test equipment. Contains four  $\frac{3}{16}$ " wide and  $\frac{5}{8}$ " long, milled slots to simulate flat plate reflectors at metal travel distances of .015", .020", .025", and .030", and six flat bottom holes, three each with diameters of  $\frac{3}{64}$ " and  $\frac{1}{64}$ " at metal travel distances of .020", .025", and .030". Dimensions:  $3 \frac{5}{8}$ " x 1 x  $\frac{1}{8}$ ". Product Code: 118-540-250.

### ASME Calibration Blocks

Provided with one flat bottom hole with diameter and depth per specifications. Special Order.

### ASTM Distance/Amplitude Block Set

(19 Blocks) All 19 blocks have the same size test hole. Hole size must be specified when ordering ( $\frac{3}{64}$ ",  $\frac{5}{64}$ ", or  $\frac{9}{64}$ "). The metal travel distances, for the set are: 0006, 0012, 0025, 0037, 0050, 0062, 0075, 0087, 0100, 0125, 0175, 0225, 0275, 0325, 0425, 0475, 0525, and 0575. Product Code: 118-540-028.

### ASTM Area/Amplitude Block Set

(8 Blocks) Includes the following blocks: 1-0300, 2-0300, 3-0300, 4-0300, 5-0300, 6-0300, 7-0300, and 8-0300. Product Code: 118-540-018.

### ASTM Distance/ Area Amplitude Set

(10 Blocks) Includes the following blocks: 3-0300, 5-0012, 5-0025, 5-0050, 5-0075, 5-0150, 5-0300, 5-0600, 8-0300, and 8-0600. Product Code: 118-540-019.

### Single ASTM Blocks

For measuring the sensitivity and/or resolution of normal beam transducers. Machined to E-127-64 dimension requirements. Available with flat bottom holes from  $\frac{1}{64}$ " to  $\frac{9}{64}$ " diameter, with test metal distances from .062" to 6.00". Prices for other lengths and diameters furnished on request. Block identification is as follows: first digit indicates hole diameter in 64ths, next four digits indicate test metal distance in hundredths of an inch. Therefore, a 3-0050 block would have a  $\frac{3}{64}$ " diameter FBH at .500" TMD. Special Order.

Notes: (Apply to all test blocks)

1. Product codes listed are for steel test blocks only. Please order all steel blocks by product code listed for each type. All other block materials should be ordered on an individual basis by description.
2. Please see price list for ordering and delivery information.
3. Krautkramer's test blocks are machined to engineering specifications and to precision tolerances from ultrasonically inspected and approved material.
4. All blocks and sets listed include quality hardware cases except single ASTM blocks.
5. Steel blocks are nickel plated unless otherwise requested.
6. Special test blocks quoted on request based on specifications, type of material, and whether material is supplied by Krautkramer or customer.
7. For details on test block certification, see table above.


Description	PRODUCT CODES
1. Certificate of compliance referencing customer name and address, customer purchase order number, description of blocks, material, and block serial numbers. Certifies that referenced blocks were manufactured in accordance with applicable specifications and checked with measuring equipment traceable to the National Bureau of Standards.	BC-916
2. For ASTM Blocks only, certificate of compliance as listed in (1) above plus Distance/Amplitude plot for all blocks referenced.	BC-917
3. Certificate of compliance and analysis listing material specification, grade, heat number, hardness, grain size, and chemical analysis. Includes all certification listed in (1) above.	Special Order



# Transducer Certification

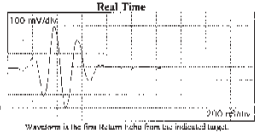
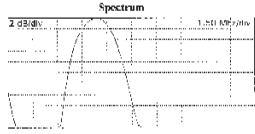
## Real Time Waveform and Frequency Spectrum

The real time waveform and frequency spectrum certifies the natural, unbiased, unfiltered waveform and the degree of damping and shows the frequency components of the gated signal. A highly damped unit such as an Alpha Series transducer gives optimum resolution while displaying a broad frequency spectrum. This is necessary for thickness gauging of thin materials or when inspecting for near-surface flaws. A transducer that is not as highly damped will have greater penetrating power but less resolution and a narrower frequency spectrum.




**Krautkramer**  
An AGFA Company

**Transducer Certification**  
Compliant to ASTM E-1065 Guidelines

<p>Date: 3/14/01          Product Code: 117-344-100          Serial Number: 00NCP1          Description: 6538ANMA5.0x.30L#1</p>	 <p>100 mV/div 200 ns/div Waveform is the first return pulse from the indicated target.</p>
<p>Test Setup:          Test Target: 1.0" 705 Steel @ 3.0" W.P.          Energy: 2          Impedance: 50 Ohms</p>	 <p>2 dB/div 1.00 MHz/div</p>
<p>Equipment Used:          UTA P/N: UTA5          UTA S/N: MM00108          UTA Cal Date: 6/20/01          O-scope S/N: D022065          O-scope Cal Date: 10/16/01</p>	
<p>Software: FNT0040 Rev D</p>	
<p>Test Data:          Sensitivity(Abs dB): -37.40 dB          Pulse Duration(@-20dB): 5.24E-07 Sec          Peak Frequency: 5.37E+06 Hz          Center Frequency: 5.25E+06 Hz          % Bandwidth@ 6dB: 51.0 %          Focal Distance: 2.97 in.          Inspector: TSN</p>	

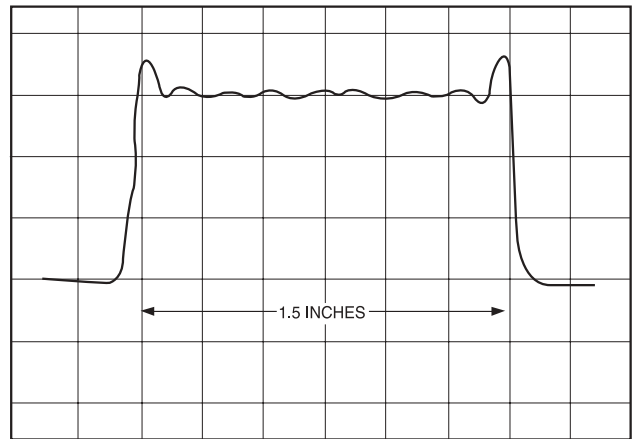
The accuracy of the instrument described above has been confirmed by factory standard test equipment and laboratory reference standards traceable to the National Institute of Standards and Technology. This facility's Quality System is registered to ISO 9001 - ISO Certificate No. 99-1023-02-1001, and is compliant to MIL-STD-45662A.



Krautkramer Inc.  
 50 Industrial Park Rd.  
 Lewisistown, PA 17044  
 Tel: 717-242-8327  
 Fax: 717-242-2666  
<http://www.krautkramer.com>

## Beam Profile

The beam profile plot is made by moving the transducer across a small rod reflector in an immersion tank. Ball or wire reflectors are also commonly used. The beam profile gives the relative intensity and width of the sound beam at a given distance from the transducer face.

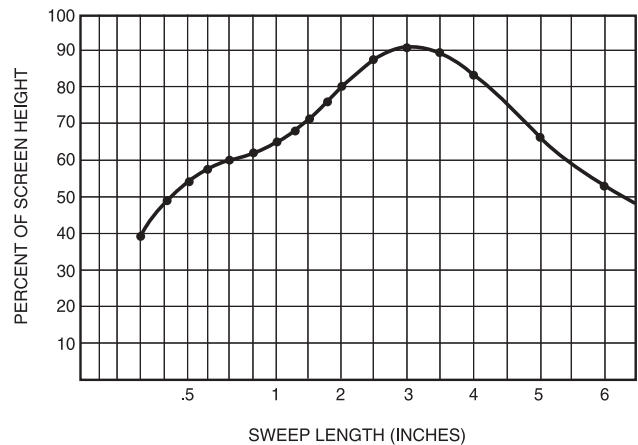


## Distance Amplitude Curve

The distance amplitude curve shows the effect of the near field (Fresnel Zone) as well as the exponential decay of the far field.

### Transducer Certification

Description	PRODUCT CODES
Real Time Waveform and Frequency Spectrum Certification Sheet	TC-911
Beam Profile, X and Y areas, at three depths: $Y_0$ , $1/2 Y_0$ , $1/3 Y_0$	TC-913
Distance Amplitude Curve, specify for 4340 steel or aluminum	TC-914



# Tables and Formulas

**dB vs. Amplitude Ratio Chart**

dB	Ratio	dB	Ratio	dB	Ratio	dB	Ratio
0	1.00:1	5	1.78:1	11	3.55:1	17	708:1
.5	1.06:1	6	2.00:1	12	3.98:1	18	7.94:1
1	1.12:1	7	2.24:1	13	4.47:1	19	8.91:1
2	1.26:1	8	2.51:1	14	5.01:1	20	10.00:1
3	1.41:1	9	2.82:1	15	5.62:1	40	100.00:1
4	1.58:1	10	3.16:1	16	6.31:1	60	1000.00:1

**Near Field Length (N) in Water (Inches)**

Frequency (MHz)	Element Diameter (inches)			
	1.00	.75	.50	.25
1.0	4.3	2.4	1.07	.27
2.25	9.6	5.4	2.4	.60
5.0	21.4	12.0	5.4	1.3
10.0	43	24	10.7	2.7

To find the approx. length in steel, divide the above values by 4.

## Velocity and Acoustic Impedance of Common Materials

Material	Longitudinal Velocity		Shear Velocity		Acoustic Impedance gm/cm <sup>2</sup> sec. × 10 <sup>5</sup>
	in. × 10 <sup>5</sup> sec.	cm. × 10 <sup>5</sup> sec.	in. × 10 <sup>6</sup> sec.	cm. × 10 <sup>5</sup> sec.	
Air	.013	.33	—	—	.0004
Aluminum	.25	6.3	.12	3.1	17.0
Alumina Oxide	.39	9.9	.23	5.8	32.0
Beryllium	.51	12.9	.35	8.9	23.0
Boron Carbide	.43	11.0	—	—	26.4
Brass	.17	4.3	.08	2.0	36.7
Cadmium	.11	2.8	.059	1.5	24.0
Copper	.18	4.7	.089	2.3	41.6
Glass (crown)	.21	5.3	.12	3.0	18.9
Glycerin	.075	1.9	—	—	2.42
Gold	.13	3.2	.047	1.2	62.6
Ice	.16	4.0	.08	2.0	3.5
Inconel	.22	5.7	.12	3.0	47.2
Iron	.23	5.9	.13	3.2	45.4
Iron (cast)	.18	4.6	.10	2.6	33.2
Lead	.085	2.2	.03	.7	24.6
Magnesium	.23	5.8	.12	3.0	10.0
Mercury	.057	1.4	—	—	19.6
Molybdenum	.25	6.3	.13	3.4	64.2
Monel	.21	5.4	.11	2.7	47.6
Neoprene	.063	1.6	—	—	2.1

Material	Longitudinal Velocity		Shear Velocity		Acoustic Impedance gm/cm <sup>2</sup> sec. × 10 <sup>5</sup>
	in. × 10 <sup>6</sup> sec.	cm. × 10 <sup>5</sup> sec.	in. × 10 <sup>6</sup> sec.	cm. × 10 <sup>5</sup> sec.	
Nickel	.22	5.6	.12	3.0	49.5
Nylon, 6-6	.10	2.6	.043	1.1	2.9
Oil (SAE 30)	.067	1.7	—	—	1.5
Platinum	.13	3.3	.067	1.7	69.8
Plexiglass	.11	2.7	.043	1.1	3.1
Polyethylene	.07	1.9	.02	.5	1.7
Polystyrene	.093	2.4	.04	1.1	2.5
Polyurethane	.070	1.9	—	—	1.9
Quartz	.23	5.8	.087	2.2	15.2
Rubber, Butyl	.07	1.8	—	—	2.0
Silver	.14	3.6	.06	1.6	38.0
Steel, mild	.23	5.9	.13	3.2	46.0
Steel, stainless	.23	5.8	.12	3.1	45.4
Teflon	.06	1.4	—	—	3.0
Tin	.13	3.3	.07	1.7	24.2
Titanium	.24	6.1	.12	3.1	27.3
Tungsten	.20	5.2	.11	2.9	101.0
Uranium	.13	3.4	.08	2.0	63.0
Water	.0584	1.48	—	—	1.48
Zinc	.17	4.2	.09	2.4	29.6

## Useful Formulas

Near Field Length =	D <sup>2</sup> F / 4C or D <sup>2</sup> / 4λ	Transit Time:	TT = 2T / C	<table border="1"> <thead> <tr> <th>Symbol Key</th> </tr> </thead> <tbody> <tr><td>λ = Wavelength</td></tr> <tr><td>D = Probe Diameter</td></tr> <tr><td>F = Probe Frequency</td></tr> <tr><td>C = Acoustic Velocity</td></tr> <tr><td>d = Density</td></tr> <tr><td>α = Incident Angle</td></tr> <tr><td>β = Refracted Angle</td></tr> <tr><td>T = Part Thickness</td></tr> <tr><td>S.P. = Sound Path</td></tr> <tr><td>N = Near Field</td></tr> <tr><td>γ = Divergence 1/2-angle</td></tr> </tbody> </table>	Symbol Key	λ = Wavelength	D = Probe Diameter	F = Probe Frequency	C = Acoustic Velocity	d = Density	α = Incident Angle	β = Refracted Angle	T = Part Thickness	S.P. = Sound Path	N = Near Field	γ = Divergence 1/2-angle
Symbol Key																
λ = Wavelength																
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T = Part Thickness																
S.P. = Sound Path																
N = Near Field																
γ = Divergence 1/2-angle																
Beam Spread	SINγ = C / DF × 1.22 or 1.22l / D	Center Frequency =	F <sub>c</sub> = (F <sub>1</sub> + F <sub>2</sub> ) / 2													
Snell's Law	SINα / SINβ = C <sub>1</sub> / C <sub>2</sub>	% Bandwidth =	%BW = (F <sub>2</sub> - F <sub>1</sub> ) / F <sub>c</sub> × 100%													
Skip Distance =	2T × TANβ	Q Factor =	F <sub>c</sub> / (F <sub>2</sub> - F <sub>1</sub> )													
V-Path =	2T × COSβ	Circumference of a Circle =	π × Diameter													
Surface Distance (Projected) =	S.P. × SINβ	Distance =	Speed × time													
Depth (1 <sup>st</sup> Leg) =	S.P. × COSβ	RPM =	Speed / Circumference													
Depth (2 <sup>nd</sup> Leg) =	2T - (S.P. × COSβ)	Maximum Scanning Speed (x, y)	(Min.Flau Length + EBW) × PRR													
Depth (3 <sup>rd</sup> Leg) =	(S.P. × COSβ) - 2T	Maximum Scanning Speed (polar)	RPM × Diameter × Clock Interval (ft per min)													
Wavelength =	l = C / F	dB Difference =	20 Log (A <sub>1</sub> / A <sub>2</sub> )													
Frequency =	F = C / l	dB Ratio =	Inv log dB / 20													
Acoustic Impedance =	Z = C × d	Water Equivalent = (steel)	WE = F(water) × (C(water)) / (C(steel)) (F = Focal Length)													
% of Reflected Sound Pressure =	Rp = (Z <sub>2</sub> - Z <sub>1</sub> ) / (Z <sub>2</sub> + Z <sub>1</sub> )	MAXβ =	SIN <sup>-1</sup> (ID / OD)													
Coefficient of Transmission =	Tp = 2Z <sub>2</sub> / (Z <sub>2</sub> + Z <sub>1</sub> )	Focal Length =	R = F (n - 1) / n													
Total Beam Width =	TBW = (Depth - N) (2TANγ) + T × Element Diameter	Cylinder Offset Technique	Offset (X) = Outside Radius × SINα													





# Transducer Kits

Transducer Kits combine the most popular transducers and accessories necessary for general ultrasonic testing applications. Discount priced and organized in a hard shell carrying case, the kit contents are easily accessible, convenient for storage, and economical.

## Basic Contact Kit— Product Code 118-450-020

Contains a wide assortment for weld inspection, lamination detection, corrosion/erosion and thin guage materials.

Qty.	PRODUCT CODES	Description
1	113-292-603	2.25 MHz, .63" x 63" AWS Style, Single Element Angle Beam Probe
1	113-242-591	2.25 MHz, .5" MSW-QC Style, BMC Single Element Angle Beam Probe
1	113-262-043	2.25 MHz, 1" CR Style, Single Element Contact Probe
1	113-544-000	5 MHz, .5 CA211A Style, Single Element Contact Probe
1	113-252-241	2.25 MHz, .75" PMCR Style, Single Element Membrane Probe

Qty.	PRODUCT CODES	Description
1	113-527-660	15 MHz, .25" ALPHA 2 DFR Style Single Element Delay Line Probe
1	113-292-751	2.25 Mhz, .5" x .5" DU-F Style, Dual Element Contact Probe
1	113-224-681	5 MHz, .25" RC Style, Dual Element Contact Probe
1	C-012	BNC-MD Coaxial Cable
1	C-016	BNC-BNC Coaxial Cable
1	C-024	BNC-MD Dual Coaxial Cable
1	C-088	BNC-RC Dual Coaxial Cable

Qty.	PRODUCT CODES	Description
1	D-050	Delay Lines for 113-527-660 (10 pcs.)
1	PM-021	Protective Membrane for 113-253-241 (12 pcs.)
1 ea.	W-104, 106	45° and 70° Lucite Wedge**
1 ea.	W-211, 212, 213	45°, 60°, and 70° Lucite Wedge**
1	XD-740	Wedge/Delay Line Couplant
1	118-540-198	5 Step Reference Standard .1" - .5"
1	118-800-020	Hardshell Carrying Case

## Basic AWS Weld Inspection Kit Part No. 118-450-500

Contains transducers and accessories required for testing weldments to specification AWS D1.1.

Qty.	PRODUCT CODES	Description
1	113-292-603	2.25 MHz, .63" x 63" AWS Style, Single Element Angle Beam Probe
1	113-292-601	2.25 MHz, .63" x 75" AWS Style, Single Element Angle Beam Probe
1	113-292-604	2.25 MHz, .75" x .75" AWS Style, Single Element Angle Beam Probe
1	113-262-043	2.25 MHz, 1" dia. CR-RHP, L-Wave Contact Probe
1	W-104	45° Lucite Wedge**
1	W-105	60° Lucite Wedge **
1	W-106	70° Lucite Wedge **
1	C-016	BNC-BNC Coaxial Cable
1	B-196	DSC Reference Standard
1	XL-820	8 oz. Couplant
1	118-800-020	Hardshell Carrying Case

## Multi-Purpose Contact Kit Part No. 118-450-510

Contains the most commonly used transducers for a variety of angle beam, lamination, corrosion, general flaw, and thickness testing.

Qty.	PRODUCT CODES	Description
1	113-544-000	5 MHz, .5" dia. CA211A Style, Single Element Contact Probe
1	113-262-043	2.25 MHz, 1" dia. CR Style, Single Element Contact Probe
1	113-527-660	15 MHz, .25" Alpha 2 DFR Style, Delay Line Probe
1	113-224-700	5 MHz, .25" dia. ADP Style, Dual Element Probe
1	113-244-591	5 MHz, .5" dia. MSW-QC Style, Benchmark Angle Beam Probe
2	W-211	45° Lucite Wedge **
2	W-212	60° Lucite Wedge **
2	W-213	70° Lucite Wedge **
2	C-016	BNC-BNC Coaxial Cable
2	C-012	BNC-MD Coaxial Cable
1	118-540-198	5 Step Reference Standard .1" - .5"
1	XL-820	8 oz. Couplant
1	118-800-020	Hardshell Carrying Case

## Basic Angle Beam Kit Part No. 118-450-030

Contains an assortment for weld and other angle beam inspections.

Qty.	PRODUCT CODES	Description
1	113-294-642	5 MHz, .18" x .18" ABFP Style, Single Element Angle Beam Probe
1	113-216-585	10 MHz, .125" SMSWS Style, Single Element Angle Beam Probe
1	113-294-600	5 MHz, .5" x 1" SWS Style, Single Element Angle Beam Probe
1	113-224-591	5 MHz, .25" MSWQC Style, Benchmark Single Element Angle Beam Probe
1	118-540-196	DSC Reference Standard
1	C-047	BNC-MMD Coaxial Cable
1	C-016	BNC-BNC Coaxial Cable
1	C-012	BNC-MD Coaxial Cable
1 ea.	W-120, 122	45° and 70° Lucite Wedge**
1 ea.	W-015, 017	45° and 70° Lucite Wedge**
1 ea.	W-201, 202, 203	45°, 60°, and 70° Lucite Wedge**
1	XL-820	8 oz. Couplant
1	118-800-020	Hardshell Carrying Case

## High Temperature Kit Part No. 118-450-530

Contains dual element delay line, and angle beam transducers for flaw detection at elevated temperatures to 1000 °F.

Qty.	PRODUCT CODES	Description
1	113-224-760	5 MHz, .25" dia. HT400A Style, Dual Element (1000°F max)
1	113-242-270	2.25 MHz, .5" dia. PWCCS Style, Single Element Delay Line
1	113-292-600	2.25 MHz, .5" x 1" SWS Style, Single Element Angle Beam
1 ea.	W-070, 086	45° and 60° High Temperature Wedge (400°F max.)
1	PK-050	High Temperature Delay Line Kit for 2 42-270 (400°F max.)
1	C-016	BNC-BNC Coaxial Cable
1	C-067	Dual MD-BNC Cable
1	C-102	BNC-HT400/400A Probe Cable
2	XH-010	2 oz. Tube HITEMPCO Couplant (ambient to 550°F)
1	XZ-471	3.5 oz. Tube ZGM Couplant (400-1000°F)
1	118-540-198	5 Step Reference Standard .1" - .5"
1	118-800-020	Hardshell Carrying Case

## Basic Immersion Kit Part No. 118-450-040

Contains an assortment of spherically focused transducers which exhibit good resolution and sensitivity and are ideal for determining which type of transducers are best suited for the testing situation.

Qty.	PRODUCT CODES	Description
1	113-127-302	15 MHz, .25" ISS Style Probe with 1.5" Spherical Focus
1	113-136-280	10 MHz, .38" ISS Style Probe with 3" Spherical Focus
1	113-254-360	5 MHz, .75" IS Style Probe with 6" Spherical Focus
1	113-244-280	5 MHz, .5" ISS Style Probe with 2" Spherical Focus
1	118-560-007	UHF RA-UHF Isolated Coaxial Adapter
1	C-016	BNC-BNC Coaxial Cable
1	A-025	BNC-UHF Adapter
1	118-800-020	Hardshell Carrying Case

## Corrosion Survey Kit Part No. 118-450-520

Contains the most popular dual element flaw detection transducers for corrosion detection in materials from ambient to 1000 °F.

Qty.	PRODUCT CODES	Description
1	113-224-700	5 MHz, .25" dia. ADP Style, Dual Element Probe
1	113-544-210	5 MHz, .375" dia. KBA560 Style, Dual Element Probe (450°F max.)
1	113-224-760	5 MHz, .25" dia. KBA-HT400A Style
1	113-292-751	2.25 MHz, .5" x .5" DU-F Style, Dual Element Probe
1	113-244-241	5 MHz, .5" dia. PMCR Style, Single Element Membrane Probe
1	C-067	BNC-KAB560 Coaxial Cable
1	C-016	BNC-BNC Coaxial Cable
1	C-024	BNC-MD Coaxial Cable
1	C-102	BNC-HT400/400A Probe Cable
2	XH-010	2 oz. Tube HITEMPCO Couplant (ambient to 550°F)
1	XZ-471	3.5 oz. Tube ZGM Couplant (400-1000°F)
1	118-540-198	5 Step Reference Standard .1" - .5"
1	XD-740	Wedge/Delay Line and Membrane Couplant
1	118-800-020	Hardshell Carrying Case

\*\* Refracted angle in carbon steel @ 70°F.



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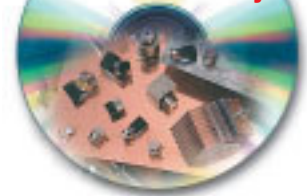
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