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ISO 9001 Certified

Ordering Information

Glossary of Transducer Part Numbers

Transducer Series

AxxxS	Accuscan "S"
AxxxR	Accuscan "R"
Dxxx	Dual
Vxxx	Videoscan
Xxxx	Miscellaneous

Transducer Type

1xx	Contact
15x	Normal Incidence Shear Wave
2xx	Videoscan Replaceable Delay Line
3xx	Immersion
4xx	Standard Angle Beam
5xx	Miniature Angle Beam
6xx	Protected Face
7xx	Dual

Transducer Connector Styles

RB	Right Angle BNC
SB	Straight BNC
RM	Right Angle Microdot
SM	Straight Microdot
RU	Right Angle UHF
SU	Straight UHF
RP	Right Angle potted cable terminating in BNC connectors
RPL1	Right Angle potted cable terminating in Large Lemo connectors

Contouring Delays

CC-R	Concave Radius
CX-R	Convex Radius

Contouring Wedges

AID	Axial Inside Diameter
AOD	Axial Outside Diameter
CID	Circumferential Inside Diameter
COD	Circumferential Outside Diameter

Focal Types (Immersion Transducers)

F	Spherical Focus
CF	Cylindrical Focus

Focal Designations

FPF	Flat Plate Focus
OLF	Optical Lens Formula
PTF	Point Target Focus

V109-RB

Transducer Series · Transducer Type · Connector Style

A309S-SU-F1.00"-PTF

Transducer Series · Transducer Type · Connector Style · Focal Type · Focal Length in water · Focal Description

Glossary of Cable Part Numbers

Cable Connector Style to Instrument

B	BNC
U	UHF
L	Lemo 00
FL	Female Lemo 00
L1	Large Lemo (Lemo1)
X	Unterminated
RL	Right Angle Lemo

Cable Connector Style to Transducer

B	BNC
M	Microdot
U	UHF
RM	Right Angle Microdot
LP	Lepra/Con
X	Unterminated
L	Lemo 00
RL	Right Angle Lemo

Cable Grade

15	Low Impedance, 15 ohms
25	Low Impedence, 25 ohms
58	RG58/U, 50 ohms
62	RG62/U, 93 ohms
74	RG174/U, 50 ohms
188	RG188/U, 50 ohms
316	RG316/U, 50 ohms

Additional Cable Description

SSA	Stainless Steel Armor
W	Waterproof at transducer end
WW	Waterproof at both ends
DS	Double shielded
HD	Heavy Duty
HDAS	Silicone sheath over cable
HDAP	PVC sheath over cable

Letters Found After Connector Styles

D	Dual
H	Handle on Straight Microdot connector
A	No boot on Microdot connector

Letters Found After Dual Cable Length

B	Used with D790-SM and Model 26 and 36 gages
C	Used with D791-RM and Model 26 and 36 gages
D	Used with D797-SM and Model 26 and 36 gages
F	Used with DHC duals

BCU-58-6W

Connector to Instrument · Connector to Transducer · Cable Grade · Cable Length in Feet · Additional Cable Description

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Transducer Selection

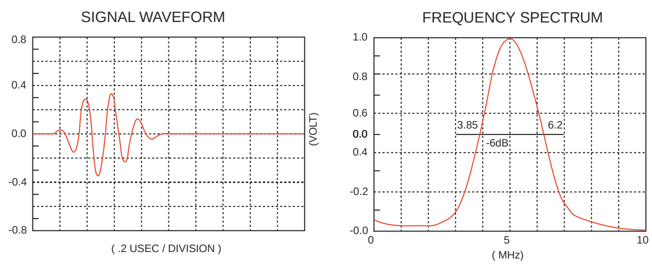
The transducer is one of the most critical components of any ultrasonic system. A great deal of attention should be paid to selecting the proper transducer for the application.

The performance of the system as a whole is of great importance. Variations in instrument characteristics and settings as well as material properties and coupling conditions play a major role in system performance.

Panametrics has developed three different series of transducers to respond to the need for variety. Each series has its own unique characteristics.

Transducer configuration also has an impact on system performance. Consideration should be given to the use of focused transducers, transducers with wear surfaces that are appropriate for the test material, and the choice of the appropriate frequency and element diameter.

The summaries below provide a general impression of the performance characteristics of each transducer series. While these guidelines are quite useful each application is unique and performance will be dependent on electronics, cabling, and transducer configuration, frequency, and element diameter.

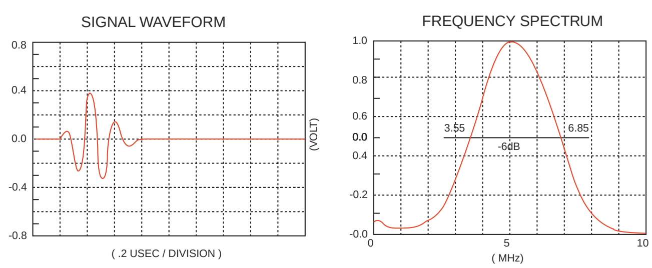


MEASUREMENTS PER ASTM E1065

WAVEFORM DURATION:		SPECTRUM MEASURANDS:	
−14DB LEVEL	.546US	CENTER FREQ.	5.03MHz
−20DB LEVEL	.650US	PEAK FREQUENCY	4.95MHz
−40DB LEVEL	1.24US	−6DB BANDWIDTH	46.77 %

ACCUSCAN "S"

The Accuscan S series is intended to provide excellent sensitivity in those situations where axial resolution is not of primary importance. Typically this series will have a longer wave form duration and a relatively narrow frequency bandwidth.

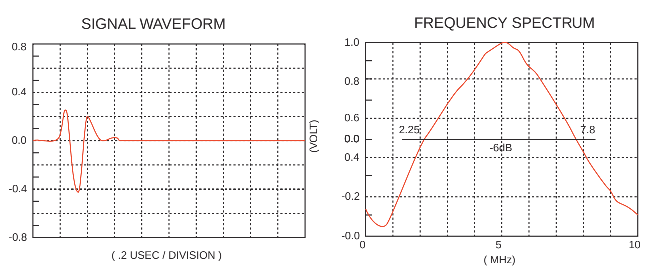


MEASUREMENTS PER ASTM E1065

WAVEFORM DURATION:		SPECTRUM MEASURANDS:	
−14DB LEVEL	.346US	CENTER FREQ.	5.20MHz
−20DB LEVEL	.494US	PEAK FREQUENCY	5.03MHz
−40DB LEVEL	.782US	−6DB BANDWIDTH	63.46 %

ACCUSCAN "R"

The Accuscan R series is designed to reduce excitation pulse and interface echo recovery time while maintaining good sensitivity at the transducer center frequency.



MEASUREMENTS PER ASTM E1065

WAVEFORM DURATION:		SPECTRUM MEASURANDS:	
−14DB LEVEL	.238US	CENTER FREQ.	5.03MHz
−20DB LEVEL	.262US	PEAK FREQUENCY	5.28MHz
−40DB LEVEL	.758US	−6DB BANDWIDTH	110.4 %

VIDEOSCAN

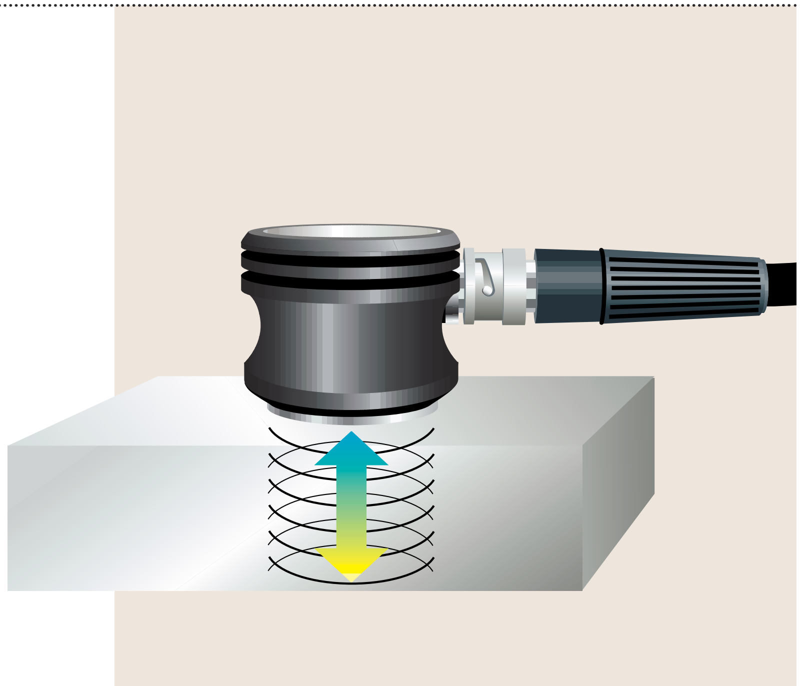
Videoscan Transducers are untuned transducers which provide heavily damped broadband performance. They are the best choice in applications where good axial or distance resolution is necessary or in tests which require improved signal-to-noise in attenuating or scattering materials.

For more information on bandwidth and sensitivity versus resolution, please refer to the Technical Notes located on pages 32-39.

Note: For sample test forms of transducers that you are interested in purchasing or if you have questions, please contact Panametrics via phone, fax, or e-mail.

Contact Transducers

A contact transducer is a single element longitudinal wave transducer intended for use in direct contact with a test piece.



Advantages:

- Proprietary WC-5 wear plate increases durability, fracture resistance, and wear resistance
- All styles are designed for use in rugged industrial environments
- Close acoustic impedance matching to most metals
- Can be used to test a wide variety of materials
- Accuscan-S, Accuscan-R, and Videoscan series satisfy a variety of acoustic performance requirements
- Videoscan transducers offer improved signal-to-noise characteristics in highly attenuating or sound scattering materials
- Videoscan transducers offer improved main bang recovery for better near surface resolution

Applications:

- Straight beam flaw detection and thickness gaging
- Detection and sizing of delaminations
- Material characterization and sound velocity measurements
- Inspection of plates, billets, bars, forgings, castings, extrusions, and a wide variety of other metallic and non-metallic components

Frequency MHz	Nominal Element Size		Transducer Part Numbers		
			ACCUSCAN-S	ACCUSCAN-R	VIDEOSCAN
0.5	1.00"	25mm	A101S-RM	A101R-RM	V101-RM
1.0	1.00"	25mm	A102S-RM	A102R-RM	V102-RM
	0.75"	19mm	A114S-RM	A114R-RM	V114-RM
	0.50"	13mm	A103S-RM	A103R-RM	V103-RM
2.25	1.00"	25mm	A104S-RM	A104R-RM	V104-RM
	0.75"	19mm	A105S-RM	A105R-RM	V105-RM
	0.50"	13mm	A106S-RM	A106R-RM	V106-RM
	0.375"	10mm	A125S-RM	A125R-RM	V125-RM
	0.25"	6mm	A133S-RM	A133R-RM	V133-RM
3.5	1.00"	25mm	A180S-RM	A180R-RM	—
	0.75"	19mm	A181S-RM	A181R-RM	V181-RM
	0.50"	13mm	A182S-RM	A182R-RM	V182-RM
	0.375"	10mm	A183S-RM	A183R-RM	V183-RM
	0.25"	6mm	A184S-RM	A184R-RM	—
5.0	1.00"	25mm	A107S-RM	A107R-RM	V107-RM
	0.75"	19mm	A108S-RM	A108R-RM	V108-RM
	0.50"	13mm	A109S-RM	A109R-RM	V109-RM
	0.375"	10mm	A126S-RM	A126R-RM	V126-RM
	0.25"	6mm	A110S-RM	A110R-RM	V110-RM
	0.125"	3mm	—	—	V1091
7.5	0.50"	13mm	A120S-RM	A120R-RM	—
	0.375"	10mm	A122S-RM	A122R-RM	V122-RM
	0.25"	6mm	A121S-RM	A121R-RM	V121-RM
10	0.50"	13mm	A111S-RM	A111R-RM	V111-RM
	0.375"	10mm	A127S-RM	A127R-RM	V127-RM
	0.25"	6mm	A112S-RM	A112R-RM	V112-RM
	0.125"	3mm	—	—	V129-RM
15	0.25"	6mm	A113S-RM	A113R-RM	V113-RM
20	0.125"	3mm	—	—	V116-RM

Fingertip Contact

- Units larger than 0.25" (6mm) are knurled for easier grip
- 303 stainless steel case
- Low profile for difficult-to-access surfaces
- Removable plastic sleeve for better grip available upon request at no additional charge, part number CAP4 for 0.25" (6mm) and CAP8 for 0.125" (3mm)
- Standard connector style is Right Angle Microdot (RM). Consult Panametrics for Straight Microdot and other styles.

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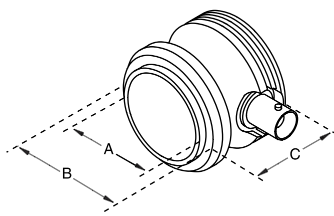
Standard Contact

- Comfort Fit Sleeves are designed to be easily held and to provide a steady grip while wearing gloves
- 303 stainless steel case
- Large element diameters for challenging applications and greater coverage
- Standard connector style is Right Angle BNC (RB), may be available in a Straight BNC (SB)

Frequency MHz	Nominal Element Size		Transducer Part Numbers		
			ACCUSCAN-S	ACCUSCAN-R	VIDEOSCAN
0.1	1.50"	38mm	—	—	V1011
0.25	1.50"	38mm	—	—	V1012
0.5	1.50"	38mm	A189S-RB	A189R-RB	V189-RB
	1.125"	29mm	A191S-RB	A191R-RB	V191-RB
	1.00"	25mm	A101S-RB	A101R-RB	V101-RB
1.0	1.50"	38mm	A192S-RB	A192R-RB	V192-RB
	1.125"	29mm	A194S-RB	—	V194-RB
	1.00"	25mm	A102S-RB	A102R-RB	V102-RB
	0.75"	19mm	A114S-RB	A114R-RB	V114-RB
	0.50"	13mm	A103S-RB	A103R-RB	V103-RB
2.25	1.50"	38mm	A195S-RB	A195R-RB	V195-RB
	1.125"	29mm	A197S-RB	A197R-RB	V197-RB
	1.00"	25mm	A104S-RB	A104R-RB	V104-RB
	0.75"	19mm	A105S-RB	A105R-RB	V105-RB
	0.50"	13mm	A106S-RB	A106R-RB	V106-RB
	0.25"x1.00"	6x25mm	A188S-RB*	A188R-RB*	—
3.5	1.00"	25mm	A180S-RB	A180R-RB	V180-RB
	0.75"	19mm	A181S-RB	A181R-RB	V181-RB
	0.50"	13mm	A182S-RB	A182R-RB	V182-RB
5.0	1.00"	25mm	A107S-RB	A107R-RB	V107-RB
	0.75"	19mm	A108S-RB	A108R-RB	V108-RB
	0.50"	13mm	A109S-RB	A109R-RB	V109-RB
7.5	0.50"	13mm	A120S-RB	A120R-RB	V120-RB
10	0.50"	13mm	A111S-RB	A111R-RB	V111-RB

** Per ASTM Standard A-418*

Standard Contact

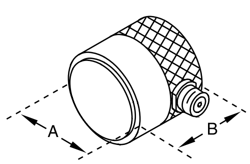


Nominal Element Size	(A)	(B)	(C)
1.50"*	1.75"	2.23"	1.25"
1.125"	1.38"	1.79"	1.25"
1.00"	1.25"	1.60"	1.25"
0.25" x 1.00"	1.25"	1.60"	1.25"
0.75"	1.00"	1.37"	1.25"
0.50"	0.63"	1.16"	1.25"

1 inch = 25.4mm

** V1011 and V1012 housed in different cases. Please see page 23, Low Frequency Broadband Transducers.*

Fingertip Contact



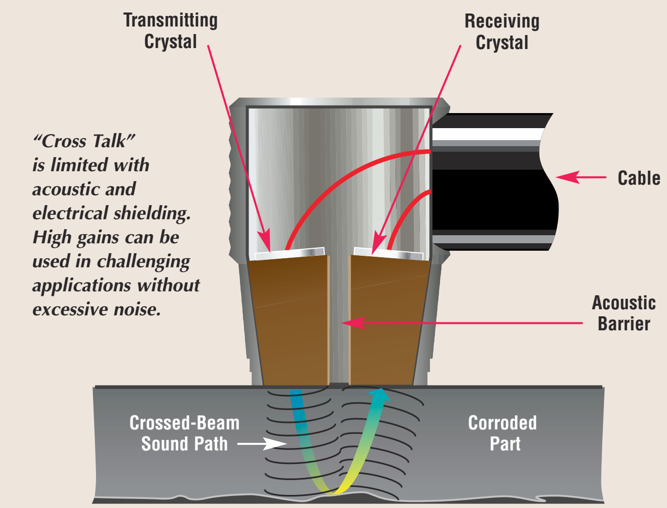
Nominal Element Size	(A)	(B)
1.00"	1.25"	0.63"
0.75"	1.00"	0.63"
0.50"	0.70"	0.63"
0.375"	0.53"	0.50"
0.25"	0.35"	0.42"
0.125"	0.25"	0.38"

1 inch = 25.4mm

Dual Element Transducers

A dual element transducer consists of two crystal elements housed in the same case, separated by an acoustic barrier. One element transmits longitudinal waves, and the other element acts as a receiver.

For information on transducers for all 26 and 36 series thickness gages (such as the D790), please consult Panametrics.



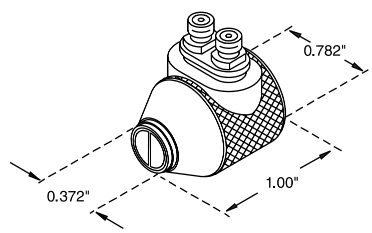
Two angled elements create a crossed–beam sound path in the test material. This "Pseudo-Focus" enhances resolution in the focal zone.

Advantages:

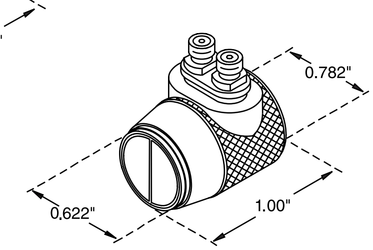
- Improves near surface resolution
- Eliminates delay line multiples for high temperature applications
- Couples well on rough or curved surfaces
- Reduces direct back-scattering noise in course grained or scattering materials
- Ideal for low temperature applications
- Combines penetration capabilities of a lower frequency single element transducer with the near surface resolution capabilities of a higher frequency single element transducer
- Can be contoured to conform to curved parts

Applications:

- Remaining wall thickness measurement
- Corrosion/erosion monitoring
- Weld overlay and cladding bond/disbond inspection
- Detection of porosity, inclusions, cracks, and laminations in castings and forgings
- Crack detection in bolts or other cylindrical objects



0.25" Element Size



0.50" Element Size

Flush Case Duals

- Metal wear ring extends transducer life
- Wear indicator references when transducer face needs resurfacing
- Knurled, 303 stainless steel case
- Replaceable cable design (special dual cables with strain relief available in Large Lemo and BNC connectors)

Frequency MHz	Nominal Element Size	Transducer Part Numbers
1.0	0.50" 13mm	DHC703-RM
2.25	0.50" 13mm 0.25" 6mm	DHC706-RM DHC785-RM
5.0	0.50" 13mm 0.25" 6mm	DHC709-RM DHC711-RM
10	0.25" 6mm	DHC713-RM

Note: Order Replaceable Cables separately, BCMD-316-5F, L1CMD-316-5F.

Flush Case Dual

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Fingertip Duals

- Highest temperature withstand capability*
- Knurled case, except the 0.25" (6mm) element size
- High-strength flexible 6' (1.8m) potted cable (BNC or Large Lemo connectors)

Frequency MHz	Nominal Element Size	Transducer Part Numbers	
		BNC Connector	Large Lemo Connector
1.0	0.75" 19mm 0.50" 13mm	D714-RP D703-RP	D714-RPL1 D703-RPL1
2.25	0.75" 19mm 0.50" 13mm 0.375" 10mm 0.25" 6mm	D705-RP D706-RP D771-RP D785-RP	D705-RPL1 D706-RPL1 D771-RPL1 D785-RPL1
3.5	0.75" 19mm 0.50" 13mm 0.375" 10mm 0.25" 6mm	D781-RP D782-RP D783-RP D784-RP	D781-RPL1 D782-RPL1 D783-RPL1 D784-RPL1
5.0	0.75" 19mm 0.50" 13mm 0.375" 10mm 0.25" 6mm	D708-RP D709-RP D710-RP D711-RP	D708-RPL1 D709-RPL1 D710-RPL1 D711-RPL1
7.5	0.50" 13mm 0.25" 6mm	D720-RP D721-RP	D720-RPL1 D721-RPL1
10	0.50" 13mm 0.25" 6mm	D712-RP D713-RP	D712-RPL1 D713-RPL1

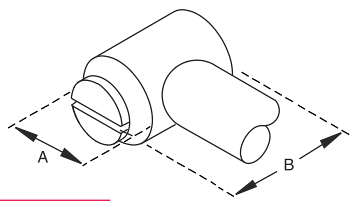
** Maximum temperature withstand capability is 800°F (427°C) for 5.0MHz and below; 350°F (177°C) for 7.5MHz and 10MHz. Recommended duty cycle for surface temperatures from 200°F (93°C) to 800°F (427°C) is ten seconds maximum contact followed by a minimum of one minute air cooling.*

Extended Range Duals

- Shallow roof angles provide greater sensitivity to deep flaws, back walls, and other reflectors, 0.75" (19mm) and beyond in steel
- Can be used for high temperature measurements when delay lines are unacceptable
- High-strength flexible 6' (1.8m) potted cable with BNC connectors

Frequency MHz	Nominal Element Size	Roof Angle (degrees)	Transducer Part Numbers
2.25	1.00" 25mm 0.50" 13mm 0.50" 13mm 0.50" 13mm 0.50" 13mm	0 0 1.5 2.6 3.5	D7079 D7071 D7072 D7074 D7073
5.0	1.00" 25mm 0.50" 13mm 0.50" 13mm 0.50" 13mm 0.50" 13mm	0 0 1.5 2.6 3.5	D7080 D7075 D7076 D7078 D7077

Fingertip and Extended Range Dual



Nominal Element Size	(A)	(B)
1.00"	1.25"	0.75"
0.75"	1.00"	0.75"
0.50"	0.70"	0.75"
0.375"	0.53"	0.62"
0.25"	0.35"	0.54"

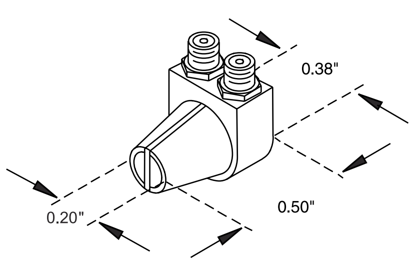
1 inch = 25.4mm

Miniature Tip Dual

- Small tip diameter provides better coupling on curved surfaces
- Low profile allows for better access in areas of limited space
- Replaceable cable available for use with any commercially available flaw detector

Frequency MHz	Tip Diameter	Nominal Element Size	Transducer Part Number
5.0	0.20" 5mm	0.15" 3.8mm	MTD705

Note: Order Replaceable Cables separately, BCLPD-78-5 and L1CLPD-78-5.



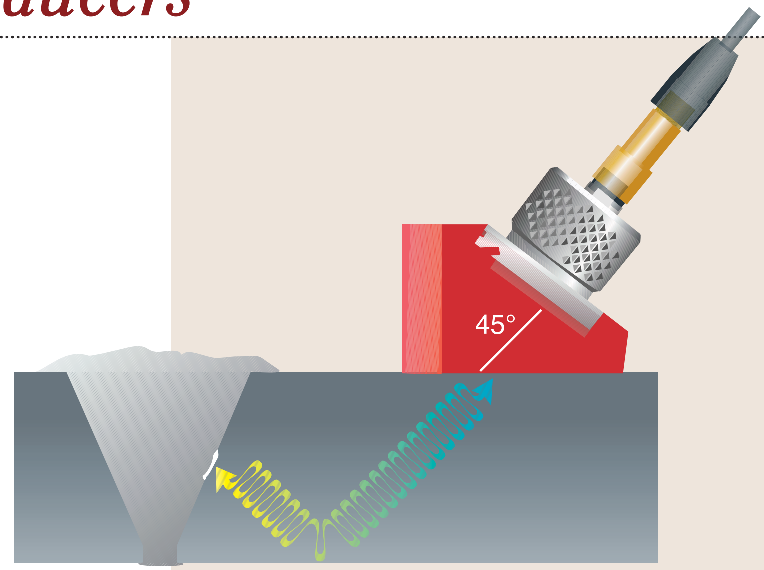
Miniature Tip Dual

Angle Beam Transducers

Angle beam transducers are single element transducers used with a wedge to introduce a refracted shear wave or longitudinal wave into a test piece.

Advantages:

- Three-material design of our Accupath wedges improves signal-to-noise characteristics while providing excellent wear resistance
- High temperature wedges available for in-service inspection of hot materials
- Wedges can be customized to create nonstandard refracted angles
- Available in interchangeable or integral designs
- Contouring available
- Wedges and integral designs are available with standard refracted angles in aluminum



Miniature Angle Beam Transducers and Wedges are used primarily for flaw detection of welds. Their design allows them to be easily scanned back and forth and provides a short approach distance.

Applications:

- Flaw detection and sizing
- Videoscan transducers can be used for time of flight diffraction techniques
- Inspection of pipes, tubes, forgings, castings, as well as machined and structural components for weld defects or cracks

Miniature Screw-In Transducers and Wedges

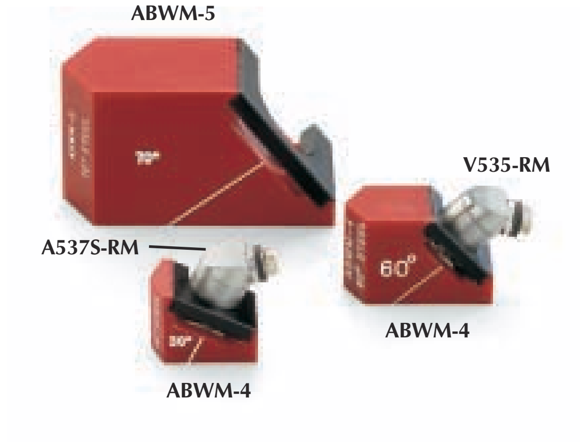
- Screw-in design 303 stainless steel case
- Small wedge footprint
- Short approach distance
- Pointed toe design allows transducer rotation even when the nose is touching a weld crown
- Special wedge design for use with 10MHz transducer
- Transducers are color coded by frequency

Nominal Element Size	Frequency MHz	Transducer Part Numbers		Wedge Part Numbers			
		ACCUSCAN-S	VIDEOSCAN	Accupath*	Surface Wave 90°	High Temp* 500°F (260°C)	Very High Temp* 900°F (480°C)
0.50" 13mm	1.0	A539S-SM	V539-SM	ABWM-5T- x	ABWML-5T-90°	ABWHT-5T- x	ABWVHT-5T- x
	2.25	A540S-SM	V540-SM				
	3.5	A545S-SM	V545-SM				
	5.0	A541S-SM	V541-SM				
	10	A547S-SM	V547-SM	ABWM-5ST- x	ABWML-5ST-90°	—	—
0.375" 10mm	1.5	A548S-SM	—	ABWM-7T- x	ABWML-7T-90°	ABWHT-7T- x	ABWVHT-7T- x
	2.25	A549S-SM	V549-SM				
	3.5	A550S-SM	V550-SM				
	5.0	A551S-SM	V551-SM				
	10	A552S-SM	V552-SM	ABWM-7ST- x	ABWML-7ST-90°	—	—
0.25" 6mm	2.25	A542S-SM	V542-SM	ABWM-4T- x	ABWML-4T-90°	ABWHT-4T- x	ABWVHT-4T- x
	3.5	A546S-SM	V546-SM				
	5.0	A543S-SM	V543-SM				
	10	A544S-SM	V544-SM	ABWM-4ST- x	ABWML-4ST-90°	—	—

** Wedges are available in standard refracted shear wave angles of 30º, 35º, 45º, 60º, and 70º in steel as measured at 5.0MHz. x indicates degrees. Please specify upon ordering.*

Miniature Snap-In Transducers and Wedges

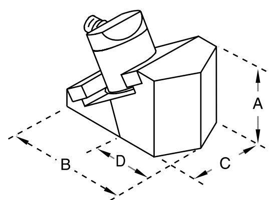
- Snap-In design 303 stainless steel case
- Small wedge footprint
- Short approach distance
- Pointed toe design allows transducer rotation even when the nose is touching a weld crown
- Special wedge design for 10MHz transducer
- Special snap-in ring provides uniform coupling while allowing rotation of the transducer to keep the cable away from interfering structures
- Low profile design
- Transducers available in Accuscan-S, Accuscan-R, and Videoscan



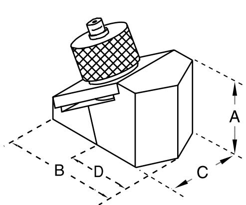
Nominal Element Size	Frequency MHz	Transducer Part Numbers			Wedge Part Numbers			
		ACCUSCAN-S	ACCUSCAN-R	VIDEOSCAN	Accupath*	Surface Wave 90°	High Temp* 500°F (260°C)	Very High Temp* 900°F (480°C)
0.50" 13mm	2.25	A534S-RM	A534R-RM	V534-RM	ABWM-5- x	ABWML-5-90°	ABWHT-5- x	ABWVHT-5- x
	5.0	A536S-RM	A536R-RM	V536-RM	ABWM-5- x	ABWML-5-90°	ABWHT-5- x	ABWVHT-5- x
	10	A538S-RM	A538R-RM	V538-RM	ABWM-5S- x	ABWML-5S-90°	—	—
0.25" 6mm	2.25	A533S-RM	A533R-RM	V533-RM	ABWM-4- x	ABWML-4-90°	ABWHT-4- x	ABWVHT-4- x
	5.0	A535S-RM	A535R-RM	V535-RM	ABWM-4- x	ABWML-4-90°	ABWHT-4- x	ABWVHT-4- x
	10	A537S-RM	A537R-RM	V537-RM	ABWM-4S- x	ABWML-4S-90°	—	—

** Wedges are available in standard refracted shear wave angles of 30°, 35°, 45°, 60°, and 70° in steel as measured at 5.0MHz. Please specify upon ordering.*

Snap-In



Screw-In



Dimension A = Wedge Height

Dimension D = Approach Distance

Accupath and Surface Wave Wedge Dimensions* (Miniature Screw-in and Snap-in)

Nominal Element Size

	0.50"				0.375"				0.25"			
	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)
30°	0.72"	1.22"	0.77"	0.54"	0.62"	1.03"	0.65"	0.42"	0.49"	0.66"	0.45"	0.23"
45°	0.85"	1.31"	0.77"	0.49"	0.76"	1.14"	0.65"	0.41"	0.53"	0.74"	0.45"	0.24"
60°	1.00"	1.66"	0.77"	0.66"	0.87"	1.41"	0.65"	0.52"	0.63"	0.95"	0.45"	0.32"
70°	1.00"	1.82"	0.77"	0.73"	0.92"	1.52"	0.65"	0.51"	0.66"	1.08"	0.45"	0.36"
90°	1.25"	1.84"	0.77"	—	1.00"	1.48"	0.65"	—	0.83"	1.13"	0.45"	—

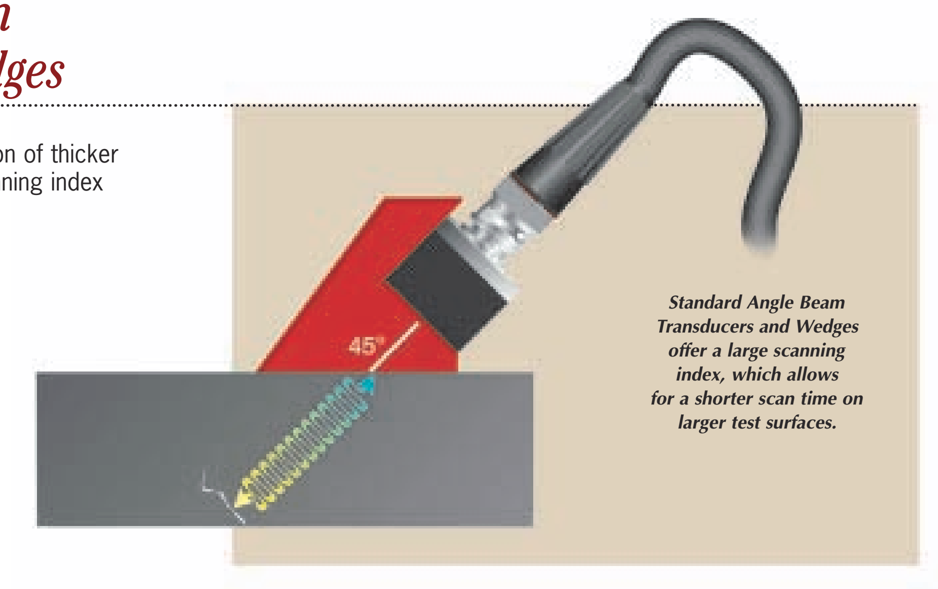
** Wedge dimensions for 10MHz transducers are slightly different, please consult Panametrics.*

Note: Dimensions for 0.375" only apply to Miniature Screw-In Wedges.

Couplants A, B, C and D (Propylene Glycol, Glycerine, Silicone Oil, Gel) are all suitable for use between transducers and wedges.

Standard Angle Beam Transducers and Wedges

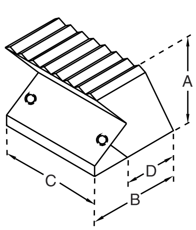
- Large element size allows for inspection of thicker components and provides a large scanning index
- Transducers available in Accuscan-S, Accuscan-R, and Videoscan Series
- Accupath and High Temperature style wedges available
- Threaded brass screw receptacles ensure firm anchoring of the transducer onto the wedge
- Available in frequencies as low as 0.5MHz and 1.0MHz
- Captive screws included with the transducer



Standard Angle Beam Transducers and Wedges offer a large scanning index, which allows for a shorter scan time on larger test surfaces.

Nominal Element Size	Frequency MHz	Transducer Part Numbers			Wedge Part Numbers			
		ACCUSCAN-S	ACCUSCAN-R	VIDEOSCAN	Accupath*	Surface Wave 90°	High Temp* 500°F (260°C)	Very High Temp* 900°F (480°C)
1.00" 25mm	0.5	A414S-SB	A414R-SB	V414-SB	ABWS-3-	ABWSL-3-90°	ABWHT-3-	ABWVHT-3-
	1.0	A407S-SB	A407R-SB	V407-SB				
	2.25	A408S-SB	A408R-SB	V408-SB				
	3.5	A411S-SB	—	—				
	5.0	A409S-SB	A409R-SB	V409-SB				
0.50" x l.00" 13 x 25mm	0.5	A413S-SB	A413R-SB	V413-SB	ABWS-2-	ABWSL-2-90°	ABWHT-2-	ABWVHT-2-
	1.0	A401S-SB	A401R-SB	V401-SB				
	2.25	A403S-SB	A403R-SB	V403-SB				
	3.5	A412S-SB	—	—				
	5.0	A405S-SB	A405R-SB	V405-SB				
0.50" 13mm	1.0	A402S-SB	A402R-SB	V402-SB	ABWS-1-	ABWSL-1-90°	ABWHT-1-	ABWVHT-1-
	2.25	A404S-SB	A404R-SB	V404-SB				
	3.5	A415S-SB	—	—				
	5.0	A406S-SB	A406R-SB	V406-SB				

** Wedges are available in standard refracted shear wave angles of 30º, 45º, 60º, and 70º in steel as measured at 5.0MHz. Please specify upon ordering.*



Accupath and Surface Wave Wedge Dimensions

Nominal Element Size

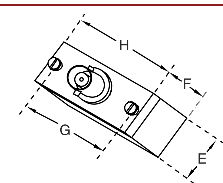
	1.00"				0.50" x 1.00"				0.50"			
	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)	(A)	(B)	(C)	(D)
30°	1.69"	2.15"	1.62"	1.15"	1.30"	1.30"	1.60"	0.76"	1.20"	1.42"	1.10"	0.83"
45°	1.47"	1.96"	1.63"	0.97"	1.30"	1.41"	1.60"	0.78"	1.20"	1.31"	1.08"	0.70"
60°	1.50"	2.18"	1.63"	1.00"	1.30"	1.50"	1.60"	0.67"	1.20"	1.48"	1.08"	0.68"
70°	1.50"	2.47"	1.63"	1.13"	1.35"	1.77"	1.60"	0.85"	1.20"	1.58"	1.09"	0.68"
90°	1.50"	2.50"	1.65"	0.44"	1.20"	1.34"	1.60"	—	1.20"	1.34"	1.00"	—

Dimension A = Wedge Height

Dimension D = Approach Distance

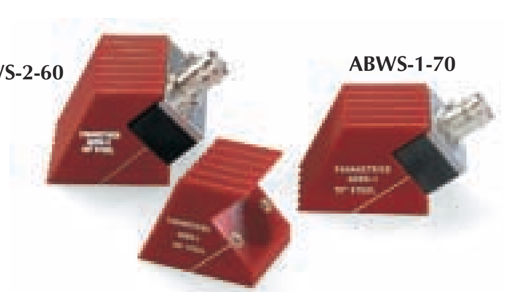
Transducer Dimensions

Nominal Element Size	(E)	(F)	(G)	(H)
1.00"	1.25"	0.63"	1.38"	1.65"
0.50" x 1.00"	0.73"	0.63"	1.31"	1.53"
0.50"	0.72"	0.63"	0.81"	1.02"



ABWS-2-60

ABWS-1-70



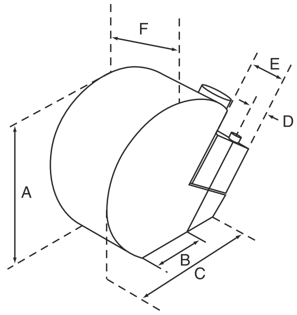
ABWS-1-60

AWS Snail Wedges and Transducers

- Transducers and wedges meet or exceed the specifications as set forth by the AWS Code Section D1.1
- Snail transducers and wedges use industry accepted hole spacing
- Captive screws included with the transducer

Nominal Element Size	Frequency MHz	Transducer Part Numbers	Wedge Part Number*
0.625" x 0.625" 0.625" x 0.75" 0.75" x 0.75"	2.25	A430S-SB A431S-SB A432S-SB	ABWS-8-

** Wedges are available in standard refracted shear wave angles of 45º, 60º, and 70º in steel. Please specify upon ordering.*



A431S-SB

Snail

Snail Wedge Dimensions*

	(A)	(B)	(C)	(D)	(E)	(F)
45°	1.99"	0.885"	1.74"	0.50"	0.868"	1.25"
60°	1.98"	0.691"	1.97"	0.50"	0.907"	1.25"
70°	1.88"	0.771"	1.88"	0.50"	0.932"	1.25"

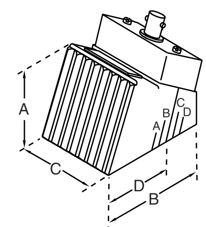
** Distance between screws (center to center) is 1.00".*

AWS Accupath Angle Beam Wedges and Transducers

- Transducers and wedges meet or exceed the specifications as set forth by the AWS Code Section D1.1
- Accupath style wedges marked with a five line graticule to assist in locating the beam exit point
- Threaded brass screw receptacles ensure firm anchoring of the transducer onto the wedge
- Captive screws included with the transducer

Nominal Element Size	Frequency MHz	Transducer Part Numbers	Wedge Part Number*
0.625" x 0.625" 0.625" x 0.75" 0.75" x 0.75"	2.25	A420S-SB A421S-SB A422S-SB	ABWS-6-

** Wedges are available in standard refracted shear wave angles of 45º, 60º, and 70º in steel. Please specify upon ordering.*



A420S

Accupath

Wedge Dimensions*

	(A)	(B)	(C)	(D)
45°	1.50"	1.96"	1.50"	0.90"
60°	1.68"	2.05"	1.50"	0.79"
70°	1.66"	2.20"	1.50"	0.96"

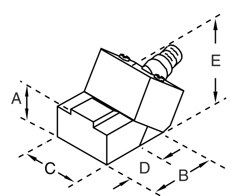
** Distance between screws (center to center) is 1.062".*

O.P. Angle Beam Wedges and Transducers

- Transducer/Wedge combination features a low profile
- Short soundpath in wedge reduces signal attenuation
- Internally threaded joint between transducer case and connector resists breakage even under the most demanding conditions

Nominal Element Size	Frequency MHz	Transducer Part Numbers	Wedge Part Number*
0.25" 6mm	2.25 3.5 5.0	A5033 A5037 A5038	OP-4-

** Wedges are available in standard refracted shear wave angles of 45º, 60º, and 70º in steel. Please specify upon ordering.*



A5037

OP-4-45

O.P.

Wedge Dimensions*

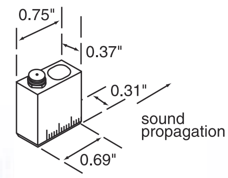
	(A)	(B)	(C)	(D)	(E)
45°	0.31"	0.57"	0.50"	0.31"	0.51"
60°	0.34"	0.69"	0.50"	0.36"	0.52"
70°	0.39"	0.79"	0.50"	0.43"	0.52"

** Distance between screws (center to center) is 0.375".*

Integral Angle Beam Transducers

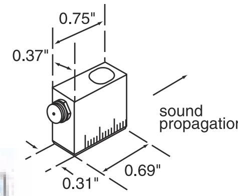
- ❖ Durable plastic wear surface extends transducer life and avoids scratching of critical components
- ❖ Small approach distance and overall transducer height make these an excellent choice for limited access applications
- ❖ Superior signal-to-noise characteristics for such a small integral transducer
- ❖ Finger ring included with Micro-Miniature -RM case style transducers

0.25", SM STYLE for Aluminum

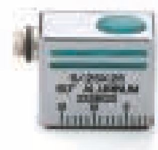


A592S-SM

0.25", RM STYLE for Aluminum



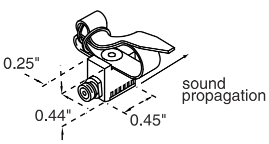
A592S-RM



Transducer Case	Nominal Element Size	Frequency MHz	Material	Connector Style	Transducer Part Numbers			
					45°	60°	70°	90°
Miniature	0.25" x 0.25" 6 x 6mm	2.25 5.0 5.0	Steel Steel Aluminum	RM RM RM or SM	A561S-RM A571S-RM A591S	A562S-RM A572S-RM A592S	A563S-RM A573S-RM A593S	A564S-RM* A574S-RM* see note*
Micro-Miniature	0.187" x 0.187" 5 x 5mm	2.25 5.0 5.0 10 5.0	Steel Steel Steel Steel Aluminum	RM RM SM SM SM	A5050 A5020 A5015 — A5067	— A5023 A5014 — A5068	— A5021 A5013 A5054 A5069	A5053* — — — see note*

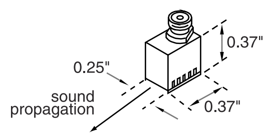
** A564S-RM, A574S-RM and A5053 create surface waves in steel and aluminum.*

0.187", RM STYLE



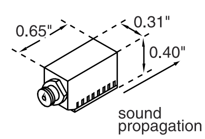
A5023

0.187", SM STYLE



A5014

0.25", RM STYLE for Steel



A564S-RM

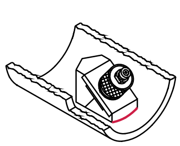
Shear Wave Wedges for Aluminum

- ❖ Compatible with our Miniature Screw-In, Snap-In, and Standard Angle Beam transducers

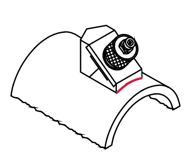
Transducer Case	Nominal Element Size		Wedge Part Numbers				
			30°	45°	60°	70°	90°
Screw-In	0.50" 0.375" 0.25"	13mm 10mm 6mm	ABWM-5053T ABWM-7024T ABWM-4086T	ABWM-5027T ABWM-7025T ABWM-4087T	ABWM-5028T ABWM-7026T ABWM-4088T	ABWM-5029T ABWM-7027T ABWM-4089T	ABWML-5041T ABWML-7028T ABWML-4074T
Snap-In	0.50" 0.25"	13mm 6mm	ABWM-5053 ABWM-4086	ABWM-5027 ABWM-4087	ABWM-5028 ABWM-4088	ABWM-5029 ABWM-4089	ABWML-5041 ABWML-4074
Standard	1.00" 0.50" x 1.00" 0.50"	25mm 13 x 25mm 13mm	ABWS-3028 ABWS-2021 ABWS-1033	ABWS-3016 ABWS-2022 ABWS-1034	ABWS-3029 ABWS-2023 ABWS-1035	ABWS-3030 ABWS-2024 ABWS-1036	ABWSL-3039 ABWSL-2056 ABWSL-1045

Contoured Wedges

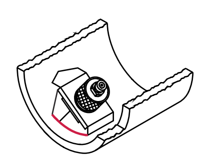
- ❖ Improves coupling on curved surfaces



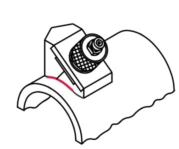
AID (Axial Inside Diameter)



AOD (Axial Outside Diameter)



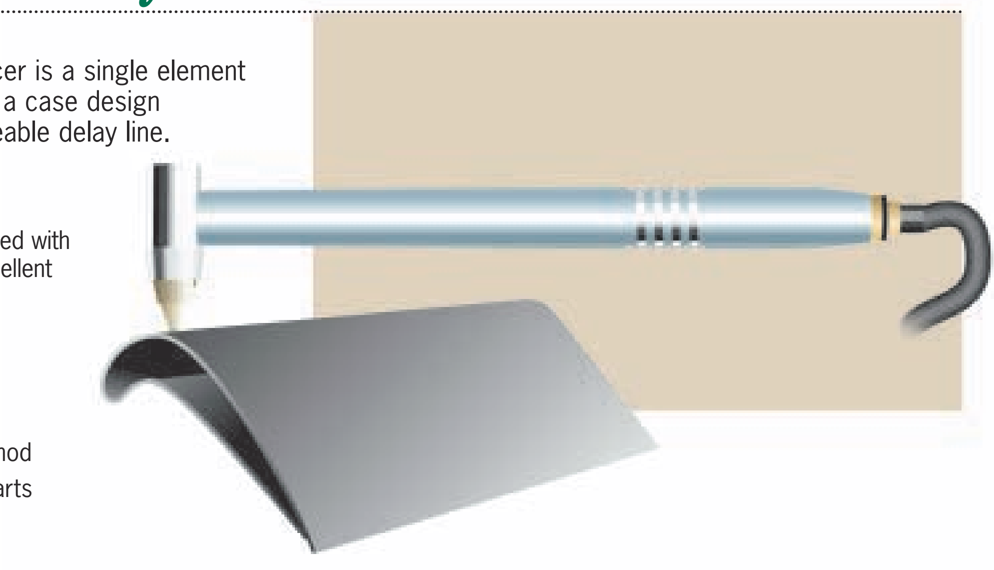
CID (Circumferential Inside Diameter)



COD (Circumferential Outside Diameter)

Replaceable Delay Line Transducers

A replaceable delay line transducer is a single element Videoscan transducer which has a case design configured for use with a replaceable delay line.



Advantages:

- Heavily damped transducer combined with the use of a delay line provides excellent near surface resolution
- Higher transducer frequency improves resolution
- Improves the ability to measure thin materials or find small flaws while using the direct contact method
- Contouring available to fit round parts

Applications:

- Precision thickness gaging
- Straight beam flaw detection
- Inspection of parts with limited contact areas

Delay Line Transducers

- Each transducer comes with a room temperature delay line and retaining ring
- High temperature and dry couple delay lines are available

Frequency MHz	Nominal Element Size	Transducer Part Numbers
2.25	0.25" 6mm	V204-RM
5.0	0.50" 13mm 0.25" 6mm	V206-RM V201-RM
10	0.25" 6mm 0.125" 3mm	V202-RM V203-RM
15	0.25" 6mm	V205-RM
20	0.125" 3mm	V208-RM

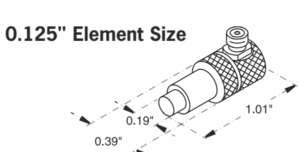
Sonopen® Transducer

- Focused replaceable delay line
- Extremely small tip diameter may improve performance on curved surfaces and small indentations
- Microdot handle for easier positioning of transducer head

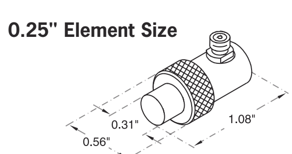
Frequency MHz	Nominal Element Size	Transducer Part Numbers		Delay Line Part Numbers
		Straight Handle	Right Angle Handle	0.080" Tip (2.0mm)
15	0.125" 3mm	V260-SM	V260-RM	DLP-3

Delay Line Transducer

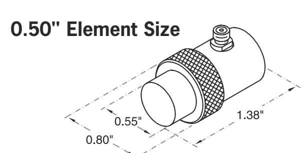
0.125" Element Size



0.25" Element Size



0.50" Element Size



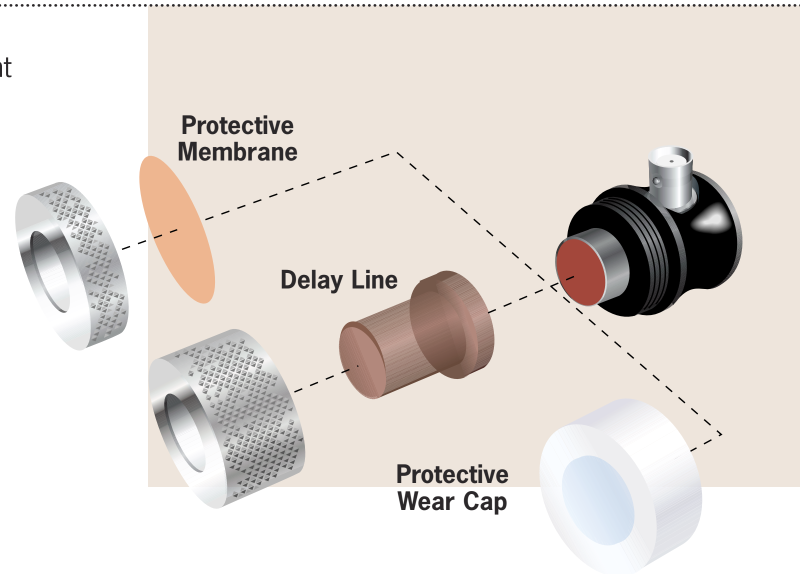
Replaceable Delay Line Options

Transducer Nominal Element Size	Standard Delay Line	Dry Couple Delay Line	Spare Retaining Ring	High Temperature 350°F Max (175°C)	High Temperature 500°F Max* (260°C)	High Temperature Spring Loaded Holders
0.50" 13mm	DLH-2	DLS-2	DRR-2	DLHT-201	DLHT-2	2130
0.25" 6mm	DLH-1	DLS-1	DRR-1	DLHT-101	DLHT-1	2127 & DRR-1H
0.125" 3mm	DLH-3	DLS-3	DRR-3	DLHT-301	DLHT-3	2133 & DRR-3H

** For higher temperature delay lines, please consult Panametrics.*

Protected Face Transducers

A protected face transducer is a single element longitudinal wave contact transducer which can be used with either a delay line, protective membrane, or protective wear cap.



Advantages:

- Provide versatility by offering removable delay line, protective wear cap, and protective membrane
- When the transducer is used alone (without any of the options), the epoxy wear face provides good acoustic impedance matching into plastics, many composites, and other low impedance materials
- Cases are threaded for easy attachment to the delay line, protective membrane, and wear cap options

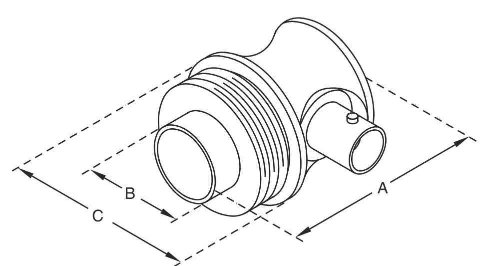
Applications:

- Straight beam flaw detection
- Thickness gaging
- High temperature inspections
- Inspection of plates, billets, bars, and forgings

Standard Protected Face

- Comfort Fit Sleeves are designed to be easily held and provide steady grip while wearing gloves
- Standard connector style Right Angle BNC (RB), may be available in Straight BNC (SB)
- Transducer sold separately from the delay line, protective membrane, and wear cap options

Frequency MHz	Nominal Element Size	Transducer Part Numbers		
		ACCUSCAN-S	ACCUSCAN-R	VIDEOSCAN
0.5	1.50" 38mm	A689S-RB	A689R-RB	V689-RB
	1.125" 29mm	A691S-RB	A691R-RB	V691-RB
	1.00" 25mm	A601S-RB	A601R-RB	V601-RB
1.0	1.50" 38mm	A692S-RB	A692R-RB	V692-RB
	1.125" 29mm	A694S-RB	A694R-RB	V694-RB
	1.00" 25mm	A602S-RB	A602R-RB	V602-RB
	0.75" 19mm	A614S-RB	A614R-RB	V614-RB
	0.50" 13mm	A603S-RB	A603R-RB	V603-RB
2.25	1.50" 38mm	A695S-RB	A695R-RB	V695-RB
	1.125" 29mm	A697S-RB	A697R-RB	V697-RB
	1.00" 25mm	A604S-RB	A604R-RB	V604-RB
	0.75" 19mm	A605S-RB	A605R-RB	V605-RB
	0.50" 13mm	A606S-RB	A606R-RB	V606-RB
3.5	1.00" 25mm	A680S-RB	A680R-RB	V680-RB
	0.75" 19mm	A681S-RB	A681R-RB	V681-RB
	0.50" 13mm	A682S-RB	A682R-RB	V682-RB
5.0	1.00" 25mm	A607S-RB	A607R-RB	V607-RB
	0.75" 19mm	A608S-RB	A608R-RB	V608-RB
	0.50" 13mm	A609S-RB	A609R-RB	V609-RB
10	0.50" 13mm	A611S-RB	A611R-RB	V611-RB



Nominal Element Size	(A)	(B)	(C)
1.50"	1.53"	2.25"	1.75"
1.125"	1.53"	1.81"	1.38"
1.00"	1.53"	1.63"	1.25"
0.75"	1.53"	1.41"	0.99"
0.50"	1.53"	1.19"	0.63"

1 inch = 25.4mm

High Temperature Delay Line Options

- ❖ Allows for intermittent contact with hot surfaces*
- ❖ Improves near surface resolution
- ❖ Improves coupling into difficult to penetrate composites and other low impedance materials
- ❖ Contouring of delay lines provides better coupling on curved surfaces
- ❖ Warm temperature delay lines (WTD) can be used for room temperature applications

Special delay lines available for 1.25" and 1.50" element size.

Transducer Nominal Element Size	Delay Line Retaining Ring	350°F max. (175°C)	500°F max. (260°C)	900°F max. (480°C)
1.00" 25mm	DRN-3	WTD-3-x	HTD-3-x	VHTD-3-x
0.75" 19mm	DRN-4	WTD-4-x	HTD-4-x	VHTD-4-x
0.50" 13mm	DRN-5	WTD-5-x	HTD-5-x	VHTD-5-x

****Recommended usage cycle is ten seconds maximum contact followed by one minute of air cooling. However, the transducer itself should not be heated above 140ºF (60ºC).***

Note: X = standard delay line lengths, available in 1/2″ (13mm), 1″ (25mm), 1-1/2″ (38mm). Specify at time of ordering.

Note: For the delay lines above, a room temperature material longitudinal wave velocity of 0.100 in/µsec ±0.005 in/µsec may be used as an approximation for basic calculations. This value should not be used for engineering design calculations. Please consult Panametrics with any questions.

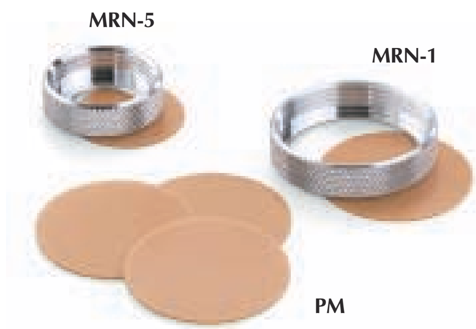
Protective Wear Cap Option

- ❖ The nylon wear cap provides an economical solution in applications requiring scanning or scrubbing of rough surfaces
- ❖ Contouring of wear caps provides better coupling on curved surfaces

Transducer Nominal Element Size		Protective Wear Caps
1.50"	38mm	NWC-1
1.125"	29mm	NWC-2
1.00"	25mm	NWC-3
0.75"	19mm	NWC-4
0.50"	13mm	NWC-5

Protective Membrane Option

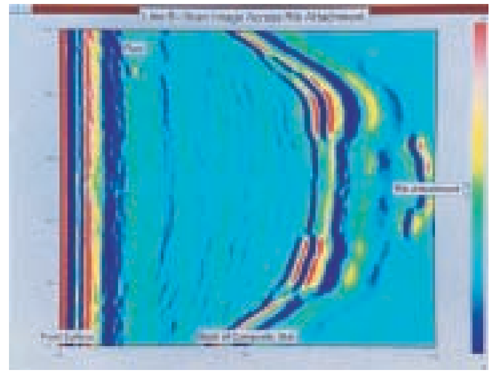
- ❖ Improves coupling on rough or uneven surfaces
- ❖ Dry couple to smooth, clean surfaces



Transducer Nominal Element Size		Membranes Only* (pkg of 12)	(pkg of 60)	Membrane Retaining Ring	Kits (12 Membranes, 1 ring, C-2 couplant)
1.50"	38mm	PM-1-12	PM-1-60	MRN-1	PMK-1
1.125"	29mm	PM-2-12	PM-2-60	MRN-2	PMK-2
1.00"	25mm	PM-3-12	PM-3-60	MRN-3	PMK-3
0.75"	19mm	PM-4-12	PM-4-60	MRN-4	PMK-4
0.50"	13mm	PM-5-12	PM-5-60	MRN-5	PMK-5

** Available in 36" x 36" x 1/32" sheets. Order part number NPD-665-3101.*

Immersion Transducers



An immersion transducer is a single element longitudinal wave transducer with a 1/4 wavelength layer acoustically matched to water. It is specifically designed to transmit ultrasound in situations where the test part is partially or wholly immersed.

Advantages:

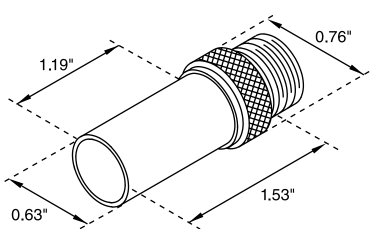
- The immersion technique provides a means of uniform coupling
- Quarter wavelength matching layer increases sound energy output
- Corrosion resistant 303 stainless steel case with chrome-plated brass connectors
- Proprietary RF shielding for improved signal-to-noise characteristics in critical applications
- All immersion transducers, except paintbrush, may be focused spherically (spot) or cylindrically (line)
- Customer specified focal length concentrates the sound beam to increase sensitivity to small reflectors; many popular focal lengths are kept in stock
- Cylindrical contour correction reduces interface ringdown on tubing and bar stock

Applications:

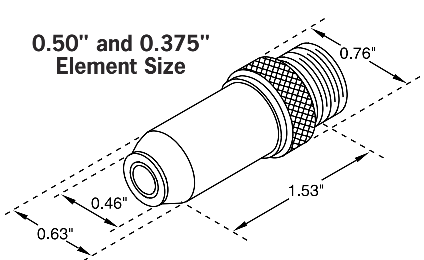
- Automated scanning
- On-line thickness gaging
- High speed flaw detection in pipe, bar, tube, plate, and other similar components
- Time-of-flight and amplitude based imaging
- Thru-transmission testing
- Material analysis and velocity measurements

Standard Case Style

- Knurled case with Straight UHF connector (SU)
- Consult Panametrics for nonknurled case design and availability of other connector styles
- Frequencies ranging from 1.0-25MHz



0.50" and 0.375" Element Size



0.25" and 0.125" Element Size

Frequency MHz	Nominal Element Size	Transducer Part Numbers		
		ACCUSCAN-S	ACCUSCAN-R	VIDEOSCAN
1.0	0.50" 13mm	A303S-SU	A303R-SU	V303-SU
2.25	0.50" 13mm 0.375" 10mm 0.25" 6mm	A306S-SU — —	A306R-SU — —	V306-SU V325-SU V323-SU
3.5	0.50" 13mm 0.375" 10mm 0.25" 6mm	A382S-SU — —	A382R-SU — —	V382-SU V383-SU V384-SU
5.0	0.50" 13mm 0.375" 10mm 0.25" 6mm	A309S-SU A326S-SU A310S-SU	A309R-SU A326R-SU A310R-SU	V309-SU V326-SU V310-SU
7.5	0.50" 13mm	A320S-SU	A320R-SU	V320-SU
10	0.50" 13mm 0.375" 10mm 0.25" 6mm	A311S-SU A327S-SU A312S-SU	A311R-SU A327R-SU A312R-SU	V311-SU V327-SU V312-SU
15	0.50" 13mm 0.375" 10mm 0.25" 6mm	A319S-SU — A313S-SU	A319R-SU — A313R-SU	V319-SU V328-SU V313-SU
20	0.25" 6mm 0.125" 3mm	— —	— —	V317-SU V316-SU
25	0.25" 6mm	—	—	V324-SU

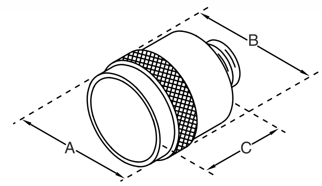
 PANAMETRICS, INC. Phone (781) 899-2719 • Fax (781) 899-1552 • Website: www.panametrics.com • E-mail: ndt@panametrics.com

Large Diameter Case Style

- Large element diameters increase near field length allowing for longer focal lengths
- Larger diameters can increase scanning index
- Low frequency, large aperture designs available for challenging applications

Large Diameter

Frequency MHz	Nominal Element Size	Transducer Part Numbers		
		ACCUSCAN-S	ACCUSCAN-R	VIDEOSCAN
0.5	1.50" 38mm 1.125" 29mm 1.00" 25mm 0.75" 19mm	A389S-SU A391S-SU A301S-SU —	A389R-SU A391R-SU A301R-SU —	V389-SU V391-SU V301-SU V318-SU
1.0	1.50" 38mm 1.125" 29mm 1.00" 25mm 0.75" 19mm	A392S-SU A394S-SU A302S-SU A314S-SU	A392R-SU A394R-SU A302R-SU A314R-SU	V392-SU V394-SU V302-SU V314-SU
2.25	1.50" 38mm 1.125" 29mm 1.00" 25mm 0.75" 19mm	A395S-SU A397S-SU A304S-SU A305S-SU	A395R-SU A397R-SU A304R-SU A305R-SU	V395-SU V397-SU V304-SU V305-SU
3.5	1.00" 25mm 0.75" 19mm	A380S-SU A381S-SU	A380R-SU A381R-SU	V380-SU V381-SU
5.0	1.00" 25mm 0.75" 19mm	A307S-SU A308S-SU	A307R-SU A308R-SU	V307-SU V308-SU
7.5	0.75" 19mm	A321S-SU	A321R-SU	V321-SU
10	1.00" 25mm 0.75" 19mm	— A315S-SU	— A315R-SU	V322-SU V315-SU



Nominal Element Size	(A)	(B)	(C)
1.50"	1.75"	1.81"	1.50"
1.125"	1.38"	1.44"	1.25"
1.00"	1.25"	1.31"	1.25"
0.75"	1.00"	1.06"	1.25"

Reflector Mirrors

- Directs sound beam when a straight-on inspection is not possible
- Standard mirrors provide a 90° reflection of the sound beam

Case Style	Incident Angle	Part Numbers
Standard	45°	F102
Slim Line	45°	F132
Pencil	45°	F198

Note: For other reflected angles, consult Panametrics.

Immersion Search Tubes

- Provides an easy and quick way to fixture and manipulate immersion transducers

Part Numbers	Length		Connectors	Outside Diameter	
F112	1.5"	38mm	UHF to UHF	0.738"	18.75mm
F113	2"	51mm	UHF to UHF	0.738"	18.75mm
F114	3"	76mm	UHF to UHF	0.738"	18.75mm
F115	6"	152mm	UHF to UHF	0.738"	18.75mm
F116	8"	203mm	UHF to UHF	0.738"	18.75mm
F117	12"	305mm	UHF to UHF	0.738"	18.75mm
F118	18"	457mm	UHF to UHF	0.738"	18.75mm
F119	24"	610mm	UHF to UHF	0.738"	18.75mm
F120	30"	762mm	UHF to UHF	0.738"	18.75mm
F211	12"	305mm	Microdot to Microdot	0.312"	7.92mm

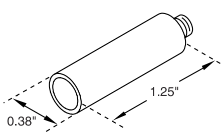
For more technical information please refer to the following pages:

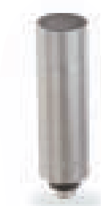
Bubblers and Couplants page 30
Theory on Focusing page 37-38
Table of Near Field Distances page 40

Slim Line Case Style

- ❖ Stainless steel case is only 0.38" (10mm) in diameter, ideal for limited access areas
- ❖ Standard connector style is Straight Microdot Connector (SM)
- ❖ Available in 0.25" (6mm) and 0.125" (3mm) element diameters

Frequency MHz	Nominal Element Size	Transducer Part Numbers		
		ACCUSCAN-S	ACCUSCAN-R	VIDEOSCAN
2.25	0.25" 6mm	—	—	V323-SM
3.5	0.25" 6mm	—	—	V384-SM
5.0	0.25" 6mm	A310S-SM	A310R-SM	V310-SM
10	0.25" 6mm	A312S-SM	A312R-SM	V312-SM
15	0.25" 6mm	A313S-SM	A313R-SM	V313-SM
20	0.25" 6mm 0.125" 3mm	— —	— —	V317-SM V316-SM
25	0.25" 6mm	—	—	V324-SM



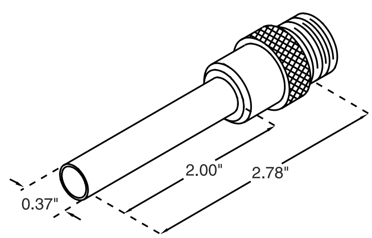


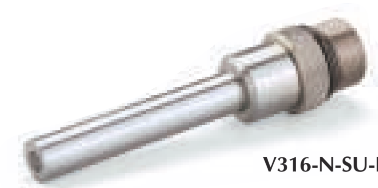
V312-SM

Pencil Case Style

- ❖ Small diameter, 2" (51mm) long barrel improves access to difficult-to-reach areas
- ❖ Standard connector style is Straight UHF Connector (SU)
- ❖ Ideal for applications such as bolt holes or the inside of tubes

Frequency MHz	Nominal Element Size	Transducer Part Numbers		
		ACCUSCAN-S	ACCUSCAN-R	VIDEOSCAN
2.25	0.25" 6mm	—	—	V323-N-SU
3.5	0.25" 6mm	—	—	V384-N-SU
5.0	0.25" 6mm	A310S-N-SU	A310R-N-SU	V310-N-SU
10	0.25" 6mm	A312S-N-SU	A312R-N-SU	V312-N-SU
15	0.25" 6mm	A313S-N-SU	A313R-N-SU	V313-N-SU
20	0.25" 6mm 0.125" 3mm	— —	— —	V317-N-SU V316-N-SU
25	0.25" 6mm	—	—	V324-N-SU





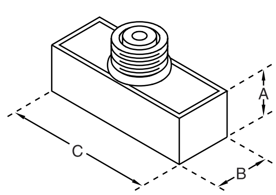
V316-N-SU-F

Accuscan Paintbrush

- ❖ Large scanning index is ideal for inspections of aluminum or steel plate
- ❖ Sensitivity uniformity of better than ±1.5dB is maintained across the transducer face (sensitivity peaks at the edges are also controlled)

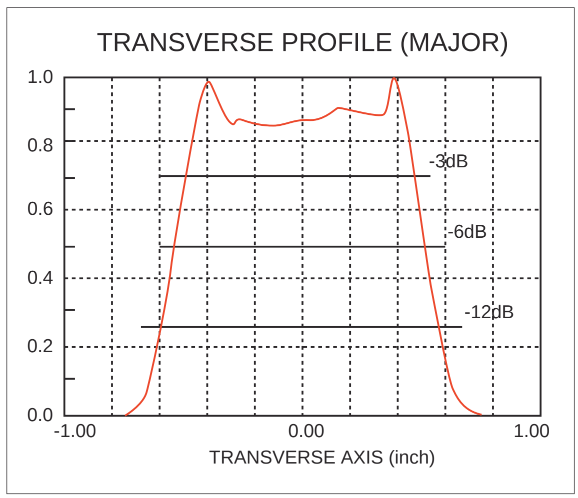
Frequency MHz	Nominal Element Size	Transducer Part Numbers
2.25 3.5 5.0 7.5 10	1.50" x 0.25" 38 x 6mm	A330S-SU A331S-SU A332S-SU A333S-SU A334S-SU
2.25 3.5 5.0 7.5 10	2.00" x 0.25" 51 x 6mm	A340S-SU A341S-SU A342S-SU A343S-SU A344S-SU

Note: Certification of beam uniformity is included with each transducer.



Nominal Element Size	(A)	(B)	(C)
2.00" x 0.25"	0.82"	0.75"	2.50"
1.50" x 0.25"	0.82"	0.75"	2.00"

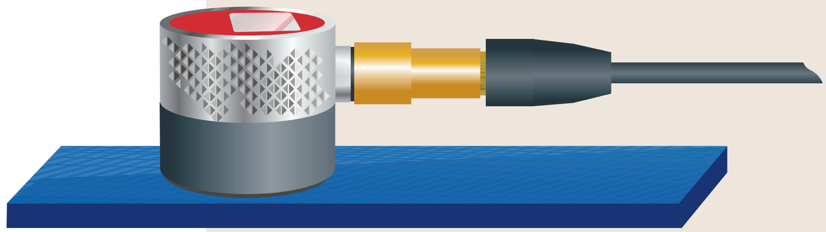
For 7.5MHz and 10MHz, case height (A) is 0.62". 1 inch = 25.4mm.



A334S-SU

Normal Incidence Shear Wave Transducers

These single element contact transducers introduce shear waves directly into the test piece without the use of refraction.



Panametrics recommends the use of our SWC shear wave couplant for general purpose testing.

Advantages:

- The ratio of the longitudinal to shear wave components is generally below -30dB
- Generate shear waves which propagate perpendicular to the test surface
- For ease of alignment, the direction of the polarization of shear wave is nominally in line with the right angle connector

Applications:

- Shear wave velocity measurements
- Calculation of Young's Modulus of elasticity and shear modulus (see Technical Notes for formulas)
- Characterization of material grain structure

Direct Contact Series

- WC-5 wear plate increases durability and wear resistance
- Available in both the Standard and Fingertip case styles
- 303 stainless steel case
- Straight Microdot (SM) connectors and Straight BNC (SB) connectors, as well as others, can be special ordered

Frequency MHz	Nominal Element Size	Transducer Part Numbers	
		Standard Case	Fingertip Case
0.1	1.00" 25mm	V1548	—
0.25	1.00" 25mm	V150-RB	V150-RM
0.5	1.00" 25mm	V151-RB	V151-RM
1.0	1.00" 25mm 0.50" 13mm	V152-RB V153-RB	V152-RM V153-RM
2.25	0.50" 13mm	V154-RB	V154-RM
5.0	0.50" 13mm 0.25" 6mm 0.125" 3mm	V155-RB — —	V155-RM V156-RM V157-RM

For dimensions, see Contact Transducers on pages 4 and 5.

Delay Line Series

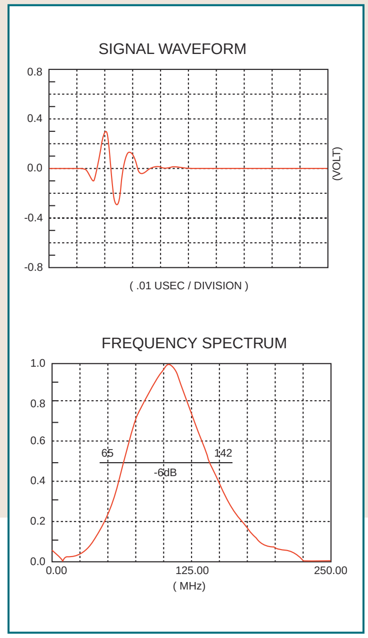
- Integral delay line permits measurements at higher frequencies
- Fused silica delay line minimizes attenuation and provides physical protection to the crystal element

Frequency MHz	Nominal Element Size	Delay Time	Transducer Part Numbers
5.0	0.25" 6mm	7µsec	V220-BA-RM
10	0.25" 6mm	7µsec	V221-BA-RM
20	0.25" 6mm 0.25" 6mm 0.25" 6mm	7µsec 7µsec 4µsec	V222-BA-RM V222-BB-RM V222-BC-RM

For dimensions, see High Frequency Contact Transducers on page 20.

High Frequency Transducers

High frequency transducers are single element contact or immersion transducers which are designed to produce frequencies of 20MHz and greater.



Advantages:

- Heavily damped broadband design provides excellent time resolution
- Short wavelengths for superior flaw resolution capabilities
- Focusing allows for very small beam diameters
- Frequencies range from 20MHz to 150MHz, for higher frequencies consult Panametrics

Applications:

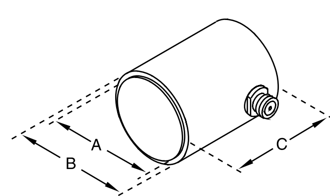
- High resolution flaw detection such as inspection for microporosity or microcracks
- C-Scan imaging of surface breaking cracks or irregularities
- Thickness measurements of materials as thin as 0.001" (0.01mm)
- Examination of ceramics and advanced engineering materials
- Materials analysis
- Acoustic microscopy

Panametrics also manufactures high frequency immersion polymer transducers, see page 24.

High Frequency Contact Transducers

- Permanent fused silica delay line allows for flaw evaluation, material analysis or thickness measurements using a direct contact testing method
- Three different delay line configurations (BA, BB, BC) allow for various combinations of delay line echoes
- Standard connector style is Right Angle Microdot (RM)

Frequency MHz	Nominal Element Size		Delay µsec	Transducer Part Numbers
20	0.25"	6mm	4.25	V212-BA-RM
	0.25"	6mm	4.25	V212-BB-RM
	0.25"	6mm	2.5	V212-BC-RM
30	0.25"	6mm	4.25	V213-BA-RM
	0.25"	6mm	4.25	V213-BB-RM
	0.25"	6mm	2.5	V213-BC-RM
50	0.25"	6mm	4.25	V214-BA-RM
	0.25"	6mm	4.25	V214-BB-RM
	0.25"	6mm	2.5	V214-BC-RM
	0.125"	3mm	4.25	V215-BA-RM
	0.125"	3mm	4.25	V215-BB-RM
	0.125"	3mm	2.5	V215-BC-RM
75	0.25"	6mm	2.5	V2022 (BC)
	0.125"	3mm	2.5	V2025 (BC)
100	0.125"	3mm	4.25	V2054 (BA)
	0.125"	3mm	2.5	V2012 (BC)
125	0.125"	3mm	2.5	V2062



Delay Style	(A)	(B)	(C)
BA	0.72"	0.81"	1.00"
BB	0.34"	0.44"	0.81"
BC	0.34"	0.44"	0.63"

1 inch = 25.4mm

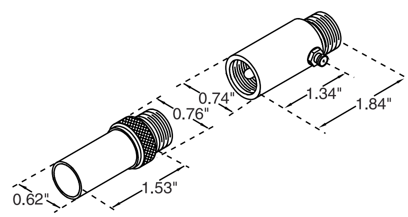
High Frequency Standard Immersion Case Style

- ❖ Permanent internal delay line
- ❖ Focused units use an optical quality ground lens
- ❖ F202 adaptor allows fixturing with the UHF connector while making an electrical connection with the microdot connector (see drawing, also page 29)
- ❖ Combines high frequency with a small case design

V358-SU

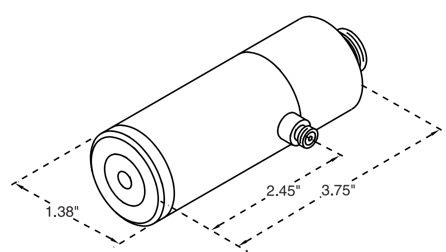
Frequency MHz	Nominal Element Size		Delay μsec	Focal Length		Transducer Part Numbers
20	0.25"	6mm	4.25	flat		V354-SU
	0.25"	6mm	2.5	0.75"	19mm	V372-SU
	0.25"	6mm	4.25	1.25"	32mm	V373-SU
	0.25"	6mm	4.25	2.00"	51mm	V374-SU
30	0.25"	6mm	4.25	flat		V356-SU
	0.25"	6mm	2.5	0.75"	19mm	V375-SU
	0.25"	6mm	4.25	1.25"	32mm	V376-SU
	0.25"	6mm	4.25	2.00"	51mm	V377-SU
50	0.25"	6mm	4.25	flat		V358-SU

V358-SU with F202 adaptor



High Frequency SU/RM Immersion Case Style

- ❖ Permanent fused silica delay with an optical quality ground lens provides a high degree of precision in beam alignment and focusing
- ❖ Stainless steel case has a passive Straight UHF (SU) connector and an active Right Angle Microdot (RM) connector
- ❖ Large cases allow for larger delay lines and decrease in delay reverberations and noise



Frequency MHz	Nominal Element Size		Delay µsec	Focal Length		Transducer Part Numbers
50	0.25"	6mm	19.5	0.50"	13mm	V390-SU/RM
	0.25"	6mm	19.5	0.75"	19mm	V3192
	0.25"	6mm	19.5	1.00"	25mm	V3193
	0.25"	6mm	19.5	1.75"	45mm	V3409
	0.25"	6mm	19.5	2.00"	51mm	V3337
	0.25"	6mm	9.4	0.20"	5mm	V3330*
	0.125"	3mm	19.5	0.50"	13mm	V3332
75	0.25"	6mm	19.5	0.50"	13mm	V3320
	0.25"	6mm	19.5	0.75"	19mm	V3349
90	0.25"	6mm	19.5	0.50"	13mm	V3512
100	0.25"	6mm	19.5	0.50"	13mm	V3194
	0.25"	6mm	19.5	1.00"	25mm	V3394
	0.25"	6mm	9.4	0.20"	5mm	V3534*
	0.125"	3mm	10.0	0.25"	6mm	V3346

***** *Transducers create surface waves in steel, titanium and other materials with similar velocities.*

V3194 with F109 transformer

Special Transducers

RTD Transducers

RTD Transducers are well known in the nuclear industry for inspection of critical weld areas in pipes and pressure vessels. Panametrics is the exclusive North American Representative for this special line of transducers manufactured by RTD in the Netherlands. The realm of applications for these transducers is extensive: inspection of coarse grain austenitic steel, location of undercladding cracks, detection and sizing of IGSCC, automated scanning of pipe and pressure vessels, and continuous high temperature applications.

Captive Water Column Transducers

Captive Water Column Transducers incorporate a replaceable pliable membrane which holds a small column of water in front of a flat or focused immersion transducer. The membrane will conform to the concave surface of the test piece. One of the most common applications for these transducers is spot weld evaluation. In addition to the captive water column assembly, replaceable delay lines may be purchased for use with these transducers in spot weld or other special applications. Delays may be modified upon request to fit specific sizes required. Ask for Spotweld Application Note.

Delay Line Transducers with Handle Assembly

These transducers are used to reach into areas of limited access such as adjacent turbine blades. The swivel head improves contact in tight areas.

CDS Wedges

CDS Wedges are used in the "30-70-70" technique for crack detection and sizing. They are compatible with our replaceable miniature screw-in angle beam transducers, making them an economical alternative to other commercially available products. Ask for Transducer Update #10.

Handheld Bubbler Transducer Assembly

Handheld bubbler transducers are available in either 20MHz (V316B) or 10MHz (V312B). They are immersion transducers that screw onto a bubbler (B120) which has a replaceable stainless steel tip. They offer high resolution and easy access inspection of thin materials. The V316B and bubbler combination can resolve thicknesses down to 0.008" (0.2mm). For more information, ask for Transducer Update #8A.

500KHz Broadband/ Highly Damped Transducers

This highly damped transducer measures the thickness of fiberglass, composites, and other attenuating materials. This transducer can also be used with a NWC-302 Nylon Wear Cap for flaw detection on thick or rough surfaced casting materials.

Magnetic Hold-Down Transducers

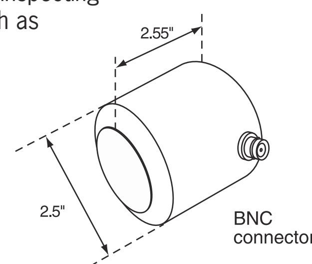
Incorporated in this transducer design is a magnetic ring around the case for stationary hands-free positioning on ferrous structures. These transducers are available in several frequencies and case sizes with newly designed magnetic rings for stronger coupling.

Low Frequency Narrowband Transducers

Meant for use in pairs for through transmission in materials such as concrete, wood, and geological samples, these are available in frequencies of 50KHz (X1021), 100KHz (X1020), and 180KHz (X1019). Recommended instruments are high voltage pulser-receivers such as Panametrics 5058PR.

100KHz and 250KHz Low Frequency Broadband Transducers

These transducers are capable of inspecting difficult to penetrate materials such as fiberglass, composites, wood, and other highly attenuating materials and geological samples in pulse-echo mode.



Combination Longitudinal/Shear Mode Transducers

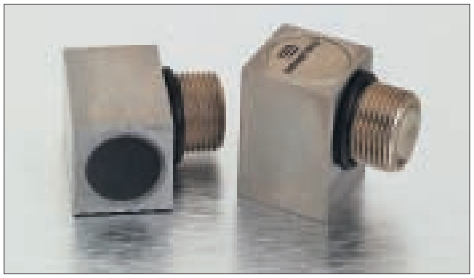
These transducers generate simultaneous longitudinal waves and shear waves in either single element, dual element or three element arrangement. They can be custom designed for different frequencies and element sizes.

Variable Angle Beam Wedge

The Variable Angle Beam Wedge allows the user to adjust the incident angle from 0° to 50° to create refracted angles in steel from 0° to 90°. The wedge is to be used with the Panametrics 0.50" x 1.00" Standard Angle Beam Transducers (see page 10).

Right Angle UHF Immersion Transducers

These immersion transducers have a stainless steel rectangular case with the UHF connector mounted at a 90° angle to the front face of the transducer, available in 0.25", 0.375" and 0.50" elements.



Low Temperature Contact Transducers

These transducers are designed for ultrasonic inspection in very cold environments such as thickness measurements of ice.

Polymer Transducers

Polymer transducers have become more popular in recent years due to their inherent broadband characteristic which results in a comparatively higher resolution transducer. Furthermore, the close impedance match of polymers to water produces a better transfer of sound energy. One of the major advantages of high frequency polymer transducers is the elimination of permanent delay lines and their associated echoes.

Extra Miniature (XMS) Transducer

The XMS transducer is an extremely small immersion transducer with a 3mm (0.118") diameter by 3mm (0.118") long case. This transducer is ideal for extremely tight access areas or for multi-element array flaw detection. The transducer assembly has a special Microtech connector attached to the 1m (38") long potted cable. A Microtech to BNC or Large Lemo adaptor is also available to interface with most commercial ultrasonic equipment.

Side-Looking Immersion Transducers and 90° Reflector Mirrors

These transducers and mirrors are suitable for tube inspection from the ID or other limited access applications. Standard side-looking transducers are available in frequencies of 10MHz (V3591) and 20MHz (V3343).

150MHz Transducers

150MHz transducers are available as immersion or contact transducers. Performance is dependent on pulser/receiver and application. All transducers are manufactured on a special basis to customer specifications. To discuss applications, please consult Panametrics.

Lightweight High Frequency Immersion Transducers

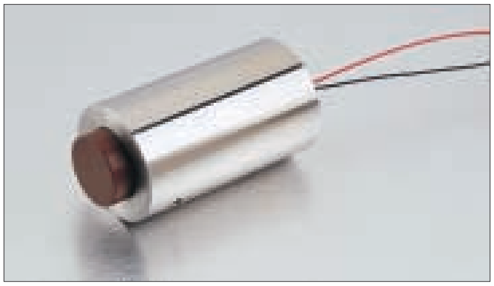
These transducers are an alternative to the Panametrics SU/RM case style transducers (see page 21). They offer a smaller case width and lighter weight without sacrificing performance.

Radiation Resistant Transducers

Designed to withstand radiation up to 100 Mrad total integrated radiation dose, these immersion transducers have an integral potted cable and can be ordered either focused or flat.

Continuous High Temperature Delay Line Transducers

These transducers can continuously withstand temperatures as high as 350°F (175°C) and pressures up to 85 PSIG. One typical application is to monitor the cure of materials in autoclave.



Extra High Temperature Dual Element Transducers

These dual element transducers are specifically designed to be used intermittently on surfaces up to 932°F (500°C) with minimal zero offset drift. They are compatible with all commercially available flaw detectors.

Miniature Screw-In and Snap-In Wedges for 2.25MHz Transducers

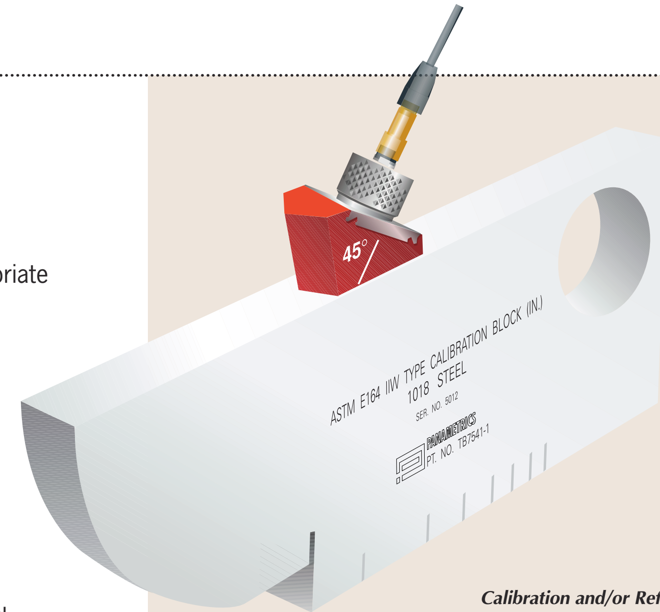
Typically, Snell's Law is used in the design of angle beam wedges. However, Snell's Law fails as a design rule at high angles of incidence/refraction with lower frequency smaller diameter transducers. For this reason, Panametrics offers the following Miniature Screw-In and Snap-In Wedges. We recommend the use of these wedges when using transducers that are 2.25MHz or less and it is important to account for the slight difference in refracted angle.

Nominal Element Size	Wedge Part Numbers Screw-In		Snap-In	
	60°	70°	60°	70°
0.50" 13mm	ABWM-5082T	ABWM-5083T	ABWM-5081	ABWM-5080
0.25" 6mm	ABWM-4119T	ABWM-4120T	ABWM-4069	ABWM-4070

Test Blocks

Panametrics has available a complete selection of calibration and reference blocks.

- ❖ Blocks can be manufactured in a variety of materials
- ❖ Replace the "X" in the part number with the appropriate number listed below to signify block material:
  - 1 = 1018 Steel
  - 2 = 4340 Steel
  - 4 = 7075-T6 Aluminum
  - 5 = 304 Stainless Steel
  - 8 = 6-4 Titanium
- ❖ Blocks manufactured from 1018 steel, 304 Stainless Steel, or 7075-T6 aluminum are commonly in stock. Other materials require special quotes for price and delivery
- ❖ For more information regarding materials not listed, blocks not listed, or custom blocks, please contact Panametrics



Calibration and/or Reference Blocks should be used in every application. Standard blocks are available for angle beam calibrations and thickness calibrations of common materials.

Calibration Blocks

Panametrics has available a complete selection of blocks for calibrating flaw detection systems. All blocks are checked dimensionally using measuring equipment traceable to the National Institute of Standards and Technology, NIST. The most commonly required calibration blocks are listed below.

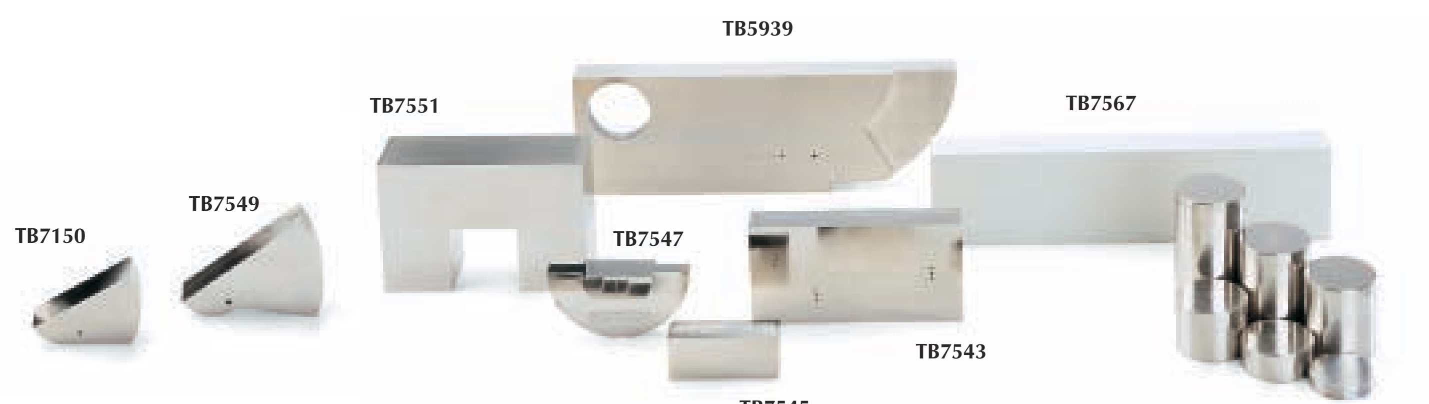
Type	Part Number	Hardwood Case	Description
ASTM E164 Calibration IIW-Type Block	TB7541-x	F129	Meets AASHTO and AWS Type 1 block requirements. Calibrate distance and sensitivity settings. Measure refracted angle and sound exit point of angle beam transducers. U.S. customary units (inches).
	TB1054-x	F129	Metric Units
US Air Force IIW-2 Calibration Block	TB5939-x	F129	IIW-type block per U.S. Air Force NDI Manual T.O. 33B-1-1. Includes 2" and 4" radius cutouts for distance calibration. No. 3, No. 5 and No. 8 side drilled holes, and distance calibration marks to the 2" hole.
RC AWS Block	TB7543-x	F157	Determining resolution capabilities of angle beam transducers per AWS and AASHTO requirements.
SC AWS Block	TB7545-x	F158	Sensitivity and refracted angle calibration per AWS and AASHTO requirements.
DC AWS Block	TB7547-x	F159	Distance and beam index calibration for angle beam transducers per AWS and AASHTO requirements.
DSC AWS Block	TB7549-x	F160	Distance, sensitivity, refracted angle and beam index calibration for angle beam transducers per AWS and AASHTO requirements.
DS AWS Block	TB7551-x	F161	Calibration block for horizontal linearity and dB accuracy procedures per AWS and AASHTO requirements.
30FBH Resolution Reference Block	TB7160-x	Included	Evaluate near surface resolution and flaw size/depth sensitivity of UT equipment. No. 3, No. 5 and No. 8 ASTM flat bottom holes at ten metal travel distances from 0.050" to 1.250".
NAVSHIPS Block	TB7567-x	F162	Contains six No. 3 side drilled holes. Used for distance-amplitude calibration per NAVSHIPS 0900-006-3010.
ASTM E164 MAB Block	TB7150-x	F197	Miniature Angle Beam (ROMPAS) Block. Distance, beam index, refracted angle and sensitivity calibration. One inch thick.
ISO 7963 Steel	TB1065-x	F197	Miniature Angle Beam Block Distance, beam index, refracted angle and sensitivity calibration. 25mm thick.

Reference Blocks

Panametrics offers commonly used sets of reference blocks recommended by ASTM standards. These sets are all manufactured to ASTM E127 and ASTM E428 physical dimensions requirements. All reference blocks are provided with an ultrasonic response curve. We can provide, by special order, materials not listed and individual reference blocks. For more information regarding materials not listed, custom calibration blocks, or quotations on blocks not listed in this section, contact Panametrics.

Type of Set*	Part Number	Description of Set
Distance-Area Amplitude Set	TB6100-X	Set of 10 ASTM blocks per US. Air Force NDI Manual T.O. 33B-1-1. Dead zone, sensitivity, distance and area amplitude linearity measurements. Flat bottom hole sizes and metal travel distances (inches) for this Basic Set per E127 Table 1 are: 3/64 at 3 5/64 at 1/8, 1/4, 1/2, 3/4, 1-1/2, 3, 6 8/64 at 3, 6
Area-Amplitude Set	TB6200-X	Set of 8 ASTM blocks used to determine the relationship between flaw size and echo amplitude by comparing signal responses. Metal travel distance is 3 inches in all 8 blocks. Flat bottom hole diameters (inches) for this Area-Amplitude Set per E127 Table 3 are: 1/64 2/64 3/64 4/64 5/64 6/64 7/64 8/64
Distance-Amplitude Set-No. 3FBH Distance-Amplitude Set-No. 5FBH Distance-Amplitude Set-No. 8FBH	TB6303-X TB6305-X TB6308-X	Set of 19 ASTM blocks all having the same flat bottom hole size. The relationship between metal distance and signal amplitude is determined by comparing the signal responses obtained. Metal travel distances (inches) selected from E127 Table 4 for the Distance-Amplitude Set are: 1/16 1/2 1 2-1/4 3-1/4 4-1/4 5-1/4 1/8 5/8 1-1/4 2-3/4 3-3/4 4-3/4 5-3/4 1/4 3/4 1-3/4 3/8 7/8
Sensitivity-Resolution Set	TB6025-X	Set of 9 ASTM blocks and one special rectangular block used to evaluate the sensitivity, entry surface resolution, and horizontal/vertical linearity characteristics of UT equipment per ASTM E317. Flat bottom hole sizes and metal travel distances (inches) are: 1/64 at 3 2/64 at 3 5/64 at 1/8, 1/4, 3/8, 1/2, 3/4, 1, 1-1/2

** Includes Hardwood case*



Thickness Calibration Blocks

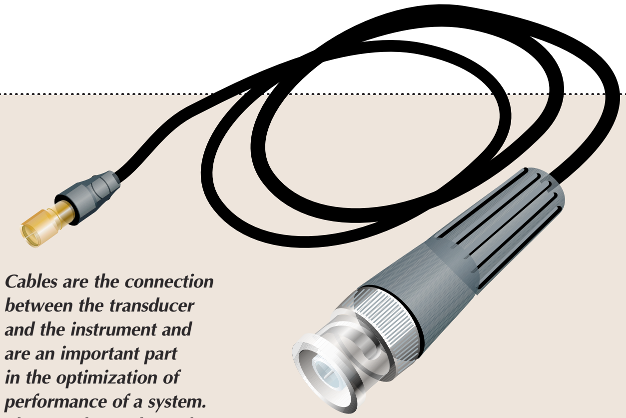
❖ Blocks are held to tighter tolerances than called out in ASTM E797 Code.

Part Numbers	Material	Steps
2211E	304 Stainless Steel	0.100", 0.200", 0.300". 0.400", and 0.500"
2211M	304 Stainless Steel	2.5mm, 5.0mm, 7.5mm, 10.0mm, 12.5mm
2212E	1018 Carbon Steel	0.250", 0.500", 0.750", and 1.00"
2212M	1018 Carbon Steel	6.25mm, 12.5mm, 18.75mm, and 25mm
2213E	7075-T6 Aluminum	0.100", 0.200", 0.300", 0.400", and 0.500"
2213M	7075-T6 Aluminum	2.5mm, 5.0mm, 7.5mm, 10.0mm, 12.5mm
2214E	1018 Carbon Steel	0.100", 0.200", 0.300", 0.400", and 0.500"
2214M	1018 Carbon Steel	2.5mm, 5.0mm, 7.5mm, 10.0mm, 12.5mm

Note: For hardwood case, order 2214C.

Cables and Adaptors

- ❖ Select from a variety of cable grades to meet your specific application needs
- ❖ Standard lengths 3' (1m), 4' (1.2m), 6' (1.8m). When ordering, replace the X in the part number with the desired cable length in feet
- ❖ Custom cable lengths are available, please specify when ordering
- ❖ Part numbering prefix indicates connector style for both ends of the cable
- ❖ Special cables may be manufactured; please consult Panametrics with specifications



Cables are the connection between the transducer and the instrument and are an important part in the optimization of performance of a system. They can be made to almost any length and with any type of connector at the ends.

Standard

Cable Part Numbers	Connector
BCB-58- x	BNC to BNC
BCB-74- x	BNC to BNC
BCM-74- x	BNC to Microdot
BCMA-74- x	BNC to Microdot without Boot
BCRM-74- x	BNC to Right Angle Microdot
BCT-58- x	BNC to TNC
BCU-58- x	BNC to UHF
BCU-62- x	BNC to UHF
FLCB-74- x	Female Lemo to BNC
LCB-74- x	Lemo 00 to BNC
LCM-74- x	Lemo 00 to Microdot
LCU-74- x	Lemo 00 to UHF
L1CB-58- x	Large Lemo to BNC
L1CM-74- x	Large Lemo to Microdot
L1CU-74- x	Large Lemo to UHF
L1CU-74- x	Large Lemo to UHF
UCM-74- x	UHF to Microdot
UCU-58- x	UHF to UHF

Heavy Duty (HD)

- ❖ External teflon coating provides flexibility and improved cable performance in industrial settings

Cable Part Numbers	Connector
BCB-188- x HD	BNC to BNC
BCM-188- x HD	BNC to Microdot
BCU-188- x HD	BNC to UHF
LCB-188- x HD	Lemo 00 to BNC
LCM-188- x HD	Lemo 00 to Microdot

Armored Stainless Steel (SSA)

- ❖ Interlocking stainless steel jacket provides flexibility, protection and ruggedness in heavy industrial settings
- ❖ Can be ordered in lengths up to 25 feet (8m)

Cable Part Numbers	Connector
BCB-188- x SSA	BNC to BNC
BCM-188- x SSA	BNC to Microdot
BCRM-188- x SSA	BNC to Right Angle Microdot
BCU-188- x SSA	BNC to UHF
LCM-188- x SSA	Lemo 00 to Microdot
LCRM-188- x SSA	Lemo 00 to Right Angle Microdot

Double Shielded (DS)

- ❖ Additional grounded shield provides low cable noise for better performance in high frequency applications
- ❖ 15 ohm or 25 ohm cable of different lengths may help to optimize high frequency system performance

Cable Part Numbers	Connector
BCM-74- x DS	BNC to Microdot
BCM-15- x DS	BNC to Microdot
BCM-25- x DS	BNC to Microdot

Cables with Handle

- ❖ Special 3" (75mm) long reinforced handle for increased durability and easier grip
- ❖ Custom handles can be ordered 6" (152mm), 9" (229mm), and 12" (305mm) in length

Cable Part Numbers	Connector
BCMH-74- x	BNC to Microdot
LCMH-74- x	Lemo 00 to Microdot
L1CMH-74- x	Large Lemo to Microdot

Waterproof

❖ Specially designed proprietary waterproof UHF connector provides a waterproof connection good to depths of about 150 feet (50m) in fresh water.

Cable Part Numbers	Connector
BCM-74- x W BCRM -74- x W BCT-74- x W BCU-58- x W BCU-62- x W BCU-74- x W	BNC to Microdot BNC to Right Angle Microdot BNC to TNC BNC to UHF BNC to UHF BNC to UHF
LCM-74- x W LCU-74- x W L1CU-74- x W	Lemo 00 to Microdot Lemo 00 to UHF Large Lemo to UHF

Adaptors

Part Numbers	Description
F108	Right Angle UHF Male to UHF Female,waterproof
F195	45^{o} UHF Male to UHF Female
F202	Active UHF Male to Passive UHF Female/Active Right Angle Microdot Female (see page 21).
F206	UHF to Flange
F267	Right Angle UHF Male to UHF Female,waterproof
BF-BF	BNC Female to BNC Female
BM-BM	BNC Male to BNC Male
BM-UF	BNC Male to UHF Female
L1F-BM	Lemo 1 Female to BNC Male
L1M-BF	Lemo 1 Male to BNC Female
LM-BF	Lemo 00 Male to BNC Female
LF-BM	Lemo 00 Female to BNC Male
MM-UMW	Microdot Male to UHF Male, waterproof
UM-BF	UHF Male to BNC Female
LF-UM	Lemo 00 Female to UHF Male
MM-UFW	Microdot Male to UHF Female, waterproof

Dual

❖ Single cable design with two connectors at each end to fit dual element transducers

Cable Part Numbers	Connector	Compatible With
BCMD-74-6 LCMD-74-6 L1CMD-74-6	Dual BNC to Microdot Dual Lemo 00 to Microdot Dual Large Lemo to Microdot	Standard Dual Transducer
BCMD-316-5B L1CMD-316-5B	Dual BNC to Microdot Dual Large Lemo to Microdot	D790-SM Transducer
BCMD-316-5F L1CMD-316-5F	Dual BNC to Microdot Dual Large Lemo to Microdot	DHC Dual Transducer
BCLPD-78-5 L1CLPD-78-5	Dual BNC to Lepra Con Dual Large Lemo to Lepra Con	MTD-705 Transducer
LCMD-316-5B LCMD-316-5C LCMD-316-5D LCMD-178-5BSSA LCLPD-78-5	For 26 and 36 series thickness gages	D790-SM D791-RM D797-SM D790-SM MTD-705
BCSD-74-6 LCSD-74-6	Dual BNC to Sealelectro Dual Lemo 00 to Sealelectro	D769 and D770

Heavy Duty, Armored PVC (HDAP)

❖ Spiral stainless steel jacket with external solid PVC coating makes this cable very durable

Cable Part Numbers	Connector
BCB-188- x HDAP BCM-188- x HDAP BCU-188- x HDAP	BNC to BNC BNC to Microdot BNC to UHF
LCB-188- x HDAP LCM-188- x HDAP	Lemo 00 to BNC Lemo 00 to Microdot

Heavy Duty, Armored Super Flexible Silicone (HDAS)

❖ Stainless steel jacket with an external silicone coating makes this cable durable, yet flexible

Cable Part Numbers	Connector
BCB-188- x HDAS BCM-188- x HDAS BCU-188- x HDAS	BNC to BNC BNC to Microdot BNC to UHF
LCB-188- x HDAS LCM-188- x HDAS	Lemo 00 to BNC Lemo 00 to Microdot

Bubblers, Couplants

Bubblers

- Allows for immersion testing when complete immersion of parts is not desirable or possible
- Designed to maintain a consistent, low volume flow of water

Part Numbers	Opening	Water Path	Case Style
MPF-B-0.5	0.300" (7.6mm)	1.00" (25.4mm)	Fits 0.125" (3mm) and 0.25" (6mm) standard immersion case
B103*	0.350" (8.9mm)	0.775" (19.9mm)	Fits 0.125" (3mm) and 0.25" (6mm) standard immersion case
B103A*	0.350" (8.9mm)	0.475" (12.1mm)	Fits 0.125" (3mm) and 0.25" (6mm) standard immersion case
B103W	0.550" (14mm)	0.775" (19.7mm)	Fits 0.375" (10mm) and 0.50" (13mm) standard immersion case
B103AW*	0.550" (14mm)	0.475" (12.1mm)	Fits 0.375" (10mm) and 0.50" (13mm) standard immersion cases
B116	0.100" (2.5mm)	variable, min of 0.075" (1.9mm)	Fits SU/RM case style (see page 21)
B117	1.375" (34.3mm)	1.400" (35.6mm)	Fits 1.00" (25.4mm) large diameter immersion case style

Note: The B103 and B103W have a V-notch shaped opening, the B103A and B103AW are flat. All four can be used with the Panametrics RBS-1 Recirculating Bubbler System.

Ultrasonic Couplants

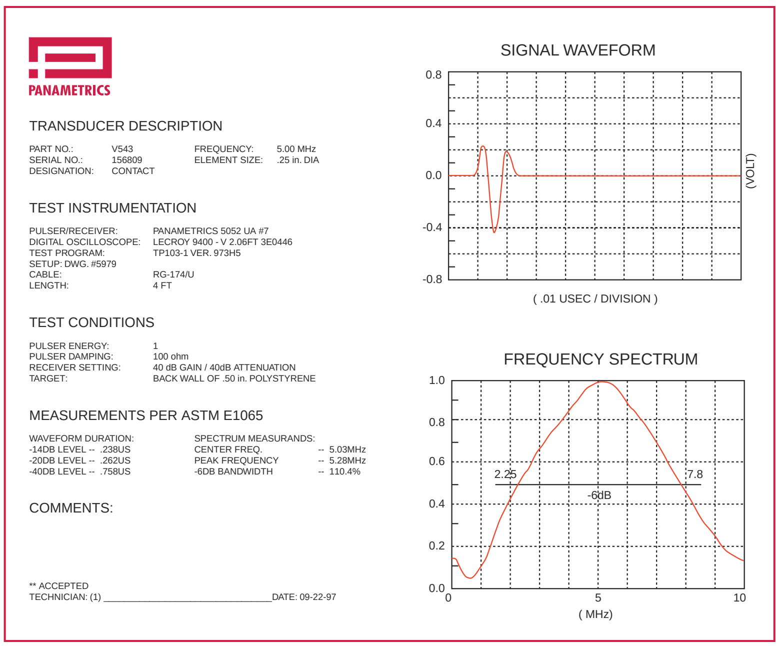
Part Numbers	Description	Volume	Application
A2 AP AQ AG	Propylene Glycol Propylene Glycol Propylene Glycol Propylene Glycol	2 oz. (0.06 liter) 1 pt. (0.47 liter) 1 qt. (0.95 liter) 1 gal. (3.78 liter)	General purpose couplant for smooth surfaces Chemically non-reactive, does not evaporate quickly The max. recommended temp. is 200°F (90°C)
B2 BQ	Glycerin Glycerin	2 oz. (0.06 liter) 1 qt. (0.95 liter)	General purpose, more viscous and has a high acoustic impedance making it the preferred couplant for rough surfaces and highly attenuating materials
C2	Silicone Oil	2 oz. (0.06 liter)	General purpose, non-corrosive, does not evaporate and is insoluble in water
D12 DG D-5G	Gel Type Gel Type Gel Type	12 oz. (0.35 liter) 1 gal. (3.78 liter) 5 gal. (18.90)	Rough surfaces such as sand-cast metals and fiberglass layups Weld inspections, overhead surfaces or vertical walls
E-2 F-2 G-2	Ultratherm Medium Temp Medium Temp	2 oz. (0.06 liter) 2 oz. (0.06 liter) 2 oz. (0.06 liter)	500°F-1000°F (260°C-540°C) 32°F-540°F (0°C-280°C) Remains a stable liquid or paste form, without boiling off. 0°F-600°F (-12°-315°C) Easy removal at high temperatures. Non-toxic and biodegradable
SWC	Shear Wave	4 oz. (0.12 liter)	Normal Incidence Shear Wave, non-toxic, water soluble organic substance of very high viscosity

Test and Documentation

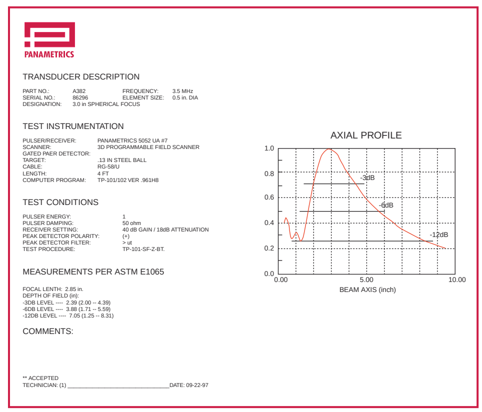
Panametrics is an active leader in the development of transducer characterization techniques and has participated in the development of the AIUM Standard Methods for Testing Single Element Pulse-Echo Ultrasonic Transducers as well as ASTM-E 1065 Standard Guide for Evaluating Characteristics of Ultrasonic Search Units. In addition we have performed characterizations according to AWS, ESI, and many other industrial and military standards. All equipment in our Transducer Test Lab is maintained in compliance with MIL-C-45662A Calibration System Requirements. As part of the documentation process an extensive database containing records of the waveform and spectrum of each transducer is maintained and can be accessed for comparative or statistical studies of transducer characteristics. Panametrics' Test Lab offers a variety of documentation services including waveform and spectrum analysis, axial and transverse beam profiles, beam alignment measurements, and electrical impedance plots. Please consult Panametrics concerning special testing requirements.

Standard Test Forms (TP103)

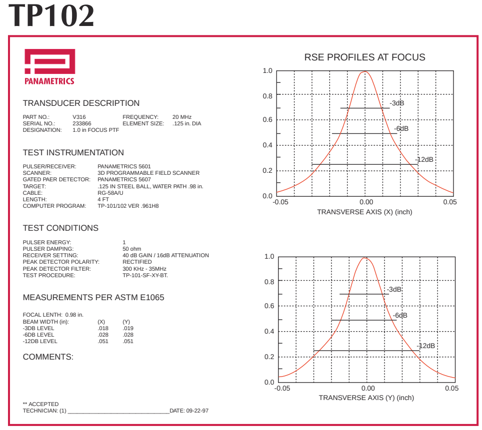
The TP103 Standard Test Form is supplied at no charge with the purchase of every Accuscan and Videoscan Transducer. This form records the actual RF waveform and frequency spectrum for each transducer. Measurements of peak and center frequency, upper and lower -6dB frequencies, bandwidth, and waveform duration are made according to ASTM-E 1065 and are tabulated on the test form.



TP101



TP102



Beam Profiles (TP101 and TP102)

Beam profiles provide valuable information about transducer sound field characteristics. Transverse beam profiles are created by scanning the transducer across a target (usually either a steel ball or rod) at a given distance from the transducer face and are used to determine focal spot size and beam symmetry. Axial beam profiles are created by recording the pulse-echo amplitude of the sound field as a function of distance from the transducer face and provide data on depth of field and focal length.

Beam Alignment Measurements (TP110A)

Beam alignment measurements provide data on the degree of alignment between the sound beam axis and the transducer housing. This information is particularly useful in applications that require a high degree of certainty regarding beam positioning with respect to a mechanical reference surface.

Electrical Impedance Plots (TP104)

Electrical impedance plots provide important information about the design and construction of a transducer and can allow users to obtain electrically similar transducers from multiple sources.

Technical Notes

The Technical Notes section is designed to provide a brief overview of the ultrasonic principles important to transducer application and design. The Technical Notes are organized in the following sections:

1. **BASIC ULTRASONIC PRINCIPLES**
2. **ADVANCED DEFINITIONS AND FORMULAS**
3. **DESIGN CHARACTERISTICS OF TRANSDUCERS**
4. **TRANSDUCER SPECIFIC PRINCIPLES**
5. **TRANSDUCER EXCITATION GUIDELINES**
6. **CABLES**

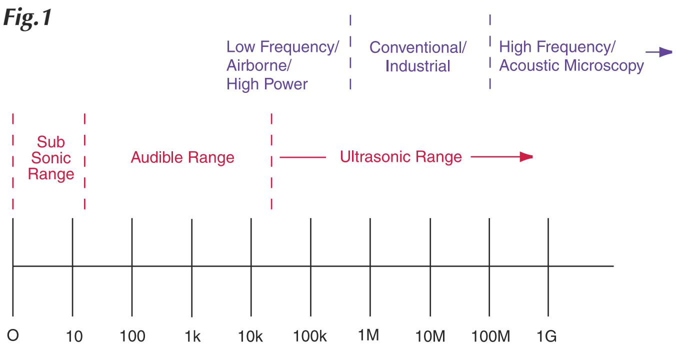
1. BASIC ULTRASONIC PRINCIPLES

a. What is Ultrasound?

Sound generated above the human hearing range (typically 20KHz) is called ultrasound. However, the frequency range normally employed in ultrasonic nondestructive testing and thickness gaging is 100KHz to 50MHz. Although ultrasound behaves in a similar manner to audible sound, it has a much shorter wavelength. This means it can be reflected off very small surfaces such as defects inside materials. It is this property that makes ultrasound useful for nondestructive testing of materials.

The Acoustic Spectrum in Figure (1) breaks down sound into 3 ranges of frequencies. The Ultrasonic Range is then broken down further into 3 sub sections.

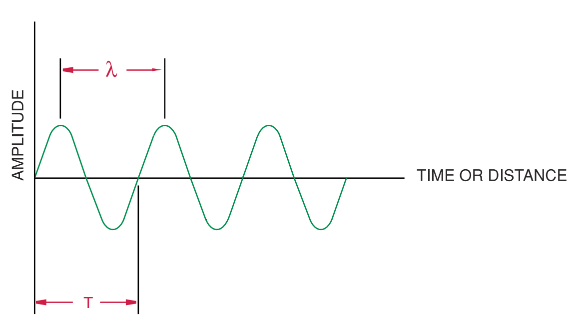
Fig. 1



b. Frequency, Period and Wavelength

Ultrasonic vibrations travel in the form of a wave, similar to the way light travels. However, unlike light waves, which can travel in a vacuum (empty space), ultrasound requires an elastic medium such as a liquid or a solid. Shown in Figure (2) are the basic parameters of a continuous wave (cw). These parameters include the wavelength (λ) and the period (T) of a complete cycle.

Fig. 2



The number of cycles completed in one second is called frequency (f) and is measured in Hertz (Hz), some examples follow;

- 1 cycle/second= 1Hz
- 1000 cycles/second= 1KHz
- 1,000,000 cycles/second= 1MHz

The time required to complete a full cycle is the period (T), measured in seconds. The relation between frequency and period in a continuous wave is given in Equation (1).

Eqn. 1 $f = 1/T$

c. Velocity of Ultrasound and Wavelength

The velocity of ultrasound (c) in a perfectly elastic material at a given temperature and pressure is constant. The relation between c, f, λ and T is given by Equations (2) and (3):

Eqn. 2 $\lambda = c/f$ Eqn. 3 $\lambda = cT$

λ = Wavelength
c = Material Sound Velocity
f = Frequency
T = Period of time

Table 1 on page 40 lists the longitudinal and shear wave velocities of materials that are commonly tested with ultrasonics.

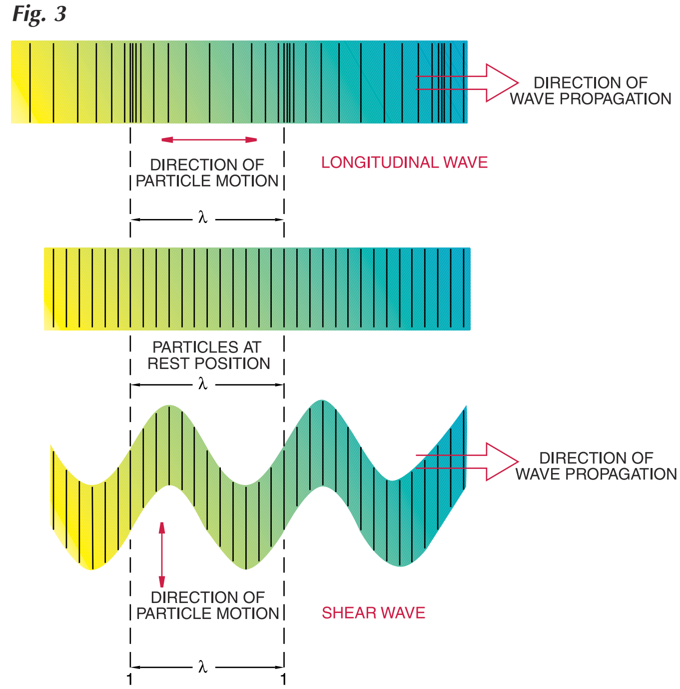
d. Wave Propagation and Particle Motion

The most common methods of ultrasonic examination utilize either longitudinal waves or shear waves. Other forms of sound propagation exist, including surface waves and Lamb waves.

- The longitudinal wave is a compressional wave in which the particle motion is in the same direction as the propagation of the wave.
- The shear wave is a wave motion in which the particle motion is perpendicular to the direction of the propagation.
- Surface (Rayleigh) waves have an elliptical particle motion and travel across the surface of a material. Their velocity is approximately 90% of the shear wave velocity of the material and their depth of penetration is approximately equal to one wavelength.
- Plate (Lamb) waves have a complex vibration occurring in materials where thickness is less than the wavelength of ultrasound introduced into it.

Figure (3) provides an illustration of the particle motion versus the direction of wave propagation for longitudinal waves and shear waves.

Fig. 3



e. Applying Ultrasound

Ultrasonic nondestructive testing introduces high frequency sound waves into a test object to obtain information about the object without altering or damaging it in any way. Two basic quantities are measured in ultrasonic testing; they are time of flight or the amount of time for the sound to travel through the sample and amplitude of received signal. Based on velocity and round trip time of flight through the material the material thickness can be calculated as follows:

Eqn. 4 $T = ct_s/2$

T = Material Thickness
c = Material Sound Velocity
t_s = Time of Flight

Measurements of the relative change in signal amplitude can be used in sizing flaws or measuring the attenuation of a material. The relative change in signal amplitude is commonly measured in decibels. Decibel values are the logarithmic value of the ratio of two signal amplitudes. This can be calculated using the following equation. Some useful relationships are also displayed in the table below;

Eqn. 5 $dB = 20\log_{10}(A_1/A_2)$

dB = Decibels
A_1 = Amplitude of signal 1
A_2 = Amplitude of signal 2

$\frac{A_1}{A_2}$	Ratio	dB
$\frac{100\%}{70.71\%}$	1.4142	3
$\frac{100\%}{50\%}$	2	6
$\frac{100\%}{25\%}$	4	12
$\frac{100\%}{10\%}$	10	20
$\frac{100\%}{1\%}$	100	40

f. Sensitivity and Resolution

- Sensitivity is the ability of an ultrasonic system to detect reflectors (or defects) at a given depth in a test material. The greater the signal that is received from these reflectors, the more sensitive the transducer system.
- Axial resolution is the ability of an ultrasonic system to produce simultaneous and distinct indications from reflectors located at nearly the same position with respect to the sound beam.
- Near surface resolution is the ability of the ultrasonic system to detect reflectors located close to the surface of the test piece.

2. ADVANCED DEFINITIONS AND FORMULAS

a. Transducer waveform and spectrum

Transducer waveform and spectrum analysis is done according to test conditions and definitions of ASTM E1065. Typical units are MHz for frequency analysis, microseconds for waveform analysis, and dB down from peak amplitude. Figure (4) illustrates waveform duration at the -14dB level or 20% amplitude of peak. The -40dB waveform duration corresponds to 1% amplitude of peak. Figure (5) illustrates peak frequency, upper and lower -6dB frequencies and MHz bandwidth measurements. The relation between MHz bandwidth and waveform duration is shown in Figure (6). The scatter is wider at -40dB because the 1% trailing end of the waveform contains very little energy and so has very little effect on the analysis of bandwidth. Because of the scatter it is most appropriate to specify waveforms in the time domain (microseconds) and spectrums in the frequency domain.

Fig. 4

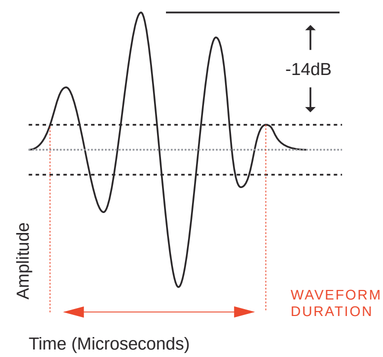


Fig. 5

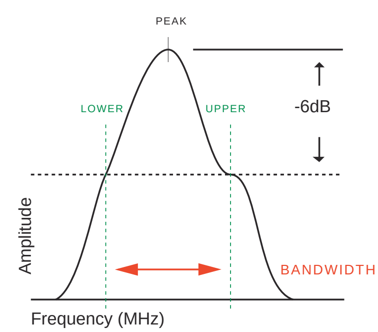
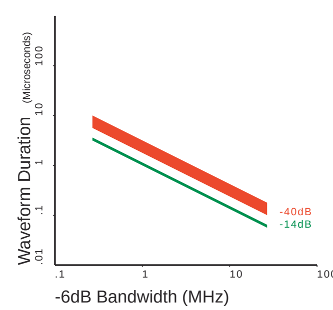


Fig. 6



The approximate relations shown in Figure (6) can be used to assist in transducer selection. For example, if a -14dB waveform duration of one microsecond is needed, what frequency transducer should be selected? From the graph, a bandwidth of approximately 1 to 1.2MHz corresponds to approximately 1 microsecond -14dB waveform duration. Assuming a nominal 50% fractional bandwidth transducer, this calculates to a nominal center frequency of 2 to 2.4MHz. Therefore, a transducer of 2.25MHz or 3.5MHz may be applicable.

b. Acoustic Impedance, Reflectivity, and Attenuation

The acoustic impedance of a material is the opposition to displacement of its particles by sound and occurs in many equations. Acoustic impedance is calculated as follows:

Eqn. 6 $Z=\rho c$

Z = Acoustic Impedance
c = Material Sound Velocity
ρ = Material Density

The boundary between two materials of different acoustic impedances is called an acoustic interface. When sound strikes an acoustic interface at normal incidence, some amount of sound energy is reflected and some amount is transmitted across the boundary. The dB loss of energy on transmitting a signal from medium 1 into medium 2 is given by:

Eqn. 7a $\text{dB loss}=10 \text{ Log}_{10} [4Z_1Z_2 / (Z_1 + Z_2)^2]$

Z_1 = Acoustic Impedance of First Material
Z_2 = Acoustic Impedance of Second Material

The dB loss of energy of the echo signal in medium 1 reflecting from an interface boundary with medium 2 is given by:

Eqn. 7b $\text{dB loss}=10 \text{ Log}_{10} [(Z_2 - Z_1)^2/ (Z_1 + Z_2)^2]$

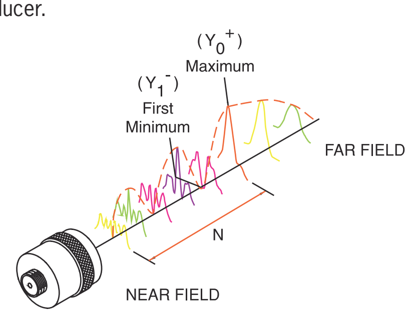
For example: The dB loss on transmitting from water (Z = 1.48) into 1020 steel (Z = 45.41) is -9.13dB; this also is the loss transmitting from 1020 steel into water. The dB loss of the backwall echo in 1020 steel in water is -0.57dB; this also is the dB loss of the echo off 1020 steel in water. The waveform of the echo is inverted when $Z_2<Z_1$.

Finally, ultrasound attenuates as it progresses through a medium. Assuming no major reflections, there are three causes of attenuation: diffraction, scattering and absorption. The amount of attenuation through a material can play an important role in the selection of a transducer for an application.

c. Sound Field

The sound field of a transducer is divided into two zones; the near field and the far field. The near field is the region directly in front of the transducer where the echo amplitude goes through a series of maxima and minima and ends at the last maximum, at distance N from the transducer.

Fig. 7



The location of the last maximum is known as the near field distance (N or Y_0^+) and is the natural focus of the transducer. The far field is the area beyond N where the sound field pressure gradually drops to zero. Because of the variations within the near field it can be difficult to accurately evaluate flaws using amplitude based techniques. The near field distance is a function of the transducer frequency, element diameter, and the sound velocity of the test material as shown by Equation 8:

Eqn. 8 $N = D^2f/4c$

Eqn. 8a $N = D^2/4\lambda$

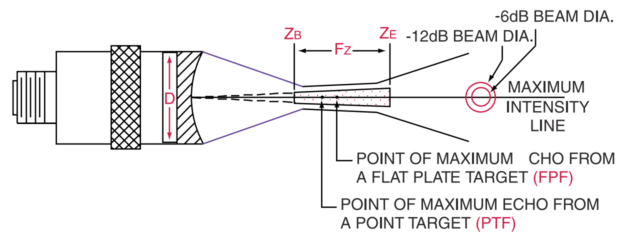
N = Near Field Distance
D = Element Diameter
f = Frequency
c = Material Sound Velocity
λ = Wavelength

(Table 2 on page 40 lists the near field distances in water for many combinations of transducer frequency and element diameter.)

d. Other Parameters of a Sound Beam

There are a number of sound field parameters that are useful in describing the characteristics of a transducer. In addition to the near field, knowledge of the beam width and focal zone may be necessary in order to determine whether a particular transducer is appropriate for a given inspection. Figure (8) gives a graphical representation of these parameters:

Fig. 8



Z_B = Beginning of the Focal Zone
F_Z = Focal Zone
Z_E = End of the Focal Zone
D = Element Diameter

Beam Diameter

A transducer's sensitivity is affected by the beam diameter at the point of interest. The smaller the beam diameter, the greater the amount of energy is reflected by a flaw. The -6dB pulse-echo beam diameter at the focus can be calculated with Equation 9 or 9a. For a flat transducer use Equation 9a with $S_F = 1$

Eqn. 9 $BD(-6dB) = 1.02Fc/fD$

Eqn. 9a $BD(-6dB) = .2568DS_F$

BD = Beam Diameter
F = Focal Length
c = Material Sound Velocity
f = Frequency
D = Element Diameter
S_F = Normalized Focal Length (Eqn. 14)

Focal Zone

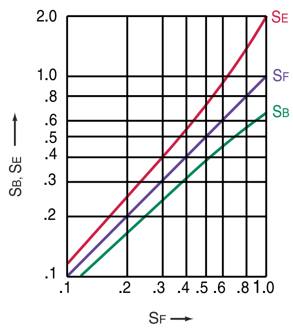
The starting and ending points of the focal zone are located where the on-axis pulse-echo signal amplitude drops to - 6dB of the amplitude at the focal point. The length of the focal zone is given by Equation 10:

Eqn. 10 $F_Z = N*S_F^2[2/(1+ .5S_F)]$

F_Z = Focal Zone
N = Near Field
S_F = Normalized Focal Length (Eqn. 14)

Figure (9) shows the normalized beginning (S_B) and ending (S_E) point of the -6dB focal zone versus the focusing factor.

Fig. 9
-6dB Focal Zone

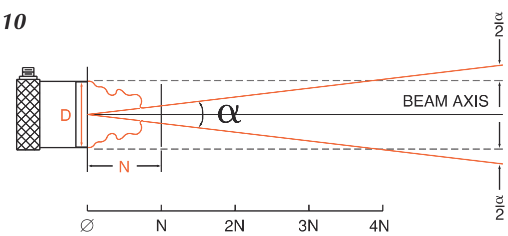


Normalized Beginning & Ending Points of the -6dB Focal Zone
as Measured by Signal Amplitude From Small Ball

Beam Spread and Half Angle

All ultrasonic beams diverge. In other words, all transducers have beam spread. Figure (10) gives a simplistic view of a sound beam for a flat transducer. In the near field, the beam has a complex shape that narrows. In the far field the beam diverges.

Fig. 10



For flat transducers as shown in Figure (10), the - 6dB pulse-echo beam spread angle is given by Equation (11):

Eqn. 11 $\sin(\alpha/2) = .514c/fD$

$\alpha/2$ = Half Angle Spread between -6dB points

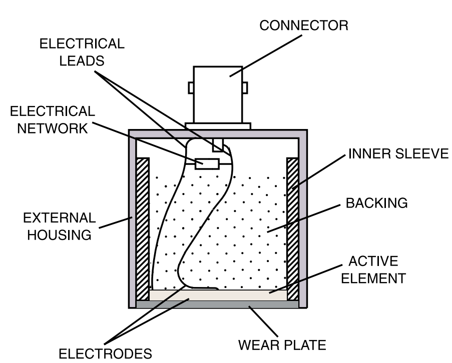
It can be seen from this equation that beam spread from a transducer can be reduced by selecting a transducer with a higher frequency or a larger element diameter or both.

3. DESIGN CHARACTERISTICS OF TRANSDUCERS

a. What is an Ultrasonic Transducer?

A transducer is any device that converts one form of energy to another. An ultrasonic transducer converts electrical energy to mechanical energy, in the form of sound, and vice versa. The main components are the active element, backing, and wear plate.

Fig. 11



b. The Active Element

The active element, which is piezo or ferroelectric material, converts electrical energy such as an excitation pulse from a flaw detector into ultrasonic energy.

The most commonly used materials are polarized ceramics which can be cut in a variety of manners to produce different wave modes. New materials such as piezo polymers and composites are also being employed for applications where they provide benefit to transducer and system performance.

c. Backing

The backing is usually a highly attenuative, high density material that is used to control the vibration of the transducer by absorbing the energy radiating from the back face of the active element. When the acoustic impedance of the backing matches the acoustic impedance of the active element, the result will be a heavily damped transducer that displays good range resolution but may be lower in signal amplitude. If there is a mismatch in acoustic impedance between the element and the backing, more sound energy will be reflected forward into the test material. The end result is a transducer that is lower in resolution due to a longer waveform duration, but may be higher in signal amplitude or greater in sensitivity.

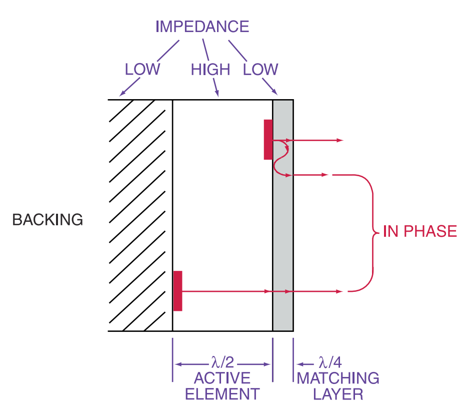
d. Wear Plate

The basic purpose of the transducer wear plate is to protect the transducer element from the testing environment. In the case of contact transducers, the wear plate must be a durable and corrosion resistant material in order to withstand the wear caused by use on materials such as steel.

For immersion, angle beam, and delay line transducers the wear plate has the additional purpose of serving as an acoustic transformer between the high acoustic impedance of the active element and the water, the wedge or the delay line all of which are of lower acoustic impedance. This is accomplished by selecting a matching layer that is 1/4 wavelength thick ($\lambda/4$) and of the desired acoustic impedance (the active element is nominally 1/2 wavelength). The choice of the wear suface thickness is based upon the idea of superposition that allows waves generated by the active element to be in phase with the wave reverberating in the matching layer as shown in Figure (4).

When signals are in phase, their amplitudes are additive, thus a greater amplitude wave enters the test piece. Figure (12) shows the active element and the wear plate, and when they are in phase. If a transducer is not tightly controlled or designed with care and the proper materials and the sound waves are not in phase, it causes a disruption in the wavefront.

Fig. 12



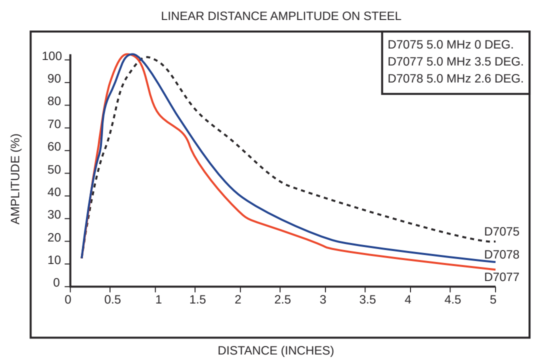
4. TRANSDUCER SPECIFIC PRINCIPLES

a. Dual Element Transducers

Dual element transducers utilize separate transmitting and receiving elements, mounted on delay lines that are usually cut at an angle (see diagram on page 6). This configuration improves near surface resolution by eliminating main bang recovery problems. In addition, the crossed beam design provides a pseudo focus that makes duals more sensitive to echoes from irregular reflectors such as corrosion and pitting.

One consequence of the dual element design is a sharply defined distance amplitude curve. In general, a decrease in the roof angle or an increase in the transducer element size will result in a longer pseudo-focal distance and an increase in useful range, as shown in Figure (13).

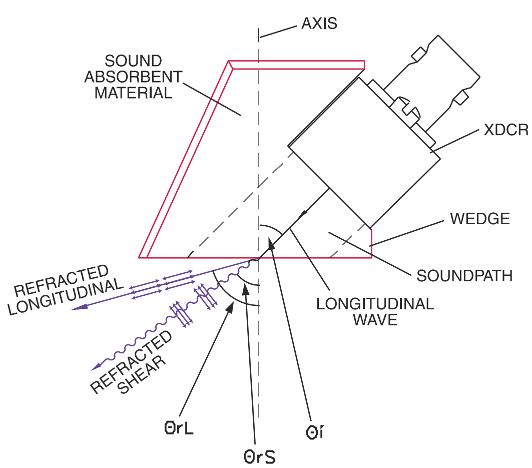
Fig. 13



b. Angle Beam Transducers

Angle beam transducers use the principles of refraction and mode conversion to produce refracted shear or longitudinal waves in the test material as shown in Figure (14).

Fig. 14



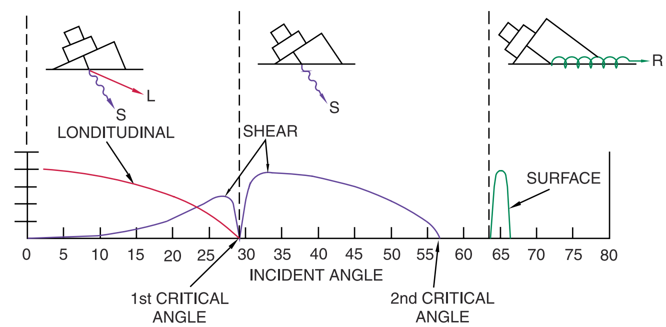
The incident angle necessary to produce a desired refracted wave (i.e. a 45° shear wave in steel) can be calculated from Snell's Law as shown in Equation (12). Because of the effects of beam spread, this equation doesn't hold at low frequency and small active element size. Contact Panametrics for details concerning these phenomena.

Eqn. 12 $\mathrm{Sin}U_i/c_i = \mathrm{Sin}U_{rl}/c_{rl} = \mathrm{Sin}U_{rs}/c_{rs}$

U_i	=	Incident Angle of the Wedge
U_{rl}	=	Angle of the Refracted Longitudinal Wave
U_{rs}	=	Angle of the Refracted Shear Wave
c_i	=	Velocity of the Incident Material (Longitudinal)
c_{rl}	=	Material Sound Velocity (Longitudinal)
c_{rs}	=	Velocity of the Test Material (Shear)

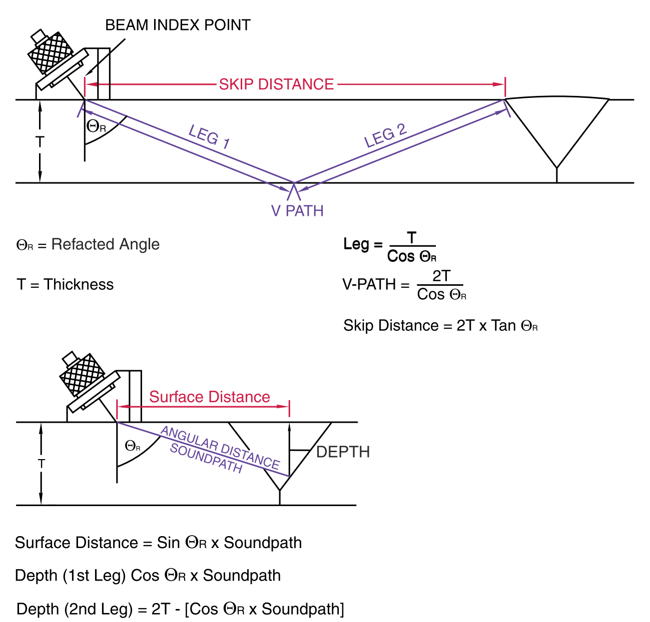
Figure (15) shows the relationship between the incident angle and the relative amplitudes of the refracted or mode converted longitudinal, shear, and surface waves that can be produced from a plastic wedge into steel.

Fig. 15



Angle beam transducers are typically used to locate and/or size flaws which are oriented non-parallel to the test surface. Following are some of the common terms and formulas used to determine the location of a flaw.

Fig. 16



Technical Notes

Many AWS inspections are performed using refracted shear waves. However, grainy materials such as austenitic stainless steel may require refracted longitudinal waves or other angle beam techniques for successful inspections.

c. Delay Line Transducers

Delay line transducers are single element longitudinal wave transducers used in conjunction with a replaceable delay line.

One of the reasons for choosing a delay line transducer is that near surface resolution can be improved. The delay allows the element to stop vibrating before a return signal from the reflector can be received. When using a delay line transducer, there will be multiple echoes from end of the delay line and it is important to take these into account.

Another use of delay line transducers is in applications in which the test material is at an elevated temperature. The high temperature delay line options listed in this catalog (pg. 13, 15) are not intended for continuous contact, they are meant for intermittent contact only.

d. Immersion Transducers

Immersion transducers offer three major advantages over contact transducers:

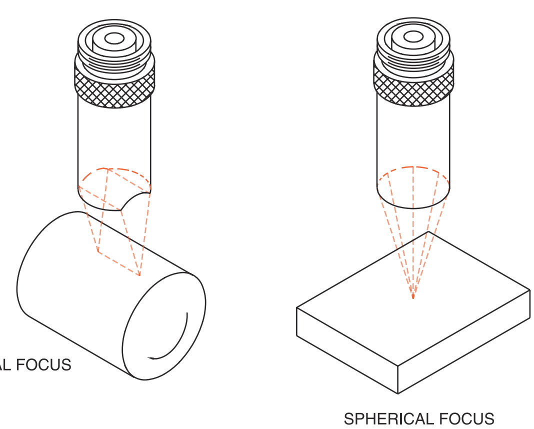
- Uniform coupling reduces sensitivity variations.
- Reduction in scan time due to automated scanning.
- Focusing of immersion transducers increases sensitivity to small reflectors.

Focusing Configurations

Immersion transducers are available in three different configurations: unfocused (“flat”), spherically (“spot”) focused, and cylindrically (“line”) focused. Focusing is accomplished by either the addition of a lens or by curving the element itself. The addition of a lens is the most common way to focus a transducer.

An unfocused transducer may be used in general applications or for penetration of thick materials. A spherically focused transducer is commonly used to improve sensitivity to small flaws and a cylindrical focus is typically used in the inspection of tubing or bar stock. Examples of spherical and cylindrical focusing are shown in Figure (17).

Fig. 17



By definition, the focal length of a transducer is the distance from the face of the transducer to the point in the sound field where the signal with the maximum amplitude is located. In an unfocused transducer, this occurs at a distance from the face of the transducer which is approximately equivalent to the transducer’s near field length. Because the last signal maximum occurs at a distance equivalent to the near field, a transducer, by definition, can not be acoustically focused at a distance greater than its near field.

When focusing a transducer, the type of focus (spherical or cylindrical), focal length, and the focal target (point or flat surface) need to be specified. Based on this information, the radius of curvature of the lens for the transducer can be calculated which varies based on above parameters. When tested, the measured focal length will be off of the target specified.

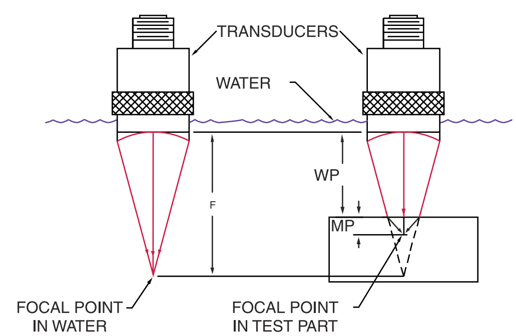
There are limitations on focal lengths for transducers of particular frequency and element diameter combinations and target designations. The maximum practical focal length for a point target focal designation is 0.8 * Near Field length. Transducers with focal lengths beyond these maximums, but less than the near field are called weakly focused units. In other words, there may not be an advantage to a focused transducer over that of a flat transducer. In addition to the limitations on maximum focal lengths, there are limitations on the minimum focal lengths. These limitations are typically due to the mechanical limitations of the transducer.

Table 2 on page 40 lists the near field distances as well as the minimum and maximum practical focal lengths for common frequency-element diameter combinations. Consult Panametrics for detailed information in focusing parameters.

Focal Length Variations due to Acoustic Velocity and Geometry of the Test Part

The measured focal length of a transducer is dependent on the material in which it is being measured. This is due to the fact that different materials have different sound velocities. When specifying a transducer’s focal length it is typically specified for water. Since most materials have a higher velocity than water, the focal length is effectively shortened. This effect is caused by refraction (according to Snell’s Law) and is illustrated in Figure (18).

Fig. 18



This change in the focal length can be predicted by Equation (13). For example, given a particular focal length and material path, this equation can be used to determine the appropriate water path to compensate for the focusing effect in the test material.

Eqn. 13 $$WP = F - MP(c_{tm}/c_w)$$

WP = Water Path
MP = Material Depth
F = Focal Length in Water
c_{tm} = Sound Velocity in the Test Material
c_w = Sound Velocity in Water

In addition, the curvature of surface of the test piece can affect focusing. Depending on whether the entry surface is concave or convex, the sound beam may converge more rapidly than it would in a flat sample or it may spread and actually defocus.

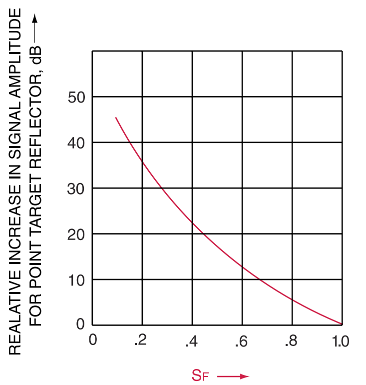
Focusing Gain

Focused immersion transducers use an acoustic lens to effectively shift the location of the Y_0^+ toward the transducer face. The end result can be a dramatic increase in sensitivity. Figure (19) illustrates the relative increase in signal amplitude from small defects due to focusing where S_F is the normalized focal length and is given by Equation (14). The amplitude from a small defect cannot exceed the echo amplitude from a flat plate.

Eqn. 14 $S_F = F/N$

S_F = Normalized Focal Length
F = Focal Length
N = Near Field

Fig. 19



Increase In On-Axis Pulse-Echo Sensitivity Versus Normalized Focal Length

For example, the chart can be used to determine the increase in on-axis pulse-echo sensitivity of a 2.25MHz, 1.0" element diameter transducer that is focused at 4 inches. The near field length of this transducer is 9.55", and the normalized focal length is 0.42 (4.0"/9.55"). From the chart it can be seen that this will result in an increase in sensitivity of approximately 21dB.

Focusing gain (dB) for cylindrical focuses can be estimated as being 3/4 of the gain for spherical focuses.

e. Normal Incidence Shear Wave Transducers

Normal Incidence Shear Wave transducers incorporate a shear wave crystal in a contact transducer case. Rather than using the principles of refraction, as with the angle beam transducers, to produce shear waves in a material, the crystal itself produces the shear wave.

Typically these transducers are used to make shear velocity measurements of materials. This measurement, along with a longitudinal velocity measurement can be used in the calculation of Poisson's Ratio, Young's Modulus, and Shear Modulus. These formulas are listed below for reference.

Eqn. 15 $$\sigma = \frac{1-2\,(V_T/V_L)^2}{2-2\,(V_T/V_L)^2}$$

Eqn. 16 $$E = \frac{V_L^2\rho\,(1+\sigma)(1-2\sigma)}{(1-\sigma)}$$

Eqn. 17 $G = V_T^2\rho$

σ = Poisson's Ratio
V_L = Longitudinal Velocity
V_T = Shear (Transverse) Velocity
ρ = Material Density
E = Young's Modulus
G = Shear Modulus

Because shear waves do not propagate in liquids, it is necessary to use a very viscous couplant when making measurements with these. When using this type of transducer in a through transmission mode application, it is important that direction of polarity of each of the transducers is in line with the other. If the polarities are 90° off, the receiver may not receive the signal from the transmitter.

5. TRANSDUCER EXCITATION

As a general rule, all Panametrics ultrasonic transducers are designed for negative spike excitation. The maximum spike excitation voltages should be limited to approximately 50 volts per mil of piezoelectric transducer thickness. Low frequency elements are thick, and high frequency elements are thin. A negative-going 600 volt fast rise time, short duration, spike excitation can be used across the terminals on transducers 5.0MHz and lower in frequency. For 10MHz transducers, the voltage used across the terminals should be halved to about 300 volts as measured across the terminals.

Although negative spike excitation is recommended, continuous wave or tone burst excitations may be used. However there are limitations to consider when using these types of excitation. First, the average power dissipation to the transducer should not exceed 125mW to avoid overheating the transducer and depoling the crystal. Since total average power depends on a number of factors such as voltage, duty cycle and transducer electrical impedance, the following equations can be used to estimate the maximum excitation duration as well as the number of cycles in a burst to stay within the total power limitation:

Eqn. 18 $V_{rms} = 1/2(0.707)V_{p\text{-}p}$

Eqn. 19 $$P_{tot} = \frac{(\text{Duty Cycle})(V_{rms})^2\cos(\text{phase angle})}{Z}$$

Eqn. 20 $$\text{No. of Cycles in a Burst} = \frac{(\text{Freq.})(\text{Duty Cycle})}{\text{Rep Rate}}$$

Following is an example of how to use the above equations to calculate a duty cycle and number of cycles for a V310-SU transducer.

V310-SU 5.0MHz, 0.25" element diameter, unfocused

Assuming: 100 V Peak-to-Peak

50 ohm nominal impedance at the transducer input impedance (Note: This value will vary from transducer to transducer and should be measured. An impedance plot can be ordered at the time of purchase if necessary.)

-45° Phase Angle

5KHz Rep Rate

Step 1: Calculate V_{rms}

$V_{rms} = 1/2(0.707)V_{p\text{-}p}$

$V_{rms} = 1/2(0.707)(100) = 35.35$ V

TECHNICAL NOTES

Technical Notes

Step 2: Rearrange Equation (19) to solve for the Duty Cycle. Use 0.125mW as P_{tot}, as this is the maximum recommended for any transducer.

$$\text{Duty Cycle} = Z*P_{tot}(Vrms)^2*\cos(\text{phase angle})$$
$$= (50)(0.125)/(35.35)^2*(\cos -45°)$$
$$= 0.007 s/s$$

This means 7 milliseconds of excitation in every 1000 milliseconds.

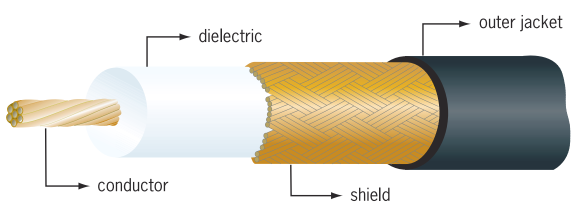
Step 3: Number of cycles in the burst can now be calculated from Equation (20).

$$\text{No. Of Cycles in Burst} = (\text{Freq.})(\text{Duty Cycle})\ \text{Rep Rate}$$
$$= (5*10^6)*(0.007)/(5*10^3)$$
$$\text{No. Of Cycles in Burst} = 7$$

6. CABLES

The inside of a cable is made of three main components. They are the conductor, the dielectric, and shield/braid. These components are then surrounded by an outer protective jacket. Figure (20) shows a cross-sectional view of a typical cable. The conductor acts as the positive connection of the cable while the shield acts as the ground. The dielectric isolates the conductor from the shield.

Fig. 20



Most cables have one shielding/braided layer. However, to better prevent electrical interference from the environment double shielded cables have an additional shielding/braided layer in contact with the other.

The following is a list of standard cable grades Panametrics offers:

Type	Grade	Impedance	Nominal Diameter
15	Low Impedance	15 ohms	0.11"
25	Low Impedance	25 ohms	0.10"
58	RG58/U	50 ohms	0.20"
62	RG62/U	93 ohms	0.24"
74	RG174/U	50 ohms	0.11"
188	RG188/U	50 ohms	0.11"
316	RG316/U	50 ohms	N/A

RG/U is the abbreviation for "radio guide, universal" in the military, 'RG" is the designation for coaxial cable and "U" stands for "general utility". Most of the cables used in ultrasonic NDT have military RG numbers that define the materials, dimensions, and electrical characteristics of the cables.

The characteristic impedance of a coaxial cable is determined by the ratio for the inner diameter of the outer conductor (D) to the outer diameter of the inner conductor (d) and by the dielectric constant (E) of the insulating material between the conductors.

Eqn. 21 $\text{Impedance (Zo)} = \frac{138}{\sqrt{E}} \log(D/d)\ \Omega$

The characteristic impedance can also be calculated form the capacitance (C) and the inductance (L) per unit length of cable

Eqn. 22 $\text{Impedance (Zo)} = \sqrt{\frac{L}{C}}$

The most common values for coaxial cables are 50 ohm, 75 ohm, and 95 ohm. Note that the actual input impedance at a particular frequency may be quite different from the characteristics impedance of the cable due to the impedance of the source and load. In ultrasonics, on transmit the source is the pulser and the load is the transducer; on receive the source is the transducer and the load is the receiver. The complex impedance of the pulser and the transducers will reflect some of the electrical energy at each end of the cable. The amount of reflection is determined by the length of the cable, the frequency of the RF signal, and the electrical impedance of the cable and its termination. In ultrasonic NDT the effect of the cable is most practically determined by experimenting with the shorter and longer cables, with cables of differing impedance, and by placing a 50 ohm feed-through attenuator at the pulser/receiver jack.

Material	Longitudinal Velocity (in/µs)*	(m/s)	Shear Velocity (in/µs)*	(m/s)	Acoustic Impedance ($Kg/m^2s \times 10^6$)
Acrylic resin (Perspex®)	0.107	2,730	0.056	1,430	3.22
Aluminum	0.249	6,320	0.123	3,130	17.06
Beryllium	0.508	12,900	0.350	8,880	23.5
Brass, naval	0.174	4,430	0.083	2,120	37.30
Cadmium	0.109	2,780	0.059	1,500	24.02
Columbium	0.194	4,920	0.083	2,100	42.16
Copper	0.183	4,660	0.089	2,260	41.61
Glycerine	0.076	1,920	—	—	2.42
Gold	0.128	3,240	0.047	1,200	62.60
Inconel®	0.229	5,820	0.119	3,020	49.47
Iron	0.232	5,900	0.127	3,230	45.43
Iron, cast					
(slow)	0.138	3,500	0.087	2,200	25.00
(fast)	0.220	5,600	0.126	3,220	40.00
Lead	0.085	2,160	0.028	700	24.49
Manganese	0.183	4,660	0.093	2,350	34.44
Mercury	0.057	1,450	—	—	19.66
Molybdenum	0.246	6,250	0.132	3,350	63.75
Motor Oil (SAE 20 or 30)	0.069	1,740	—	—	1.51
Nickel, pure	0.222	5,630	0.117	2,960	49.99
Platinum	0.156	3,960	0.066	1,670	84.74
Polyamide, (nylon, Perlon®)					
(slow)	0.087	2,200	0.043	1,100	2.40
(fast)	0.102	2,600	0.047	1,200	3.10
Polystyrene	0.092	2,340	—	—	2.47
Polyvinylchloride, PVC, hard	0.094	2,395	0.042	1,060	3.35
Silver	0.142	3,600	0.063	1,590	37.76
Steel, 1020	0.232	5,890	0.128	3,240	45.63
Steel, 4340	0.230	5,850	0.128	3,240	45.63
Steel, 302 austenitic stainless	0.223	5,660	0.123	3,120	45.45
Steel, 347 austenitic stainless	0.226	5,740	0.122	3,090	45.40
Tin	0.131	3,320	0.066	1,670	24.20
Titanium, Ti 150A	0.240	6,100	0.123	3,120	27.69
Tungsten	0.204	5,180	0.113	2,870	99.72
Uranium	0.133	3,370	0.078	1,980	63.02
Water (20°C)	0.058	1,480	—	—	1.48
Zinc	0.164	4,170	0.095	2,410	29.61
Zirconium	0.183	4,650	0.089	2,250	30.13

Table 1
Acoustic Properties of Materials

Conversion Factor: 1 m/s = 3.937×10^{-5} in/µS
Source: Nondestructive Testing Handbook 2nd Edition Volume 7 Ultrasonic Testing ASNT 1991 ed Paul McIntire

Near Field Distances of Flat Transducers in Water

The near field values in this table have been determined using the following equation:

$$N = \frac{D^2}{4\lambda}\left[1 - \left(\frac{\lambda}{D}\right)^2\right]$$

Note that equations 8 and 8A on page 34 were derived from this expression. The calculations were carried out assuming an ultrasonic velocity in water of 0.586×10^5 in/sec at 22°C and using the actual transducer element diameters. It should be noted that the actual transducer element diameters are slightly smaller than the nominal element diameters listed in the tables in the catalog.

The minimum and maximum practical focal lengths have been calculated by considering the acoustic and mechanical limitations of each configuration. These limitations are a function of transducer frequency, element diameter, and case dimensions. There may be exceptions to the limits listed in the table.

Table 2
Near Field Distances of Flat Transducers in Water

Frequency (MHz)	Element Diameter (Inches)	N (Inches)	Focal Length (PTF)** Min (Inches)	Focal Length (PTF)** Max (Inches)
0.5	1.50	4.757	2.15	3.80
	1.125	2.661	1.50	2.10
	1.00	2.095	1.25	1.65
	0.75	1.164	0.78	0.93
1.0	1.50	9.559	2.50	7.65
	1.125	5.366	1.90	4.30
	1.00	4.235	1.625	3.38
	0.75	2.372	1.00	1.90
	0.50	1.043	0.60	0.80
2.25	1.50	21.534	2.70	14.50
	1.125	12.099	2.15	9.50
	1.00	9.554	1.875	7.60
	0.75	5.364	1.00	4.30
	0.50	2.374	0.80	1.90
	0.375	1.329	0.50	1.06
	0.25	0.584	0.35	0.45
3.5	1.00	14.868	1.95	11.25
	0.75	8.350	1.00	6.65
	0.50	3.699	0.83	2.95
	0.375	2.073	0.60	1.65
	0.25	0.914	0.385	0.70
5.0	1.00	21.243	1.95	14.40‡
	0.75	11.932	1.00	9.50
	0.50	5.287	0.75	4.20
	0.375	2.965	0.60	2.35
	0.25	1.309	0.43	1.00
7.5	0.75	17.900	1.00	12.75‡
	0.50	7.933	0.75	6.30‡
10	1.00	42.490	2.00	20.00‡
	0.75	23.868	1.00	15.375‡
	0.50	10.579	0.75	8.40‡
	0.375	5.934	0.60	4.75‡
	0.25	2.622	0.46	2.10
15	0.50	15.870	0.75	11.75‡
	0.375	8.902	0.60	7.10‡
	0.25	3.935	0.50	3.15‡
20	0.25	5.247	0.50	4.20‡
	0.125	1.290	0.25	1.00‡
25	0.25	6.559	0.50	5.25‡

Panametrics' Standard Case Style, Large Diameter Case Style, Slim Line Case Style, and Pencil Case Style Immersion Transducers with straight connectors (see pages 16, 17, and 18) can be focused between the Minimum and Maximum Point Target Focal (PTF) distance limits listed in Table 2. Please consult Panametrics before ordering a transducer focused outside these limits.

‡ Consideration should be given to attenuation effects which increase linearity and with the square of frequency and the square of bandwidth. In applications where long water paths are required the effects of frequency dependent attenuation should be checked per ASTM E 1065 Annex A7. It is advisable to consider the effects of frequency dependent attenuation if the focal distance equals or exceeds the following values:

Frequency	Focal Length
5.0MHz	13 in.
7.5MHz	6 in.
10MHz	3.5 in.
15MHz	1.5 in.
20MHz	0.8 in.
25MHz	0.5 in.
30MHz	0.4 in.