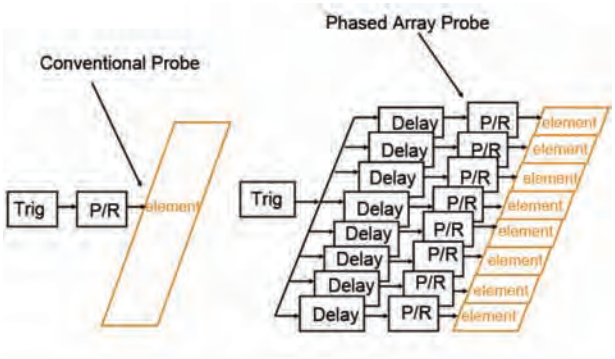
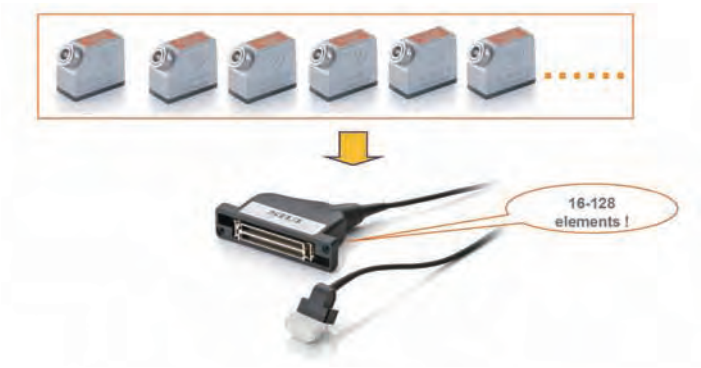
Phased Array&TOFD Probes

SIUI

Phased Array Probe





One phased array probe consists of many small elements, each one can be pulsed on separately. The structure of the phased array probe is like putting many single element probes into one probe.

Advantage of Phased Array Probe

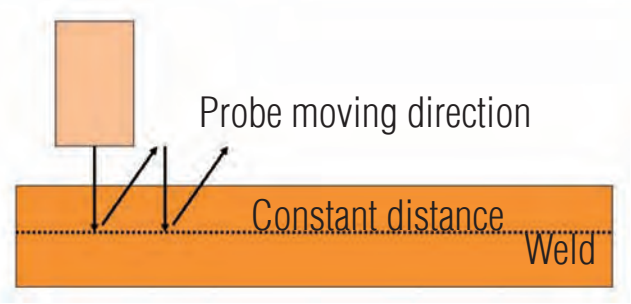
Small Size and Multi-channel

One small phased array probe can take place of multiple conventional probes to access some difficult-to-reach area.

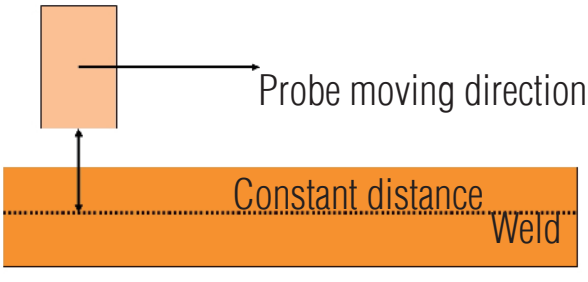
For one phased array probe, multi groups of element and multi angles can be applied for scanning at the same time, fully covering the welding area and enhancing the inspection efficiency.

Faster Inspection Efficiency

Conventional UT adopts the raster scanning achieved by the connection of probe and encoder, which is an order of magnitude slower than the phased array technology with electronic scanning.



Conventional Probe



Phased Array Probe

Higher Inspection Efficiency

Conventional probes adopts raster scanning, which is an order of magnitude slower than the phased array technology with electronic scanning.

SIUI can Provide a Variety of Probes for Different Kinds of Inspections

Custom Phased Arrav Probes

Near-Wall Probe

Flexible PA Probe

Matrix PA Probe

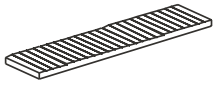
SIUI can produce custom phased array probes to suit specific applications and geometries.
For custom probe, please provide following info:

- Frequency
- Number of elements, pitch and elevation
- Probe type (angle beam, immersion, integrated wedge, matrix)
- Array shape (flat, curve)
- Cable jacket required
- Cable length
- Connector type
- Housing and/or dimension constraints
- Application
- Comparable UT single element transducer

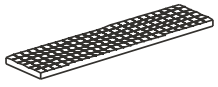
Frequency	Number of elements		Pitch		Active aperture	
MHz			mm		mm	
	X	Y	X	Y	X	Y
2.0	3	10	5	3	15	30
5.0	8	8	1	1	8	8

Custom Matrix Array Probe Specification

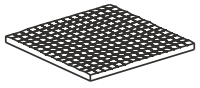
Standard Phased Array Probes



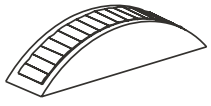
Linear



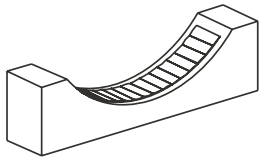
1.5-D array



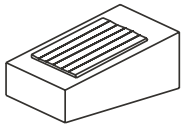
2-D array



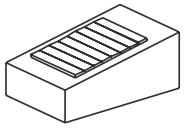
Convex



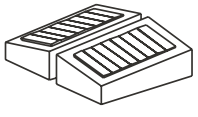
Concave



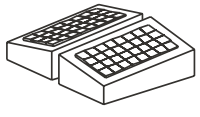
Skewing



Variable angle

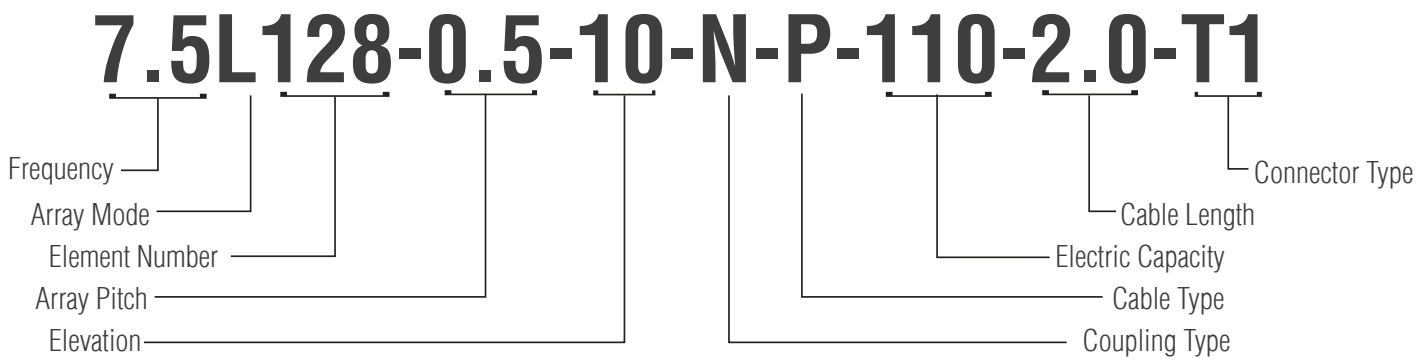


Dual linear



Dual 1.5-D

Ordering Code for Phased Array Probe



For Example

Frequency
7.5=7.5MHz

Array Mode
L=Linear
C=Convex
V=Concave
M=Matrix

Element Number
128=128 elements

Array Pitch
Unit: mm
0.5=0.5mm

Elevation
Unit: mm
10=10mm

Coupling Type
N is coupled by wedge. I is coupled by immersion. E is coupled by integrated wedge.

Cable Type
P=PVC wrap
Metal armor and radiation proof wrap can be provided.

Electric Capacity
Electric capacity each meter.
110=110pF for one meter;
50=50pF for one meter.

Cable Length
Unit: m
2.0=2 meters

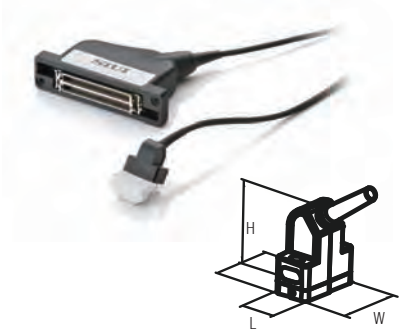
Connector Type
T1= Tyco TC ZIF 260P
P1=Omni Connector
H1=Hypertronics
D1=DL-156P
D2=DL-96P
D5=DL-260P
C1=High Density 78 Way D-Type

Other parameters can be added after the model name following the suffix form in "-".

SIUI can provide PA probes with different connectors compatible with PA equipments from other manufacturers.

Universal Probes

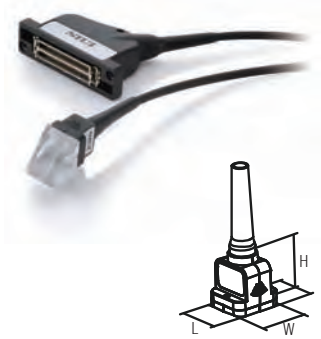
Small/ Medium/ Large-Size & Low Frequency Probes



Small-size Linear Array Probe

Medium-size Linear Array Probe

Large-size Linear Array Probe



Low Frequency Probe

Superior Features:

Sound Beam angle, focusing and scan step can be electronically controlled;
Wide scan coverage can be achieved by one single probe;
Replaceable angle wedge and delay block, with customizable surface curvature;
Array pitch and elevation can be customized.

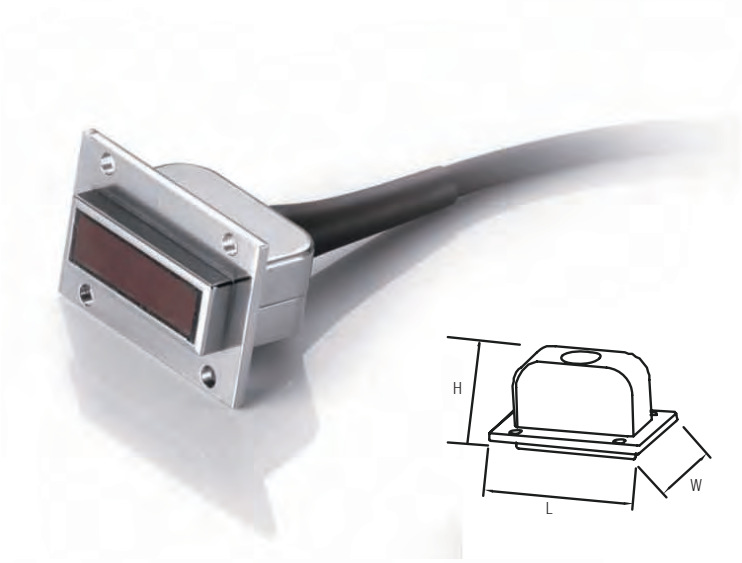
Typical Application

- Small-size Linear Array Probe
  --good for inspection on limited space;
- Medium-size Linear Array Probe
  --suitable for a wide range of applications;
- Large-size Linear Array Probe
  --inspections of cracks on plate-type pieces;
- Low Frequency Probe
  --inspection on thick plates or noisy or granular material.

Probe Model	Frequency	Number of elements	Pitch	Active aperture	Housing Dimension (mm)		
	MHz		mm	mm	L	W	H
Small-size Linear Array Probe							
2.5L8-1.0-9	2.5	8	1	8	15	28	28
4.0L16-0.5-9	4	16	0.5	8	15	28	33.5
5.0L16-0.5-9	5	16	0.5	8	15	28	33.5
5.0L16-0.6-10	5	16	0.6	9.6	17	28	33.5
7.5L16-0.5-9	7.5	16	0.5	8	15	28	33.5
10L16-0.5-9	10	16	0.5	8	15	28	33.5
Medium-size Linear Array Probe							
2.5L16-1.0-10	2.5	16	1	16	28	31	33
5.0L32-0.5-10	5	32	0.5	16	28	31	33
5.0L32-0.6-10	5	32	0.6	19.2	32	31	33
7.5L32-0.5-10	7.5	32	0.5	16	28	31	33
Large-size Linear Array Probe							
5.0L64-1.0-10	5	64	1	64	84	36	36
5.0L64-0.5-10	5	64	0.5	32	45	31	33
5.0L64-0.6-10	5	64	0.6	38.4	52	31	33
5.0L128-0.5-10	5	128	0.5	64	84	36	36
7.5L64-1.0-10	7.5	64	1	64	84	36	36
7.5L128-0.5-10	7.5	128	0.5	64	84	36	36
Low Frequency Probe							
2.0L32-1.0-10	2	32	1	32	45	31	33
1.5L16-2.0-10	1.5	16	2	32	45	31	33

The probes are equipped with standard 2m cable.

Immersion Probes



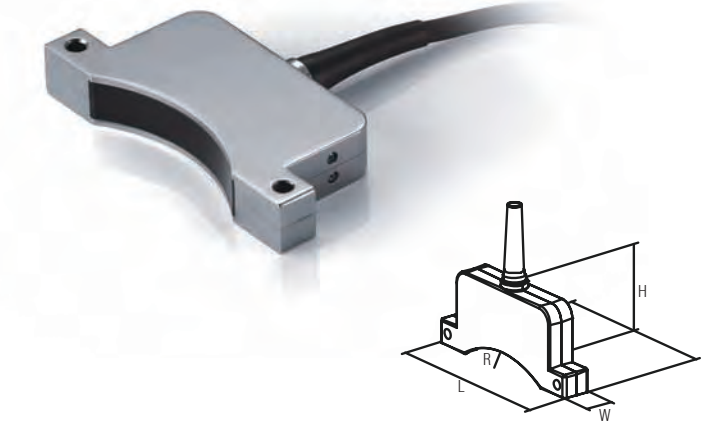
Immersion Linear Array Probe

Superior Features:

Sound Beam angle, focusing and scan step can be electronically controlled;
Wide scan coverage can be achieved by one single probe;
*Probe size and outer housing can be customized.

Typical Application:

Suitable for underwater inspection;
Inspection of thin plate or tubing (steel, aluminum, or other);
Composite inspection for delamination;
Inline thickness gaging;
Automated scanning.



Immersion Curved Array Probe

Superior Features:

Adopt immersion method for inspection;
Sound Beam angle, focusing and scan step can be electronically controlled;
Wide scan coverage can be achieved by one single probe;
The curvature radius of curved probes can be customized;
*Different parameters can be customized.

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Typical Application:

Suitable for underwater inspection;
Inspection of tubing;
Inspection of carbon fiber reinforced polymers (CFRP) corners;
Inspection of composite materials for delamination.

Small-size immersion curved array probe

Large-size immersion curved array probe

Probe Model	Frequency	Number of elements	Pitch	Active aperture
	MHz		mm	mm
Immersion Linear Array Probe				
5.0L64-0.6-10-I	5	64	0.6	38
5.0L64-1.0-10-I	5	64	1	64
7.5L128-0.39-6-I	7.5	128	0.39	50
7.5L128-0.6-6-I	7.5	128	0.6	76.8
2.0L64-0.6-10-I	2.0	64	0.6	64
Immersion Curved Array Probe				
3.5V128-0.6-10-R65-I	3.5	128	0.6	/
3.5V64-1.6-12-R65-I	3.5	64	1.6	/
5.0V64-1.0-10-R40-I	5.0	64	1.0	/
10.0V128-0.6-10-R40-I	10.0	128	0.6	/

The probes are equipped with standard 2m cable.
Housing dimension can be customized.

High Penetration Probe & Small Footprint Probe

High Penetration Probes

Superior Features:

Good resolution and high penetration;
Replaceable angle wedge and delay block, with customizable surface curvature;
Array pitch and elevation can be customized.

Typical Application:

Detection of flaws and sizing;
Inspections of defects in forgings;
Inspection on noisy or granular material.

Small Footprint Probe

Superior Features:

Compact size;
Cable connector can come out from either the side or the top;
Replaceable angle wedge and delay block, with customizable surface curvature;
Array pitch and elevation can be customized.

Typical Application:

Inspection on limited space;
Detection of flaws and sizing;
Inspection on reduced probe access, or with surfaces with complex geometry.

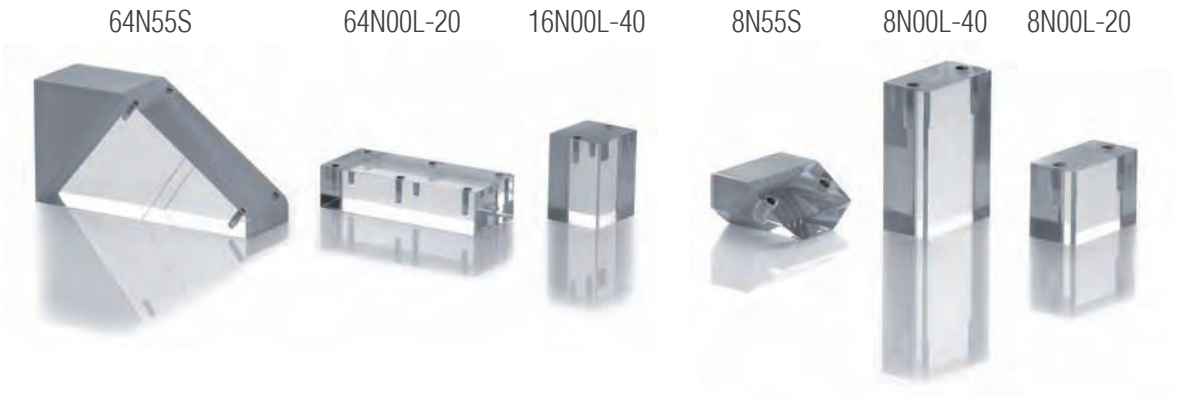
Probe Model	Frequency	Number of elements	Pitch	Active aperture	Housing Dimension (mm)		
	MHz		mm	mm	L	W	H
High Penetration Probe							
2.5L16-1.2-20	2.5	16	1.2	19.2	40	48	29
5.0L32-0.6-20	5	32	0.6	19.2	40	48	29
Small Footprint Probe							
5.0L10-0.6-6	5	10	0.6	6	13	10	23
7.5L10-0.6-6	7.5	10	0.6	6	13	10	23
10.0L10-0.6-6	10.0	10	0.6	6	13	10	23

The probes are equipped with standard 2m cable.

Wedge for Phased Array Probe

Superior Features:

Variable angles in steel for selection.
Wedges with different specifications can be made.
Compatible with crawler.
Anti-wear structure design are available.
Wedges with curvature can be made on request.



64N55S-I-AOD-80

- Array Length
- Probe Mounting
- Refracted Angle in Steel
- Wave Type
- Irrigation
- Curvature Type
- Pipe Diameter

For Example

Active Aperture
64=Compatible phased array probe is 64mm.
Active Aperture= Pitch × Elements

Probe Mounting
N=Normal
L=Skew (in lateral direction)

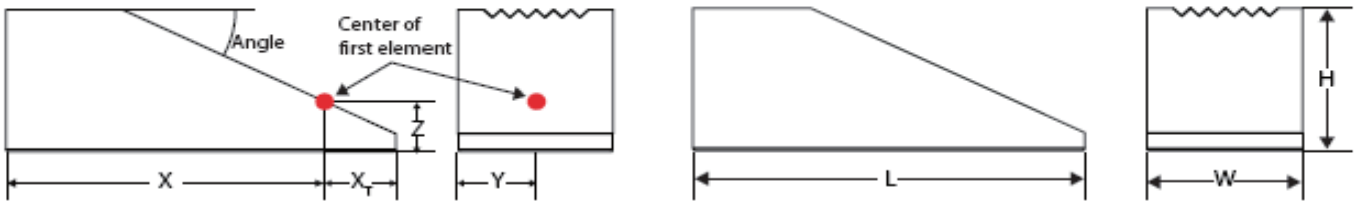
Refracted Angle in Steel
55=55°

Wave Type
S=Shear wave in steel
L=longitudinal wave in steel

Irrigation
I=Irrigation
Note: without "I" is non-irrigation

Curvature Type
AOD, COD, AID, CID are available.
AOD=Axial outside diameter
COD=Circumferential outside diameter
AID=Axial inside diameter
CID=Circumferential inside diameter

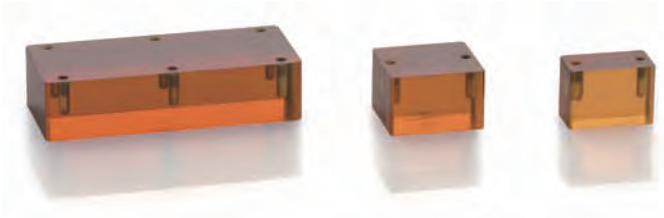
Pipe Diameter
Pipe diameter in mm.
AOD and COD is the outside diameter.
AID and CID is the inside diameter.
80=80mm



Wedge Model	Description	X	XT	Z	Velocity	Refracted Ang	L	W	H
		mm	mm	mm	m/s		mm	mm	mm
Standard Wedge									
64N00L-20	20mm delay block	73.5	10.5	20	2360	0°	84	35.6	20
64N00L-40	40mm delay block	73.5	10.5	40	2360	0°	84	35.6	40
64N55S	30-70° shear wave angle block	108.67	8.93	14.48	2360	55°	117.6	36	58.5
16N00L-20	20mm delay block	21.75	6.25	20	2360	0°	28	31	20
16N00L-40	40mm delay block	21.75	6.25	40	2360	0°	28	31	40
16N55S	30-70° shear wave angle block	34.94	5.06	9.74	2360	55°	40	31	22.5
8N00L-20	20mm delay block	11.25	3.75	20	2360	0°	15	28	20
8N00L-40	40mm delay block	11.25	3.75	40	2360	0°	15	28	40
8N55S	30-70° shear wave angle block	21.69	3.31	8.4	2360	55°	25	28	15
40N00L-20	20mm delay block	44.9	7.1	20	2360	0°	52	31	20
40N00L-40	40mm delay block	44.9	7.1	40	2360	0°	52	31	40
40N55S	30-70° shear wave angle block	73.24	7.76	13.64	2360	55°	81	31	41.5
32N00L-20	20mm delay block	38	7	20	2360	0°	45	31	20
32N00L-40	40mm delay block	38	7	40	2360	0°	45	31	40
32N55S	30-70° shear wave angle block	64.44	7.56	13.49	2360	55°	72	31	37.5
20N00L-20	20mm delay block	25.3	6.7	20	2360	0°	32	31	20
20N00L-40	40mm delay block	25.3	6.7	40	2360	0°	32	31	40
20N55S	30-70° shear wave angle block	52.58	5.42	18.94	2360	55°	58	31	35.5
10N00L-20	20mm delay block	13	4	20	2360	0°	17	28	20
10N00L-40	40mm delay block	13	4	40	2360	0°	17	28	40
10N55S	30-70° shear wave angle block	27.26	3.24	8.35	2360	55°	30.5	28	17.5

High Temperature Wedge

High temperature wedge enables testing on surface up to 200℃.
Maximum contact time is 10 seconds.
Cool to ambient before reuse.



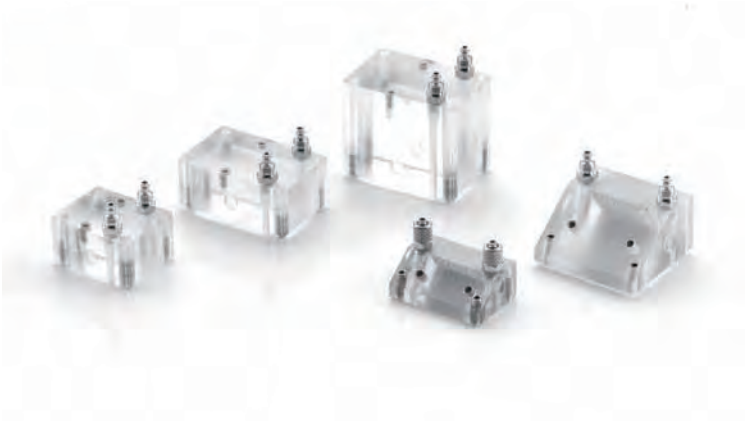
Wedge Model	Description	X mm	XT mm	Z mm	Velocity m/s	Refracted Ang	L mm	W mm	H mm
High Temperature Wedge									
64N00L-20-H	20mm Delay Block	73.5	10.5	20	2590	0°	84	35.6	20
64N00L-40-H	40mm Delay Block	73.5	10.5	40	2590	0°	84	35.6	40
16N00L-20-H	20mm Delay Block	21.75	6.25	20	2590	0°	28	31	20
16N00L-40-H	40mm Delay Block	21.75	6.25	40	2590	0°	28	31	40
8N00L-20-H	20mm Delay Block	11.25	3.75	20	2590	0°	15	28	20
8N00L-40-H	40mm Delay Block	11.25	3.75	40	2590	0°	15	28	40
40N00L-20-H	20mm Delay Block	44.9	7.1	20	2590	0°	52	31	20
40N00L-40-H	40mm Delay Block	44.9	7.1	40	2590	0°	52	31	40
32N00L-20-H	20mm Delay Block	38	7	20	2590	0°	45	31	20
32N00L-40-H	40mm Delay Block	38	7	40	2590	0°	45	31	40
20N00L-20-H	20mm Delay Block	25.3	6.7	20	2590	0°	32	31	20
20N00L-40-H	40mm Delay Block	25.3	6.7	40	2590	0°	32	31	40
10N00L-20-H	20mm Delay Block	13	4	20	2590	0°	17	28	20
10N00L-40-H	40mm Delay Block	13	4	40	2590	0°	17	28	40

Curved Wedge

All the wedge models available now can be customized with curvature.

Irrigation Wedge

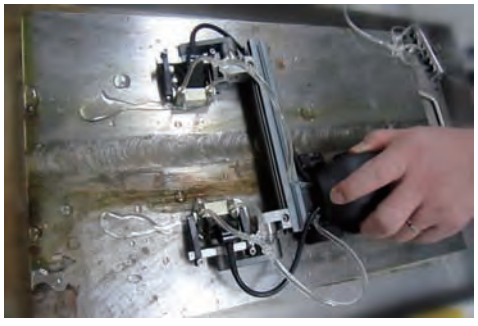
Water is used as couplant;
Suitable for automatic inspection.
Conventional wedges with surface curvature can be made based on requirement.



Wedge Model	Description	X mm	XT mm	Z mm	Velocity m/s	Refracted Ang	L mm	W mm	H mm
Irrigation Wedge									
8N55S-I	30-70° shear wave angle block	21.69	3.31	8.4	2360	55°	25	39	15
8N00L-20-I	20mm Delay Block	25.25	9.75	20	2360	0°	35	28	20
8N00L-40-I	40mm Delay Block	25.25	9.75	40	2360	0°	35	28	40
16N55S-I	30-70° shear wave angle block	34.94	5.06	9.67	2360	55°	40	43	22.5
16N00L-20-I	20mm Delay Block	43.5	4.5	20	2360	0°	48	31	20
16N00L-40-I	40mm Delay Block	43.5	4.5	40	2360	0°	48	31	40

Crawler for Phased Array

Different crawlers compatible with PA probes can be provided by SIUI.



Example of Phased Array Probe Test Report

Probe:5.0L64-1.0-10
Serial Number:********

Probe Information

Frequency: 5.0MHz
Probe Type: Linear Array
Element Count: 64
Cable Length: 2.0M

Active Area Dimension

Length: 64mm
Elevation: 10mm
Pitch: 1.0mm
Matching Medium: Rexolite

Probe Conformance Summary

Overall Vp-p Sensitivity: 2.39dB (<=3dB)
Average Center Frequency: 5.13MHz(5.0MHz+/-10%)
Average -6dB Bandwidth: 78.46%(>=60%)

Probe Test Condition

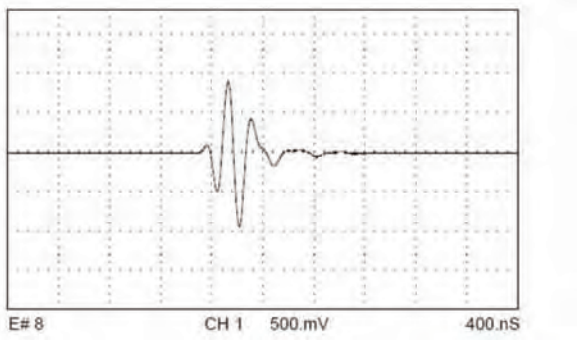
Instrument Model: 5052UA
Pulse Voltage: 120V
Pulse Type: Negative
Dumping: 50ohm
Energy: 1
Target Medium: Rexolite
Target Type: 25.4mm Plate

Probe Test Result

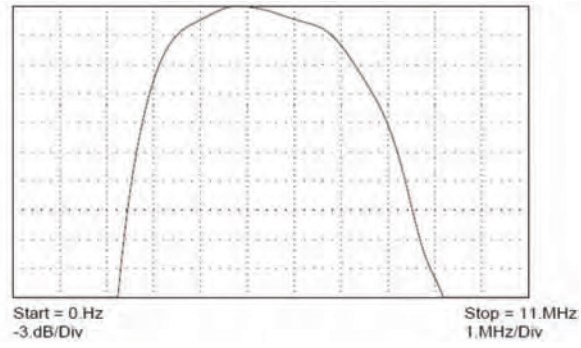
Parameters	Unit	Min	Max	Mean
Peak-Peak Sensitivity	dB	-47.61	-45.22	-46.79
-20dB Pulse Length	nS	582.4	636	605.23
-6dB Center Frequency	MHz	5.07	5.25	5.13
-6dB Bandwidth	%	74.59	80.39	78.46

Probe Test Graph

1. Element Waveform:



2. Element Waveform FFT:



SIUI can Provide

A series of phased array probes compatible with different phased array flaw detectors;
Customization of phased array probes and wedges with different specifications.

TOFD Probes

Ordering Information:

T2-12L-UN

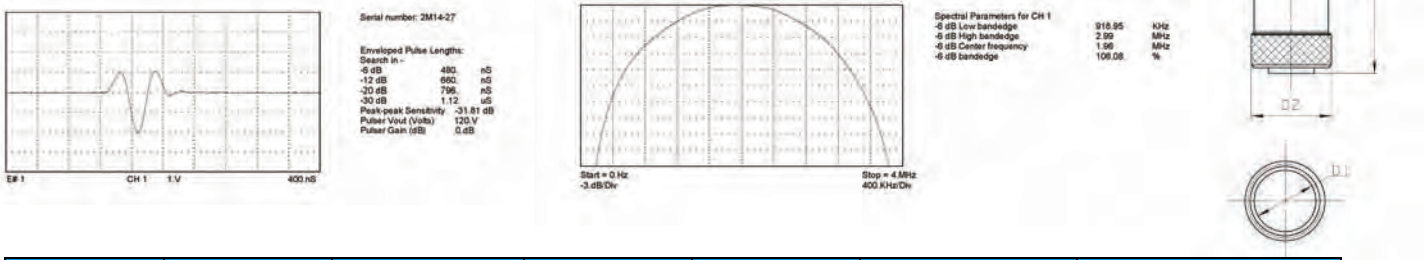
- T2 — TOFD Frequency
- 12 — Crystal dimension Φ12
- L — Connector Type: L-LEMO 00,MD-Microdot
- UN — Screw Thread Unit:M/ UN

LEMO 00 Connector

Microdot Connector

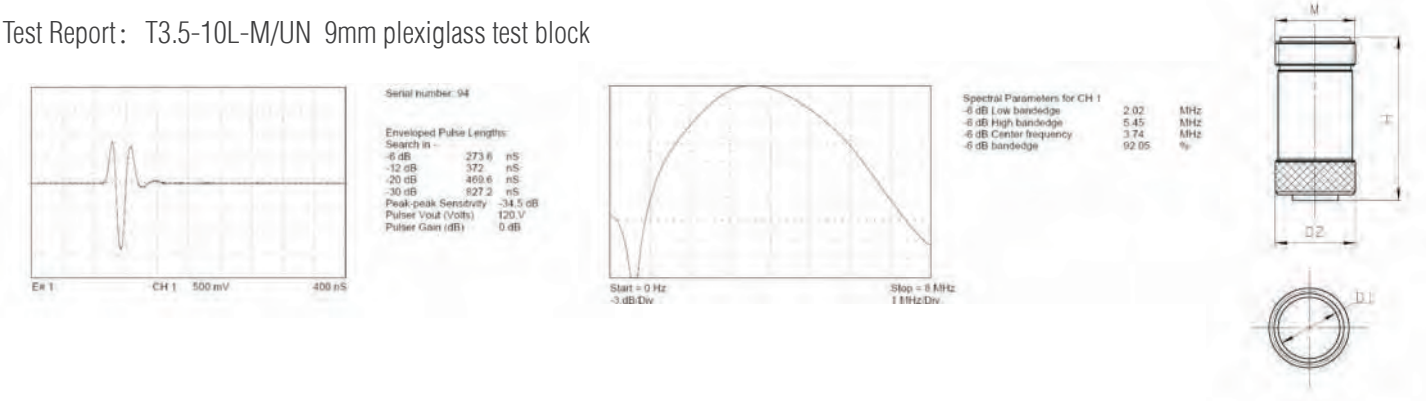
Probe	Frequency	Crystal Diameter D1	Max. Pulse Voltage	Housing Dimension	Screw Thread Unit	Compatible Wedge
	MHz	mm	V	mm		
T2-12L-**	2	12	-800	D2:18 H:32	M:M18x1 UN:11/16-24UNEF	TFD Series
T2-14L-**	2	14	-800	D2:18 H:32		

Test Report： T2-14L-M/UN 9mm plexiglass test block



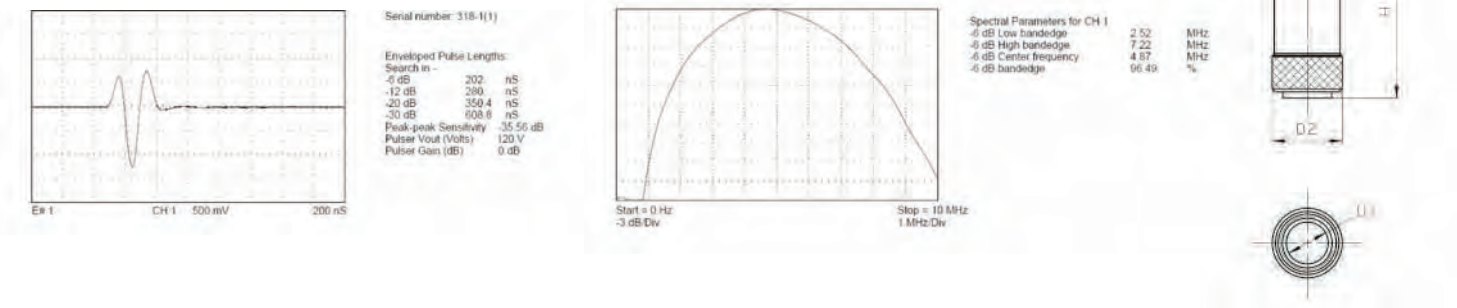
Probe	Frequency	Crystal Diameter D1	Max. Pulse Voltage	Housing Dimension	Screw Thread Unit	Compatible Wedge
	MHz	mm	V	mm		
T2-10L-**	2	10	-800	D2:18 H:32	M:M18x1 UN:11/16-24UNEF	TFD Series
T2.5-10L-**	2.5	10	-700	D2:18 H:32		
T3.5-10L-**	3.5	10	-700	D2:18 H:32		
T5-10L-**	5	10	-500	D2:18 H:32		

Test Report： T3.5-10L-M/UN 9mm plexiglass test block



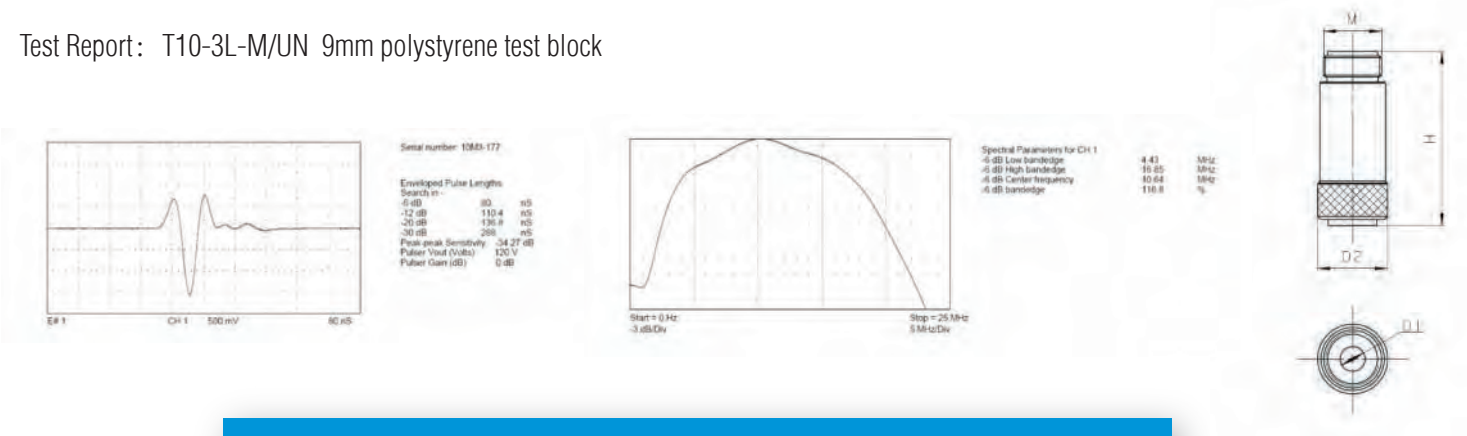
Probe	Frequency	Crystal Diameter D1	Max. Pulse Voltage	Housing Dimension	Screw Thread Unit	Compatible Wedge
	MHz	mm	V	mm		
T4-6L-**	4	6	-500	D2:11.5 H:28.7	M:M10x1 UN:3/8-32UNEF	TFB Series
T5-3L-**	5	3	-500	D2:11.5 H:28.7		
T5-6L-**	5	6	-500	D2:11.5 H:28.7		
T7.5-3L-**	7.5	3	-300	D2:11.5 H:28.7		
T7.5-6L-**	7.5	6	-300	D2:11.5 H:28.7		

Test Report： T5-6L-M/UN 9mm plexiglass test block



Probe	Frequency	Crystal Diameter D1	Max. Pulse Voltage	Housing Dimension	Screw Thread Unit	Compatible Wedge
	MHz	mm				
T10-3L-**	10	3	-300	D2:11.5 H:28.7	M:M10x1 UN:3/8-32UNEF	TFC Series
T10-6L-**	10	6	-300	D2:11.5 H:28.7		
T15-3L-**	15	3	-200	D2:11.5 H:28.7		

Test Report： T10-3L-M/UN 9mm polystyrene test block



SIUI can Provide

A series of TOFD probes compatible with different TOFD flaw detectors;
Customization of TOFD probes and wedges with different specifications.

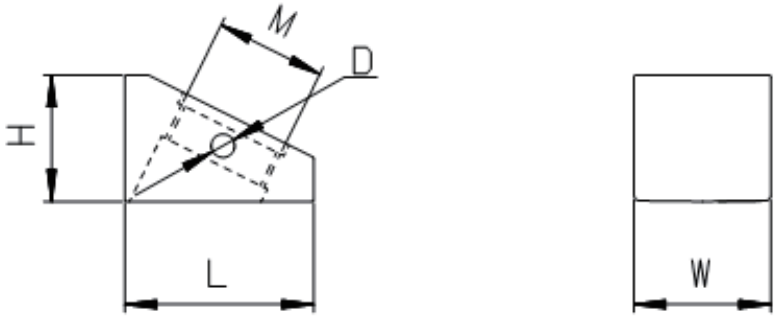
Wedge for TOFD Probe

Ordering Information:

TFB-45-UN-I

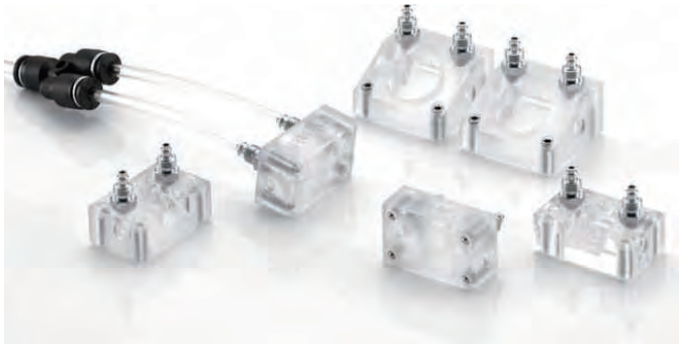
- Series Code
- Refracted Angle in Steel
- Screw Thread Unit:M/ UN
- I:irrigation/ without "I" is non-irrigation

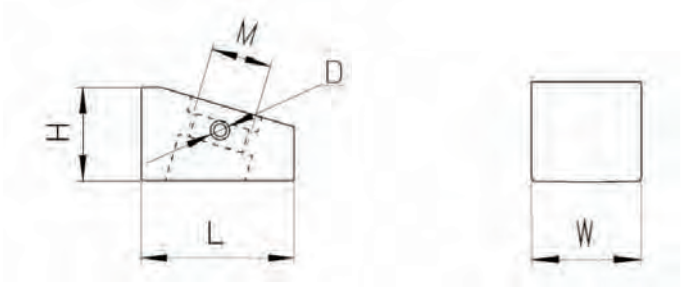
Non-irrigation Wedge



Wedge Model	Type	Velocity	Refracted Angle in Steel	L	W	H	D	Screw Thread Unit
		m/s		mm	mm	mm	mm	
TFB-45-**	Longitudinal wave wedge	2730	45°	24	16	16	3	M:M10x1 UN:3/8-32UNEF
TFB-60-**		2730	60°	24	16	16	3	
TFB-70-**		2730	70°	24	16	16	3	
TFC-45-**		2360	45°	24	16	14.6	3	M:M10x1 UN:3/8-32UNEF
TFC-60-**		2360	60°	24	16	14.6	3	
TFC-70-**		2360	70°	24	16	14.6	3	
TFD-45-**		2730	45°	31	24	21.5	3	M:M18x1 UN:11/16-24UNEF
TFD-60-**		2730	60°	31	24	21.5	3	
TFD-70-**		2730	70°	31	24	21.5	3	

Irrigation Wedge

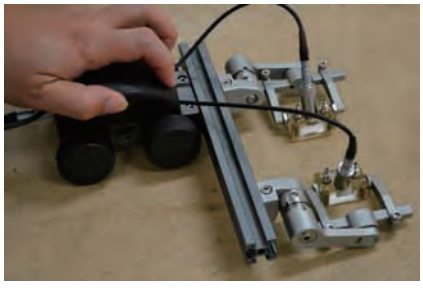




Wedge Model	Type	Velocity	Refracted Angle in Steel	L	W	H	Outer Aperture D	Inner Aperture D	Screw Thread Unit
		m/s		mm	mm	mm	mm	mm	
TFB-45-**-I	Longitudinal Wave Wedge	2730	45	20	32	13	6	3	M:M10x1 UN:3/8-32UNEF
TFB-60-**-I		2730	60	20	32	13	6	3	
TFB-70-**-I		2730	70	20	32	13	6	3	
TFC-45-**-I		2360	45	20	32	12.5	6	3	M:M10x1 UN:3/8-32UNEF
TFC-60-**-I		2360	60	20	32	12.5	6	3	
TFC-70-**-I		2360	70	20	32	12.5	6	3	
TFD-45-**-I		2730	45	30.5	32	18	6	3	M:M18x1 UN:11/16-24UNEF
TFD-60-**-I		2730	60	30.5	32	18	6	3	
TFD-70-**-I		2730	70	30.5	32	18	6	3	

Crawler for TOFD

Different crawlers compatible with TOFD probes can be provided by SIUI.



TOFD Probe Selection
(Based on ASTM E2373-04)

Probe selection shall be based on the application requirements. The following tables provide initial recommended probe parameters for specified thickness ranges in ferritic steels. For austenitic or other attenuative materials, nominal frequencies normally need to be reduced and element sizes increased.

Table 1 For Steel Thickness Ranges up to 75 mm (3 in.)

Nominal Wall Thickness	Nominal Frequency	Element Size	Recommended Angles
mm(in.)	MHz	mm(in.)	
<12 (0.375)	10 to 15	2 to 6 (0.08 to 0.25)	60 to 70°
12 to < 35 (0.375 to 1.4)	5 to 10	2 to 6 (0.08 to 0.25)	50 to 70°
35 to < 75 (1.4 to 3)	2 to 5	6 to 12 (0.25 to 0.5)	45 to 65°

For thickness ranges in steel 75 to 300 mm, the beam divergence from a single element is not likely to provide sufficient intensity for good detection over the entire thickness. For thickness 75 mm (3 in.) and greater (in steel) the examination piece shall be divided into multiple zones. For thickness 75 mm (3 in.) and greater (in steel) and when required in smaller thickness, sensitivity targets shall be placed in a reference block at least at 25% and 75% through thickness in each zone to verify that there is adequate beam coverage for the multiple zone technique used.

Table 2 For Steel Thickness Range 75 mm (3 in.) to 300 mm (12 in.)

Wall Thickness Zone	Nominal Frequency	Element Size	Nominal Angles
mm(in.)	MHz	mm(in.)	
<35 (0 to 1.4)	5 to 10	2 to 6 (0.08 to 0.25)	50 to 70°
35 to < 100 (1.4 to 4)	2 to 7.5	6 to 12 (0.25 to 0.5)	45 to 65°
100 to < 300 (4 to 12)	2 to 7.5	6 to 12 (0.25 to 0.5)	45 to 65°

On thick sections requiring more than one TOFD pair the lateral wave or back-wall signal may not always be visible. Therefore, provision in the linearizing algorithms must be made to permit inputs of other parameters instead of the lateral and back-wall signal positions. For wall thickness less than 75 mm (3 in.), technique qualifications may require they too be divided into smaller ranges with each range addressed by a dedicated TOFD pair.

SIUI

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