

# ULTRASONIC TESTING OF COMPOSITE MATERIALS

## Transducer and Capabilities Overview





## WHO WE ARE

Sensor Networks, Inc. (SNI) is a Pennsylvania-based technology company specializing in the design and fabrication of industrial ultrasonic transducers and tooling for demanding in-situ test, factory floor and inspection applications. Engineered for precision, ease of use, and maximum durability, our offerings include ultrasonic transducers, fixtures, couplant-delivery systems, qualification/calibration standards, procedure development, personnel training and instrumentation.



With well over 1,000 combined years of NDT experience, our team of engineers, technicians, assemblers, and general managers have an extremely deep background in solving unusual, demanding, and complicated NDT projects. Industries served over this time include aerospace engines and airframes, nuclear vessels, heat exchangers, large gas turbines, wind turbines and others.

“The Transducer Enables and/or Optimizes the UT Exam”

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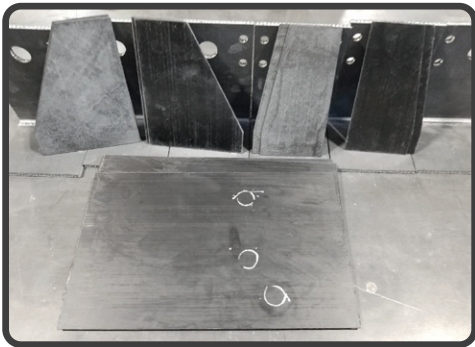
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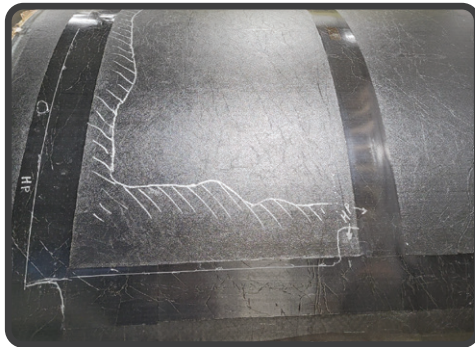
# UT Examination of Composite Materials

Composite materials have been used in many industries due to their excellent performance including high strength-to-weight ratio, corrosion resistance and durability.

Due to manufacturing and environmental factors, defects and damages can occur and can be difficult to detect. Therefore, there is a need to test and evaluate the material, in the factory and the field in order to maintain the highest level of safety, reliability, and quality.



Carbon Fiber Composite Structures

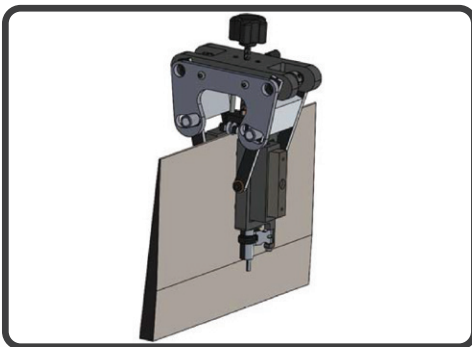


Suspected Bad Area Verified with Ultrasonic

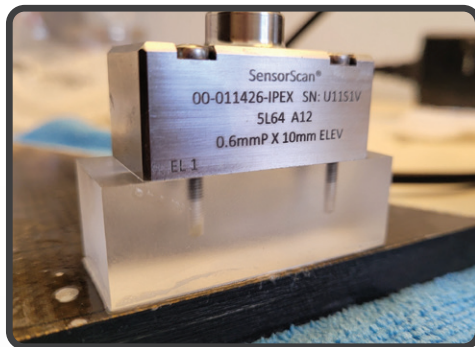


Cross-Section of defect from an Ultrasonic Indication

SNI's deep domain expertise enhances NDT solutions through the selection, design, and optimization of the ultrasonic technique. The transducers' efficiency is paramount for converting electrical energy into sound, then coupling and directing that acoustic energy back into the test piece to maximize its signal-to-noise ratio.



Custom through-transmission phased-array tool head for scanning composite aerospace materials with complex geometries



SNI A12, 5 MHz x 64-Elements Linear Array with 0-Degree Delay



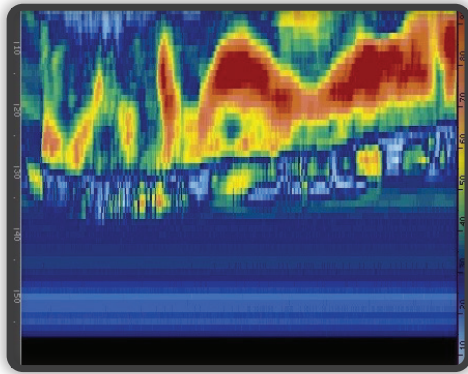
SNI QS 3.5 MHz x .375" with 0-Degree Delay





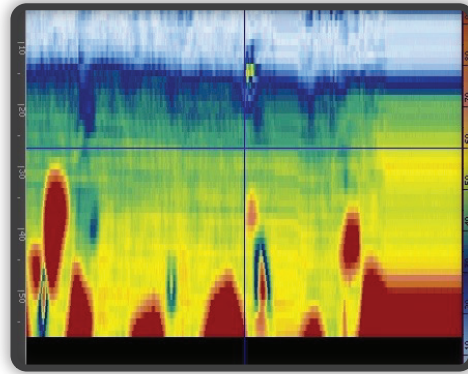
# The Array Advantage

- Useful for volumetric location and sizing of smaller defects such as cracking, porosity, inclusions, and delamination.
- Can support a broad range of requirements and can be applied to many composite materials and geometries.
- Proven industry-accepted imaging technology is fast and reliable.
- Ability to help diagnose manufacturing issues on the factory floor.



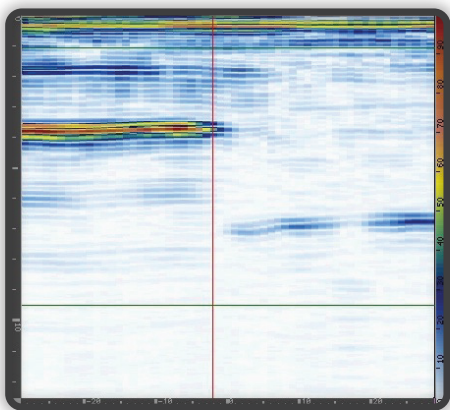
**Major Disbond (Top View, Looking Down on the Structure)**

*The red cloud images represent severe damage.*



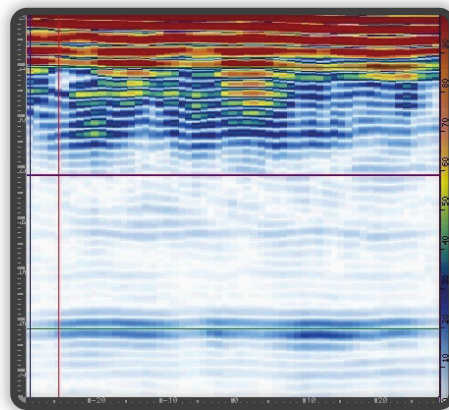
**Major Disbond (Top View, Looking Down on the Structure)**

*Insufficient paste adhesive was applied in a zig zag pattern. The red areas show a lack of bond. Subsequently, additional adhesive was applied to all components.*



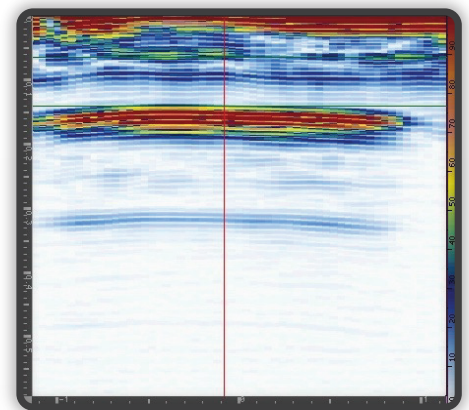
**Delamination**

*The right half of the screen shows a clear path to the back surface while the left half shows a strong indication of delamination.*



**Rough Outer Surface**

*B-scan, cross-sectional view produced from a 5 MHz transducer providing higher resolution at the expense of penetrating power through to the back surface.*



**Major Disbond**

*The red color indicates very strong echo returns.*



# WheelArray™

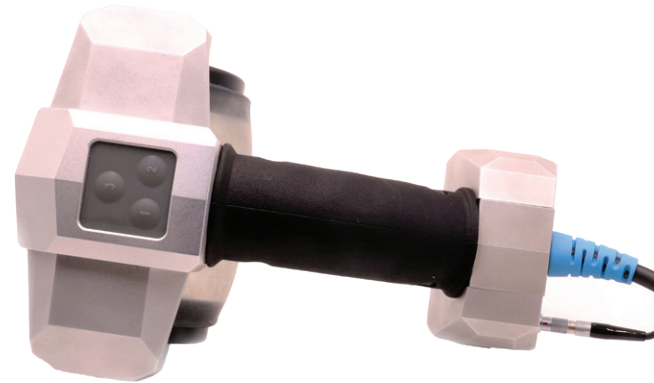
Phased-Array Transducer For Composite Material

## Phased-Array Transducer for Composite Material Ultrasonic Testing

The WheelArray is a unique tool and ultrasonic test fixture used to increase inspection productivity of large surface areas associated with composite materials and metal plates. Available in 5 different test frequencies ranging from 1 to 10 MHz, the scanning wheel can be easily swapped out.

Prior to inspection, a small quantity of water or other suitable couplant needs to be sprayed on the test area.

Custom WheelArrays can be requested including custom frequency, elements, pitch, cable length, and connector.

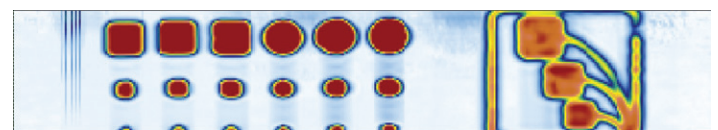
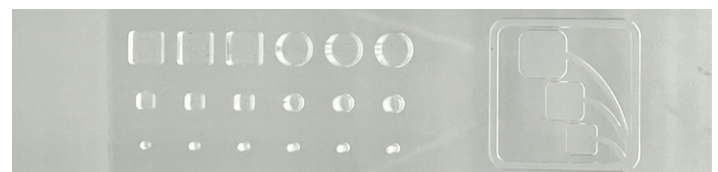


### Applications:

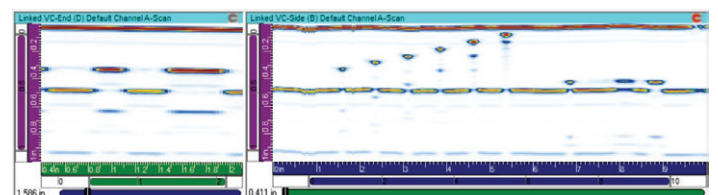
- Aerospace: airframe structure and engine components
- Helicopter: rotor blade inspection
- Energy: wind turbine blades
- Pipes and Vessels

- Translucent tire for easy identification of air bubbles
- Compliant tire for better coupling to test material
- Ergonomic comfort grip
- Accommodates composites up to ~ 2.0" (52mm) thick
- Tool weighs 3.8lbs (1.7kg) filled
- P68 magnetic rotary encoder
- Optional front encoder

The unit's encoder wheel can interface with any UT test instrument for easy B- or C-scan imaging.

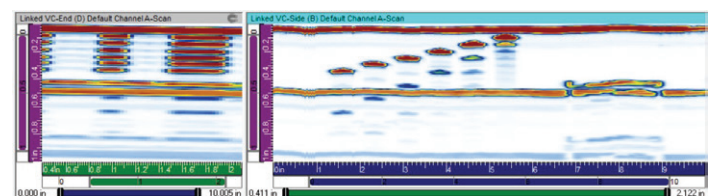


C-Scan from Soft Gate between Front Surface and Backwall



Single Plane End View

Single Plane B-Scan



Merged End View

Merged B-Scan



WheelArray on a composite stiffener

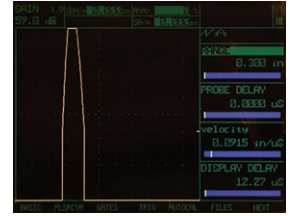


# Conventional Transducers

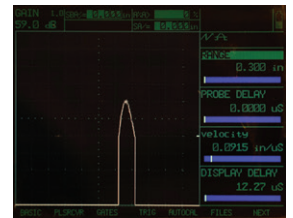
## Zero-Interface Probes

Zero-Interface Probes (ZIP) are low-frequency delay-line transducers designed to inspect composite material. The special delay lines used are acoustically matched to the composite material which allows for a zero-interface signal, more efficient energy coupling & transmission, and increased near-surface resolution. Replaceable delay lines are available in packs of 5.

ZIP probes are special delay-line contact probes that are single-element, longitudinal-wave (straight beam) transducers designed for the detection of near-surface flaws and thickness measurement of thin cross-section materials.



Echo of a ZIP Delay



Backwall Echo from a 0.14" (3.6mm) Composite Component with ZIP

## Dual-Frequency Transducers for Testing Machines

Ultrasonic testing machines are offered by many Original Equipment Manufacturers (OEMs) to cover a wide variety of inspection applications including pipe, tube and bar, plate, and composite materials. This in turn requires transducers with a wide variety of physical and acoustic performance specifications.

One unique example is the annular dual-frequency transducer which includes a low-frequency annular ring that surrounds a higher-frequency center transducer. This combination then enables near surface detection of small defects combined with deeper penetration of heavier-wall sections.



## Water-Filled Membrane Transducers

The water-filled flexible membrane transducer maximizes the defect response on irregular entry surfaces, enhancing the ability to inspect irregularly shaped components with better penetration and resolution.

The current low-frequency models (1.5, 2.25, and 3.5 MHz) were designed to inspect carbon composite in the aerospace industry – but this technique is applicable to many other applications and materials.

The transducer is customizable for an easy and accurate inspection process. The membrane is replaceable and available in two materials - UltraFlex (for maximum conformability) and UltraWear (for maximum wear). The membrane can also be filled with water or Glycol liquid (for cold environments).





# Phased Array Immersion Linear

## Immersion Linear

Immersion arrays are used in automatic and manual scanning systems using water or other liquids to couple to parts with complex geometries or large surface areas, making them effective for inspecting composite materials.

### Hardwater Arrays:

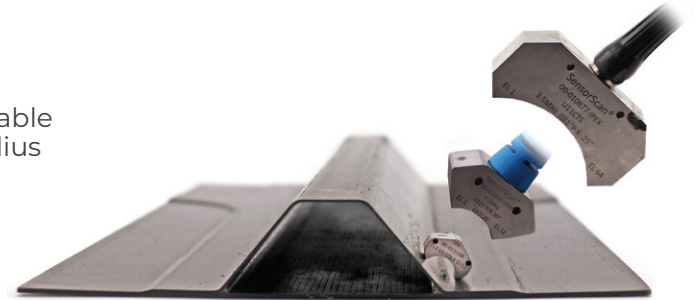
The hardwater array is acoustically matched to water to minimize interface echoes, thereby improving near-surface resolution.

The array is manufactured with a 5MHz ceramic and is tested before the hardwater delay is applied to the face of the transducer. Once applied, the center frequencies available are typically between 2.2-3.5MHz.



### Curved Arrays:

Curved arrays have a corrosion-resistant design and are waterproof up to 3.3 ft (1m) of water, making them highly reliable for testing machines. The array is designed to inspect the radius of curvatures ranging from  $\sim \frac{1}{4}$ " (6.35mm) to  $\sim 8$ " (200mm), making them perfect for the inspection of carbon-fiber-reinforced polymers (CFRP) corners.



### Near Wall Arrays:

Near Wall arrays allow for the inspection of 90-degree cross-sectional components. By having the first element very close to the edge of the case, it is well suited for B- or C-scan imaging for defects such as cracking, porosity, inclusions, and delamination.



## Optimized Solutions for Cost-Effective Productivity

SNI has the experience and the capability to customize any transducer shown on this page and in this brochure. Customization includes:

- Frequency
- Element and transducer size and shape
- Array pitch and elevation
- Housing size and material
- Cable length and instrument connector
- OEM / Private Label

# Part Numbers

## COMPLETE WHEELARRAY KIT

Frequency* (Mhz)	Number of Elements	Element Pitch		Elevation		Sound Path		Beam Width		Part Number
		in	mm	in	mm	in	mm	in	mm	
1	32	0.06	1.6	0.47	12	1.0	25.4	2.0	51.2	00-013242
2.5	64	0.03	0.8	0.25	6.4	1.0	25.4	2.0	51.2	00-013241
3.5	64	0.03	0.8	0.25	6.4	1.0	25.4	2.0	51.2	00-013076
5	64	0.03	0.8	0.25	6.4	1.0	25.4	2.0	51.2	00-013073
10	64	0.03	0.8	0.25	6.4	1.0	25.4	2.0	51.2	00-013081

\*Available with ZPAC or IPEX connectors. Others available upon request.

\*These spare/replacement parts include the fluid-filled wheel, transducer, cable, and connector sub-assembly.

## REPLACEMENT WHEEL

Frequency* (Mhz)	Number of Elements	Element Pitch		Elevation		Sound Path		Beam Width		Part Number
		in	mm	in	mm	in	mm	in	mm	
1	32	0.06	1.6	0.47	12	1.0	25.4	2.0	51.2	00-013233
2.5	64	0.03	0.8	0.25	6.4	1.0	25.4	2.0	51.2	00-013232
3.5	64	0.03	0.8	0.25	6.4	1.0	25.4	2.0	51.2	00-013228
5	64	0.03	0.8	0.25	6.4	1.0	25.4	2.0	51.2	00-013227
10	64	0.03	0.8	0.25	6.4	1.0	25.4	2.0	51.2	00-013229

\*Available with ZPAC or IPEX connectors. Others available upon request.

\*These spare/replacement parts include the fluid-filled wheel, transducer, cable, and connector sub-assembly.

## IMMERSION LINEAR - Near Wall, Curved, Hardwater

Frequency* (Mhz)	Number of Elements	Element Pitch		Elevation		Part Number	Case
		in	mm	in	mm		
3.5	64	0.040	1.00	0.28	7	00-010331	Near Wall 1
3.5	128	0.040	1.00	0.28	7	00-013046	Near Wall 3
5	64	0.040	1.00	0.28	7	00-010332	Near Wall 1
5	128	0.040	1.00	0.28	7	00-011929	Near Wall 3
5	32	0.052	1.32	0.24	6	00-010334	R4 (Curved Linear)
5	64	0.050	1.27	0.31	8	00-010327	HW (Hardwater)

## WATER-FILLED MEMBRANE

Frequency* (Mhz)	Element Diameter		Part Number	Membranes
	in	mm		
1.5	0.25	6.35	00-013863	See H2O Membrane Guide
1.5	0.50	12.7	00-013866	See H2O Membrane Guide
2.25	0.25	6.35	00-013864	See H2O Membrane Guide
2.25	0.50	12.7	00-013867	See H2O Membrane Guide
3.5	0.25	6.35	00-013865	See H2O Membrane Guide
3.5	0.50	12.70	00-013868	See H2O Membrane Guide

## ZERO-INTERFACE PROBES

Frequency (MHz)	Element Diameter		Part Number
	in	mm	PN
0.5	1	15.4	00-012361
1.5	0.375	9.5	00-011173
	0.5	12.7	00-012616

## DUAL FREQUENCY TRANSDUCERS

\*Custom size, type, frequencies available upon request.