Composite Inspection Solutions

Basic Concept of Composite Inspection

Aircraft manufacturers, maintenance service providers, and airline operators have recently started to use ultrasonic phased array (PA) technology to help ensure the quality of their composite parts during maintenance and manufacturing. Parts manufactured of carbon fiber reinforced polymer (CFRP) pose an inspection challenge because of their many shapes and thicknesses.

Phased array technology is a nondestructive technique that utilizes an ultrasonic beam where parameters such as angle, focal distance, and focal points size are controlled through software. Furthermore, phased array technology improves the detection of defects common in composite inspection (notably delamination).

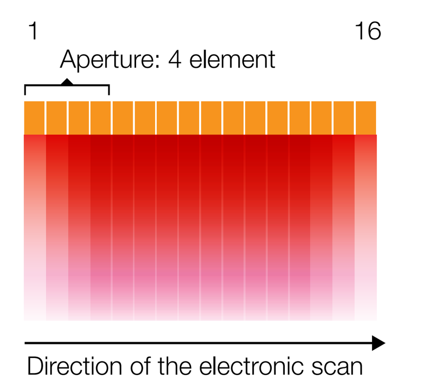
Benefits of Phased Array Technology for Composite Inspections

There are many benefits associated with using phased array ultrasound for inspecting flat and radii composite parts. Notably, the enhanced data imaging helps reduce human error. Likewise, the use of C-scan imaging increases the reliability of the inspection because it provides full coverage of the inspected surface. Also, large multi-element probes increase inspection speed and resolution. A-scan and C-scan data can be stored for further analysis or periodic comparisons.

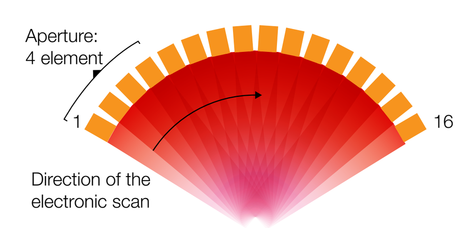
Our OmniScan® PA instrument supports both phased array and conventional ultrasonic modes with one-button switching between the two techniques.

Phased array technology advantages:

- **Faster** inspection speed
- **Full coverage** in a single scan
- **Better** probability of detection (POD)
- **Reporting** and traceability



Linear at 0° electronic scan is well suited for the inspection of flat panels.



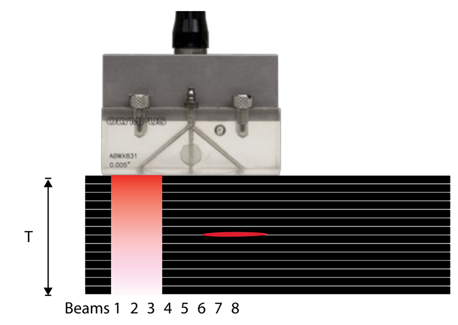
Linear at 0° electronic scan on a curved array is well suited for the inspection of radii.

Terminology

Composite parts come in many shapes and thicknesses. Several parts consist of a somewhat flat section while many parts consist of corners. Flat panels are primarily defined by their thickness while additional parameters have to be considered with radii parts.

Flat surfaces

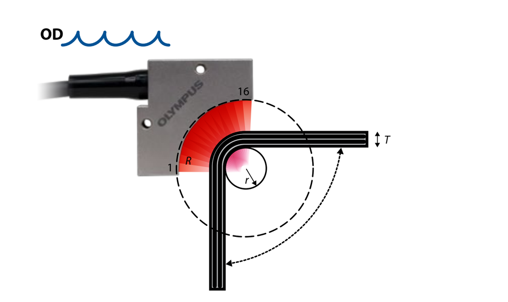
CFRP flat panels are only characterized by thickness.



Radii

CFRP radii are characterized by three main parameters:

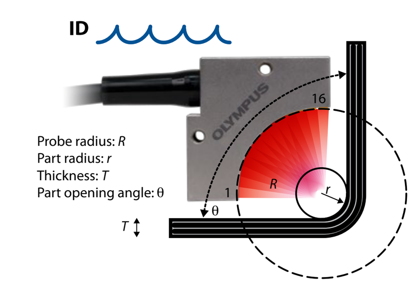
- Part radius
- Part opening angle
- Thickness



The specific linear curved array PA probes used to inspect these radii are also defined by the probe radius and the probe angle.

Two main inspection types exist — each is characterized by the relative position of the probe to the corner.

- Inside the ID corner
- Outside the OD corner



Typical Setup Configuration

A typical setup configuration is very similar for both flat surfaces and radii in composite inspections. Both inspections require users to position gate A immediately after the front-wall echo until past the back-wall echo. The flat panel inspection is performed with the use of a manual scanner with two encoded axes, while the radii inspection is an immersion technique with one encoded axis.

Two or three gates (I, A, B)

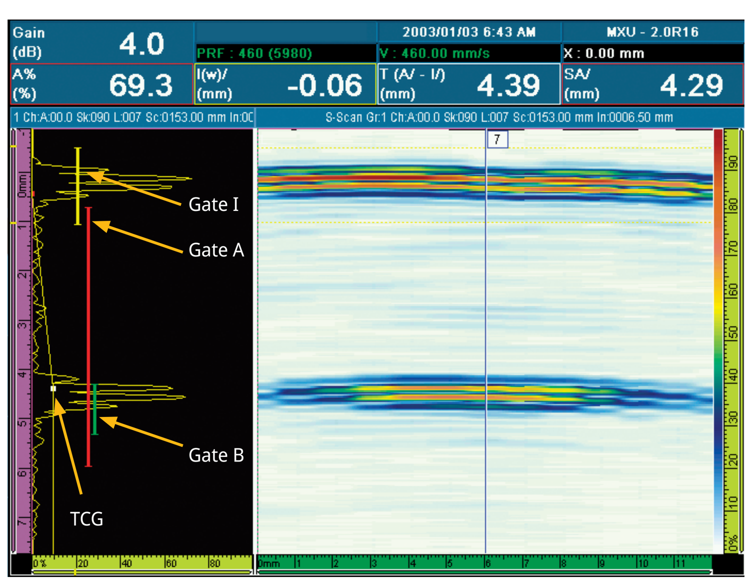
- Gate I can be used to synchronize the other 2 gates on the front wall.
- Gate A typically commences right after the front wall and continues past the back wall. This gate is used to produce amplitude and time-of-flight (TOF) C-scans.
- Gate B is typically employed to monitor back- wall amplitude on panels with relatively constant thickness.

Time-Corrected Gain (TCG)

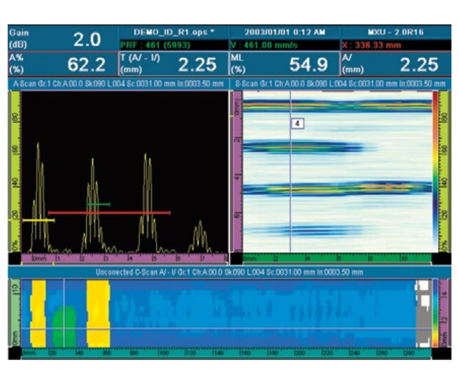
- To obtain 80% front-wall and back-wall echoes.

C-scan displays (A%, TOF, B%)

- Depending on the sample and the defects, each display has its merits and inconveniences.



Typical setup with a display showing an A-scan and S-scan.



Display showing an A-scan, S-scan, and TOF C-scan.

Display showing an A-scan, amplitude C-scan, and TOF C-scan.

Display showing an A-scan, S-scan, and amplitude C-scan.

Data Analysis

Performing fast inspections on large surfaces requires nondestructive tools with appropriate imaging capabilities. The various imaging capabilities, such as A-scan, B-scan, S-scan, and amplitude and/or time-of-flight C-scans, help the operator perform reliable inspections.

The main differences between inspecting corners and inspecting a flat panel are:

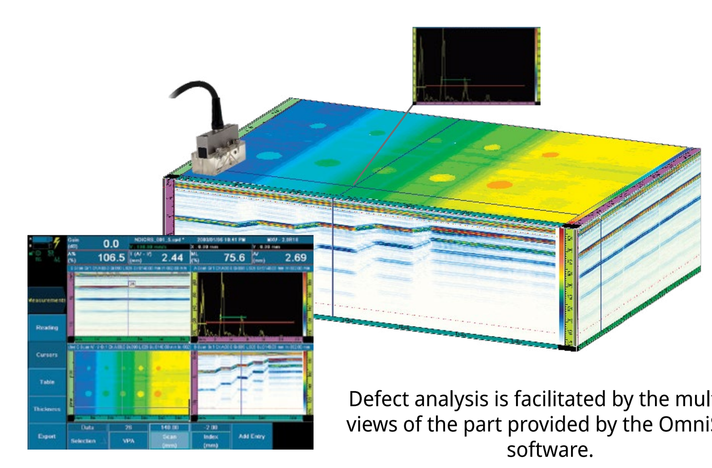
- The correlation required for index sizing on the corners.
- The beam inversion for ID inspection.

Index sizing on the corners

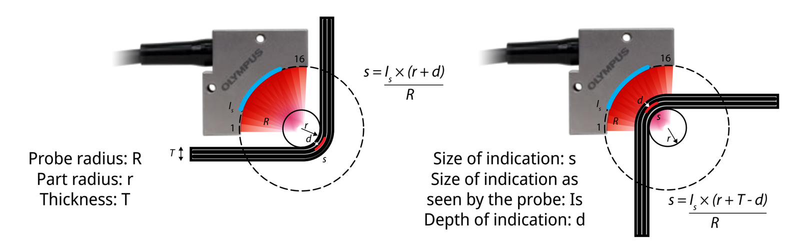
Indication sizing in the scan direction can be directly measured from the encoded readings and the displays on the OmniScan flaw detector. A geometric conversion taking into account the radius of the phased array probe (*R*), the radius of the corner (*r*), the depth of the indication (d), the thickness of the part (*T*), and the indication size as displayed on the OmniScan (*S*) instrument, is required to obtain the actual indication size (*s*). This conversion is also dependent on the type of inspection (ID or OD).

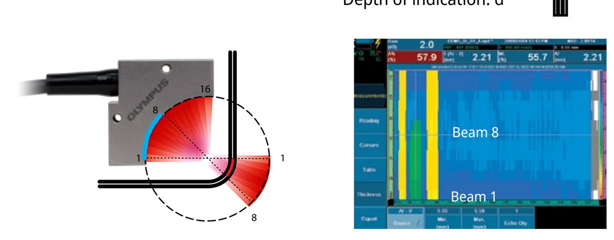
Beam Inversion for ID Inspection

When performing an inspection from the inside diameter (ID), the beam created from the first elements of the probe reflects on the highest part of the corner (beam 1), whereas the beam created from the last elements reflects on the bottom part of the corner (beam 8). Therefore, the beams are inverted on the S-scan display as well as on the C-scan.



Defect analysis is facilitated by the multiple views of the part provided by the OmniScan software.



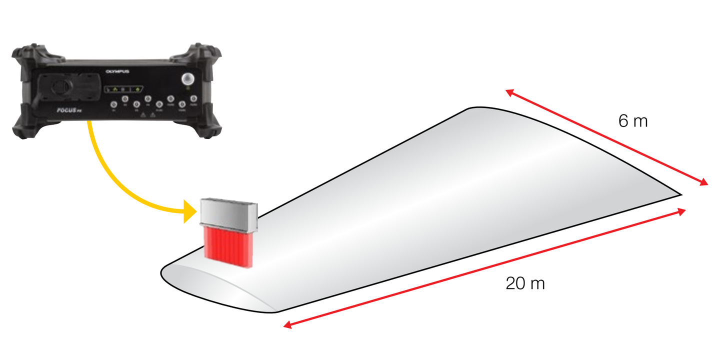


Due to the beam inversion phenomenon, the beams are inverted on the C-scan.

Automated Composite Part Inspection Systems

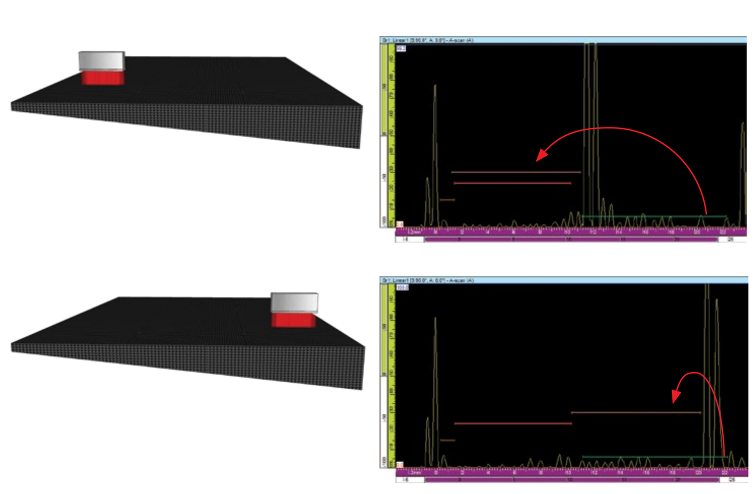
Unlimited Part Size Feature

The continuous inspection feature enables the inspection of very large parts without having to interrupt the inspection sequence. This feature enables data files to be continuously produced throughout the inspection, resulting in significant time savings.



Advanced Detection Capabilities

Multiple gates with advanced synchronization and presynchronization capabilities provide you with effective tools to deal with difficulties that are common with inspecting complex geometries, including parts with varying thicknesses.



Linked gates automatically adjust their position to account for geometric variation.

Bond Testing Reinvented with C-Scan

Easy-to-read C-scan imagery is possible using a portable instrument. This OmniScan solution is ideally suited for disbond detection in honeycomb composite, as well as equally accurate delamination detection. Primarily designed for aerospace in-service inspection, this solution is also useful for the manufacturing sector, including the automotive and naval industries (e.g., for composite boat hulls).

For each C-scan, the operator has two viewing options to choose from: the amplitude C-scan displays color variation based on the amplitude of the signal, regardless of the phase, which is ideal for clear and efficient disbond detection; or, the phase C-scan uses a 0° to 360° color palette to display changes in the phase angle, making it easy to distinguish between different types of indications, such as putty (repair) and delamination.

High-Precision Inspection of CFRP Flat Panels

OmniScan Flaw Detector and Software

GLIDER™ Scanner

PA Probes and Wedges

Ergonomic Inspection of CFRP Flat or Curved Surfaces

OmniScan Flaw Detector and Software

RollerFORM® Scanner

PA Probe

CFRP Radii Inspection Solution

OmniScan Flaw Detector and Software

Linear Curved PA Probes and Wedges
(performed in water immersion)

More Products for Composite Inspection

EvidentScientific.com

920-419-EN Rev. A - Posters_Composite_EN_202304_Evident. Printed in the USA.