Photoelastic Visualisation _ Phased Array Sound Fields  
Part 17 – Contact Probe –E-scan and S-scan

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The video to this article can be seen here: www.ndt.net/search/docs.php3?id=16912&content=1

1. Introduction

This technical note is Part 17 of a series in NDT.net.

Perhaps the most well known aspect of phased array ultrasound technology is the capability of the instrumentation to provide a dynamic beam without mechanical motion. Moving a fixed angle beam along the length of a linear array probe is considered an “electronic scan”, or E-scan. When the phased array instrument is configured to generate an E-scan the same focal law is multiplexed across a group of active elements. E-scans are equivalent to a conventional ultrasonic probe performing a raster scan.

The other dynamic beam movement is the sectorial scan, or S-scan. In medical applications this has also been termed the azimuthal scan. When used to refer to the beam movement, it refers to the set of focal laws that sweeps through a defined range of angles using the same set of elements.

The associated video in this article uses a nominal 5MHz linear array having 64 elements with a passive length dimension of 10mm. Elements are 0.5mm high with a 0.1mm kerf thereby producing a 0.6mm pitch. The probe is placed in direct contact with the glass plate specimen with no refracting wedge.

Pulsing of the probe is achieved using an RD Tech Focus 16/64 laboratory unit. Pulse width is adjusted to 100ns to provide the optimum output at a single half-wave negative pulse at 210 V.

The glass block specimen is made of soda-lime float glass (compression mode velocity 5840m/s, transverse velocity 3450m/s, density 2.5g/cm³). Through-thickness of the model, parallel to the light path, is 20mm.

The active aperture in the demonstrations uses 15 elements in the array and these are configured to focus the compression mode at 11mm depth in the glass. In the first part of the video the E-scan is demonstrated with the first element being element #1 and the step increment between each firing is 5 elements (e.g. the first delay law uses elements 1-15, then the next firing uses elements 6-20, then 11-25, etc. until the remaining number of elements is less than 15 when the sequence starts again.

Figure 1 illustrates the E-scan configuration used.
In the second part of the video the S-scan is illustrated for the 15 elements starting at element #30. The focal laws are configured to sweep from -30° to +30° in 3° angular steps. As with the E-scan portion of the video, the S-scan focal laws are configured to focus the beam at 11mm sound path. This implies that the focal point will occur along an arc 11mm from the entry point.

Figure 2 illustrates the S-scan configuration used.
2. Comments on the Video

The video begins with the E-scan sequence and a focussed pulse captured at 11mm depth formed by the first 15 elements in the array. See Figure 3.

**Figure 3** Pulse from elements 1-15 at 11mm depth in glass

In order to illustrate the E-scan effect of a sequence of delay laws with a fixed depth focus, the strobe-light delay is held constant as the electronics from the photoelastic system is synchronised to display the advance of the beam along the probe length. The video sequences through the E-scan four times. Using image stacking software, the compilation of the delay laws is seen in Figure 4.

**Figure 4** Accumulated Pulses from E-scan with 5 element step

If we overlay the probe outline and beam paths on the focal spot intensities and plot the intensity at each point, we can see the coverage that such a delay law provides. This is illustrated in Figure 5.
In the second part of the video, the effect of a simple S-scan is seen. The same aperture size and focal distance is configured as was used for the E-scan. The sweep from -30° to +30° is seen repeated twice. Even with a 3° angular increment between the steps, the sweep has a relatively smooth appearance. Figure 5 illustrates the beam at the -30°, 0° and +30° positions.

Figure 5 Relative spot positions and beam width from E-scan with 5 element step

As with the E-scan, the strobe light delay was fixed. Having illuminated the 0° beam where it reaches the calculated focal depth (11mm in glass), we can expect that the -30° and +30° positions are also illuminated at the focal points because the delay law was configured to focus in halfpath.

For more information about the photoelastic system see [www.eclipsescientific.com](http://www.eclipsescientific.com).

**The video to this article can be seen here:**
www.ndt.net/search/docs.php3?id=16912&content=1