

ULTRASONIC PROBE

Equipment

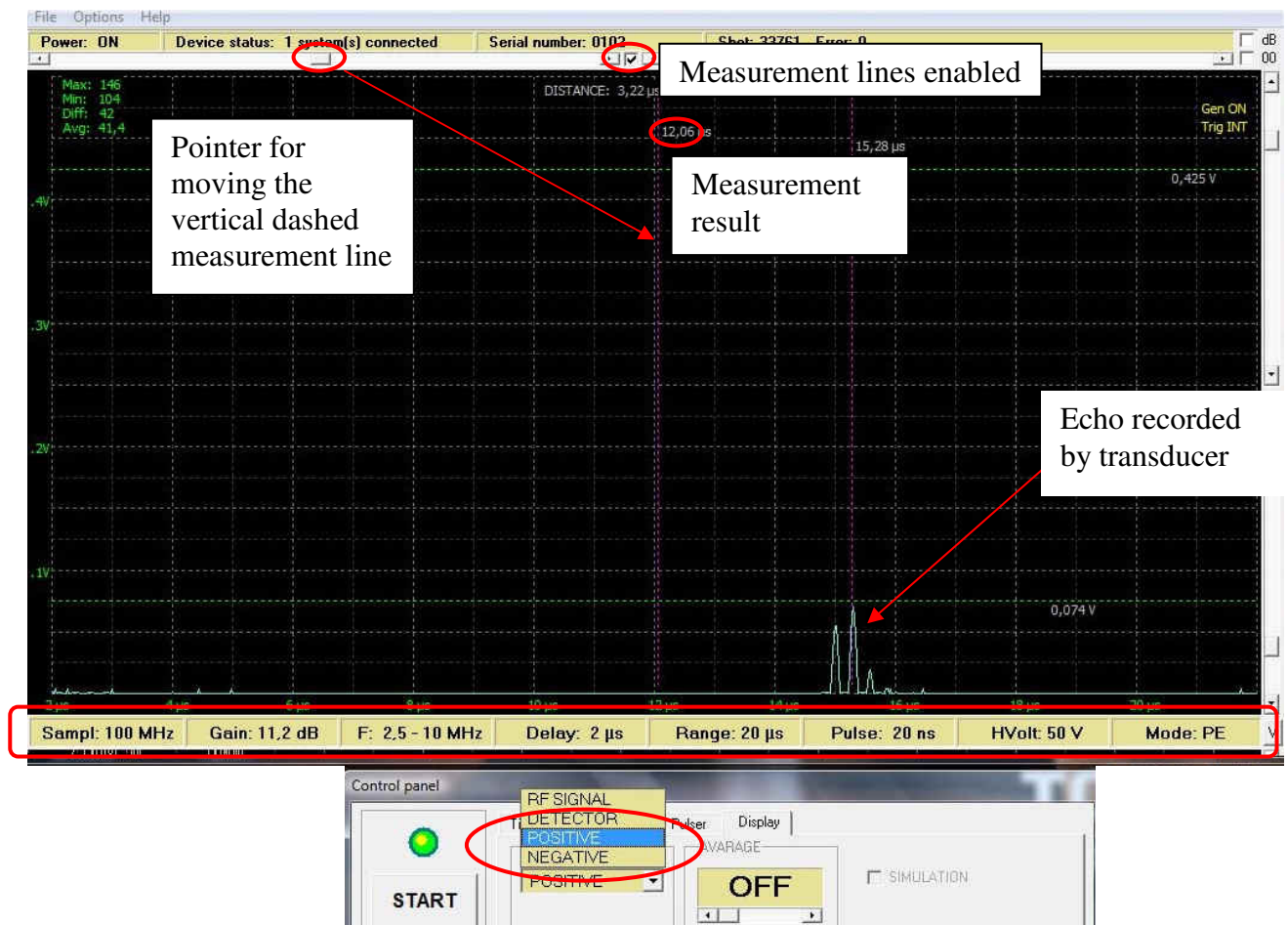
A scanning system with an ultrasonic transducer operating in transmit-receive mode, a computer with software for controlling the scanning system, a flaw detector, two prisms, plexiglass, and a 2.6 MHz probe.

Experimental Procedure

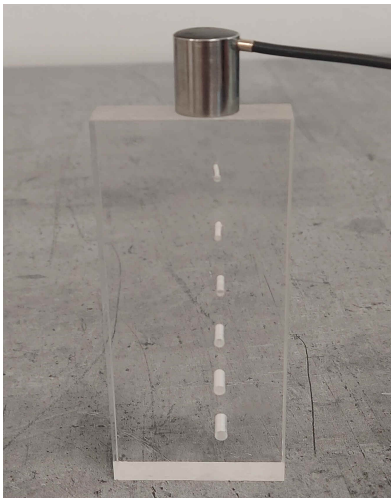
Part A

The aim of this part of the experiment is to measure the time of flight of the ultrasonic pulse in order to calculate the ultrasonic wave velocity in the material and determine the location of the holes in the plexiglass.

1. Start the VSystem software and then start the recording by clicking the “Start” button.
2. Check that the appropriate parameters are set as shown in the image below, highlighted by the red horizontal box.



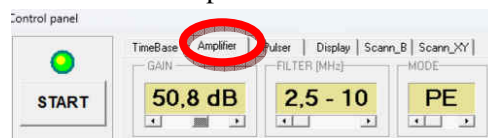
3. Using a caliper, measure the heights of the samples provided by the instructor:
 - SAMPLE No. 1 is made of organic glass (plexiglass),
 - SAMPLE No. 2 is made of flint-type lead glass,
 - SAMPLE No. 3 is made of crown-type potassium glass.
 4. Enter the measurement results in the appropriate fields of the report form.
 5. Apply ultrasonic coupling gel to one surface of the sample being analyzed. Then place the ultrasonic probe against the surface and read the time of flight of the ultrasonic pulse from the screen at the maximum amplitude. The time of flight is the time required for the signal to travel to the opposite surface and back.
 6. Repeat the procedure for all samples provided.
- Calculate the ultrasonic wave velocity in each of the analyzed materials. In which material does sound propagate fastest, and in which does it propagate slowest?



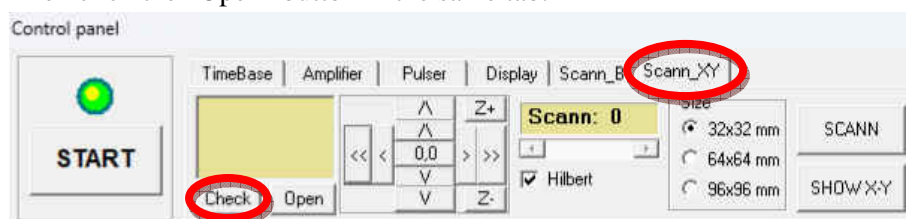
7. In the next part of the experiment, use the same ultrasonic probe to measure the distances between the individual holes and the surface of the phantom (see image). To make it easier to identify the echo signal, set Delay to 7 μ s, Gain to 40 dB, and Range to 40–80 μ s.
8. In your calculations, use the speed of sound in plexiglass determined in the previous measurement.
9. If no echo signal is observed from a subsequent hole, enter a dash (—) in the appropriate cell of the table.
10. Determine the maximum number of holes from the phantom surface for which the distance can be measured using the 2.6 MHz probe. Explain why the echo amplitude decreases as the depth of the hole increases and why echoes from the deeper holes cannot be observed.

Part B

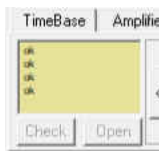
1. Unplug the flaw detector and ask the instructor to change the probe and switch on the scanning system.
2. Switch on the flaw detector and start recording in the VSystem software by clicking the “Start” button (if recording was stopped previously).
3. Set “Gain” to approximately 50 dB in the “Amplifier” tab and set “Delay” to 10 ns.



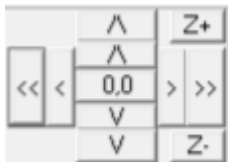
4. Connect the scanning system to the software by clicking the “Check” button in the “Scann_XY” tab. Then click the “Open” button in the same tab.



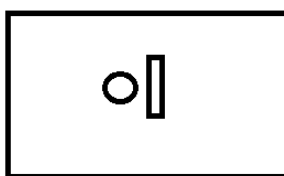
5. The software will indicate that the system is ready by displaying “OK” in the yellow field..



6. At this point, the probe can be moved using the arrow buttons located around the “Start Position”, marked as “0,0”. The “Z+” and “Z-” buttons are used to move the probe along the Z-axis.

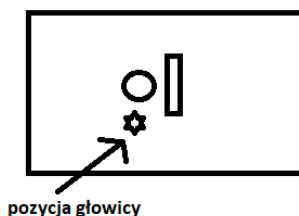


7. Click the “0,0” button.
8. Place the selected objects into the container (see figure). Fill the container halfway with cold water.



NOTE! It is important that the objects are NOT placed close to the walls of the container, as the probe and its holder are lowered into the container during the scanning process. Placing the objects too close to the walls may cause the probe holder to collide with the container.

9. Manually position the container so that the probe is positioned relative to the objects as shown in the figure. This position of the probe will allow a complete scan of the objects to be performed.



10. Using a graduated cylinder, add cold water until the water level is approximately 1 cm below the maximum height of the container.
11. Lower the probe using the “Z-” button until its tip is submerged in the water by approximately 0.5 cm. Set the scanning area to 64×64 mm and start the scan by clicking the “SCANN” button.
12. After the scan is complete, an additional X-Y image window should appear. In the upper-right corner, there is a slider that allows you to display successive images corresponding to different distances from the probe.
13. Identify the appropriate images and measure the dimensions of the objects using the vertical and horizontal sliders located to the right of and below the image, respectively. There are two lines for each axis. Note that the upper-left corner displays the distance between the corresponding pair of lines.
14. If the objects were positioned at an angle relative to the scanning axes, the Pythagorean theorem can be used to determine their dimensions.
15. Record the results in the appropriate table.
16. Raise the probe using the “Z+” button.

17. **Carefully** remove the container and pour out the water. Then, using a caliper, measure the corresponding actual dimensions of the objects and compare them with the measurement results obtained from the scan.
18. Switch off the equipment and the computer.

Required theoretical knowledge:

1. Ultrasound as a mechanic wave. Wavelength, frequency and propagation rate of ultrasound.
2. Reflection coefficient, acoustic impedance, and Fresnel equations.
3. Impulse echolocation as a method of a spatial localization of organs inside a body in an ultrasound image. The axial resolution of an ultrasound beam and its dependence on the frequency of ultrasound.
4. Ultrasound echo presentation modes A and B.
5. Artifacts in an ultrasound image.

Wroclaw Medical University Department of Biophysics and Neuroscience	Practical No 25 Ultrasonic probe	
..... Names of students		Faculty: Group No: Date:
Grade:	Tutor's signature	

Part A.

Object	Height [mm]	Echo return time [μ s]	Velocity [m/s]
(1) Organic glass (plexiglass)			
(2) flint-type lead glass			
(3) crown-type potassium glass			

	Hole I	Hole II	Hole III	Hole IV	Hole V
Echo return time [μ s]					
Distance between individual holes and the surface of the phantom [mm]					

Why does the echo amplitude decrease with increasing hole location depth, and why do we not see echoes from further holes?

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Part B.

Object.....

	Width/Diameter [mm]	Length/Diameter [mm]	Height [mm]
USG measurements			
Actual measurements			

Object.....

	Width/Diameter [mm]	Length/Diameter [mm]	Height [mm]
USG measurements			
Actual measurements			

Object.....

	Width/Diameter [mm]	Length/Diameter [mm]	Height [mm]
USG measurements			
Actual measurements			

Why do ultrasonic measurements overestimate the actual dimensions of objects?

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