

5.3.5. AUTOMATED SYSTEM FOR QUICK ULTRASONIC TRANSDUCERS CALIBRATION

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This paper describes ultrasonic transducers calibration system AUGUR 5.4 which was developed in Scientific and Production Center "ECHO+". AUGUR 5.4 is a new generation of systems for probes verification. The system allows measuring or calculating most part of contact and immersion probes parameters described in European Standard EN 12688-2 and Russian Standard GOST 23702–90. The simple and compact system for probes verification was developed. Main system feature is based on use of scanning device with one or two axes and single hemispherical or semicylinder test block (for contact probes) and small ball-type reflectors (for immersion probes). Single measurement with pulse-echo technique allows calculating of pulse parameters (pulse shape, pulse spectrum, sensitivity, noise level), probe index, beam axis offset, beam and squint angle, angles of divergence. The principle of full 3D directivity pattern calculation (therefore beam and divergence angles in any plane) based on calculation of multiple-frequency holograms of "omnidirectional source" (FT-SAFT framework). Distance-amplitude curves calculated numerically with discrete model of probe's crystal and batch of flat bottom reflectors. The time for common parameters set verification (impulse parameters, sensitivity, probe index and directivity pattern in plane of incidence, noise curve, DAC) could be completed for about a two minutes including probe set up, measurements, calculation and datasheet printing. Verification of full parameters set with 2D scanning and manual analysis of some characteristics could be completed for twenty minutes or less.

With acoustic holography framework the probe field could be calculated and visualized right up to probe plate. This allows to analyze beam properties and to seek flaws of probe plate.

The errors of most parameters measurement were determined. Twelve typical probes for rails inspection were verified five times by conventional manual technique and five times by system AUGUR 5.4 to substantiate directivity pattern calculation algorithm. In the absence of bias was detected that mean-square error of incidence angle measurement is 0.55 degree for manual technique and 0.31 for automatic technique. The sensitivity measurement limiting error is 1.5 dB. The probe index measurement limiting error is 1 mm. Effective frequency measurement error is less then 50 kHz. Probe delay time measurement error is 5%.

System allows to complete probe verification task without additional metrological equipment (oscilloscope, pulse generator, set of standard blocks, direct current power supply, plotter etc). The measurements automation allows to reduce operators qualification demands, to reduce human factor, to provide probe datasheet generation and storage, to check acceptance criterions. The system application recommendations are to specify acceptance criterions for typical probes and to make probe verification at manufacturer site, user site and during the probes' life. System also useful for investigations of non-typical probes and for ultrasonic inspection of compact specimens.

One of the systems is working on Vyksa Steel Works to complete codes of probes calibration routine in international project NordStream and batch of systems is ordered by Russian Railways.