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Heterodyne and Time-gated Time-delay Spectrometry for Amplitude and Phase Calibration of Hydrophones up to 50 MHz

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To date, primary and secondary hydrophone calibration techniques provide the amplitude of the hydrophone sensitivity of internal standards or for a calibration service. In many applications precise and reliable measurements are, however, impeded by the non-ideal transfer characteristic of the hydrophone, and deconvolution procedures are necessary for data correction, which requires the complex sensitivity of the hydrophone being determined.
Two methods based on the principles of time-delay spectrometry (TDS) are presented providing the complex hydrophone sensitivity up to 50 MHz. In the first technique heterodyning is used to ensure a fixed phase relation between transmitting and receiving voltage at the ports of a network analyser. The second method separates unwanted signals from the measurement information in the time domain using a fast-Fourier transform (FFT).
To show the performance of the methods, several hydrophones of membrane and needle type were investigated in different frequency ranges. The two reference hydrophones used were calibrated before by a primary interferometry-based calibration technique yielding the amplitude of the sensitivity. As a phase standard an optical multilayer hydrophone was successfully employed showing an extremely flat amplitude and phase response. Thus, absolute amplitude and phase values are obtained from the TDS-technique in a wide frequency range. To validate the new method, results were compared with those of interferometric calibration, of a pulse calibration technique recently developed for hydrophones with small diameters and optical techniques, and of a hydrophone model. The agreement is excellent in most cases and the data provide a basis for deconvolution correction procedures.