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Measurement of the phase response of a membrane hydrophone and its application to ultrasonic field characterisation

VF Humphrey¹, MP Cooling¹, TM Duncan², F Duck²

¹Institute of Sound and Vibration Research, University of Southampton,
²Medical Physics Department, Royal United Hospital, Bath, UK.

The accurate measurement of acoustic waveforms containing multiple frequencies is complicated by the need to know the frequency dependent phase response of the measurement system. This is particularly relevant for high amplitude ultrasound propagation resulting in non-linear distortion. However, if the phase response of the system is known then the true acoustic waveform can be recovered. This work describes a means of obtaining the required phase response of a hydrophone and receiver system over a wide frequency range, its application, and impact on measurements.

A single element, circular, 3.5MHz transducer with a focal length of 137mm was driven at high amplitude and the shocked waveforms measured beyond the focus. Measured characteristics of this field (focal length, radius and source pressure) were then used as input parameters for a non-linear finite difference model, enabling the true acoustic waveform to be predicted. Comparison of the relative phases of the harmonics making up the experimental and model waveforms enabled the phase shifts of the measurement system to be calculated.

The obtained phase response is applied, in conjunction with traditionally obtained amplitude response data, to recover the acoustic pressure waveform. This is achieved by means of a Wiener filter deconvolution process. The effects of this application are discussed, including specifically it’s affect on measurements including peak compression and rarefaction pressure.

Measurements of the acoustic output of modern ultrasound imaging systems are increasingly being complicated by propagation non-linear distortion. To accurately measure the shocked waveforms which develop it is necessary to account for the phase response of the measurement system.