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Adjusting the phase of the signals transmitted from dual frequency probe for reducing second harmonic during propagation

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During propagation of the ultrasound wave, nonlinearities of the medium, causes rise of higher harmonics that are seen in amplitude spectrum. In ultrasound contrast harmonic imaging this is unwanted effect, since it is expected to image only higher harmonics produced by contrast agents. In previous studies Christopher, Krishnan and Shen proposed transmitting either an inverted signal (collected by hydrophone), transmitting 2nd harmonic with broadband transducer or transmitting third harmonic to reduce the second harmonic at measurement point. Our study uses a dual frequency probe which transmits one wave at frequency f0 and one wave at double frequency 2f0 named second harmonic reduction signal (SHRS) for reducing the second harmonic in the propagating signal. The hardest task is the appropriate adjustment of the phase of the SHRS to reduce second harmonic during propagation in the focal area. We outline how to set phase and established that the phase of the SHRS in not affected by the nonlinear parameter B/A and excitation pressure P0 but rather by the excitation frequency and the ultrasound system geometry (transducer size and distance to focal area). A reduction of 25dB has been obtained in simulation (Po=100kPa, fo=2.25 MHz). Experiments in water tank, have shown the reduction of 2nd harmonic by 30dB.