

# Effective Compensation of Higher Order Harmonics of a Servo-Hydraulic Test Shaker

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**Summary** Inspire AG together with Oelhydraulik Hagenbuch AG Ebikon is involved in a project for the performance improvement of a servo hydraulic test shaker. We focus on the quality of the FRF response of the system's acceleration. Experimental measurements showed the presence of significant harmonic components at frequencies multiple of the exciting frequency. Fig. 1 presents an example for a commanded frequency of 160 Hz and an amplitude of 40 g, Fig 2 shows the corresponding frequency spectrum. A compensation algorithm has been developed and successfully incorporated into the control loop of the shaker. The control strategy uses a Kalman filter to estimate the harmonic content of the system response during operational conditions; simultaneously the control signal is corrected by higher order harmonic terms whose magnitudes and phases are optimized in order to minimize undesired components in the response spectrum.

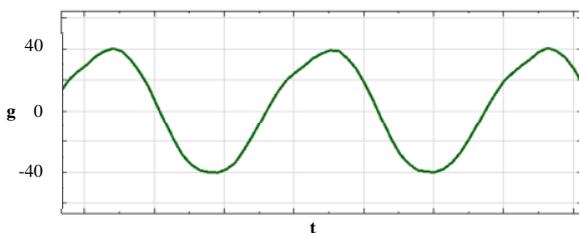


Figure 1: Measured Acceleration Time Signal

**Results** The effectiveness of the proposed strategy has been tested on the test shaker made available from Oelhydraulik Hagenbuch AG, for several operating conditions. The compensation

effects may be appreciated in Fig. 3 where the response spectrum of the compensated signal is shown.

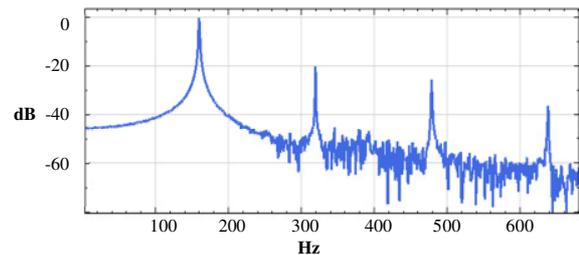


Figure 2: Acceleration Frequency Spectrum

The third peak is not anymore discernible while the second has been substantially reduced. When compensation is active the second harmonic has a magnitude of ca. -40dB when referred to the fundamental harmonic while the amplitude of the third harmonic may be confused with the noise.

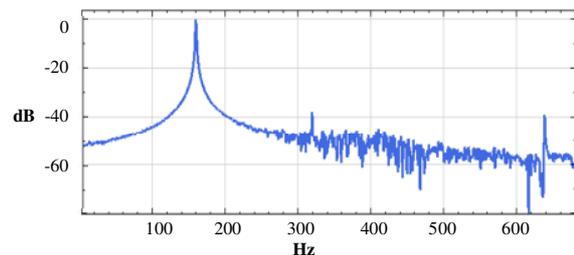


Figure 3: Spectrum of compensated acceleration

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