Fluctuation Control of Measurement Interferometers: Application of algorithms to correct interferometers for local stage motion induced pressure surges

Shane R. Palmer
Nikon Research Corporation of America, Tucson, AZ 85737
spalmer@nikonrca.com

Abstract: On the critical path to achieve nanometer precision in pattern placement is the accurate correction (or compensation) of fluctuations to stage interferometers. A method to correct for local interferometer fluctuations created by stage motions was successfully used in a feed-forward algorithm. Experimental measurements of pressure surges induced by a moving stage inside an enclosure were made to determine the accuracy of the model. The condition for stage motion was varied in stroke, i.e. length of scan, the acceleration, velocity and position. A stage-induced pressure surge model was derived based on the reduced Navier-Stokes equations that result in the Euler equation for acoustics with additional terms from a fluid flow treatment of the stage-induced air flow (and surges) inside an enclosure. The latter approximations account for the position and velocity dependencies of the moving stage. An example of the fit to the experimental pressure measurements using a 4-term model is described. A more advanced 6-term model that uses a fit to the amplitude of the pressure signal versus distance from the measurement point is also shown. Finally, a correction algorithm was applied to an interferometer with a fixed path length to demonstrate the ability to correct for local pressure surges not corrected by the wavelength tracker.

The results for applying a 4-term local correction to an interferometer for stage motion using parameters from the bottom plot, is provided in figure 1. The top graph shows the raw and filtered (50 Hz) pressure signal in red and blue, respectively, obtained from a pressure sensor and calculated from a 4-term pressure model (shown as the green line). The second plot (middle) contains the raw and filtered interferometer signal (green and black respectively). The pressure correction signal from the model is shown by the red dotted line and the final corrected signal in blue. The one sigma fluctuation of the signal was reduced from 0.36 nm to 0.20 nm with this model representing an improvement of over 40%.

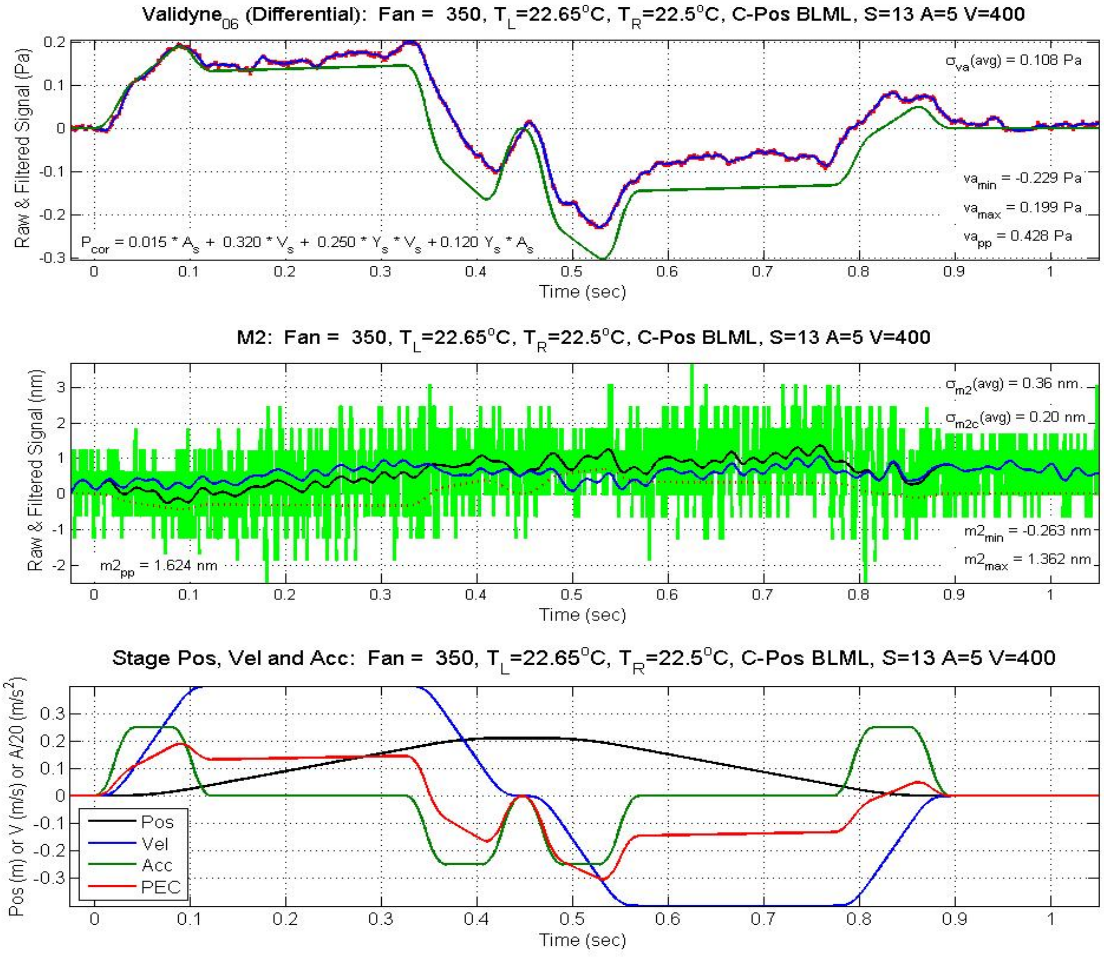

Figure 1: Pressure correction of local interferometer fluctuations using the 4-term pressure surge algorithm.