Improved frequency/voltage converters for fast quartz crystal microbalance applications

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Abstract

The monitoring of frequency changes in fast quartz crystal microbalance (QCM) applications is a real challenge in today’s instrumentation. In these applications, such as ac electrogravimetry, small frequency shifts, in the order of tens of hertz, around the resonance of the sensor can occur up to a frequency modulation of 1 kHz. These frequency changes have to be monitored very accurately both in magnitude and phase. Phase-locked loop techniques can be used for obtaining a high performance frequency/voltage converter which can provide reliable measurements. Sensitivity higher than 10μV / Hz, for a frequency shift resolution of 0.1 Hz, with very low distortion in tracking both the magnitude and phase of the frequency variations around the resonance frequency of the sensor are required specifications. Moreover, the resonance frequency can vary in a broad frequency range from 5 to 10 MHz in typical QCM sensors, which introduces an additional difficulty. A new frequency-voltage conversion system based on a double tuning analog-digital phase-locked loop is proposed. The report includes characterization and experimental results obtained with conducting polymers proving its reliability for ac-electrogravimetry measurements and, in general, for fast QCM applications.

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Article outline:
I. INTRODUCTION II. SYSTEM DESCRIPTION III. MATERIALS AND METHOD A. System modelling, simulation, and implementation B. System characterization C. ac-electrogravimetric measurements IV. RESULTS AND DISCUSSION A. Static characterization B. Dynamic characterization C. ac-electrogravimetric measurements V. CONCLUSIONS

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