Abstract

A low phase noise oscillator referenced to a 61-MHz vibrating wine-glass disk resonator with anchor-isolating supports designed to suppress microphonics has posted (without any compensation) a measured acceleration sensitivity at least as good as $\gamma \approx 0.2$ppb/g for vibration frequencies up to 2kHz and in all directions, yielding a vector magnitude $|\gamma|$ less than 0.5ppb/g. Remarkably, this result is at least 30 times better than previous work using a similar wine-glass disk resonator and is the best mark among MEMS-based oscillators to date, including those aided by feedback compensation circuits.

Vibration-Insensitive 61-MHz Micromechanical Disk Reference Oscillator

Thura Lin Naing, Tristan O. Rocheleau

Profs. Elad Alon and Clark T.-C. Nguyen (PI)

61-MHz MEMS-Based Oscillator and Acceleration Sensitivity

The procedure for measurement of oscillator acceleration entails vibrating oscillator at frequency $f_0$, while measuring its output spectrum as shown on the right, where

$$ L(f_0) = 20 \log \left( \frac{f_0 - f_0}{2f_0} \right) $$

with $\Delta f_0 = F \cdot \Delta f_0$. $f_0$ the oscillation frequency, $\Delta f_0$ changes in $f_0$ at the peak amplitude of the acceleration vector $F$ the acceleration sensitivity vector

$$ |F| = \sqrt{f_x^2 + f_y^2 + f_z^2} $$

Acceleration Induced Frequency Instability

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Conclusions

- Balanced sustaining amplifier rejects common-mode noise, e.g., generated by vibrations
- Measured acceleration sensitivity $\gamma$ better than $5 \times 10^{-10}$/g at all frequencies up to 2kHz
- $\gamma$ at least 30x better than previous work on similar wine-glass mode resonators
- Best mark among MEMS resonators, including those aided by feedback circuits
- Better than an “average” crystal oscillator
- Par on par with some low sensitivity OCXO’s
- Still not as good as the best crystal oscillators specifically designed for low g-sensitivity
- Even better performance possible (3 orders of magnitude better) Future Work

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