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MEMS Based Digital-Controlled Vibratory-Beam-Accelerometer

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Abstract
This paper provides MEMS (micro-electromechanical systems) vibratory beam accelerometer (VBA) for human movement measurements, which have a digital control system. The device structure with size of 5 × 5 mm^2 includes a frame, heavy mass, thick suspension beams, and thin vibrating beams made of silicon single crystal. The VBA measures acceleration using the resonant frequency change of the vibrating beams, which are designed to provide little resistance to movement along the sensitive axis and stiff resistance on the off-axis. This provides low off-axis sensitivity and high shock survivability. In this study, we designed a fully digital PLL (phase-locked loop) circuitry in a FGPA (field programmable gate array) based hardware controller. By Allan deviation, we proved that our system shows an extremely high resolution of 34 μG $Hz^{-1/2}$ and wide dynamic range of 90 dB in a device operation at 1 mTorr ambient pressure.