

## 非线性微机械谐振器的频率跟踪控制及数值仿真

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摘要：

本文分析了微机械谐振器的非线性动力学原理，根据振梁的非线性谐振条件下激励与检测信号相位关系，确定了基于锁相技术驱动的系统分析模型。利用平均周期法得到了系统稳定条件和稳态平衡点，理论分析和仿真表明：振梁刚度的高次项系数的增大，不影响系统的稳定性；当积分控制器系数小于临界值时，频率跟踪时间长，不出现频率抖动；反之，频率跟踪稳定时间短，频率抖动。

关键词：微机械电子系统；谐振器；非线性；平均周期法；锁相技术

## Resonance Frequency Tracking Control for Nonlinear MEMS Resonator

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**Abstract:**

The nonlinear principle of the typical MEMS resonator was introduced, according to the phase relation between input electrostatic force and output displacement, phase-locked loop technology was adopted for resonator. The control equations based on phase-locked technology were also built for the system. With the help of the averaging method, the system stability was analyzed and the equilibrium for the vibration amplitude was achieved. The theoretical analysis and simulation show the integral gain is critical to the system stability. When it larger than the critical point, the system stable time is less, but the frequency tracking process would fluctuate; if it smaller than the critical point, the system stable time is longer, but the frequency tracking process would un-fluctuating.

**Keywords:** Micro-electromechanical Systems; resonator; nonlinear; phase-locked technology; averaging method

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