Chip-Scale Precision Timing Unit for PicoSatellites

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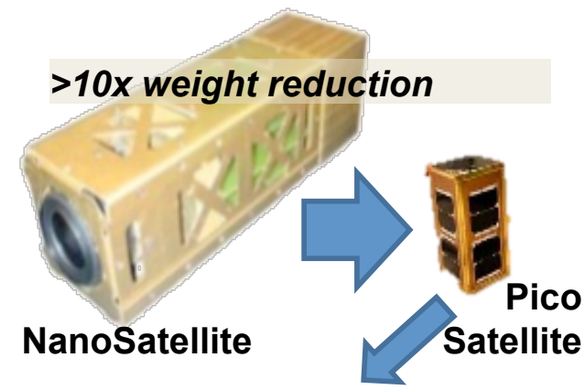
Timing Units for Space Applications

- Smaller satellites demand small-size and low-power yet accurate timing units
- Micromechanical resonators are good candidates in terms of SWaP as compared to atomic clock but have large temperature coefficient (TCF) of frequency and low Q factors
- Circuit-level temp. and acceleration compensation increases phase noise

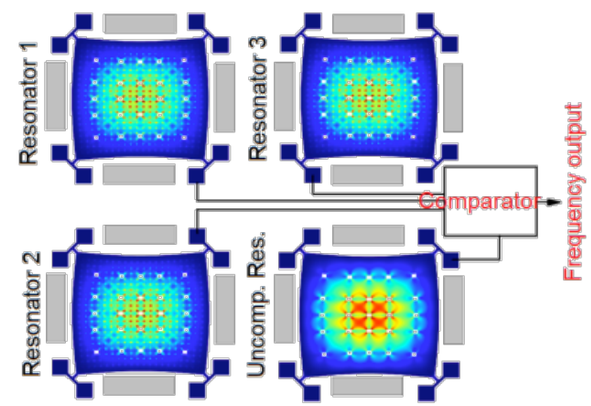


NEW INSIGHTS

- Arraying resonators can increases freq. accuracy by orders of magnitude
- Passive temperature compensation can reduce zero bias TCF
- Novel circuit design techniques can be applied to reduce phase noise at no extra power
- Packaging can reduce ionizing and EM radiation sensitivity

TECHNICAL APPROACH:

- Combination of intrinsic and circuit-based temperature compensation to minimize TCF
- Reliance on bulk resonant modes to increase stored energy and minimize acceleration sensitivity
- Resonator loaded-Q enhancement and oscillator phase-noise reduction through innovative circuit design techniques
- Increase time keeping accuracy by an order of magnitude using an array of resonators with different TCF values



POTENTIAL IMPACT

- More precise mechanical clocks operating in space→ increased precision of relative & absolute position and velocity
- ***Significant impact on NASA's autonomous platforms by enabling more precise landing, autonomous rendezvous, etc.***

Multi-Disciplinary Approach Combines Material Engineering, Mechanical Design Innovation, and Circuit-Level Design Techniques to Achieve State-of-the art Performance in Micromechanical Timing Units for Space Applications