Title: RC Frequency References Based on Pulse-Density Trimmed Resistors

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Abstract: Stable frequency references serve many essential purposes, such as timekeeping for calendar functions and reference clocks for radios and micro-controllers. While quartz crystal-based references can achieve the desired performance, they are bulky, expensive, and suffer from a long start-up time. Hence, techniques for implementing power-efficient frequency references that can be fully integrated in standard CMOS technology and achieve excellent frequency stability across a wide temperature and voltage range are needed. Highly stable on-chip RC frequency references offer the possibility of replacing crystal oscillators in many cost- and form-factor-constrained applications. However, achieving good frequency stability in a power-efficient manner across process, voltage, and temperature variations poses many design challenges. In this talk, we describe these challenges and present methods for improving the frequency accuracy of RC oscillators by overcoming them. We show that the impact of the resistor temperature coefficient on the output frequency accuracy can be mitigated by using a parallel combination of switched resistors digitally controlled by pulse-density modulated sequences. Finally, we present experimental results obtained from prototype oscillators fabricated in a 65nm CMOS process and use them to illustrate that reducing the inaccuracy to better than ±140ppm over −40°C to 95°C (2.1ppm/°C) is feasible without compromising long-term stability (1.3ppm Allan deviation) and power efficiency (1µW/MHz).

Author / Presenter BIO:

- He joined the University of Illinois at Urbana-Champaign, USA, in 2018, where he is currently working toward his Ph.D. degree in electrical and computer engineering.
- Kyu-Sang is a recipient of the Analog Devices Outstanding Student Designer Award in 2022.
- His research interest includes temperature-compensated oscillators and high-speed wireline transceivers.