Novel Sensor to Transduce and Digitalize Temperature Utilizing Near-Zero-Power Levels

Tech ID: 28735 / UC Case 2017-310-0

BACKGROUND

Temperature sensors are routinely found in devices used to monitor the environment, the human body, industrial equipment, and beyond. In many such applications, the energy available from batteries or the power available from energy harvesters is extremely limited, thus the power consumption of sensing should be minimized in order to maximize operational lifetime.

TECHNOLOGY DESCRIPTION

Researchers at UC San Diego have developed a sensor that can monitor its environment with near zero power, enabling ultra-long battery life, or energy harvesting from low-power sources towards energy-autonomous operation. Specifically, two pA current references are generated via small tunneling-current metal-oxide-semiconductor field effect transistors (MOSFETs) that are independent and proportional to temperature, respectively, which are then used to charge digitally-controllable banks of metal-insulator-metal (MIM) capacitors that, via a discrete-time feedback loop that equalizes charging time, digitize temperature directly. The proposed temperature sensor was integrated into a silicon microchip and occupied 0.15 mm2 of area. Four tested microchips were measured to consume only 113 pW with a resolution of 0.21^{o}C and an inaccuracy of ±1.65^{o}C, which represents a 628x reduction in power compared to prior-art without a significant reduction in performance.

APPLICATIONS

This invention is a useful as a sensor for applications with sub-nW power consumption requirements. Some examples include usage in:

- “Internet of Things”
- Environment
- Industrial and Agricultural Equipment
- Wearable devices/biomedical devices
- Smart Homes

ADVANTAGES

- 628x lower power consumption than market alternatives without a significant reduction in sensing accuracy
- Small size-efficient sensor that only takes up 0.15 mm2 of area
- Fully integrated Design
- Robust operating temperature range, from -20 to 40 Celsius

STATE OF DEVELOPMENT

A prototype model was constructed utilizing a microchip fabricated in a 65 mm 1P9M commercial technology. More die-to-die, wafer-to-wafer, and lot-to-lot measurements would be needed in future work to validate accuracy for volume manufacturing.

INTELLECTUAL PROPERTY INFO

A provisional patent has been submitted and the technology is available for licensing.

PATENT STATUS

Country	Type	Number	Dated	Case
United States Of America	Published Application	0117147-A1	04/16/2020	2017-310

Additional Patents Pending

CONTACT
University of California, San Diego
Office of Innovation and Commercialization
innovation@ucsd.edu
tel: 858.534.5815.

OTHER INFORMATION

KEYWORDS

sensor, sub-nW power consumption, “Internet of Things”, wearable & biomedical devices

CATEGORIZED AS

- **Environment**
  - Sensing
- **Sensors & Instrumentation**
  - Environmental Sensors
  - Medical
  - Physical Measurement
  - Scientific/Research

RELATED CASES

2017-310-0

University of California, San Diego

Office of Innovation and Commercialization

9500 Gilman Drive, MC 0910, ,

La Jolla,CA 92093-0910

Tel: 858.534.5815

innovation@ucsd.edu

https://innovation.ucsd.edu

Fax: 858.534.7345