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Research Article

A High Accuracy Capacitance-to-Digital Converter with Improving Nonidealities Effects

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Abstract

This paper presents a high-precision capacitance-to-digital converter (CDC) based on period-modulation (PM) for grounded capacitive sensors. In this work, with a symmetrical design, the performance of the proposed capacitance to digital converter is significantly improved by applying zoom-in and three signal auto-calibration techniques. The dominant nonidealities of the CDC circuit are located at the three asymmetrical phases of the auto-calibration pathes. These effects are investigated here which are mainly caused by charge injection of switches and associated parasitic effects. These nonidealities are reduced by utilizing dummy switches at asymmetrical paths of the applied auto-calibration. The proposed interface is designed as an integrated circuit using a standard 0.18µm CMOS technology. A worst-case capacitance error less than 0.2fF for a 10pF sensor capacitor with maximum variation of 200fF, and parasitic capacitance of up to 20pF is obtained. The CDC achieves an absolute capacitance resolution of 0.479fF across a 10pF sensor capacitance with a 200fF variation, corresponding to an energy efficiency of 6.94pJ/step. The achieved latency is 128µs and the CDC consumes 170µA from a 2V power supply.

Keywords: Capacitive-to-voltage converter (CVC), Zoom-in technique, Grounded capacitive sensor, Dummy switch.

Highlights

- A novel structure of symmetrical capacitance to digital converter.
- Achieving low noise level and high accuracy.
- Improving non-linear effects using circuit techniques.

Citation: (in Persian).