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High-resolution capacitance-frequency converter for biosensor applications

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Abstract

This paper presents the design of a low-complexity, linear and sub-pF CMOS capacitance-frequency converter for reading out capacitive bacterial bio/sensors in an attempt to create a widespread bio/sensor readout module. The significant design objectives included a high resolution as well as an extensive dynamic range. The circuit was based on a method which outputs a digital frequency signal directly from a differential capacitance by the accumulation of charges produced by repetitive charge integration and charge preservation. A prototype was designed for manufacture using the 0.35 µm, 3.3V ams CMOS technology. At a 1MHz clock speed, the results obtained for the designed converter were: (i) a power consumption of 1.37mW; (ii) a resolution of at least 5fF for sensitive capacitive transduction; (iii) an input dynamic range of at least 43.5 dB from a measurable capacitance value range of 5 – 750fF and (iv) a Pearson's coefficient of linearity of 0.99. Furthermore, a large-scale CFC was constructed with discrete IC's in order to verify the function of the CMOS design.