Voltage-to-Frequency Converter for Low-Power Sensor Interfaces

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Abstract

This work presents a low-power rail-to-rail temperature compensated voltage-to-frequency converter (VFC) which constitutes the last stage of a sensor read-out interface targeting wireless sensor networks (WSN) applications. These quasi-digital converters are now receiving great interest, since they combine the simplicity of analog devices with the accuracy and noise immunity proper to digital signal processing; besides, frequency output is directly driven to the embedded node microcontroller μC, which next performs the A/D conversion using its internal timers. A first read-out interface prototype using low-voltage low-power commercial components shows that the VFC means 99 % of the total interface consumption in read-out mode. Further, existing CMOS VFCs in the form of ASICs have a rather limited input range and an unsuitable output frequency span for typical μC clock frequencies used in WSN. Hence, a novel full custom VFC solution is needed, fullfilling the main requirements of rail-to-rail operation, to take advantage of the full supply voltage range to optimize the output frequency resolution, and low-power low-voltage operation to have a power supply compatible with conventional WSN batteries while maximizing the operating life of the sensor node. Experimental results for a 0.18–μm 1.2–V CMOS VFC implementation show for an input range of (0–1.2 V) an output frequency range of (0.1–1.0 MHz), adequate to digitize the signal with the direct counting method in the sensor node μC achieving 13 bits resolution. It has a power consumption of 60 μW (35 nW in sleep mode) and it is temperature insensitive for a temperature range of (-40, 120 ºC).

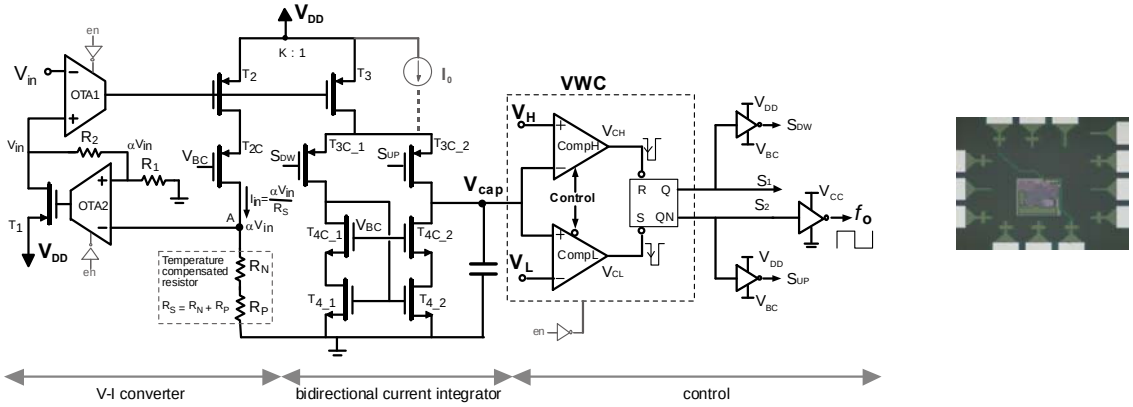

Fig. 1: Basic scheme of the integrated VFC and its microphotograph.