

## 一种用于无电池胎压监测系统的低功耗8 bit SAR ADC 设计

王 义, 乌力吉, 张向民, 吴行军, 方华军

(清华大学 微电子学研究所, 北京 100084)

**摘要:** 在无电池胎压监测系统中, 为降低 ADC 功耗, 采用了一种改进的 DAC 结构并设计实现了一款低功耗 8 bit SAR ADC. 与传统结构中采用  $V_{ref}$  作为参考电压相比, 设计中 DAC 采用  $V_{ref}/2$  作为参考电压, 并实现了  $(0, V_{ref})$  的满量程输入, 在 DAC 的量化中可降低 87.5% 动态功耗. 在完成电路和版图设计后, 仿真结果显示, 在采样率为 2 kS/s, 电源电压为 3 V, 参考电压为 1.5 V 时, ADC 平均动态功耗为  $0.9 \mu\text{W}$ . MATLAB 频谱分析显示, ADC 有效位数为 7.6 bit, 无杂散动态范围为 63.2 dB, 工作温度范围为  $-40\sim 125^\circ\text{C}$ . 并已运用于胎压监测 SoC 中提交  $0.35 \mu\text{m}$  BCD 汽车电子工艺流片.

**关键词:** 无电池; 胎压监测系统; SAR ADC; 低功耗; 高稳定性

## A Novel Low-Power 8 bit SAR ADC for Battery-less TPMS SoC

WANG Yi, WU Li-ji, ZHANG Xiang-min, WU Xing-jun, FANG Hua-jun

(Institute of Microelectronics, Tsinghua University, Beijing 100084, China)

**Abstract:** An analog-to-digital converter is used to digitalize the pressure data in Battery-less TPMS (Tire Pressure Monitoring System). To reduce power consumption, an 8-bit low-power SAR(Successive Approximation Register) ADC, with a modified switching method, is designed after analysis the requirements of the interface of pressure sensor. The DAC switching method uses  $V_{ref}/2$ , rather than  $V_{ref}$  in conventional way, as the only reference voltage to digitalize the input signals with the amplitude range of  $(0, V_{ref})$ . The proposed design reduces the average power consumption in the DAC by 87.5% during digitization. Post simulation results show that at the power supply of 3 V and reference voltage of 1.5 V and with the sampling rate of 2 kS/s, the average dynamic power is  $0.9 \mu\text{W}$ , and the ADC can digitize the input signal in a full-scale range of 3 V with ENOB of 7.6 bits and SNDR of 63.2 dB. It can work steadily with a temperature range of  $-40\sim 125^\circ\text{C}$ . The ADC has been applied to the Battery-less TPMS SoC and taped out in a  $0.35 \mu\text{m}$  BCD (Bipolar-CMOS-DMOS) automotive electronic process.

**Key words:** battery-less; TPMS; SAR ADC; low power; high stability

**作者简介:**

王 义 男, (1990-), 硕士研究生. 研究方向为无电池胎压监测系统关键 IP 设计.

乌力吉 (通讯作者) 男, (1965-), 博士, 博士生导师. 研究方向为汽车电子与信息安全.

E-mail: lijwu@mail.tsinghua.edu.cn.

张向民 男, (1966-), 硕士, 助理研究员. 研究方向为汽车电子与信息安全.

方华军 男, (1972-), 博士, 副研究员. 研究方向为微电子机械系统.

吴行军 男, (1969-), 博士, 副研究员. 研究方向为汽车电子与信息安全集成电路.