

Low-Voltage Low-Power Current-Mode Squaring and Multiplier/Divider Circuits

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Abstract—Original designs of a squaring and a multiplier/divider circuits will be presented. The utilization of translinear loops containing pairs of opposite identical transistors and of the current-mode operation strongly reduce the errors introduced by temperature variations and, also the technological-caused errors. The squaring and the multiplier/divider circuits are developed for low-voltage applications, having a supply voltage equal with $\pm 0.4V$. The capability of the circuits to operate at extremely low values of the currents allows to obtain a low-power operation for the new proposed squaring and multiplier/divider circuits, decreasing its power consumption to approximately $0.04\mu W$ for the squaring circuit and to approximately $0.1\mu W$ for the multiplier/divider circuit. SPICE simulations made for $0.18\mu m$ TSMC CMOS process confirm the results obtained after the theoretical analysis. The area occupied on silicon by the squaring circuit is approximately $3\mu m^2$, while the area occupied by the multiplier/divider circuit is approximately $7\mu m^2$.

Keywords—squaring circuit, multiplier/divider circuit, current-mode operation, low voltage low-power designs

SUMMARY

In CMOS VLSI designs it is possible to implement a multitude of computational circuits such as: squaring and square-root circuits, multiplier/divider circuits, exponential circuits, Gaussian circuits, or analog function synthesizer structures. Considering as the most important figure of merit for a computational circuit the relationship that exists between the circuit accuracy and its silicon occupied area, the squaring

and the multiplier/divider circuits usually represent the most convenient choice. In addition, most of other computational circuits can be implemented using these fundamental structures, using a convenient approximation function.

The squaring circuits are extensively used in frequency dividers, modulators, signal processing, peak detectors or signal generators, while the analog multiplier/divider structures have a multitude of applications in instrumentation systems, measurement, adaptive filters, telecommunication areas, analog signal processing, frequency doublers and modulators.

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