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DESIGN OF CMOS RING OSCILLATOR FOR TEMPERATURE SENSOR

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work.

I, hereby, acknowledge that I have been supplied with the Academic Rules and Regulations, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

This work investigates the design of a CMOS-based ring oscillator (RO) for temperature monitoring, with an emphasis on a small and energy-efficient solution appropriate to today's integrated circuits (ICs). The suggested design takes advantage of CMOS ROs' intrinsic frequency-temperature relationship, together with supplies from a bandgap reference (BGR) circuit and a low-dropout (LDO) regulator. This integration removes the need for extra sensing components, resulting in lower complexity and power consumption while preserving high accuracy. The system comprises two sets of 5-stage RO and a frequency-to-digital converter (FDC) to detect temperature ranges of -40 °C to 125 °C with a 16-bit resolution designed with Cadence PDK45nm technology. To guarantee reliable performance, the design process includes simulating essential components such as the BGR, LDO, RO, and FDC in Cadence Virtuoso. The top-level architecture is designed with a chosen NMOS transistor sizing of 4.934 µm producing a reference frequency of 640 MHz making it appropriate for temperature-independent applications. The findings from this study revealed that despite the non-linearity of frequency generation with the elevated temperature, the digital conversion still manages to leverage its output throughout the temperature variations. This paper demonstrates the benefits of CMOS ROs and the FDC technique for on-chip temperature monitoring.

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