**An Integrated Circuit Solution to Johnson Noise Thermometry and High Speed Three-Stage Amplifier Design**

by

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Abstract – In this work, an integrated circuit solution to Johnson noise thermometry (ICJNT) is investigated. By using fast and low-cost complementary metal-oxide-semiconductor (CMOS) technology, benefits from both noise thermometry and integrated circuits (ICs) can be maintained in ICJNTs which will significantly reduce the cost, work orders of magnitude faster than discrete–device JNTs, and can be applied to various applications.

This work reviewed the basics of JNT designs including history, academic efforts and recent development. From the development, it can be seen that there is an urgent requirement for JNTs to be minified, and implementing JNTs in ICs would be a promising solution which is based on low-cost CMOS technology. With the motivation of miniaturization for JNTs, as a first attempt at an ICJNT, this work presented the relevant analysis and design techniques, demonstrated the potential benefits of ICJNTs, and discussed the challenges unique to integrated circuit solutions. A prototype IC chip was fabricated with core circuits fully implemented on–chip, including sensing resistors, a pre–amplifier, and a flash analog-to-digital converter (ADC). To demonstrate the efficacy, a test PCB for the ICJNT was developed and measured in a standard industrial thermal chamber with a laboratory grade platinum resistance thermometer (PRT) as a comparison reference. The test results showed that this first ICJNT prototype is able to provide temperature measurement from 0˚C to 70˚C. The measurement time is only 10 ms due to the fast IC technology, and the maximum and minimum errors are +5 and -5 ˚C. These results established the feasibility of the ICJNT concept.

Because the concept of ICJNT is simple and accurate, there are no complicated read-out circuits, and the ICJNT has the potential of reaching higher level of accuracy in the future. Besides, thermal noise has long-term stability. That is, it will not change with the resistor material or environment. These advantages make ICJNTs a promising solution for various emerging applications, such as electric vehicles (EVs) and microelectrome-chanical systems (MEMS).