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ANALOG CIRCUIT FAULT DIAGNOSIS UNDER PARAMETER VARIATIONS BASED ON TYPE-2 FUZZY LOGIC SYSTEMS

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Abstract. *In order to handle noisy measurement data, an interval type-2 fuzzy logic system (T2FLS) is proposed. In this paper, the evolution of soft fault diagnosis for analog circuits is explored based on a type-2 fuzzy logic system (T2FLS) which can handle measurement uncertainties. In order to evaluate the values of the faulty components accurately, a type-2 fuzzy rule base is adopted to describe the behavior of the circuit under test (CUT) both in fault and fault-free circumstances and to estimate the faulty element values when the measurement data are corrupted by white Gaussian noise. From the experimental results, we can find that the advocated interval type-2 fuzzy logic system has succeeded in evaluating crisp values of the faulty elements and the performance is better than that of previous work. Furthermore, to validate the capability of the proposed approach, the T2FLS is applied to extract the component values of the integrated circuit electromagnetic (ICEM) modeling.*

Keywords: Type-1 fuzzy logic system, Type-2 fuzzy logic system, Simulation before test, Simulation after test, Hard fault, Soft fault

1. **Introduction.** Analog fault diagnosis has been an active region of research since 1970s, with adequate work carried out at the circuit, chip and system levels [1-6]. Automated fault diagnosis and fault estimation techniques can improve plant efficiency, reliability and safety by early detecting [22], isolating and accommodating of system faults which can result in catastrophic effects. Generally, analog circuit faults can be classified into two classes: catastrophic faults and parametric faults (or hard faults and soft faults) [7-9]. Catastrophic faults are sometimes referred to as open nodes or shorts between nodes while parametric faults or deviation faults refer to component changes in a circuit that do not affect its connectivity. Catastrophic faults are relatively easy to detect because they often produce totally unwanted output. However, parametric faults are more difficult to detect because the relationship between parameter deviation and performance degradation can be very complicated.

Fault diagnosis of analog circuits is an important problem of analog circuit testing for researchers and test engineers. Analog fault diagnosis is complicated due to the lack of efficient fault models, component tolerance and nonlinearities. There are two categories of analog circuit fault diagnosis: simulation before test (SBT) and simulation after test (SAT). The SBT approach builds some forms of a data dictionary through simulation and uses the pattern recognition concept to identify and locate faults. Under the SAT category, all the faulty parameters can be identified by using parameter identification methods if sufficient measurements are guaranteed. Although many techniques for fault diagnosis have been proposed, the problem is still open and no fully automatic method has been developed for analog circuits.