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FAULT DETECTION AND DIAGNOSIS OF ANALOG CIRCUIT USING SOFT COMPUTING TECHNIQUE BASED ON SUPPLY CURRENT AND OUTPUT VOLTAGE

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ABSTRACT:

Circuit fault diagnosis is an important area for electronic manufacturing industries. For critical applications, it is desired to design & develop the system that will detect the fault appearing condition by analyzing various circuit parameters in real time. It is proposed to analyze circuit parameters like supply current and output voltage of circuit under test (CUT). From these parameters it is possible to identify the deviation in performance of the circuit. By using the soft computing technique, it is possible to identify the fault & to diagnose it.

***Keyword:** CUT, Circuit Parameters, Fault Diagnosis, Real Time.*

INTRODUCTION

Electronic circuits and systems have become part and parcel of our daily life. Whenever a system does not behave normally as it should, that means the system is faulty. Fault diagnosis involves two steps. One the detection of fault in the system is called fault detection. Second to locate the position of the fault is called fault isolation. A system which includes the capacity of detecting, isolating, identifying or classifying faults is called a fault diagnosis system. There are three types of circuits Analog, Digital and Mixed signal circuits. Fault diagnosis is an important problem of analog circuit testing. Due to lack of efficient fault models and limited accessible nodes and due to inherent features of analog circuits such as component tolerance and non linearity, the automation level of analog fault diagnosis has not yet achieved the same level of its digital counterpart. Analog circuits play a vital role in ensuring availability of industrial systems. Unexpected circuit failures in such systems during field operation can have severe implications. The occurrence of circuit failures during field operation can affect system functionality and the cost of failure can be enormous. To address this concern we are developing a method for detecting faulty circuit condition, isolating fault locations and predicting the remaining useful performance of analog circuit.

REVIEW OF LITERATURE

Testing of electronic circuits is an active research topic in recent years and it remains crucial, especially for the rapidly developed mixed-mode (analog and digital) circuits. Fault detection methods using simulation data of power supply current (IPS), rms values and magnitude components of its spectrum have been described [4-8] showing promising results. However, the use of these methods using measurement data needs

more investigation, since there are problems arising from the practical application of the methods. Various other approaches exploited the utilization of the wavelet transform, which resolves a signal in both time and frequency, simultaneously [10-13]. Wavelet transform gives a better approximation of a transient current waveform than the Fourier transform for a certain limiting high frequency of the signal, which is already imposed by the measurement setup in practical situations. [1] This paper explains standard multivariate techniques of hypothesis testing and discrimination analysis have been applied to detect faults in a variety of linear IC designs. These techniques are potentially useful for tracking IC failures during processing or for assessing failure mechanisms of IC's once the circuits are in field use.[3] Transient signal analysis (TSA) is a testing method that is based on the analysis of a set of various transient waveforms measured simultaneously at each supply port. Defect detection is performed by applying linear regression analysis to the time or frequency domain representations of these signals. [4] In this paper, a fault dictionary approach using power supply current spectrum measurements for fault location in analogue active circuits is presented. A discrimination factor is introduced for efficient fault identification.[5] Fault simulation is used for the investigation of dynamic supply current test of a PLL, confirming existing results from smaller circuits. The parameters monitored are supply current and output voltage which leads to increase in fault coverage. In the paper, fault coverage is further improved; using cross-correlation of the supply current and output signals, and the potential for BIST implementation of this technique is demonstrated using low resolution polarized cross-correlation. Fault simulation is also performed on an analogue multiplier to investigate the effect of process parameter deviations on the supply current. [6] A method using magnitude and phase spectrum components for fault detection of catastrophic and parametric faults is presented. A procedure is developed, discrimination factors are defined and their values are adjusted to include circuit parameter deviations. [8] In this paper, a new method using power supply current spectrum phase components for fault detection in analogue and mixed mode circuits is presented. A procedure is introduced, a discrimination factor is defined and its value is adjusted for efficient application of the method. [9] In this paper a test method based on the measurement of the magnitude of the supply current spectrum is presented. The method is evaluated as a preprocessing test step for fast detection of faulty circuits. This method, along with a functional test method is utilized by a versatile system, which is used for production line test of emergency luminaire circuits. Main advantages of the method are the single test point and the single measured signal (power supply current) that are needed. [10] In this paper, a novel test generation methodology for the detection of faults in analog cores is proposed. A transient signal is taken as input stimulus for the circuit under test and the output response is analyzed using wavelets. Specifications of the circuit are mapped to the performance space and the specifications are checked implicitly. The proposed fault oriented test generator also computes the optimal test patterns based on genetic algorithm. [11] An IDDQ test method is proposed in this paper, which is applicable even if supply current measurement is impaired by noise. Wavelet transformation is used for noise elimination in the test method. In this paper, it is shown by some experiments that bridging faults will be detected by using the proposed test method. Since expert knowledge on filter design is not needed in noise elimination of the IDDQ test method, it is expected

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that the test method will be used in many IDDQ tests. [12] This paper concluded that multi-resolution analysis of the IDD (transient current) waveform using the wavelet transform can be effective for fault detection and localization in digital circuits. Generation of the optimal set of input stimuli for fault detection and localization is necessary to make the testing process more efficient. The execution time of the localization process and the granularity with which we can identify the faulty region substantially depends on the set of input vectors chosen. [14] It refers to a test method which is a two phase process. At the first phase (*Initial Phase*), the wavelet energy value for the reference circuit is measured and stored. In the second phase (*Main Test Phase*) the wavelet energy of the CUT (Circuit Under Test) is measured and compared with the corresponding value of the reference circuit. The detection of a faulty circuit instance will be successful when its wavelet energy value exceeds certain tolerance limits. [15] In this paper, the application of a fault detection method based on measured data of the spectrum magnitude components of the RMS value of I_{PS} is established, whereas the tolerance limits of fault-free circuits are exploited using statistical data. This method takes into consideration fault-free CUT losses (which is a common custom in production line testing) and uses the RMS value, as well as the harmonic components of the power supply current spectrum to detect the faulty circuits. Component harmonics above the third seem to have negligible contribution on the fault detect abilities and can be omitted.[16] This paper conducted the fault detection through the extraction of the characteristics quantity of the residual voltage and current generated when the high impedance fault occurred, utilizing the detail coefficients of the discrete wavelet of the residual voltage and current. Theoretical analysis and PSCAD simulation results showed that the algorithm was not only fast, but also hardly affected by fault location or the initial angle of the fault, and was able to detect the high impedance ground fault in a rapid, sensitive and selective way. [17] This paper discusses the various ways to detect intermittent failures. The paper discusses the root causes of intermittent failures. Also, a discussion takes place that addresses why we must pursue new techniques, methods and technologies to detect elusive failures. [18] In this paper new method for detection of defects (cracks and change of conductive path width) on PCB was designed. This method is based on measurement of scattering parameters or spectrum of transmission signal. By evolution of measurement values failures and defects can be detected. [19] In This paper, the fault diagnostics problem is posed and solved as a pattern recognition problem using kernel methods. The fault diagnostics method established in this paper follows an ML-based approach that uses only the measurements made at the circuit output to generate patterns for the early fault detection and isolation. In contrast to diagnostic methods based on circuit nodal equations, the proposed approach is not limited by the inaccessibility to the internal nodes of analog circuits as in modern ICs because the approach monitors only the response of the circuit at the output node. [20]This paper proposes two improved fault models with satisfactory FDR based on collaborative analysis of output voltage and supply current. Moreover, to isolate ambiguity groups, a design for testability (DFT) method is proposed to achieve better fault isolation ratio (FIR) against the influence of analog tolerance and measurement errors.

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