When N-Detect Doesn't Detect: Cell-Aware-Type Faults and Stuck-At ATPG

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***Abstract*—Cell-aware faults have been proposed to more effectively detect defects within gates. We investigate the effectiveness of different types of ATPG for efficiently detecting cell-aware-type faults that are most important during functional operation.**

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I. INTRODUCTION

II. PREVIOUS WORK

When a manufacturer goes about designing their test set, they have to realize that there is always an inherent trade off between the time used to complete the test and the coverage of defaults by the test set. Thus their goal is to examine a method whereby test pattern sets are created that are both effective and efficient.

In 1959 Eldred discovered a fault model called the "stuck-at fault model" that has since been used to generate a highly effective test set of a reasonable size [1] This model, unfortunately, breaks down in the presence of faults that do not behave as stuck-at faults. For these faults variations of n-detect test sets(which require that each fault be detected n times, where $n > 1$) are used. These tests obtain better fortuitous detection of faults that did not fit the model [2] [3] [4].

The notion of these n-detect test sets have been extended and optimized even further to ensure that each additional detection provides the best possible value, including the maximum excitation balance [5]. Some have even considered the site values in a particular region around a particular gate [6].

Other researchers in addition have proposed gate exhaustive tests, which attempt to ensure that all possible input combinations for each gate are tested [7]. These methods have a much higher defect coverage, but follow the general trade off between fault coverage and test time as discussed above.

All of the previously mentioned faults deal with the values that occur on the wires, and do not necessarily consider that faults can occur within the gates or "cells" themselves. In order to address this variety of fault, the cell-aware fault model was presented [8].This model was extensively tested and found to be a decent new model [9] [10] [11]. This model was subsequently compared with other models, and test set generation methods [12]. The one unfortunate thing about considering these additional models, as expected, the more models tested for the greater the test duration.

Although certain models test for all the possible faults that fit a certain fault model, it might be more beneficial to only consider the faults that would significantly affect the end user of the product. In the past it has been shown that stuck-at faults can be graded based on fault criticality and how estimates of such can be used to create effective test sets when testing resources are limited [13] [14]. Some researchers have even deemed that defective parts can be sold if it is unlikely that the end user will ever use the product in such a way that the defects that passed the test phase will ever effect them [15] [16].

III. ALGORITHM/ PROBLEM ETC.

A. Cell-Aware Fault Models and their Relation to Stuck-at ATPG

1) Cell-aware fault detection conditions:

2) Why n-detect ATPG Test Sets May Be Biased:

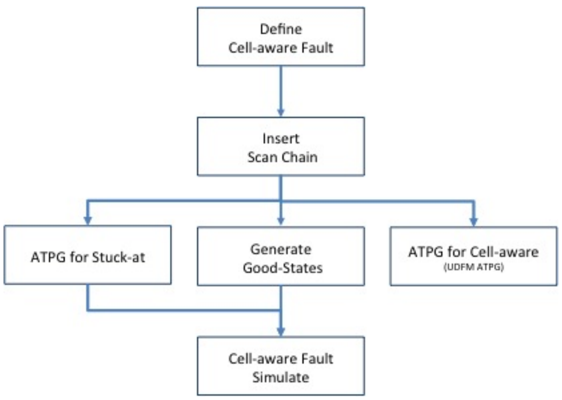
B. Determining which Cell-aware faults to target

IV. EXPERIMENTAL SETUP & RESULTS

A. Set Up

To approve the effectiveness of functional cell-aware detection, s38584, s38417, s15850, s13207 and s9234 are chosen as benchmarks since they have more kind and larger number of gates among ISCAS89. The experiment Testing flow is shown in Fig.4. We create two different Cell-Aware fault sets except for two inputs gates as described in section 3. (Cell-Aware Fault Models and their Relation to Stuck-at ATPG), replaced all primitive gates with two more inputs by cell library. One Scan-Chain is inserted in each benchmark for testing. Then ATPG testing pattern sets for Stuck-at and Cell-aware faults are obtained on Mentor Graph- ics Tessent. To achieve N-detect of Stuck-at model effects on Cell-Aware faults, four setting up arguments for ATPG Stuck- at are implemented; they are n0 (disable multiple detection function), n1 (guaranteed detections=1, desired detections=3), n2 (guaranteed detections=2, desired detections=5) and n3 (guaranteed detections=3, desired detections=7). According to section 3, a test bench in which initializes DFFs as 0 to engender DFFs into stable state is employed for capturing Good-State sets when Synopsys VCS simulates a golden benchmark. Note because the functionality of benchmarks are unknown, random patterns are created to represent the real functional inputs. In order to balancing randomness, we do two times of creating random pattern sets for each number of Good-States. Since UDFM of Tessent does not support N detection, we split Good-state sets and APTG sets into 5 patterns per simulation pattern file and repeat simulation processes multiple times.

Flow of Set Up



V. Conclusions

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