Synopsys TestMAX CustomFault

Enabling Full-chip Analog Fault Simulation for Functional Safety and Test Coverage Analysis

Overview

The growth in safety-critical applications combined with high analog defect rates is driving the need for rigorous verification of safety and test coverage on automotive ICs. As a result, analog fault simulation is emerging as a critical requirement for automotive SoC design verification flows. IC designers are looking for the highest simulator performance and the most efficient fault reduction to verify safety and test coverage at the sub-system and full-chip level.

Synopsys' TestMAX™ CustomFault simulator is a breakthrough new product that enables subsystem and chip-level analog fault simulation. Featuring industry-leading FastSPICE technology and a highly differentiated feature set, TestMAX CustomFault deliver orders-of-magnitude performance improvement versus SPICE-based solutions for functional safety and test coverage analysis.

Introduction

TestMAX CustomFault is a high-performance analog fault simulation solution that was built from the ground up to make subsystem and full-chip analog fault simulation practical. It is built on industry-leading CustomSim™ and FineSim® FastSPICE technology and features integration with VCS® functional verification to enable subsystem and chip-level analog fault simulation.

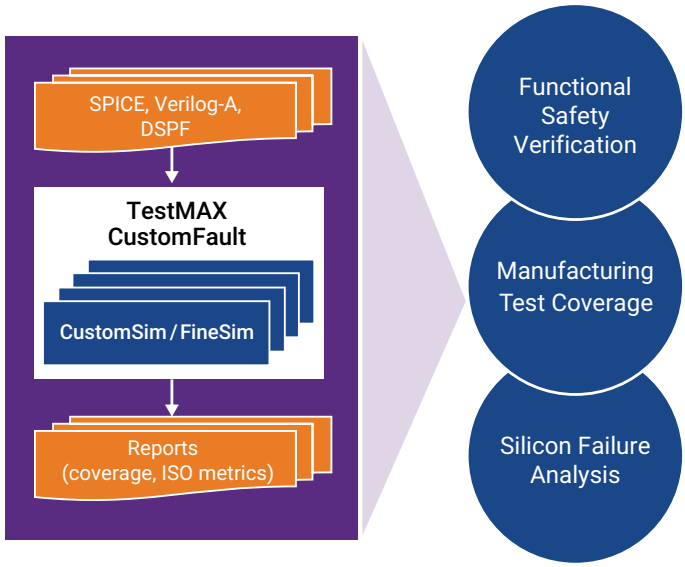

Figure 1: TestMAX CustomFault

Key Features:

Throughput/capacity	Ease of use	Diagnostics and reporting
• Industry leading FastSPICE • MSV with VCS, industry's fastest digital engine • 10-1000X fewer sims. with adaptive sampling • Advanced scoping • Distributed simulations • Incremental fault sims.	• Non-invasive fault injection • GUI/batch mode setup • Configurable fault models, scoping, fault detection • Flexible fault weighting • Pre-simulation estimates of sample size vs. coverage • Testbench re-use	• Weighted/un-weighted coverage summary • Advanced fault analytics • Data for ISO metrics reporting • Rich fault database to enable post-processing

Breakthrough Performance and Throughput

TestMAX CustomFault is architected with a powerful front-end and a flexible simulator backbone to enable seamless fault identification, reduction, distributed simulation, and report generation. Users have the choice of using the industry's highest-performance circuit simulators (CustomSim or FineSim) for transistor-level fault simulation campaigns. Furthermore, TestMAX CustomFault is integrated with Synopsys' VCS simulator to provide the industry's highest-performance mixed-signal fault simulation.

TestMAX CustomFault also features the innovative Adaptive Weighted Random Sampling (AWRS) technology that uses random sampling based on built-in or user-defined fault weights to reduce the number of fault simulations by several orders of magnitude. Users can define fault weights based on foundry, technology, and design data to ensure high sampling efficiency. TestMAX CustomFault provides pre-simulation confidence level estimates of simulated coverage for various sample sizes, allowing users to pick the smallest sample size that meets their confidence level requirements.

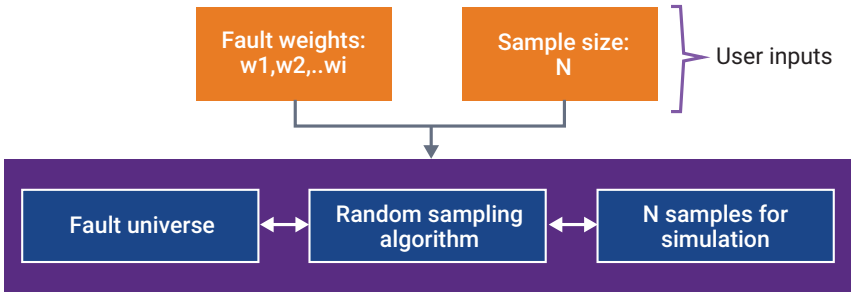

Figure 2: Adaptive weighted random sampling

Additional Throughput Technologies:

- Fault scoping by sub-circuit/instance to minimize effective size of design-under-test
- Dynamic "on-the-fly" fault detection and Stop-after-fault detection
- Incremental fault simulation
- Distributed simulation

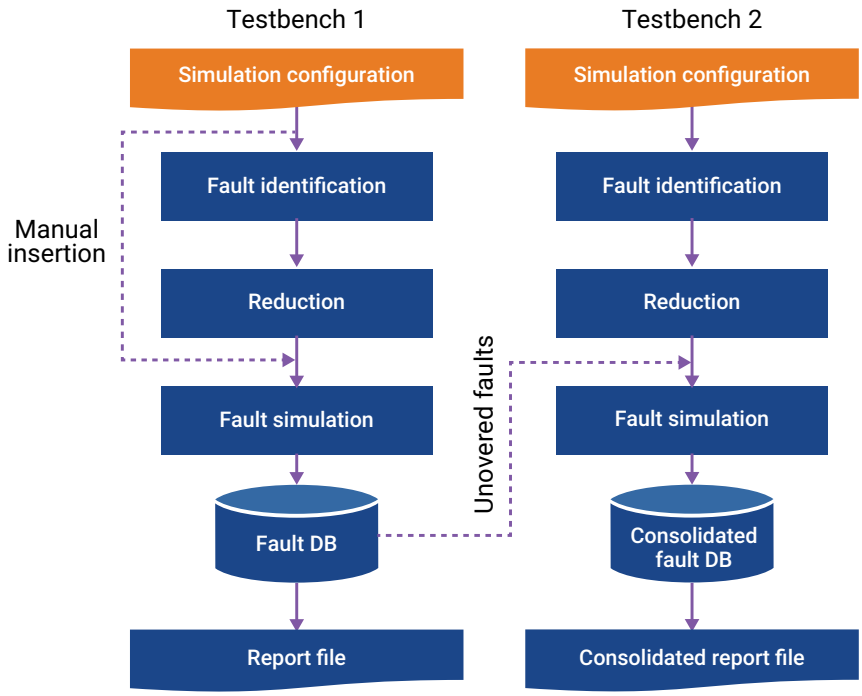

Figure 3: Incremental fault simulation flow

Broad Fault Model Support

TestMAX CustomFault supports a broad set of fault models, including commonly used open/short fault models, as well as transient and parametric faults.

Fault model	Fault type
Catastrophic single-point faults	MOSFET open and short faults • 6 short and 4 open faults • Includes stuck-on and stuck-off faults • Support for macro models
	Design register, capacitor, diode, inductor, BJT, JFET • Opens and shorts
Transient faults	Soft error (SEU) • Parametrizable current pulse at node of interest
Parametric faults	MOSFET parameter variation • Absolute & % variation on W, L, Idsat, Vth

Superior Ease-of-Use

Ease-of-use becomes a critical requirement as users begin to scale their fault campaigns to assess large designs using multiple testbenches. TestMAX CustomFault supports a host of features that deliver superior ease-of-use for functional safety and test coverage analysis.

Key Features:

- Batch mode and GUI mode support for simulation setup, fault model configuration, sampling configuration, simulation launch, and debugging
- Interface to allow fault weights to be expressed as a function of model and instance parameters
- Automatic fault identification to generate the default fault universe
- Support for user-defined fault lists

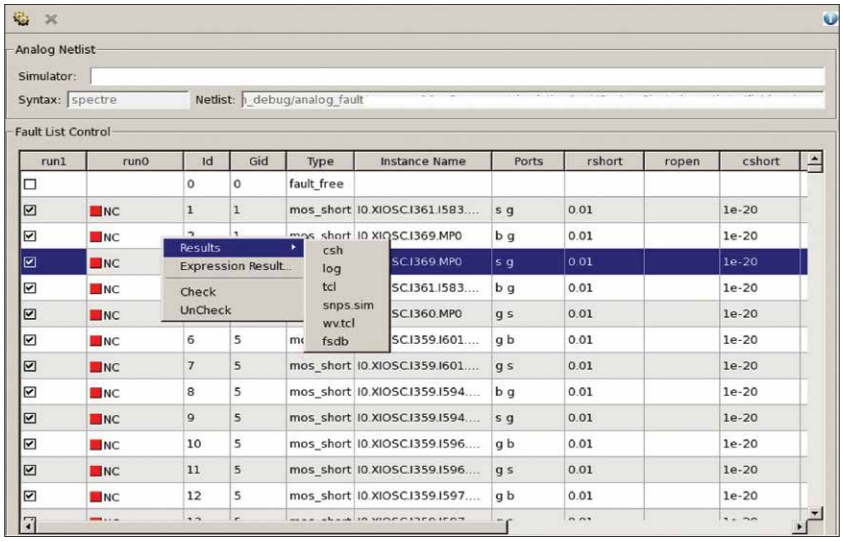

Figure 4: Built-in GUI

Advanced Diagnostics and Reporting

TestMAX CustomFault supports a comprehensive set of reporting and diagnostics features to enable ease of reporting and efficient debug.

Key Features:

- Weighted and un-weighted coverage reporting for exhaustive and sampled runs
- Advanced per-fault and per-testbench fault analytics
- Data for ISO metrics reporting
- Rich fault database to enable post-processing

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                        TestMAX CustomFault
       Version P-2019.06-SP1-20190823 - Aug 23 2019 02:21:41 5763457

       Tags    Sample-Size
    DropOut           600
 funcTestMax          600
 funcTestMin          600

*DEFECT UNIVERSE SUMMARY
    mos_mac_open                  4311
   mos_mac_short                  4078

          TOTAL                   8389

*COVERAGE SUMMARY
Defects covered - unweighted (covered/simulated):
          Type                 DropOut             funcTestMax             funcTestMin

    mos_mac_open                25/338                  24/338                  34/338
   mos_mac_short               194/643                 220/643                 226/643
          TOTAL                219/981                 244/981                 260/981

Defects covered - weighted (covered/simulated):
          Type                 DropOut             funcTestMax             funcTestMin

    mos_mac_open         44.3269/516.224         75.2444/516.224          60.9/516.224
   mos_mac_short         157.309/450.494         189.453/450.494         198.455/450.494
          TOTAL          201.635/966.719         264.698/966.719         259.355/966.719

Weighted test coverage:
        DropOut                 20.86%  (sample size: 600)    (95% Confidence Interval: 20.86±2.18%)
     funcTestMax                27.38%  (sample size: 600)    (95% Confidence Interval: 27.38±2.38%)
     funcTestMin                26.83%  (sample size: 600)    (95% Confidence Interval: 26.83±2.37%)

TOTAL Coverage:
      Sampled[*]                32.75%  (sample size: 600)    (95% Confidence Interval: 32.75±2.5%)
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Figure 5: Coverage reporting

Netlist and Device Model Support

- HSPICE, Spectre, and Eldo
- Common HSPICE device models
- Spectre and Eldo models
- Verilog-A models
- SPF, DPF, and SPEF for post-layout parasitic data

Fault Detection Methods

- HSPICE measure
- VCD
- VEC
- Digital FSDB compare

Waveform Format Support

- WDF, WDB, FSDB, and many more waveform database formats

Platform Support

- CentOS 6.6+, 7.X
- RHEL 6.6+, 7.X
- SLES 11.4+, 12.X