A picture containing schematic

Description automatically generated

Figure 1: Synthesized ISCAS’89 S444 Benchmark Circuit with rXOR Scan

Diagram

Description automatically generated

Figure 2: Scan Path with rXOR Scan

![Graphical user interface

Description automatically generated]()

Figure 3: Simulation Results for Normal Scan Operation in S444 without rXOR

![Graphical user interface, diagram, schematic

Description automatically generated with medium confidence]()

Figure 4: Simulation Results for rXOR based Scan Operation in S444 Circuit

A picture containing text

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Figure 5: Simulation Results for rXOR based Scan Operation in C432 Circuit

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Figure 6: Design Implemented on Spartan 7

Chart, line chart, surface chart

Description automatically generated

Figure 7: Security measure based on Hamming distance

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Benchmark Circuits** | **LUT** | **Flip-flops** | **BUF** | **Scan Pins** |
| ISCAS’85 C432 | 57 | 10 | 32 | 5 |
| ISCAS’89 S386 | 68 | 6 | 43 | 5 |
| ISCAS’89 S420 | 87 | 16 | 49 | 5 |
| ISCAS’89 S444 | 78 | 21 | 47 | 5 |

Table 1. Resource Utilization for Conventional Scan.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Benchmark Circuits** | **LUT** | **Flip-flops** | **BUF** | **Scan Pins** |
| ISCAS’85 C432 | 68 | 23 | 52 | 8 |
| ISCAS’89 S386 | 79 | 19 | 66 | 7 |
| ISCAS’89 S420 | 102 | 31 | 73 | 9 |
| ISCAS’89 S444 | 91 | 34 | 77 | 9 |

Table 2. Resource Utilization for rXOR Scan.

Chart, histogram

Description automatically generated

Figure 8: Utilization Report of S444 with rXOR on Spartan7 after Synthesis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Benchmark Circuits** | **Stuck at Patterns** | **Test Cycles** | **Fault Coverage** | **Area Overhead** |
| ISCAS’85 C432 | 68 | 1280 | 94.35% | 20.43% |
| ISCAS’89 S386 | 79 | 1477 | 98.36% | 4.82% |
| ISCAS’89 S420 | 67 | 3310 | 97.34% | 7.56% |
| ISCAS’89 S444 | 72 | 3297 | 95.57% | 8.6% |

Table 3. Fault Coverage and Area overhead for rXOR