Design of Fault Injection Circuit for Digital Systems

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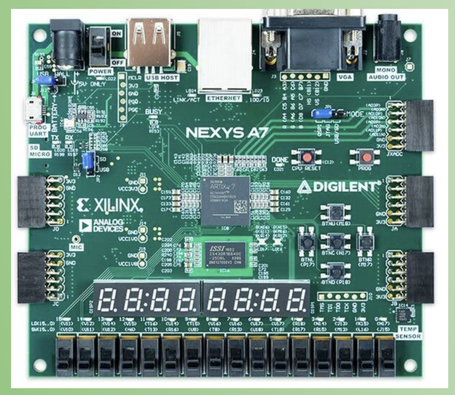
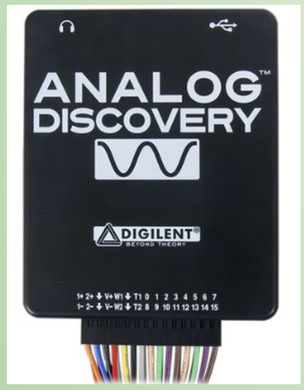
Abstract

A fault injection system provides the capability of introducing a fault at any desired location into the digital system. The purpose of this project is to design, test, and implement a controllable fault injection circuit that can be easily applied to devices under test described using VHDL language.

Tools

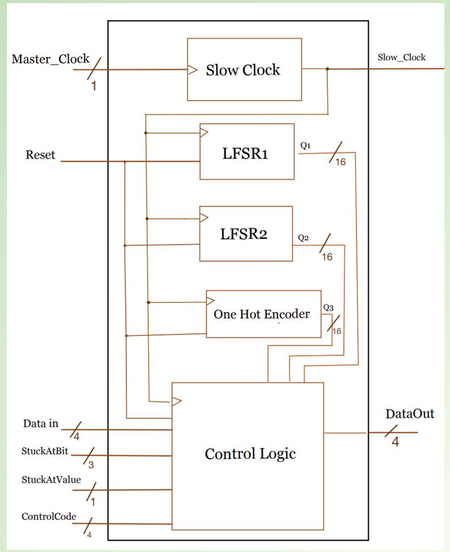
Hardware Platforms: Digilent Nexys A7 FPGA
Digilent Analog Discovery
Software: Xilinx Vivado
Digilent Waveforms



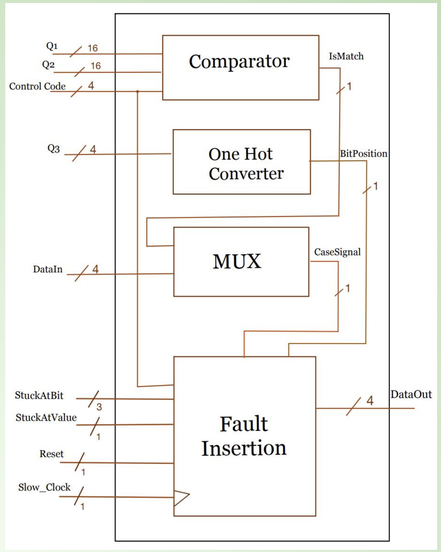


AMD Vivado ML Edition

Implementation



Fault Injector Block Diagram



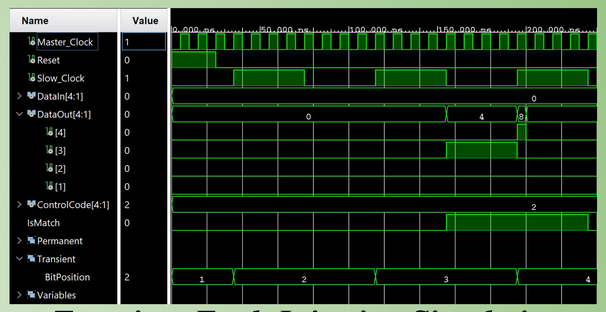
Control Logic Block Diagram

```
architecture Behavioral of Fault_Insertion is

SIGNAL DataToChange: STD_LOGIC_VECTOR(DataSize downto 1) := (OTHERS => '0');
SIGNAL StuckBit: INTEGER := 1;

begin
    PROCESS(DataIn, StuckAtBit, StuckAtValue, Reset, Clock, BitPosition, CaseSignal)
    BEGIN
        if Reset = '1' then
            DataToChange <= DataIn;
        else
                case CaseSignal is
                    WHEN 1 => DataToChange <= DataIn; --No injection
                    WHEN 2 => -- Permanent
                        DataToChange <= DataIn;
                        StuckBit <= to_integer(unsigned(StuckAtBit));
                        DataToChange(StuckBit) <= StuckAtValue;
                    WHEN 3 => -- Transient
                        DataToChange <= DataIn;
                        DataToChange(BitPosition) <= NOT DataToChange(BitPosition);
                    WHEN OTHERS => DataToChange <= DataIn;
                end case;
        end if;
    END PROCESS;

DataOut <= DataToChange;

end Behavioral;
```

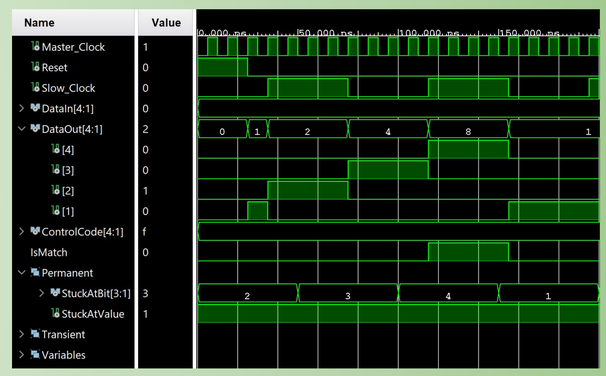
Fault Injector VHDL Code: Fault Insertion Module

Simulation

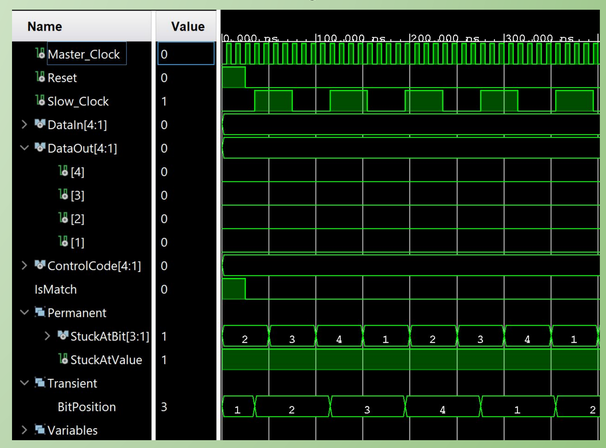
(Preliminary Results)



Transient Fault Injection Simulation



Permanent Fault Injection Simulation



No Fault Injection Simulation

Conclusion and Future Work

In this project, a controllable fault injection system was designed and simulated. Future work will include implementation on the Digilent Nexys A7 board and tests using the Digilent Analog Discovery Board.