



Department of Electrical and Computer Engineering

ECE 3300L Section 1

Lab 3 – 16x1 Multiplexer Using Nested 2x1 MUXes with Debounced Toggle Select Control

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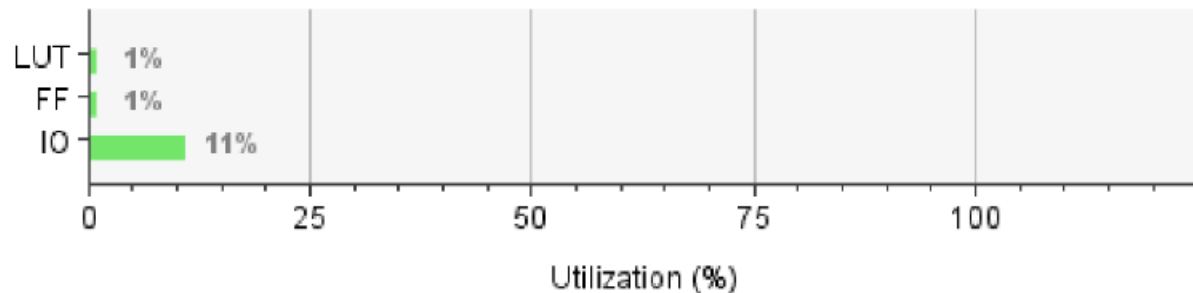
## Code and Explanation:

```
module top_mux (  
    input clk,  
    input rst,  
    input [15:0] SW,  
    input btnU, btnD, btnL, btnR,  
    output LED0  
);  
    wire [3:0] sel;  
  
    toggle_switch t0 (.clk(clk), .rst(rst), .btn_raw(btnD), .state(sel[0]));  
    toggle_switch t1 (.clk(clk), .rst(rst), .btn_raw(btnR), .state(sel[1]));  
    toggle_switch t2 (.clk(clk), .rst(rst), .btn_raw(btnL), .state(sel[2]));  
    toggle_switch t3 (.clk(clk), .rst(rst), .btn_raw(btnU), .state(sel[3]));  
  
    mux16x1 mux (.in(SW), .sel(sel), .out(LED0));  
endmodule
```

```
module toggle_switch (  
    input clk,  
    input rst,  
    input btn_raw,  
    output reg state  
);  
    wire btn_clean;  
    reg btn_prev;  
  
    debounce db (.clk(clk), .btn_in(btn_raw), .btn_clean(btn_clean));  
  
    always @(posedge clk) begin  
        if (rst) begin  
            state <= 0;  
            btn_prev <= 0;  
        end else begin  
            if (btn_clean && !btn_prev)  
                state <= ~state;  
            btn_prev <= btn_clean;  
        end  
    end  
endmodule
```

## Vivado utilization (LUTs, FFs, Power)

Resource	Utilization	Available	Utilization %
LUT	12	63400	0.02
FF	24	126800	0.02
IO	23	210	10.95

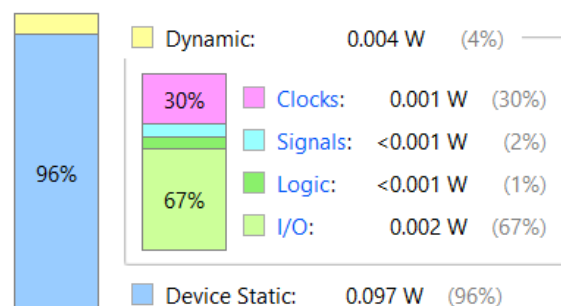


## Summary

Power estimation from Synthesized netlist. Activity derived from constraints files, simulation files or vectorless analysis. Note: these early estimates can change after implementation.

**Total On-Chip Power:** 0.101 W  
**Design Power Budget:** Not Specified  
**Process:** typical  
**Power Budget Margin:** N/A  
**Junction Temperature:** 25.5°C  
 Thermal Margin: 59.5°C (12.9 W)  
 Ambient Temperature: 25.0 °C  
 Effective  $\theta_{JA}$ : 4.6°C/W  
 Power supplied to off-chip devices: 0 W  
 Confidence level: Low  
[Launch Power Constraint Advisor](#) to find and fix invalid switching activity

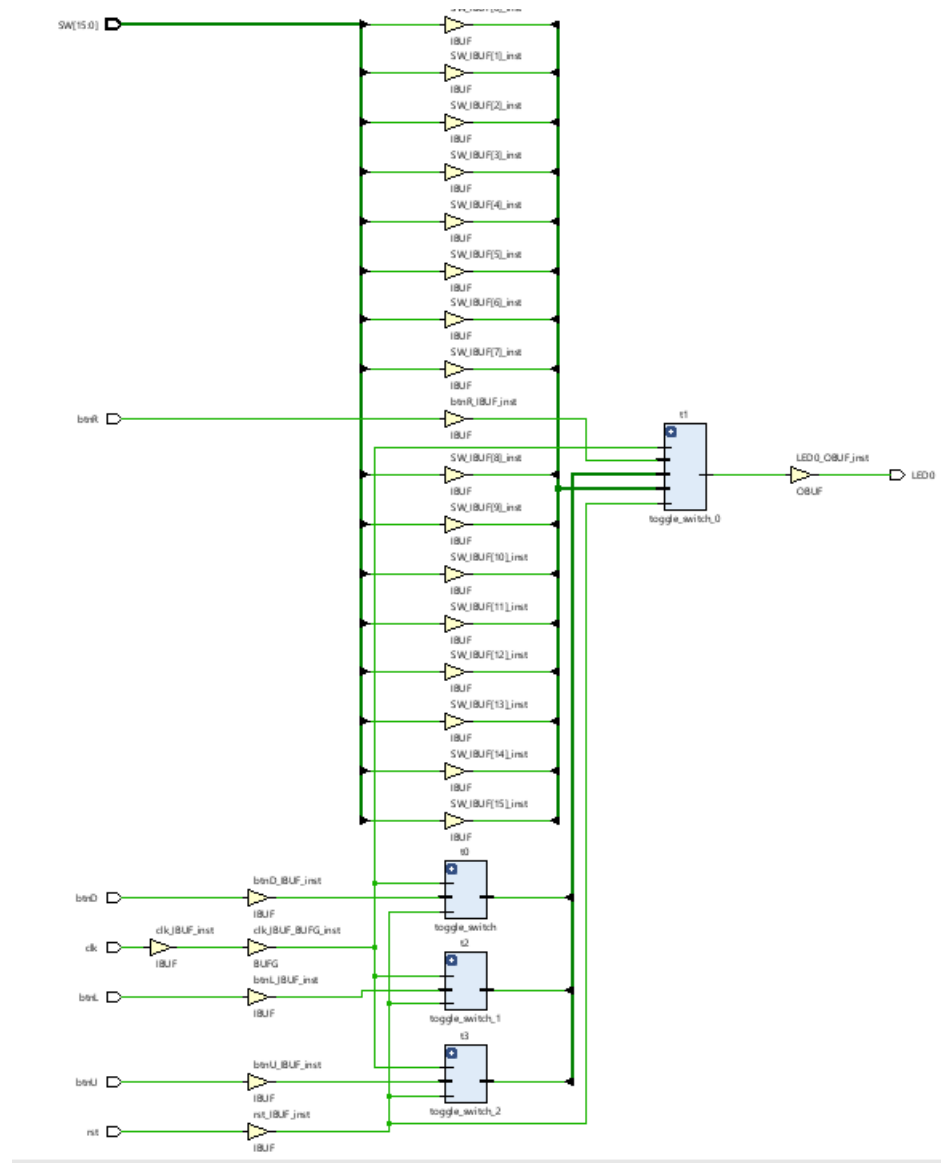
## On-Chip Power



Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 8.328 ns	Worst Hold Slack (WHS): 0.137 ns	Worst Pulse Width Slack (WPWS): 4.500 ns
Total Negative Slack (TNS): 0.000 ns	Total Hold Slack (THS): 0.000 ns	Total Pulse Width Negative Slack (TPWS): 0.000 ns
Number of Failing Endpoints: 0	Number of Failing Endpoints: 0	Number of Failing Endpoints: 0
Total Number of Endpoints: 20	Total Number of Endpoints: 20	Total Number of Endpoints: 25

All user specified timing constraints are met.

## Screenshots:



**Contributions:**

**Bryan Liu: Coding, Code Explanation : 50%**

**Jaden Yermenko: Simulation, Synthesis, Testing: 50%**