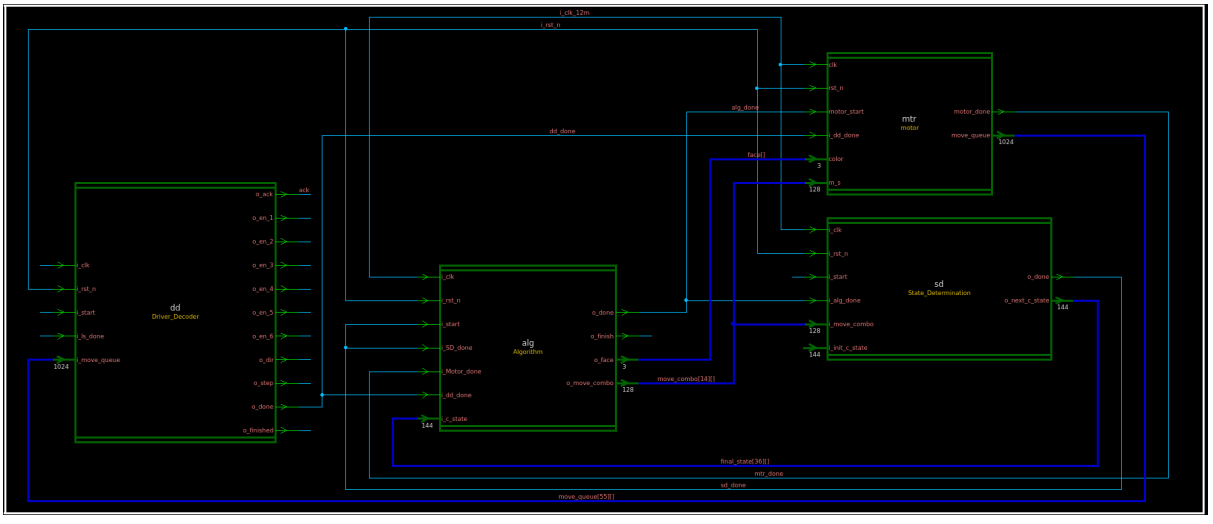
File Structure

```
team01_final
|   team01_final_report.pdf
|
\---src
    |   Algorithm.sv
    |   I2C_Read.sv
    |   I2C_sensor.sv
    |   I2C_Setup.sv
    |   motor.sv
    |   ps2.sv
    |   real_Driver_Decoder.sv
    |   State_Determination.sv
    |   Top.sv
    |
    +---Altpll
    |   |   Altpll.bsf
    |   |   Altpll.cmp
    |   |   Altpll.html
    |   |   Altpll.xml
    |   |   Altpll_bb.v
    |   |   Altpll_generation.rpt
    |   |   Altpll_inst.v
    |   |   Altpll_inst.vhd
    |   |
    |   \---synthesis
    |       |   Altpll.debuginfo
    |       |   Altpll.qip
    |       |   Altpll.v
    |       |
    |       \---submodules
    |               altera_reset_controller.sdc
    |               altera_reset_controller.v
    |               altera_reset_synchronizer.v
    |               Altpll_altpll_0.v
    |
    +---DE2_115
    |       DE2_115.qsf
    |       DE2_115.sdc
    |       DE2_115.sv
    |       Debounce.sv
    |       SevenHexDecoder.sv
    |
    +---python_file
    |       check_if_sv_right.py
    |       combo_dec.py
    |       Find_corner_edge.py
```

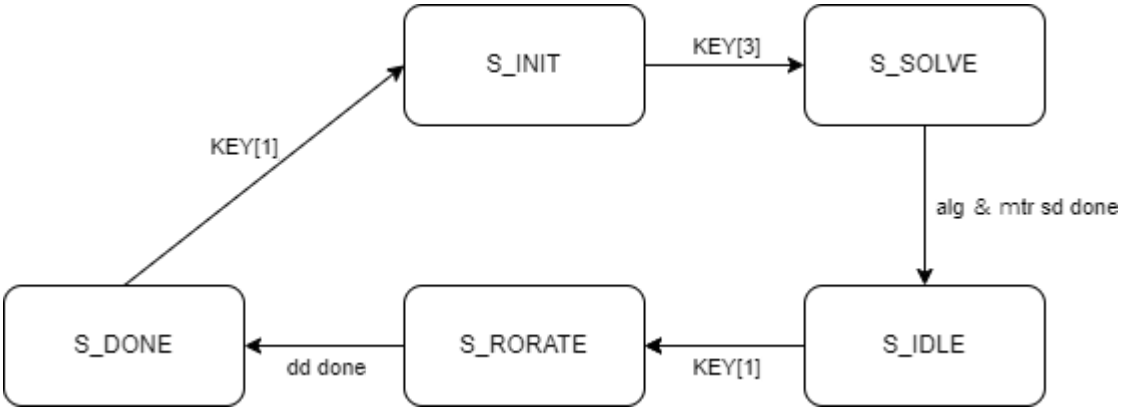
```
|       gen_binary_input.py
|       pycode.py
|       pycode_gen_all.py
|       simc_combo_answer.py
|       state_trans.py
|       state_trans_sv.py
|       transition.py
|
\---txt_file
        Back_clockwise.txt
        Back_counterclockwise.txt
        change_view.txt
        Down_clockwise.txt
        Down_counterclockwise.txt
        find_corner.txt
        find_edge.txt
        Front_clockwise.txt
        Front_counterclockwise.txt
        Front_to_top.txt
        Left_clockwise.txt
        Left_counterclockwise.txt
        Right_clockwise.txt
        Right_counterclockwise.txt
        Top_clockwise.txt
        Top_counterclockwise.txt
        transition.sv
```

System Architecture

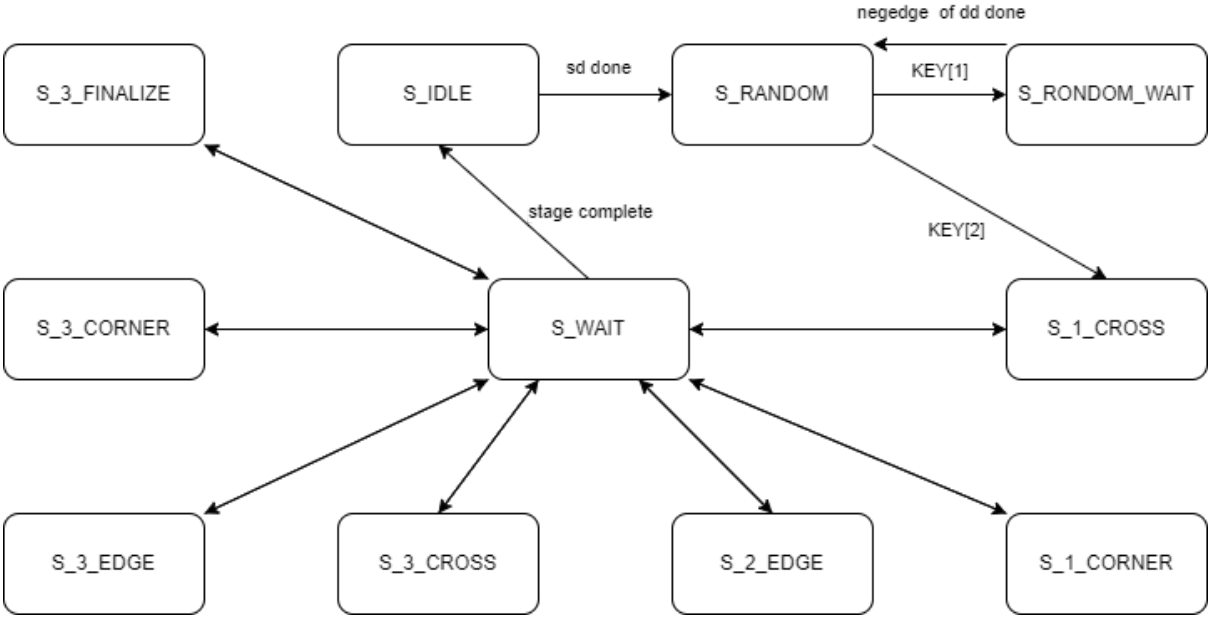


Hardware Scheduling

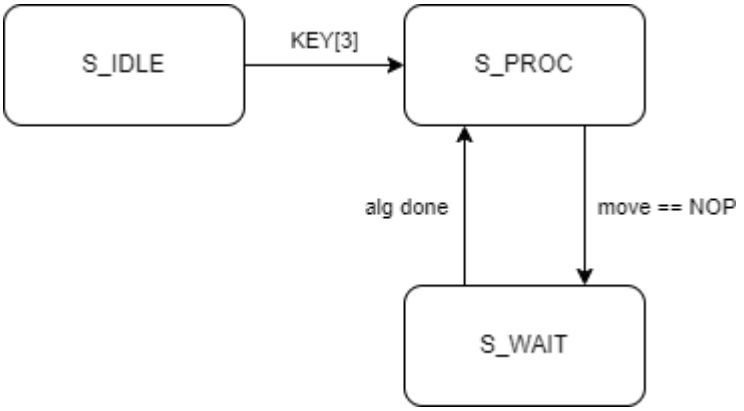
FSM of Top.sv



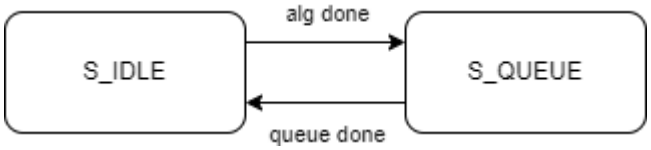
FSM of Algorithm.sv



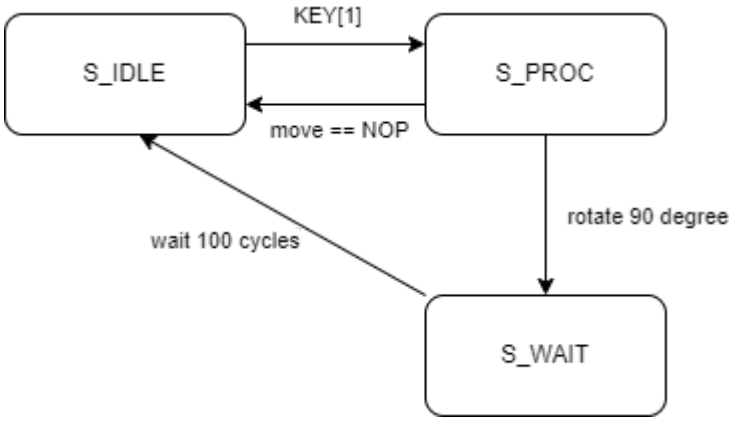
FSM of State_Determination.sv



FSM of motor.sv



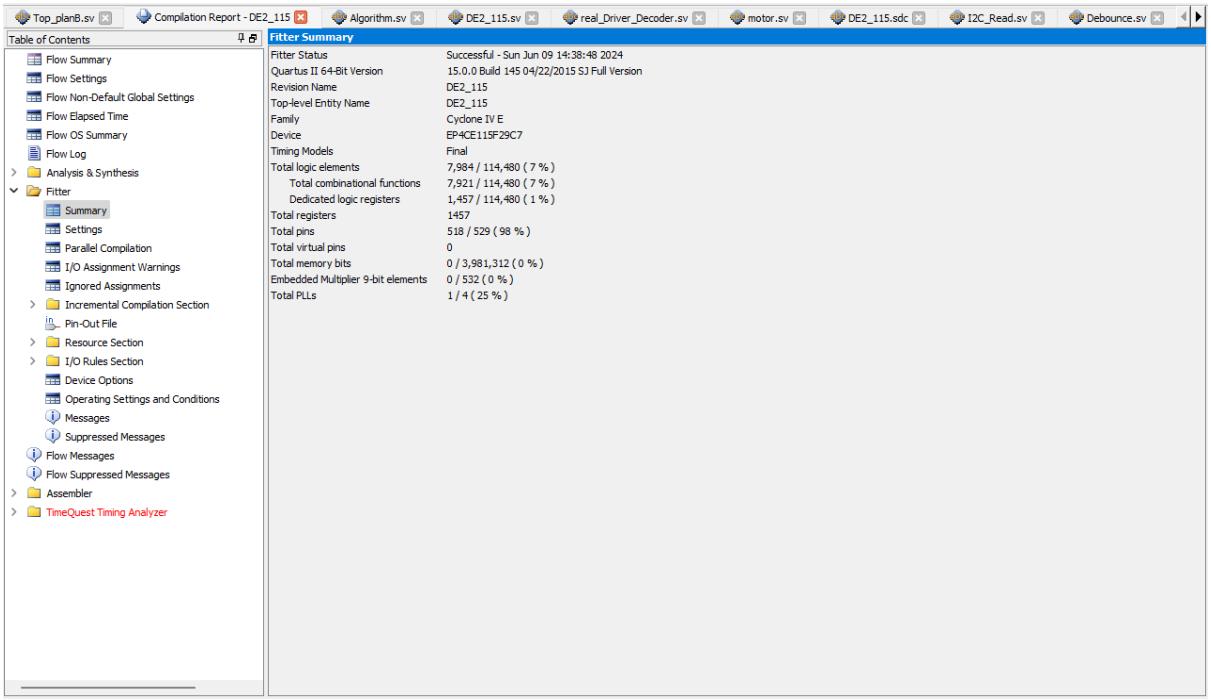
FSM of En_Ctrl in real_Driver_Decoder.sv



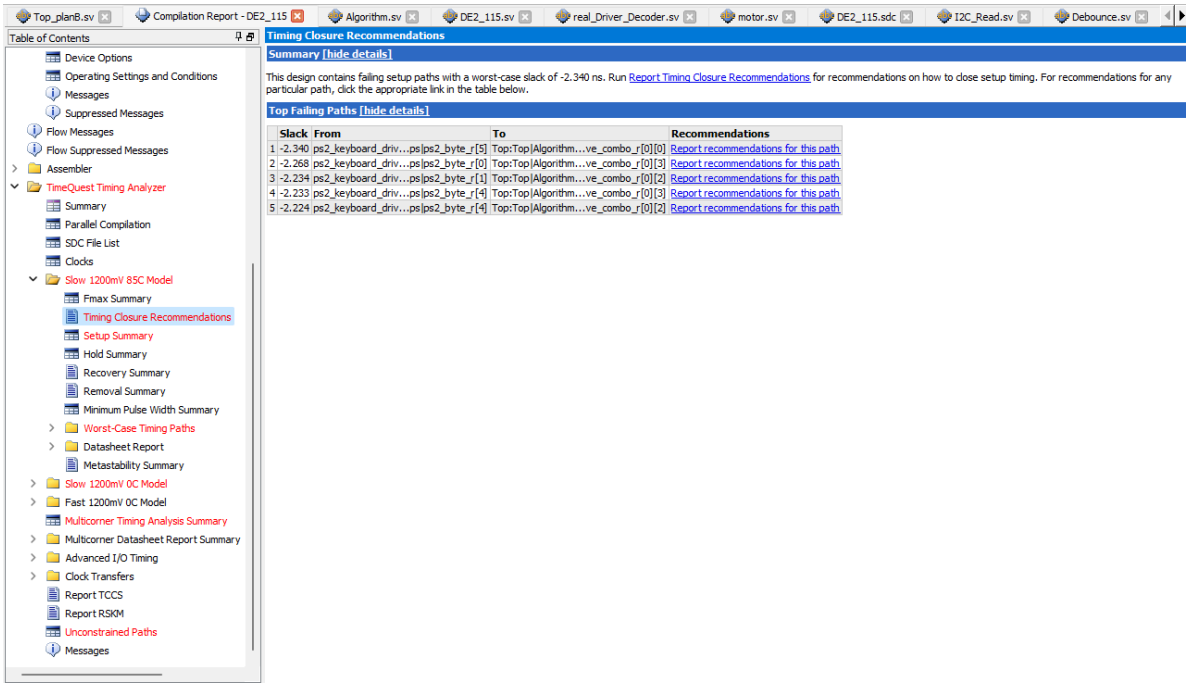
Algorithm Workflow

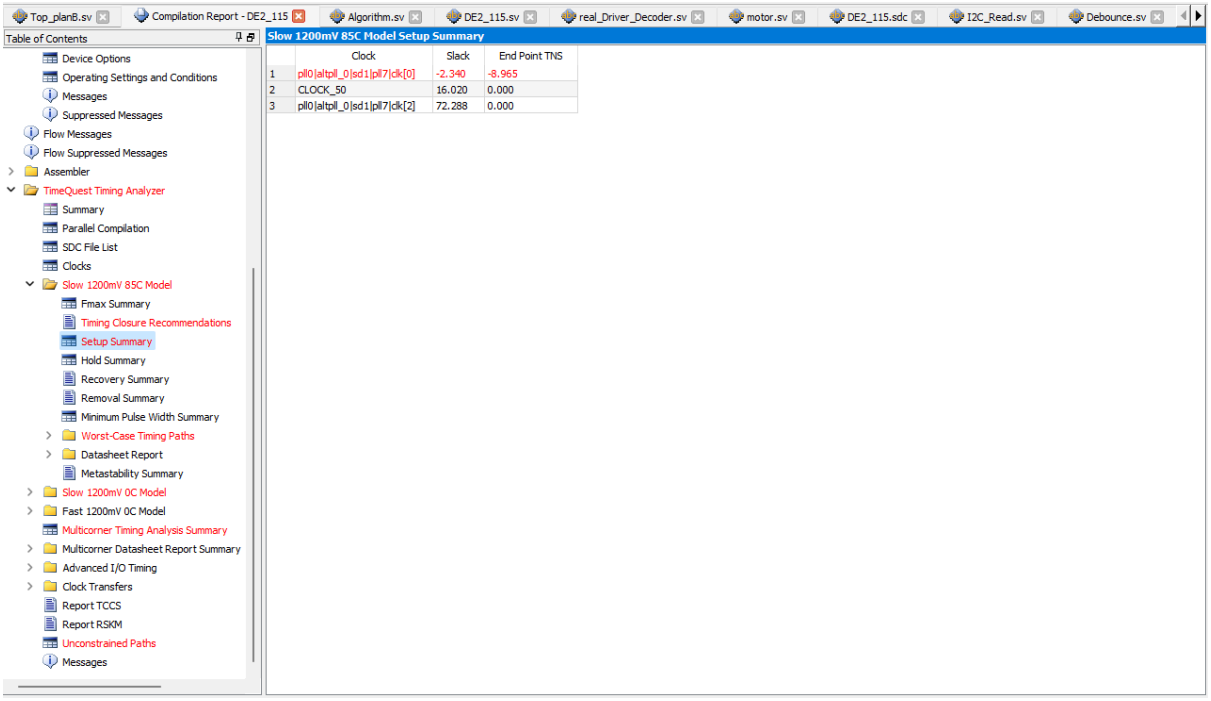
https://ruwix.com/the-rubiks-cube/how-to-solve-the-rubiks-cube-beginners-method/
https://www.speedcube.com.au/pages/how-to-solve-a-rubiks-cube

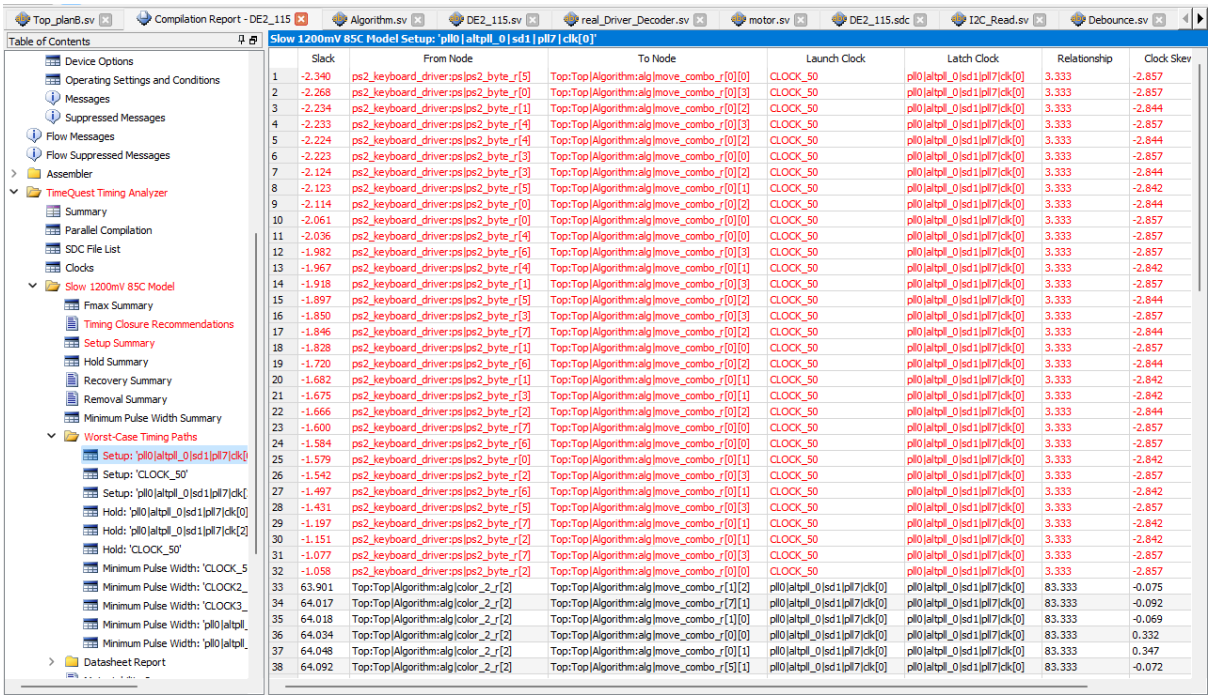
Fitter Summary



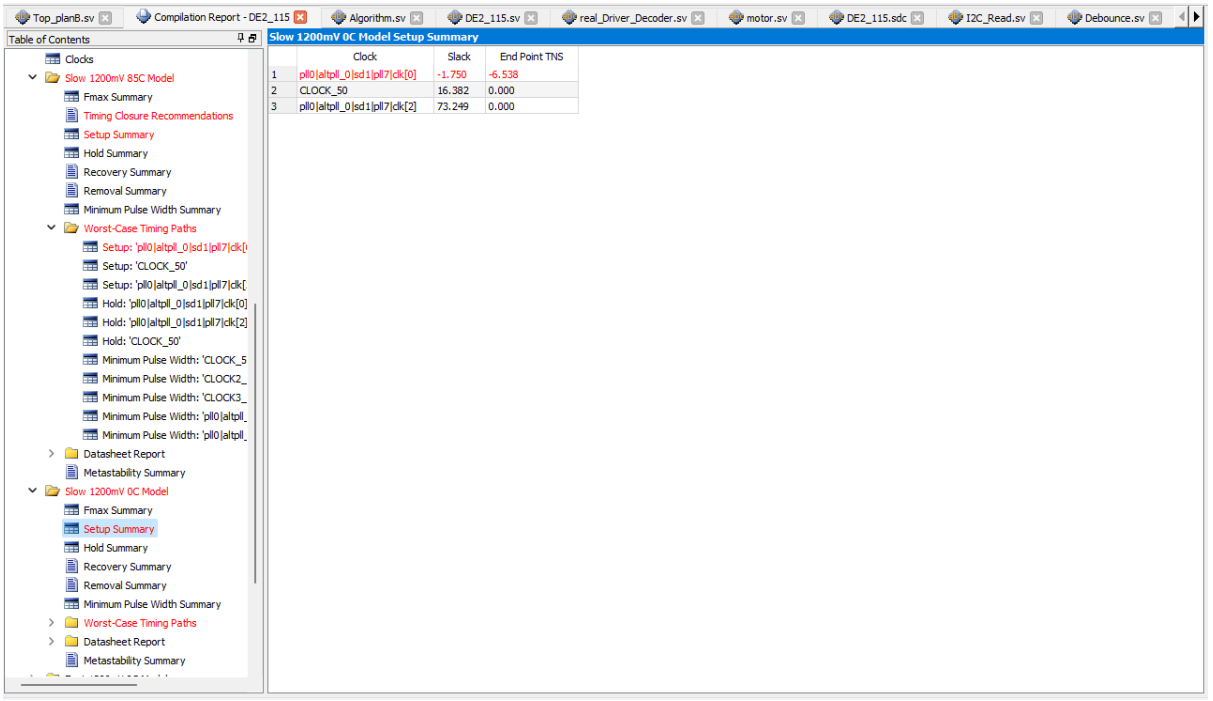
Timing Analyzer



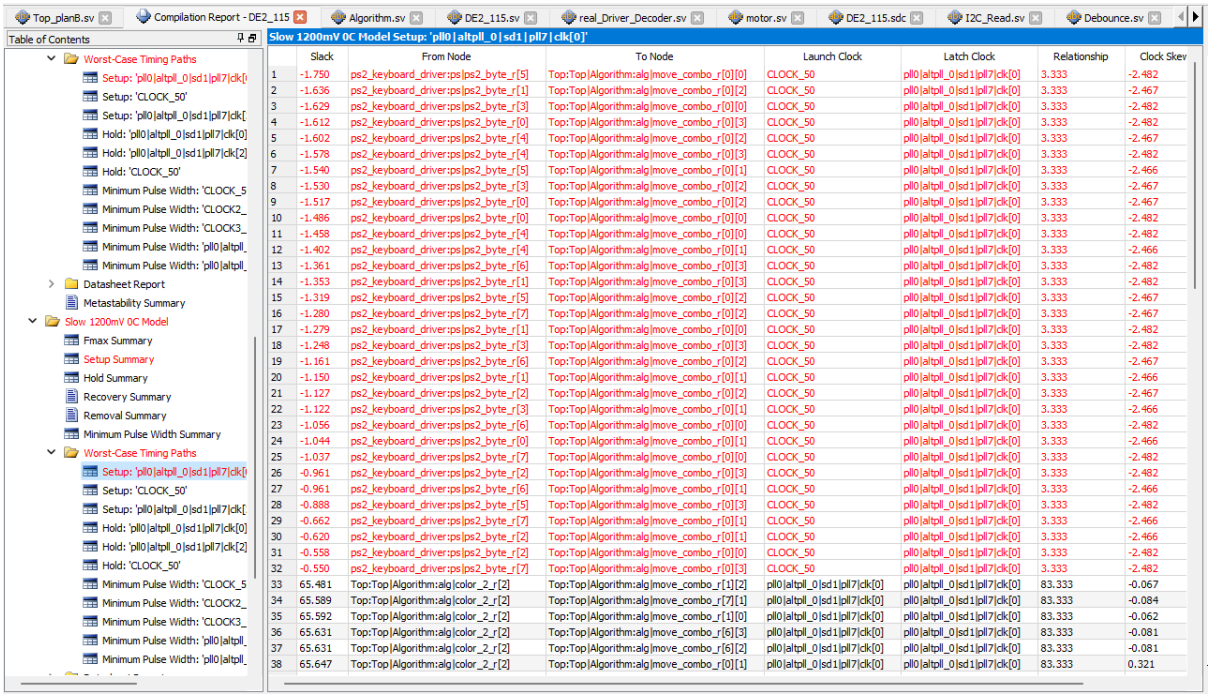




	Slack	From Node	To Node	Launch Clock	Latch Clock	Relationship	Clock Skew
1	-2.340	ps2_keyboard_driver:ps|ps2_byte_r[5]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
2	-2.268	ps2_keyboard_driver:ps|ps2_byte_r[0]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
3	-2.234	ps2_keyboard_driver:ps|ps2_byte_r[1]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.844
4	-2.233	ps2_keyboard_driver:ps|ps2_byte_r[4]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
5	-2.224	ps2_keyboard_driver:ps|ps2_byte_r[4]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.844
6	-2.223	ps2_keyboard_driver:ps|ps2_byte_r[3]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
7	-2.124	ps2_keyboard_driver:ps|ps2_byte_r[3]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.844
8	-2.123	ps2_keyboard_driver:ps|ps2_byte_r[5]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.842
9	-2.114	ps2_keyboard_driver:ps|ps2_byte_r[0]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.844
10	-2.061	ps2_keyboard_driver:ps|ps2_byte_r[0]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
11	-2.036	ps2_keyboard_driver:ps|ps2_byte_r[4]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
12	-1.982	ps2_keyboard_driver:ps|ps2_byte_r[6]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
13	-1.967	ps2_keyboard_driver:ps|ps2_byte_r[4]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.842
14	-1.918	ps2_keyboard_driver:ps|ps2_byte_r[1]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
15	-1.897	ps2_keyboard_driver:ps|ps2_byte_r[5]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.844
16	-1.850	ps2_keyboard_driver:ps|ps2_byte_r[3]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
17	-1.846	ps2_keyboard_driver:ps|ps2_byte_r[7]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.844
18	-1.828	ps2_keyboard_driver:ps|ps2_byte_r[1]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
19	-1.720	ps2_keyboard_driver:ps|ps2_byte_r[6]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.844
20	-1.682	ps2_keyboard_driver:ps|ps2_byte_r[1]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.842
21	-1.675	ps2_keyboard_driver:ps|ps2_byte_r[3]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.842
22	-1.666	ps2_keyboard_driver:ps|ps2_byte_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.844
23	-1.600	ps2_keyboard_driver:ps|ps2_byte_r[7]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
24	-1.584	ps2_keyboard_driver:ps|ps2_byte_r[6]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
25	-1.579	ps2_keyboard_driver:ps|ps2_byte_r[0]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.842
26	-1.542	ps2_keyboard_driver:ps|ps2_byte_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
27	-1.497	ps2_keyboard_driver:ps|ps2_byte_r[6]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.842
28	-1.431	ps2_keyboard_driver:ps|ps2_byte_r[5]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
29	-1.197	ps2_keyboard_driver:ps|ps2_byte_r[7]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.842
30	-1.151	ps2_keyboard_driver:ps|ps2_byte_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.842
31	-1.077	ps2_keyboard_driver:ps|ps2_byte_r[7]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
32	-1.058	ps2_keyboard_driver:ps|ps2_byte_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.857
33	63.901	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[1][2]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	-0.075
34	64.017	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[7][1]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	-0.092
35	64.018	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[1][0]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	-0.069
36	64.034	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][0]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	0.332
37	64.048	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][1]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	0.347
38	64.092	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[5][1]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	-0.072

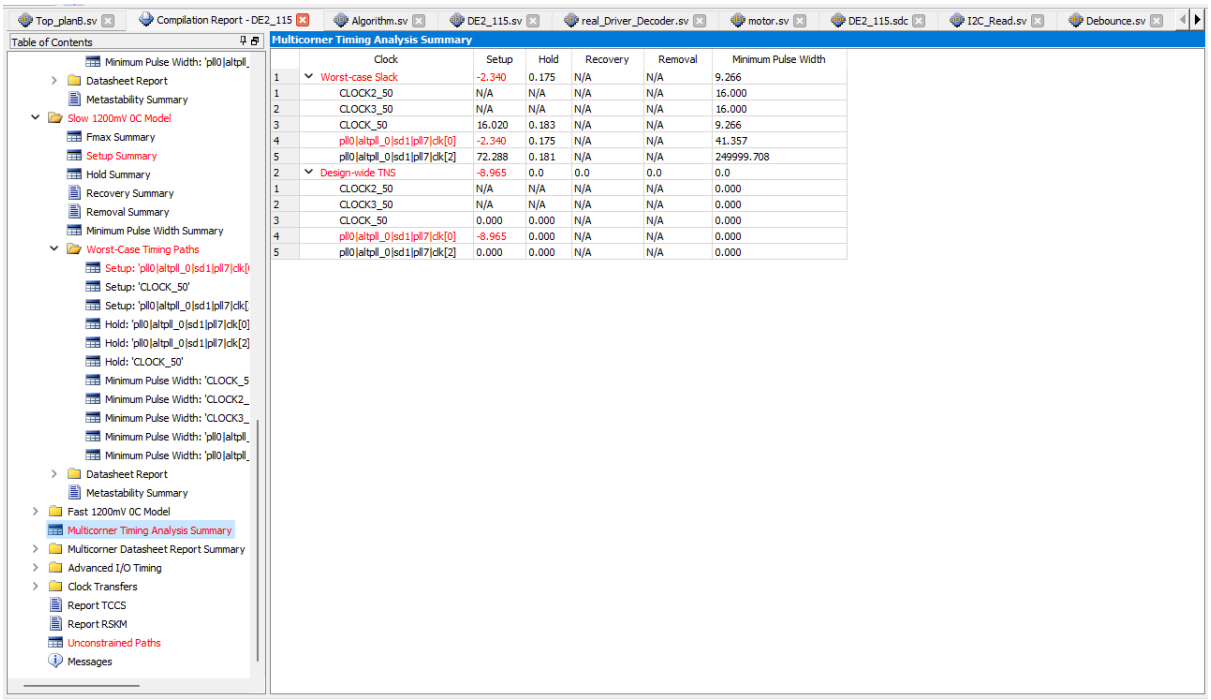


	Clock	Slack	End Point TNS
1	pll0|altpll_0|sd1|pll7|clk[0]	-1.750	-6.538
2	CLOCK_50	16.382	0.000
3	pll0|altpll_0|sd1|pll7|clk[2]	73.249	0.000

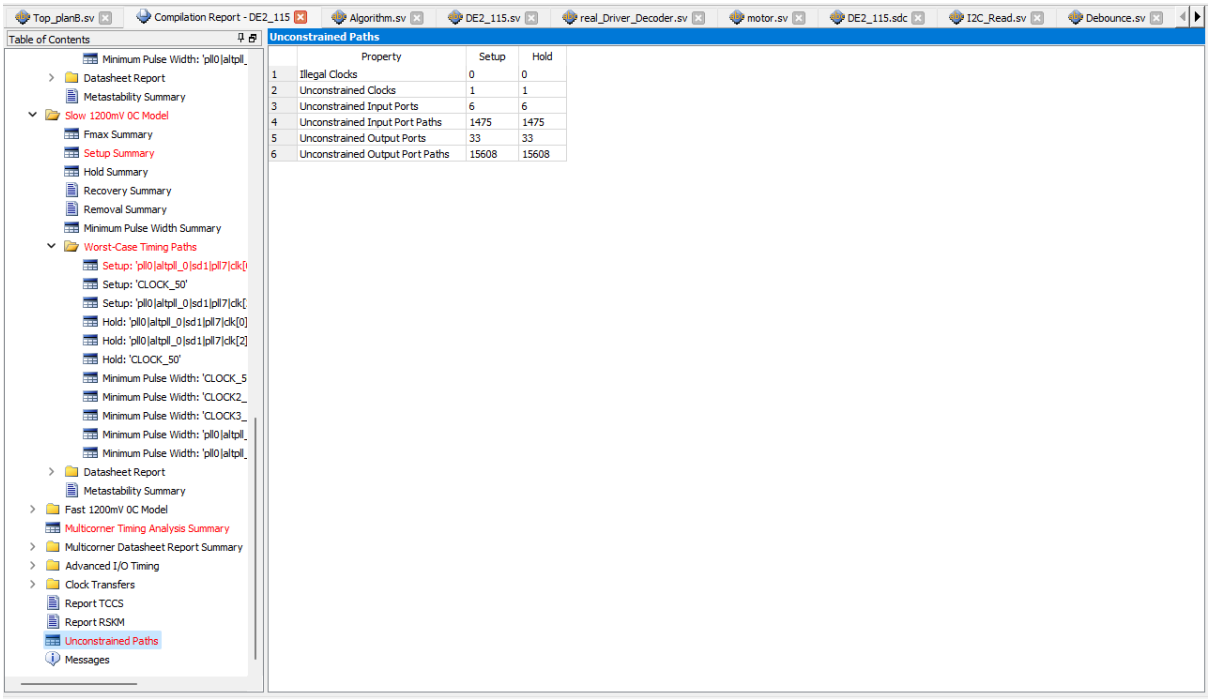


Slow 1200mV 0C Model Setup: 'pll0|altpll_0|sd1|pll7|clk[0]'

	Slack	From Node	To Node	Launch Clock	Latch Clock	Relationship	Clock Skew
1	-1.750	ps2_keyboard_driver:ps|ps2_byte_r[5]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
2	-1.636	ps2_keyboard_driver:ps|ps2_byte_r[1]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.467
3	-1.629	ps2_keyboard_driver:ps|ps2_byte_r[3]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
4	-1.612	ps2_keyboard_driver:ps|ps2_byte_r[0]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
5	-1.602	ps2_keyboard_driver:ps|ps2_byte_r[4]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.467
6	-1.578	ps2_keyboard_driver:ps|ps2_byte_r[4]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
7	-1.540	ps2_keyboard_driver:ps|ps2_byte_r[5]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.466
8	-1.530	ps2_keyboard_driver:ps|ps2_byte_r[3]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.467
9	-1.517	ps2_keyboard_driver:ps|ps2_byte_r[0]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.467
10	-1.486	ps2_keyboard_driver:ps|ps2_byte_r[0]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
11	-1.458	ps2_keyboard_driver:ps|ps2_byte_r[4]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
12	-1.402	ps2_keyboard_driver:ps|ps2_byte_r[4]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.466
13	-1.361	ps2_keyboard_driver:ps|ps2_byte_r[6]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
14	-1.353	ps2_keyboard_driver:ps|ps2_byte_r[1]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
15	-1.319	ps2_keyboard_driver:ps|ps2_byte_r[5]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.467
16	-1.280	ps2_keyboard_driver:ps|ps2_byte_r[7]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.467
17	-1.279	ps2_keyboard_driver:ps|ps2_byte_r[1]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
18	-1.248	ps2_keyboard_driver:ps|ps2_byte_r[3]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
19	-1.161	ps2_keyboard_driver:ps|ps2_byte_r[6]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.467
20	-1.150	ps2_keyboard_driver:ps|ps2_byte_r[1]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.466
21	-1.127	ps2_keyboard_driver:ps|ps2_byte_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][2]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.467
22	-1.122	ps2_keyboard_driver:ps|ps2_byte_r[3]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.466
23	-1.056	ps2_keyboard_driver:ps|ps2_byte_r[6]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
24	-1.044	ps2_keyboard_driver:ps|ps2_byte_r[0]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.466
25	-1.037	ps2_keyboard_driver:ps|ps2_byte_r[7]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
26	-0.961	ps2_keyboard_driver:ps|ps2_byte_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
27	-0.961	ps2_keyboard_driver:ps|ps2_byte_r[6]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.466
28	-0.888	ps2_keyboard_driver:ps|ps2_byte_r[5]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
29	-0.662	ps2_keyboard_driver:ps|ps2_byte_r[7]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.466
30	-0.620	ps2_keyboard_driver:ps|ps2_byte_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][1]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.466
31	-0.558	ps2_keyboard_driver:ps|ps2_byte_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][0]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
32	-0.550	ps2_keyboard_driver:ps|ps2_byte_r[7]	Top:Top|Algorithm:alg|move_combo_r[0][3]	CLOCK_50	pll0|altpll_0|sd1|pll7|clk[0]	3.333	-2.482
33	65.481	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[1][2]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	-0.067
34	65.589	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[7][1]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	-0.084
35	65.592	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[1][0]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	-0.062
36	65.631	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[6][3]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	-0.081
37	65.631	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[6][2]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	-0.081
38	65.647	Top:Top|Algorithm:alg|color_2_r[2]	Top:Top|Algorithm:alg|move_combo_r[0][1]	pll0|altpll_0|sd1|pll7|clk[0]	pll0|altpll_0|sd1|pll7|clk[0]	83.333	0.321



	Clock	Setup	Hold	Recovery	Removal	Minimum Pulse Width
1	Worst-case Slack	-2.340	0.175	N/A	N/A	9.266
1	CLOCK2_50	N/A	N/A	N/A	N/A	16.000
2	CLOCK3_50	N/A	N/A	N/A	N/A	16.000
3	CLOCK_50	16.020	0.183	N/A	N/A	9.266
4	pll0|altpll_0|sd1|pll7|clk[0]	-2.340	0.175	N/A	N/A	41.357
5	pll0|altpll_0|sd1|pll7|clk[2]	72.288	0.181	N/A	N/A	249999.708
2	Design-wide TNS	-8.965	0.0	0.0	0.0	0.0
1	CLOCK2_50	N/A	N/A	N/A	N/A	0.000
2	CLOCK3_50	N/A	N/A	N/A	N/A	0.000
3	CLOCK_50	0.000	0.000	N/A	N/A	0.000
4	pll0|altpll_0|sd1|pll7|clk[0]	-8.965	0.000	N/A	N/A	0.000
5	pll0|altpll_0|sd1|pll7|clk[2]	0.000	0.000	N/A	N/A	0.000



	Property	Setup	Hold
1	Illegal Clocks	0	0
2	Unconstrained Clocks	1	1
3	Unconstrained Input Ports	6	6
4	Unconstrained Input Port Paths	1475	1475
5	Unconstrained Output Ports	33	33
6	Unconstrained Output Port Paths	15608	15608