

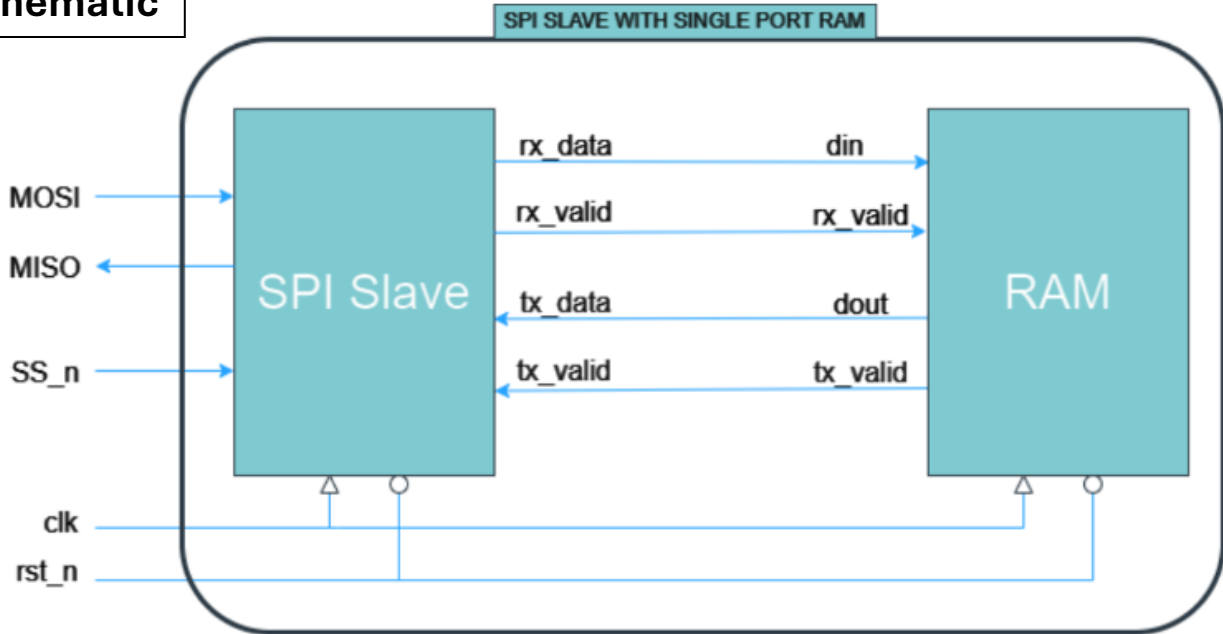
SPI Slave with Single Port RAM

by

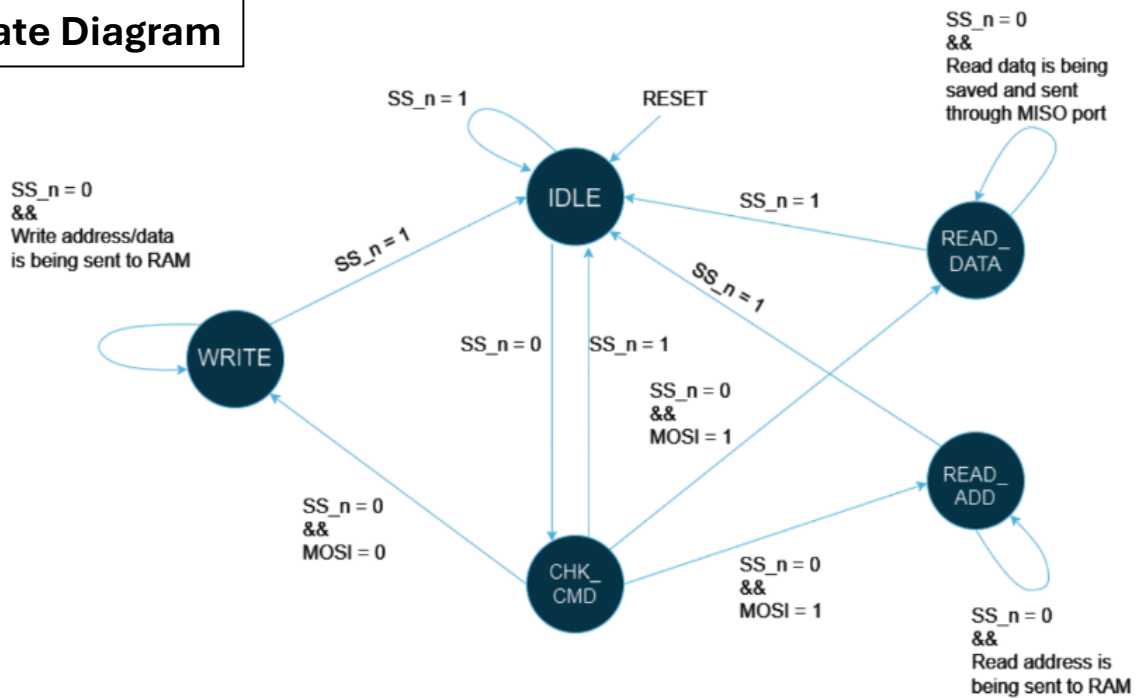
Ahmed Ibrahim Hassan Ibrahim

Under the guidance of Eng. Kareem Waseem

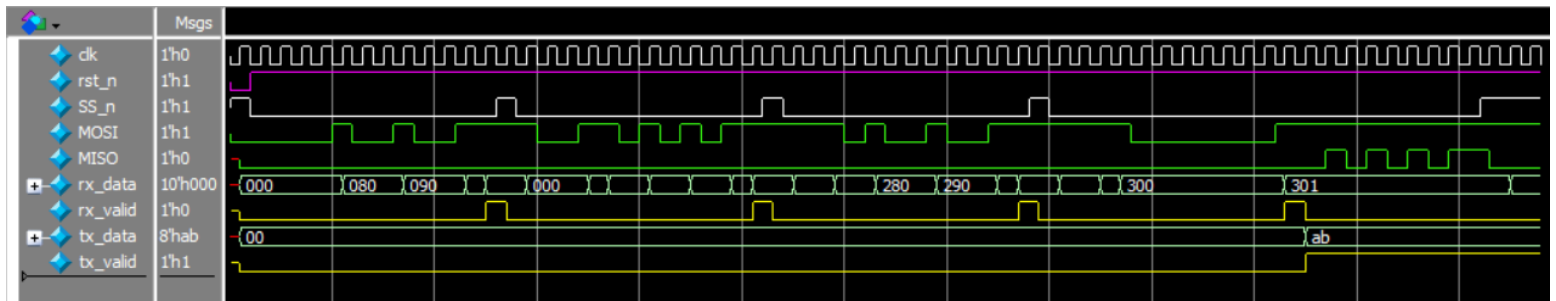
Schematic



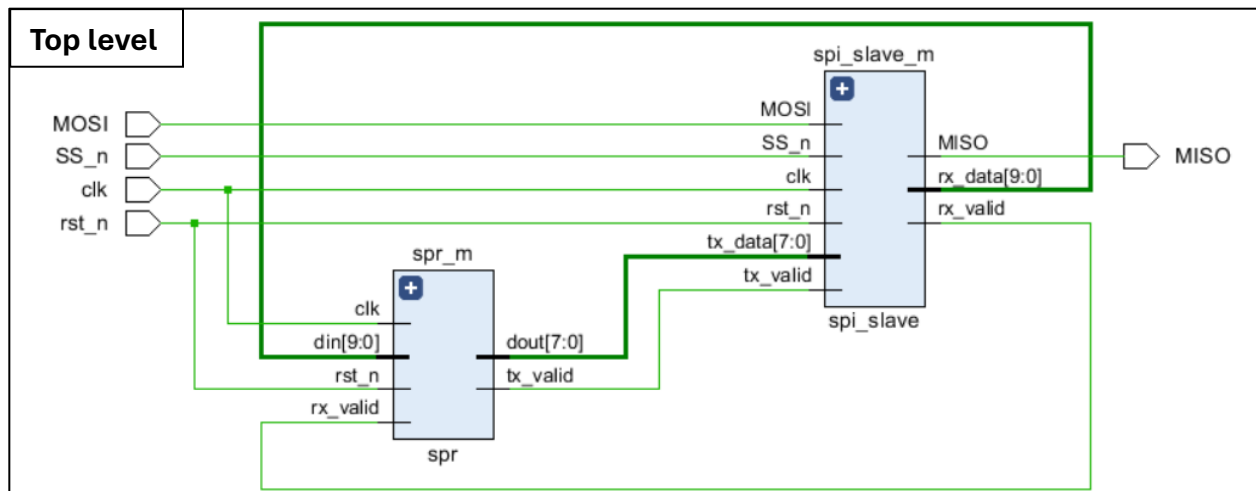
State Diagram



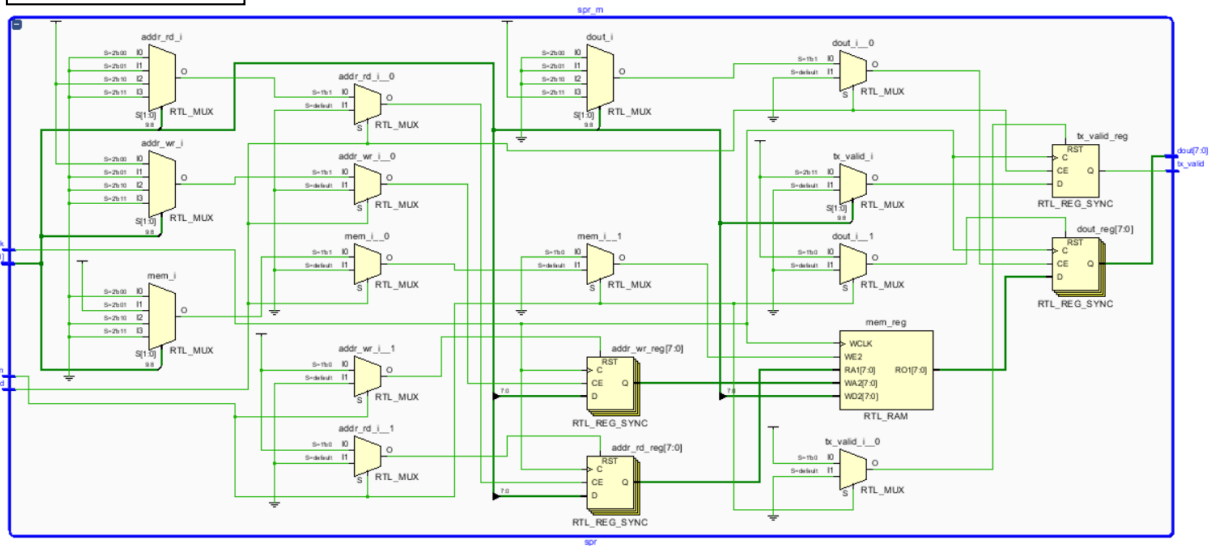
→ waveform



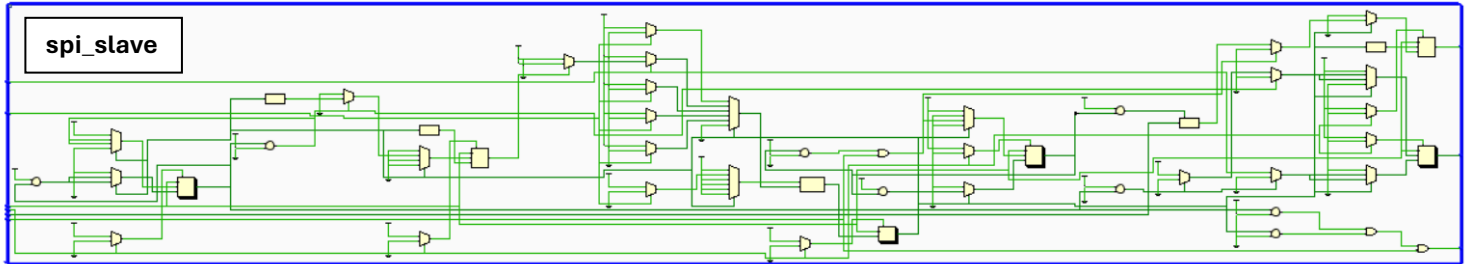
→ Elaboration



Single-port Ram

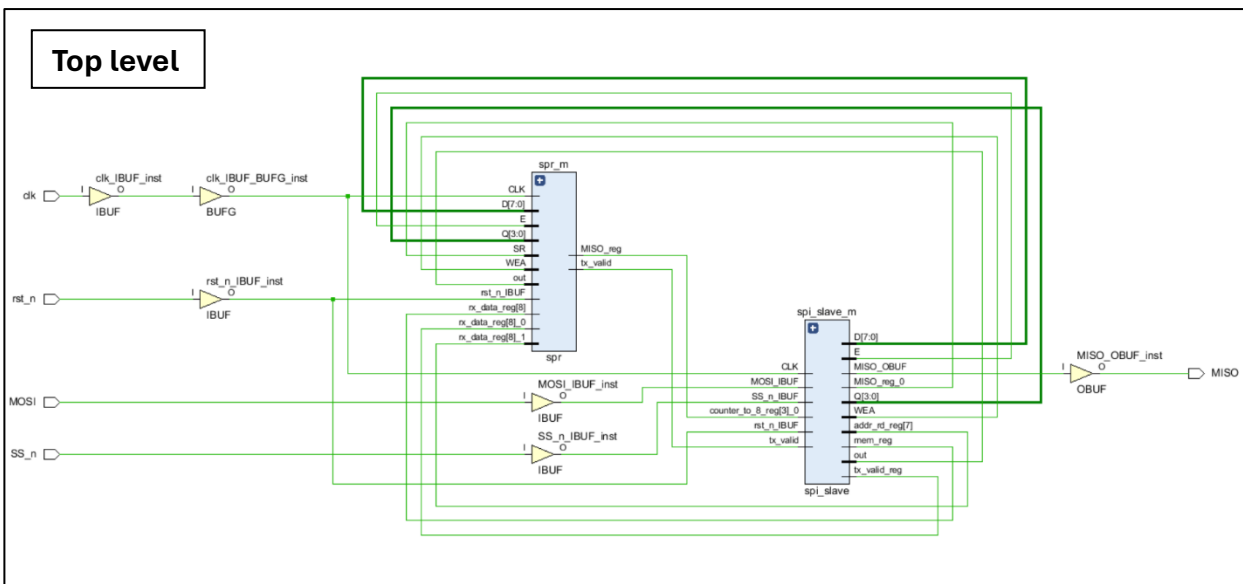


spi_slave

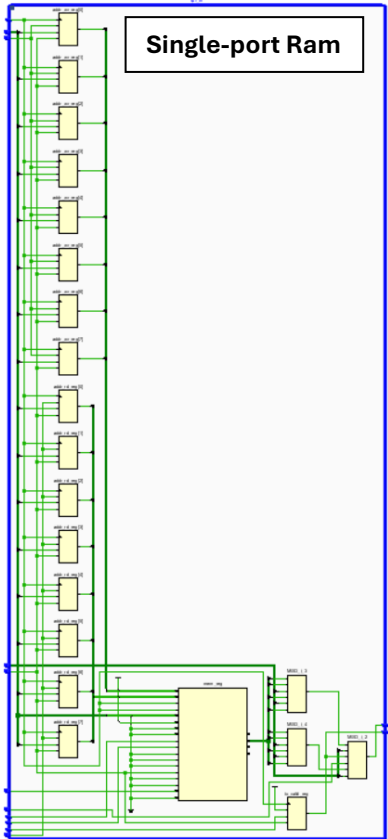
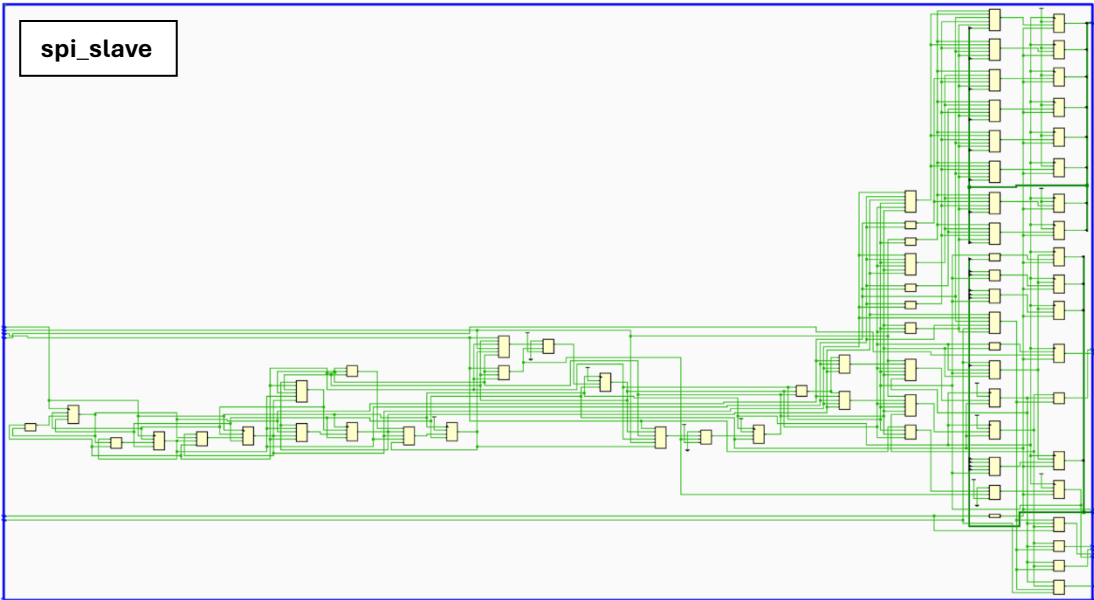


→ Synthesis

Top level

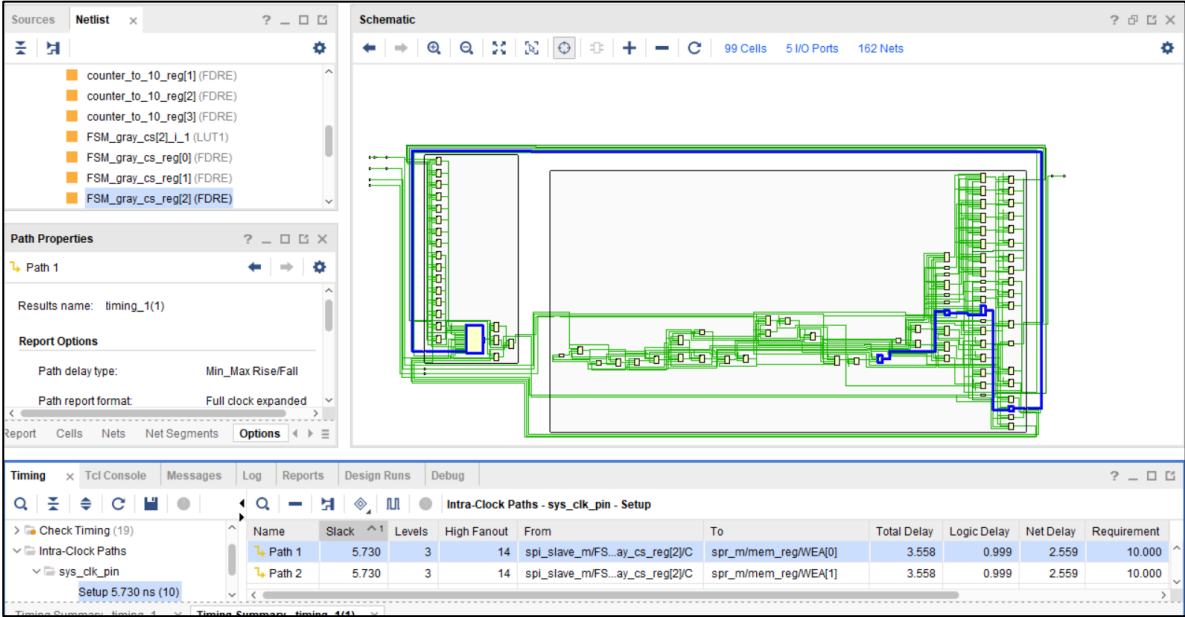


- gray Encoding



State	New Encoding	Previous Encoding
IDLE	000	000
CHK_CMD	001	001
WRITE	011	010
READ_DATA	010	100
READ_ADD	111	011

Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 5.730 ns	Worst Hold Slack (WHS): 0.146 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: 89	Total Number of Endpoints: 89	Total Number of Endpoints: 43
All user specified timing constraints are met.		



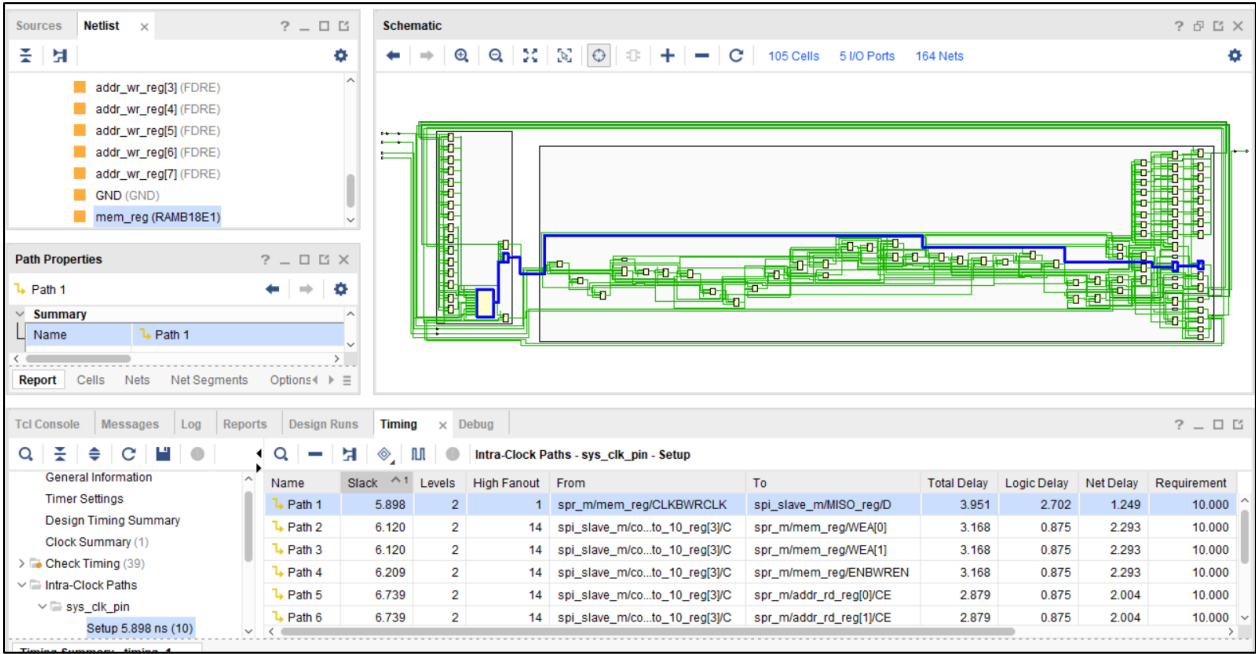
- one_hot Encoding

spi_slave

Single-port Ram

State	New Encoding	Previous Encoding
IDLE	00001	000
CHK_CMD	00010	001
WRITE	00100	010
READ_DATA	01000	100
READ_ADD	10000	011

Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 5.898 ns	Worst Hold Slack (WHS): 0.142 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: 89	Total Number of Endpoints: 89	Total Number of Endpoints: 45
All user specified timing constraints are met.		



- sequential Encoding

spi_slave

Single-port Ram

State	New Encoding	Previous Encoding
IDLE	000	000
CHK_CMD	001	001
WRITE	010	010
READ_DATA	011	100
READ_ADD	100	011

Setup

Worst Negative Slack (WNS): 5.722 ns

Total Negative Slack (TNS): 0.000 ns

Number of Failing Endpoints: 0

Total Number of Endpoints: 89

Hold

Worst Hold Slack (WHS): 0.146 ns

Total Hold Slack (THS): 0.000 ns

Number of Failing Endpoints: 0

Total Number of Endpoints: 89

Pulse Width

Worst Pulse Width Slack (WPWS): 4.500 ns

Total Pulse Width Negative Slack (TPWS): 0.000 ns

Number of Failing Endpoints: 0

Total Number of Endpoints: 43

All user specified timing constraints are met.

Sources Netlist

- FSM_sequential_cs[2]_L1 (LUT1)
- FSM_sequential_cs_reg[0] (FDRE)
- FSM_sequential_cs_reg[1] (FDRE)
- FSM_sequential_cs_reg[2] (FDRE)
- FSM_sequential_ns_reg[0] (LDCE)
- FSM_sequential_ns_reg[0]_L1 (LUT6)

Path Properties

Path 1

Summary

Name	Path 1
Slack	5.722ns

Schematic

99 Cells 5 I/O Ports 162 Nets

Tcl Console Messages Log Reports Design Runs Timing x Debug

Intra-Clock Paths - sys_clk_pin - Setup

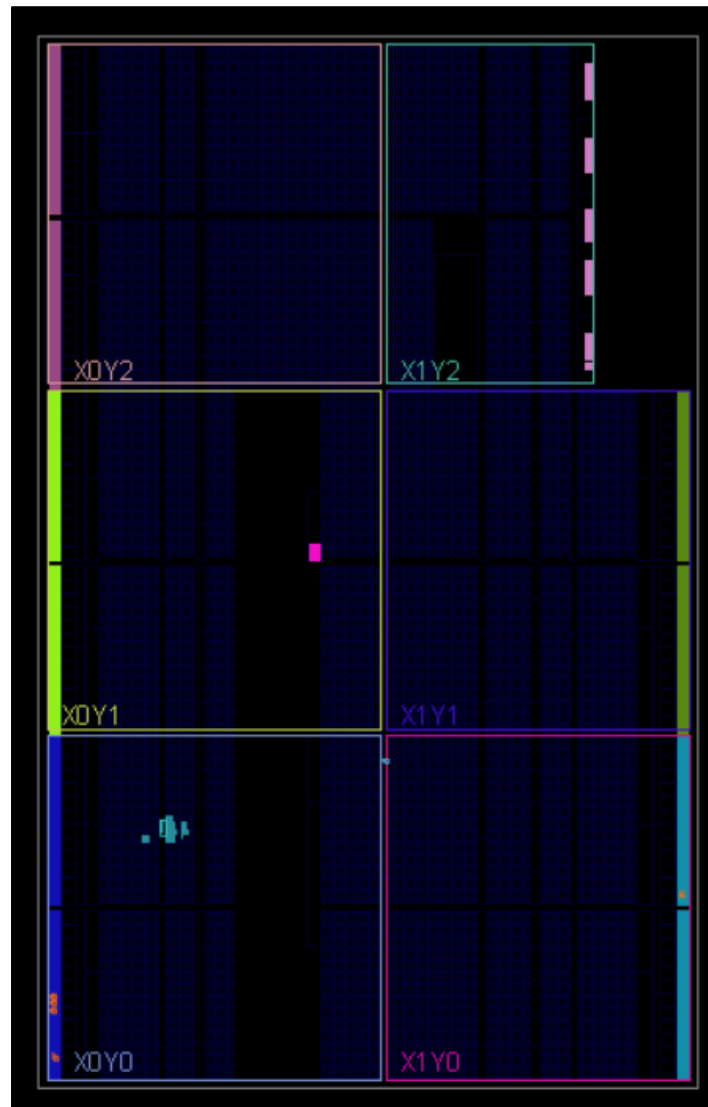
Name	Slack	Levels	High Fanout	From	To	Total Delay	Logic Delay	Net Delay	Requirement
Path 1	5.722	3	19	spi_slave_mFS...al_cs_reg[2]C	spr_m/mem_reg/WEA[0]	3.566	0.999	2.567	10.000
Path 2	5.722	3	19	spi_slave_mFS...al_cs_reg[2]C	spr_m/mem_reg/WEA[1]	3.566	0.999	2.567	10.000
Path 3	5.811	3	19	spi_slave_mFS...al_cs_reg[2]C	spr_m/mem_reg/ENBWREN	3.566	0.999	2.567	10.000
Path 4	5.898	2	1	spr_m/mem_reg/CLKBWRCLK	spi_slave_mMISO_regID	3.951	2.702	1.249	10.000
Path 5	6.341	3	19	spi_slave_mFS...al_cs_reg[2]C	spr_m/addr_rd_reg[0]CE	3.277	0.999	2.278	10.000
Path 6	6.341	3	19	spi_slave_mFS...al_cs_reg[2]C	spr_m/addr_rd_reg[1]CE	3.277	0.999	2.278	10.000

→ Implementation

- gray Encoding

Name	1	Slice LUTs (20800)	Slice Registers (41600)	Slice (8150)	LUT as Logic (20800)	LUT Flip Flop Pairs (20800)	Block RAM Tile (50)	Bonded IOB (106)	BUFGCTRL (32)
▼ N spi_slave_with_spr		42	43	13	42	23	0.5	5	1
❏ spi_slave_m (spi_slave)		39	26	13	39	22	0	0	0
❏ spr_m (spr)		3	17	4	3	0	0.5	0	0

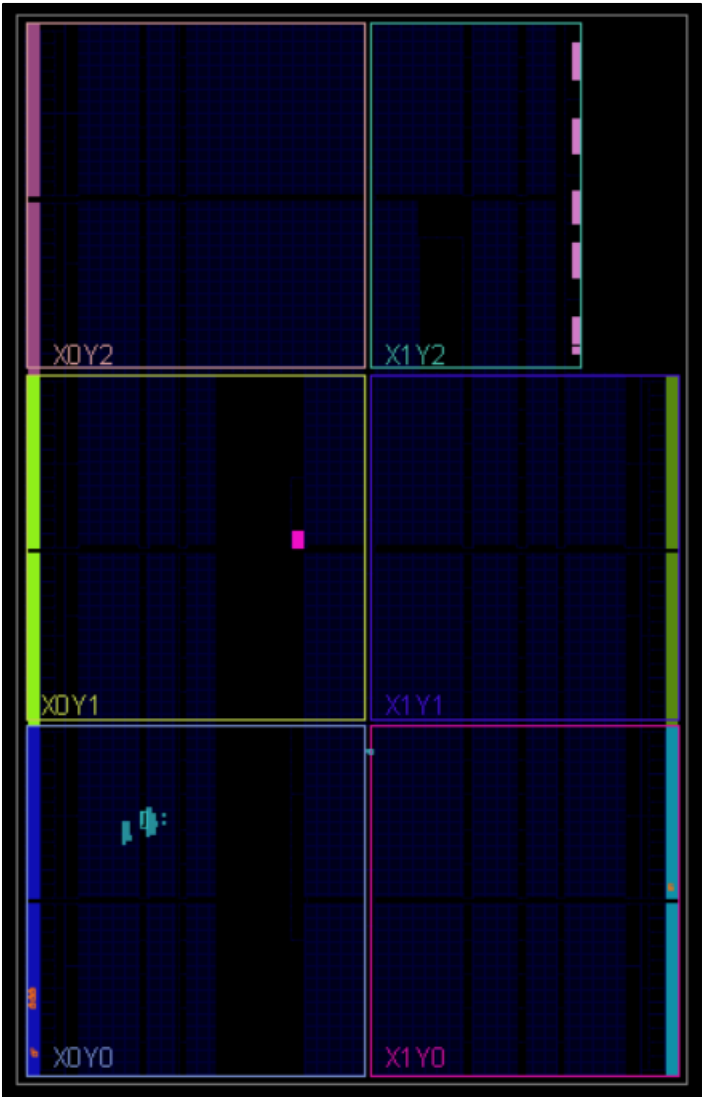
Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 5.833 ns	Worst Hold Slack (WHS): 0.057 ns	Worst Pulse Width Slack (WPWS): 4.500 ns
Total Negative Slack (TNS): 0.000 ns	Total Hold Slack (THS): 0.000 ns	Total Pulse Width Negative Slack (TPWS): 0.000 ns
Number of Failing Endpoints: 0	Number of Failing Endpoints: 0	Number of Failing Endpoints: 0
Total Number of Endpoints: 89	Total Number of Endpoints: 89	Total Number of Endpoints: 43
All user specified timing constraints are met.		



- one_hot Encoding

Name	1	Slice LUTs (20800)	Slice Registers (41600)	Slice (8150)	LUT as Logic (20800)	LUT Flip Flop Pairs (20800)	Block RAM Tile (50)	Bonded IOB (106)	BUFGCTRL (32)
▼ N spi_slave_with_spr		44	47	17	44	23	0.5	5	1
❏ spi_slave_m (spi_slave)		41	30	17	41	23	0	0	0
❏ spr_m (spr)		3	17	5	3	0	0.5	0	0

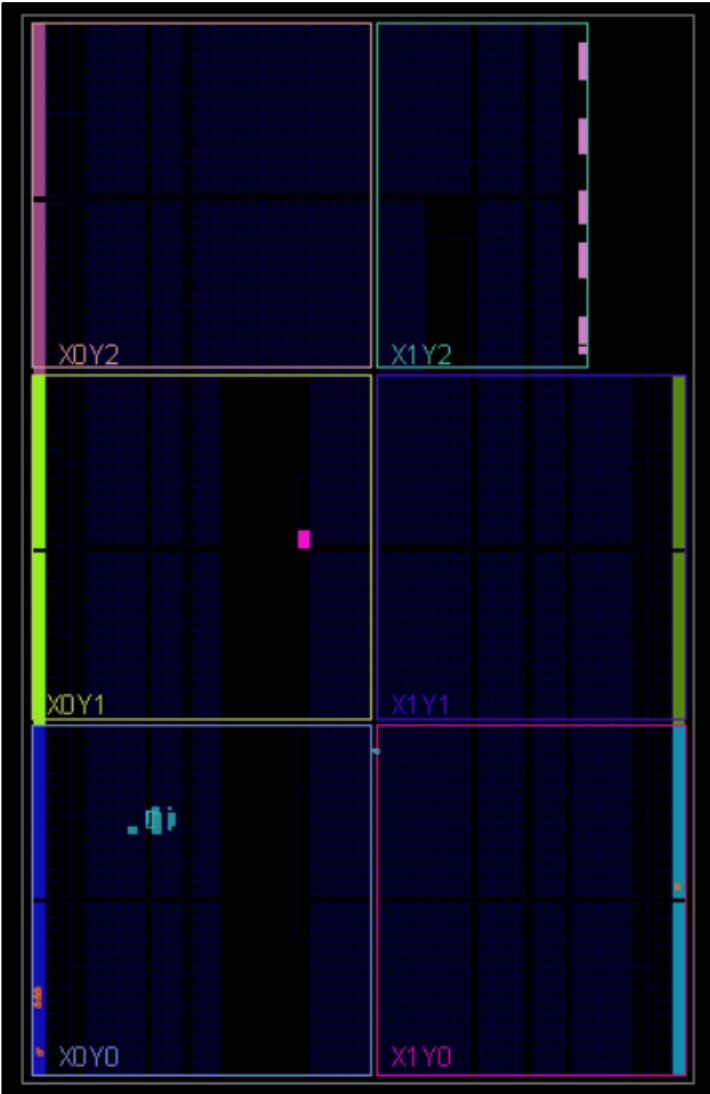
Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 5.397 ns	Worst Hold Slack (WHS): 0.055 ns	Worst Pulse Width Slack (WPWS): 4.500 ns
Total Negative Slack (TNS): 0.000 ns	Total Hold Slack (THS): 0.000 ns	Total Pulse Width Negative Slack (TPWS): 0.000 ns
Number of Failing Endpoints: 0	Number of Failing Endpoints: 0	Number of Failing Endpoints: 0
Total Number of Endpoints: 90	Total Number of Endpoints: 90	Total Number of Endpoints: 45
All user specified timing constraints are met.		



- sequential Encoding

Name	Slice LUTs (20800)	Slice Registers (41600)	Slice (8150)	LUT as Logic (20800)	LUT Flip Flop Pairs (20800)	Block RAM Tile (50)	Bonded IOB (106)	BUFGCTRL (32)
spi_slave_with_spr	44	43	16	44	23	0.5	5	1
spi_slave_m (spi_slave)	41	26	14	41	22	0	0	0
spr_m (spr)	3	17	6	3	0	0.5	0	0

Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 5.465 ns	Worst Hold Slack (WHS): 0.046 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: 89	Total Number of Endpoints: 89	Total Number of Endpoints: 43
All user specified timing constraints are met.		



■ The best Encoding for this design is the Gray Encoding

➔ Debug

Name	1	Slice LUTs (20800)	Slice Registers (41600)	F7 Muxes (16300)	Slice (8150)	LUT as Logic (20800)	LUT as Memory (9600)	LUT Flip Flop Pairs (20800)	Block RAM Tile (50)	Bonded IOB (106)	BUFGCTRL (32)	BSCANE2 (4)
▼ spi_slave_with_spr		1282	1959	10	629	1174	108	755	1	5	2	1
> > dbg_hub (dbg_hub)		475	727	0	237	451	24	312	0	0	1	1
spi_slave_m (spi_slave)		40	26	0	13	40	0	20	0	0	0	0
spr_m (spr)		3	17	0	6	3	0	0	0.5	0	0	0
> u_ila_0 (u_ila_0)		764	1189	10	383	680	84	421	0.5	0	0	0

Design Timing Summary

Setup

Worst Negative Slack (WNS): 2.716 ns

Total Negative Slack (TNS): 0.000 ns

Number of Failing Endpoints: 0

Total Number of Endpoints: 3874

Hold

Worst Hold Slack (WHS): 0.048 ns

Total Hold Slack (THS): 0.000 ns

Number of Failing Endpoints: 0

Total Number of Endpoints: 3858

Pulse Width

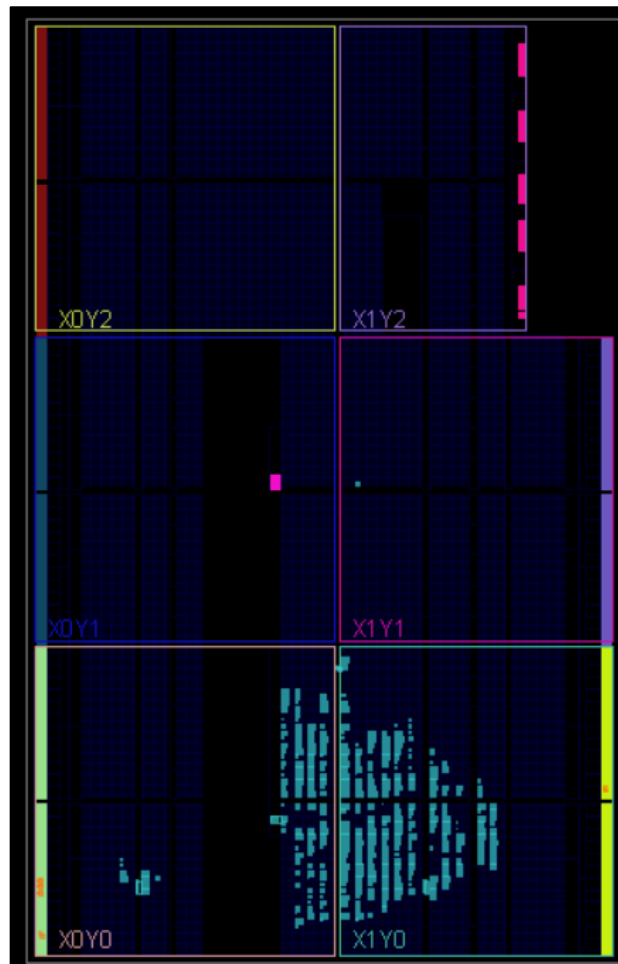
Worst Pulse Width Slack (WPWS): 3.750 ns

Total Pulse Width Negative Slack (TPWS): 0.000 ns

Number of Failing Endpoints: 0

Total Number of Endpoints: 2143

All user specified timing constraints are met.



→ Messages tab

