

# SPI Slave with Single Port RAM

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Team Name:

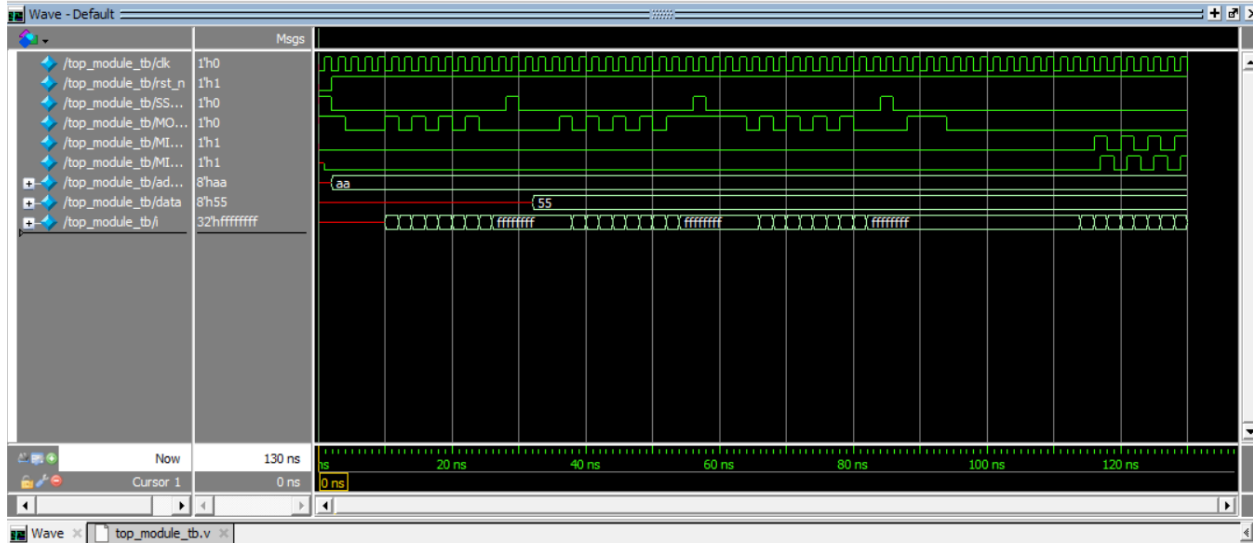
Place & Route

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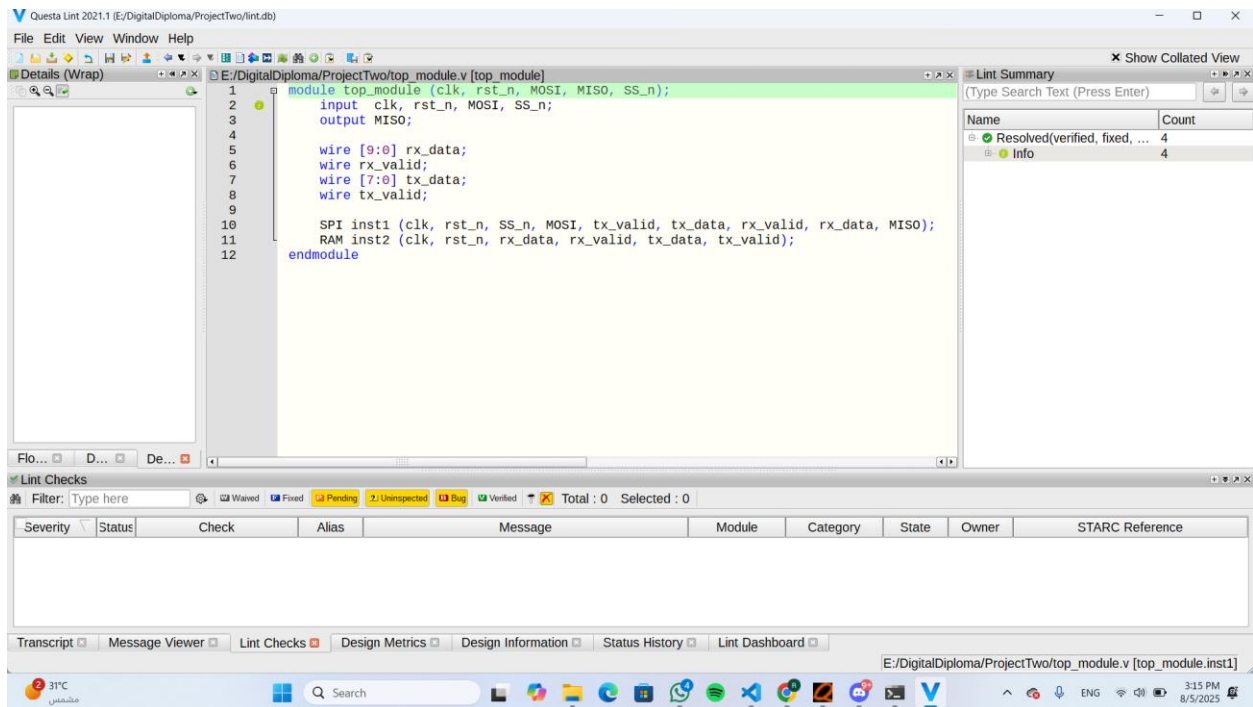
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# Waveform Snippets

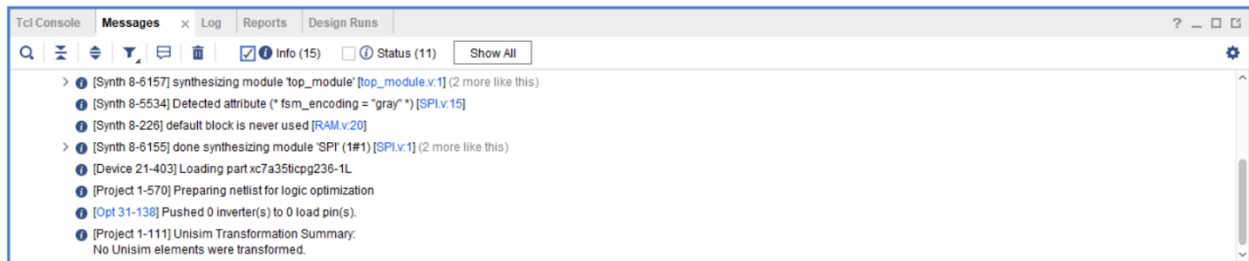


# Linting Snippets

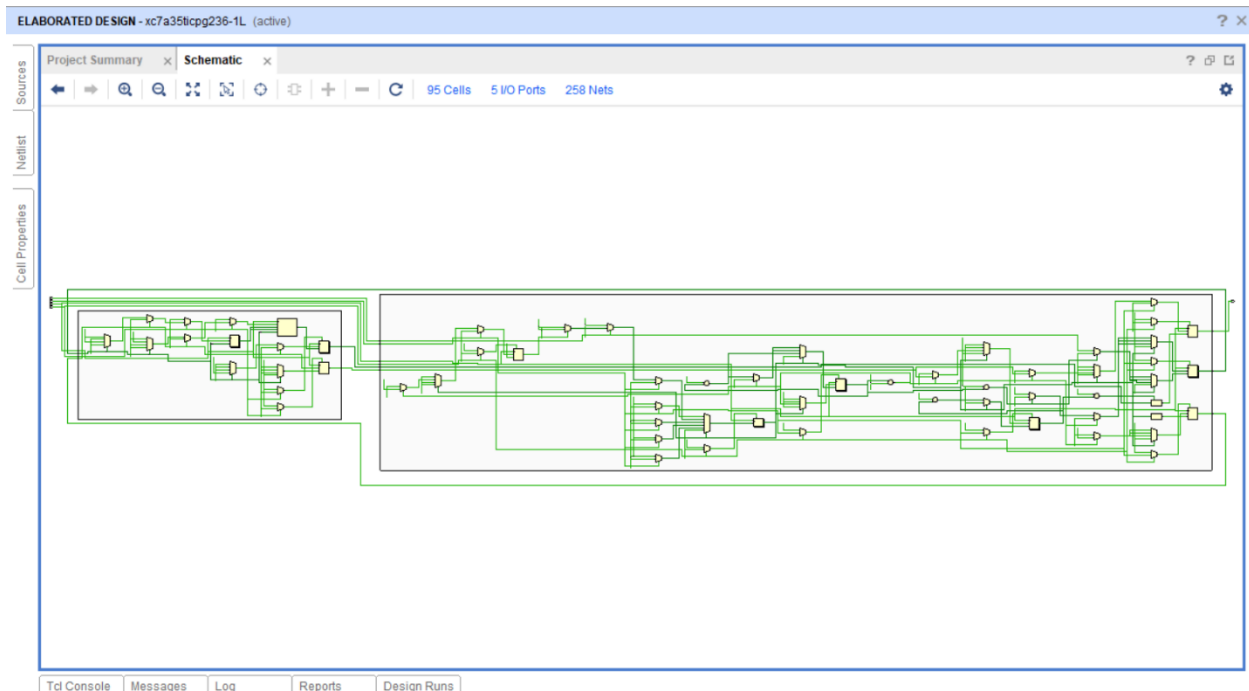


# Elaboration

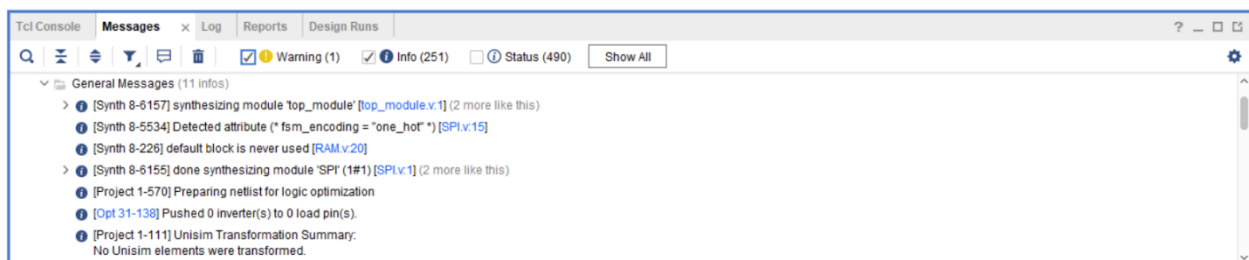
## Messages for Gray Encoding



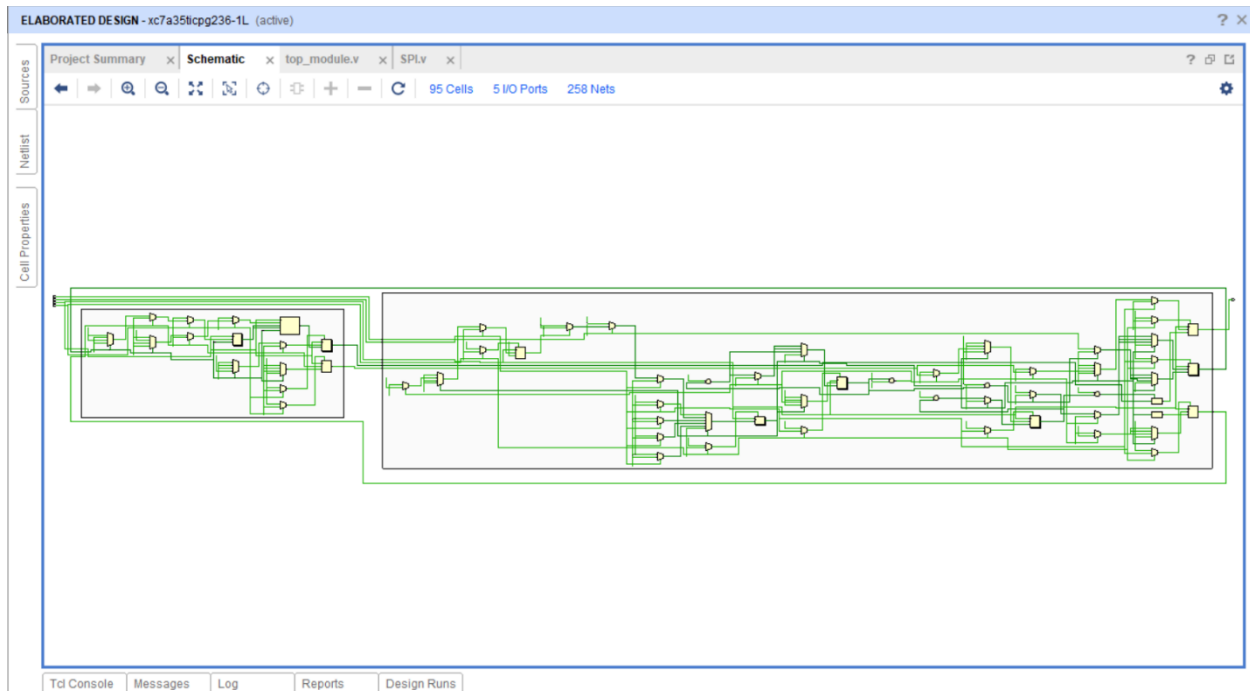
## Schematic for Gray Encoding



## Messages for One Hot Encoding



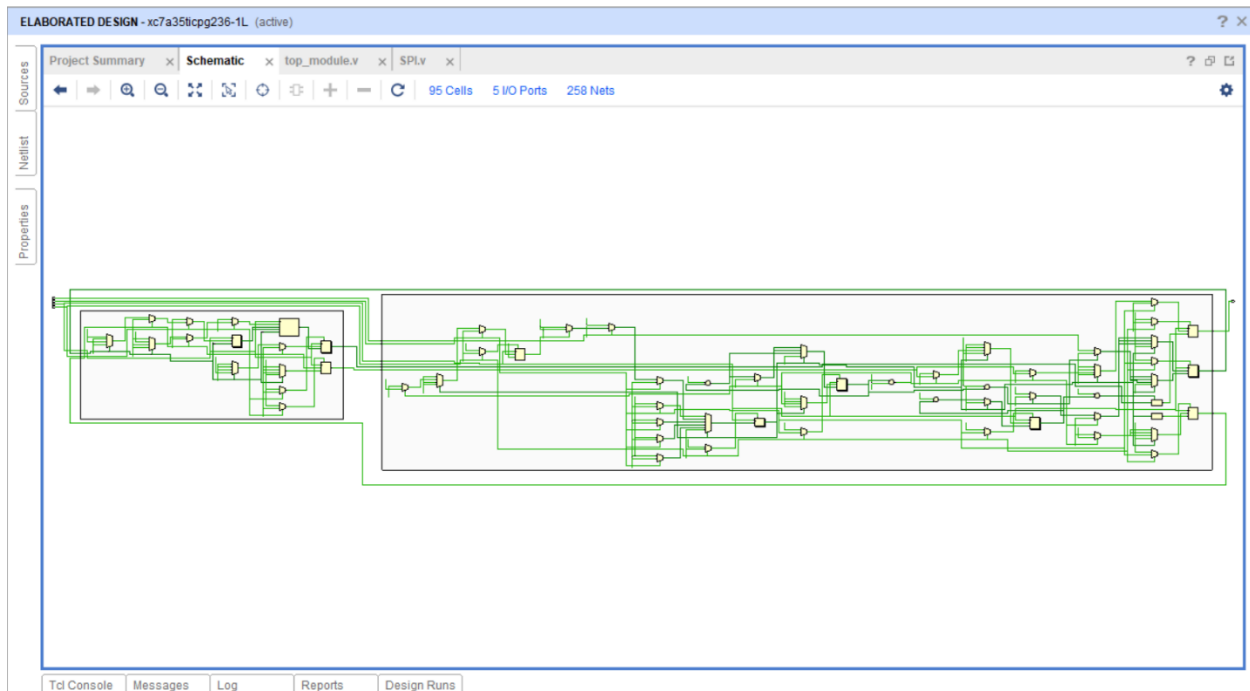
## Schematic for One Hot Encoding



## Messages for Sequential Encoding

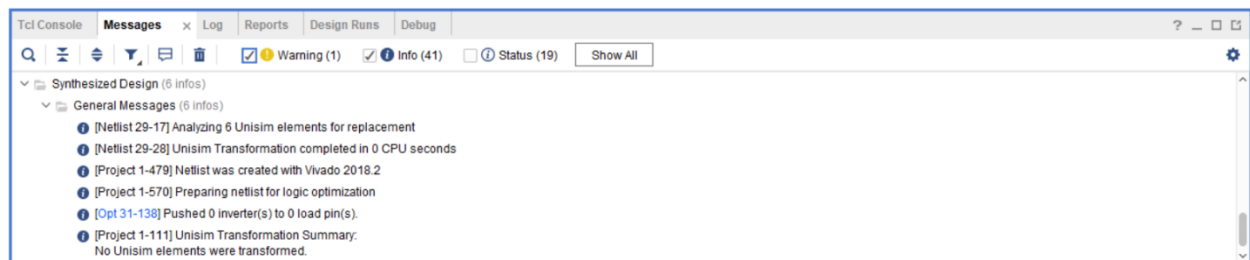


## Schematic for Sequential Encoding

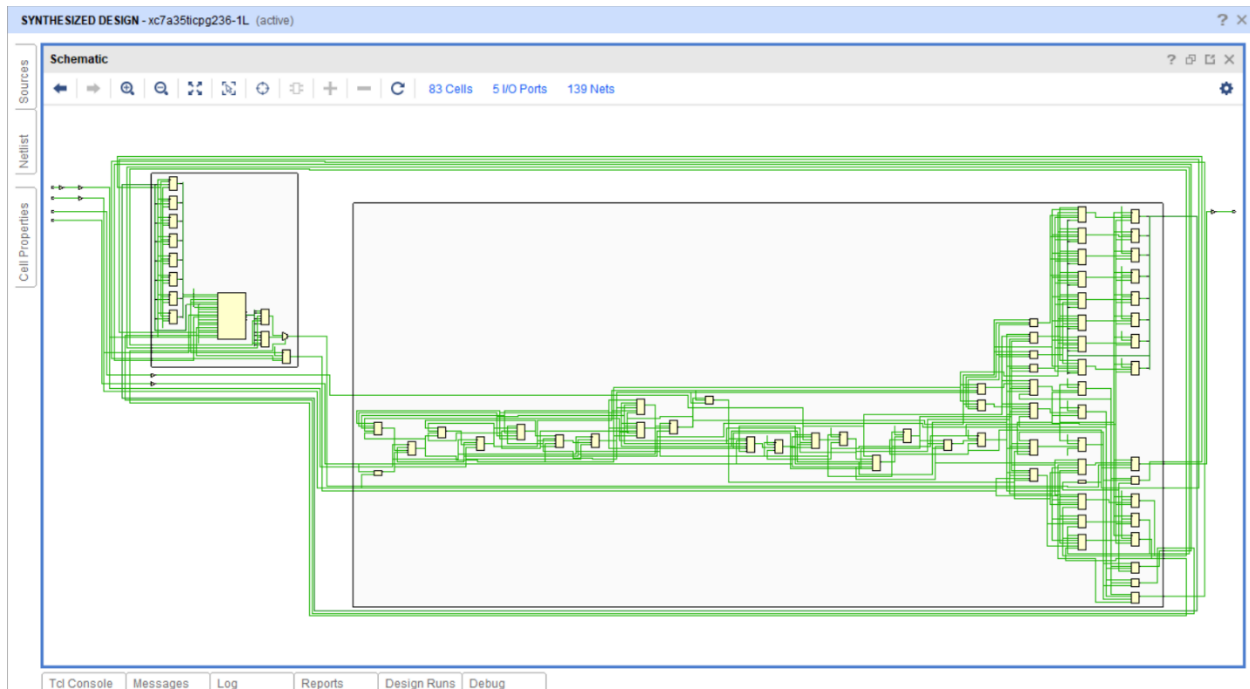


## Synthesis

### Messages for Gray Encoding



## Schematic for Gray Encoding



## Report Showing Gray Encoding

The image shows a screenshot of a synthesis report window titled "synth\_1\_synth\_synthesis\_report\_0 - synth\_1". The report is displayed in a window titled "Schematic" and contains the following information:

E:/DigitalDiploma/ProjectTwo/ProjectTwo/ProjectTwo.runs/synth\_1/top\_module.vds

91 INFO: [Synth 8-5544] ROM "ns" won't be mapped to Block RAM because address size (1) smaller than threshold (5)  
92 INFO: [Synth 8-5544] ROM "ns" won't be mapped to Block RAM because address size (1) smaller than threshold (5)  
93

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

101

102 INFO: [Synth 8-3354] encoded FSM with state register 'cs\_reg' using encoding 'gray' in module 'SPI'

103

104 Finished RTL Optimization Phase 2 : Time (s): cpu = 00:00:18 ; elapsed = 00:00:22 . Memory (MB): peak = 758.441 ; gain

105

106

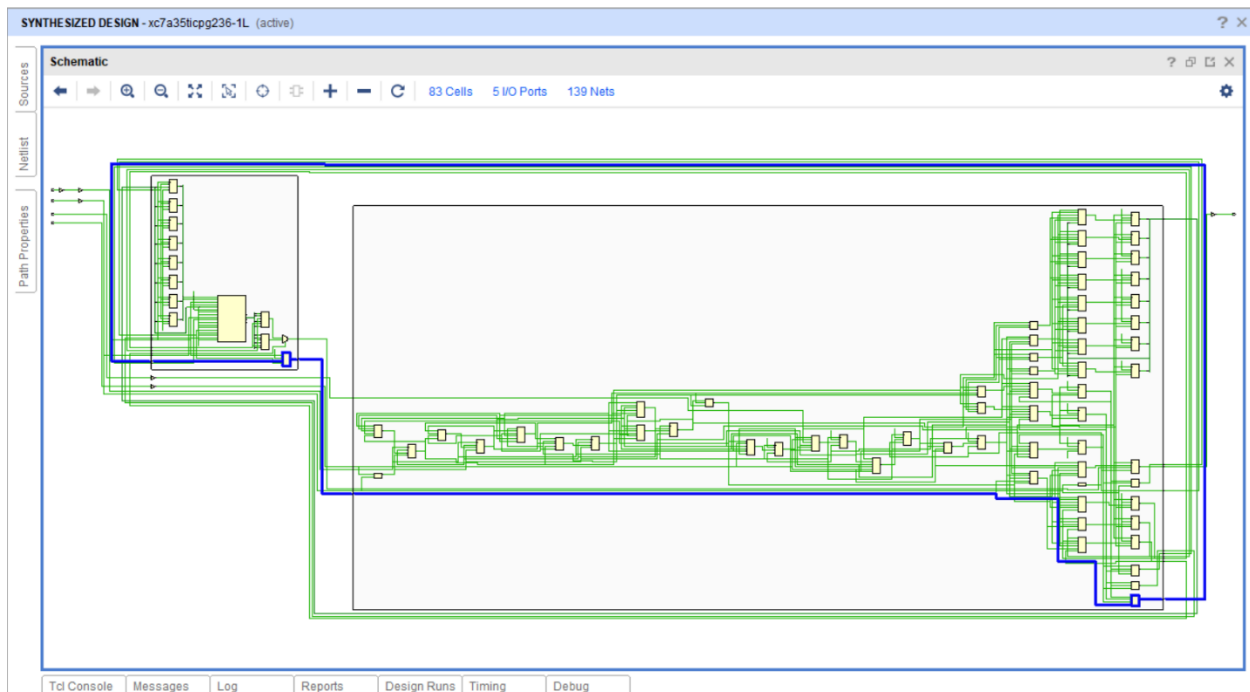


## Timing Report for Gray Encoding

Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 6.261 ns	Worst Hold Slack (WHS): 0.147 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: 72	Total Number of Endpoints: 72	Total Number of Endpoints: 35

All user specified timing constraints are met.

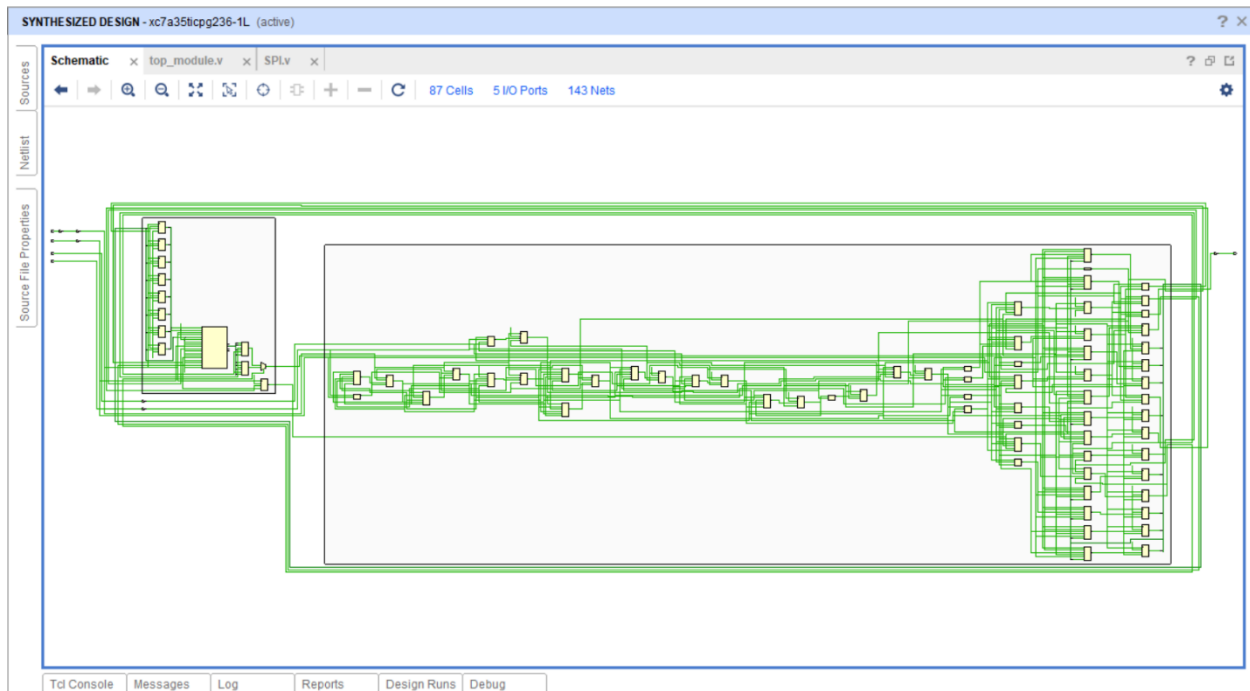
## Critical Path for Gray Encoding



## Messages for One Hot Encoding

Message
[Netlist 29-17] Analyzing 6 Unisim elements for replacement
[Netlist 29-28] Unisim Transformation completed in 0 CPU seconds
[Project 1-479] Netlist was created with Vivado 2018.2
[Project 1-570] Preparing netlist for logic optimization
[Opt 31-138] Pushed 0 inverter(s) to 0 load pin(s).
[Project 1-111] Unisim Transformation Summary: No Unisim elements were transformed.

## Schematic for One Hot Encoding

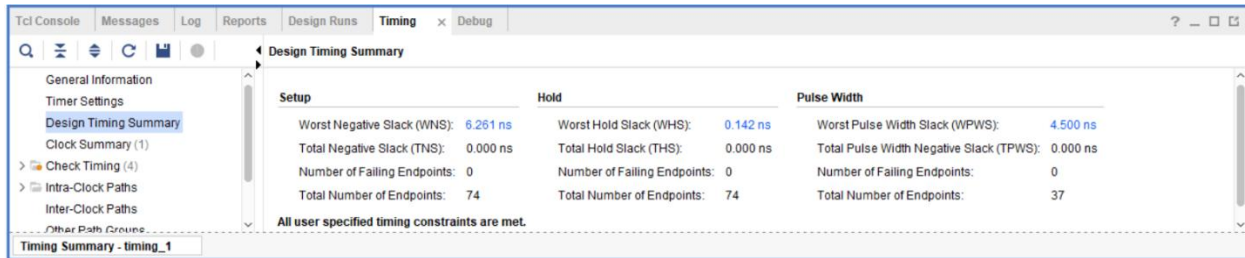


## Report Showing One Hot Encoding

```
Schematic x top_module.v x SPLv x synth_1_synth_synthesis_report_0 - synth_1 x
E:\DigitalDiploma\ProjectTwo\ProjectTwo\ProjectTwo.runs\synth_1\top_module.vds
Read-only

91 INFO: [Synth 8-5544] ROM "ns" won't be mapped to Block RAM because address size (1) smaller than threshold (5)
92 INFO: [Synth 8-5544] ROM "ns" won't be mapped to Block RAM because address size (1) smaller than threshold (5)
93
94 -----
95 State | New Encoding | Previous Encoding
96 -----
97 IDLE | 00001 | 000
98 CHK_CMD | 00010 | 001
99 WRITE | 00100 | 010
100 READ_ADD | 01000 | 011
101 READ_DATA | 10000 | 100
102 -----
103 INFO: [Synth 8-3354] encoded FSM with state register 'cs_reg' using encoding 'one-hot' in module 'SPI'
104
105 Finished RTL Optimization Phase 2 : Time (s): cpu = 00:00:17 ; elapsed = 00:00:20 . Memory (MB): peak = 759.332 ; gain
106
```

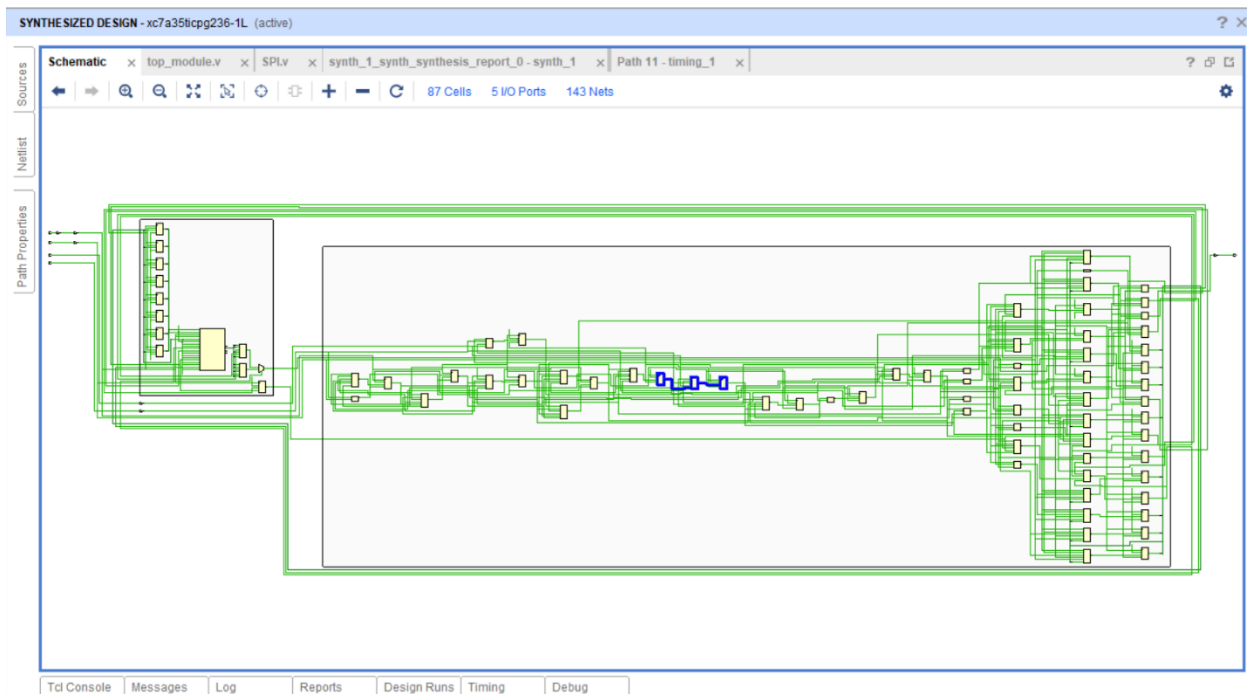
## Timing Report for One Hot Encoding



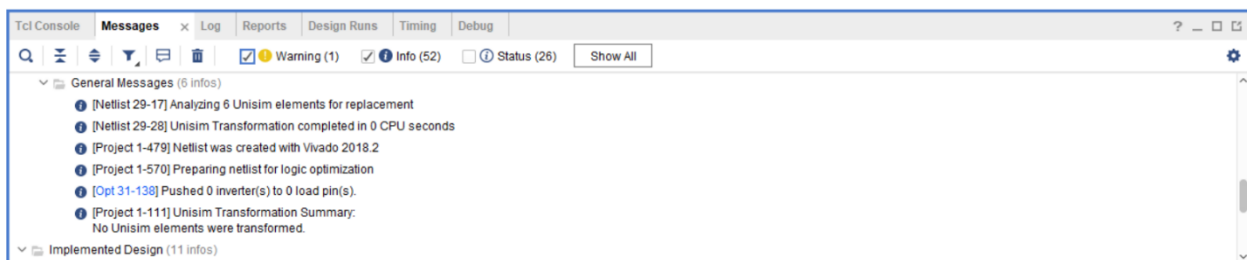
Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 6.261 ns	Worst Hold Slack (WHS): 0.142 ns	Worst Pulse Width Slack (WPWS): 4.500 ns
Total Negative Slack (TNS): 0.000 ns	Total Hold Slack (THS): 0.000 ns	Total Pulse Width Negative Slack (TPWS): 0.000 ns
Number of Failing Endpoints: 0	Number of Failing Endpoints: 0	Number of Failing Endpoints: 0
Total Number of Endpoints: 74	Total Number of Endpoints: 74	Total Number of Endpoints: 37

All user specified timing constraints are met.

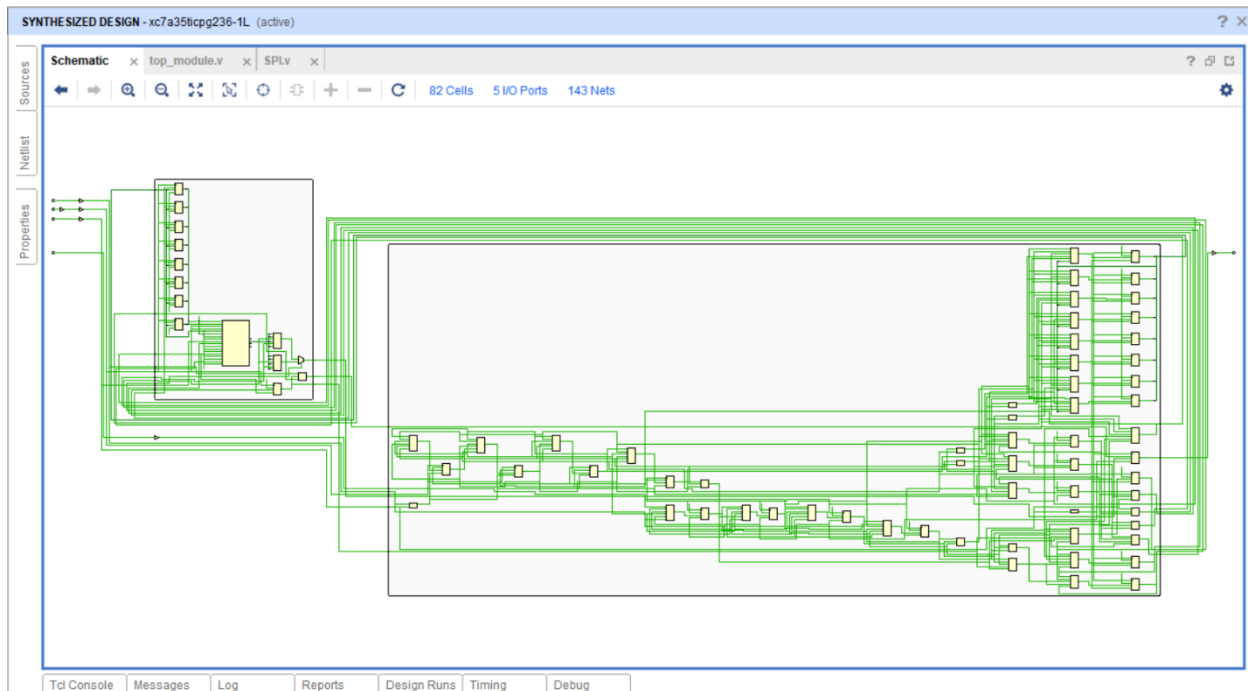
## Critical Path for One Hot Encoding



## Messages for Sequential Encoding



## Schematic for Sequential Encoding



## Report Showing Sequential Encoding

The image shows a screenshot of a synthesis report window titled "synth\_1\_synth\_synthesis\_report\_0 - synth\_1". The report displays information about the synthesis of a sequential circuit, including state encoding details. The report is in a "Read-only" mode.

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

INFO: [Synth 8-3354] encoded FSM with state register 'cs\_reg' using encoding 'sequential' in module 'SPI'

## Timing Report for Sequential Encoding



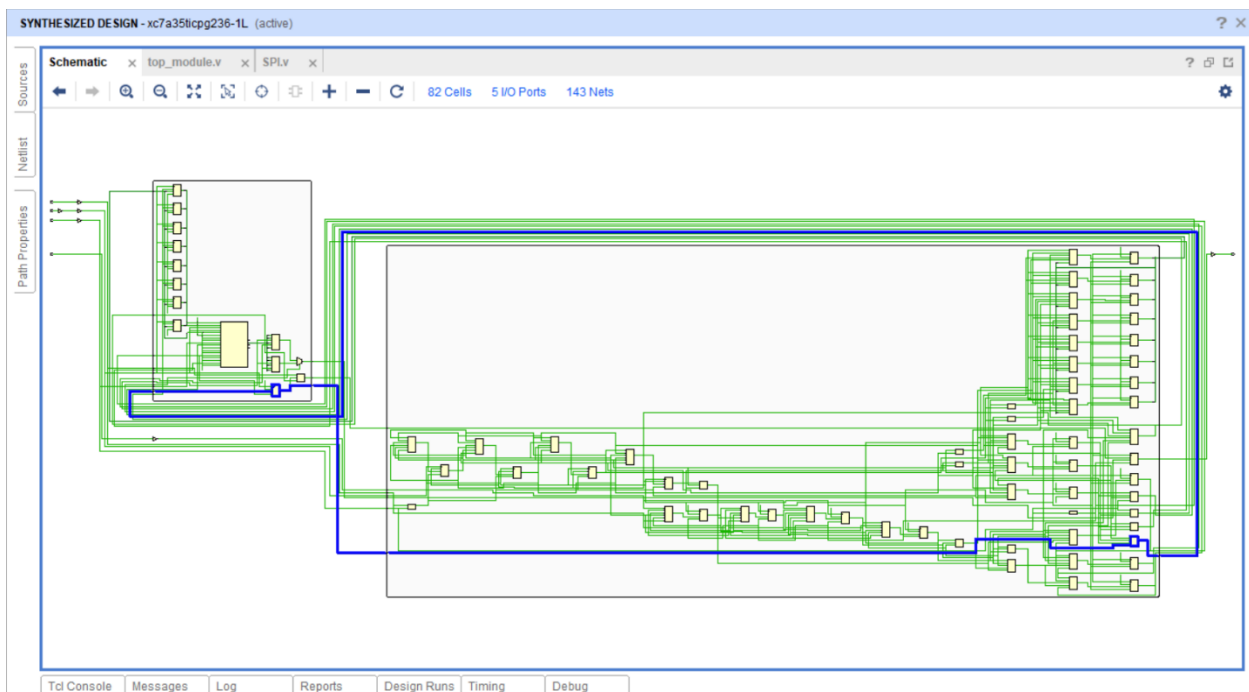
The image shows a screenshot of the 'Design Timing Summary' window in a CAD tool. The window has a sidebar on the left with a tree view containing 'General Information', 'Timer Settings', 'Design Timing Summary' (selected), 'Clock Summary (1)', 'Check Timing (4)', 'Intra-Clock Paths', 'Inter-Clock Paths', and 'Other Path Groups'. The main area displays a table with three columns: 'Setup', 'Hold', and 'Pulse Width'. Each column contains three rows of data: 'Worst Negative Slack (WNS)', 'Total Negative Slack (TNS)', and 'Number of Failing Endpoints'. Below the table, it states 'All user specified timing constraints are met.' The status bar at the bottom indicates 'Timing Summary - timing\_1'.

Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 6.261 ns	Worst Hold Slack (WHS): 0.147 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: 72	Total Number of Endpoints: 72	Total Number of Endpoints: 35

All user specified timing constraints are met.

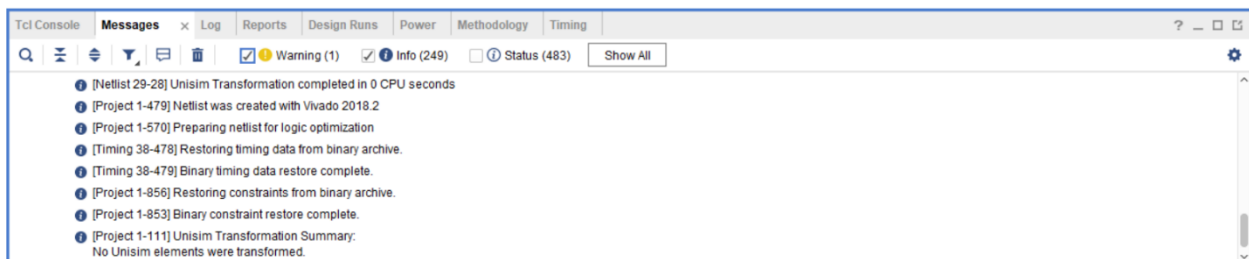
Timing Summary - timing\_1

## Critical Path for Sequential Encoding



## Implementation

## Messages for Gray Encoding



The image shows a screenshot of the 'Messages' window in a CAD tool. The window has a sidebar on the left with a tree view containing 'Tcl Console', 'Messages' (selected), 'Log', 'Reports', 'Design Runs', 'Power', 'Methodology', and 'Timing'. The main area displays a list of messages. The messages are as follows:

- [Netlist 29-28] Unisim Transformation completed in 0 CPU seconds
- [Project 1-479] Netlist was created with Vivado 2018.2
- [Project 1-570] Preparing netlist for logic optimization
- [Timing 38-478] Restoring timing data from binary archive.
- [Timing 38-479] Binary timing data restore complete.
- [Project 1-856] Restoring constraints from binary archive.
- [Project 1-853] Binary constraint restore complete.
- [Project 1-111] Unisim Transformation Summary:  
No Unisim elements were transformed.

# Utilization Report for Gray Encoding

Tcl Console Messages Log Reports Design Runs Power Methodology Timing **Utilization** x ? - □

Hierarchy

Name	1	Slice LUTs (20800)	Slice Registers (41600)	F7 Muxes (16300)	Slice (815 0)	LUT as Logic (20800)	LUT Flip Flop Pairs (20800)	Block RAM Tile (50)	Bonded IOB (106)	BUFGCTRL (32)
▼ <b>top_module</b>		38	32	1	12	38	21	0.5	5	1
inst1 (SPI)		35	23	0	11	35	20	0	0	0
inst2 (RAM)		3	9	1	3	3	0	0.5	0	0

utilization\_1

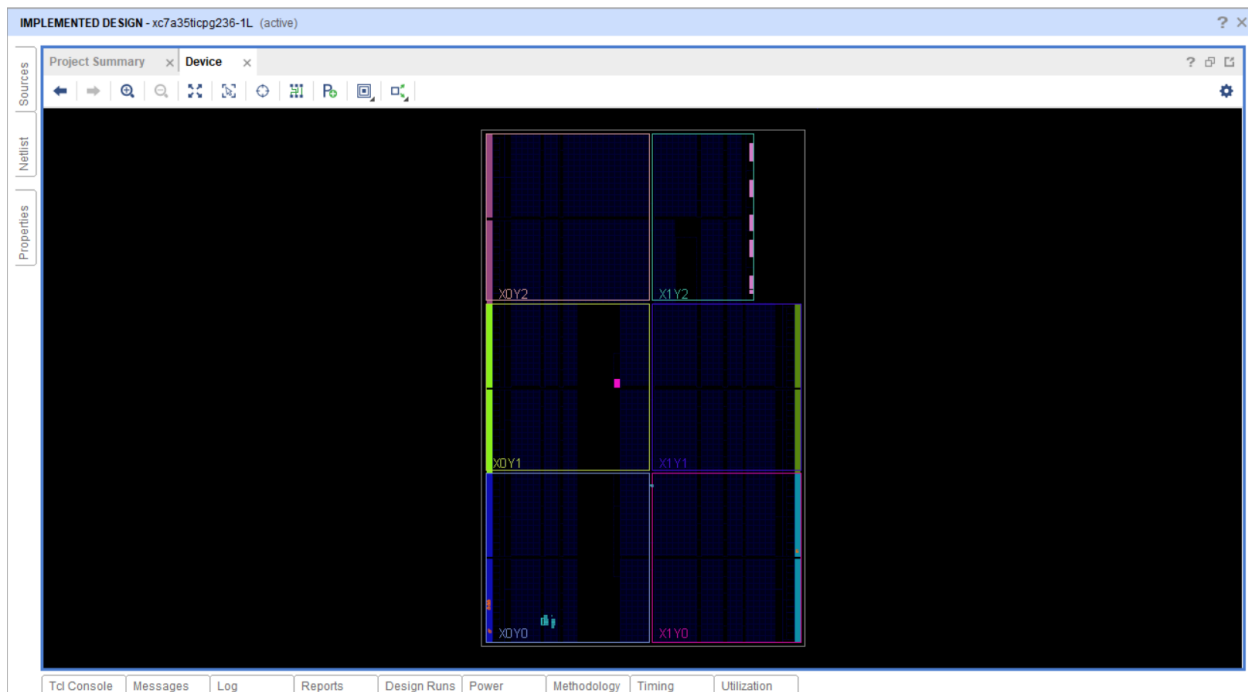
## Timing Report for Gray Encoding

The screenshot shows the 'Design Timing Summary' window. The left sidebar contains a tree view with 'Design Timing Summary' selected. The main area displays a table with three columns: Setup, Hold, and Pulse Width. The table contains the following data:

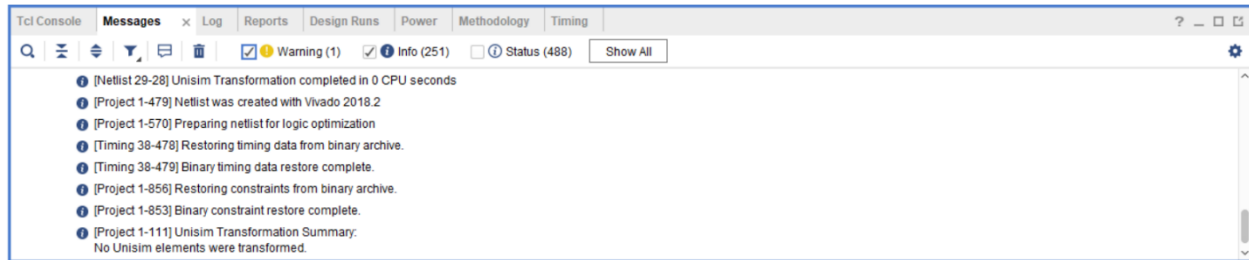
Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 6.037 ns	Worst Hold Slack (WHS): 0.110 ns	Worst Pulse Width Slack (WPWS): 4.500 ns
Total Negative Slack (TNS): 0.000 ns	Total Hold Slack (THS): 0.000 ns	Total Pulse Width Negative Slack (TPWS): 0.000 ns
Number of Failing Endpoints: 0	Number of Failing Endpoints: 0	Number of Failing Endpoints: 0
Total Number of Endpoints: 73	Total Number of Endpoints: 73	Total Number of Endpoints: 35

At the bottom of the window, a status bar indicates: 'All user specified timing constraints are met.'

## Device Snippet for Gray Encoding



## Messages for One Hot Encoding



## Utilization Report for One Hot Encoding

The Utilization Report window displays a hierarchy of resource utilization for One Hot Encoding. The report shows the following utilization data:

Name	Slice LUTs (20800)	Slice Registers (41600)	F7 Muxes (16300)	Slice (815 0)	LUT as Logic (20800)	LUT Flip Flop Pairs (20800)	Block RAM Tile (50)	Bonded IOB (106)	BUFGCTRL (32)
top_module	40	34	1	13	40	25	0.5	5	1
inst1 (SPI)	37	25	0	12	37	24	0	0	0
inst2 (RAM)	3	9	1	5	3	0	0.5	0	0

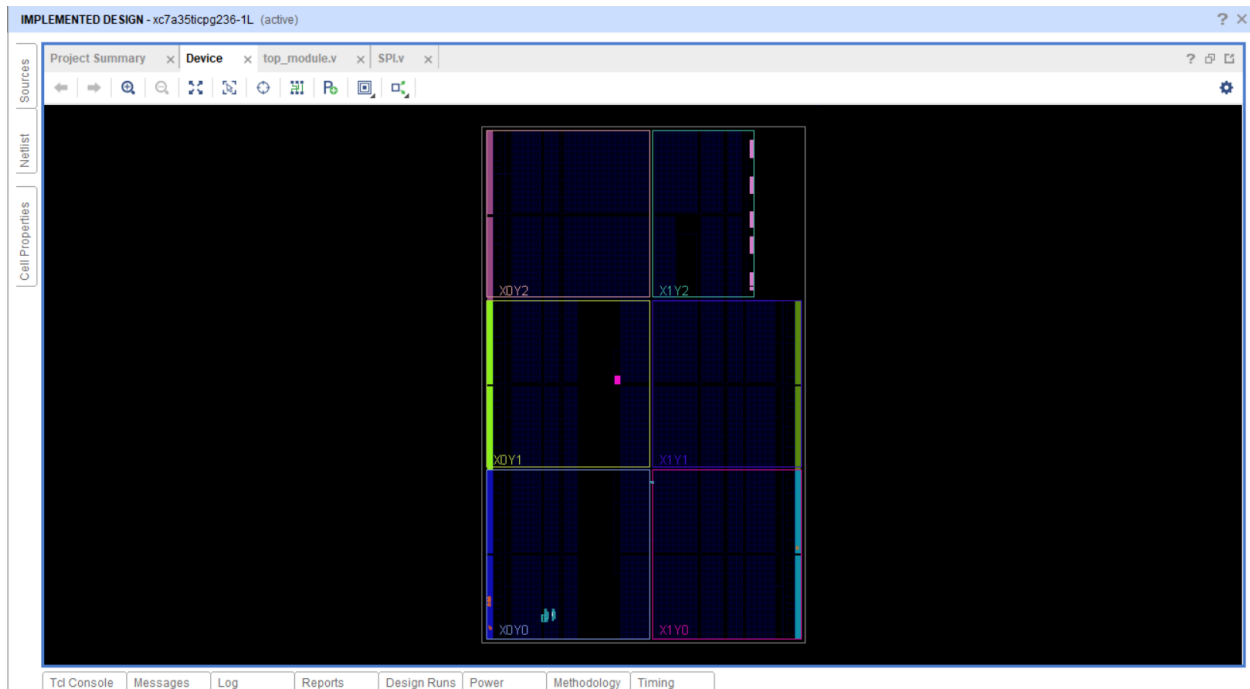
## Timing Report for One Hot Encoding

The Timing Report window displays the Design Timing Summary for One Hot Encoding. The summary shows the following timing metrics:

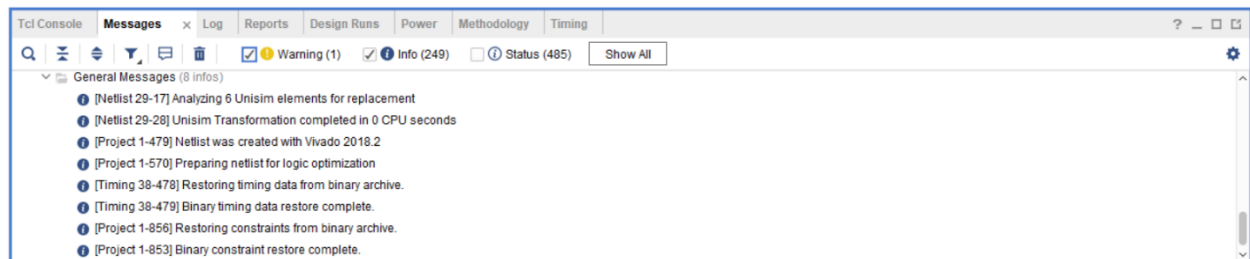
Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 6.015 ns	Worst Hold Slack (WHS): 0.105 ns	Worst Pulse Width Slack (WPWS): 4.500 ns
Total Negative Slack (TNS): 0.000 ns	Total Hold Slack (THS): 0.000 ns	Total Pulse Width Negative Slack (TPWS): 0.000 ns
Number of Failing Endpoints: 0	Number of Failing Endpoints: 0	Number of Failing Endpoints: 0
Total Number of Endpoints: 75	Total Number of Endpoints: 75	Total Number of Endpoints: 37

All user specified timing constraints are met.

## Device Snippet for One Hot Encoding



## Messages for Sequential Encoding



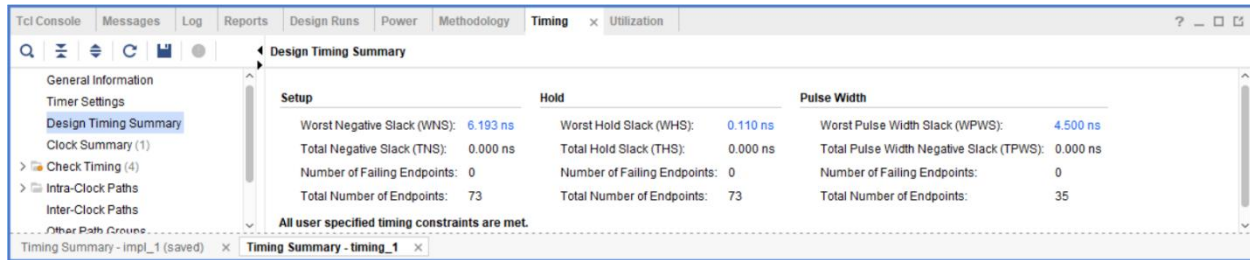
## Utilization Report for Sequential Encoding

The screenshot shows the Vivado IDE with the 'Utilization' window active. The window displays a table of utilization data for Sequential Encoding.

Name	Slice LUTs (20800)	Slice Registers (41600)	F7 Muxes (16300)	Slice (815 0)	LUT as Logic (20800)	LUT Flip Flop Pairs (20800)	Block RAM Tile (50)	Bonded IOB (106)	BUFGCTRL (32)
top_module	37	32	1	12	37	23	0.5	5	1
inst1 (SPI)	33	23	0	10	33	22	0	0	0
inst2 (RAM)	4	9	1	5	4	0	0.5	0	0



## Timing Report for Sequential Encoding

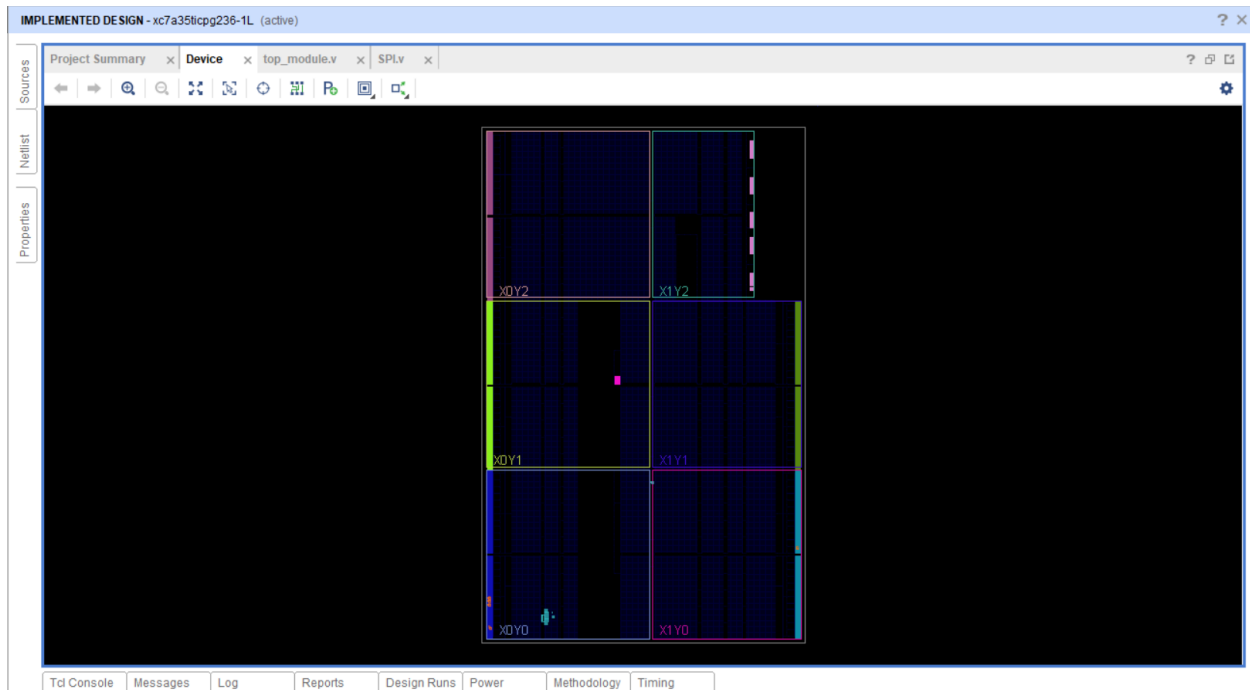


The screenshot shows the 'Design Timing Summary' window. The left sidebar contains a tree view with 'Design Timing Summary' selected. The main area displays a table with three columns: Setup, Hold, and Pulse Width. Each column contains three rows of data: Worst Negative Slack (WNS), Total Negative Slack (TNS), and Number of Failing Endpoints. A status bar at the bottom indicates 'All user specified timing constraints are met.'

Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 6.193 ns	Worst Hold Slack (WHS): 0.110 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: 73	Total Number of Endpoints: 73	Total Number of Endpoints: 35

All user specified timing constraints are met.

## Device Snippet for Sequential Encoding



# Successful Bitstream Generation (for Gray Encoding)

