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# Project 2

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**Eng/ Kareem Waseem**

**By:**

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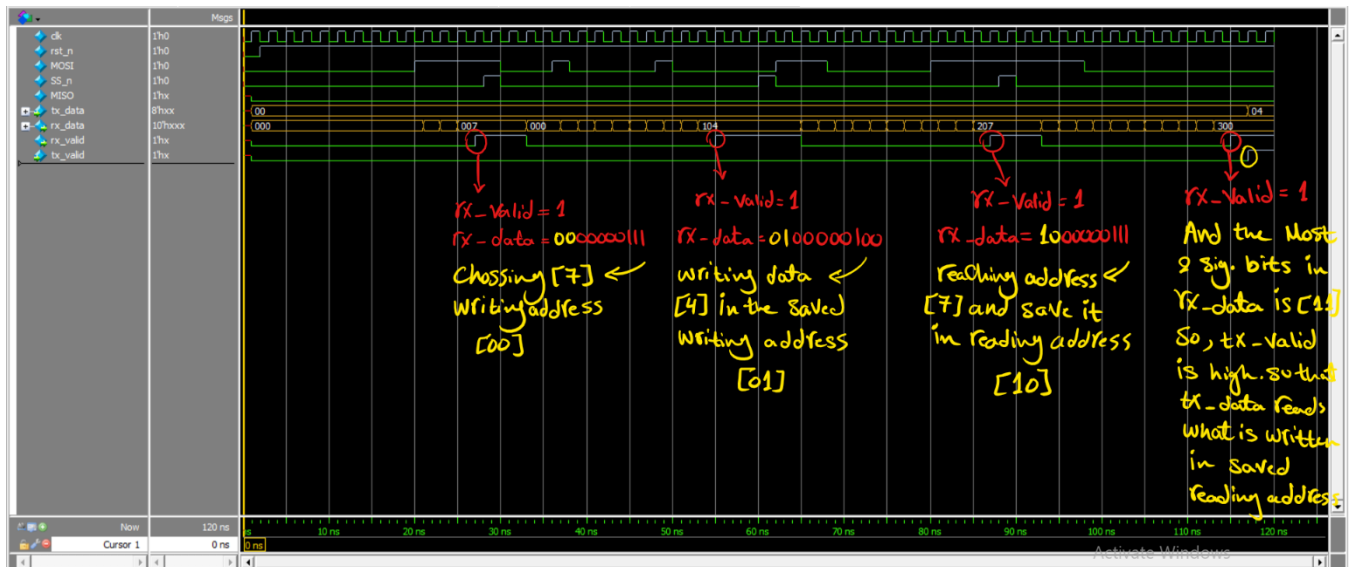
Naira Ahmed Ali

**“Team : ON”**

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# 1-QuestaSim Snippets



# 2-QuestaLint Snippets

Questa Lint 2021.1.1 (L2/Kareem\_Waseem/Project\_2/Q\_lint/lint.db)

File Edit View Lint Checks Window Help

Design D:/Engineering/ASU/3\_Summer2/Kareem\_Waseem/Project\_2/Q\_lint/SPI\_Wrapper.v [SPI\_Wrapper]

Search: Type Search...

Instance Module

SPI\_Wrapper ... SPI\_Wrap

```
1 module SPI_Wrapper(MOSI, SS_n, clk, rst_n, MISO);
2
3   input MOSI, SS_n, clk, rst_n;
4   output MISO;
5
6   wire rx_valid_w, tx_valid_w;
7   wire [7:0] dout_w;
8   wire [9:0] rx_data_w;
9
10  sync_RAM Ram (.clk(clk), .rst_n(rst_n), .din(rx_data_w), .rx_valid(rx_valid_w), .dout(dout_w));
11  sync_SPI SPI (.clk(clk), .rst_n(rst_n), .MOSI(MOSI), .MISO(MISO), .SS_n(SS_n), .rx_data(rx_data_w));
12
13 endmodule
```

Lint Summary

(Type Search Text (Press Enter))

Name	Count
Open/uninspected, pending...	10 (11)
Warning	5
Info	5 (6)

Flow Navigator Design

Lint Checks

Filter: Type here

Waived Fixed Pending 2/ Uninspected Bug Verified Total: 10 Selected: 0

Severity	Status	Check	Alias	Message	Module	Category	State	Owner	STARC Reference
Warning	2	seq_block_has_duplicate...		Signal is assigned more than once in a sequential bloc...	sync_SPI	Rtl Design Style	open	unassign...	2.2.3.3
Warning	2	seq_block_has_duplicate...		Signal is assigned more than once in a sequential bloc...	sync_SPI	Rtl Design Style	open	unassign...	2.2.3.3
Warning	2	seq_block_has_duplicate...		Signal is assigned more than once in a sequential bloc...	sync_SPI	Rtl Design Style	open	unassign...	2.2.3.3
Warning	2	seq_block_has_duplicate...		Signal is assigned more than once in a sequential bloc...	sync_SPI	Rtl Design Style	open	unassign...	2.2.3.3
Warning	2	seq_block_has_duplicate...		Signal is assigned more than once in a sequential bloc...	sync_SPI	Rtl Design Style	open	unassign...	2.2.3.3
Warning	2	always_signal_assign_large		Always block has more signal assignments than the s...	sync_SPI	Rtl Design Style	open	unassign...	2.6.1.3

Transcript Message Viewer Lint Checks Design Metrics Design Information Status History Lint Dashboard

...r.v [SPI\_Wrapper]

## 3-Choosing the best encoding

### 3.1 – gray encoding

```
95 -----
96 State | New Encoding | Previous Encoding
97 -----
98 IDLE | 000 | 000
99 CHK_CMD | 001 | 001
100 WRITE | 011 | 011
101 READ_DATA | 010 | 100
102 READ_ADD | 111 | 010
103 -----
104 INFO: [Synth 8-3354] encoded FSM with state register 'cs_reg' using encoding 'gray' in module 'sync_SPI'
```

The screenshot shows the 'Design Timing Summary' window for the 'gray' encoding. The 'Setup' column shows a Worst Negative Slack (WNS) of 6.267 ns, Total Negative Slack (TNS) of 0.000 ns, and 0 failing endpoints. The 'Hold' column shows a Worst Hold Slack (WHS) of 0.058 ns, Total Hold Slack (THS) of 0.000 ns, and 0 failing endpoints. The 'Pulse Width' column shows a Worst Pulse Width Slack (WPWS) of 4.500 ns, Total Pulse Width Negative Slack (TPWS) of 0.000 ns, and 0 failing endpoints. The total number of endpoints is 119. A message at the bottom states 'All user specified timing constraints are met.'

Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 6.267 ns	Worst Hold Slack (WHS): 0.058 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: 119	Total Number of Endpoints: 119	Total Number of Endpoints: 48

### 3.2 -one\_hot

```
95 -----
96 State | New Encoding | Previous Encoding
97 -----
98 IDLE | 00001 | 000
99 CHK_CMD | 00010 | 001
100 WRITE | 00100 | 011
101 READ_DATA | 01000 | 100
102 READ_ADD | 10000 | 010
103 -----
104 INFO: [Synth 8-3354] encoded FSM with state register 'cs_reg' using encoding 'one-hot' in module 'sync_SPI'
```

The screenshot shows the 'Design Timing Summary' window for the 'one-hot' encoding. The 'Setup' column shows a Worst Negative Slack (WNS) of 5.715 ns, Total Negative Slack (TNS) of 0.000 ns, and 0 failing endpoints. The 'Hold' column shows a Worst Hold Slack (WHS) of 0.067 ns, Total Hold Slack (THS) of 0.000 ns, and 0 failing endpoints. The 'Pulse Width' column shows a Worst Pulse Width Slack (WPWS) of 4.500 ns, Total Pulse Width Negative Slack (TPWS) of 0.000 ns, and 0 failing endpoints. The total number of endpoints is 119. A message at the bottom states 'All user specified timing constraints are met.'

Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 5.715 ns	Worst Hold Slack (WHS): 0.067 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: 119	Total Number of Endpoints: 119	Total Number of Endpoints: 50

### 3.3 -seq

```
99 -----
100 State | New Encoding | Previous Encoding
101 -----
102 IDLE | 000 | 000
103 CHK_CMD | 001 | 001
104 WRITE | 010 | 011
105 READ_DATA | 011 | 100
106 READ_ADD | 100 | 010
107 -----
108 INFO: [Synth 8-3354] encoded FSM with state register 'cs_reg' using encoding 'sequential' in module 'sync_SPI'
```

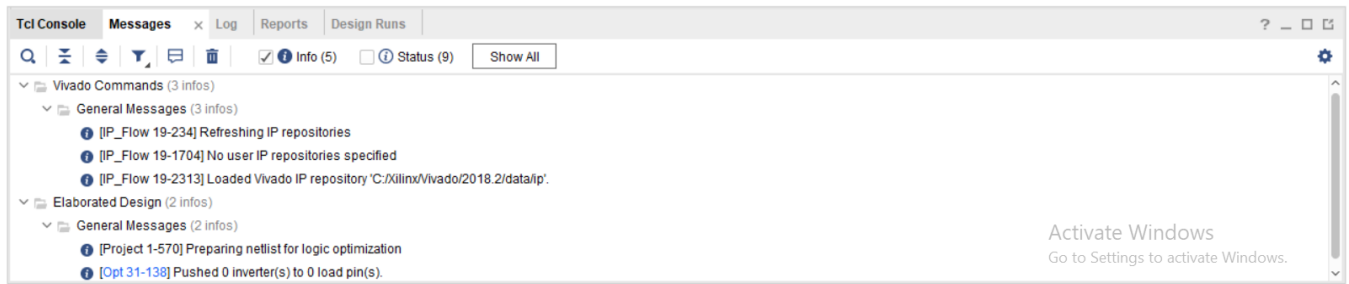
The screenshot shows the 'Design Timing Summary' window for the 'sequential' encoding. The 'Setup' column shows a Worst Negative Slack (WNS) of 5.901 ns, Total Negative Slack (TNS) of 0.000 ns, and 0 failing endpoints. The 'Hold' column shows a Worst Hold Slack (WHS) of 0.066 ns, Total Hold Slack (THS) of 0.000 ns, and 0 failing endpoints. The 'Pulse Width' column shows a Worst Pulse Width Slack (WPWS) of 4.500 ns, Total Pulse Width Negative Slack (TPWS) of 0.000 ns, and 0 failing endpoints. The total number of endpoints is 123. A message at the bottom states 'All user specified timing constraints are met.'

Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 5.901 ns	Worst Hold Slack (WHS): 0.066 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: 123	Total Number of Endpoints: 123	Total Number of Endpoints: 48

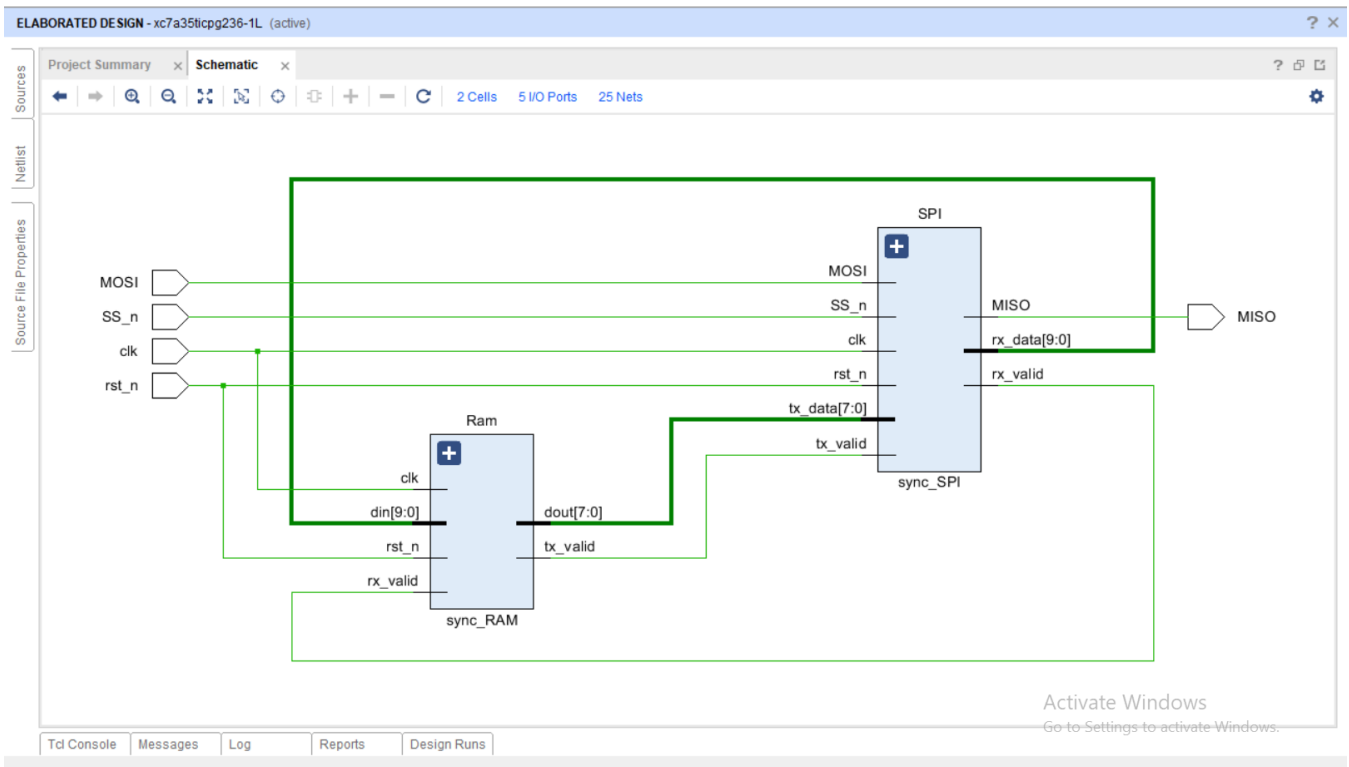
Gray encoding was selected as it provides the highest setup slack of 6.267 ns, which allows for the highest operating frequency.

## 4-Elaboration snippets after choosing the encoding

### 3.1 – Massage

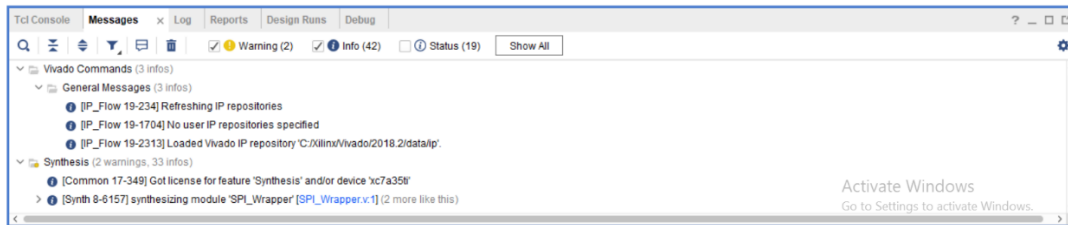


### 3.2 – Schematic

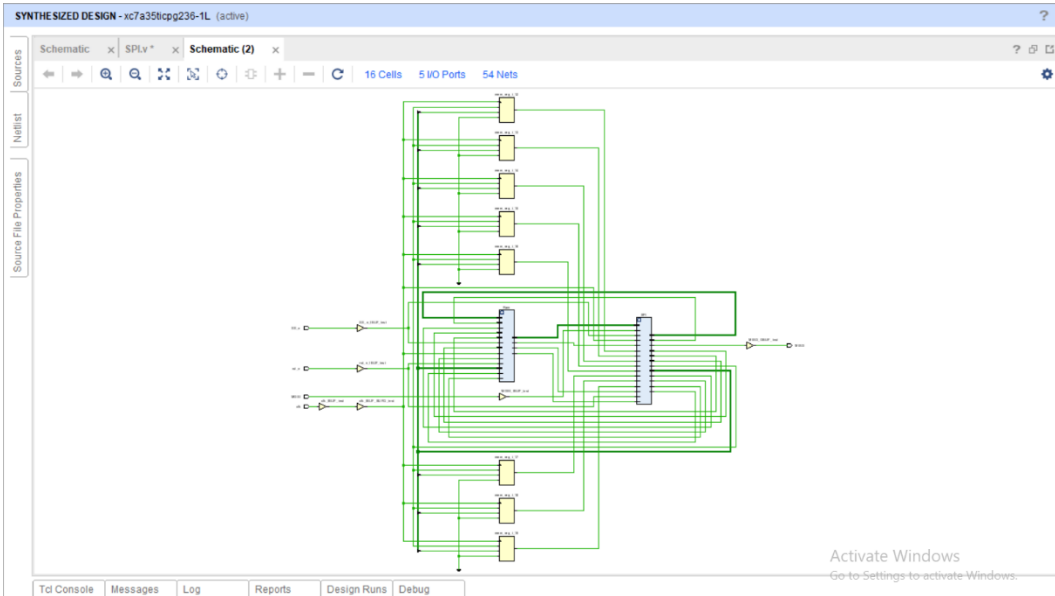


## 4- Synthesis snippets after choosing the encoding

### 3.1 – Massage



### 3.2 – Schematic



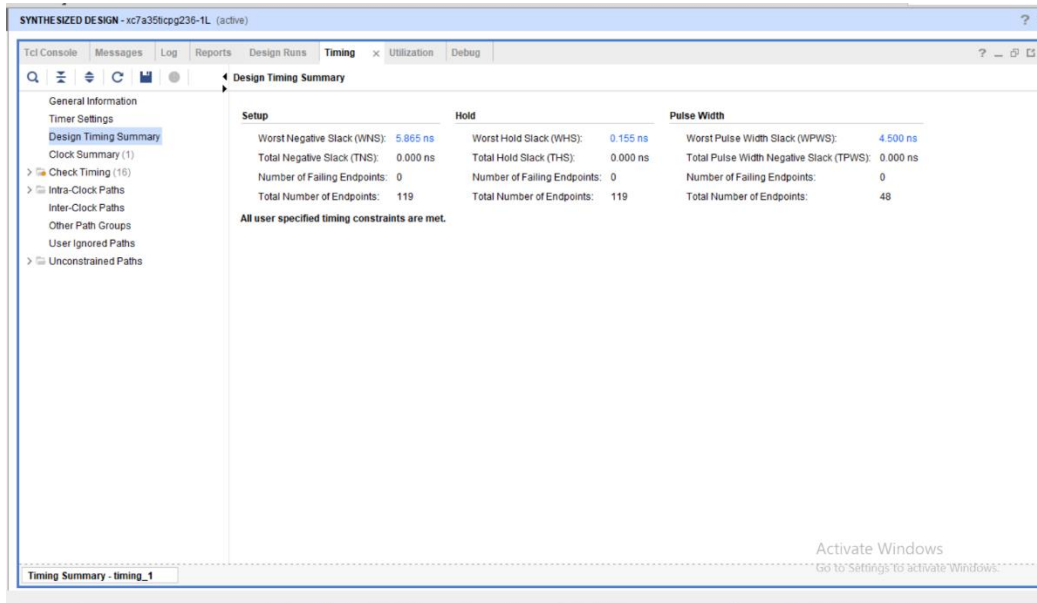
### 3.2 – Utilization

The screenshot shows the Vivado Utilization window for a synthesized design. The title bar indicates "SYNTHESIZED DESIGN - xc7a35fcp236-1L (active)". The window displays a table of resource usage. The table has the following columns: Name, Slice LUTs (20800), Slice Registers (41600), Block RAM Tile (50), Bonded IOB (106), and BUFGCTRL (32). The table is organized into a hierarchy, with the following sections:

- Hierarchy**
  - Summary**
  - Slice Logic**
    - Slice LUTs (<1%)
      - LUT as Logic (<1%)
        - Ram (sync\_RAM) 1 9 0.5 0 0
        - SPI (sync\_SPI) 54 31 0 0 0
    - Slice Registers (<1%)
      - Register as Latch (<1%)
      - Register as Flip Flop (<1)
  - Memory**
    - Block RAM Tile (1%)
      - RAMB18 (1%)
        - RAMB18E1 only
  - DSP**
  - IO and GT Specific**
    - Bonded IOB (5%)
      - IOB Master Pads
      - IOB Slave Pads
  - Clocking**
    - BUFGCTRL (3%)
    - Specific Feature
    - Primitives
    - Black Boxes
    - Instantiated Netlists

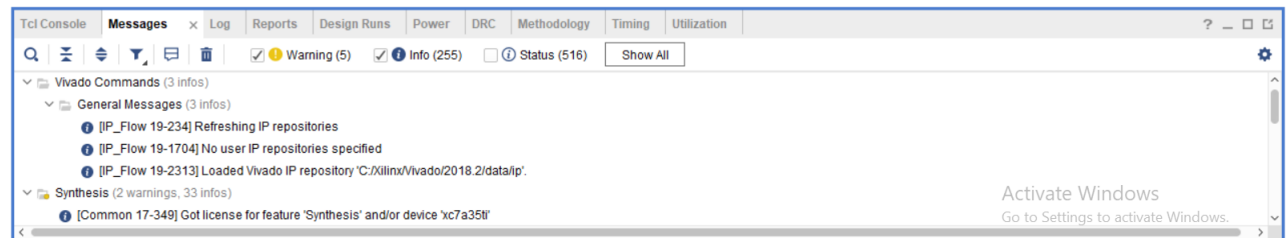
At the bottom right, there is a message: "Activate Windows. Go to Settings to activate Windows."

### 3.2 – Timming

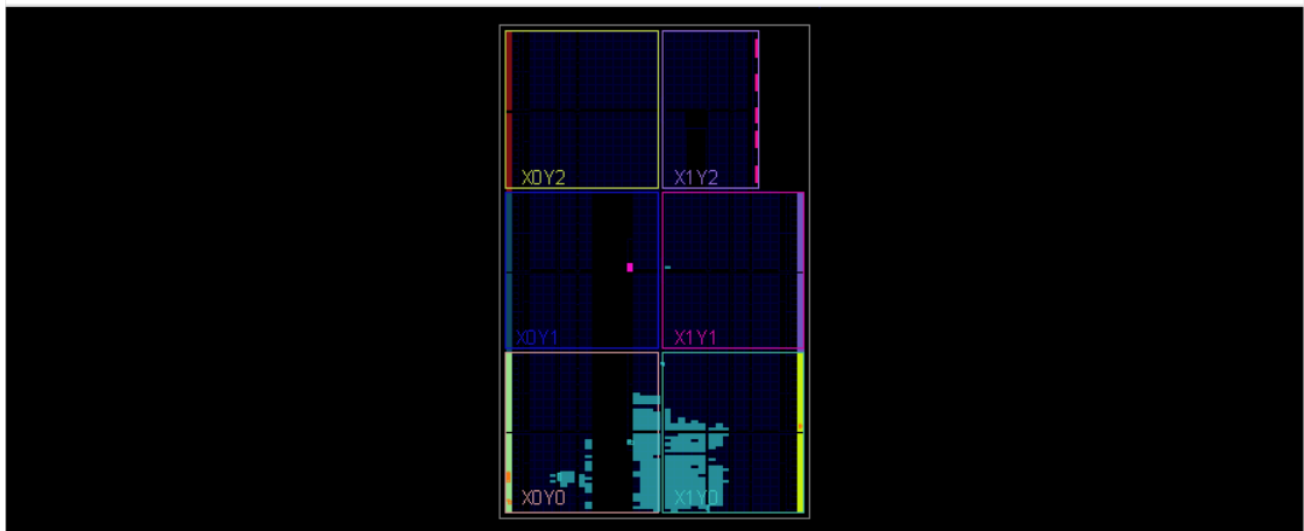


## 5- Implementation snippets after choosing the encoding

### 3.1 – Massage



### 3.2 – Device



### 3.2 – Utilization

IMPLEMENTED DESIGN - xc7a35t1cpg236-1L (active)

Tcl Console Messages Log Reports Design Runs Power DRC Methodology Timing **Utilization** x

Hierarchy

Summary

▼ Slice Logic

- ▼ Slice LUTs (6%)
  - ▼ LUT as Memory (1%)
    - LUT as Shift Register
    - LUT as Distributed RAM
    - LUT as Logic (6%)
  - F7 Muxes (<1%)
  - ▼ Slice Registers (5%)
    - Register as Latch (<1%)
    - Register as Flip Flop (<1%)
  - ▼ Slice Logic Distribution
    - ▼ Slice (8%)
      - SLICEM
      - SLICEL
    - ▼ LUT as Memory (1%)
      - ▼ LUT as Shift Register
        - using O5 output or O6 output or O5 and O6
      - ▼ LUT as Distributed RAM
        - using O5 and O6
    - ▼ LUT Flip Flop Pairs (4%)
      - LUT-FF pairs with one fully used LUT-FF pair

Name	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)	BUFGCT (32)
▼ N SPI_Wrapper	1294	1964	10	629	1186	108	754	1	5	
> IF dbg_hub (dbg_hub)	476	727	0	240	452	24	305	0	0	
IF Ram (sync_RAM)	1	9	0	3	1	0	0	0.5	0	
IF SPI (sync_SPI)	54	31	0	18	54	0	27	0	0	
> IF u_ila_0 (u_ila_0)	763	1189	10	375	679	84	421	0.5	0	

utilization\_1

Activate Windows  
Go to Settings to activate Windows.

### 3.2 – Timing

IMPLEMENTED DESIGN - xc7a35t1cpg236-1L (active)

Tcl Console Messages Log Reports Design Runs Power DRC Methodology **Timing** x Utilization

Design Timing Summary

General Information

Timer Settings

Design Timing Summary

Clock Summary (2)

> Check Timing (16)

- > Intra-Clock Paths
- > Inter-Clock Paths
- > Other Path Groups
  - User Ignored Paths
  - Unconstrained Paths

Setup	Hold	Pulse Width
Worst Negative Slack (WNS): 1.830 ns	Worst Hold Slack (WHS): 0.038 ns	Worst Pulse Width Slack (WPWS): 3.750 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: 3904	Total Number of Endpoints: 3888	Total Number of Endpoints: 2148

All user specified timing constraints are met.

Timing Summary - impl\_1 (saved)

Activate Windows  
Go to Settings to activate Windows.