ABS Progress and Simulation Results

Finite State Machine (FSM) States in the ABS_Controller

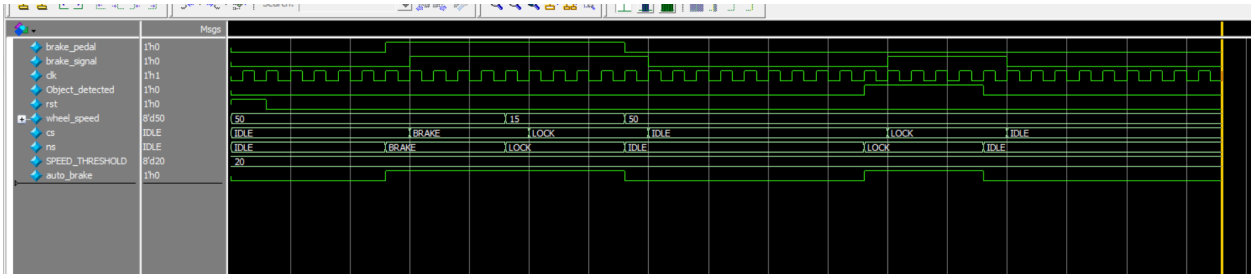
The **ABS_Controller** module operates based on a **Finite State Machine (FSM)** with three primary states:

1. **IDLE State:**
    - The system is in the **IDLE** state when no braking input is detected.
    - It ensures that braking force is released to prevent wheel locking.
    - The system remains in this state unless the driver presses the brake pedal or an obstacle is detected.
2. **BRAKE State:**
    - The system enters the **BRAKE** state when the driver manually applies the brakes, provided no obstacle is detected.
    - Normal braking occurs, and the system continues in this state until one of the following happens:
        1. If the wheel speed drops below the threshold (20 km/h), the system transitions to the **LOCK** state.
        2. If the driver releases the brake pedal, the system returns to the **IDLE** state.
3. **LOCK State:**
    - The system enters the **LOCK** state under two conditions:
        1. An obstacle is detected, triggering automatic braking.
        2. The wheel speed falls below the threshold while braking.
    - The system remains in the **LOCK** state until **all braking inputs are removed**, ensuring the vehicle comes to a complete stop when an obstacle is detected.

State Transitions

- **IDLE → BRAKE**: When the driver applies the brake manually without an obstacle detected.
- **IDLE → LOCK**: When an obstacle is detected, requiring an emergency stop.
- **BRAKE → LOCK**: If an obstacle is detected or if wheel speed drops below the defined threshold.
- **BRAKE → IDLE**: If the driver releases the brake pedal.
- **LOCK → IDLE**: When no braking input is present.

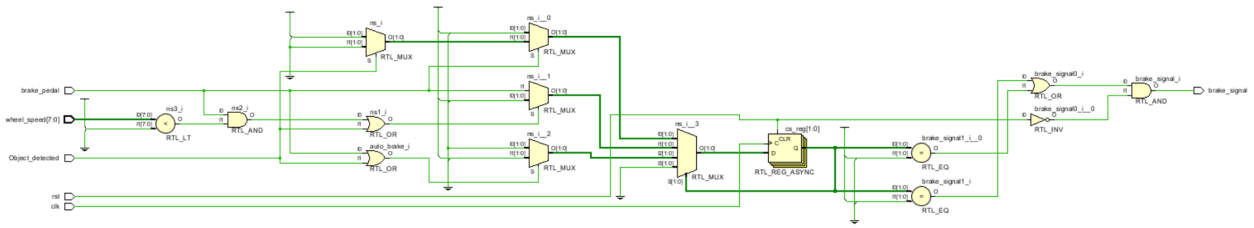
This FSM ensures an effective anti-lock braking system by preventing wheel locking, allowing smooth transitions between braking states, and automatically stopping the vehicle in case of an obstacle.



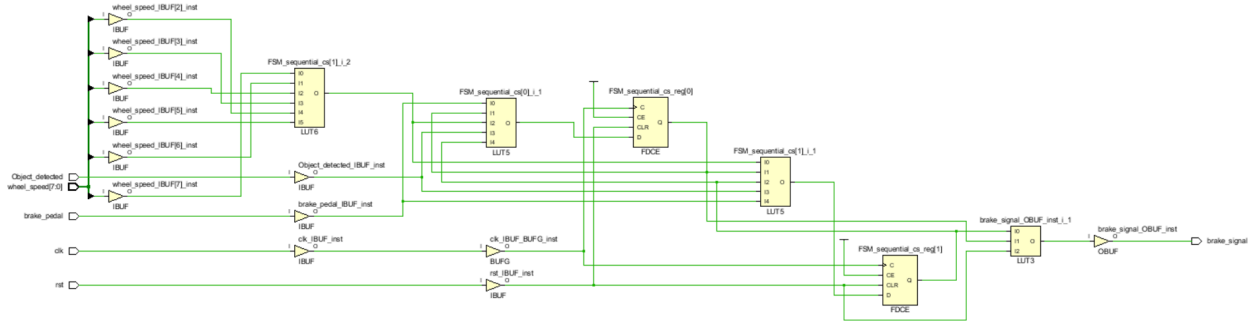
- `(ref_speed - wheel_speed) > SPEED_THRESHOLD`:
    - This part checks if the wheel is decelerating too quickly compared to the expected or reference speed, which could indicate that the wheel is at risk of locking up.

VIVADO:

- Elaborated design



- Simulation



- Timing report

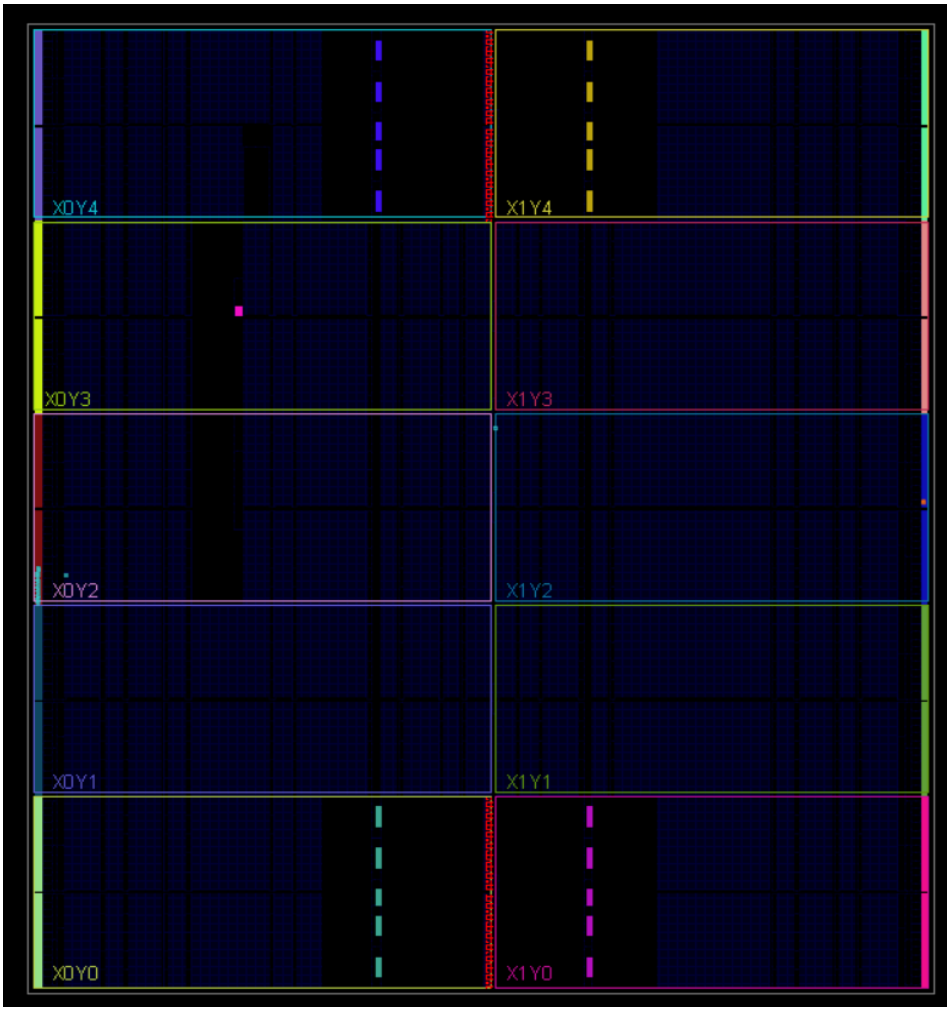
Setup		Hold		Pulse Width	
Worst Negative Slack (WNS):	18.705 ns	Worst Hold Slack (WHS):	0.193 ns	Worst Pulse Width Slack (WPWS):	9.500 ns
Total Negative Slack (TNS):	0.000 ns	Total Hold Slack (THS):	0.000 ns	Total Pulse Width Negative Slack (TPWS):	0.000 ns
Number of Failing Endpoints:	0	Number of Failing Endpoints:	0	Number of Failing Endpoints:	0
Total Number of Endpoints:	2	Total Number of Endpoints:	2	Total Number of Endpoints:	3

All user specified timing constraints are met.

- Report utilization

Name 1	Slice LUTs (134600)	Slice Registers (269200)	Bonded IOB (500)	BUFGCTRL (32)
N ABS_Controller	4	2	11	1

- Implementation



- Timing report

Setup		Hold		Pulse Width	
Worst Negative Slack (WNS):	19.044 ns	Worst Hold Slack (WHS):	0.276 ns	Worst Pulse Width Slack (WPWS):	9.500 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:	2	Total Number of Endpoints:	2	Total Number of Endpoints:	3

- Utilization report

Name	Slice LUTs (133800)	Slice Registers (267600)	Slice (33450)	LUT as Logic (133800)	LUT Flip Flop Pairs (133800)	Bonded IOB (500)	BUFGCTRL (32)
N ABS_Controller	4	2	2	4	2	11	1