# Test Strategy for Traffic Light Controller Testbench

This document outlines the test strategy for verifying the Traffic Light Controller using waveform analysis. The strategy ensures comprehensive testing of scheduling, priority handling, reset functionality, and dynamic adjustments based on sensor inputs.

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| Test Scenario | Objective | Inputs (Stimuli) | Expected Outputs/Behavior |
| Reset Functionality | Ensure all traffic lights reset to a default state when rst\_n = 0. | rst\_n = 0 | All traffic lights switch to the reset state (e.g., Red for all directions). |
| Round-Robin Scheduling | Verify fair and cyclic light transitions among all directions (no starvation). | Sa = 1, Sb = 1, Sc = 1, Sd = 1 (or similar priority inputs). | Traffic lights transition in a round-robin manner: one direction turns Green, others remain Red. |
| Sensor-Based Adjustments | Confirm light timings adjust dynamically based on sensor signals (at positions 1 and 5). | Sensor at a specific lane (e.g., Sa = 3, others = 0). | Extended Green for the lane with higher priority sensor values, other lights maintain Red. |
| Fixed Priority Testing | Test priority-based light handling to ensure correct precedence among directions. | Assign higher priority (Sd = 3) while others are lower. | Priority lane (Sd) maintains Green until completion, other lanes wait (Red). |
| Dynamic Priority Changes | Check behavior when priorities change dynamically during operation. | Vary priorities in real time (e.g., Sa = 2, Sd = 3, etc.). | System adapts to new priorities, transitioning traffic lights accordingly. |
| Edge Cases | Test system with all lanes inactive or all lanes highly active. | - Case 1: Sa = Sb = Sc = Sd = 0. - Case 2: Sa = Sb = Sc = Sd = 3. | - Case 1: All directions should remain Red. - Case 2: Ensure non-conflicting Green transitions or round-robin behavior. |
| Conflicting Paths Prevention | Ensure system avoids intersecting traffic paths as per design. | Simulate conflicting paths using inputs representing multiple active lanes. | Lights for conflicting paths are never simultaneously Green. |
| Clock Dependency | Validate output transitions occur only on the negative clock edge (negedge clk). | Observe behavior during clock transitions. | Outputs (lights) update only on negative edge of clk. |
| Long Simulation Runs | Check system stability and robustness over extended simulation time. | Vary input patterns over hundreds of cycles. | System continues to function correctly under long-term scenarios (no deadlocks or undefined states). |
| Reset Recovery | Confirm the system recovers seamlessly after coming out of reset (rst\_n = 1). | rst\_n = 1 after being held low. | Lights resume normal operation following the pre-defined scheduling or priority rules. |