CAR PARK WİTH 2 GATES

LAB REPORT

1-) Title And Authors

Lab 2: Car Park With 2 Gates

Course: Fundamentals of Electronics / Logic Networks

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2-) Objectives and Specifications

The objective of this laboratory is to design and verify a parking control system with two entrance gates and two exit gates using Finite State Machines (FSM). The system manages vehicle access to a parking area, controls entrance and exit barriers, handles payment procedures at exit gates, and maintains an internal counter representing the number of vehicles currently parked.

The main specifications of the system are:

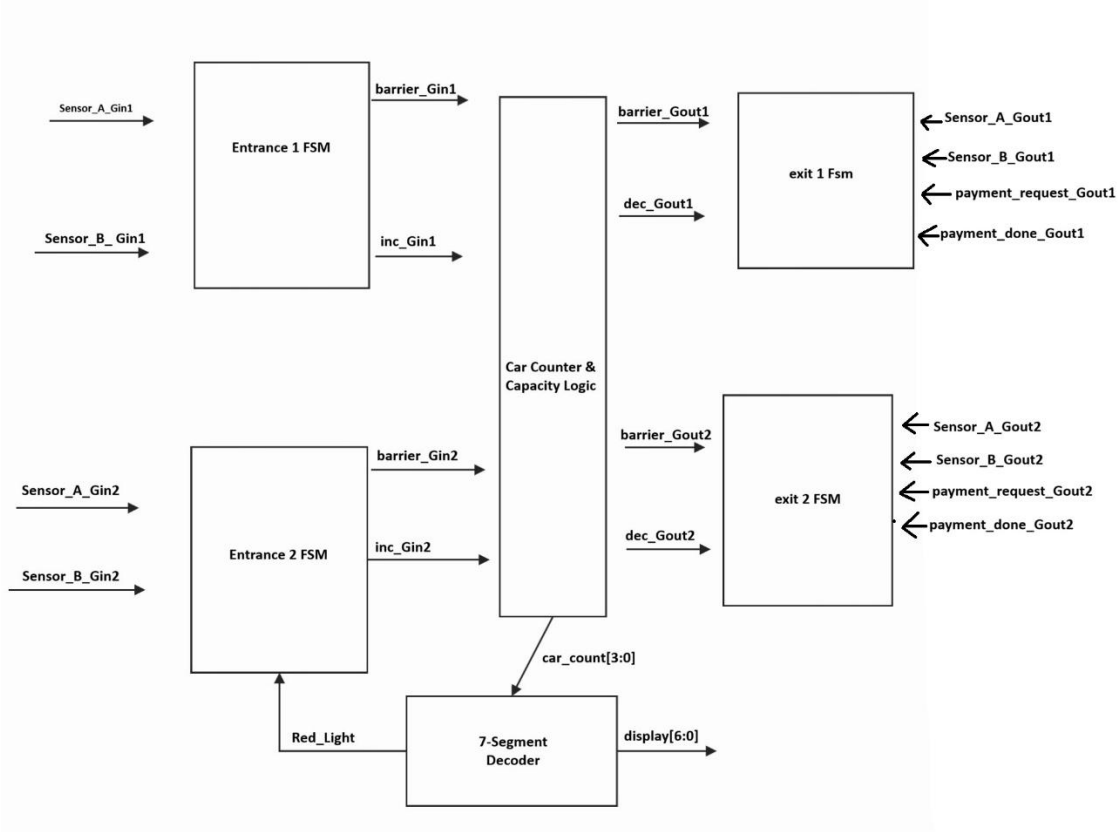
- Two independent entrance gates and two independent exit gates.
- Each gate is controlled by an FSM that processes sensor inputs and generates barrier control signals.
- A global counter (car_count) tracks the number of vehicles inside the parking area.
- Entrance gates are disabled when the parking area reaches its maximum capacity.
- Exit gates require a payment procedure before allowing a vehicle to leave.
- Traffic lights (green/red) indicate whether the parking area is available or full.
- A seven-segment display shows the current number of parked vehicles.

3. System Overview

The parking controller is composed of four FSMs, one for each gate (two entrance FSMs and two exit FSMs). Entrance FSMs detect the correct sequence of sensor activations to identify a vehicle entering the parking area. Exit FSMs additionally integrate a payment mechanism that must be completed before a vehicle is allowed to leave.

All FSMs interact with a centralized counter management logic that updates the internal vehicle count. The system also includes output logic for traffic lights and a seven-segment display to provide real-time feedback to users.

4. Architecture and Block Diagram



This block diagram shows the overall architecture of the parking control system. Each entrance and exit gate is managed by an independent Finite State Machine (FSM). The entrance FSMs detect the correct sequence of sensor activations and generate barrier control signals, as well as increment pulses for the car counter. The exit FSMs handle the payment procedure and allow vehicle exit only after payment completion, generating decrement pulses for the counter. The central counter and capacity logic keeps track of the number of parked vehicles and determines whether the parking area is full. Based on this information, the traffic lights are updated and the current car count is displayed through a seven-segment decoder.

5. Implementation Details

The FSMs are implemented using synchronous processes triggered by the system clock and reset signal. Each FSM progresses through defined states representing idle conditions, sensor detection phases, barrier control, and completion states.

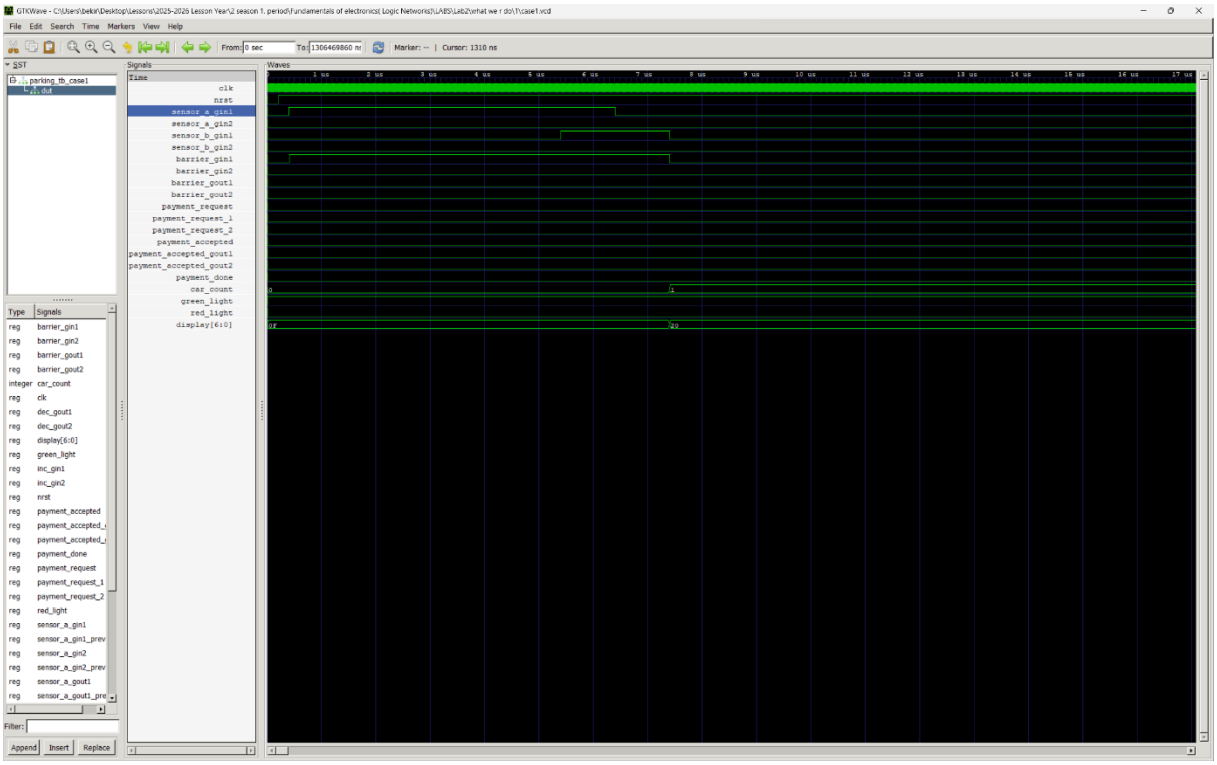
The counter management logic ensures consistent updates to the number of parked vehicles by incrementing the count after a valid entrance sequence and decrementing it after a valid exit sequence. The design guarantees that counter updates occur only after successful FSM transitions, preventing inconsistent states.

Traffic light logic continuously monitors the counter value. When the maximum capacity is reached, the red light is activated and all entrance FSMs are inhibited. The green light is reactivated once the vehicle count drops below the maximum capacity.

6. Simulation Results

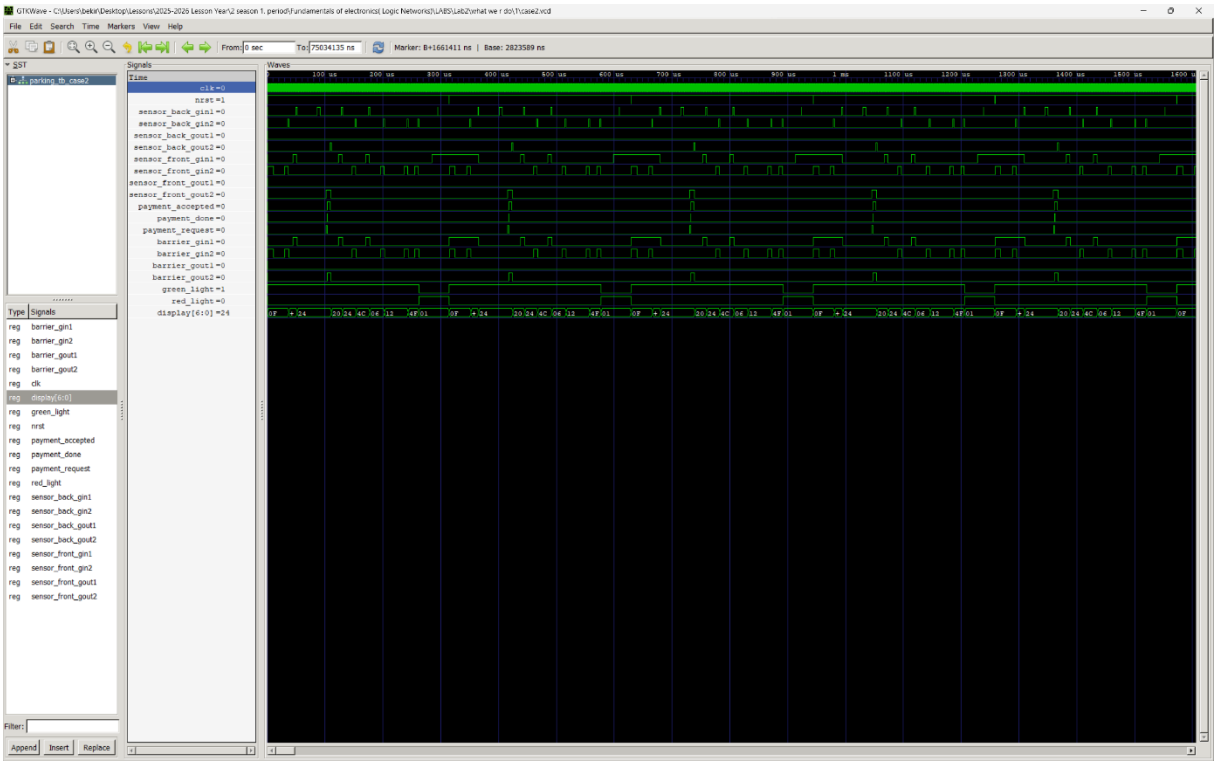
The system was verified using four different testbenches, each representing a distinct operational scenario. Waveform simulations were generated using Ghdl and Gtkwave.

Case 1 – Single Car Entry Test



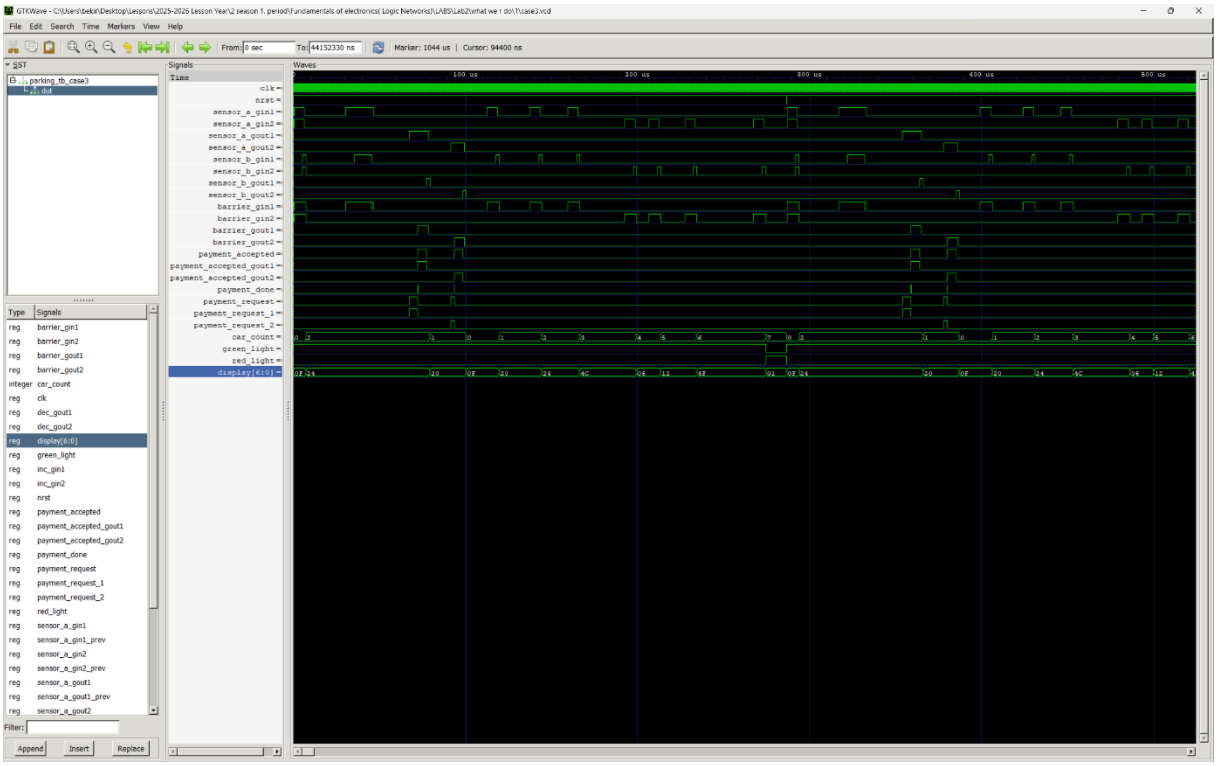
This testbench verifies the correct behavior of one entrance gate. The input sensors A and B of Gate In 1 are activated sequentially, simulating a vehicle entering the parking area. As shown in the waveform, after the correct sensor sequence is detected, the entrance barrier is opened and the internal car counter is incremented by one. The green light remains active, indicating that the parking area is not full. The seven-segment display updates accordingly to reflect the new number of parked vehicles. This confirms the correct operation of the entrance gate FSM and the counter management logic.

Case 2 – Multiple Events Test



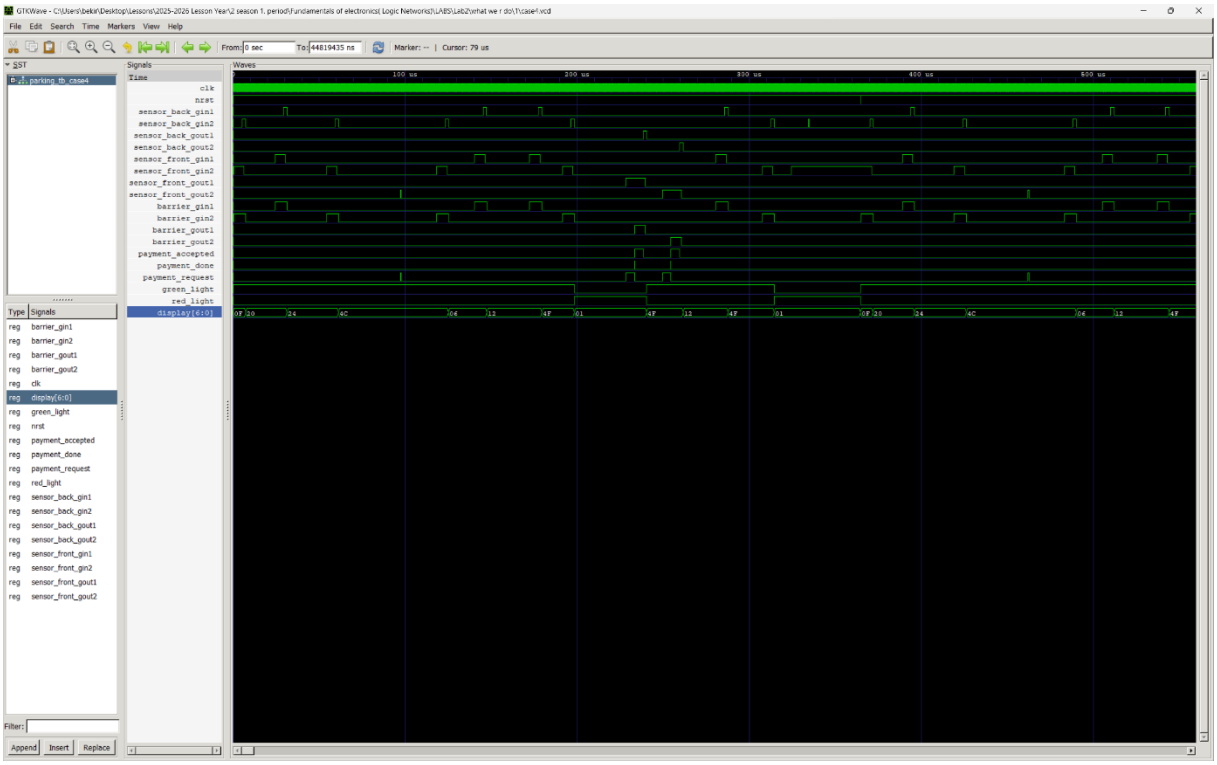
This testbench evaluates the behavior of the parking controller under multiple and consecutive events involving both entrance and exit gates. Several sensor activations occur over time, leading to repeated opening and closing of the corresponding barriers. The seven-segment display and the traffic lights update consistently with the internal car counter, demonstrating correct synchronization between the FSMs and the counter management logic. This test confirms that the system operates correctly under continuous activity and non-trivial operating conditions.

Case 3 – Exit and Payment Test



This testbench verifies the correct behavior of the exit gates with payment control. When a vehicle approaches an exit gate, a payment request is generated. After the payment is accepted and completed, the corresponding exit barrier is opened, allowing the vehicle to leave the parking area. Following the correct sensor sequence, the internal car counter is decremented and the seven-segment display is updated accordingly. This confirms the correct operation of the exit gate FSM and the integration of the payment mechanism with the parking control logic.

Case 4 – Full Parking Condition Test



This testbench verifies the correct behavior of the parking controller when the parking area reaches its maximum capacity. When the car counter reaches the defined limit, the red light is activated and all entrance gates are disabled, preventing additional vehicles from entering the parking area. Exit gates remain operational, allowing vehicles to leave after completing the payment procedure. Once a vehicle exits, the parking area is no longer full, the green light is reactivated, and entrance gates resume normal operation. This confirms the correct handling of the full condition and dynamic system recovery.

7. Conclusions

The designed parking controller successfully meets all specified requirements. The FSM-based architecture ensures reliable control of entrance and exit gates, correct integration of payment procedures, and accurate tracking of parked vehicles. Simulation results demonstrate correct behavior under single-event, concurrent-event, payment-controlled exit, and full-capacity scenarios. The system is robust, scalable, and suitable for real-world parking control applications.

8. Credits

This project was developed by the group using:

- Course material provided by instructor Philippe Velha
- VHDL inspired by lecture materials

  Simulation Tools :

- GTKWave screenshots generated by the group
- External diagrams/tools referenced: Antares