Ahsanullah University of Science and Technology

Department of EEE

Digital Electronics Lab Project Report

Name of Project: Digital Combination Lock System.

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Introduction:

A 4-bit digital combination lock system is a compact and efficient electronic security mechanism designed to restrict access or grant permission based on the entry of a specific 4-bit binary code. The system employs a set of four binary switches, each representing a bit in the code. Users input the code by manipulating these switches, and the system uses digital logic circuits to compare the entered code with a predefined master code. If the entered code matches the master code, the system activates an unlocking mechanism, granting access. If the codes do not match, access remains denied.

The "Digital Combination Lock System" is a circuit designed to simulate the functionality of a combination lock using XOR gates as bit comparators. The system allows users to set a secret key code using switches and then enter a data code to compare it with the secret key. The system utilizes XOR gates and LEDs to indicate whether the entered code matches the key code.

Significance:

The 4-bit digital combination lock system holds significant importance for various applications due to its simplicity, security, and versatility:

1. Home Security: A 4-bit digital lock provides an additional layer of security for homes, apartments, or individual rooms. It can be used to safeguard personal belongings, restrict access to sensitive areas, or serve as an alternative to traditional key-based locks.

2. Small-Scale Access Control: In office spaces, laboratories, or educational institutions, this type of lock offers an effective solution for restricting access to specific rooms, equipment, or resources. It eliminates the need for physical keys and simplifies access management.

3. Safe and Locker Security: Digital combination locks are commonly used in safes, lockers, and cabinets to secure valuable items, documents, or confidential information. Their compact size and keyless operation make them convenient for personal use.

4. Automotive Security: Digital locks can be employed in vehicles to secure glove compartments or trunk spaces, providing an extra layer of security beyond the main vehicle lock system.

5. Education and Learning: This type of lock system serves as an educational tool to introduce learners to digital logic concepts, binary representation, and basic circuit design. It offers a practical application for understanding logic gates and code comparison.

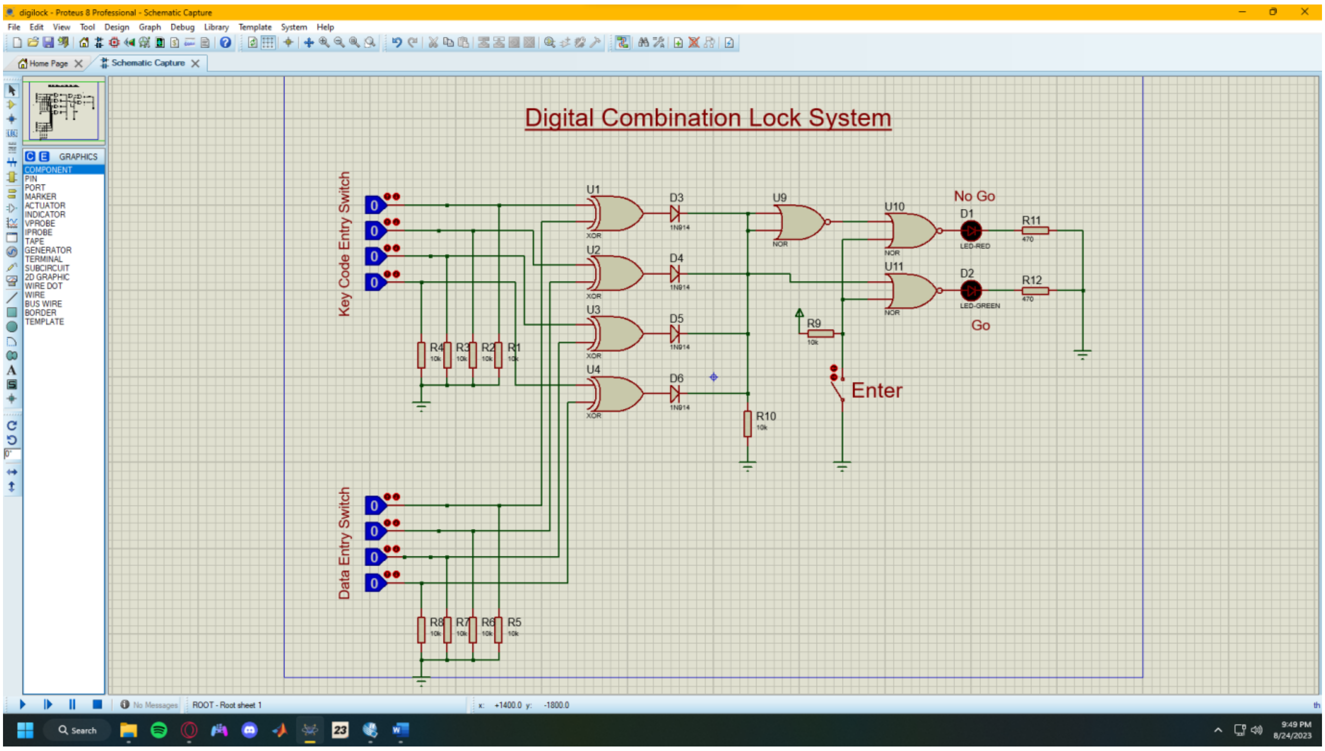
6. Low-Cost Solution: Compared to more sophisticated electronic locks, a 4-bit digital combination lock system is relatively inexpensive to implement, making it accessible for personal and small-scale applications.

7. Customizable Codes: Users can easily change the access code by adjusting the binary switches. This feature enhances security by allowing quick code changes without the need for new physical keys.

8. Keyless Convenience: Users do not need to carry physical keys, reducing the risk of key loss or theft. This also eliminates the need for key duplication and minimizes maintenance costs.

In summary, a 4-bit digital combination lock system offers a simple yet effective means of securing access to various spaces and resources. Its importance lies in providing reliable security, ease of use, and educational value while catering to a wide range of applications, from home security to educational learning tools.

Circuit Description:



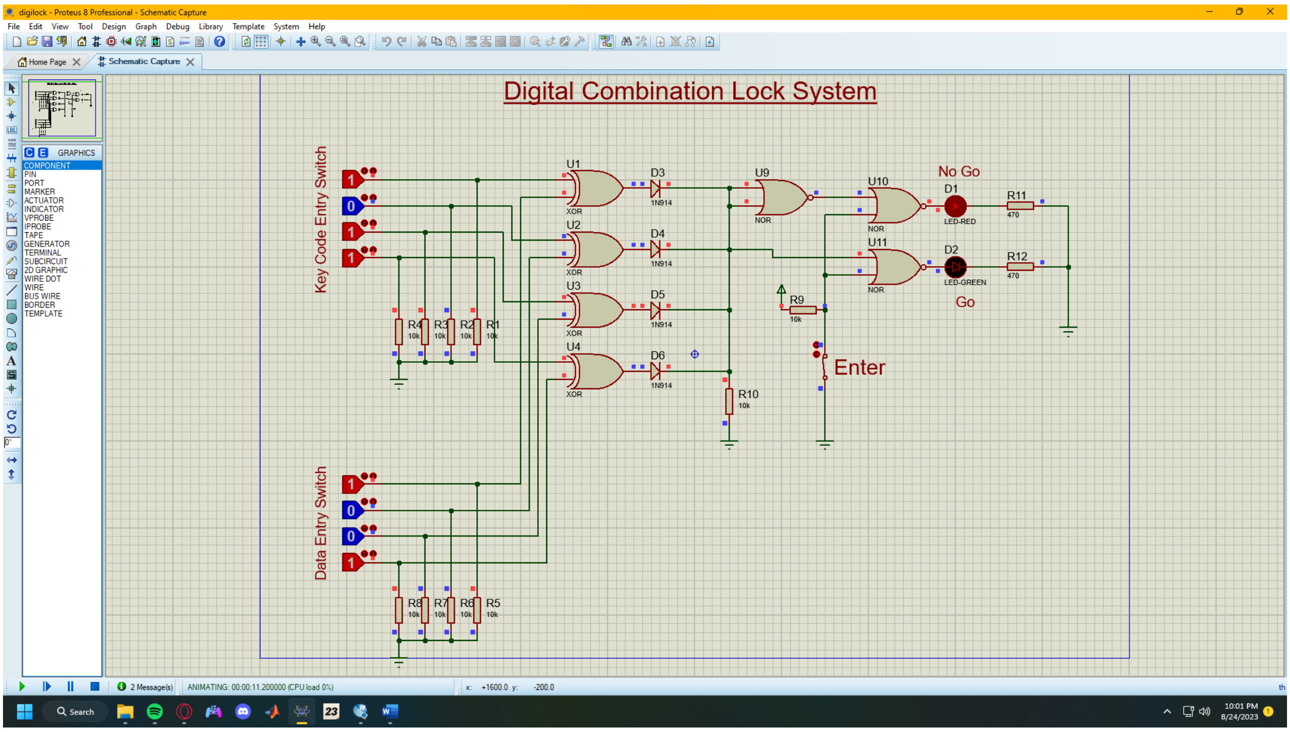
The circuit consists of the following components:

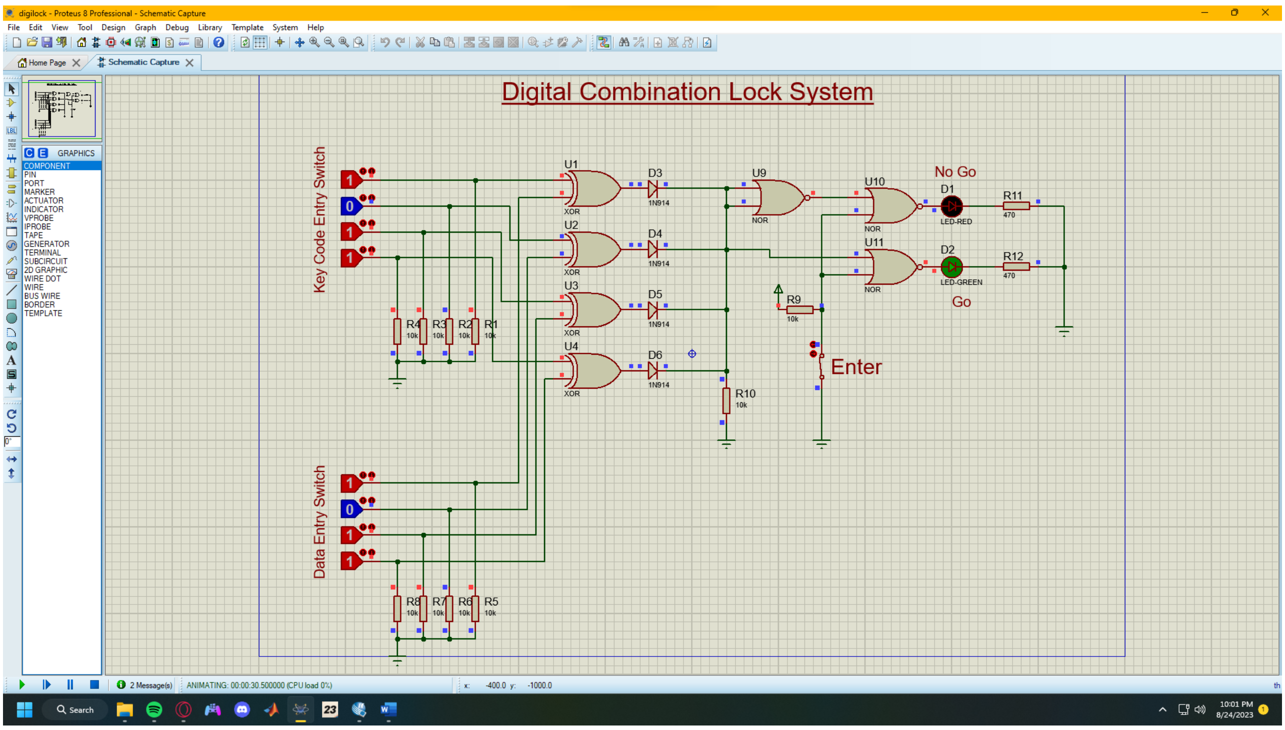
- Four sets of binary switches representing the secret key code and data entry code.
- Four XOR gates to compare the corresponding bits of the key code and data code.
- Green "Go" LED and red "No Go" LED to indicate whether the entered code is correct or not.
- Diode network to create a logical OR gate to determine if any XOR gate outputs are high.
- NOR gate to control LED activation based on the state of the ENTER button.

Operation:

The operation of the circuit is as follows:

1. Setting the Key Code: Configure the four key code switches to set the desired secret key.
2. Matching Key Code: Set the data entry switches to match the secret key code. When the ENTER button is pressed, the green "Go" LED lights up if the key code and data code match bit for bit.
3. Non-Matching Key Code: Set the data entry switches to a different configuration from the key code. Pressing the ENTER button now lights up the red "No Go" LED, indicating a mismatch between the key code and data code.





Logic Explanation:

- XOR gates compare corresponding bits of the key code and data code. An XOR gate outputs 1 when its inputs are different and 0 when they are the same.
- Diode network functions as a logical OR gate for the outputs of the XOR gates. If any XOR gate output is 1 (indicating a mismatch), the OR gate outputs 1.
- NOR gate ensures that the LEDs can only light up when the ENTER button is pressed. It prevents false LED activation without button press.

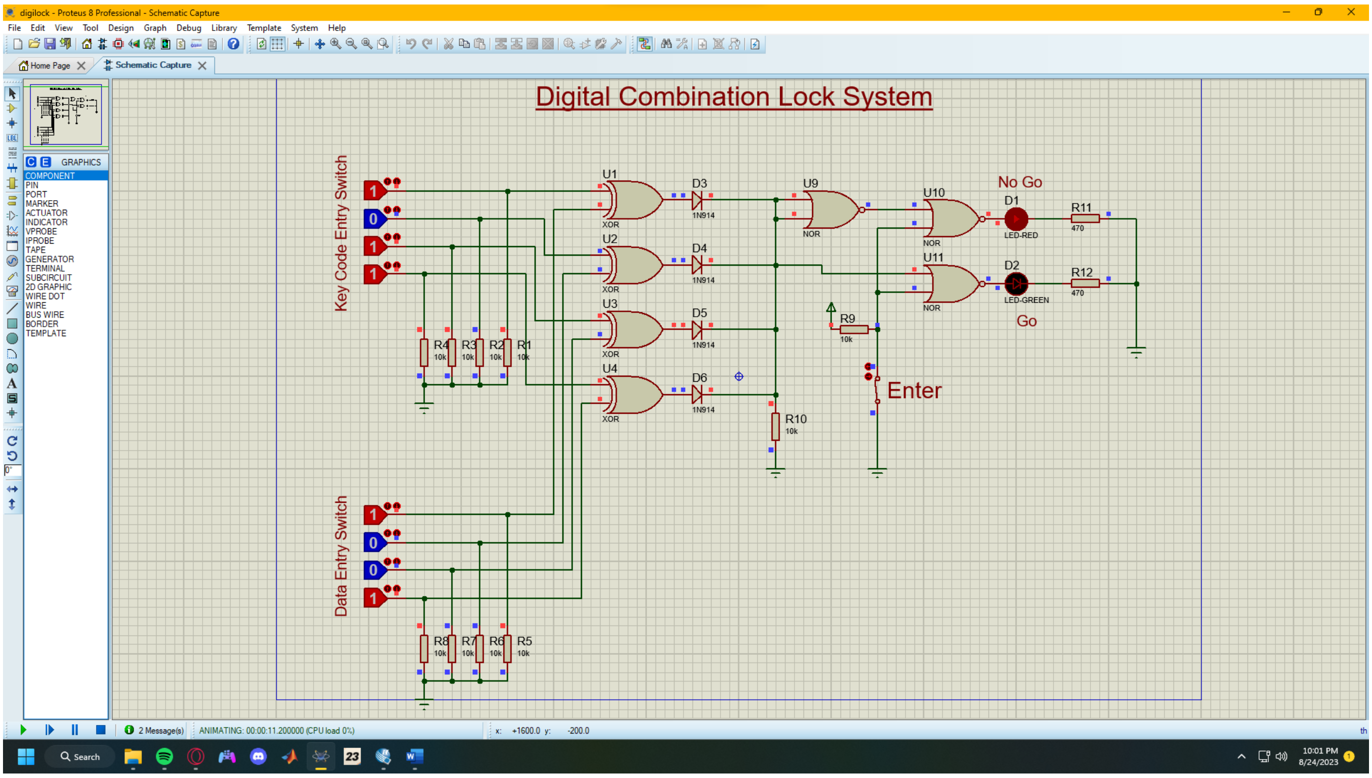
Application and Enhancements:

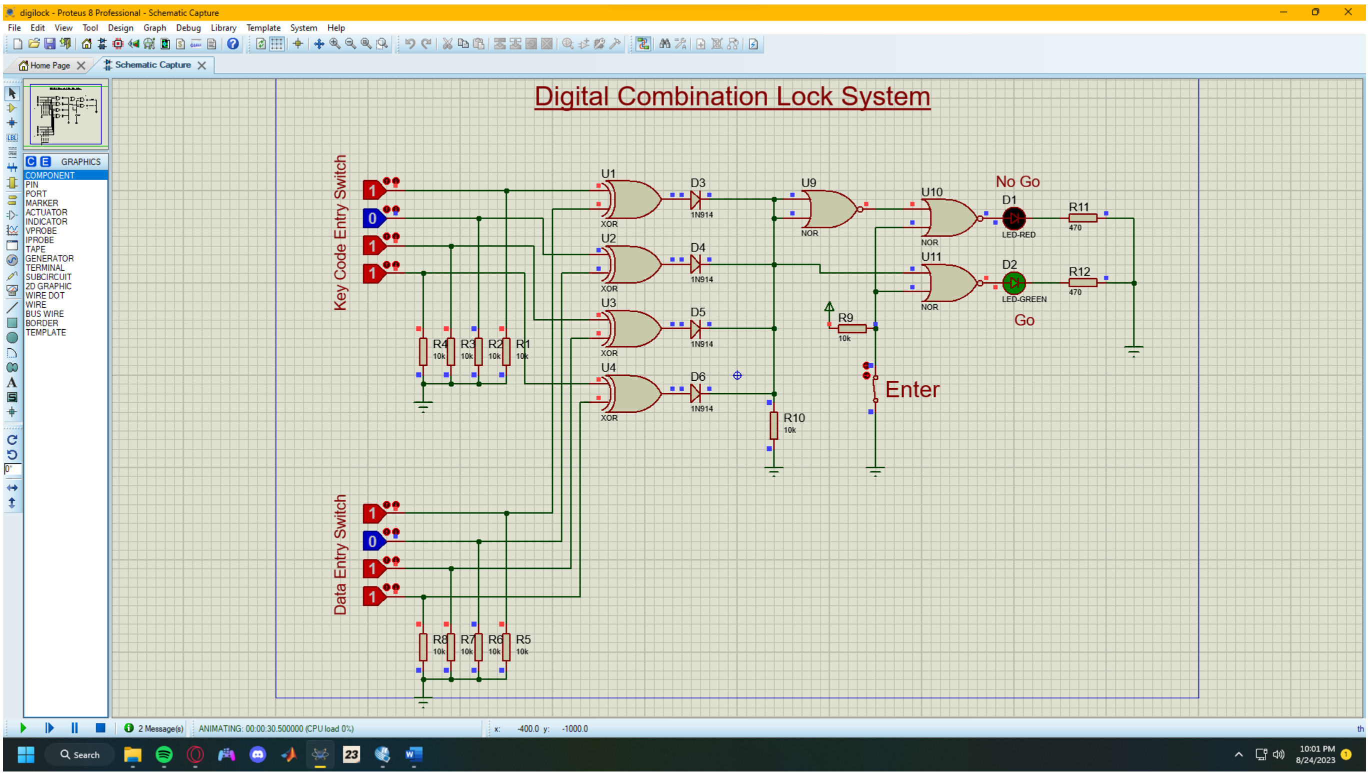
The project demonstrates the concept of using XOR gates for code comparison and the basic functionality of a combination lock. In a real security application, enhancements could include:

- Connecting the "No Go" output to an alarming device to deter unauthorized attempts.
- Implementing more sophisticated code combinations and security features.

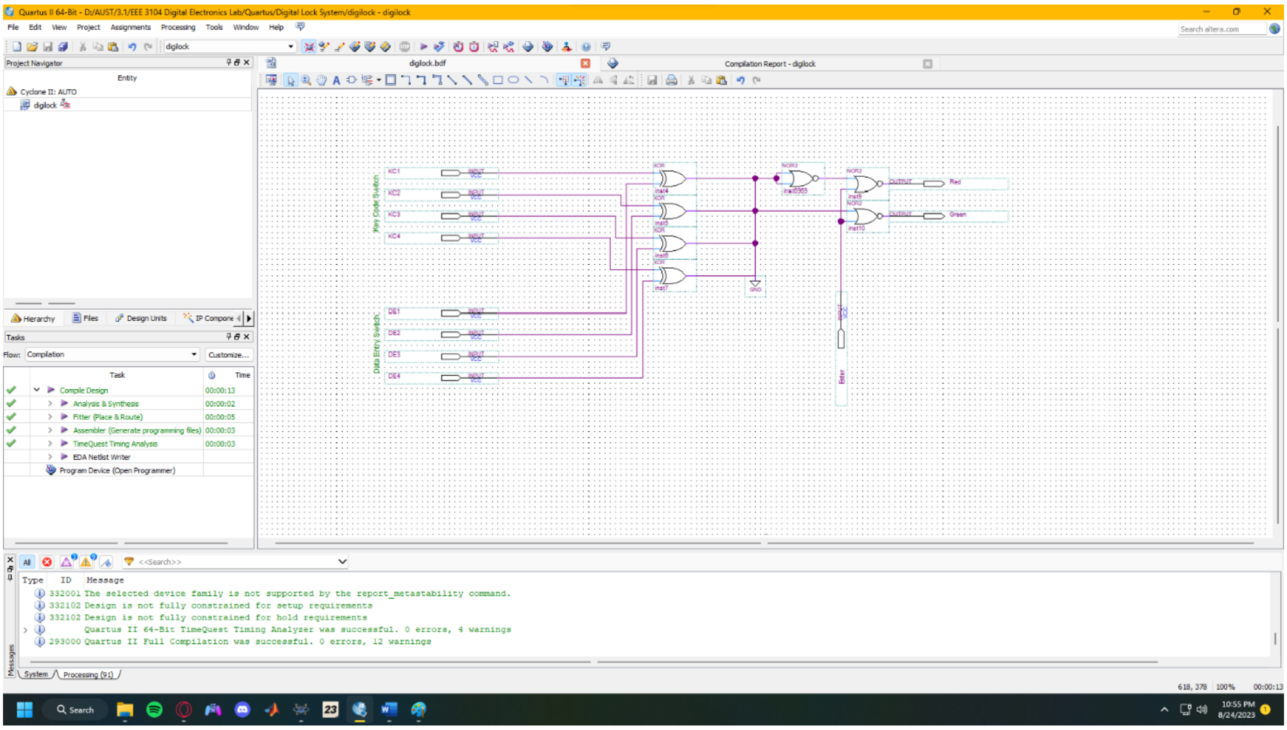
The "Digital Combination Lock System" project provides a hands-on introduction to the use of XOR gates in code comparison scenarios. It simulates a basic digital combination lock, highlighting the importance of XOR gate behavior in determining code matching. While this project is a simplified version, it serves as a foundation for understanding more complex security systems and logic circuits.

Proteus Simulation:





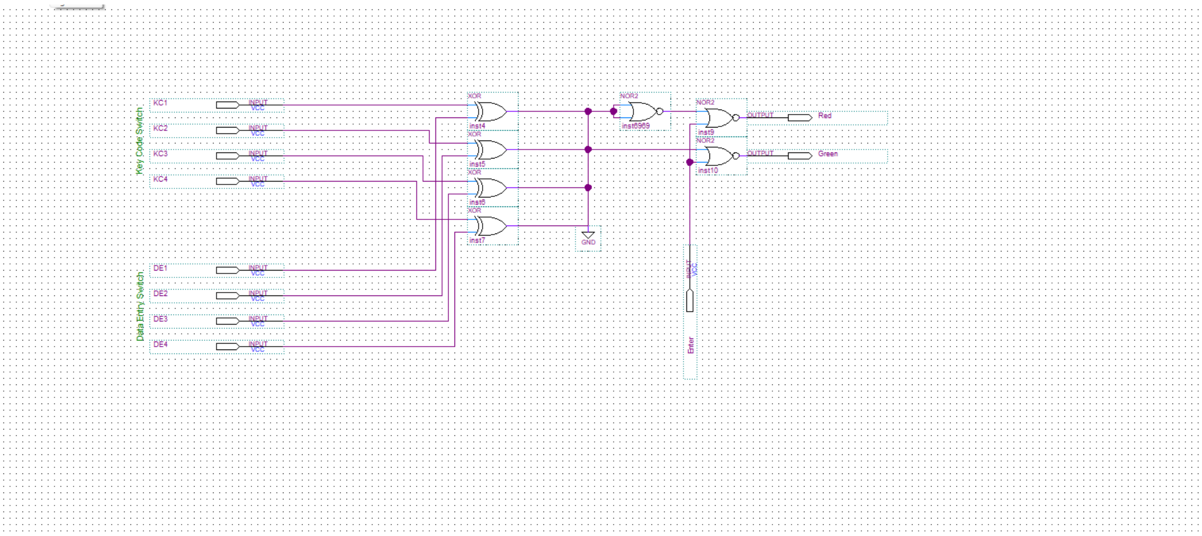
Quartus Simulation:



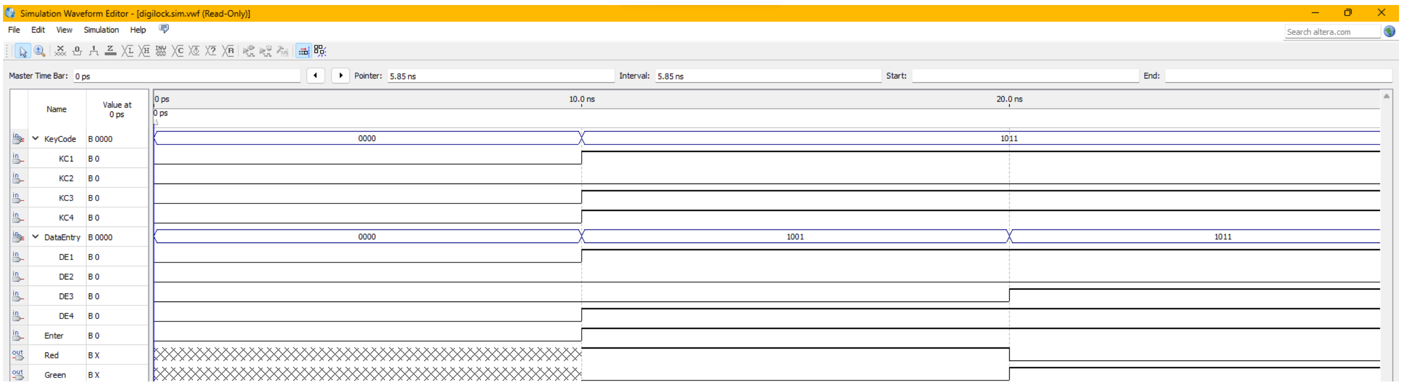
Reason why there isn't any resistor and diodes in this circuit:

Quartus is a software tool provided by Intel (formerly Altera) that is used for designing and programming field-programmable gate arrays (FPGAs) and complex digital logic circuits. Quartus is primarily focused on designing and simulating digital logic circuits, which are composed of gates, flip-flops, multiplexers, memory blocks, and more. The reason Quartus doesn't deal directly with resistors and diodes is because it's designed for digital logic design, which is centered around binary states (0s and 1s) and boolean operations (AND, OR, NOT, etc.). Digital circuits rely on switches that can represent these binary states, and they operate on discrete values. Digital logic design doesn't involve continuous voltages or analog concepts like those used in resistor and diode circuits.

Resistors and diodes are components commonly used in analog electronics, where continuous voltages and currents play a crucial role. They're used to control voltage levels, create voltage dividers, limit current flow, and perform other analog functions. In digital logic circuits, these functions are achieved using digital components like gates and flip-flops. Since that doesn't have an effect on our circuit in Quartus we removed them for a straighter output.



The following vector waveform shows the inputs and outputs of our combination lock. When the Data Entry inserted doesn't match the Key code the red output shows 1 while the green output shows 0. And when the Data Entry inserted doesn't match the Key code the green output shows 1 while the red output shows 0. And when the Enter button is turned off no output is shown.



Conclusion:

The "Digital Combination Lock System" project provides a hands-on introduction to the use of XOR gates in code comparison scenarios. It simulates a basic digital combination lock, highlighting the importance of XOR gate behavior in determining code matching. While this project is a simplified version, it serves as a foundation for understanding more complex security systems and logic circuits.

This project successfully demonstrates the principles of XOR gate-based code comparison and can be a starting point for students and enthusiasts interested in digital logic and security systems.