Home Security System

DSD PROJECT

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2024

1. Specifications

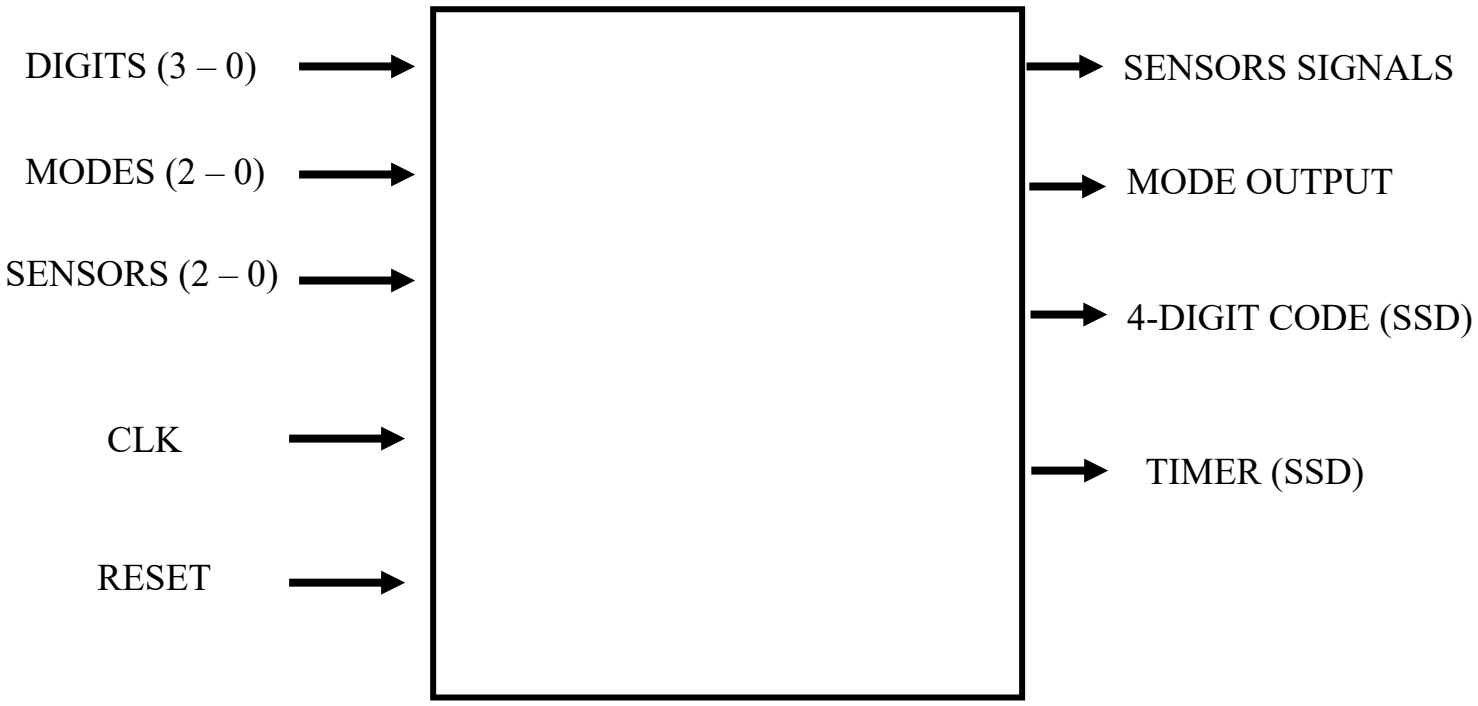
The objective of this project was to create a functional Home Security System. The component of the project is the Basys 3 FPGA board.

You are part of a team tasked with designing a security system of a house. The system must adhere to the following specifications:

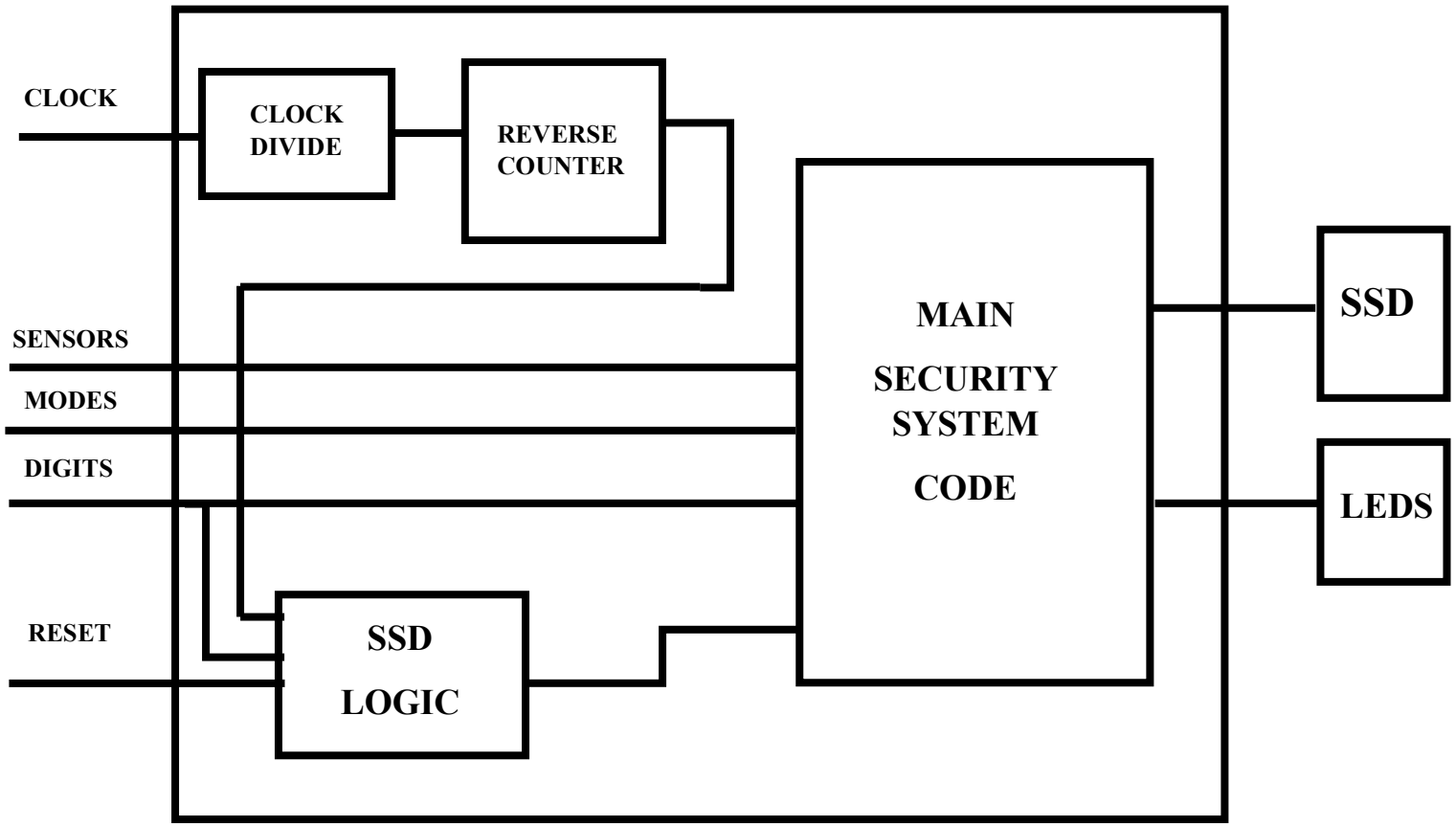
- A two-room house has several sensors: motion sensors in each room, window opening sensor in each room, main door opening sensor.
- All sensors are connected in an alarm system, which monitors each sensor and if something happens (e.g. the door opens), the alarm sounds, if the way this automatic is set allows it.
- The selectable modes are: inactive (in this case the system ignores the sensors), at home (only the door and window sensors are taken into account) and off (in this case the system takes into account all the features).
- To change the system mode, a four-digit code must be entered.
- When the system starts working, the user must enter the 4-digit code before the 15 second delay so that he can choose the mode.
- If the 15 seconds delay is finished the user will not be able to use it anymore until the reset button is pressed.

2. Design

2.1 Black Box



2.2 Detail diagram



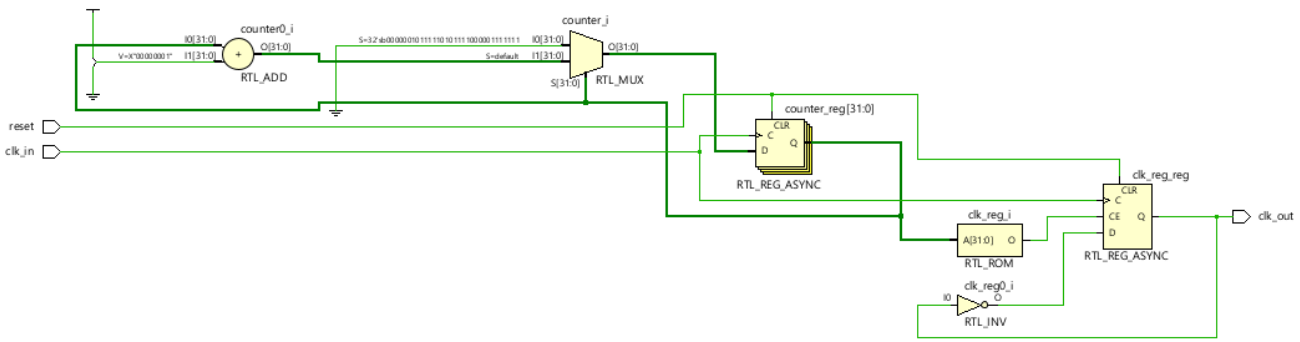
3. Structure and functionality

3.1 Resources

1. Formal Description of the Main Components
2. Logical Schematics

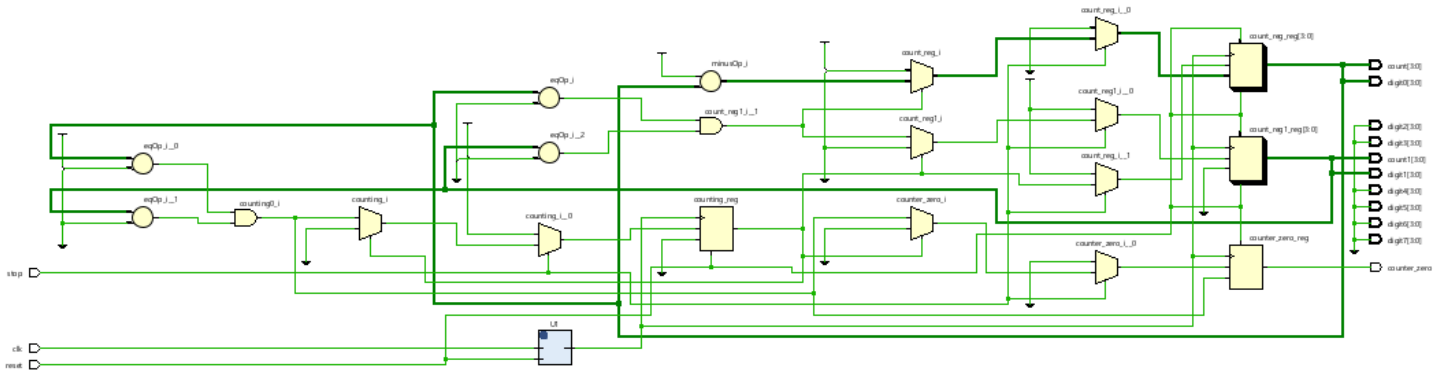
Clock Divider

A clock divider is a digital circuit used to reduce the frequency of a clock signal. It works by counting the input clock pulses and generating an output clock pulse after a predefined number of input pulses. In this implementation, the clock divider transforms an input clock signal into a 1 Hz output clock signal when the input clock frequency is 50 MHz.



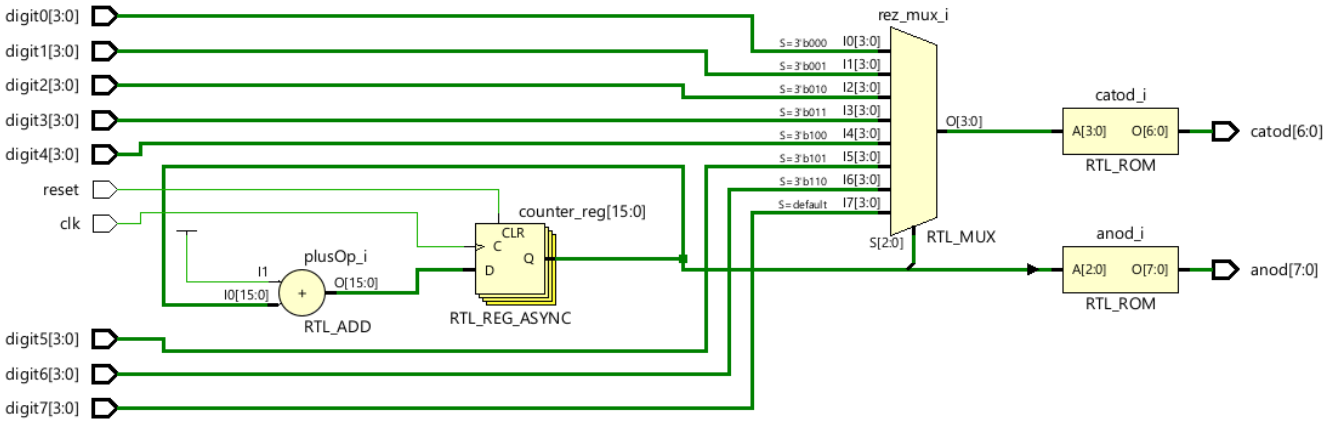
Reverse Counter

A reverse counter is a digital circuit used to count down from a specified value. This implementation counts down from a predefined value and integrates a clock divider component to reduce the frequency of the clock signal driving the counter. The counter also includes outputs for a seven-segment display (SSD) and indicates when the count reaches zero.



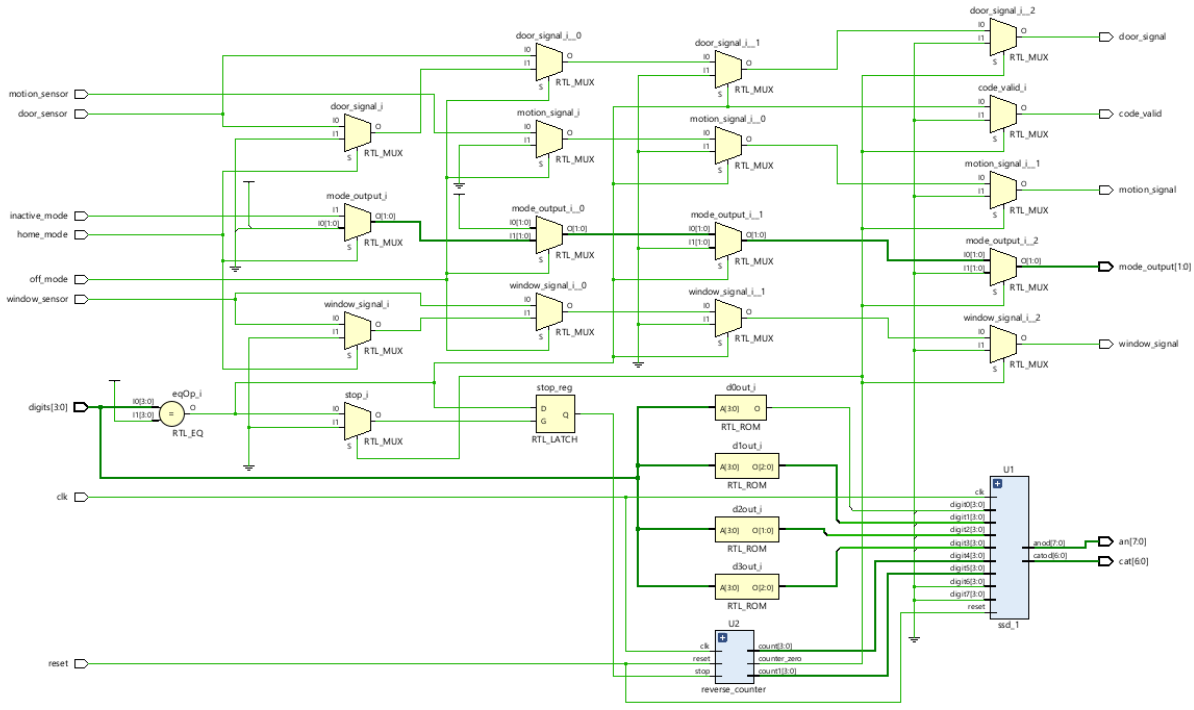
Seven Segment Display

A seven-segment display (SSD) driver is a digital circuit used to control a seven-segment display. This specific implementation drives an eight-digit SSD by multiplexing the display of each digit. The SSD driver takes in eight 4-bit digit inputs and controls the anode and cathode signals to display the corresponding digits on the SSD.

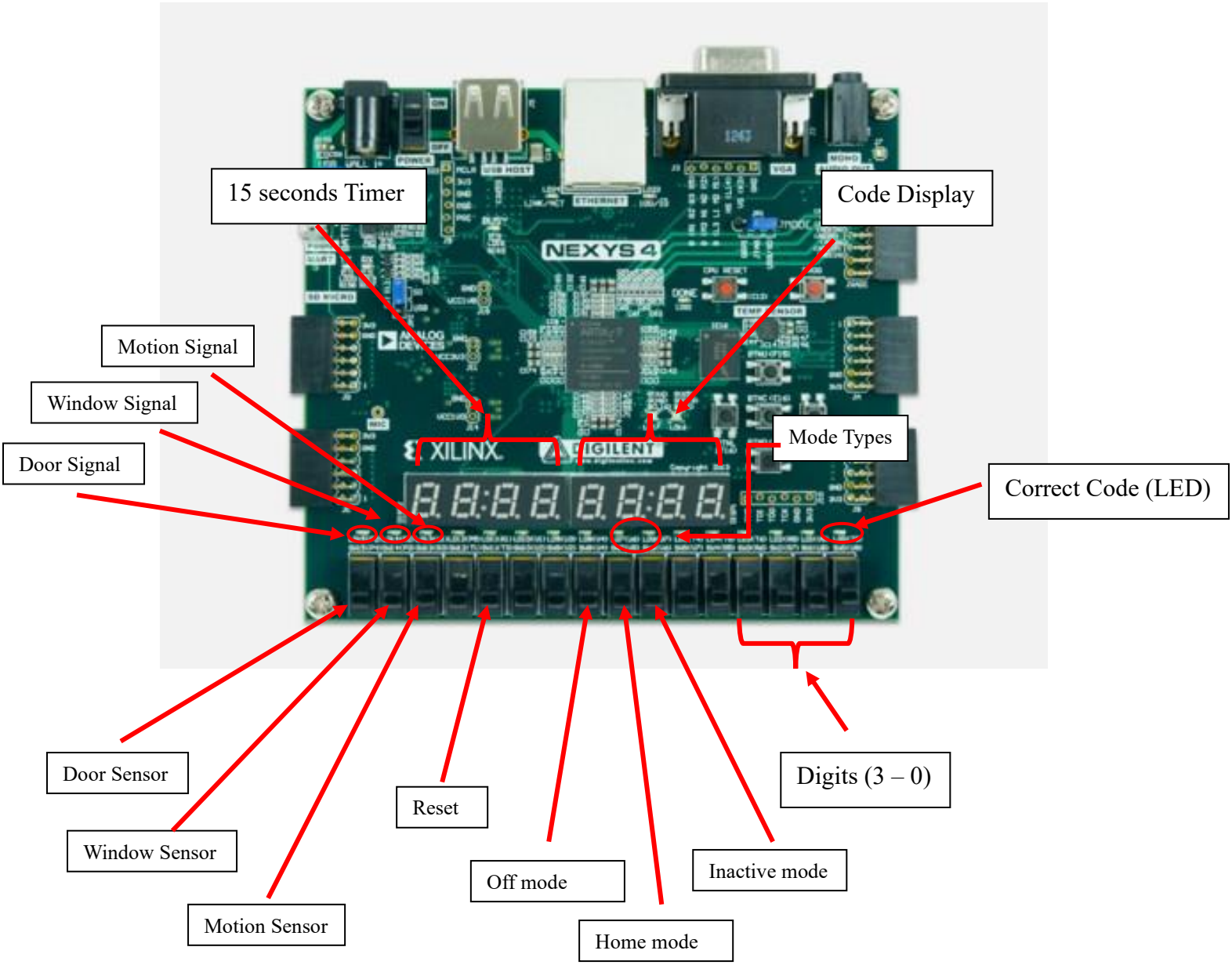


The main code of the system

Upon system startup, a countdown timer begins, providing the user with a limited window to enter a four-digit security code. If the code is not entered before the timer expires, the system will become inactive and will require a reset to be functional again. When the correct code is entered within the allotted time, the user gains the ability to switch between different security modes: Inactive, Home, and Off. The system monitors three sensors—window, door, and motion—according to the selected mode, ensuring appropriate responses to detected activities based on the current security status.



4. Utility and results



- The first four switches are used to enter the code.
- The next three switches according to the schematic are used to change the system mode.
- The next switch is used to reset in system.
- And the last three are used to simulate sensors.
- The LEDs used are according to the picture.
- The first four-digits of the SSD are used for displaying the code.
- The other four-digits of the SSD are used for displaying the 15-second timer.

5. Further development

Future developments for the Home Security System designed on an FPGA and implemented in VHDL can enhance both functionality and hardware performance. The system should be capable of interfacing with real sensors, and once the countdown timer expires without a valid code entry, it could trigger an alarm and automatically notify a security agency to respond to potential intrusions.

Additional improvements could include allowing the user to set and modify the security code at any time. Integrating the system with a mobile application would enable remote monitoring of the home, potentially including live camera feeds for comprehensive surveillance. These enhancements would significantly increase the system's usability and security, providing users with greater control and peace of mind.

5. Technical justifications for the design

For this project, I selected the Nexys 4 FPGA board due to its robust features and versatility. The Nexys 4 is an ideal choice for developing a Home Security System as it provides a comprehensive suite of inputs and outputs necessary for interfacing with various sensors and peripherals. The board's capabilities allow for seamless integration of window, door, and motion sensors, as well as the implementation of a seven-segment display for user interaction.