Systems Design

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I. Case Study

This case study looks at the design and functionality of a system based on the 8086 microprocessor that is optimized to improve the management and operation of air conditioners. The system includes several features that favor user comfort and safety. The system attempts to address typical issues in air conditioning management by combining microprocessor control, temperature sensors, user-friendly interfaces, and a safety system, all while providing centralized and remote control capabilities.

The system is designed with the following features:

1. User-friendly temperature adjustment;
2. Time-based operation scheduling of air conditioning units;
3. Energy consumption display;
4. Centralized control for air conditioner operation and scheduling;
5. Emergency shutoff and alerts for abnormal temperature ranges;
6. Remote Control using Keypad Interface.

User-friendly Temperature Adjustment

The 8086 microprocessor is integrated with various peripherals, including an LCD for real-time temperature and air condition status displays, and a thermostat for temperature adjustments. The thermostat enables users to set desired temperature levels, while the analog-to-digital converter converts sensor data for the microprocessor to process and implement changes. With the LCD displaying the current status of the air conditioning units, users are able to adjust air conditioning temperatures of their preference.

Time-based Operation Scheduling of Air Conditioning Units

The system is capable of implementing time-based operation scheduling of air conditioning units by utilizing interrupt functionalities. With the integration of the 8086 microprocessor and the

8259 interrupt controller, hardware interrupts occur to execute predefined schedules. This allows air conditioning units to automatically turn on or off at specified times.

Energy Consumption Display

The system provides users with information on the operational status of the air conditioning units. The display shows whether each air conditioning unit is turned on or off. This feature allows users to assess the state of the system, as well as monitor and manage air conditioning usage more effectively.

Centralized Control for Aircon Operation and Scheduling

The system allows the user to have master control over the air conditioning units to be turned on/off. The use of a clock module, allows the user to input the desired time for the air conditioning unit to be on/off. By comparing the set scheduled time to the clock, the system utilizes interrupts to turn on/off the air conditioning units at the scheduled moment.

Emergency Shutoff and Alerts for Abnormal Temperature Ranges

The system has an emergency shutoff and alert mechanism whenever the thermostat detects that the air conditioning units are within abnormal temperature ranges. In this system, a range between 30° Celsius and 16° Celsius is considered normal temperature. If the detected temperature exceeds or falls below predefined thresholds, the system triggers an automatic shutoff to prevent damage to the air conditioning units. Simultaneously, the buzzer provides an auditory alert and the LCD displays a warning message to notify users of the issue.

Remote Control using Keypad Interface

A keypad interface is used as a remote control for the system to allow the user to interact with the system from a distance. This prioritizes user convenience and accessibility to simplify the interaction between the user and the system.

The 8086 microprocessor-based system offers an efficient and user-friendly solution for building control system management. With key features like temperature adjustment, time-based scheduling, and centralized control, this system enables users to effectively manage operations and use the system with ease. With shutoff mechanisms, it ensures safety by addressing common challenges like abnormal temperature ranges. This case study highlights the potential of a microprocessor system to improve efficiency and reliability in building control system management.

II. System Overview

The proposed system is a Building Control System designed to monitor and control air conditioning usage within a simulated building environment. The overview of the system is shown in the following figure:

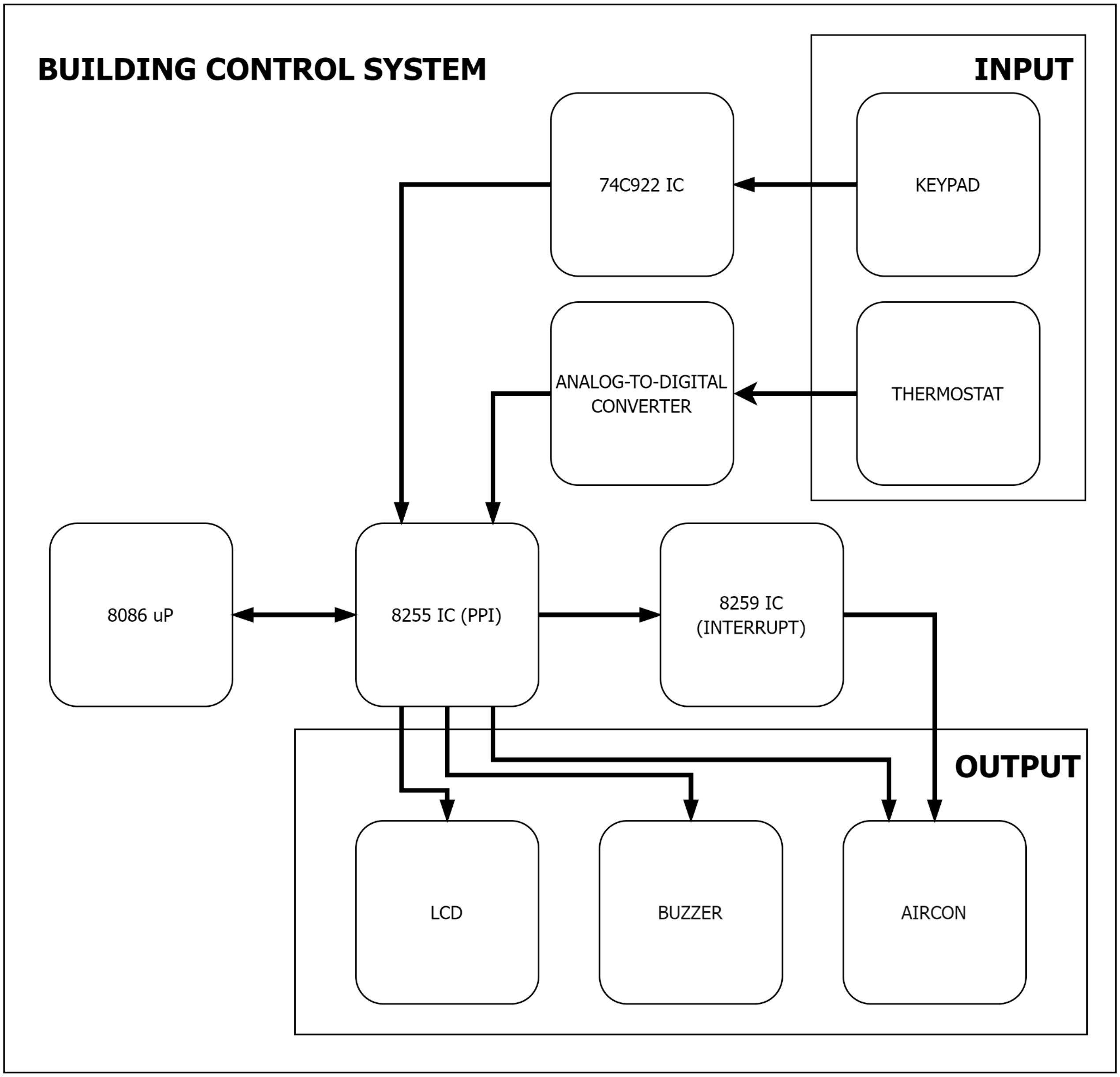

Figure 1.0 - Block Diagram of the System

The core of the system is the 8086 microprocessor, which serves as the main control unit. For simulation purposes, the setup includes air conditioning units. The system also incorporates peripherals such as a liquid crystal display (LCD) for visual interface, a keypad for user input, a buzzer for audio alerts, and a temperature sensor to monitor the temperature conditions of the area. In addition, an 8255 Programmable Peripheral Interface (PPI) is used for parallel communication between the 8086 and the peripherals to be used in the system. An 8259 integrated circuit (IC) will be utilized to manage hardware interrupts. Additional integrated chips such as the 74C922 IC and ADC IC will be used for keypad interfacing and analog-to-digital conversion respectively.

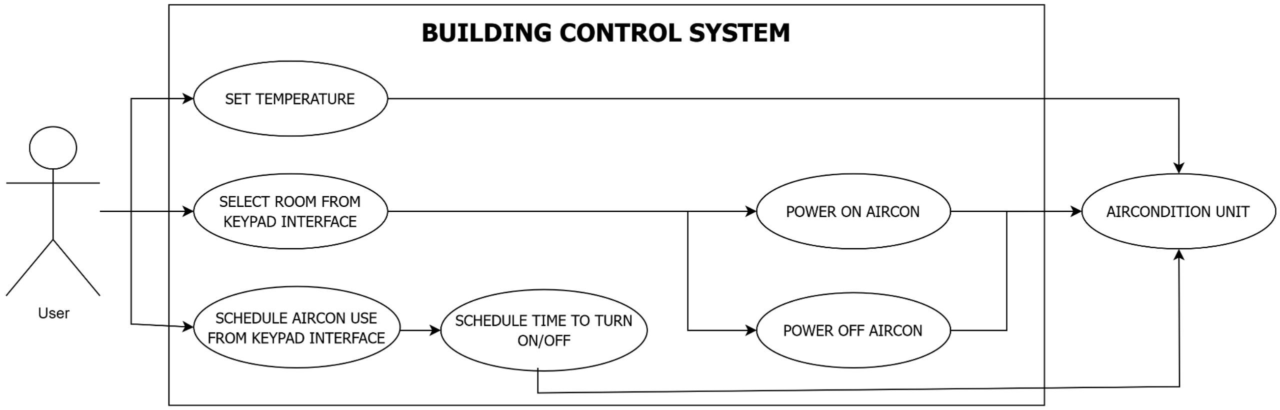

Figure 1.1 - Use Case Diagram

The use case diagram demonstrates how a user interacts with an AC Control System to manage air conditioning units. Using a keypad interface, the user selects a room and turns on or off the air conditioning unit. When turned on, the user in the room can select the desired temperature and schedule usage. These features provide effective and user-friendly control of the air conditioner based on the user's preferences.

System Functionality:

1. **Input Handling**

   Keypad

   User inputs are received through the keypad. The keypad will be utilized to navigate through the menu, enabling air conditioning status to either on or off, and scheduling time for air conditioning units usage.

   Temperature Sensor

   Data processed by the temperature sensor is converted through the use of an Analog-to-Digital Converter and is sent to the 8086 microprocessor.

2. **Processing and Output Generation**

   8086 Microprocessor

   The 8086 microprocessor processes the input data and determines the appropriate system response.

3. **Output Displays**

   LCD

   The LCD is utilized to display the status of every aircon and temperature readings from every room.

   Buzzer

   Auditory alerts for warnings. The buzzer will activate under the condition that there is a significant temperature fluctuation/abnormal temperature readings or emergency shutdowns triggered by environmental and system factors such as temperature beyond the system's predefined thresholds and a power fault is detected.

4. Interrupt Mechanisms

8259 IC

Prioritize tasks and handle urgent events such as emergency shut offs whenever the aircon reaches abnormal temperature ranges and scheduling when to turn on or turn off the aircon.

III. Hardware Design

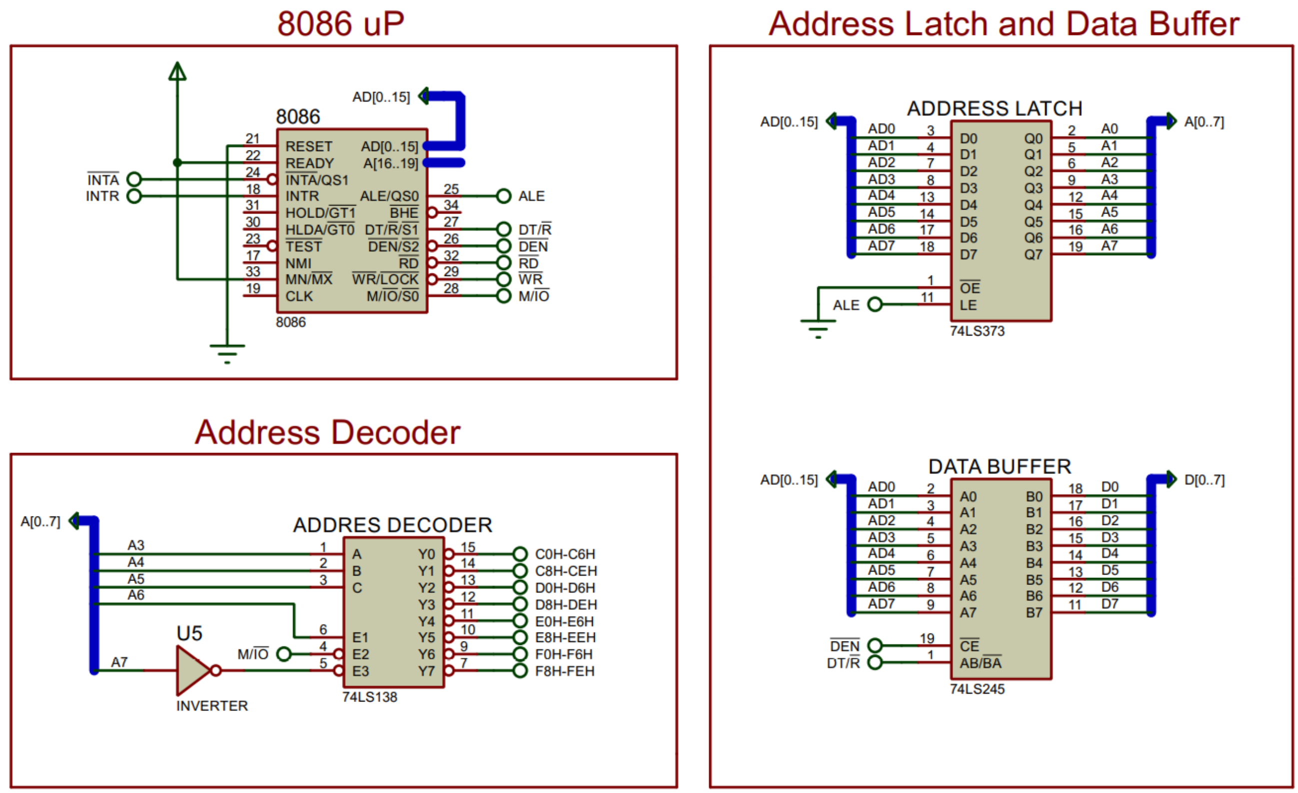

Figure 2.0 - Address Decoding

The system is controlled by the 8086 Microprocessor, it manages tasks like interrupt handling, timing, processing inputs and outputs. The 8086 microprocessor is connected to the address latches, data buffers, and an address decoder to ensure proper addressing and transmission of data to the peripherals as shown in Figure 2.0.

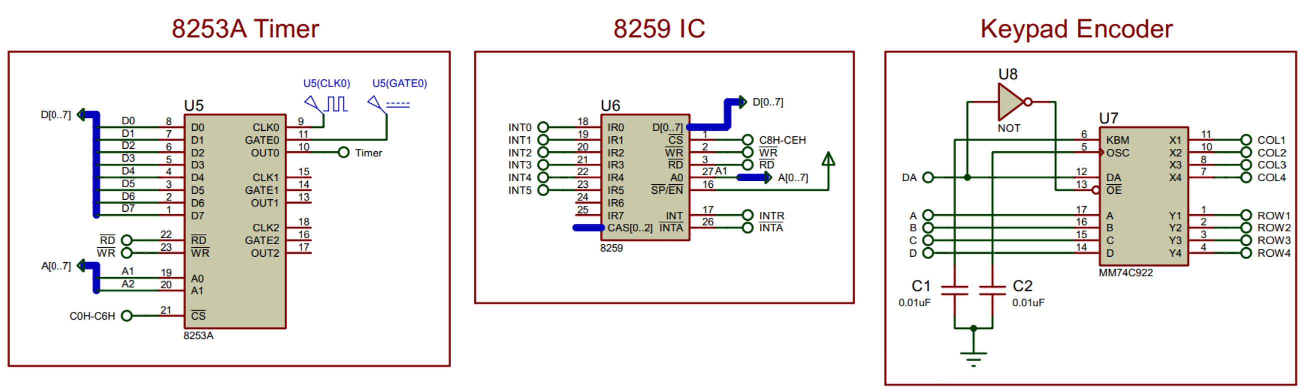

Figure 2.1 - Programmable Peripheral Devices and Keypad Encoder

The 8253 Timer and 8259 Interrupt Controller are essential components for timing and incorporating interrupts into our system. The keypad encoder allows the information to be in digital format from the keypad so that the system can easily read it.

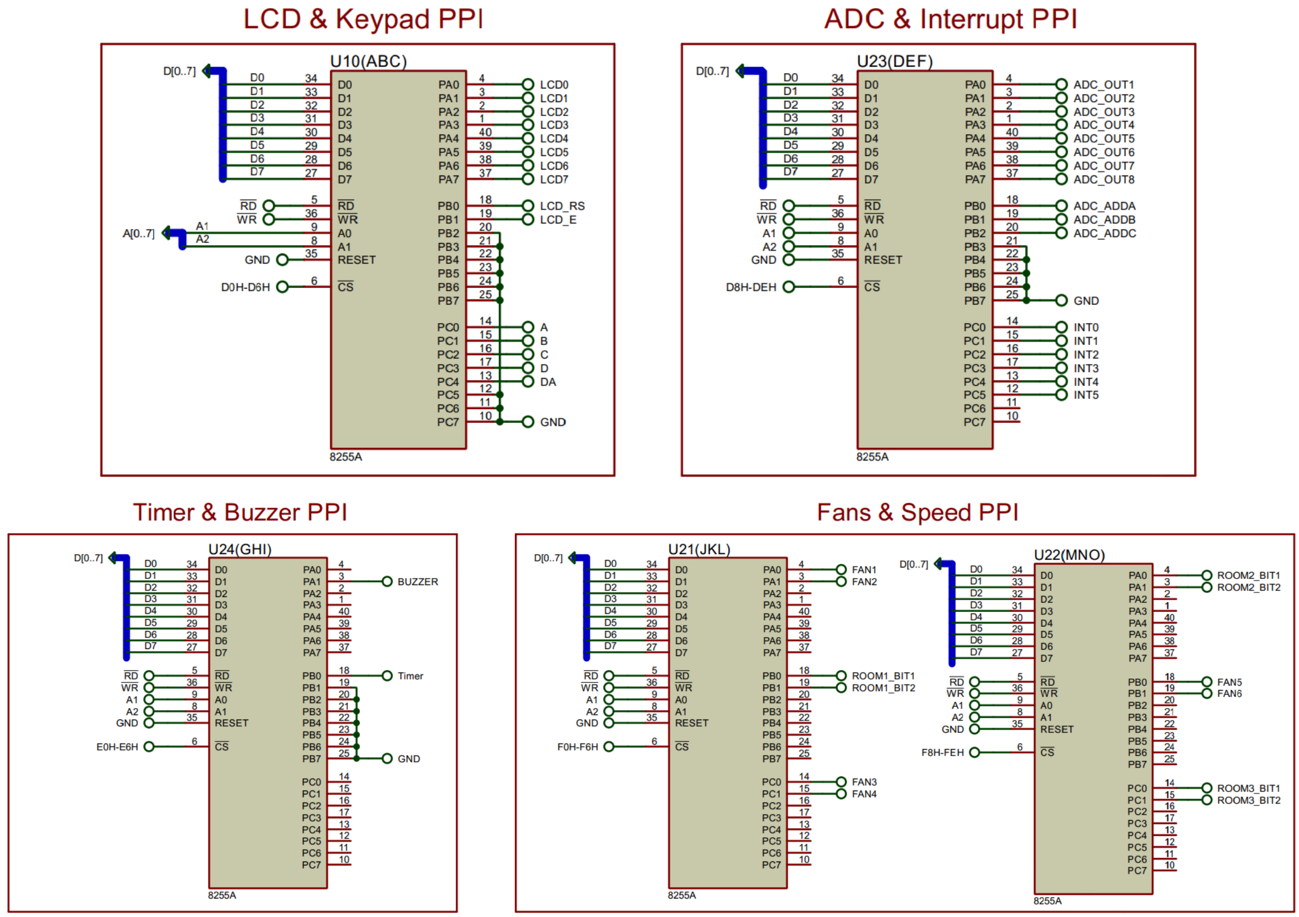

Figure 2.3 - Programmable Peripheral Interfaces

The 8255 Programmable Peripheral Interface allows for the communication of the 8086 microprocessor and peripheral devices. It serves as the main input and output part of the system. The LCD & Keypad PPI handle the output digital data from the LCD and the input digital data from our keypad encoder. For the ADC & Interrupt PPI, the ADC converts the analog data from the temperature sensor (LM35) into digital data to be understood by the microprocessor, while the Interrupts are digital data sent to the 8259 IC. The Timer & Buzzer PPI both take digital inputs and outputs in the system. Finally, the Fans PPI manages the overall control of the aircons in the system. These only handle digital outputs to direct the fan speed and operation.

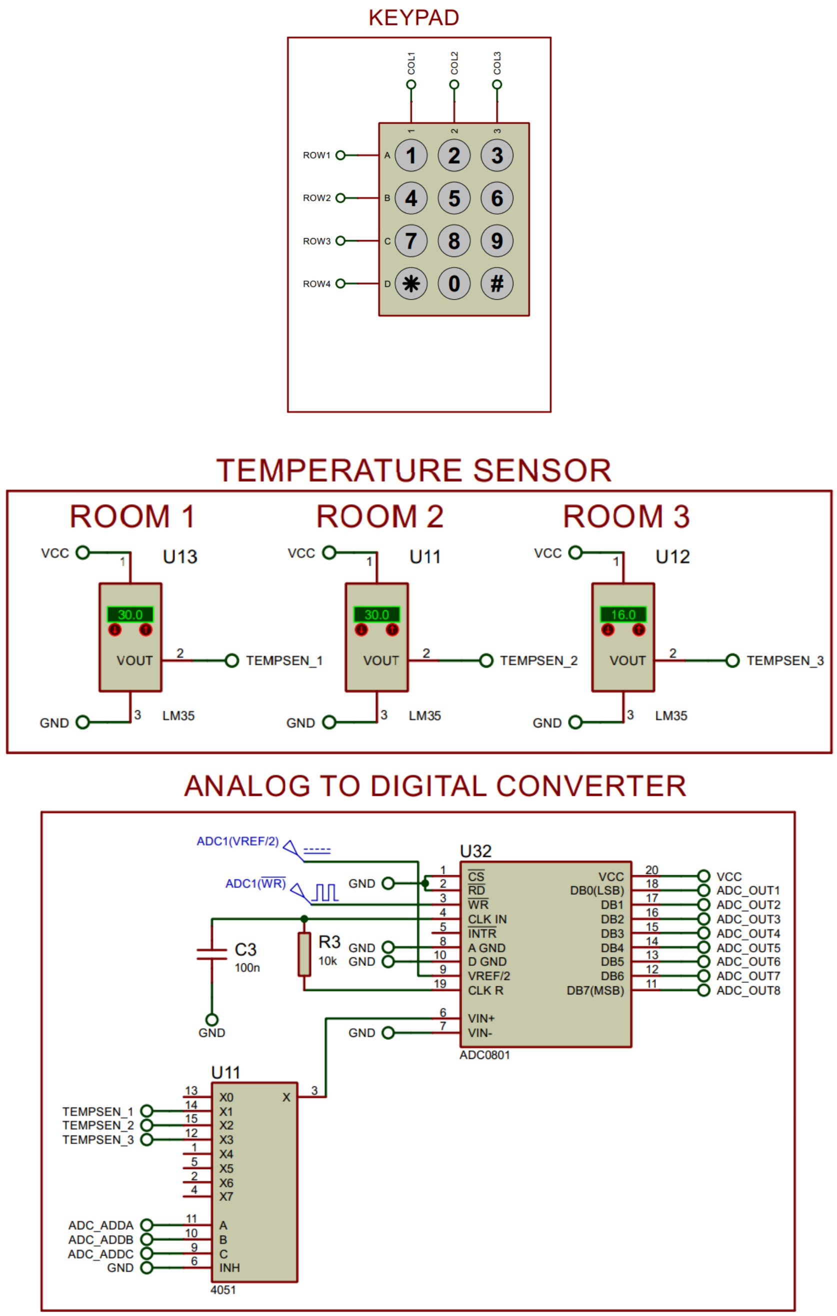

Figure 2.4 - Input Peripherals

The input peripherals are all connected to their respective 8255 PPIs and encoder. The keypad is connected to the encoder, when pressed it sends an analog signal to the keypad encoder, and then the signal is converted into digital data towards its respective PPI. The thermostats are multiplexed and connected to the analog-to-digital converter since the output of the thermostat is an analog signal, it is important to convert that analog data into a digital signal for the microprocessor to interpret.

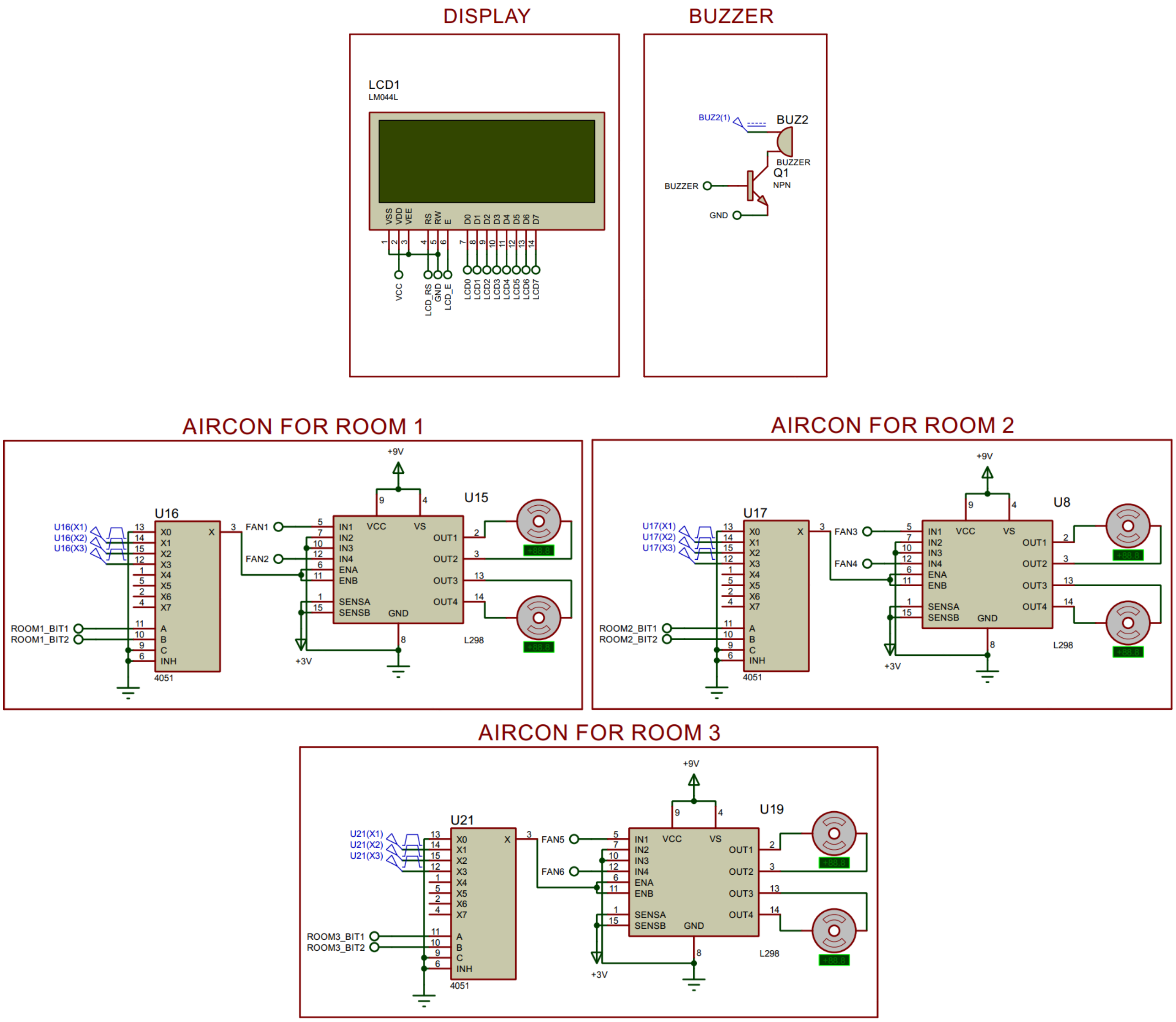

Figure 2.5 - Output Peripherals

The output peripherals serve as critical functions for user interaction and system objectives. The data for all output devices comes from the digital data from the 8255 PPIs. The LCD display serves as a window for the system control. The control for the operation and speed of the fans are through the full bridge driver (L298) which allows each fan to be toggled on/off independently. Speed is then controlled by a multiplexer with different duty cycles connected to the full bridge driver.

IV. Software Design

This system's software architecture is a combination of interrupt-based and scheduler-based approaches, with programmed I/O used selectively for basic operations. This design was chosen to efficiently handle both real-time and periodic chores while remaining simple for non-critical functions.

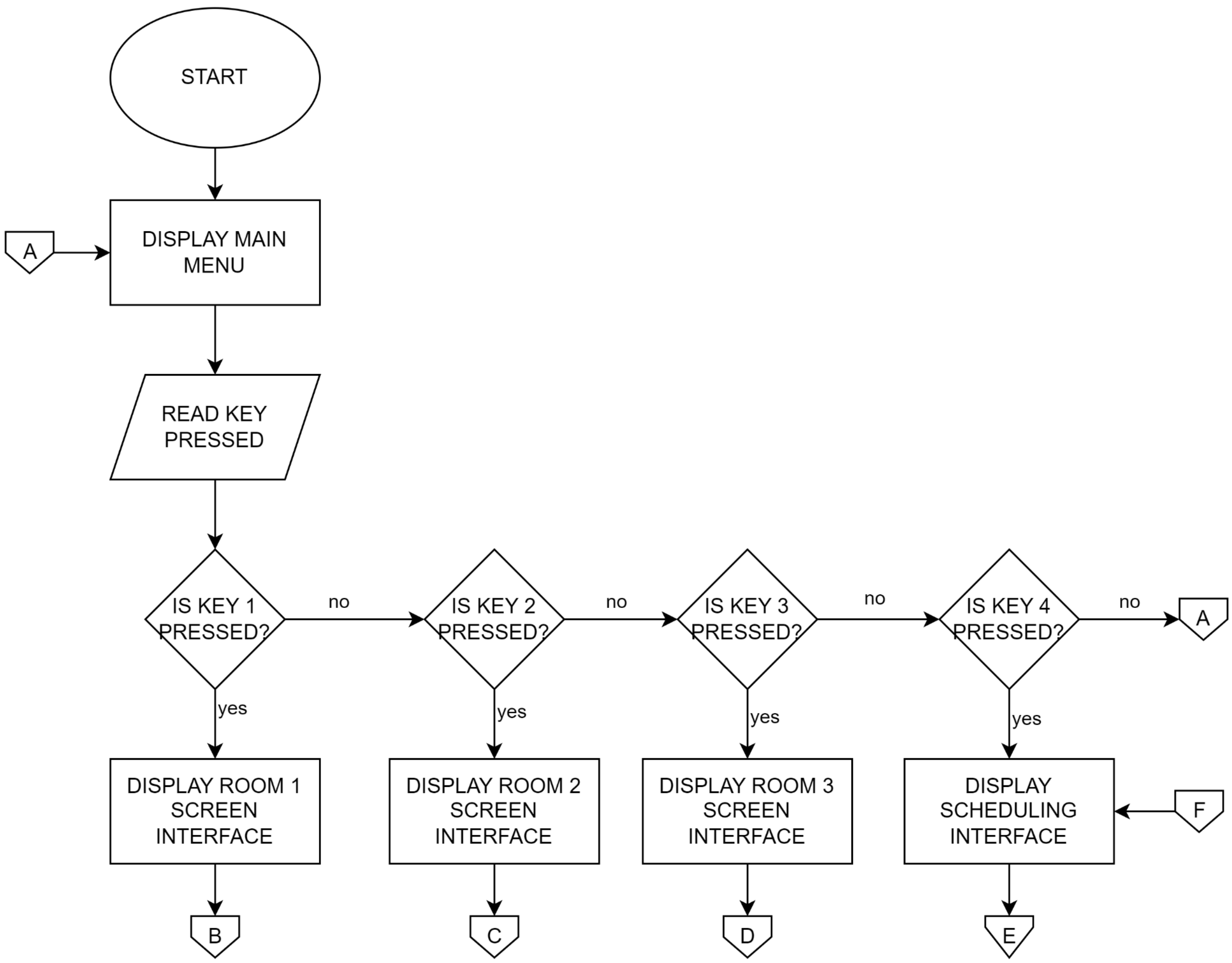

Figure 3.1.0 - Overall Architecture of the System

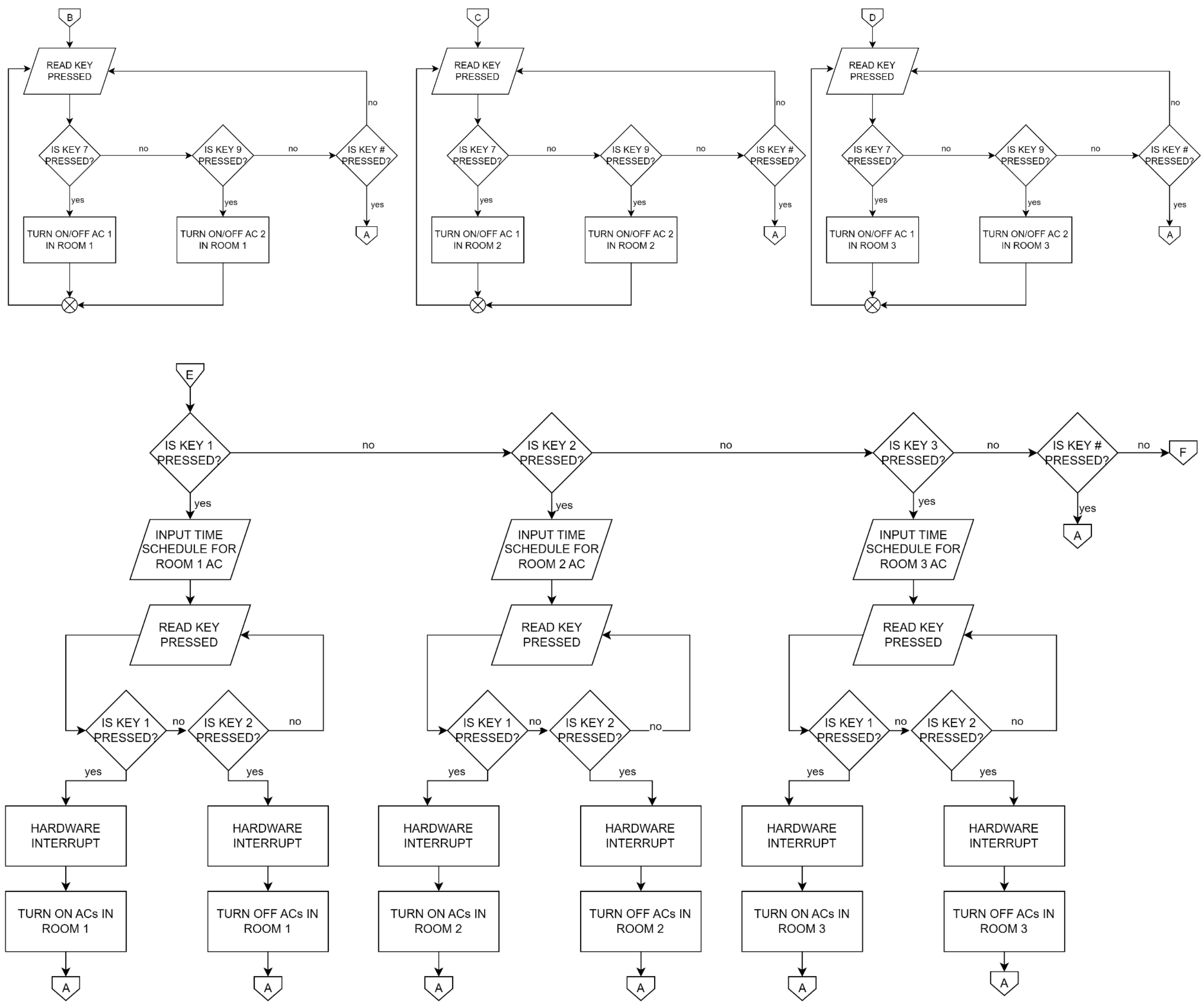

Figure 3.1.1 - Overall Architecture of the System

Interrupt-Based Architecture:

The system has an interrupt-based architecture for time-sensitive tasks, which ensures immediate response. Interrupts are used by functions such as the emergency shutdown mechanism to detect abnormal temperature ranges then immediately interrupt the foreground routine, and activate LCD and buzzer alerts. Similarly, fan operation uses flags where interrupts can also manage and control each fan.

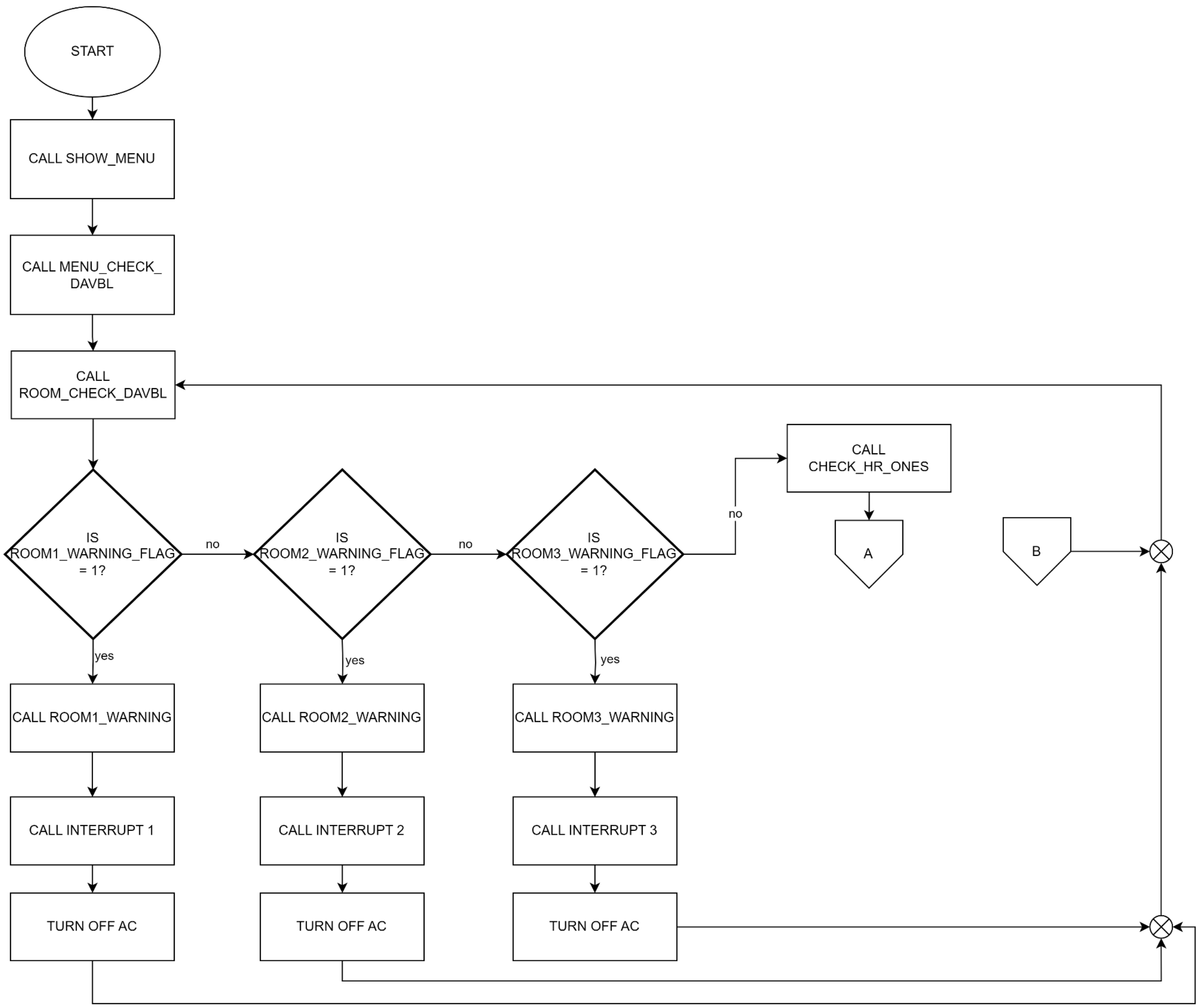

Figure 3.2.0 - Interrupt-Based Architecture *(Abnormal Shut Off for Abnormal Temperature Range)*

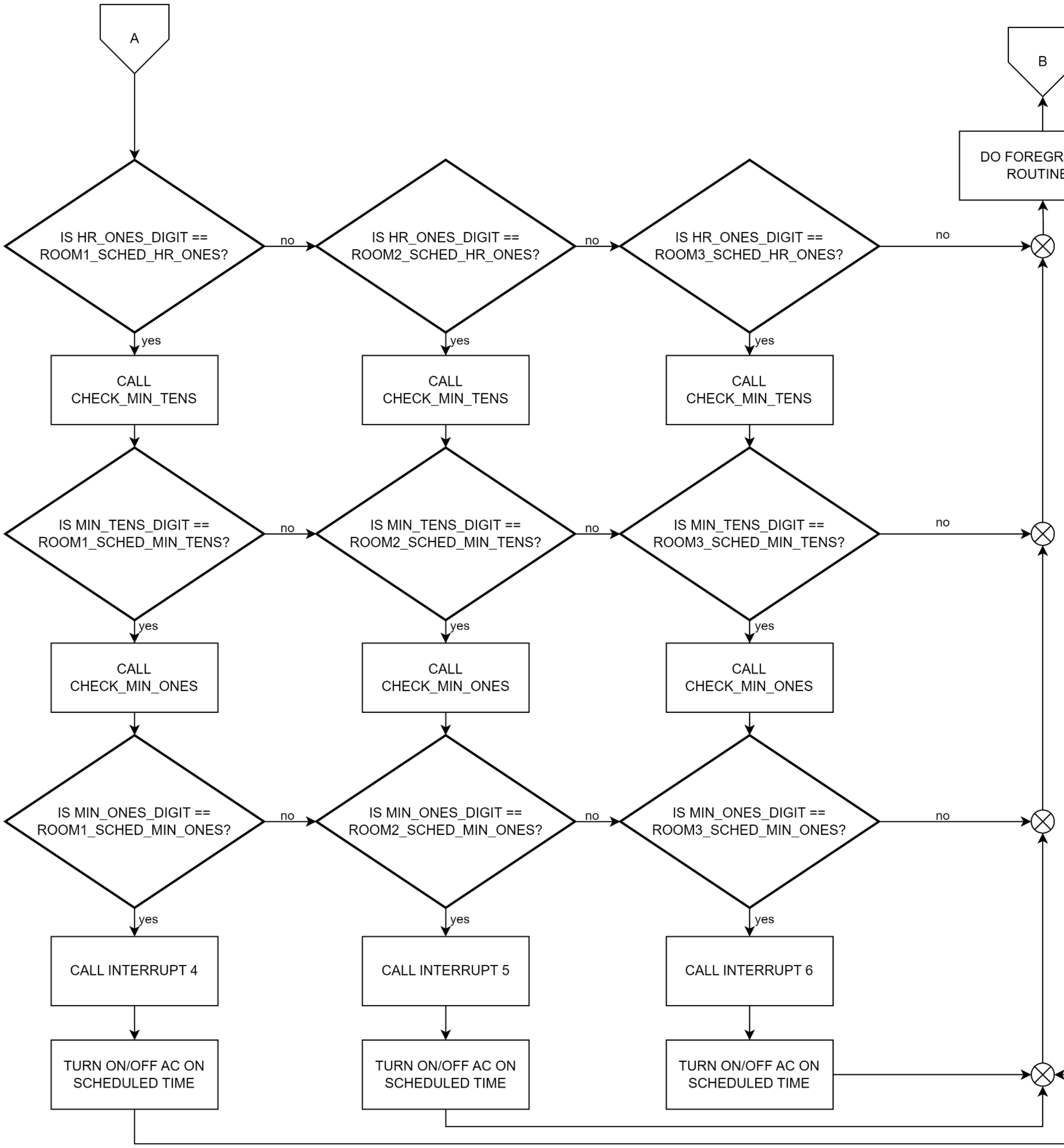

Figure 3.2.1 - Interrupt-Based Architecture *(Time-based Scheduling)*

Scheduler-Based Architecture:

The system utilizes a scheduler-based architecture to handle periodic tasks like adaptive scheduling. This ensures that operations such as fan operations are scheduled depending on the user's needs, optimizing system efficiency and performance without interfering with other processes.

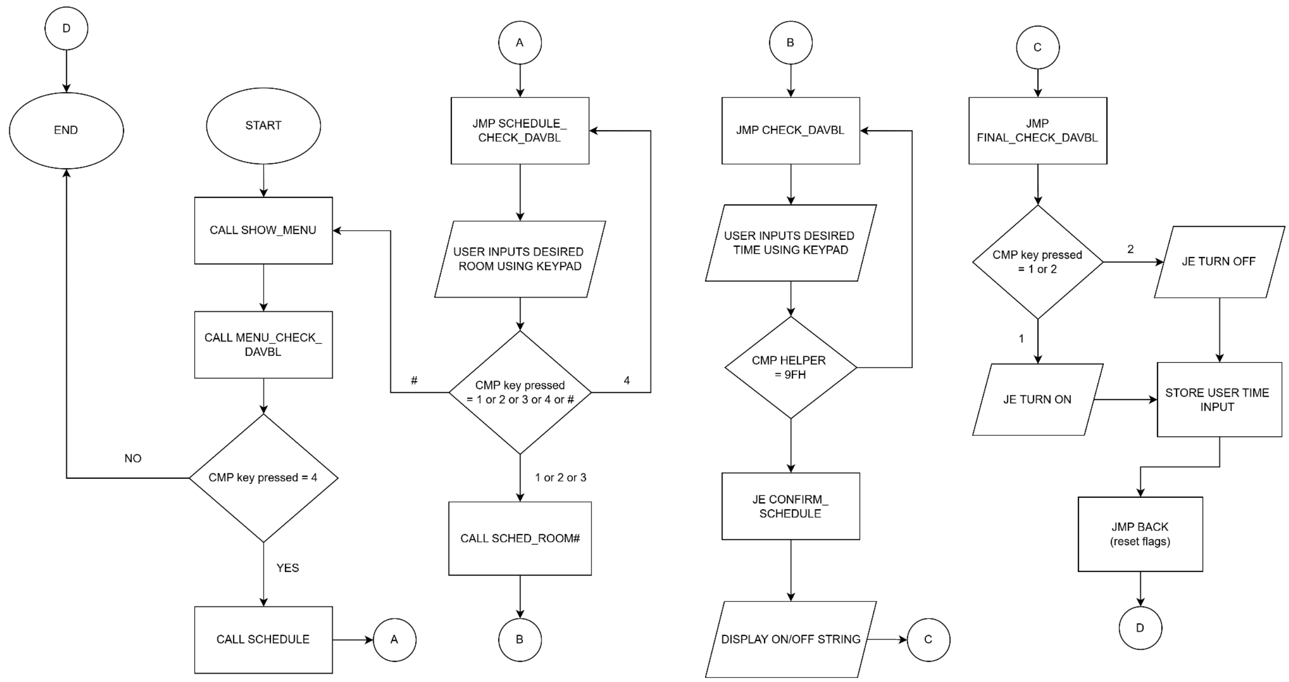

Figure 3.3 - Scheduler-Based Architecture Flowchart

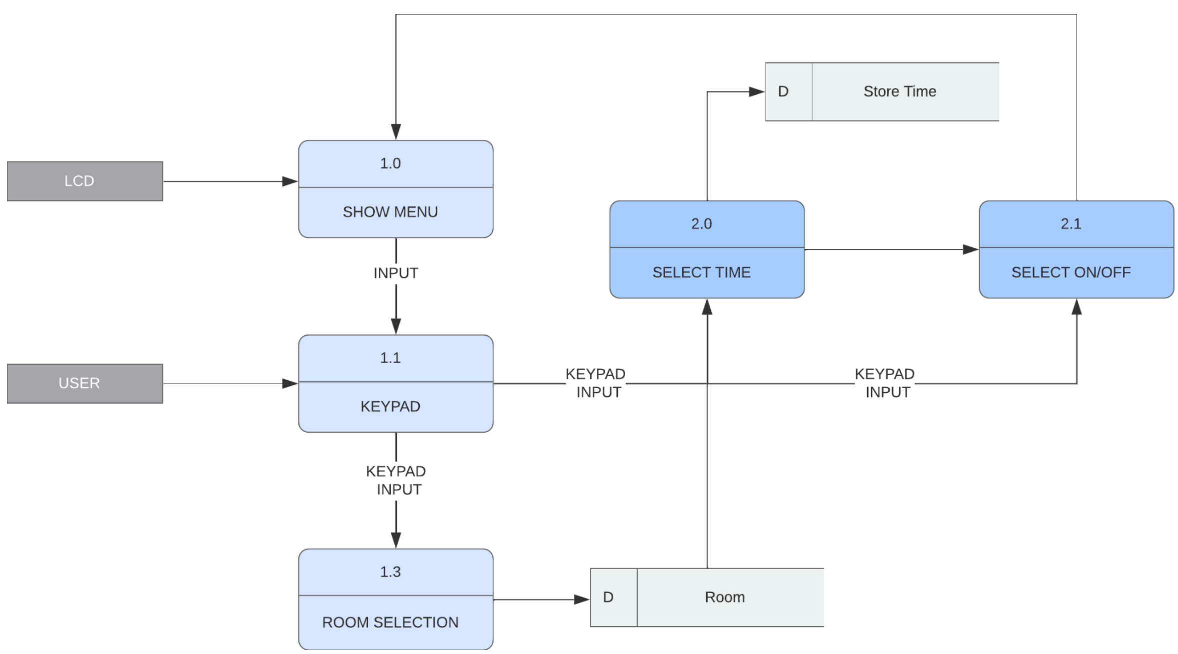

Figure 3.4 - Scheduler-Based Architecture Data Flow Diagram

Programmed I/O:

The system requires the use of the programmed I/O architecture to ensure details are visibly present in the system. For example the setting up of the LCD, keypad, and other peripherals at startup. This also includes the basic reading of inputs from the sensors and outputting the display to the LCD. This architecture allows the system to meet its basic requirements.

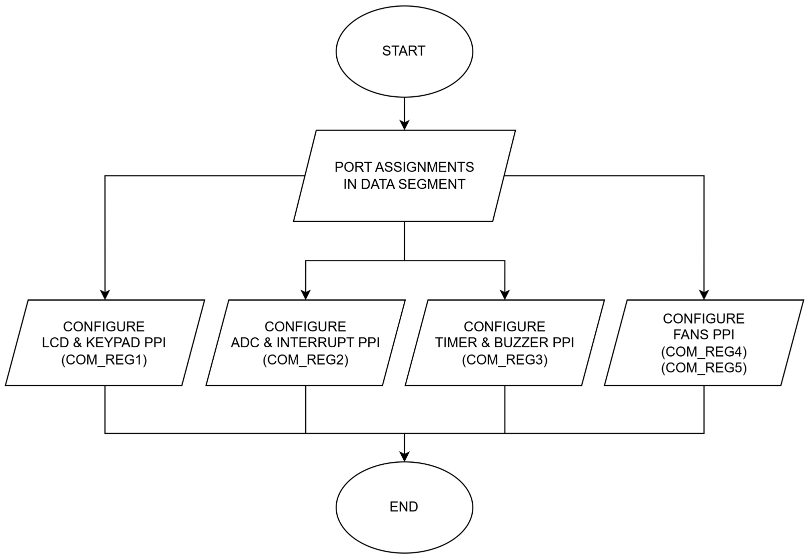

Figure 3.5 - 8255 PPI Configuration Flowchart

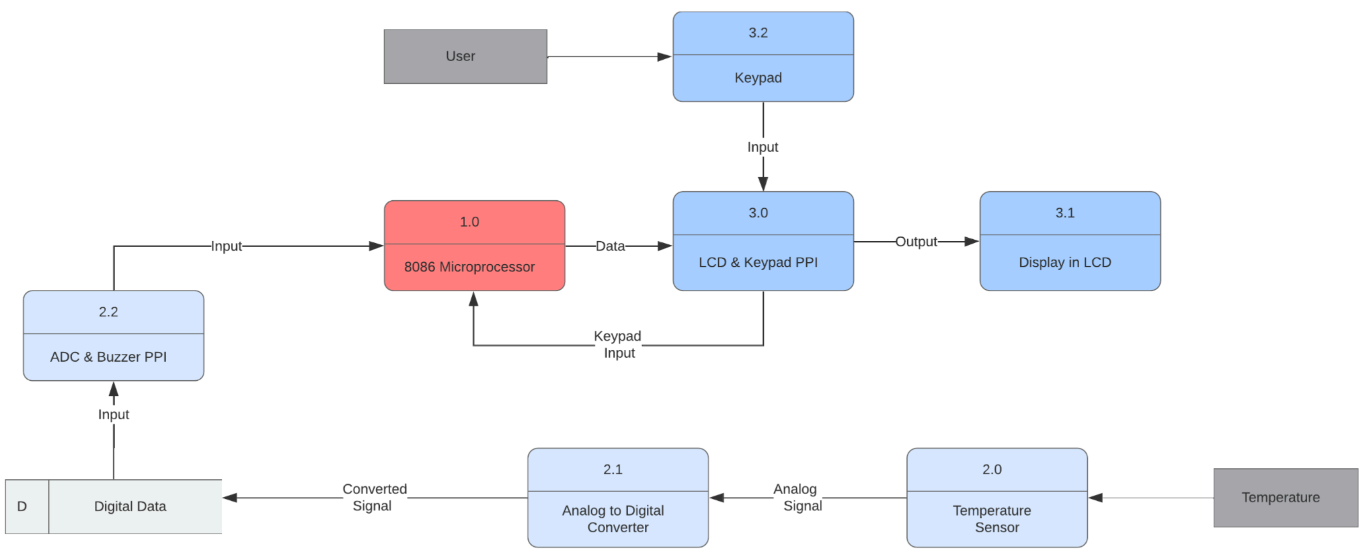

Figure 3.6 - Programmed I/O Data Flow Diagram

References

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