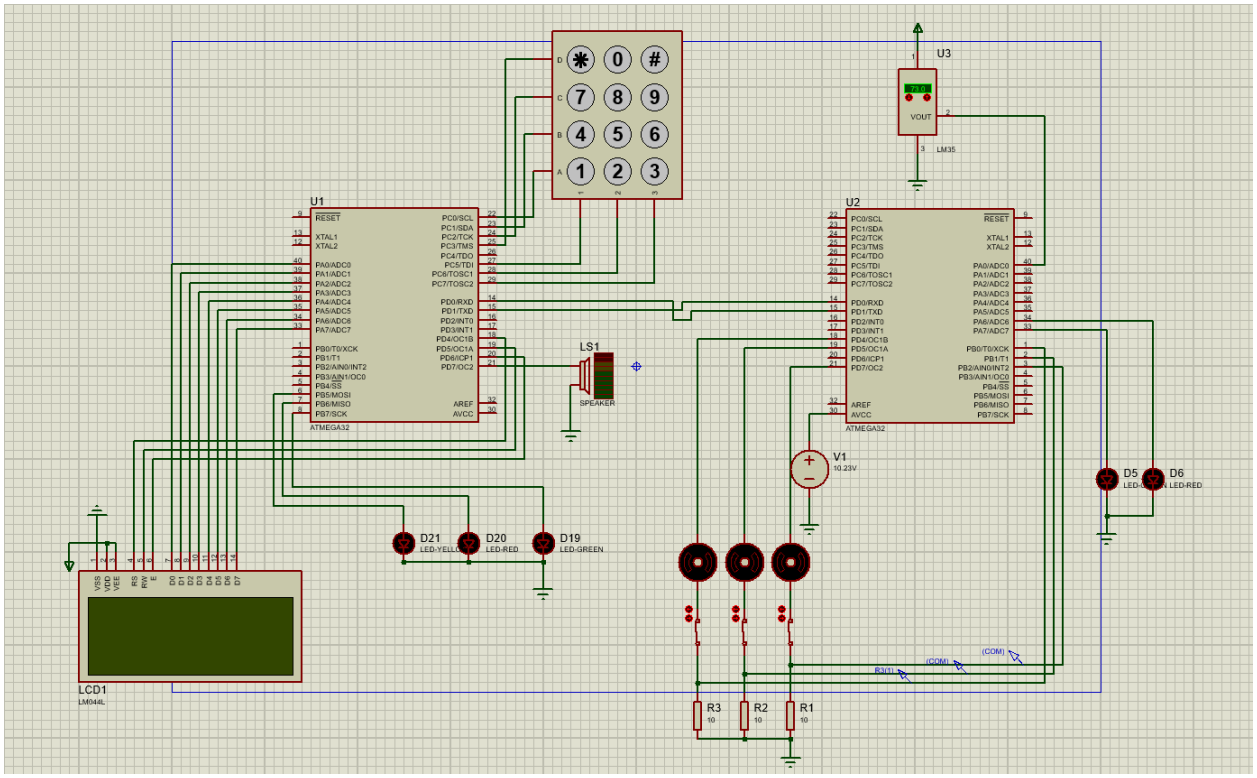
Micro Project Documentation **Mohammadreza Naziri 40030505**

A master/slave temperature control system using two Atmega32 microcontrollers

System Overview



Hardware Components

- **Atmega32 Microcontrollers**: Master unit handles user interface; Slave unit manages temperature control.
- **LCD Screen**: Connected to PORTA on the Master, displays menus and system information.
- **Keypad**: Connected to PORTC on the Master, used for password entry and menu navigation.
- **LED Indicators and Speaker**: Connected to PORTD on the Master, indicate system status and alarm.
- **Temperature Sensor (LM35)**: Connected to ADC0 on the Slave, measures server temperature.
- **Motors**: Controlled via Timer/Counter 1A, 1B, and 2 on the Slave, manage cooling based on temperature.
- **Speaker for Alarm**: Uses Timer/Counter2 and Fast PWM on the Master to generate sound.

Software Design

- **Password Entry and Verification**:
  - User enters a password via the keypad.
  - The Master transmits the encrypted password to the Slave using USART.
  - The Slave decrypts the password and verifies it.
  - The Slave sends a response back to the Master indicating success or failure.
- **Temperature Monitoring and Motor Control**:
  - The Slave reads temperature data from the LM35 sensor connected to ADC0.
  - Motor duty cycles are adjusted based on the temperature:
    - Duty cycle increases by 10% per 10°C.
    - If motors are disconnected via switches, the duty cycle is redistributed among the connected motors.
- **Alarm System**:
  - If a critical error occurs, the Master activates the speaker using Timer/Counter2 and Fast PWM to generate an alarm.
- **LCD Display**:
  - Displays system menus, current temperature, and motor status.
- **LED Indicators**:
  - Green LED: Normal operation.
  - Yellow LED: One or two motors failed.
  - Red LED: Critical error (all motors failed or insufficient cooling capacity).

System Functionality

- **Initial Lock State**: System is locked and prompts for a password on the LCD.
- **Password Entry and Verification**: User enters the password; the Master sends it to the Slave for verification.
- **System Start**: On successful password verification, the system unlocks and the Slave starts sending data to the Master.
- **Motor Control Logic**:
  - Motors are controlled based on the temperature read from the LM35 sensor.
  - Duty cycle adjustments:
    - 10% per 10°C per motor.
    - Redistribution of duty cycle if motors are disconnected.
- **Error Handling**:
  - Display error messages on the LCD.
  - Activate LED indicators and speaker alarm.

User Interface

- **LCD Display**:
  - Main menu with options for checking motor status and temperature.
  - Motor status menu shows individual motor information (working status and duty cycle).
  - Temperature menu displays the current temperature.
- **Keypad**:
  - Used for password entry and menu navigation.

- **LED Indicators**:
  - Green: Everything is functioning normally.
  - Yellow: One or two motors failed.
  - Red: Critical error.
- **Speaker**:
  - Activated for alarms using Fast PWM on Timer/Counter2.

Communication Protocol

- **USART Communication**:
  - Master and Slave communicate via USART without interrupt.
  - Passwords are encrypted using AES before transmission.
  - The Slave decrypts and verifies the password.
  - Communication includes commands for password verification, temperature data requests, and motor status updates.

Bonus Features

- **Password Attempts and Lockout Mechanism**:
  - After three incorrect password attempts, system locks the user out for 30 seconds.
- **Encrypted Communication**:
  - AES encryption ensures secure password transmission.
- **Alarm System**:
  - Activated for critical errors using the speaker connected to PORTD on the Master.
- Documentation