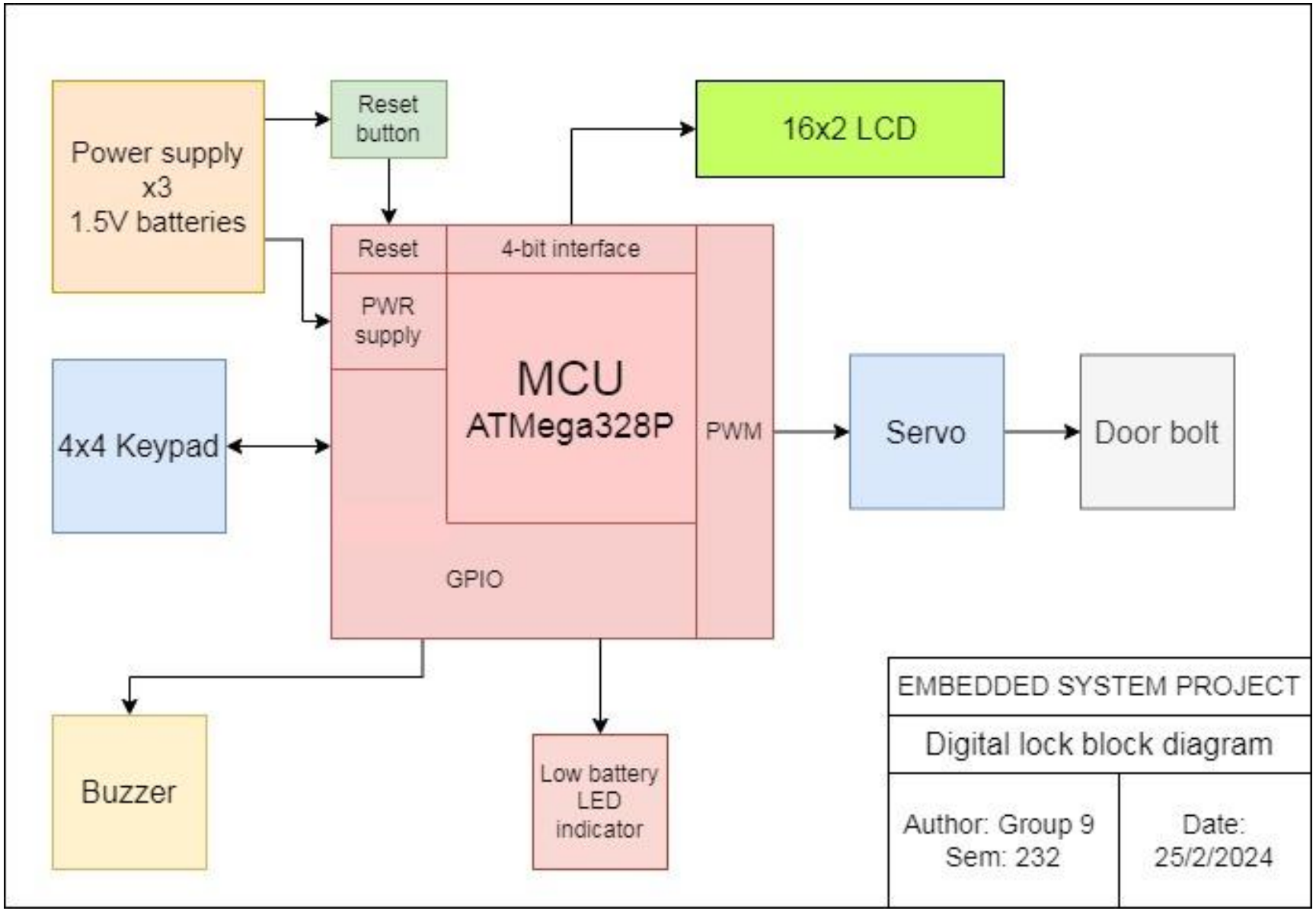

Power supply
x3
1.5V batteries
Reset
button
16x2 LCD
Reset
4-bit interface
PWR
supply
MCU
ATMega328P
PWM
Servo
Door bolt
4x4 Keypad
GPIO
Buzzer
Low battery
LED
indicator
EMBEDDED SYSTEM PROJECT
Digital lock block diagram
Author: Group 9
Sem: 232
Date:
25/2/2024

HARDWARE SELECTION

- **Microcontroller:** ATMEGA328P

Manufacturer Part Number: ATMEGA328P-PU

Package / Case: 28-DIP (0.300", 7.62mm)

Voltage - Supply (Vcc): 1.8~ 5.5VDC

DC current per I/O pin: 40mA

Memory: 32KB FLASH, 2KB SRAM, 1KB EEPROM

6 selectable clock sources

23 general purpose I/O lines which are enough for LCD (8 lines), Keypad (8 lines), Servo motor (1 line), Buzzer (1 line)

Available internal EEPROM for storing password

Available Timers for delay and providing PWM for controlling servo motor

5 software selectable power saving modes

Available external interrupts for waking up the system from sleep

Available ADC channels for indicating low input voltage

- **Display device:** LCD1602

16 Characters x 2 Lines LCD Module (black character, green screen, backlight)

Operating voltage: 5VDC

Interface: 8-bit/4-bit mode

- **Input device:** Keypad

Matrix keypad 4x4, 16 buttons

- **Actuator:** SG90 Servo Motor

Operating voltage: 5VDC

Stall Torque: 1.2kg-cm ~ 1.6kg-cm

Rotational Degree: 180 degree

- **Output device:** Buzzer, LED

- The buzzer is used to signal the opening of the door and to sound an alarm when an incorrect password is entered multiple times.

Operating voltage: 3.5 – 5.5VDC

Max Rated Current: ≤32 mA

Min. Sound Output at 10cm: 85dB

- The LED red is used to indicate low battery

1.8-2.2VDC forward drop

Max current: 20mA

Luminous Intensity: 150-200mcd

- **Power supply:** Alkaline AA Batteries

Three 1.5V Alkaline AA Batteries are connected in series

Supply voltage range: 3.6V ~ 4.8V

Capacity: 2600mAh

- **Other components**

Resistor for LED:

Forward voltage drop across LED: 2V Desired LED current: 12mA

$$R = \frac{V_{cc} - V_{LED}}{I} = \frac{4.8 - 2}{12 \times 10^{-3}} = 233.333\ \Omega$$

⇒ Choosing R = 220Ω

- Resistor for LCD Backlight:

Forward voltage drop across Backlight: 3.8V Desired current: 12mA

$$R = \frac{V_{cc} - V_{LED}}{I} = \frac{4.8 - 3.8}{12 \times 10^{-3}} = 83.333\ \Omega$$

⇒ Choosing R = 82Ω

- Potentionmeter for LCD Contrast Pin

The bias voltage applied to the display's contrast pin determines the difference in voltage levels between the segments and the backplane of the LCD, affecting the displayed contrast. The typical recommended bias voltage range is between 3V to 5V and use a potentiometer as part of a voltage divider circuit.

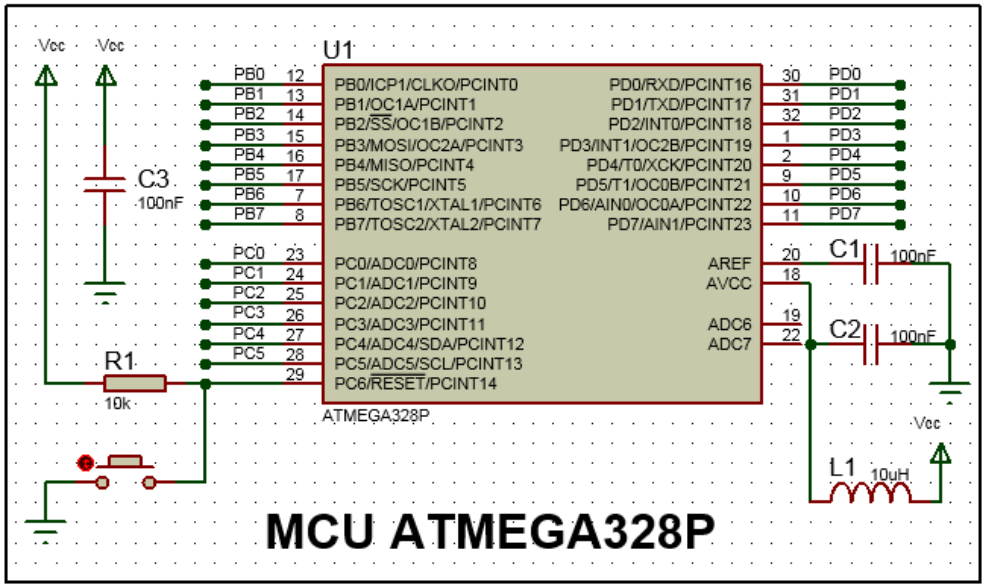
Choosing a 10K Potentionmeter

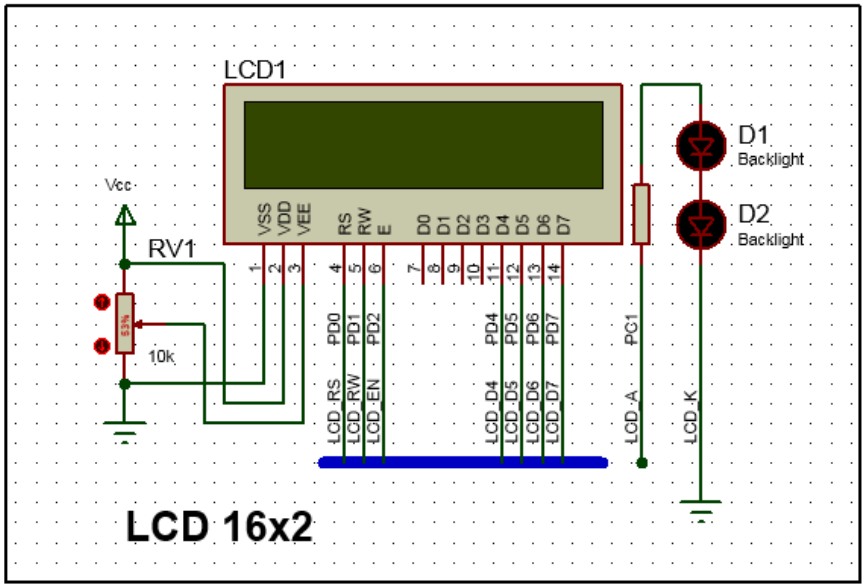
$$V_{contrast} = V_{cc} \times \frac{R_{varied}}{R_{max}} = 4.8 \times \frac{R_{varied}}{10K}, \text{where } 0 < R_{varied} < R_{max}$$

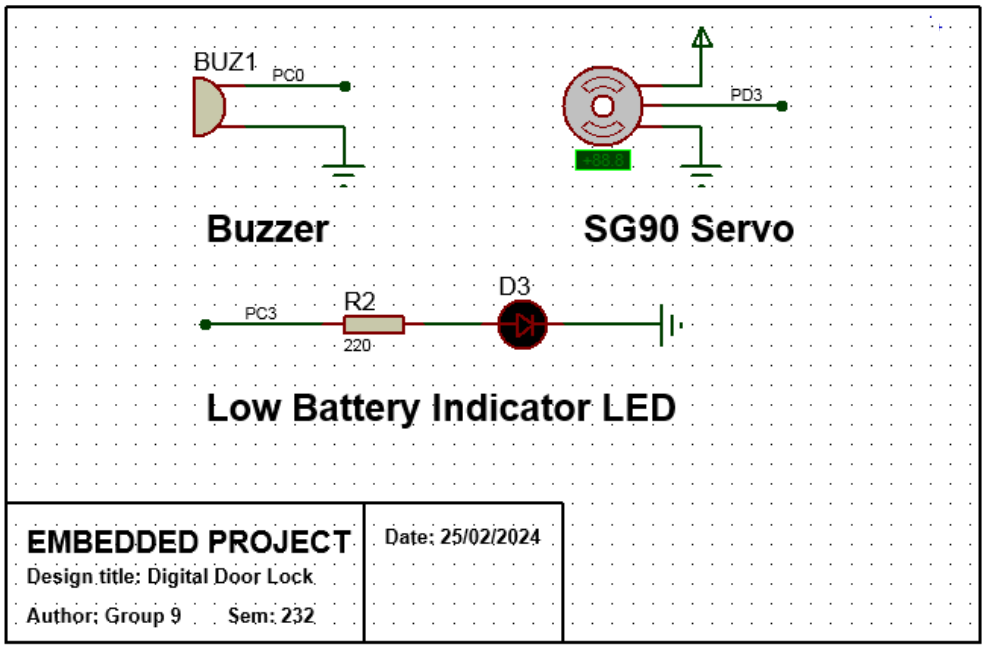
⇒ $V_{contrast}$ is varied from 0V to 4.8V

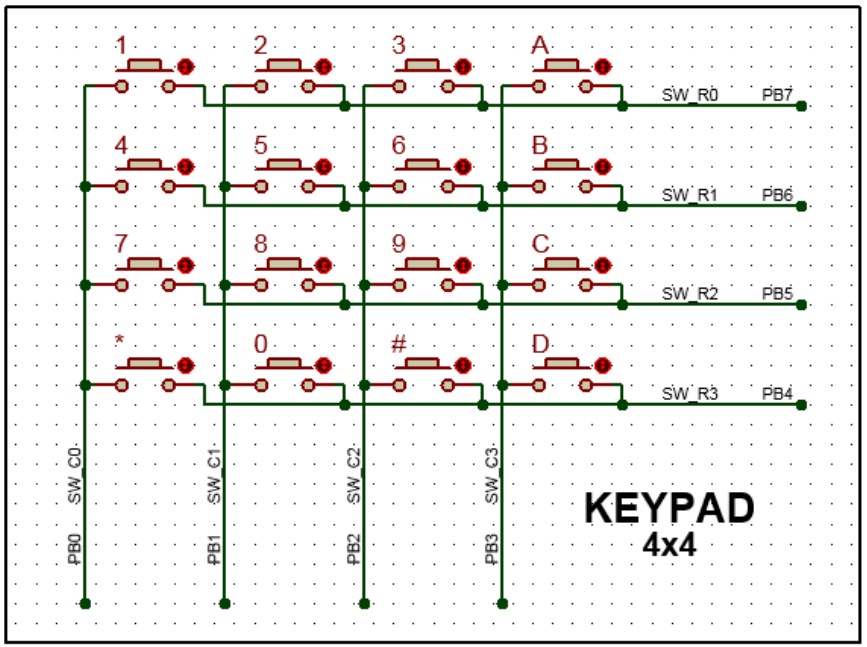
- Based on Datasheet and AVR® Microcontroller Hardware Design Considerations document, it is recommended that using:

10K pull-up resistor to the Reset line
100nF decoupling capacitor for Vcc
100nF capacitor and 10uH inductor to the AVcc pin that performs as a low pass filter.


Vcc
Vcc
U1
PB0 12
PB1 13
PB2 14
PB3 15
PB4 16
PB5 17
PB6 7
PB7 8
PC0 23
PC1 24
PC2 25
PC3 26
PC4 27
PC5 28
29
PB0/ICP1/CLKO/PCINT0
PB1/OC1A/PCINT1
PB2/SS/OC1B/PCINT2
PB3/MOSI/OC2A/PCINT3
PB4/MISO/PCINT4
PB5/SCK/PCINT5
PB6/TOSC1/XTAL1/PCINT6
PB7/TOSC2/XTAL2/PCINT7
PC0/ADC0/PCINT8
PC1/ADC1/PCINT9
PC2/ADC2/PCINT10
PC3/ADC3/PCINT11
PC4/ADC4/SDA/PCINT12
PC5/ADC5/SCL/PCINT13
PC6/RESET/PCINT14
PD0/RXD/PCINT16
PD1/TXD/PCINT17
PD2/INT0/PCINT18
PD3/INT1/OC2B/PCINT19
PD4/T0/XCK/PCINT20
PD5/T1/OC0B/PCINT21
PD6/AIN0/OC0A/PCINT22
PD7/AIN1/PCINT23
AREF
AVCC
ADC6
ADC7
30 PD0
31 PD1
32 PD2
1 PD3
2 PD4
9 PD5
10 PD6
11 PD7
20
18
19
22
C3
100nF
R1
10k
C1
100nF
C2
100nF
Vcc
L1
10uH
ATMEGA328P
MCU ATMEGA328P


LCD1
VSS
VDD
VEE
RS
RW
E
D0
D1
D2
D3
D4
D5
D6
D7
Vcc
RV1
10k
PD0
PD1
PD2
PD4
PD5
PD6
PD7
PC1
LCD_RS
LCD_RW
LCD_EN
LCD_D4
LCD_D5
LCD_D6
LCD_D7
LCD_A
LCD_K
D1
Backlight
D2
Backlight
LCD 16x2


BUZ1
PC0
Buzzer
PD3
SG90 Servo
PC3
R2
220
D3
Low Battery Indicator LED
EMBEDDED PROJECT
Design title: Digital Door Lock
Author: Group 9
Sem: 232
Date: 25/02/2024


1
2
3
A
4
5
6
B
7
8
9
C
*
0
#
D
SW_R0
SW_R1
SW_R2
SW_R3
PB7
PB6
PB5
PB4
SW_C0
SW_C1
SW_C2
SW_C3
PB0
PB1
PB2
PB3
KEYPAD
4x4

Functional MCU connections:

- PC6 (RESET active low) -> button to trigger reset.
- AVCC -> Power source
- AREF -> Power source

4x4 keypad:

- PB0-PB3: Output mode (Columns)
- PB4-PB7: Input mode (Rows)
- DDRB: 0x0F
- PORTB: 0xFX (X is don’t care)
- 14 character buttons, 2 functional buttons

16x2 Character LCD connections:

- VSS -> GND
- VDD -> Power source
- VEE -> Variable resistor that connect to power source
- RS -> PD0
- RW -> PD1
- E -> PD2
- D4-D7 -> PD4-PD7
- Backlight -> PC1

Buzzer:

- Pin 1 -> PC0
- Pin 2 -> GND

Servo:

- Pin 1 -> Power source
- Pin 2 -> PD3 (PWM)
- Pin 3 -> GND

Low battery LED indicator:

- Control through PC3