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

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

$\Rightarrow$ Choosing R = 220Ω

- Resistor for LCD Backlight:

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

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

$\Rightarrow$ 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

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

$\Rightarrow V_{contrast}$ 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.

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