ELL201 Project Report

Password-Based Digital Lock with Password Reset

1 Introduction

This project implements a password-protected digital lock system on a CPLD board. The lock uses a 4-bit switch input as the password.

The system supports features like:

- Lock/Unlock with password entry
- Lockout after multiple incorrect attempts
- Password reset when unlocked
- Automatic re-lock after a timeout

2 System Overview

Inputs

- **clk**: System clock (1 Hz assumed for timing)
- **switches[3:0]**: 4-bit password input
- **enter_btn**: Button to confirm entry or relock
- **set_btn**: Button to set a new password (when unlocked)

Outputs

- **leds[7:0]**: Status indicators
  - `leds[0]` - Locked
  - `leds[1]` - Unlocked
  - `leds[2]` - Lockout
  - `leds[7]` - Ready to set new password

3 Design Details

States

- **LOCKED**: System locked; awaits correct password
- **UNLOCKED**: Password accepted; system unlocks; supports reset
- **LOCKOUT**: 3 failed attempts; 15s auto-reset

Password Handling

- Default password: `4'b1010`
- Password can be reset in UNLOCKED state
- New password activates `leds[7]`

Security Features

- Max 3 attempts before LOCKOUT
- Lockout and auto-relock timers: 15 seconds

Debouncing

Implemented to avoid false triggering:

- Counters for enter_debounce and set_debounce
- Debounce threshold: 15 cycles

4 Testing and Results

Test Case	Expected Result	Pass?
Correct password	Unlock → `leds[1]`	✓
3 wrong attempts	Lockout → `leds[2]`	✓
Set new code	New password persists after relock	✓

5 Key Code Snippets

Debounce Logic

```
if (enter_btn != enter_prev) enter_debounce <= 0;
else if (enter_debounce < 15) enter_debounce <= enter_debounce +
   ↪ 1;
```

Password Matching

```
if ((enter_debounce == 15) && enter_btn) begin
    if (switches == CODE) begin
        state <= UNLOCKED;
    end else begin
        attempts <= attempts + 1;
        if (attempts == 2) state <= LOCKOUT;
    end
end
```

Password Reset

```
if ((set_debounce == 15) && set_btn) begin
    CODE <= switches;  // Set new code
    new_code_ready <= 1;
end
```