

Lab 3

Instructions

Complete each task and demonstrate the working program to your tutor. Tasks should be demonstrated using the board provided. You will have two lab sessions to work on this lab, and all questions must be marked by the end of the second session.

Part A – Static Pattern (1 Mark)

Use the bottom 8 LEDs to display the pattern 0xE5. The LED pins 2 to 9 should be driven by port C, with the most significant bit displayed on the top LED.

Part B – Moving Pattern (2 Marks)

Use the LEDs and timer0 to display a moving pattern that rotates downwards on the bottom 8 LEDs. You must use timer0 to generate an interrupt that determines when the LEDs are updated. The pattern must be 16-bits long, and should be defined using a `.equ` constant in your source file.

The pattern should shift by one bit every second. 8 bits of the pattern will be displayed at a time, with the pattern repeating every 16 seconds.

Part C – Dynamic Pattern (4 Marks)

Use the two push buttons to enter a binary pattern, and then display it on the LEDs. The left button (PB1) will enter a 1, and the right button (PB0) will enter a 0. When 8 bits have been collected, they should be displayed on the green LEDs 3 times, with each flash lasting one second and all LEDs turned off for one second after each flash. The bits should be displayed in the order they were entered, with the first one on the top LED.

You must use timer0 to generate an interrupt to control the display speed, and falling-edge external interrupts 0 and 1 to detect the button pushes. It must be possible to enter a new pattern while the last one is still displaying, although you may assume that no more than one pattern will be entered while the last one is displaying.

The buttons must be software debounced, so that one button press reliably generates only a single bit in the pattern. You should implement debouncing by ignoring spurious interrupts, not by disabling interrupts or busy-waiting.

Part D – Enhanced Dynamic Pattern (3 Marks)

Implement the following enhancements to your solution to part C:

- Allow at least 32 patterns to be queued when they are entered faster than they can be displayed.
- If more than four patterns are queued, the current pattern should be displayed at twice the normal speed.
- If both buttons are pressed simultaneously, the queue should be emptied and the current message should stop displaying immediately.