

Lab 4

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.

An example program that uses the LCD is provided.

Part A – Keypad (3 Marks)

Write a program to detect keypad presses and display them on the LEDs. Buttons 0-9 should display their numeric value in binary, with the lsb at the bottom. The other buttons do not need to be handled.

The keypad should be connected to PORTL, with none of the wires crossed over (same as lab 3). The low 4 bits will be connected to the rows, and the high 4 bits will be used to read the column outputs.

You will need to activate the **pull-up resistors** on the input pins to reliably detect key presses.

Part B – LCD (2 Marks)

Write a program to display some text on the LCD. The top line should display 'COMP2121' and the bottom should display 'Lab 4'. The LCD manual lists available commands and is available in the AVR resources section on the course website.

The LCD data pins D0-D7 should be connected to PORTF0-7. The four LCD control pins BE-RS should be connected to PORTA4-7.

Part C – Calculator (4 Marks)

Use the keypad and LCD together to implement a simple **unsigned 8-bit** calculator. The program should allow the user to enter decimal numbers using the number keys on the keypad. Numbers should be displayed on the bottom row of the LCD as they are entered. You do not need to handle overflow.

The calculator should use an accumulator that is initialised to 0 when the program starts. Pressing the '*' button should reset the accumulator to 0 and clear the current input. The current accumulator should be displayed on the top line of the LCD at all times.

After a number has been entered, the buttons 'A' and 'B' are used to add or subtract the new number from the accumulator.

Each key press must be registered only once, and holding down a key should not result in multiple inputs. **This will require some form of debouncing.**

eg. Pressing '*' should result in the following display:

0

Then pressing '1 2 2' should enter the number 122:

0
122

Pressing 'A' should add 122 to the accumulator, and then clear the current number.

122
0

Entering '5' then 'B' should subtract 5 from the accumulator.

117
0

Part D – Multiply and Divide (1 Mark)

Extend the calculator so the 'C' and 'D' buttons implement 8-bit multiply and divide.

