Demonstration Project
Buttons on the LCD Shield

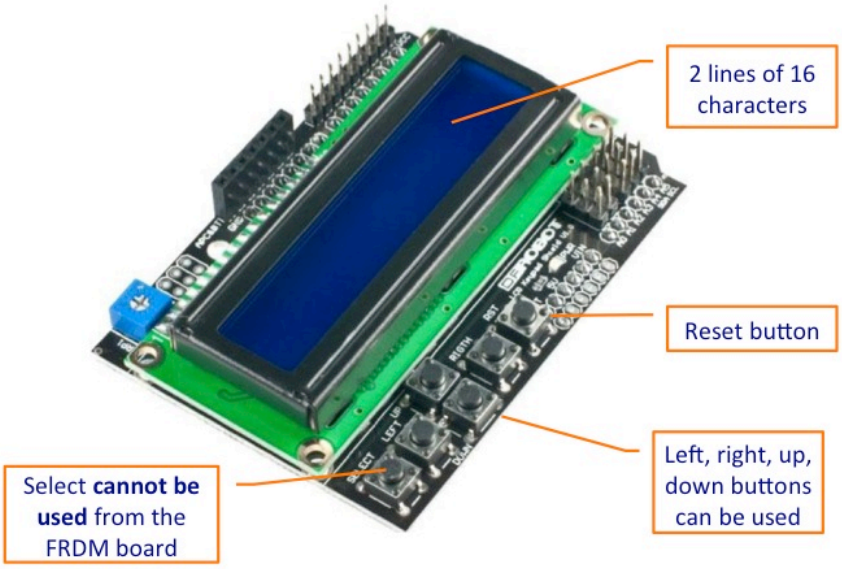
This project shows how to use the Arduino LCD shield with the Freescale FDRM-KL25Z. This document:

1. Explains how the buttons on the Arduino LCD shield work
2. Introduces a demonstration project that uses the buttons.

1. Principles

1.1 Buttons on the Arduino Shield

The Arduino LCD shield has a small array of buttons, marked: Up, Down, Left, Right and Select as shown below.



These buttons are monitored using a single analogue to digital (ADC) pin (compared with multiple GPIO pins in the way we have connected buttons so far). This design allows multiple buttons to be monitored from a single pin.

The headers on the Freescale FRDM-KL25Z are intentionally pin compatible with the Arduino[1]. The design of the shield (the pins chosen) therefore fixes the ports that must be used to drive the circuit.

2. Demonstration Project

The demonstration project is intended to show the use of the buttons on the LCD shield. You can

- Read the code of the demonstration project to see how the buttons are interfaced using an ADC.
- Run the demonstration project to show the voltage measured by the ADC for each button.

2.1 Hardware

The project uses an Arduino LCD shield and one buttons on the breadboard. The connections are the same as the other LCD demonstration project (except that the button on PTB7 can be ignored). See that project for further details. **Remember the GND connection.**

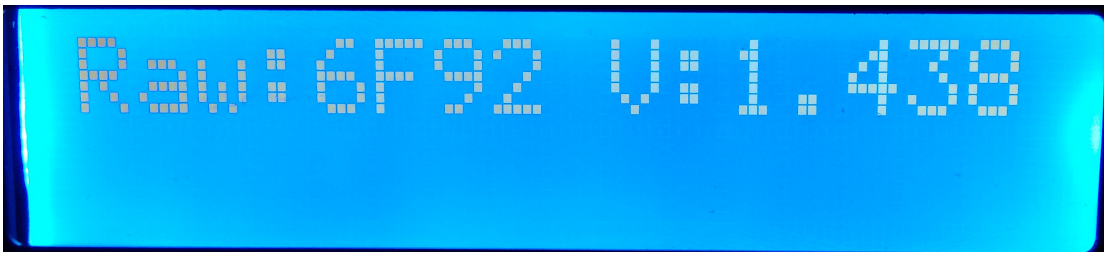
[1] See https://www.arduino.cc/ if you want to know more about Arduino

The pin used to monitor the buttons is Arduino AD0, which is FRDM-KL25Z PTB pin 0, function ADC0_SE8. **This is the same pin as is used in the ADC demonstration project**.

2.2 Functionality of the Project

The demonstration project behaves as follows:

- When the breadboard button is pressed, the voltage on the ADC is measured and displayed on the LCD, as shown below.
- If you hold one of the LCD shield buttons down and then press the breadboard button, you can measure the voltage associated with each LCD-shield button.



You will see the measurement is quite stable – it may change by a small amount on each measurement. You need to complete a table similar to the following, which shows the measured voltage for each button and the range of voltages that will be matched to the button. The ends of the ranges should be midway between the voltage for the button and the next nearest voltage.

LCD Shield Button	Measured Voltage	Range
(none)	3.3v	?? to 3.3v
Right	0v	0v to ??
Up		
Down		
Left		
Select		

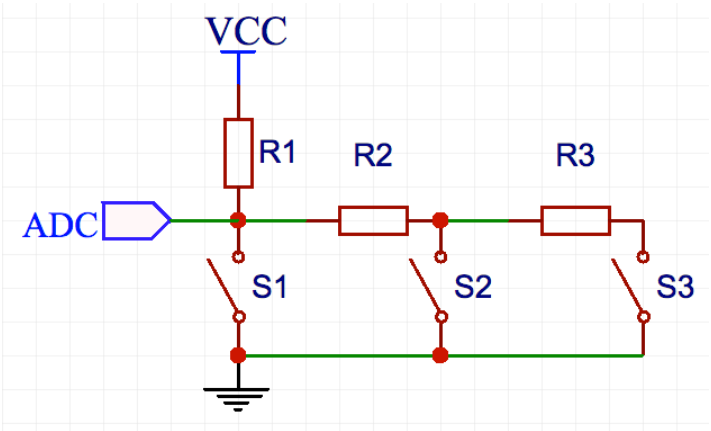
It may not be possible to use the Select button because it gives the same voltage as no button. The next section explains why.

3. How to Interface Buttons using an ADC

This section gives some further details on how this type of interface works. The information here is not essential.

3.1 Resistor Ladder

The LVD shield buttons are connected using a resistor ladder, similar to the one shown below.



When all the switches are open, there is no connection to GND and the measured voltage is V_{CC}. When S1 is closed, the ADC line is connected to GND and measured zero.

S2 and S3 give voltages between these extremes. For S2, the voltage is:

$$\frac{R2}{R1 + R2}$$

for S3, it is:

$$\frac{R2 + R3}{R1 + R2 + R3}$$

Suitable values for R1, R2 and R3 can make the voltage evenly spaced between V_{CC} and GND (0v). Note that when S1 is pressed, the measured voltage will always be zero even if one of the other buttons is pressed at the same time. In general, a button with a lower voltage than hides one with a higher voltage. With this interface, only one button can be sensed at any time.

3.2 Why Select May Not Work

The Arduino works at 5v whereas the FRDM-KL25Z uses 3.3v. The V_{CC} on the resistor ladder is 5v but the ADC on the KL25Z has a voltage range of 0v to 3.3v. When the Select button is pressed, the voltage[2] is less than 5v (around 3.6v) but the KL25Z cannot distinguish this from 3.3v.

[2] The shield I tested most recently does give a different voltage for SELECT. Perhaps the resisters have been changed for greater compatibility with 3.3v devices.