

# Project SB3: Data Logger

## Interim Report

### Team 6

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## 1 Introduction

This project requires the development of a data logging embedded system. It was decided to target parcel delivery as an application, and to develop a system that could monitor the condition of a parcel through transit. For this, it requires logging of temperature, humidity, shock/impact and orientation. If time, we will also attempt to monitor vibration. A prototype will be developed to show functionality, but this system would need to be miniaturised for real-world usage.

For the project, the circuit design was shared but overseen primarily by James. Firmware is to be developed by James while Andrew will develop the computer side software.

## 2 Circuit Design

### 2.1 EEPROM and Accelerometer

The EEPROM and the accelerometer will be connected to the I<sup>2</sup>C bus (I2C1) of the microcontroller. The resistor pullups are needed because I<sup>2</sup>C is open drain (Although the microcontroller does also have optional internal pullups). The INT connector is used to signal to the microcontroller that the accelerometer has registered an event. The MM17660FC has a number of modes that can be configured to send an interrupt when a sudden acceleration or change of orientation has occurred. This will make the software more effective, as we will not have to poll the accelerometer constantly. The circuit diagram is shown in appendix A, figure 1.

### 2.2 Humidity Sensor

The humidity sensor responds to changes in humidity with a varying capacitance. The principle of operation of the sensor circuit is as follows: first, **CHARGE** is pulled low, to discharge the capacitor. After a small delay it is pulled high, charging the capacitor through the resistor. The microcontroller will poll the **SENSE** pin, incrementing a counter, until **SENSE** reads high. This counter value will be proportional to capacitance, and hence humidity. To take repeated readings, the sensor is periodically charged and discharged. This will not be quite as accurate as a humidity sensor with digital or analogue output, but the low cost is ideally suited to this project. The circuit diagram is shown in appendix A, figure 2. The design is based on one found online [1].

## 2.3 Temperature Sensor

The temperature is monitored using a thermistor. The conditioning circuit is based on an example in *CITE H&H*. The use of a series  $10\text{k}\Omega$  resistor gives very good linearity over a wide temperature range, easily including that expected to be experienced by a parcel in transit. The resistor values are chosen to give an op-amp output voltage of  $0\text{ V}$  at  $-20^\circ\text{C}$  and  $3.3\text{ V}$  at  $50^\circ\text{C}$ . The op-amp used has very good rail-rail operation, so may be run from a  $3.3\text{V}$  with negligible affect on performance (especially as extremes of temp are unlikely to be experienced and at limits of reasonable linearity of thermistor operation). The gain setting resistors may be knocked up a decade if current draw from reference divider proves too high. The circuit diagram is shown in appendix A, figure 3.

## 2.4 Voltage Regulator

A  $5\text{ V}$  regulator is being used to allow running from batteries when in standalone mode. The circuit diagram is shown in figure

## 3 Parts List

The full parts list is shown in appendix B. The total cost is  $\pounds 13.18$ , but not all of these will be used (bicolour LEDs came in pack of 5). Key features are the accelerometer, EEPROM and LCD display.

## 4 Communications

## 5 Firmware Design

## 6 Software Design

## A Circuit Diagrams

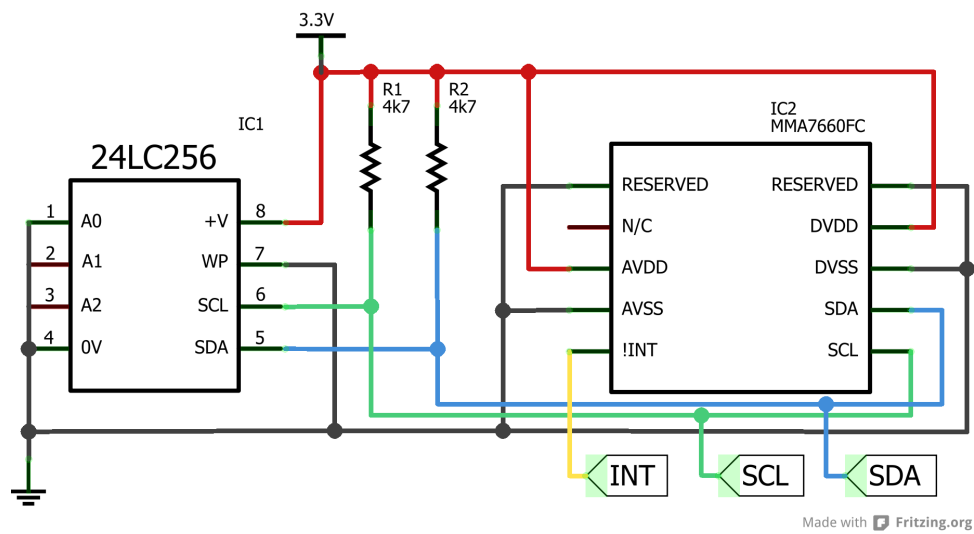


Figure 1: EEPROM and accelerometer on I<sup>2</sup>C Bus

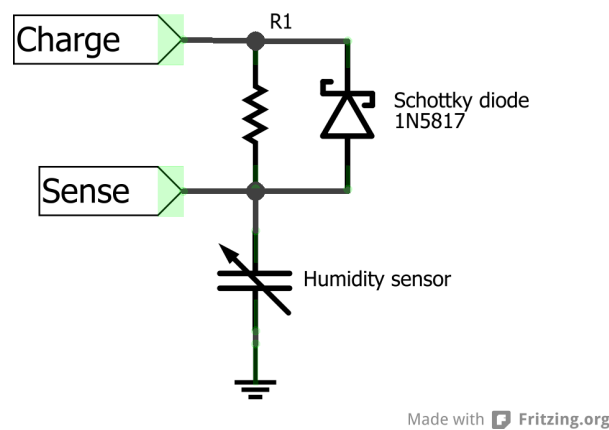


Figure 2: Measurement of humidity through varying capacitance

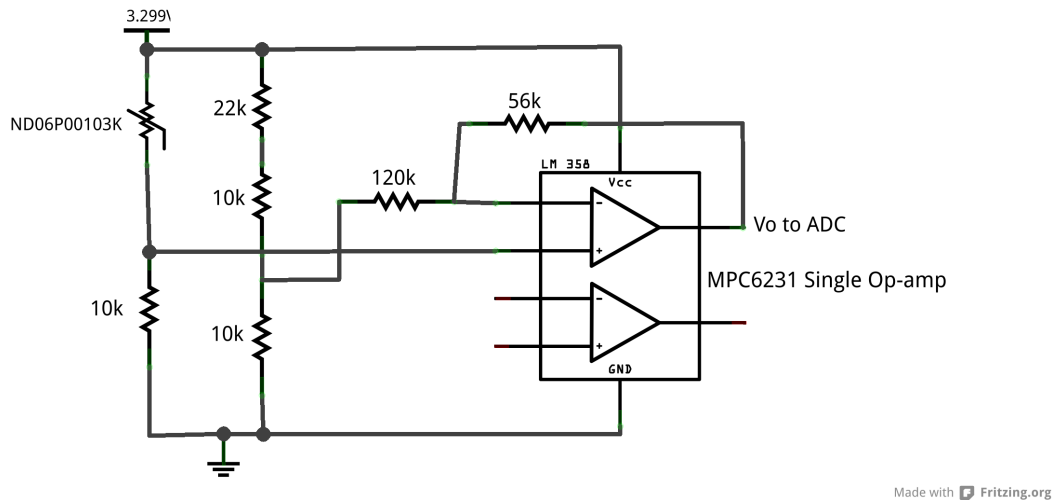


Figure 3: Thermistor conditioning circuit

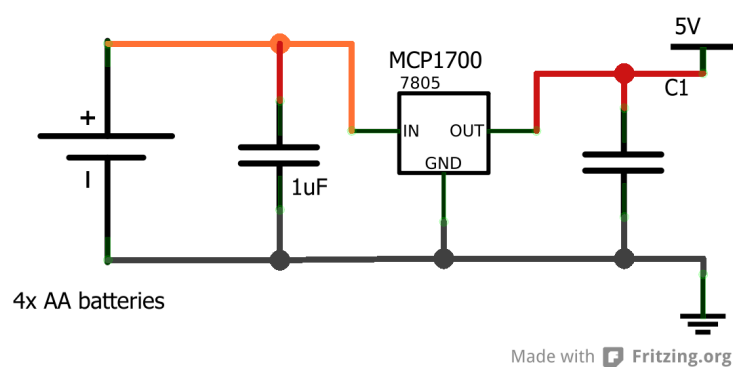


Figure 4: Voltage Regulator

## B Full Parts List

| Order Code | Description                    | Quantity | Unit price | Total Price |
|------------|--------------------------------|----------|------------|-------------|
| 2238133    | Freescale 3-axis accelerometer | 2        | 0.97       | 1.94        |
| 1672384    | AUX NTC 10k thermistor         | 1        | 0.20       | 0.20        |
| 1891432    | Multicomp humidity sensor      | 1        | 2.08       | 2.08        |
| 2001770    | Kingbright bicolour LED        | 5        | 0.159      | 0.80        |
| 1671493    | Powertip 8x2 lcd module        | 1        | 3.40       | 3.40        |
| 9757970    | 256k eeprom                    | 1        | 0.80       | 0.80        |
| 1439438    | Microchip op-amp               | 1        | 0.30       | 0.30        |
| 1650685    | Keystone 4xAA battery holder   | 1        | 1.36       | 1.36        |
| 1712515    | Panasonic AA battery 4 pack    | 1        | 1.94       | 1.94        |
| 1331481    | Microchip 5V regulator         | 1        | 0.36       | 0.36        |
|            |                                |          | Total:     | £13.18      |

## References

- [1] J Ellsworth. Read capacitive humidity sensors with two digital io lines. <http://correctenergysolutions.com/electronics/cap-humidity-sensor-circuit/>, 2009. Accessed on 13/5/13.