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 though transit. For this, it requires logging of temperature, humidity, shock/impact and orientation. If time allows, 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 between both team members. 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^2C bus (I2C1) of the microcontroller. The resistor pullups are needed because I^2C 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 2.

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 3. 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 [2]. The use of a series 10kΩ 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 V at −20 °C and 3.3 V at 50 °C. The op-amp used has very good rail-rail operation, so may be run from a 3.3V supply with negligible effect on performance (especially as extremes of temp are unlikely to be experienced and are at limits of good 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 4.

2.4 Voltage Regulator

A 5 V regulator is being used to allow running from batteries when in standalone mode. The circuit diagram is shown in appendix A, figure 5.

3 Parts List

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

4 Communications

2 way communication will be implemented between the computer and data logging unit. The computer sends commands to the microcontroller and the microcontroller sends data back to the computer.

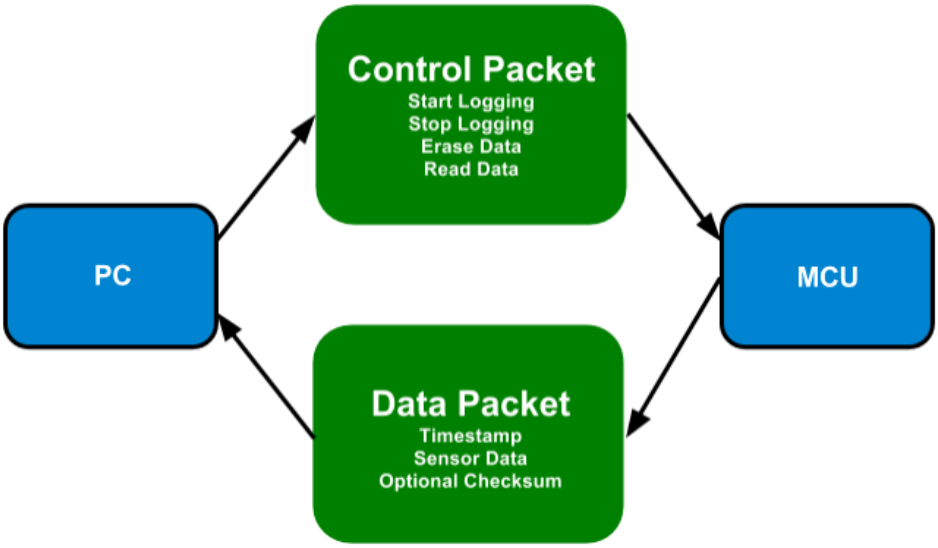

Figure 1: Communications block diagram

5 Firmware Design

At all times the microcontroller will be in one of the following states:

- Streaming to pc continuously.
- Standalone mode. Starts logging on button press.
- Transferring logged data to pc
- Command mode (Waiting for instruction such as EEPROM erase)

6 Software Design

The software will require functions for communication with the microcontroller and its own analysis and display routines. For communication with the microcontroller, the following functions will be required:

- Start logging in linked mode.
- Stop logging in linked mode.
- Read data from standalone operation.
- Erase data.

The data related functions will be:

- Ask for new data from MCU.
- Read in data when it arrives.
- Get all saved data from standalone operation.
- Add to data store (initially use an array/vector. If time allows, implement a database, allowing long term, high data storage).
- Find interest points (eg temperature over/under given set level, shocks etc).

For display of data:

- General GUI functions.
- Graph data (OpenGL?).
- Display interest points.
- Allow different views.

A Circuit Diagrams

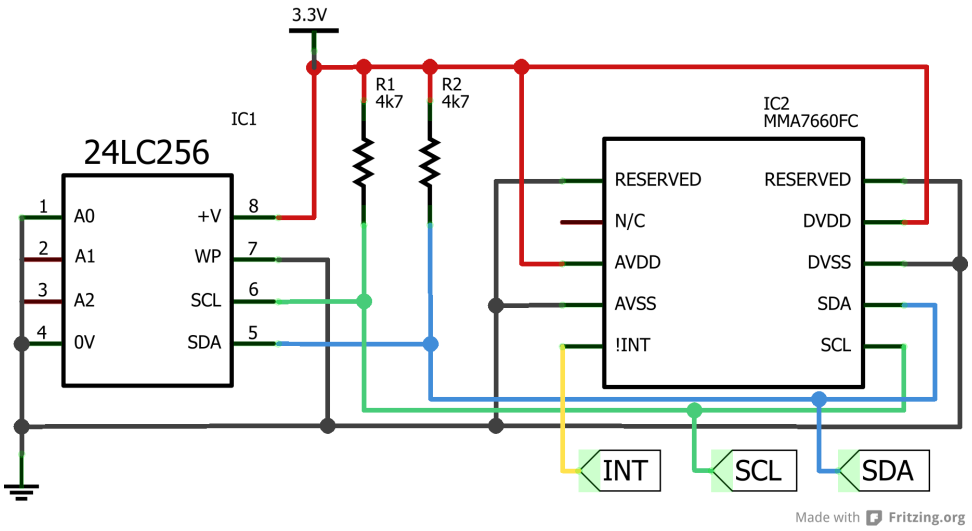

Figure 2: EEPROM and accelerometer on I^2C Bus

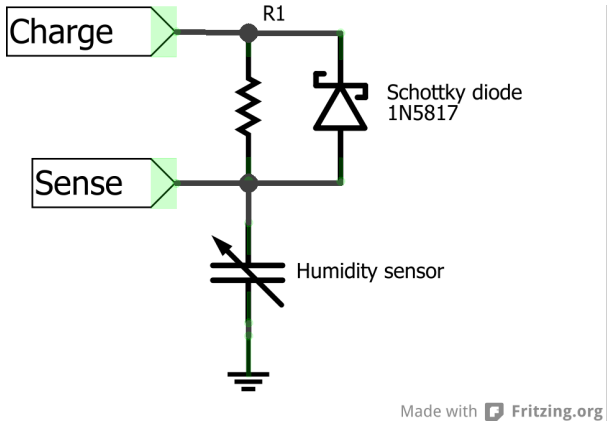

Figure 3: Measurement of humidity though varying capacitance

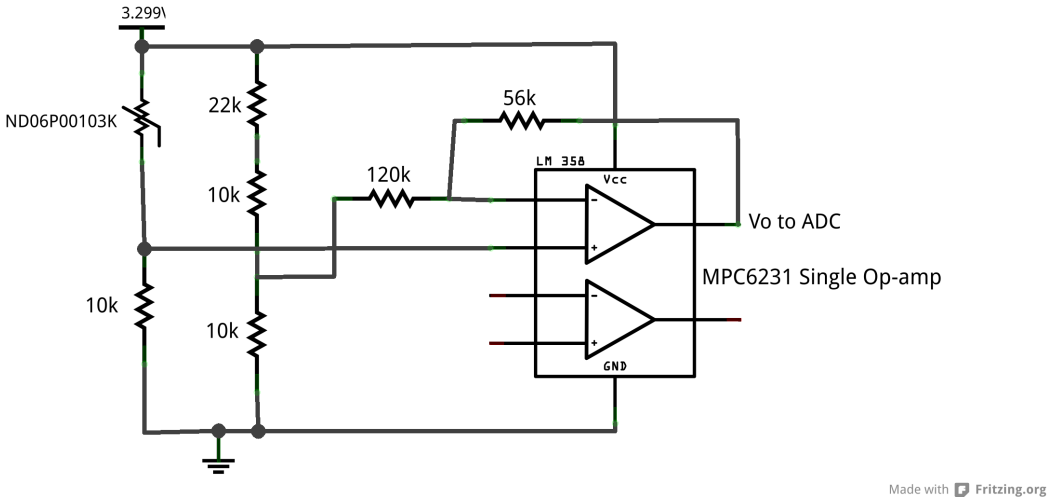

Figure 4: Thermistor conditioning circuit

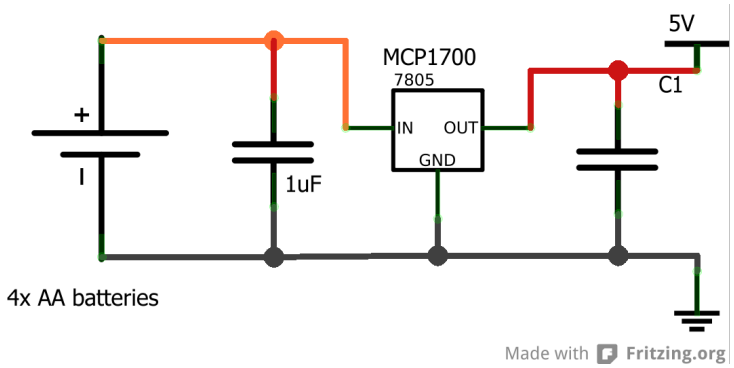

Figure 5: Voltage Regulator

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.

[2] P Horowitz and W Hill. *The Art of Electronics*. Cambridge University Press, second edition, 1989.