ECSE 426
Analog Data Acquisition, Digitizing Filtering, and Digital I/O

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1 Abstract

Micro-Controllers commonly have multiple different sensors to receive analogue data. Temperature sensor is one of the critical sensors which checks whether microchip is not overheating which can damage chip. This experiment is mainly focusing on receiving temperature of microchip using temperature sensor. Additionally, a LED display was used to display the temperature data. The system was designed to display temperature in Celsius. When an user interface (switch) receives signal, the temperature in Fahrenheit would display. A FIR filter was implemented to filter out noisy data read from the sensor.

2 Problem Statement

3 Theory and Hypothesis

3.1 Temperature Calculation

The analogue data of sensor is in voltage. Analogue to Digital Converter (ADC) in this experiment uses 12 bit data which gives 4096 different inputs. The sensor can measure temperature between -40℃ 125℃. Equation (1) was used to calculate temperature in Celsius. Equation (2) was used to convert Celsius data into Fahrenheit.

$$temperature(℃) = 400 * S * \frac{3.6}{4096} + 25 \quad (1)$$

$$temperature(^{\circ}F) = 1.8 * temperature(℃) + 32 \quad (2)$$

3.2 Data Display

For displaying data, four digit 7-segment display was used. Individual segment can be controlled by using general purpose input output (GPIO) pins implemented on the Micro-controller unit. Figure 1 shows how 7-segment LCD display is consisted.

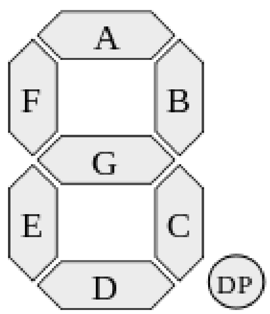

Figure 1: 7-segment LED display

To display each digit from 0 to 9, each number was defined separately. List of bit sequence to display number is follow in table.

a	b	c	d	e	f	g	display
1	1	1	1	1	1	0	0
0	1	1	0	0	0	0	1
1	1	0	1	1	0	1	2
1	1	1	1	0	0	1	3
0	1	1	0	0	1	1	4
1	0	1	1	0	1	1	5
0	0	1	1	1	1	1	6
1	1	1	0	0	0	0	7
1	1	1	1	1	1	1	8
1	1	1	0	0	1	1	9

3.3 Data Filtering

FIR filter was used

$$\begin{aligned}
\text{Mass of magnesium metal} &= 8.59\,\mathrm{g} - 7.28\,\mathrm{g} \\
&= 1.31\,\mathrm{g} \\
\text{Mass of magnesium oxide} &= 9.46\,\mathrm{g} - 7.28\,\mathrm{g} \\
&= 2.18\,\mathrm{g} \\
\text{Mass of oxygen} &= 2.18\,\mathrm{g} - 1.31\,\mathrm{g} \\
&= 0.87\,\mathrm{g}
\end{aligned}$$

Because of this reaction, the required ratio is the atomic weight of magnesium: 16.00 g of oxygen as experimental mass of Mg: experimental mass of oxygen or $\frac{x}{1.31} = \frac{16}{0.87}$ from which, $M_{\mathrm{Mg}} = 16.00 \times \frac{1.31}{0.87} = 24.1 = 24\,\mathrm{g\,mol^{-1}}$ (to two significant figures).

4 Implementation

The atomic weight of magnesium is concluded to be $24\,\mathrm{g\,mol^{-1}}$, as determined by the stoichiometry of its chemical combination with oxygen. This result is in agreement with the accepted value.

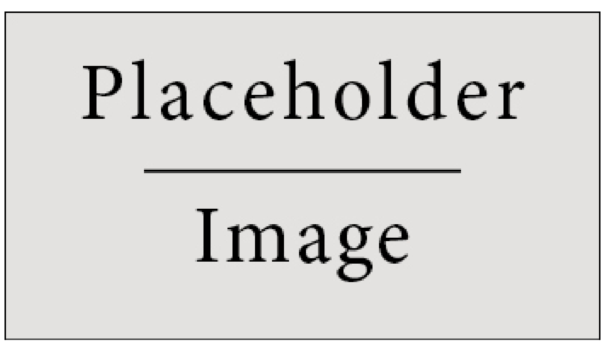

Figure 2: Figure caption.

5 Observation

The accepted value (periodic table) is $24.3\,\mathrm{g\,mol^{-1}}$ **?**. The percentage discrepancy between the accepted value and the result obtained here is 1.3%. Because only a single measurement was made, it is not possible to calculate an estimated standard deviation.
The most obvious source of experimental uncertainty is the limited precision of the balance. Other potential sources of experimental uncertainty are: the reaction might not be complete; if not enough time was allowed for total oxidation, less than complete oxidation of the magnesium might have, in part, reacted with nitrogen in the air (incorrect reaction); the magnesium oxide might have absorbed water from the air, and thus weigh "too much." Because the result obtained is close to the accepted value it is possible that some of these experimental uncertainties have fortuitously cancelled one another.

6 Conclusion

a. The *atomic weight of an element* is the relative weight of one of its atoms compared to C-12 with a weight of 12.0000000..., hydrogen with a weight of 1.008, to oxygen with a weight of 16.00. Atomic weight is also the average weight of all the atoms of that element as they occur in nature.

b. The *units of atomic weight* are two-fold, with an identical numerical value. They are g/mole of atoms (or just g/mol) or amu/atom.

c. *Percentage discrepancy* between an accepted (literature) value and an experimental value is

$$\frac{\text{experimental result} - \text{accepted result}}{\text{accepted result}}$$