Chapter 7

Exercise 2:

(a)

$$100 = 20 \log_{10} \left(\frac{P}{20\times10^{-6}}\right)$$

$$P = 20\times10^{-6} \times 10^{5} = 2\,Pa$$

So the sound pressure of the loudest sound is 2 Pa.

(b)

Using $D_{dB} = 20\,n \log_{10}(2) \approx 6n$ dB

$$100 = 20\,n \log_{10}(2)$$

$$\Rightarrow \quad n = \frac{100}{20\log_{10}(2)} \approx 16.6$$

Thus, ADC should have at least 17 bits to match the dynamic range of human hearing.

Exercise 3.

(a) Measure the output when the entire assembly is in free fall of if the assembly is lying horizontally, in order to get rid of the gravitational force.

(b) Measure the output when the assembly is lying vertically, which is experiencing "1g" and including bias. Then subtrating value "b" will give the pure difference between "0g" and "1g".

(c) The affine function model is

$$f(x) = ax + b.$$

Since $a, b \in \{0, \cdots, 2^B - 1\}$, which are all integers, there will be some quantization errors. In addition to this, if values are out of range, they will be quantized to 0 or 2^{B-1}, which are not accurate.

But within the range, this model is a very good approximation.

(d) $f(x) = ax + b$

$$\Rightarrow x = \frac{f(x) - b}{a}$$

(e) Sensors are not indentical due to manufacturing capability. Each single sensor may have its own parameters.

Moreover, the acceleration of gravity varies in different geographical areas. Calibration will give more accurate parameters.

f) $128 = a \cdot 0 + b$

$b = 128$

$1 = a \cdot (-3) + 128$ or $255 = a \cdot 3 + 128$

$a = 127/3$ $a = 127/3$

$$P = \frac{3}{127} \approx 0.0249$$

$$D_{dB} = 20 \log_{10} \left(\frac{H - L}{P} \right)$$

$$= 20 \log_{10} \frac{3 - (-3)}{0.024} \approx 48 \, dB$$

Chapter 9.

Exercise 1.

(a) Only data need to be stored in memory

$\Rightarrow$ Number of addresses needed $= 16 \times 4 = 64$

$$\log_2 64 = 6 \text{ bits} < 8 \text{ bits}$$

$\Rightarrow$ All integers can be stored in one cache set.

and since there are 8 bits for block offset,

all addresses have same tag and set index.

$\Rightarrow$ Cache miss only occurs on first number in "data" array.

$\Rightarrow$ There will be only 1 cache miss

(b) when $N = 32$, number of address needed $= 32 \times 4 = 128$

$$\# \text{ bits needed} = \log_2 128 = 7 \text{ bits} = 8 \text{ bits},$$

Again, Cache miss only occurs on first number in "data" array.

$\Rightarrow$ There will be only 1 cache miss.

(c) number of address $= 16 \times 4 = 64$

$\#$ bits needed $= \log_2 64 = 6$ bits $>$ 4 bits

$\Rightarrow$ There are four 8 bits set indexes:

00000000 , 00000001 , 00000010 , 00000011.

But all tag indexes are the same.

$\Rightarrow$ Cache miss occurs every 16 addresses, which is every 4 numbers in "data" array.

$\Rightarrow$ There will be 4 cache misses.

Exercise 3:

(a) $n \Rightarrow C$, $m \Rightarrow C$, $a \Rightarrow D$.

(b) The program will print

"n = 0".

(c) function "foo" will be excuted forever so that it will finally overflow the stack and overwrite the program and static variables region.

The result will not be predictable.

Chapter 10

Exercise 7:

(a) Yes, it is possible.

When the "main" function is checking whether sensor1 is faulty, the "flag" is 1. If the program is interrupted, everything is paused and "sensor1" is able to be updated. Once ISR has completed, the program resumes with updated "sensor1".

(b) Yes, if "flag" is currently 0, the program will not check faulty value. And before the functions "isFaulty1" and "isFaulty2" are excuted, the program is interrupted and all sensor values are updated as non-faulty. The the program will not report "Sensor1 faulty" or "sensor2 faulty", as they are skipped.

(c) If conditions are always true (like timer ≥ 0) one interrupt is always followed by another interrupt so that there is no chance for main program to resume.