Embedded Systems: Homework #1

Yousef Alaa Awad

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1

Given: For the questions below, write the code using the masks that are pre-defined in the header file. Perform the operations below on the 8-bit variable (uint_8t data).

A) Write code that independently sets bit5, clears bit5, and inverts bit5

```
data |= BIT5;  // Ensuring BIT5 is on.
data &= ~BIT5; // Setting BIT5 to 0, but leaving the rest the same
data ^= BIT5;  // Inverting only BIT5.
```

B) Write code that independently sets bit2 and bit3, clears bit2 and bit3, inverts bit2 and bit3, and sets bit2 and clears bit3

```
data |= (BIT2 | BIT3);          // Setting bit2 and bit3
data &= ~(BIT2 | BIT3);         // Clearing bit2 and bit3
data ^= (BIT2 | BIT3);          // Inverting bit2 and bit3
data = (data | BIT2) & ~BIT3; // Setting bit2 and clearing bit3
```

C) Write an if-condition line that independently checks if bit4 is 1, checks if bit4 is 0, checks if bits4 and 5 are both 1, checks if bit4 is 0 and bit5 is 1, and checks if bits 4 and 5 are both 0

The following are just snippets

```
if (!(data & BIT4)) // Checks if bit4 is 1 by only leaving bit4 via the &

if (data & BIT4) // Checks if bit4 is 0

if (!(data & (BIT4 | BIT5))) // Checks if bit4 and bit5 are 1

if ((data & BIT4) && !(data & BIT5)) // Checks if bit4 is 0 and bit5 is 1

if (data & (BIT4 | BIT5)) // Checks if bit4 and bit5 are both 0
```

2

Given: A module on the microcontroller is configured using a control register called CTL that haas the format shown below.

SLP	CLK	CAP	IE
2 bits	3 bits	2 bits	1 bit

- SLP: Selects sleep mode (0-3)
- CLK: Selects clock speed (0-7)
- CAP: Selects built-in capacitor value (0-3)
- IE: Interrupt enable bit (0/1)

A) Write a line that configures: Sleep mode 3, clock speed 4, capacitor value 1, and interrupts enabled

```
CTL = (SLP_3 |  CLK_4 | CAP_1 | IE);
```

B) Using Part A, show the masks used and the final value of CTL in binary

The following are the original masks:

- SLP_3 = 1100 0000
- CLK_4 = 0010 0000
- CAP_1 = 0000 0010
- IE = 0000 0001

Therefore, the total mask will look like the following

11	100	01	1

or **1110 0011**.

C) Write a piece of code that changes SLP to 1 from any unknown value of SLP

```
CLT = (CTL & ~SLP_1) | SLP_1;
```

D) Write an if-condition that checks if SLP is 3

```
if ((CTL & SLP_3) == SLP_3)
```

E) Write an if-condition that checks if the current value of CLK is 0, 2, 4, or 6

```
if ((CTL & CLK_1) != CLK_1)
```

3

A) A memory is byte addressable and has an 18-bit address. All the addresses are value, what is the total size of the memory?

First, with a 18-bit long address bus, we know that there are 2^18 possible addresses. Alongside this, since each address is simply 1 byte, we know that there are 2^18 bytes. Therefore we have the following math...

$$2^{18} \text{ addresses} = 2^{18} \text{ bytes} = 2^{10} * 2^8 \text{ bytes} = 2^8 \text{ kilobytes} = 256 \text{ kilobytes}$$

B) A memory is byte addressable and has a total size of 17,408 bytes (17KB). What is the smallest address size that can be used for this memory?

With 17KB of memory, you have $2^4 + 1$ kilobytes, of which is $2^{10} * (2^4 + 1)$ bytes of which is $2^{14} + 2^{10}$ bytes of which means we have 14 whole bits of space, alongside another full 1024 addresses needed. Meaning we need **15** bits of an address bus to accomodate 17KB of memory.

4

A) A microcontroller's memory map allocates the FLASH code space to the address range 0x0500 to 0x0CFF. What is the code size, in bytes, that is supported by this microcontroller?

$$0xCFF - 0x500 = 0x7FF \rightarrow 0x7FF = 2047 \rightarrow 2047 + 1 \text{ (for base)} = 2048 \text{ Bytes} = 2\text{KB}$$

B) The vector table contains memory addresses (a vector is memory address). In a certain MSP430 device, the vector table is in the range 0xFFC0 to 0cFFFF. The memory address is 16-bit. How many vectors does this vector table support?

- $0xFFFF - 0xFFC0 = 0x003F$
- $0xx003F = 16^1 * 3 + 16^0 * 15 = 63$
- $16 + 1$ (for base) $= 64$
- $\frac{64}{2}$ 2 bytes per vector = **32 vectors**