CLASS 5 HOMEWORK

3. Pin 12 is one of the 64 pins on the PIC32. Pin 12 is ***NOT*** 5 V tolerant. Functionalities of pin 12 are:

    (i.) Analog-to-digital (AN5):

    This is one out of the 16 analog input pins in the 10-bit Analog-to-Digital Converter (ADC). These pins can be used for analog voltage inputs (typically sensor inputs). So, pin 12 is the 6th pin that connects to the ADC. The ADC can distinguish between 2^{10} = 1024 different values of voltage ranging from 0 to 3.3 Volts. The PIC32 has 1 ADC with 16 pins.

    (ii.) Comparator negative input (C1IN-):

    PIC32 comparator module has 2 comparators that pins connected to them. These comparators compare 2 analog input voltages and pin 12 has a negative input function to the comparator.

    (iii.) Change notification (CN6):

    There are 19 notification pins on the PIC32 (from 0 to 18), which provides the PIC32 the ability to generate an interrupt request to the CPU in response to a change in state of the selected pin. Pin 12 has the functionality of one of the 19 change notification pins, specifically pin 6.

    (iv.) Digital I/O (RB4):

    Pin 12 also processes the functionality of an input or output pin.

4. If you would like to change pins on PORTC from output to input, you would have to modify the TRISC register. Setting the TRISC register = 0 changes the corresponding port pins from output to input. TRISx is a Data Direction or Tri-State control register.

5. Reset value of the CM1CON register is 0xC3 (from the Data sheet).

6. Definition of some items in the architecture block of the PIC32:

    (a.) SYSCLK:

    Clocks the CPU at a maximum frequency of 80 MHz, adjustable down to 0 MHz.

    (b.) PBCLK:

    Used by many peripherals, and its frequency is set to the SYSCLK's frequency divided by 1,2,4, or 8.

(c.) PORTA to G:

These are I/O ports (PORTA can be used for analog input and PORTB – G are digital I/O ports that can read or output a digital voltage).

(d.) Timer1 to 5:

Five 16-bit counter/timers that counts the number of pulses of a signal.

(e.) 10 – bit ADC:

Programmed to continuously read data from a sequence of input pins, or to read a single value.

(f.) PWM OC1-5:

There are 5 PWM (Pulse-Width modulated) OC pins that generate a single pulse of specified duration, or a continuous pulse train of specified duty cycle and frequency.

(g.) Data RAM:

This is your 12 KB Random Access Memory, which is volatile (loses its data if the power is switched off) and your program runs on RAM.

(h.) Program Flash Memory:

This a nonvolatile 512 KB memory called that flash memory which preserves and stores your data.

(i.) Prefetch Cache Module:

This stores recently executed program instructions, which are likely to be run again soon, and it also predictively fetches future instructions that the CPU might need.

7. Peripherals that are NOT clocked by PBCLK are:

   (a.) PORTA-G
   (b.) Prefetch Module
   (c.) Priority Interrupt Controller
   (d.) Universal Serial Bus (USB)
   (e.) Controller Area Network (CAN1, 2)
   (f.) Ethernet
   (g.) Direct Memory Access Controller (DMAC)
   (h.) In-Circuit Debugger (ICD)

8. The ADC has a 10-bit resolution and therefore can take 2^{10}= 1024 different voltage values between 0 to 3.3 V. So, the ADC probably can't pick up on voltage under 3.2 mV ($\frac{3.3-0}{1024}$ = 0.0032 approx.).

9. A maximum of 16 bytes of the program loop can be stored entirely on the Prefetch Module.

10. This is because the 128-bit wide data path between the prefetch module and the flash memory allows the prefetch module to run ahead and fetch future instructions.

11. The digital output can also be configured as an open drain so that take values between 0 V and 4 V by connecting it to an external pull up resistor. This allows the pin's output transistor to either sink current or turn off.

12. Program flash on the PIC32 is between addresses 0x1D000000 and 0x1D07FFFF. If we take a look at the physical memory map from the data sheet, we can see that there is a reserve space between the program flash and the SFRs. So, the maximum memory flash can have before we have to change the current choice of base address, we add the reserved memory space to our flash, to get **40 MB** (in hex: 0x1F800000 – 0x00000001 – 0x1D000000= **0x027FFFFF**).

    PIC32 has a RAM of 128 KB between addresses 0x00000000 and 0x0001FFFF. According to the physical memory map in the data sheet, there is reserved space between RAM and program flash. So, the maximum memory we can have before changing the current choice of base address is **463 MB** (in hex: 0x1D000000 – 0x00000001 = **0x1CF00000**).

13. From the Special Features section of the Data Sheet:

    (a.) To set PBCLK frequency to be half the frequency of SYSCLK, we would have to change bits 13-12 to '01' in the DEVCFG1 register which is a Device Configuration Register.

    (b.) To set the watchdog timer to be enabled we set bit 23 to '1' in the DEVCFG1 (Device Configuration) register.

    To set the watchdog timer postscale we modify bits 20-16 in the DEVCFG1 (Device Configuration) register. To set the time interval to be maximum we set the bits to '10100'.

    (c.) To select the HS Oscillator mode, we would have to set bit 9-8 in DEVCFG1 (Device Configuration) register to '10'. To enable the primary oscillator and turn on the PLL module we would have to set bit 2-0 to '011' in the DEVCFG1 register.

14. We should avoid drawing more than 200 – 300 mA of current. So, if you consider these current limits, we get a resistance of around 16-17 Ohm. This is the smallest resistance that would be safe.

15. The PIC32 requires a voltage between 2.3 to 3.6 V. The NU board can regulate voltages more than 6 V, but we should not exceed 9 V to avoid heating. So, our range of voltage is 2.3 – 9 V.

16. Pins that are connected to the 2 buttons and 2 LEDs on the PIC32:

    (i.) RESET Button: PIN 7 – MCLR (Master Clear Reset)
    (ii.) USER Button: PIN 55 – RD7 (Digital input pin 7 in PORTD)
    (iii.) LED 1: PIN 58 – RF0 (Digital output pin 0 in PORTF)
    (iv.) LED 2: PIN 59 – RF1 (Digital output pin 1 in PORTF)