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//*******************************************************************
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//******** CDA3331 Intro to Micro class, updated on November 17, 2020
//******** Dr. Bassem Alhalabi, FAU EE512, Boca Raton, Florida
//******** Contributors: Pablo Pastran 2015, David Wilson 2019
//******** Skeleton Program for Lab 5, in C
//******** Run this program as is to show you have correct hardware
connections
//******** Explore the program and see the effect of Switches on pins
P2. 5/4/3
//******** Lab5 Grade --> Make the appropriate changes to build the
desired effects of input switches
// SW-321 = 000: Counter resets to 00
// SW-321 = 001: Right digit cycles 0-9
// SW-321 = 010: Left digit cycles 0-9
// SW-321 = 011: Right and left digits both hold values (preset
value),for now they have a segment rotating pattern
// SW-321 = 101: Recall the preset value
// SW-321 = 110: Recall the preset value
// SW-321 = 100: Counter cycles up from the preset value to 90, and
repeats
// SW-321 = 111: Counter cycles down from the preset value to 10, and
repeats


#include <msp430.h>

//Digit configuration, make sure segments h-a are connected to PORT1
pins 7-0
//also besides digits 0-9, you have single segments a/b/c/d/e/f/g/ for
the rotating pattern
int LEDS[] =
{0x3F,0x06,0x5B,0x4F,0x66,0x6D,0x7D,0x07,0x7F,0x67,0x01,0x02,0x04,0x08
,0x10,0x20,0x40,0x80};

int switches=0;
int leftdigit=0,  rightdigit=0;
int pleftdigit=0, prightdigit=0;    //preset values
int flag=0;

int main(void)
{
    //Ports set up, simple and direct
    P1DIR = 0xff;                   // port 1 all output
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    P2DIR = 0x03;                     // port 2 all inputs, except BIT0
and BIT1

    //Sub Master clock dividers: DIVS_0 (/1 for 1000 Hz), DIVS_1 (/2
for 500 Hz), DIVS_2 (/4 for 250 Hz), DIVS_3 (/8 for 125 Hz)
    //DIVS_0 means divide by 1, so the SMCLK = MCLK/1, that 1M Hz or 1
millisecond for period
    //You can change DIVS_0 to DIVS_2 to divide the frequency by 4,
and see how the digits will start flickering
    BCSCTL2 |= DIVS_0;

    // WDT set up, normally we turn it off, but here we using it to
generate a constant interrupt to display multiplexing
    // we chose to generate an interrupt interval every 8*1000 pulses
from the SMCLK; other values: WDT_MDLY_32, WDT_MDLY_0_5, etc.
    // so the interrupt frequency is 1,000,000 Hz/(8,000+8,000) = 62.5
Hz, meaning the display is refreshed about 62 times every second
    // if you divide the SMCLK frequency by 4, as suggested above, the
digit display multiplexing will drop to 15, which will make flickering
easy to see
    WDTCTL = WDT_MDLY_8;

    IE1 |= WDTIE;                     // WDT Interrupt Enable
    __enable_interrupt();             // enable general interrupt

for (;;)
{
    // read the switches status for the port 2, and then look at the
various combinations of switches mounted on bits 5/4/3
    switches =  P2IN; //if wired as active low
//    switches = ~P2IN; //if wired as active high

    // SW-321 = 000: left and right digits reset to 00
    if (((switches & BIT5) != BIT5) && ((switches & BIT4) != BIT4) &&
((switches & BIT3) != BIT3))
    {leftdigit=0; rightdigit=0; }//When all SW UP, display 00

    // SW-321 = 001: right digit counts up
    if (((switches & BIT5) != BIT5) && ((switches & BIT4) != BIT4) &&
((switches & BIT3) == BIT3))
    {rightdigit++; if (rightdigit >=10) {rightdigit=0;} }

    // SW-321 = 010: left digit counts up
    if (((switches & BIT5) != BIT5) && ((switches & BIT4) == BIT4) &&
((switches & BIT3) != BIT3))
    {leftdigit++ ; if (leftdigit >=10) {leftdigit=0;} }
```

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```
    // SW-321 = 011: right and left digits both hold previously set
values (preset value)
    if (((switches & BIT5) != BIT5) && ((switches & BIT4) == BIT4) &&
((switches & BIT3) == BIT3))
    {pleftdigit=leftdigit; prightdigit=rightdigit; }

    // SW-321 = 101: Recall the presetvalue
    if (((switches & BIT5) == BIT5) && ((switches & BIT4) != BIT4) &&
((switches & BIT3) == BIT3))
    // *** modify this section according to the lab manual requirement
    { leftdigit=pleftdigit; rightdigit=prightdigit; }

    // SW-321 = 110: Recall the preset value
    if (((switches & BIT5) == BIT5) && ((switches & BIT4) == BIT4) &&
((switches & BIT3) != BIT3))
    // *** modify this section according to the lab manual requirement
    { leftdigit=pleftdigit; rightdigit=prightdigit;
}

    // SW-321 = 100: Counter cycles up from preset value to 90, and
repeat
    if (((switches & BIT5) == BIT5) && ((switches & BIT4) != BIT4)&&
((switches & BIT3) != BIT3))
    // *** modify this section according to the lab manual requirement
    {  //Check if counter is 90 or above
        if (leftdigit >= 9 & rightdigit == 0) {leftdigit=pleftdigit;
rightdigit=prightdigit;}
                //otherwise count up until counter is 90
                else {//Countup Algorithim
                    if (rightdigit==9) {++leftdigit; rightdigit=0;}
                    else {++rightdigit;};
                }
    }

    // SW-321 = 111: Counter cycles down from preset value to 10, and
repeats
    if (((switches & BIT5) == BIT5) && ((switches & BIT4) == BIT4)&&
((switches & BIT3) == BIT3))
    // *** modify this section according to the lab manual requirement
    {
        //Check if counter is 10 or lower
        if (leftdigit <= 1 & rightdigit == 0) {leftdigit=pleftdigit;
rightdigit=prightdigit;}
        //otherwise count down until counter is 10
        else {//Countdown Algorithim
```

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```
            if (rightdigit==0) {--leftdigit; rightdigit=9;}
            else {--rightdigit;};
        };
    }

    // this delay determines the speed of changing the numbers being
displayed
    // 500,000 microseconds for half a second, you can change it to
100,000 for example to make the numbers change 10 times faster
    // remember, this is the delay of the man loop, and it has no
effect on the interrupt frequency
    __delay_cycles (500000);

} // end of for loop
} // end of main

//General interrupt call
// WDT interrupt service routine
#pragma vector=WDT_VECTOR
__interrupt void WDT(void)
{
    //This executes every time there is an interrupt from WDT
    //The frequency of this interrupt is about 62.5 Hz which is enough
to eliminate the flickering of display
    //The right and left digits are displayed alternatively
    //Note that both digits must be turned off to avoid aliasing

    //Display code for Common-Cathode display
    P1OUT= 0; P2OUT=0;// P2OUT is connected to transistor
    __delay_cycles (100);
    if (flag == 0) {P2OUT= BIT0; P1OUT= LEDS[leftdigit];  flag=1;}  //
display left  digit and change flag to 1
    else           {P2OUT= BIT1; P1OUT= LEDS[rightdigit]; flag=0;}  //
display right digit and change flag to 0
    __delay_cycles (100);

/*
    //Display code for Common-Anode display
    P1OUT= 0xFF; P2OUT=0xFF;
    __delay_cycles (100);
    if (flag == 0) {P2OUT &= ~BIT0; P1OUT= ~LEDS[leftdigit];  flag=1;}
    else           {P2OUT &= ~BIT1; P1OUT= ~LEDS[rightdigit]; flag=0;}
    __delay_cycles (100);
*/
}
```

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• CDA3331C • *Intro to Microcomputers* • **Lab Assignment** 5

Name/Semester: Aaron P. Mills **Grade:** /20

[20] 5) Write a C program using the MSP430G2553 Launchpad which creates a counter from 00-99. Your kit may have 7-seg displays with different pinout than the one in the drawings. As always check datasheets of your hardware components before wiring. For input control we use three DIP switches SW-321 which are connected to pins P2.5-3 with pull-up resistors. The different combinations of these 3 switches determine the operation of the counter as explained below. The two 7-segment digits are multiplexed (turned on alternately) by two control signals coming from P2.0 and P2.1. The two 2N2222 transistors with 1K Ohm resistors on the gate are used as power drivers for the Common Cathode pins of the displays. The 8 segments (a,b,c,d,e,f,g) of both displays are connected to Port 1 pins P1.0-P1.6 through a resister network (470-1000 Ohm). Please use the figure below as a sample how to organize components and wires on your breadboard. For exact pinout of the 2-digit 7-segment display, check the actual data sheet on the display part you are given in the lab kit. If the displays have Common Anode instead of Common Cathode, you need to use PNP transistors instead of NPN.

[4] 5.a) Build the circuit as described above and run the skeleton code.

[8] 5.b) Modify the code so that the counter initial number setup goes as follows. You may wish to slow down the display update so you see the changes better:

- SW-321 = 000: *Counter resets to 00*
- SW-321 = 001: Right digit cycles 0-9
- SW-321 = 010: Left digit cycles 0-9
- SW-321 = 011: Right and left digits both hold values (preset value)

[8] 5.c) Counter counts up or down

- SW-321 = 111: Counter cycles down from the preset value to 10, and repeats
- SW-321 = 101: Recall the preset value
- SW-321 = 110: Recall the preset value
- SW-321 = 100: Counter cycles up from the preset value to 90, and repeats