Universidad Del Valle De Guatemala 24/02/2021

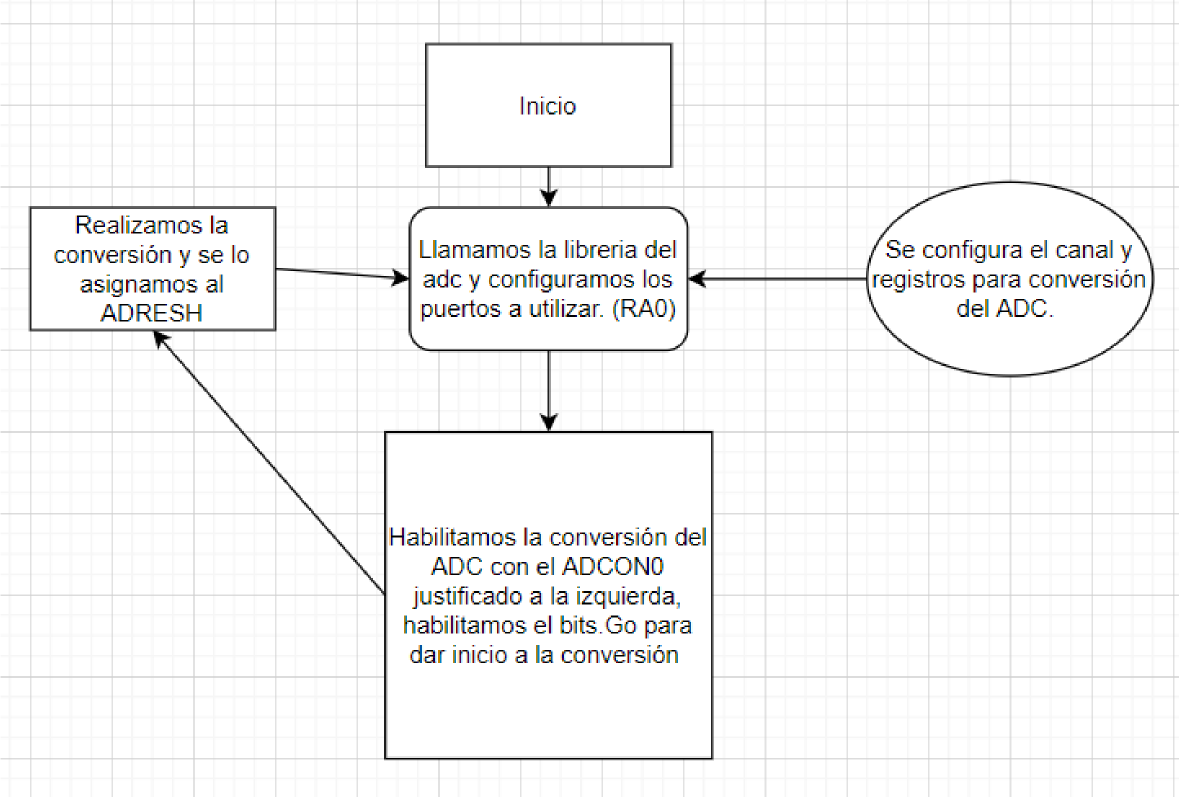
Digital 2 Helder Ovalle Barrios

Sección: 18349

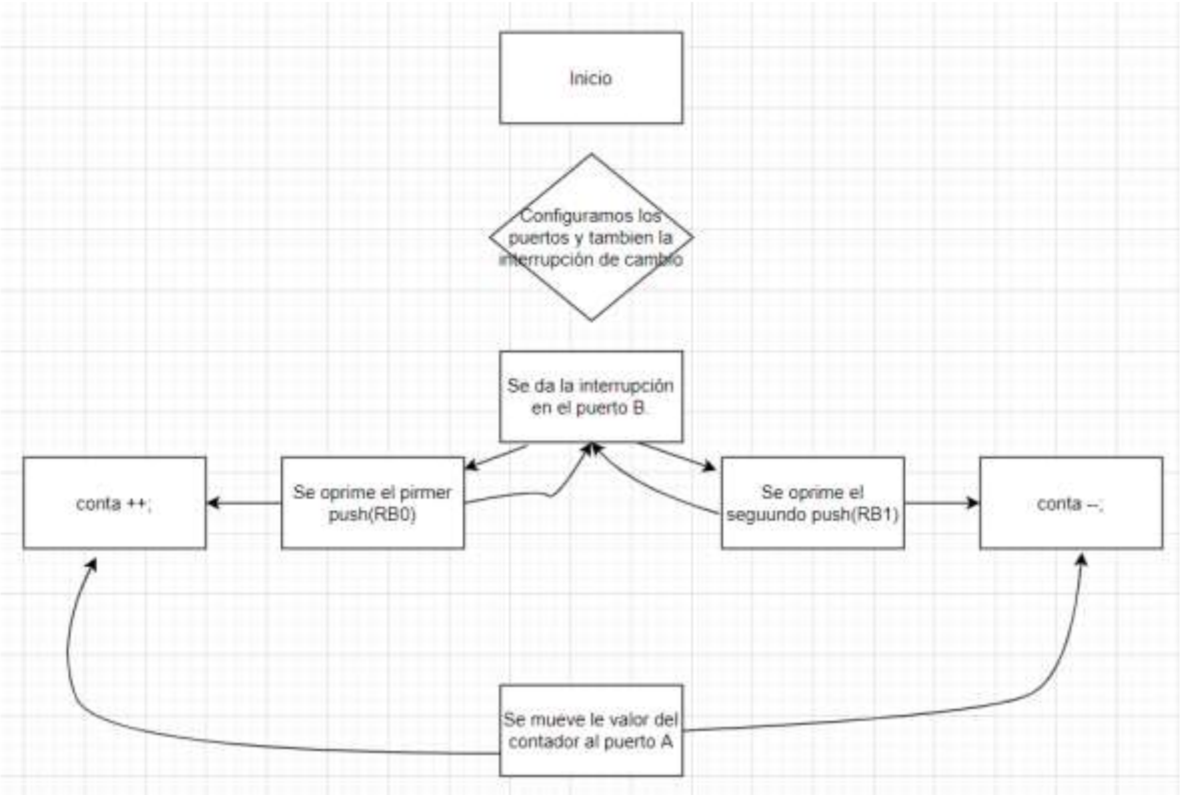
Laboratorio #2

Diagrama de flujo:

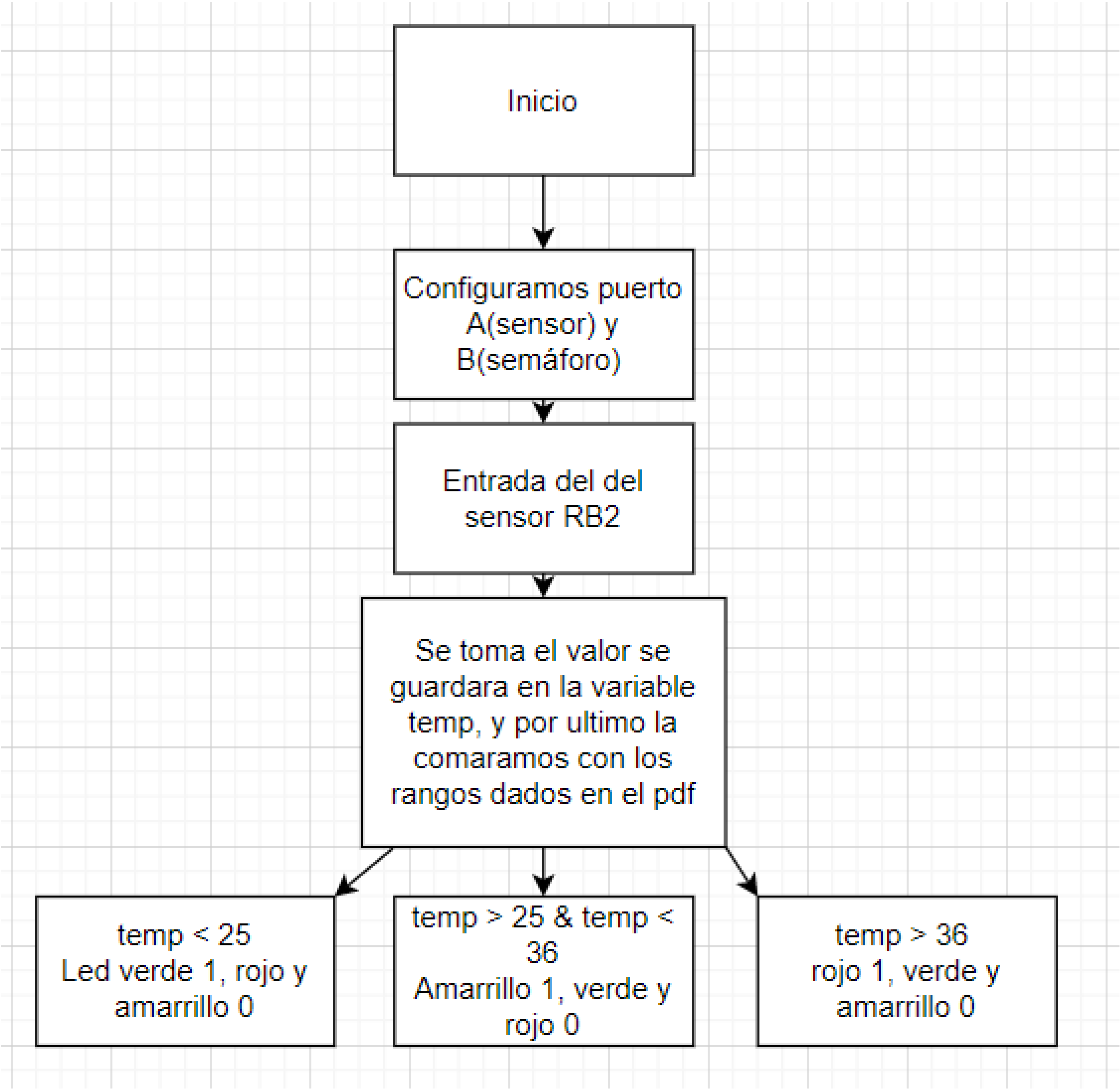
Esclavo adc:


Inicio
Llamamos la libreria del adc y configuramos los puertos a utilizar. (RA0)
Se configura el canal y registros para conversión del ADC.
Realizamos la conversión y se lo asignamos al ADRESH
Habilitamos la conversión del ADC con el ADCON0 justificado a la izquierda, habilitamos el bits.Go para dar inicio a la conversión

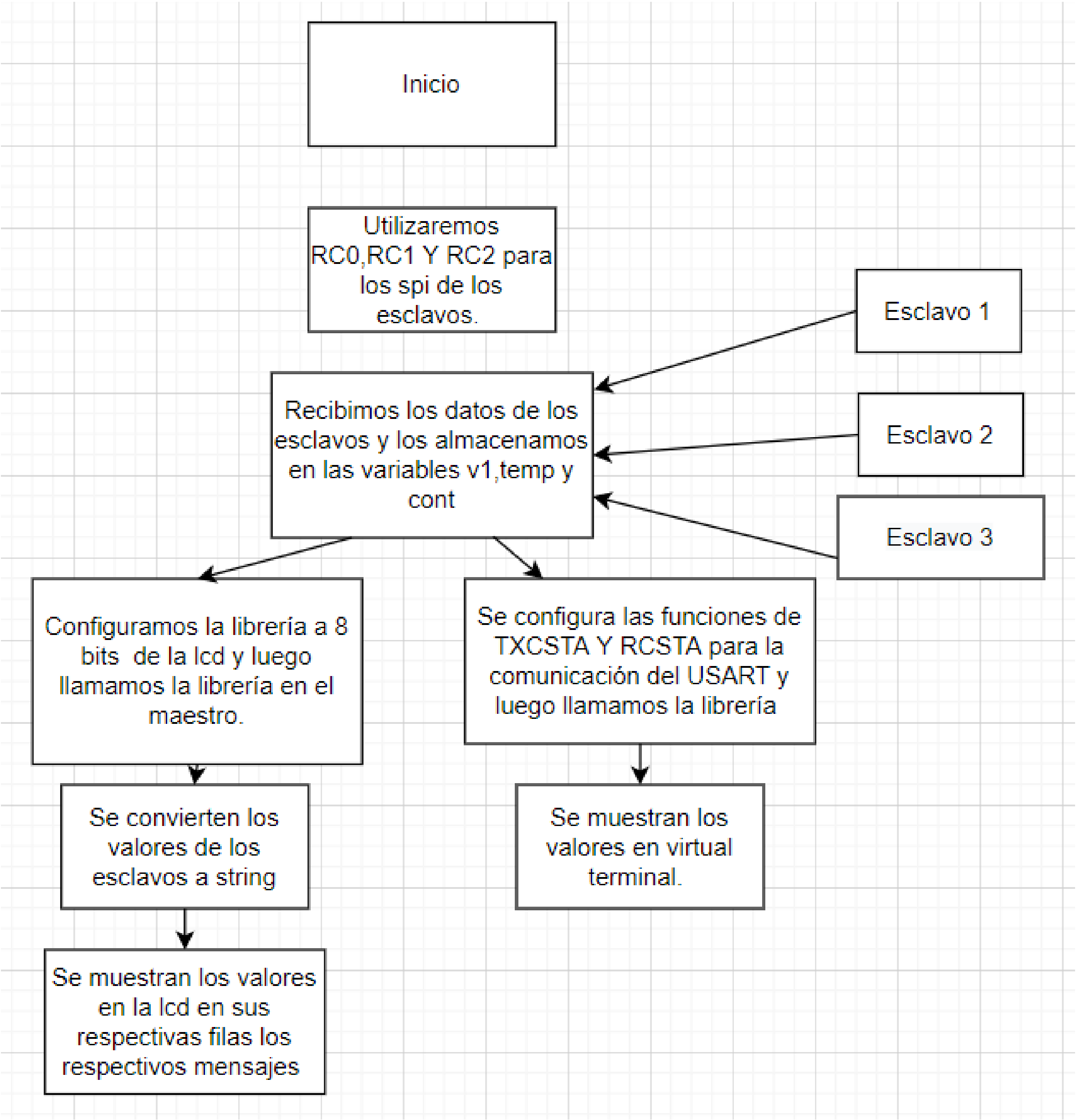
Esclavo contador:


Inicio
Configuramos los puertos y tambien la interrupción de cambio
Se da la interrupción en el puerto B.
conta ++;
Se oprime el pirmer push(RB0)
Se oprime el seguundo push(RB1)
conta --;
Se mueve le valor del contador al puerto A

Esclavo temperatura:


Inicio
Configuramos puerto A(sensor) y B(semáforo)
Entrada del del sensor RB2
Se toma el valor se guardara en la variable temp, y por ultimo la comaramos con los rangos dados en el pdf
temp < 25 Led verde 1, rojo y amarrillo 0
temp > 25 & temp < 36 Amarrillo 1, verde y rojo 0
temp > 36 rojo 1, verde y amarrillo 0

Todo unido:


Inicio
Utilizaremos RC0,RC1 Y RC2 para los spi de los esclavos.
Esclavo 1
Esclavo 2
Esclavo 3
Recibimos los datos de los esclavos y los almacenamos en las variables v1,temp y cont
Configuramos la librería a 8 bits de la lcd y luego llamamos la librería en el maestro.
Se configura las funciones de TXCSTA Y RCSTA para la comunicación del USART y luego llamamos la librería
Se convierten los valores de los esclavos a string
Se muestran los valores en virtual terminal.
Se muestran los valores en la lcd en sus respectivas filas los respectivos mensajes

Link de github:

https://github.com/Helder1121/Labsdigitaldos/tree/main/Proyecto

Link de youtube:

https://www.youtube.com/watch?v=yucoTpjiLfY

Progra comentada:

Maestro:

Librerias:

```
/*
 * File:   LCD.c
 * Author: Helder Ovalle
 *
 * Created on 21 de febrero de 2021, 11:37 PM
 */

//Libreria de Pablo Mazariegos en clase de 4 bits modificada a unos de 8bits

#include <xc.h>
#include <stdint.h>
#include "LCD.h"
#define _XTAL_FREQ 8000000

//Funcion para indicar el caracter segun sea el tamaño del mismo.
void Puerto(uint8_t x){
        if(x & 1){D0 = 1;}else{D0 = 0;}
   if(x & 2){D1 = 1;}else{D1 = 0;}
   if(x & 4){D2 = 1;}else{D2 = 0;}
   if(x & 8){D3 = 1;}else{D3 = 0;}
   if(x & 16){D4 = 1;}else{D4 = 0;}
   if(x & 32){D5 = 1;}else{D5 = 0;}
   if(x & 64){D6 = 1;}else{D6 = 0;}
   if(x & 128){D7 = 1;}else{D7 = 0;}
}

//Funcion para imprimir el caracter
void LCD_CMD(char a){
   RS = 1;//Las direcciones a los caracteres
   Puerto(a);
   EN = 1;//Mandar el valor
   __delay_us(5);
   EN = 0;//Verificar si el valor de carac llego
   __delay_us(5);
   __delay_us(50);
}
//Funcion para mandar los datos a la LCD
void datosLCD(uint8_t x){
   RS = 0;//Modifica el contraste de la patalla
   Puerto(x);
   EN = 1;//Mandar el valor
   __delay_us(5);
   EN = 0;//Verificar si el valor de carac llego
   __delay_us(5);
   __delay_ms(2);
}
//Funcion para limpiar la LCD
void LCD_Limpia(void){
   datosLCD(0);
   datosLCD(1);
}
//Funcion para iniciar la LCD
//En base de la presentacion de clase.
void Lcd_Init(){
   __delay_ms(20);
   datosLCD (0x30);
   __delay_ms(5);
   datosLCD (0x30);
   __delay_us(100);
```

```
  datosLCD (0x30);
  __delay_us(100);
  datosLCD (0x38);
  __delay_us(60);
  datosLCD (0x08);
  __delay_us(60);
  datosLCD (0x01);
  __delay_ms(5);
  datosLCD (0x06);
  __delay_us(60);
  datosLCD (0x0C);
  __delay_us(60);
}
//Funcion para configurar el cursor
void Lcd_Set_Cursor(uint8_t x, uint8_t y){
        uint8_t a;
        if(x == 1){//Linea que se coloca arriba
         a = 0x80 + y;//direccion(hexadecimal) y posicion para colocarlo en la fila
            //adecuada para ir leyendo adecuadamente
                datosLCD(a);
  }
        else if(x == 2){//Linea que se coloca abajo
         a = 0xC0 + y;//direccion(hexadecimal) y posicion para colocarlo en la fila
            //adecuada para ir leyendo adecuadamente
                datosLCD(a);
  }
}
//Funcion para mandar un string
void Lcd_Write_String(char *a){
  //funcion para poder imprimir texto usando el puntero
  //para guardar la direccion del registro o valor de a
```

```
        int i;
        for(i=0;a[i]!='\0';i++)
          LCD_CMD(a[i]);
}
/*
 * File           : spi.c
 * Author         : Ligo George
 * Company        : electroSome
 * Project        : SPI Library for MPLAB XC8
 * Microcontroller : PIC 16F877A
 * Created on April 15, 2017, 5:59 PM
 */
//Extraido de https://electrosome.com/ indicado por Pablo Mazariegos
#include "SPI.h"

void spiInit(Spi_Type sType, Spi_Data_Sample sDataSample, Spi_Clock_Idle
sClockIdle, Spi_Transmit_Edge sTransmitEdge)
{
   TRISC5 = 0;
   if(sType & 0b00000100) //If Slave Mode
   {
      SSPSTAT = sTransmitEdge;
      TRISC3 = 1;
   }
   else            //If Master Mode
   {
      SSPSTAT = sDataSample | sTransmitEdge;
      TRISC3 = 0;
   }

   SSPCON = sType | sClockIdle;
```

```
}

static void spiReceiveWait()
{
   while ( !SSPSTATbits.BF ); // Wait for Data Receive complete
}

void spiWrite(char dat)  //Write data to SPI bus
{
   SSPBUF = dat;
}

unsigned spiDataReady() //Check whether the data is ready to read
{
   if(SSPSTATbits.BF)
      return 1;
   else
      return 0;
}

char spiRead() //REad the received data
{
   spiReceiveWait();       // wait until the all bits receive
   return(SSPBUF); // read the received data from the buffer
}
/*
 * File:   USART.c
 * Author: betov
 *
 * Created on 22 de febrero de 2021, 07:53 AM
 */
```

```
#include <xc.h>
#include <pic16f887.h>
#include "USART.h"

void _baudios(void){
    SPBRG = 12; //9600 baudios para 8MHZ
}
//Configuracion dada en el datasheet
void config_txsta(void){
    TXSTAbits.CSRC = 0;//Clock terminal
    TXSTAbits.TX9 = 0;//8 bits de transmicion
    TXSTAbits.TXEN = 1;//Transmicion habilitada
    TXSTAbits.SYNC = 0;//modo asincrono
    TXSTAbits.BRGH = 0;//low speed
    TXSTAbits.TRMT = 0;//Tsr full
    TXSTAbits.TX9D = 0;
}
//Configuracion dada en el datasheet
void config_rcsta(void){
    RCSTAbits.SPEN = 1;//Se habilita el puerto serial
    RCSTAbits.RX9 = 0;
    RCSTAbits.SREN = 0;
    RCSTAbits.CREN = 1;//Recibir habilitada
    RCREG = 0;
}
//Extraido de https://electrosome.com/uart-pic-microcontroller-mplab-xc8/
void Write_USART(uint8_t a){
    while(!TRMT);
    TXREG=a;
}
void Write_USART_String(char *a){
    uint8_t i;
    for(i=0;a[i]!='\0';i++){
        Write_USART(a[i]);
    }
}
uint8_t Read_USART(){
  while(!RCIF);
  return RCREG;
}
```

Main:

```
/*
 * File:   contador.c
 * Author: Helder Ovalle
 *
 * Created on 21 de febrero de 2021, 01:36 PM
 */
//Basados en la implementación de comunicación SPI de Pablo
//****************************************************************************
// Palabra de configuración
//****************************************************************************
// CONFIG1
#pragma config FOSC = XT        // Oscillator Selection bits (XT oscillator: Crystal/resonator on RA6/OSC2/CLKOUT and RA7/OSC1/CLKIN)
#pragma config WDTE = OFF       // Watchdog Timer Enable bit (WDT disabled and can be enabled by SWDTEN bit of the WDTCON register)
#pragma config PWRTE = OFF      // Power-up Timer Enable bit (PWRT disabled)
#pragma config MCLRE = OFF      // RE3/MCLR pin function select bit (RE3/MCLR pin function is MCLR)
#pragma config CP = OFF         // Code Protection bit (Program memory code protection is disabled)
#pragma config CPD = OFF        // Data Code Protection bit (Data memory code protection is disabled)
```

```
#pragma config BOREN = OFF      // Brown Out Reset Selection bits (BOR disabled)
#pragma config IESO = OFF       // Internal External Switchover bit (Internal/External Switchover mode is disabled)
#pragma config FCMEN = OFF      // Fail-Safe Clock Monitor Enabled bit (Fail-Safe Clock Monitor is disabled)
#pragma config LVP = OFF        // Low Voltage Programming Enable bit (RB3 pin has digital I/O, HV on MCLR must be used for programming)

// CONFIG2
#pragma config BOR4V = BOR40V   // Brown-out Reset Selection bit (Brown-out Reset set to 4.0V)
#pragma config WRT = OFF        // Flash Program Memory Self Write Enable bits (Write protection off)

//*********************************************************************************
// Importación de librerías
//*********************************************************************************
#include <xc.h>
#include <stdint.h>
#include <stdio.h>
#include "SPI.h"
#include "LCD.h"
#include "USART.h"

//*********************************************************************************
// Variables
//*********************************************************************************
#define _XTAL_FREQ 8000000
uint8_t cont = 0;
uint8_t ADC1 = 0;
uint8_t ADC2 = 0;
float v1,temp;
char data[20];//Variable mostrara los valos en la lcd
//*********************************************************************************
```

```
//Portotipos de funciones
//******************************************************************************
void setup(void);
void contador(void);
void ADC_lectura(void);
float temperatura(void);
//******************************************************************************
// Ciclo principal
//******************************************************************************
void main(void){
   setup();


   _baudios();
   config_txsta();
   config_rcsta();
   Lcd_Init();
   LCD_Limpia();
   //***************************************************************************
   // Loop principal
   //***************************************************************************
   while(1){
      contador();
      ADC_lectura();
      //temperatura();
      LCD_Limpia();//Limpiamos la lcd
      Lcd_Set_Cursor(1,1);//Se mostrar en la primera fila de la lcd
      Lcd_Write_String("S1   CONT   S3");
      //Mensaje que se muestra en la terminal en la primera linea
//        v1 = ADC1*0.0196;
      temp = temperatura();
      sprintf(data, "%1.0f   %d   %3.0f" ,v1,cont,temp);
```

```
        Lcd_Set_Cursor(2,1);//Segunda fila
        Lcd_Write_String(data);//Mostrara el valor en la LCD

        Write_USART_String("S1   CONT   S3");
        //Mensaje que se muestra en la terminal en la segunda linea
        Write_USART(13);
        Write_USART(10);
        //Saltar lineas
        Write_USART_String(data);//Muestra en la terminal los valores
        Write_USART(13);
        Write_USART(10);
        //Saltar lineas
        __delay_ms(500);
    }
}

void ADC_lectura(void){
    PORTCbits.RC0 = 0;       //Slave Select
    __delay_ms(1);

    spiWrite(1);
    v1 = spiRead();

    __delay_ms(1);
    PORTCbits.RC0 = 1;       //Slave Deselect
    __delay_ms(1);
}

void contador(void){
    PORTCbits.RC1 = 0;      //Slave Select
```

```
  __delay_ms(1);


  spiWrite(1);
  cont = spiRead();


  __delay_ms(1);
  PORTCbits.RC1 = 1;       //Slave Deselect
  __delay_ms(1);
}


float temperatura(void){
  PORTCbits.RC2 = 0;       //Slave Select
  __delay_ms(1);


  spiWrite(1);
  temp = spiRead();


  __delay_ms(1);
  PORTCbits.RC2 = 1;         //Slave Deselect
  __delay_ms(1);
  return temp;
}


//******************************************************************************
// Configuración
//******************************************************************************
void setup(void){
  ANSEL = 0;
  ANSELH = 0;
  TRISB = 0;
  TRISE = 0;
```

```
    TRISD = 0;
    //Steo los puertos
    PORTE = 0;
    PORTD = 0;
    PORTB = 0;

    TRISC0 = 0;
    TRISC1 = 0;
    TRISC2 = 0;
    PORTCbits.RC0 = 1;
    PORTCbits.RC1 = 1;
    PORTCbits.RC2 = 1;
    PORTCbits.RC7 = 1;

    spiInit(SPI_MASTER_OSC_DIV4, SPI_DATA_SAMPLE_MIDDLE, SPI_CLOCK_IDLE_LOW,
        SPI_IDLE_2_ACTIVE);
}
```

Esclavo adc:

Librerías:

```
*
 * File:   ADC.c
 * Author: Helder Ovalle
 *
 * Created on 21 de febrero de 2021, 02:32 PM
 */

#include <xc.h>
#include <stdint.h>
#include "ADC.h"
```

```
#define _XTAL_FREQ 8000000



void config_ADC(void){
  ADCON1 = 0b00000000;//Justificado a la izquierda
}

unsigned Canal_ADC(unsigned short x){ //Fosc/8,datasheet
  switch(x){
    //Canal analogico
    case 0:
      ADCON0bits.CHS3 = 0;
      ADCON0bits.CHS2 = 0;
      ADCON0bits.CHS1 = 0;
      ADCON0bits.CHS0 = 0;//Canal00
      break;
    case 1:
      ADCON0bits.CHS3 = 0;
      ADCON0bits.CHS2 = 0;
      ADCON0bits.CHS1 = 0;
      ADCON0bits.CHS0 = 1;//Canal1
      break;
    case 2:
      ADCON0bits.CHS3 = 0;
      ADCON0bits.CHS2 = 0;
      ADCON0bits.CHS1 = 1;
      ADCON0bits.CHS0 = 0;//Canal2
      break;
    case 3:
      ADCON0bits.CHS3 = 0;
      ADCON0bits.CHS2 = 0;
```

```
   ADCON0bits.CHS1 = 1;
   ADCON0bits.CHS0 = 1;//Canal3
   break;
case 4:
   ADCON0bits.CHS3 = 0;
   ADCON0bits.CHS2 = 1;
   ADCON0bits.CHS1 = 0;
   ADCON0bits.CHS0 = 0;//Canal4
   break;
case 5:
   ADCON0bits.CHS3 = 0;
   ADCON0bits.CHS2 = 1;
   ADCON0bits.CHS1 = 0;
   ADCON0bits.CHS0 = 1;//Canal5
   break;
case 6:
   ADCON0bits.CHS3 = 0;
   ADCON0bits.CHS2 = 1;
   ADCON0bits.CHS1 = 1;
   ADCON0bits.CHS0 = 0;//Canal6
   break;
case 7:
   ADCON0bits.CHS3 = 0;
   ADCON0bits.CHS2 = 1;
   ADCON0bits.CHS1 = 1;
   ADCON0bits.CHS0 = 1;//Canal7
   break;
case 8:
   ADCON0bits.CHS3 = 1;
   ADCON0bits.CHS2 = 0;
   ADCON0bits.CHS1 = 0;
```

```
    ADCON0bits.CHS0 = 0;//Canal8
    break;
case 9:
    ADCON0bits.CHS3 = 1;
    ADCON0bits.CHS2 = 0;
    ADCON0bits.CHS1 = 0;
    ADCON0bits.CHS0 = 1;//Canal9
    break;
case 10:
    ADCON0bits.CHS3 = 1;
    ADCON0bits.CHS2 = 0;
    ADCON0bits.CHS1 = 1;
    ADCON0bits.CHS0 = 0;//Canal10
    break;
case 11:
    ADCON0bits.CHS3 = 1;
    ADCON0bits.CHS2 = 0;
    ADCON0bits.CHS1 = 1;
    ADCON0bits.CHS0 = 1;//Canal11
    break;
case 12:
    ADCON0bits.CHS3 = 1;
    ADCON0bits.CHS2 = 1;
    ADCON0bits.CHS1 = 0;
    ADCON0bits.CHS0 = 0;//Canal12
    break;
case 13:
    ADCON0bits.CHS3 = 1;
    ADCON0bits.CHS2 = 1;
    ADCON0bits.CHS1 = 0;
    ADCON0bits.CHS0 = 1;//Canal13
```

```
            break;
        case 14:
            ADCON0bits.CHS3 = 1;
            ADCON0bits.CHS2 = 1;
            ADCON0bits.CHS1 = 1;
            ADCON0bits.CHS0 = 0;//CVref
            break;
        case 15:
            ADCON0bits.CHS3 = 1;
            ADCON0bits.CHS2 = 1;
            ADCON0bits.CHS1 = 1;
            ADCON0bits.CHS0 = 1;//Fixed Ref
            break;
        default:
            ADCON0bits.CHS3 = 0;
            ADCON0bits.CHS2 = 0;
            ADCON0bits.CHS1 = 0;
            ADCON0bits.CHS0 = 0;//Canal 0
            break;
    }
}
/*
 * File           : spi.c
 * Author         : Ligo George
 * Company        : electroSome
 * Project        : SPI Library for MPLAB XC8
 * Microcontroller : PIC 16F877A
 * Created on April 15, 2017, 5:59 PM
 */
//Extraido de https://electrosome.com/ indicado por Pablo Mazariegos
#include "SPI.h"
```

```
void spiInit(Spi_Type sType, Spi_Data_Sample sDataSample, Spi_Clock_Idle
sClockIdle, Spi_Transmit_Edge sTransmitEdge)
{
   TRISC5 = 0;
   if(sType & 0b00000100) //If Slave Mode
   {
      SSPSTAT = sTransmitEdge;
      TRISC3 = 1;
   }
   else           //If Master Mode
   {
      SSPSTAT = sDataSample | sTransmitEdge;
      TRISC3 = 0;
   }

   SSPCON = sType | sClockIdle;
}

static void spiReceiveWait()
{
   while ( !SSPSTATbits.BF ); // Wait for Data Receive complete
}

void spiWrite(char dat)  //Write data to SPI bus
{
   SSPBUF = dat;
}

unsigned spiDataReady() //Check whether the data is ready to read
{
   if(SSPSTATbits.BF)
       return 1;
   else
       return 0;
}

char spiRead() //REad the received data
{
   spiReceiveWait();       // wait until the all bits receive
   return(SSPBUF); // read the received data from the buffer
}
```

Main:

```
/*
 * File:   SPadc.c
 * Author: Helder Ovalle
 *
 * Created on 21 de febrero de 2021, 04:48 PM
 */

//******************************************************************************
// Palabra de configuración
//******************************************************************************
// CONFIG1
#pragma config FOSC = XT        // Oscillator Selection bits (XT oscillator: Crystal/resonator on RA6/OSC2/CLKOUT and RA7/OSC1/CLKIN)
#pragma config WDTE = OFF       // Watchdog Timer Enable bit (WDT disabled and can be enabled by SWDTEN bit of the WDTCON register)
#pragma config PWRTE = OFF      // Power-up Timer Enable bit (PWRT disabled)
#pragma config MCLRE = OFF      // RE3/MCLR pin function select bit (RE3/MCLR pin function is MCLR)
#pragma config CP = OFF         // Code Protection bit (Program memory code protection is disabled)
#pragma config CPD = OFF        // Data Code Protection bit (Data memory code protection is disabled)
```

```
#pragma config BOREN = OFF      // Brown Out Reset Selection bits (BOR disabled)
#pragma config IESO = OFF       // Internal External Switchover bit (Internal/External Switchover mode is
disabled)
#pragma config FCMEN = OFF      // Fail-Safe Clock Monitor Enabled bit (Fail-Safe Clock Monitor is disabled)
#pragma config LVP = OFF        // Low Voltage Programming Enable bit (RB3 pin has digital I/O, HV on MCLR
must be used for programming)

// CONFIG2
#pragma config BOR4V = BOR40V   // Brown-out Reset Selection bit (Brown-out Reset set to 4.0V)
#pragma config WRT = OFF        // Flash Program Memory Self Write Enable bits (Write protection off)

//*****************************************************************************
// Importación de librerías
//*****************************************************************************
#include <xc.h>
#include <stdint.h>
#include "SPI.h"
#include "ADC.h"

//*****************************************************************************
// Variables
//*****************************************************************************
#define _XTAL_FREQ 8000000
uint8_t ADC = 0;
uint8_t volt, volt2;//variable para los voltajes en los pots
//*****************************************************************************
//Portotipos de funciones
//*****************************************************************************
void setup(void);
uint8_t adc_11(void);
uint8_t adc_21(void);
```

```
void Enviar_1(void);

void Enviar_2(void);

//******************************************************************************

// COdigo de interrupcion

//******************************************************************************

void __interrupt() isr(void){

    if(SSPIF == 1){

        spiWrite(ADC);

        SSPIF = 0;

    }

}

//******************************************************************************

// Ciclo principal

//******************************************************************************

void main(void){

    setup();

    config_ADC();

    //**************************************************************************

    // Loop principal

    //**************************************************************************

    while(1){

        //ADC_1();

        adc_21();

        ADC = adc_21();

        PORTD = ADC;

    }

}

//******************************************************************************

// Configuración

//******************************************************************************

void setup(void){
    ANSEL = 1;
    ANSELH = 0;
    TRISA = 1;
    TRISB = 0;
    TRISD = 0;

    //Seteo el puerto
    PORTA = 0;
    PORTB = 0;
    PORTD = 0;

    INTCONbits.GIE = 1;         // Habilitamos interrupciones
    INTCONbits.PEIE = 1;        // Habilitamos interrupciones PEIE
    PIR1bits.SSPIF = 0;         // Borramos bandera interrupción MSSP
    PIE1bits.SSPIE = 1;         // Habilitamos interrupción MSSP
    TRISAbits.TRISA5 = 1;       // Slave Select

    spiInit(SPI_SLAVE_SS_EN, SPI_DATA_SAMPLE_MIDDLE, SPI_CLOCK_IDLE_LOW,
            SPI_IDLE_2_ACTIVE);

}

//*****************************************************************************
// Funciones
//*****************************************************************************
uint8_t adc_11(void){
    Canal_ADC(0);//canal 0
    //Configuracion bits ADCON0
    ADCON0bits.ADCS0 = 1;//Clock ADC conversion
    ADCON0bits.ADCS1 = 0;
    ADCON0bits.ADON = 1;//Habilitamos el ADC
```

```
   __delay_ms(0.25);//Para la conversion
   ADCON0bits.GO = 1;//Inicia la conversion
   while (ADCON0bits.GO == 1){
      return  ADRESH;//Conversion de 0V-5V
   }
}
uint8_t adc_21(void){
   Canal_ADC(0);//Canal 0
   //Configuracion bits ADCON0
   ADCON0bits.ADCS0 = 1;//Clock ADC conversion
   ADCON0bits.ADCS1 = 0;
   ADCON0bits.ADON = 1;//Habilitamos el ADC
   __delay_ms(0.25);//Para la conversion
   ADCON0bits.GO = 1;//Inicia la conversion
   while (ADCON0bits.GO == 1){
      return  ADRESH; //Conversion
   }
}
void Enviar_1(void){//Envio de datos
   TXREG = volt;
   while (TXSTAbits.TRMT == 1){//Retorna y envia el voltaje a ADC1
      return;
   }
}
void Enviar_2(void){//Envio de datos
   TXREG = volt2;
   while (TXSTAbits.TRMT == 1){//Retorna y envia el voltaje a ADC2
      return;
   }
}
```

Esclavo contador:

Librerías:

```
/*
 * File           : spi.c
 * Author         : Ligo George
 * Company        : electroSome
 * Project        : SPI Library for MPLAB XC8
 * Microcontroller : PIC 16F877A
 * Created on April 15, 2017, 5:59 PM
 */
//Extraido de https://electrosome.com/ indicado por Pablo Mazariegos
#include "SPI.h"

void spiInit(Spi_Type sType, Spi_Data_Sample sDataSample, Spi_Clock_Idle
sClockIdle, Spi_Transmit_Edge sTransmitEdge)
{
    TRISC5 = 0;
    if(sType & 0b00000100) //If Slave Mode
    {
        SSPSTAT = sTransmitEdge;
        TRISC3 = 1;
    }
    else            //If Master Mode
    {
        SSPSTAT = sDataSample | sTransmitEdge;
        TRISC3 = 0;
    }

    SSPCON = sType | sClockIdle;
}
```

```
static void spiReceiveWait()

{

   while ( !SSPSTATbits.BF ); // Wait for Data Receive complete

}


void spiWrite(char dat)  //Write data to SPI bus

{

   SSPBUF = dat;

}


unsigned spiDataReady() //Check whether the data is ready to read

{

   if(SSPSTATbits.BF)

       return 1;

   else

       return 0;

}


char spiRead() //REad the received data

{

   spiReceiveWait();        // wait until the all bits receive

   return(SSPBUF); // read the received data from the buffer

}
```

Main:

```
/*

 * File:   contador.c

 * Author: Helder Ovalle

 *

 * Created on 21 de febrero de 2021, 01:36 PM
 */
//Basados en la implementación de comunicación SPI de Pablo
//*****************************************************************************
// Palabra de configuración
//*****************************************************************************
// CONFIG1
#pragma config FOSC = XT        // Oscillator Selection bits (XT oscillator: Crystal/resonator on RA6/OSC2/CLKOUT and RA7/OSC1/CLKIN)
#pragma config WDTE = OFF       // Watchdog Timer Enable bit (WDT disabled and can be enabled by SWDTEN bit of the WDTCON register)
#pragma config PWRTE = OFF      // Power-up Timer Enable bit (PWRT disabled)
#pragma config MCLRE = OFF      // RE3/MCLR pin function select bit (RE3/MCLR pin function is MCLR)
#pragma config CP = OFF         // Code Protection bit (Program memory code protection is disabled)
#pragma config CPD = OFF        // Data Code Protection bit (Data memory code protection is disabled)
#pragma config BOREN = OFF      // Brown Out Reset Selection bits (BOR disabled)
#pragma config IESO = OFF       // Internal External Switchover bit (Internal/External Switchover mode is disabled)
#pragma config FCMEN = OFF      // Fail-Safe Clock Monitor Enabled bit (Fail-Safe Clock Monitor is disabled)
#pragma config LVP = OFF        // Low Voltage Programming Enable bit (RB3 pin has digital I/O, HV on MCLR must be used for programming)

// CONFIG2
#pragma config BOR4V = BOR40V   // Brown-out Reset Selection bit (Brown-out Reset set to 4.0V)
#pragma config WRT = OFF        // Flash Program Memory Self Write Enable bits (Write protection off)

//*****************************************************************************
// Importación de librerías
//*****************************************************************************
#include <xc.h>
#include <stdint.h>
#include "SPI.h"
```

```
//****************************************************************************
// Variables
//****************************************************************************
#define _XTAL_FREQ 8000000
uint8_t conta = 0;

//****************************************************************************
//Portotipos de funciones
//****************************************************************************
void setup();

//****************************************************************************
// COdigo de interrupcion
//****************************************************************************
void __interrupt() isr(void){
   if(SSPIF == 1){
      spiWrite(conta);
      SSPIF = 0;
      //Mandarlo al SPI
   }
}
//****************************************************************************
// Ciclo principal
//****************************************************************************
void main(void){
   setup();
   //************************************************************************
   // Loop principal
   //************************************************************************
   while(1){
      if (PORTBbits.RB0 == 0){
            __delay_ms(100);
            if (PORTBbits.RB0 == 1){
                conta ++;
                PORTD = conta;
            }
        }
        if (PORTBbits.RB1 == 0){
            __delay_ms(100);
            if (PORTBbits.RB1 == 1){
                conta --;
                PORTD = conta;
            }
        }
    }
}
//*****************************************************************************
// Configuración
//*****************************************************************************
void setup(void){
    ANSEL = 0;
    ANSELH = 0;



    TRISB = 3;
    TRISD = 0;

    //Steo los puertos
    PORTB = 0;
    PORTD = 0;

    INTCONbits.GIE = 1;         // Habilitamos interrupciones
    INTCONbits.PEIE = 1;        // Habilitamos interrupciones PEIE
    PIR1bits.SSPIF = 0;         // Borramos bandera interrupción MSSP
    PIE1bits.SSPIE = 1;         // Habilitamos interrupción MSSP
    TRISAbits.TRISA5 = 1;       // Slave Select

    spiInit(SPI_SLAVE_SS_EN, SPI_DATA_SAMPLE_MIDDLE, SPI_CLOCK_IDLE_LOW,
            SPI_IDLE_2_ACTIVE);

}
```

Esclavo temperatura:

Librerías:

```
/*
 * File           : spi.c
 * Author         : Ligo George
 * Company        : electroSome
 * Project        : SPI Library for MPLAB XC8
 * Microcontroller : PIC 16F877A
 * Created on April 15, 2017, 5:59 PM
 */
//Extraido de https://electrosome.com/ indicado por Pablo Mazariegos
#include "SPI.h"

void spiInit(Spi_Type sType, Spi_Data_Sample sDataSample, Spi_Clock_Idle
sClockIdle, Spi_Transmit_Edge sTransmitEdge)
{
    TRISC5 = 0;
    if(sType & 0b00000100) //If Slave Mode
    {
        SSPSTAT = sTransmitEdge;
        TRISC3 = 1;
```

```
   }
   else            //If Master Mode
   {
      SSPSTAT = sDataSample | sTransmitEdge;
      TRISC3 = 0;
   }

   SSPCON = sType | sClockIdle;
}

static void spiReceiveWait()
{
   while ( !SSPSTATbits.BF ); // Wait for Data Receive complete
}

void spiWrite(char dat)  //Write data to SPI bus
{
   SSPBUF = dat;
}

unsigned spiDataReady() //Check whether the data is ready to read
{
   if(SSPSTATbits.BF)
      return 1;
   else
      return 0;
}

char spiRead() //REad the received data
{
   spiReceiveWait();      // wait until the all bits receive
```

```c
    return(SSPBUF); // read the received data from the buffer
}
/*
 * File:   ADC.c
 * Author: Helder Ovalle
 *
 * Created on 21 de febrero de 2021, 02:32 PM
 */

#include <xc.h>
#include <stdint.h>
#include "ADC.h"
#define _XTAL_FREQ 8000000

void config_ADC(void){
    ADCON1 = 0b00000000;//Justificado a la izquierda
    //ADCON1bits.VCFG0 = 1;
}

unsigned Canal_ADC(unsigned short x){ //Fosc/8,datasheet
    switch(x){
        //Canal analogico
        case 0:
            ADCON0bits.CHS3 = 0;
            ADCON0bits.CHS2 = 0;
            ADCON0bits.CHS1 = 0;
            ADCON0bits.CHS0 = 0;//Canal00
            break;
        case 1:
            ADCON0bits.CHS3 = 0;
            ADCON0bits.CHS2 = 0;
            ADCON0bits.CHS1 = 0;
            ADCON0bits.CHS0 = 1;//Canal1
            break;
        case 2:
            ADCON0bits.CHS3 = 0;
            ADCON0bits.CHS2 = 0;
            ADCON0bits.CHS1 = 1;
            ADCON0bits.CHS0 = 0;//Canal2
            break;
        case 3:
            ADCON0bits.CHS3 = 0;
            ADCON0bits.CHS2 = 0;
            ADCON0bits.CHS1 = 1;
            ADCON0bits.CHS0 = 1;//Canal3
            break;
        case 4:
            ADCON0bits.CHS3 = 0;
            ADCON0bits.CHS2 = 1;
            ADCON0bits.CHS1 = 0;
            ADCON0bits.CHS0 = 0;//Canal4
            break;
        case 5:
            ADCON0bits.CHS3 = 0;
            ADCON0bits.CHS2 = 1;
            ADCON0bits.CHS1 = 0;
            ADCON0bits.CHS0 = 1;//Canal5
            break;
        case 6:
            ADCON0bits.CHS3 = 0;
            ADCON0bits.CHS2 = 1;
            ADCON0bits.CHS1 = 1;
            ADCON0bits.CHS0 = 0;//Canal6
            break;
        case 7:
            ADCON0bits.CHS3 = 0;
            ADCON0bits.CHS2 = 1;
            ADCON0bits.CHS1 = 1;
            ADCON0bits.CHS0 = 1;//Canal7
            break;
        case 8:
            ADCON0bits.CHS3 = 1;
            ADCON0bits.CHS2 = 0;
            ADCON0bits.CHS1 = 0;
            ADCON0bits.CHS0 = 0;//Canal8
            break;
        case 9:
            ADCON0bits.CHS3 = 1;
            ADCON0bits.CHS2 = 0;
            ADCON0bits.CHS1 = 0;
            ADCON0bits.CHS0 = 1;//Canal9
            break;
        case 10:
            ADCON0bits.CHS3 = 1;
            ADCON0bits.CHS2 = 0;
            ADCON0bits.CHS1 = 1;
            ADCON0bits.CHS0 = 0;//Canal10
            break;
        case 11:
            ADCON0bits.CHS3 = 1;
            ADCON0bits.CHS2 = 0;
            ADCON0bits.CHS1 = 1;
            ADCON0bits.CHS0 = 1;//Canal11
            break;
        case 12:
            ADCON0bits.CHS3 = 1;
            ADCON0bits.CHS2 = 1;
            ADCON0bits.CHS1 = 0;
            ADCON0bits.CHS0 = 0;//Canal12
            break;
        case 13:
            ADCON0bits.CHS3 = 1;
            ADCON0bits.CHS2 = 1;
            ADCON0bits.CHS1 = 0;
            ADCON0bits.CHS0 = 1;//Canal13
            break;
        case 14:
            ADCON0bits.CHS3 = 1;
            ADCON0bits.CHS2 = 1;
            ADCON0bits.CHS1 = 1;
            ADCON0bits.CHS0 = 0;//CVref
            break;
        case 15:
            ADCON0bits.CHS3 = 1;
            ADCON0bits.CHS2 = 1;
            ADCON0bits.CHS1 = 1;
            ADCON0bits.CHS0 = 1;//Fixed Ref
            break;
        default:
            ADCON0bits.CHS3 = 0;
            ADCON0bits.CHS2 = 0;
            ADCON0bits.CHS1 = 0;
            ADCON0bits.CHS0 = 0;//Canal 0
            break;
```

```
   }
}
```

Main:

```
/*
 * File:   Temperatura.c
 * Author: Helder Ovalle
 *
 * Created on 21 de febrero de 2021, 06:20 PM
 */


//*****************************************************************************
// Palabra de configuración
//*****************************************************************************
// CONFIG1
#pragma config FOSC = XT        // Oscillator Selection bits (XT oscillator: Crystal/resonator on RA6/OSC2/CLKOUT and RA7/OSC1/CLKIN)
#pragma config WDTE = OFF       // Watchdog Timer Enable bit (WDT disabled and can be enabled by SWDTEN bit of the WDTCON register)
#pragma config PWRTE = OFF      // Power-up Timer Enable bit (PWRT disabled)
#pragma config MCLRE = OFF      // RE3/MCLR pin function select bit (RE3/MCLR pin function is MCLR)
#pragma config CP = OFF         // Code Protection bit (Program memory code protection is disabled)
#pragma config CPD = OFF        // Data Code Protection bit (Data memory code protection is disabled)
#pragma config BOREN = OFF      // Brown Out Reset Selection bits (BOR disabled)
#pragma config IESO = OFF       // Internal External Switchover bit (Internal/External Switchover mode is disabled)
#pragma config FCMEN = OFF      // Fail-Safe Clock Monitor Enabled bit (Fail-Safe Clock Monitor is disabled)
#pragma config LVP = OFF        // Low Voltage Programming Enable bit (RB3 pin has digital I/O, HV on MCLR must be used for programming)

// CONFIG2
#pragma config BOR4V = BOR40V   // Brown-out Reset Selection bit (Brown-out Reset set to 4.0V)
```

```
#pragma config WRT = OFF        // Flash Program Memory Self Write Enable bits (Write protection off)

//**********************************************************************************
// Importación de librerías
//**********************************************************************************
#include <xc.h>
#include <stdint.h>
#include "ADC.h"
#include "SPI.h"

//**********************************************************************************
// Variables
//**********************************************************************************
#define _XTAL_FREQ 8000000
uint8_t ADC = 0;
float temp;
uint8_t volt, volt2;//variable para los voltajes en los pots
//**********************************************************************************
//Portotipos de funciones
//**********************************************************************************
void setup(void);
void semaf(uint8_t temp);
uint8_t adc_11(void);
//uint8_t adc_21(void);
//void Enviar_1(void);
//void Enviar_2(void);
//**********************************************************************************
// COdigo de interrupcion
//**********************************************************************************
void __interrupt() isr(void){
   if(SSPIF == 1){
        spiWrite(temp);
        SSPIF = 0;
        //Mandarlo al SPI
    }
}
//*****************************************************************************
// Ciclo principal
//*****************************************************************************
void main(void){
    setup();
    //*************************************************************************
    // Loop principal
    //*************************************************************************
    while(1){
        adc_11();
        //ADC_2();
        ADC = adc_11();
        temp = (1.95*ADC);//COnversion para los grados
        semaf(temp);
    }
}
void semaf(uint8_t temp){
    if (temp < 25){//Verde <25
        PORTD = 1;}
    else if (temp > 25 && temp < 36){//Amariillo para el rango de 25-36
        PORTD = 2;}
    else if (temp > 36){//Rojo para >36
        PORTD = 4;}
}
//*****************************************************************************
// Configuración
```

```
//************************************************************************************
void setup(void){
   ANSEL = 0b00001000;
   ANSELH = 0;

   //TRISB = 0;
   TRISD = 0;
   //Steo el puerto
   PORTD = 0;
   PORTB = 0;

   INTCONbits.GIE = 1;         // Habilitamos interrupciones
   INTCONbits.PEIE = 1;        // Habilitamos interrupciones PEIE
   PIR1bits.SSPIF = 0;         // Borramos bandera interrupción MSSP
   PIE1bits.SSPIE = 1;         // Habilitamos interrupción MSSP
   TRISAbits.TRISA5 = 1;       // Slave Select

   spiInit(SPI_SLAVE_SS_EN, SPI_DATA_SAMPLE_MIDDLE, SPI_CLOCK_IDLE_LOW,
         SPI_IDLE_2_ACTIVE);

}

//************************************************************************************
// Funciones
//************************************************************************************
uint8_t adc_11(void){
   Canal_ADC(8);//canal 8
   //Configuracion bits ADCON0
   ADCON0bits.ADCS0 = 1;//Clock ADC conversion
   ADCON0bits.ADCS1 = 0;
   ADCON0bits.ADON = 1;//Habilitamos el ADC
```

```
    __delay_ms(0.25);//Para la conversion
    ADCON0bits.GO = 1;//Inicia la conversion
    while (ADCON0bits.GO == 1){
        //Conversion
    }
    return ADRESH;
}
```