Tecnológico de Monterrey
Escuela de Ingeniería y Ciencias

Report week 11: LCD, Keyboard, Timers and Interrupts integration.

Laboratory of Microcontrollers

Gilberto Ochoa Ruiz

Perla Vanessa Jaime Gaytán ITE

A00344428

Nicol Gómez Tisnado ITE

A00227180

Instituto Tecnológico de Estudios Superiores de Monterrey Campus Guadalajara

Zapopan, Jalisco, México.

May 18, 2020

Part 1. Simple GPIO Interrupt. Implement the example one seen in class: the main program toggles the red LED continuously and can be interrupted by a push button connected to port PTA1. The interrupt routine service (SIR) for this button is simply toggle the green LED for a short time, then moves back to tread mode to toggle de red LED again.

Code:

```
/* p6_1: PORTA interrupt from a switch

       Upon pressing a switch(button) connecting either PTA1 or PTA2  ground,
       the green LED will toggle for three times.
       Main program toggles red LED while waiting for interrupt from switches.

*/

#include "MKL25Z4.h"


void PORTA_IRQHandler(void);
void delayMs(int n);


int main(void) {

    NVIC_ICPR |= 0x40000000;    // disable INT30 (bit 30 of ISER[0]) while configuring

    SIM_SCGC5  |=  0x400;       // enable clock to Port B
    PORTB_PCR18 = 0x100;        // make PTB18 pin as GPIO
    PORTB_PCR19 = 0x100;        // make PTB19 pin as GPIO
    GPIOB_PDDR |= 0xC0000;      // make PTB18, 19 as output pin
    GPIOB_PDOR |= 0x90000;      // turn off LEDs

    SIM_SCGC5 |= 0x200;         // enable clock to Port A

    /* configure PTA1 for interrupt */
    PORTA_PCR1 |=  0x00103;     // make it GPIO and enable pull-up
    GPIOA_PDDR &= ~0x0002;      // make pin input
    PORTA_PCR1 &= ~0xF0000;     // clear interrupt selection
    PORTA_PCR1 |=  0xA0000;     // enable falling edge interrupt

    /*configure PTA2 for interrupt*/
    PORTA_PCR2 |=  0x00103;     // make it GPIO and enable pull-up
    GPIOA_PDDR &= ~0x0004;      // make pin input
    PORTA_PCR2 &= ~0xF0000;     // clear interrupt selection
    PORTA_PCR2 |=  0xA0000;     // enable falling edge interrupt

    NVIC_ISER |= 0x40000000;    // enable INT30 (bit 30 of ISER[0])

    /* toggle the red LED continuously */
```

```
    /* toggle the red LED continuously */
    while(1)
    {
        GPIOB_PTOR |= 0x40000;  // toggle red LED
        delayMs(500);
    }
}
```

```
void PORTA_IRQHandler(void)
{
    int i;
    /* toggle green LED (PTB19) three times */
    for (i = 0; i < 3; i++)
    {
        GPIOB_PDOR &= ~0x80000;     //turn on green LED
        delayMs(500);
        GPIOB_PDOR |= 0x80000;      // turn off green LED
        delayMs(500);
    }
    PORTA_ISFR = 0x00000006;        // clear interrupt flag
}

void delayMs(int n) {
    int i;
    int j;
    for(i = 0 ; i < n; i++){
        for(j = 0 ; j < 7000; j++) { }
    }
}
```

Registers:

NVIC_ISER	0x40000000
NVIC_ICER	0x40000000

01000000000000000000000000000000

SIM_SCGC5	0x00000780

000000000000	0	00000	0	0	0	1	1	11	0	0	000	0	0

```
SIM_SCGC5 = 780

System Clock Gating Control Register 5

Bit Field Values:
          bits[ 31:20 ] = 0
          bits[ 19:19 ] = 0
          bits[ 18:14 ] = 0
    PORTE bits[ 13:13 ] = 0 Clock disabled
    PORTD bits[ 12:12 ] = 0 Clock disabled
    PORTC bits[ 11:11 ] = 0 Clock disabled
    PORTB bits[ 10:10 ] = 1 Clock enabled
    PORTA bits[  9:9  ] = 1 Clock enabled
          bits[  8:7  ] = 3
          bits[  6:6  ] = 0
    TSI   bits[  5:5  ] = 0 Access disabled
          bits[  4:2  ] = 0
          bits[  1:1  ] = 0
    LPTMR bits[  0:0  ] = 0 Access disabled
```

PORTB_PCR18	0x00000105
PORTB_PCR19	0x00000105

0000000	0	0000	0000	00000	001	0	0	0	0	0	1	0	1

```
PORTB_PCR18 = 105

Pin Control Register n

Bit Field Values:
         bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
         bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = 0  Interrupt/DMA request disabled.
         bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
         bits[  7:7  ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
         bits[  5:5  ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
         bits[  3:3  ] = 0
    SRE  bits[  2:2  ] = 1  Slow slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 0  Internal pullup or pulldown resistor is not enabled on the
corresponding pin.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
pin, if the corresponding Port Pull Enable field is set.
```

GPIOB_PDDR	0x000c0000

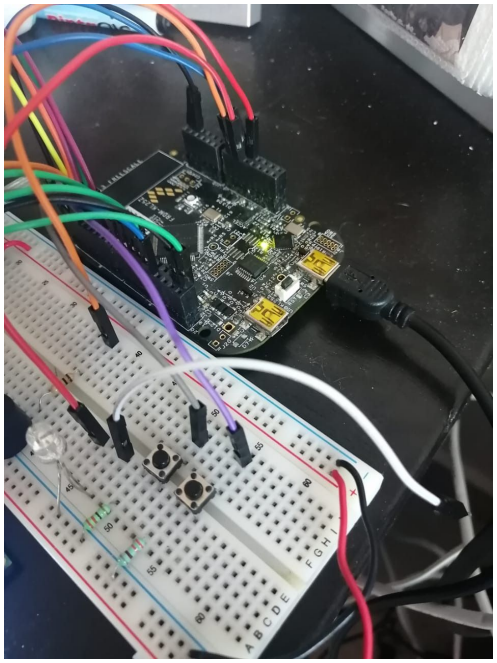
GPIOB_PDOR	0x000c0000

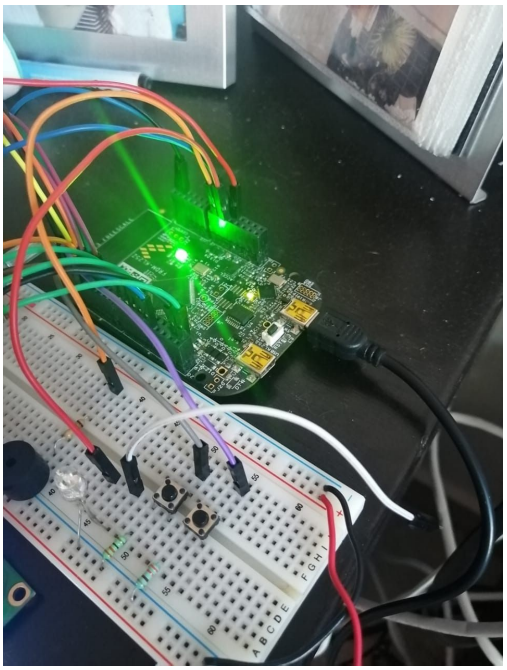
00000000000011000000000000000000

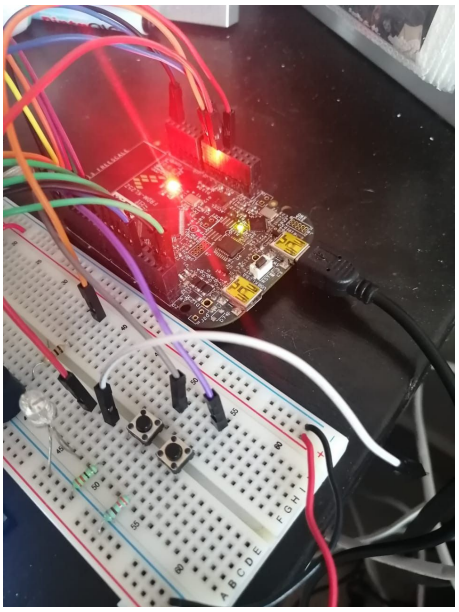
PORTA_PCR1	0x000a0107
PORTA_PCR2	0x000a0107

```
PORTA_PCR2 = a0107

Pin Control Register n

Bit Field Values:
         bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
         bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = a  Interrupt on falling edge.
         bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
         bits[  7:7  ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
         bits[  5:5  ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
         bits[  3:3  ] = 0
    SRE  bits[  2:2  ] = 1  Slow slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 1  Internal pullup or pulldown resistor is enabled on the
corresponding pin, if the pin is configured as a digital input.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
pin, if the corresponding Port Pull Enable field is set.
```

Pictures:







Video: https://youtu.be/6LyHNAuvcFs

Part 2. Distinguishing interrupts from different pins. In this part, you should implement the second example seen in class: two buttons are connected to the KL25Z board though the port A (PTA1 and PTA2), and both can interrupt the main process running in thread mode is the processor (again, just the red LED being toggled continuously).
As there is just one interrupt for the port A, we need to implement a mechanism for differentiating between the two ports; this can be done through flags in the ISFR register. Please remember to properly disable interrupts before the initialization code in your program. Also, is important to clear the interrupt after having served it, otherwise we might never go back to the main program!!!

Code:

```
/*
     Main program toggles red LED while waiting for interrupt from switches
     which toogles green LED A1 and blue LED A2
 */

#include "MKL25Z4.h"
void delayMs(int n);


int main(void)
{
    NVIC_ICPR |= 0x40000000;    // disable INT30 (bit 30 of ISER[0]) while configuring

    SIM_SCGC5  |=  0x400;       // enable clock to Port B
    SIM_SCGC5  |= 0x1000; /* enable clock to Port D */

    PORTB_PCR18 = 0x100;        // make PTB18 pin as GPIO red
    PORTB_PCR19 = 0x100;        // make PTB19 pin as GPIO green
    PORTD_PCR1  = 0x100;        // make PTD1 pin as GPIO blue
    GPIOB_PDDR |= 0xC0000;      // make PTB18, 19 as output pin
    GPIOB_PDOR |= 0xC0000;      // turn off LEDs
    GPIOD_PDDR |= 0x02;         // make PTD1 as output pin
    GPIOD_PDOR |= 0x02;         // turn off blue LED

    SIM_SCGC5 |= 0x200;         // enable clock to Port A

    /* configure PTA1 for interrupt */
    PORTA_PCR1 |=  0x00103;     // make it GPIO and enable pull-up
    GPIOA_PDDR &= ~0x0002;      // make pin input
    PORTA_PCR1 &= ~0xF0000;     // clear interrupt selection
    PORTA_PCR1 |=  0xA0000;     // enable falling edge interrupt


    /*configure PTA2 for interrupt*/
    PORTA_PCR2 |=  0x00103;     // make it GPIO and enable pull-up
    GPIOA_PDDR &= ~0x0004;      // make pin input
    PORTA_PCR2 &= ~0xF0000;     // clear interrupt selection
    PORTA_PCR2 |=  0xA0000;     // enable falling edge interrupt

    NVIC_ISER |= 0x40000000;    // enable INT30 (bit 30 of ISER[0])

    /* toggle the red LED continuously */
    while(1)
    {
        GPIOB_PTOR |= 0x40000;  // toggle red LED
        delayMs(500);
    }
}
```

```c
void PORTA_IRQHandler(void)
{
    int i;
    while (PORTA_ISFR & 0x00000006)
    {
        if (PORTA_ISFR & 0x00000002) //Port A1
        {
            /* toggle green LED (PTB19) three times */
            for (i = 0; i < 3; i++)
            {
                GPIOB_PDOR &= ~0x80000; //turn on green LED
                delayMs(500);
                GPIOB_PDOR |= 0x80000; // turn off green LED
                delayMs(500);
            } PORTA_ISFR = 0x00000002; // clear interrupt flag
        }
        if (PORTA_ISFR & 0x00000004) //Port A2
        {
            /* toggle blue LED (PTD1) three times */
            for (i = 0; i < 3; i++)
            {
                GPIOD_PDOR &= ~0x02; // turn on blue LED
                delayMs(500);
                GPIOD_PDOR |= 0x02; // turn off blue LED
                delayMs(500);
            } PORTA_ISFR = 0x00000004; // clear interrupt flag
        }
    }
}
```

```c
    /* Delay n milliseconds */
void delayMs(int n)
{
    int i;
    int j;
    for(i = 0 ; i < n; i++)
    {
        for (j = 0; j < 7000; j++) {}
    }
}
```

Registers:

NVIC_ISER	0x40000000

01000000000000000000000000000000

SIM_SCGC5	0x00001780

00000000000	0	00000	0	1	0	1	1	11	0	0	000	0	0

```
SIM_SCGC5 = 1780

System Clock Gating Control Register 5

Bit Field Values:
          bits[ 31:20 ] = 0
          bits[ 19:19 ] = 0
          bits[ 18:14 ] = 0
    PORTE bits[ 13:13 ] = 0 Clock disabled
    PORTD bits[ 12:12 ] = 1 Clock enabled
    PORTC bits[ 11:11 ] = 0 Clock disabled
    PORTB bits[ 10:10 ] = 1 Clock enabled
    PORTA bits[  9:9  ] = 1 Clock enabled
          bits[  8:7  ] = 3
          bits[  6:6  ] = 0
    TSI   bits[  5:5  ] = 0 Access disabled
          bits[  4:2  ] = 0
          bits[  1:1  ] = 0
    LPTMR bits[  0:0  ] = 0 Access disabled
```

PORTB_PCR18	0x00000105
PORTB_PCR19	0x00000105

0000000	0	0000	0000	00000	001	0	0	0	0	0	1	0	1

```
PORTB_PCR19 = 105

Pin Control Register n

Bit Field Values:
         bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
         bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = 0  Interrupt/DMA request disabled.
         bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
         bits[  7:7  ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
         bits[  5:5  ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
         bits[  3:3  ] = 0
    SRE  bits[  2:2  ] = 1  Slow slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 0  Internal pullup or pulldown resistor is not enabled on the
corresponding pin.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
pin, if the corresponding Port Pull Enable field is set.
```

PORTD_PCR1	0x00000105

0000000	0	0000	0000	00000	001	0	0	0	0	0	1	0	1

```
PORTD_PCR1 = 105

Pin Control Register n

Bit Field Values:
        bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
        bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = 0  Interrupt/DMA request disabled.
        bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
        bits[  7:7   ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
        bits[  5:5   ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
        bits[  3:3   ] = 0
    SRE  bits[  2:2  ] = 1  Slow slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 0  Internal pullup or pulldown resistor is not enabled on the
corresponding pin.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
```

GPIOB_PDDR	0x000c0000

GPIOB_PDOR	0x000c0000

00000000000011000000000000000000

GPIOD_PDDR	0x00000002

GPIOD_PDOR	0x00000002

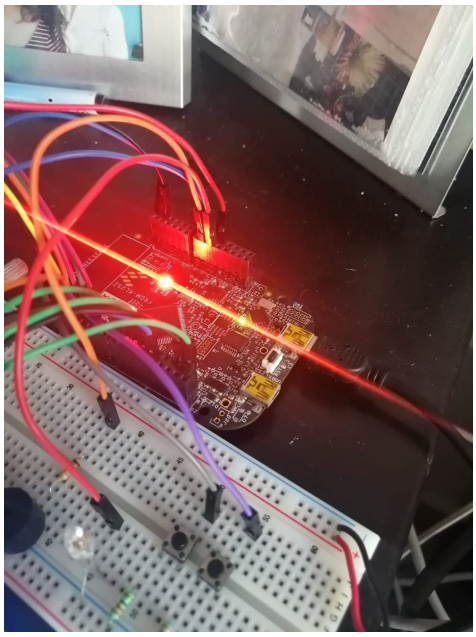
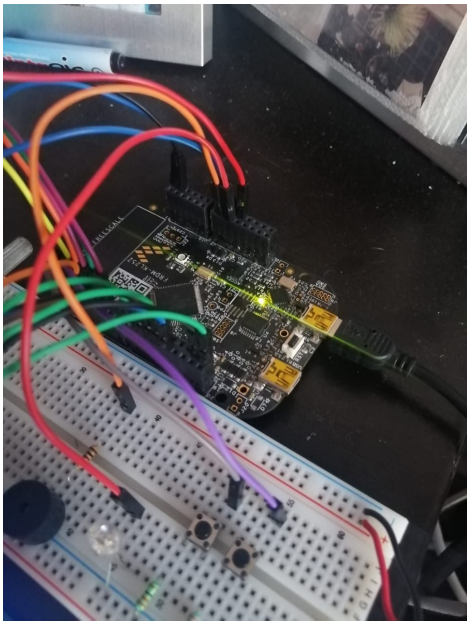
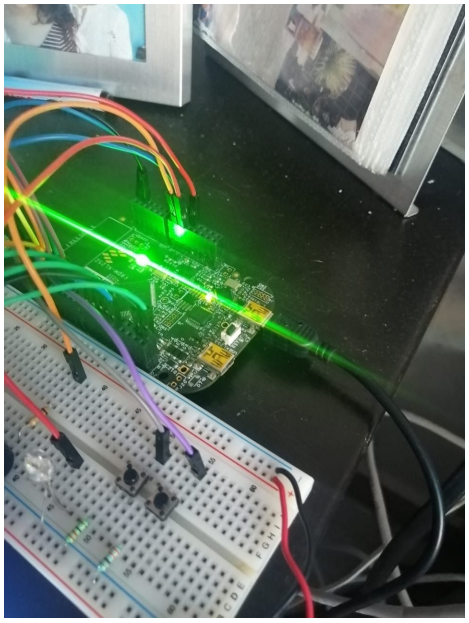
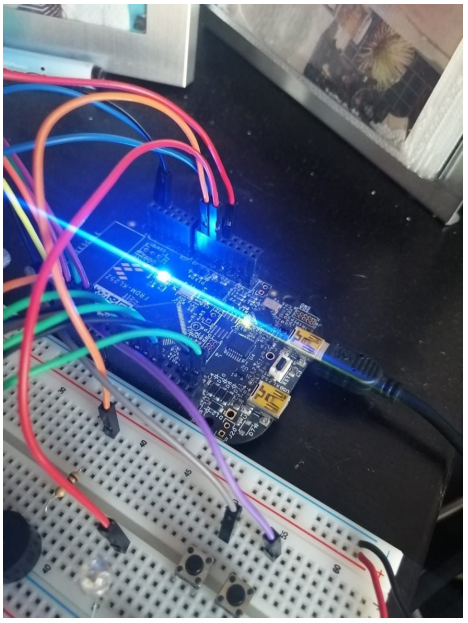
00000000000000000000000000000010

PORTA_PCR1	0x000a0107
PORTA_PCR2	0x000a0107

0000000	0	0000	1010	00000	001	0	0	0	0	0	1	1	1

```
PORTA_PCR1 = a0107

Pin Control Register n

Bit Field Values:
         bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
         bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = a  Interrupt on falling edge.
         bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
         bits[  7:7  ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
         bits[  5:5  ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
         bits[  3:3  ] = 0
    SRE  bits[  2:2  ] = 1  Slow slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 1  Internal pullup or pulldown resistor is enabled on the
corresponding pin, if the pin is configured as a digital input.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
pin, if the corresponding Port Pull Enable field is set.
```

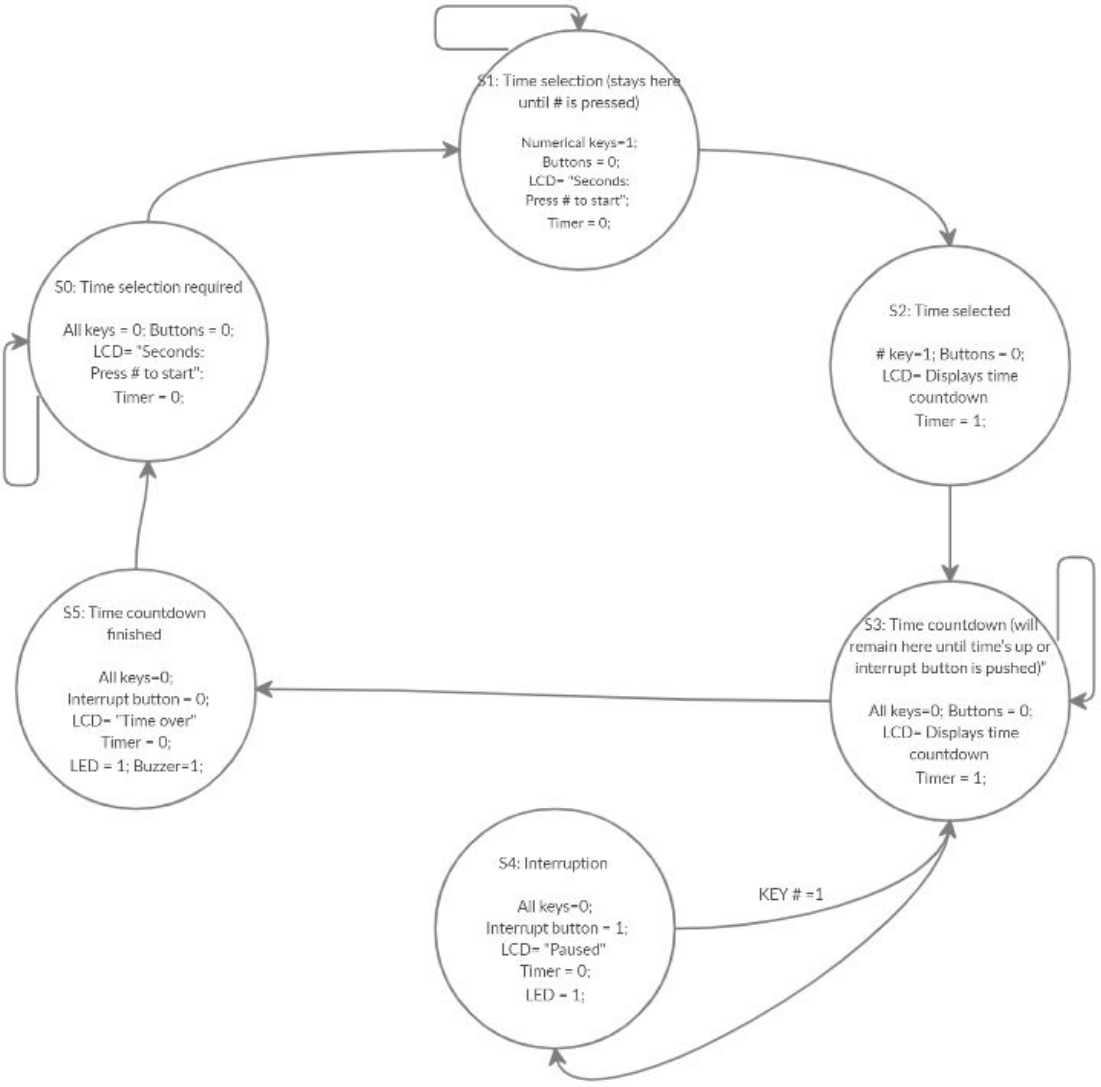
Pictures:

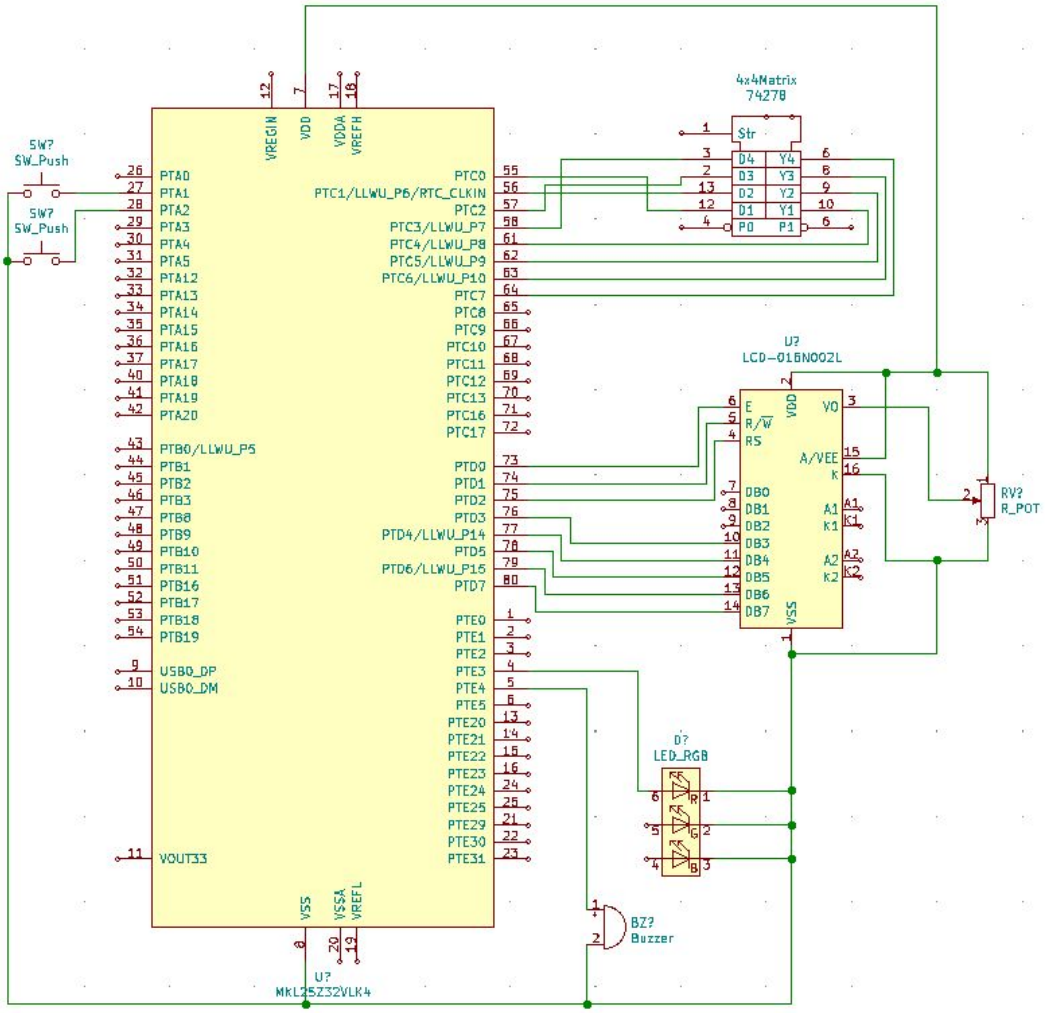
Video:https://youtu.be/tnGijMN-kyI

Part 3. Event counter. The goal of this last part of the lab is to integrate concepts of interrupts and timers, and put together a simple application involving the LCD and the 4x4 matrix keyboard. The main idea is to reuse the code of part 1 of this lab, but instead of toggling LEDs, we will integrate into the second part of the previous lab (ascending timer): when the counter is counting, if interrupt from PTA1 is activated, the code should execute and ISR that halts the counter and shows a message such as "PAUSED", the main program can resume if you press the * key.

State machine or a flow diagram:



Schematic:


4x4Matrix
74278
Str
D4
D3
D2
D1
P0
Y4
Y3
Y2
Y1
P1
SW?
SW_Push
SW?
SW_Push
U?
LCD-016N002L
E
R/W
RS
VDD
VO
A/VEE
K
DB0
DB1
DB2
DB3
DB4
DB5
DB6
DB7
VSS
A1
K1
A2
K2
RV?
R_POT
D?
LED_RGB
BZ?
Buzzer
U?
MKL25Z32VLK4
VREGIN
VDD
VDDA
VREFH
VSS
VSSA
VREFL
PTA0
PTA1
PTA2
PTA3
PTA4
PTA5
PTA12
PTA13
PTA14
PTA15
PTA16
PTA17
PTA18
PTA19
PTA20
PTB0/LLWU_P5
PTB1
PTB2
PTB3
PTB8
PTB9
PTB10
PTB11
PTB16
PTB17
PTB18
PTB19
USB0_DP
USB0_DM
VOUT33
PTC0
PTC1/LLWU_P6/RTC_CLKIN
PTC2
PTC3/LLWU_P7
PTC4/LLWU_P8
PTC5/LLWU_P9
PTC6/LLWU_P10
PTC7
PTC8
PTC9
PTC10
PTC11
PTC12
PTC13
PTC16
PTC17
PTD0
PTD1
PTD2
PTD3
PTD4/LLWU_P14
PTD5
PTD6/LLWU_P15
PTD7
PTE0
PTE1
PTE2
PTE3
PTE4
PTE5
PTE20
PTE21
PTE22
PTE23
PTE24
PTE25
PTE29
PTE30
PTE31

Code:

```
#include "derivative.h"

#define RS 1    // BIT0 mask
#define RW 2    // BIT1 mask
#define EN 4    // BIT2 mask

void LCD_init(void);
void LCD_nibble_write(unsigned char data, unsigned char control);
void LCD_command(unsigned char command);
void LCD_data(unsigned char data);

void TPM_init(void);
void delayUs(int n);
void delayMs(int n);
void TPM_timer(void);

void keypad_init(void);
char keypad_getkey(void);
int read_key(int x);
int getNum(int key);

void led_init(void);

void interupt_init(void);

void writeHello(void);
void askTime(void);
void writeNumbers(int value);


void writeTimer1(int num1, int num2);
void writeTimer2(int num1, int num2);
void writeTimeLeft(void);
void ledandbuzzerOn(void);
void ledandbuzzerOff(void);
void TimeOver(void);


void LCD_init(void)
{
    SIM_SCGC5 |= 0x1000;      // enable clock to Port D
    PORTD_PCR0 = 0x100;       // make PTD0 pin as GPIO
    PORTD_PCR1 = 0x100;       // make PTD1 pin as GPIO
    PORTD_PCR2 = 0x100;       // make PTD2 pin as GPIO
    PORTD_PCR3 = 0x100;       // make PTD3 pin as GPIO
    PORTD_PCR4 = 0x100;       // make PTD4 pin as GPIO
    PORTD_PCR5 = 0x100;       // make PTD5 pin as GPIO
    PORTD_PCR6 = 0x100;       // make PTD6 pin as GPIO
    PORTD_PCR7 = 0x100;       // make PTD7 pin as GPIO

    GPIOD_PDDR |= 0xF7;          // make PTD7-4, 2, 1, 0 as output pins
    delayMs(30);                 // initialization sequence
    LCD_nibble_write(0x30, 0);
    delayMs(10);
    LCD_nibble_write(0x30, 0);
    delayMs(1);
    LCD_nibble_write(0x30, 0);
    delayMs(1);
    LCD_nibble_write(0x20, 0);   // use 4-bit data mode
    delayMs(1);
    LCD_command(0x28);           // set 4-bit data, 2-line, 5x7 font
    LCD_command(0x06);           // move cursor right
    LCD_command(0x01);           // clear screen, move cursor to home
    LCD_command(0x0F);           // turn on display, cursor blinking
}
```

```
void LCD_nibble_write(unsigned char data, unsigned char control)
{
    data &= 0xF0;       // clear lower nibble for control
    control &= 0x0F;    // clear upper nibble for data
    GPIOD_PDOR = data | control;       // RS = 0, R/W = 0
    GPIOD_PDOR = data | control | EN;  // pulse E
    delayMs(0);
    GPIOD_PDOR = data;
    GPIOD_PDOR = 0;
}

void LCD_command(unsigned char command)
{
    LCD_nibble_write(command & 0xF0, 0);   // upper nibble first
    LCD_nibble_write(command << 4, 0);     // then lower nibble
    if (command < 4)
        delayMs(4);         // commands 1 and 2 need up to 1.64ms
    else
        delayMs(1);         // all others 40 us
}

void LCD_data(unsigned char data)
{
    LCD_nibble_write(data & 0xF0, RS);     // upper nibble first
    LCD_nibble_write(data << 4, RS);       // then lower nibble
    delayMs(1);
}


void TPM_init(void){

    SIM_SCGC6|= SIM_SCGC6_TPM0_MASK;    //assign clk to TPM0
    //
    SIM_SOPT2 |= (SIM_SOPT2 & ~SIM_SOPT2_TPMSRC_MASK)|SIM_SOPT2_TPMSRC(3); //SET CLK SOURCE TO BE 32.768 kHZ
    MCG_C1 |= MCG_C1_IRCLKEN_MASK;
    TPM0_SC = 0;

    TPM0_MOD = 32768-1;             //TPMx_MOD = value

    TPM0_SC |= TPM_SC_TOF_MASK;     //Clear TOF  flag

    TPM0_SC |= TPM_SC_CMOD(1);      //Enable timer

}


void delayMs(int n) {
    int i;
    int j;
    for(i = 0 ; i < n; i++){
        for(j = 0 ; j < 7000; j++) { }
    }
}
void delayUs(int n){
    int i,j;
    for(i = 0 ; i < n; i++) {
        for(j = 0; j < 5; j++) ;
    }
}

void TPM_timer(void){
    while (!(TPM0_SC & TPM_SC_TOF_MASK));   //wait until tof is set
    TPM0_SC |= TPM_SC_TOF_MASK;             //clear tof flag
}
```

```
void keypad_init(void){
    SIM_SCGC5 |= 0x0800;     //enable clk to port c

    PORTC_PCR0 = 0x103;     //PTC0 as GPIO and enable pullup
    PORTC_PCR1 = 0x103;     //PTC1 as GPIO and enable pullup
    PORTC_PCR2 = 0x103;     //PTC2 as GPIO and enable pullup
    PORTC_PCR3 = 0x103;     //PTC3 as GPIO and enable pullup
    PORTC_PCR4 = 0x103;     //PTC4 as GPIO and enable pullup
    PORTC_PCR5 = 0x103;     //PTC5 as GPIO and enable pullup
    PORTC_PCR6 = 0x103;     //PTC6 as GPIO and enable pullup
    PORTC_PCR7 = 0x103;     //PTC7 as GPIO and enable pullup
    GPIOC_PDDR = 0x0F;      //make PTC7-0 as input pins
}


char keypad_getkey(void){

    int col, row;
    const char row_select[] = {0x01, 0x02, 0x04, 0x08};

    GPIOC_PDDR = 0x0F;  //enable al rows
    GPIOC_PCOR = 0x0F;
    delayUs(2);         //wait for signal

    col = 0xF00 & GPIOC_PDIR;   //read all columns

    GPIOC_PDDR = 0;             //disable all rows

    if (col == 0xF0)            //no key pressed;
    return 0;

    for (row = 0; row<4; row++) //finds out which key was pressed
    {
        GPIOC_PDDR = 0;                 //disable all rows
        GPIOC_PDDR |= row_select[row];  //enable one row
        GPIOC_PCOR = row_select[row];   //drive the active row low
        delayUs(2);                     //wait for signal to settle
        col = GPIOC_PDIR & 0xF0;        //read all columns
        if (col != 0xF0) break;         //if one of the inputs is low some key is pressed
    }


    GPIOC_PDDR = 0; //disable all rows

    if (row == 4)   //no key was pressed
    return 0;

    if (col == 0xE0) return row * 4 + 1; //key in column 1
    if (col == 0xD0) return row * 4 + 2; //key in column 2
    if (col == 0xB0) return row * 4 + 3; //key in column 3
    if (col == 0x70) return row * 4 + 4; //key in column 4
    return 0;                            //other information received
}


int read_key(int x)
{
    int key_press;

    if(x!=0)                //if a key was pressed return 1
    return key_press = 1;
    else                    //if there is no key pressed return 0
    return key_press = 0;

}
```

```
int getNum(int value){
    if(value == 15)
    {
        return 0;
    }
    else if(value == 4)
    {
        return 1;
    }
    else if(value == 3)
    {
        return 2;
    }
    else if(value == 2)
    {
        return 3;
    }
    else if(value == 8)
    {
        return 4;
    }
    else if(value == 7)
    {
        return 5;
    }
    else if(value == 6)
    {
        return 6;
    }
                                    else if(value == 6)
                                    {
                                        return 6;
                                    }
                                    else if(value == 12)
                                    {
                                        return 7;
                                    }
                                    else if(value == 11)
                                    {
                                        return 8;
                                    }
                                    else if(value == 10)
                                    {
                                        return 9;
                                    }
                                }

void led_init(void){

    SIM_SCGC5 |= 0x2000;    //enable clk to port E

    //RED LED
    PORTE_PCR3 = 0x100;     //make PTE3 as GPIO
    GPIOE_PDDR |= 0x08;     //make PTE3 as output pin
    GPIOE_PCOR |= 0x08;     //turn off red LED
    //BLUE LED
    PORTE_PCR5 = 0x100;     //make PTE3 as GPIO
    GPIOE_PDDR |= 0x20;     //make PTE3 as output pin
    GPIOE_PCOR |= 0x20;     //turn off blue LED
    //BUZZER
    PORTE_PCR4 = 0x100;     //make PTE4 as GPIO
    GPIOE_PDDR |= 0x10;     //make PTE4 as output pin
    GPIOE_PCOR |= 0x10;     //turn off buzzer

}


void interupt_init(void)
{
    NVIC_ICPR |= 0x40000000;    // disable INT30 (bit 30 of ISER[0]) while configuring
    SIM_SCGC5 |= 0x200;         // enable clock to Port A

    /* configure PTA1 for interrupt */
    PORTA_PCR1 |=  0x00103;     // make it GPIO and enable pull-up
    GPIOA_PDDR &= ~0x0002;      // make pin input
    PORTA_PCR1 &= ~0xF0000;     // clear interrupt selection
    PORTA_PCR1 |=  0xA0000;     // enable falling edge interrupt

    /*configure PTA2 for interrupt*/
    PORTA_PCR2 |=  0x00103;     // make it GPIO and enable pull-up
    GPIOA_PDDR &= ~0x0004;      // make pin input
    PORTA_PCR2 &= ~0xF0000;     // clear interrupt selection
    PORTA_PCR2 |=  0xA0000;     // enable falling edge interrupt

    NVIC_ISER |= 0x40000000;    // enable INT30 (bit 30 of ISER[0])
}
```

```
void PORTA_IRQHandler(void)
{
    char key;

    LCD_command(1);         // clear display
    LCD_command(0x85);      // set cursor at the middle
    LCD_data('P');
    LCD_data('A');
    LCD_data('U');
    LCD_data('S');
    LCD_data('E');
    LCD_data('D');
    LCD_command(0xC1);
    LCD_data('P');
    LCD_data('R');
    LCD_data('E');
    LCD_data('S');
    LCD_data('S');
    LCD_data(' ');
    LCD_data('*');
    LCD_data(' ');
    LCD_data('T');
    LCD_data('O');
    LCD_data(' ');


    LCD_data('P');
    LCD_data('L');
    LCD_data('A');
    LCD_data('Y');
    while(key != 16)
            {
                GPIOE_PTOR |= 0x20;
                key = keypad_getkey();
            }
    PORTA_ISFR = 0x00000002; // clear interrupt flag
    GPIOE_PCOR |= 0x20;
    writeTimeLeft();

}


void writeHello(void){
    LCD_command(1);         // clear display
    LCD_command(0x85);      // set cursor at the middle
    LCD_data('H');          // write the word
    LCD_data('E');
    LCD_data('L');
    LCD_data('L');
    LCD_data('O');
    delayMs(500);
    LCD_command(1);         // clear display
}
```

```
void askTime(void){
    LCD_command(1);         // clear display
    LCD_command(0x80);      // set cursor at the middle
    LCD_data('E');          // write the word
    LCD_data('N');
    LCD_data('T');
    LCD_data('E');
    LCD_data('R');
    LCD_data(' ');
    LCD_data('#');
    LCD_data(' ');
    LCD_data('O');
    LCD_data('F');
    LCD_command(0xC0);
    LCD_data('S');
    LCD_data('E');
    LCD_data('C');
    LCD_data('O');
    LCD_data('N');
    LCD_data('D');
    LCD_data('S');
    delayMs(500);
    LCD_command(1);         // clear display


    LCD_command(0x80);
    LCD_data('S');
    LCD_data('E');
    LCD_data('C');
    LCD_data('O');
    LCD_data('N');
    LCD_data('D');
    LCD_data('S');
    LCD_data(':');
    LCD_command(0xC0);
    LCD_data('P');
    LCD_data('R');
    LCD_data('E');
    LCD_data('S');
    LCD_data('S');
    LCD_data(' ');
    LCD_data('#');
    LCD_data(' ');
    LCD_data('T');
    LCD_data('O');
    LCD_data(' ');
    LCD_data('S');
    LCD_data('T');
    LCD_data('A');
    LCD_data('R');
    LCD_data('T');
    LCD_command(0x88);
}
```

```
void writeNumbers(int value){
    if(value == 0)
    {
        LCD_data('0');
    }
    else if(value == 1)
    {
        LCD_data('1');
    }
    else if(value == 2)
    {
        LCD_data('2');
    }
    else if(value == 3)
    {
        LCD_data('3');
    }
    else if(value == 4)
    {
        LCD_data('4');
    }
    else if(value == 5)
    {
        LCD_data('5');
    }
    else if(value == 6)
    {
        LCD_data('6');
    }
    else if(value == 7)
    {
        LCD_data('7');
    }
    else if(value == 8)
    {
        LCD_data('8');
    }
    else if(value == 9)
    {
        LCD_data('9');
    }

}
```

```
void writeTimeLeft(void){
    LCD_command(1);          // clear display
    LCD_command(0x82);       // set cursor at the middle
    LCD_data('S');
    LCD_data('E');
    LCD_data('C');
    LCD_data('O');
    LCD_data('N');
    LCD_data('D');
    LCD_data('S');
    LCD_data(' ');
    LCD_data('L');
    LCD_data('E');
    LCD_data('F');
    LCD_data('T');
}
```

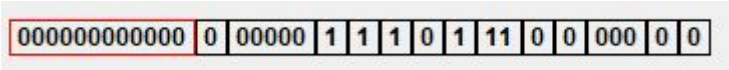
```
void writeTimer1(int num1, int num2){

    while(num1>0)                //cuando el numero sea igual a 1
    {
        LCD_command(0xC7);       //Cursor en la segunda linea espacio 7
        writeNumbers(num2);      //Escribir el numero
        LCD_command(0xC8);       //Situar el curso en la segunda linea espacio 8
        writeNumbers(num1);      //Escribir el número actual
        TPM_timer();             //Esperar 1 segundo
        num1--;                  //restarle al num1
    }
    LCD_command(0xC8);           //Situarlo en el curso 8
    LCD_data('0');               //escribir el 0

}
```

```
void writeTimer2(int num1, int num2)
{
    while(num1>=0)                          // mientras el numero 1 sea mayor o igual a 0, crear un loop
        {
                if(num1==0 && num2>0)       //Numeros menores iguales a 9
                {
                    writeTimer1(num2,0);        //Cuenta regresiva
                    num2 = 0;               //termino por lo tanto num2 ya es 0

                }

                else if(num1>0 && num2>=0)  //Para número mayores a 9
                {

                    writeTimer1(num2,num1);     //Cuenta regresiva
                    TPM_timer();            //esperar 1 segundo
                    num1--;                 //restarle 1 a num1
                    num2 = 9;               //por lo tanto num 2 es 9
                }
                else{                       //caso cuando ambos digitos son 0 terminar el loop
                    return;
                }
        }

}


void ledandbuzzerOn(void){
    GPIOE_PSOR |= 0x08;      //turn RED LED on and off
    GPIOE_PSOR |= 0x10;      //turn buzzer on
}

void ledandbuzzerOff(void){
    GPIOE_PCOR |= 0x08;      //turn RED LED on and off
    GPIOE_PCOR |= 0x10;      //turn buzzer on
}


void TimeOver(void){
    LCD_command(1);          // clear display
    LCD_command(0x84);       // set cursor at the middle
    LCD_data('T');
    LCD_data('I');
    LCD_data('M');
    LCD_data('E');
    LCD_data(' ');
    LCD_data('O');
    LCD_data('V');
    LCD_data('E');
    LCD_data('R');
    LCD_command(0xC7);           //Situarlo en el curso 8
    LCD_data('0');
    LCD_command(0xC8);
    LCD_data('0');               //escribir el 0

    //turn on and of the red led and buzzer
    ledandbuzzerOn();
    delayMs(300);
    ledandbuzzerOff();
    delayMs(300);
    ledandbuzzerOn();
    delayMs(300);
    ledandbuzzerOff();
    delayMs(300);
    ledandbuzzerOn();
    delayMs(300);
    ledandbuzzerOff();}
```

```
int main(void)
{
    unsigned char key;
    int rkey;
    int m;
    int n;
    int num;
    int num1;
    int num2;
    LCD_init();
    keypad_init();
    led_init();
    TPM_init();
    interupt_init();

    for(;;)
    {
        m = 1;
        n = 0;                                  //números escritos
        writeHello();                           //escribir Hello
        askTime();                              //ask for time
        while(m == 1){
            key = keypad_getkey();              //get which key was pressed
            rkey  = read_key(key);              //read if the key was pressed


          num = getNum(key);
          if(rkey == 1)                         //if it was pressed then
          {
              if(key != 13 && key!=14 && key!=16 && key!= 0 && key!= 1 && key!= 9 && key!= 5)
              //si key no es igual a null,*,#,D,C,B,A
              {
                  if (n==0 && num != 0)             //para escribir el primer numero
                  {
                      n++;
                      writeNumbers(num);            //escribir el numero presionado
                      num1 = num;
                      while (rkey == 1)             //if still pressed stay here till is not as debouncer
                      {
                          key = keypad_getkey();    //get the key pressed
                          rkey  = read_key(key);    //read if the key is still pressed
                      }
                  }
                  else if(n==1)                     //para escribir el segundo numero
                  {
                      n++;
                      writeNumbers(num);            //escribir el numero presionado
                      num2 = num;
                      while (rkey == 1)             //if still pressed stay here till is not as debouncer
                      {
                          key = keypad_getkey();    //get the key pressed
                          rkey  = read_key(key);    //read if the key is still pressed
                      }
                  }
              }

---

          }
          else if(key == 14)                    //if # is pressed
          {
              if (n==1)                         //si solamente un numero fue ingresado
              {
                  writeTimeLeft();              //escribir TIME LEFT en la LCD
                  TPM_timer();                  //esperar 2 segundos antes de la cuenta regresiva
                  TPM_timer();
                  writeTimer1(num1,0);              //cuenta regresiva
                  TimeOver();                   //Despliega TIME OVER y hace paradear el LED y buzzer
                  m=2;

              }
              else if(n==2){                    //si dos numeros fueron ingresados
                  writeTimeLeft();              //escribir TIME LEFT en la LCD
                  TPM_timer();                  //esperar 2 segundos antes de la cuenta regresiva
                  TPM_timer();
                  writeTimer2(num1,num2);       //cuenta regresiva
                  TimeOver();                   //Despliega Time Over y hace parpadear el LED y buzzer
                  m=2;
              }

          }
          else if(key == 16)                    //if * was pressed reset
          {
              m = 2;
          }
      }
  }
```

Registers:

SIM_SCGC5	0x00003b80




```
SIM_SCGC5 = 3b80

System Clock Gating Control Register 5

Bit Field Values:
          bits[ 31:20 ] = 0
          bits[ 19:19 ] = 0
          bits[ 18:14 ] = 0
    PORTE bits[ 13:13 ] = 1 Clock enabled
    PORTD bits[ 12:12 ] = 1 Clock enabled
    PORTC bits[ 11:11 ] = 1 Clock enabled
    PORTB bits[ 10:10 ] = 0 Clock disabled
    PORTA bits[  9:9  ] = 1 Clock enabled
          bits[  8:7  ] = 3
          bits[  6:6  ] = 0
    TSI   bits[  5:5  ] = 0 Access disabled
          bits[  4:2  ] = 0
          bits[  1:1  ] = 0
    LPTMR bits[  0:0  ] = 0 Access disabled
```

SIM_SCGC6	0x01000001

Bit Fields

Description

```
SIM_SCGC6 = 1000001

System Clock Gating Control Register 6

Bit Field Values:
    DAC0   bits[ 31:31 ] = 0    Clock disabled
           bits[ 30:30 ] = 0
    RTC    bits[ 29:29 ] = 0    Access and interrupts disabled
           bits[ 28:28 ] = 0
    ADC0   bits[ 27:27 ] = 0    Clock disabled
    TPM2   bits[ 26:26 ] = 0    Clock disabled
    TPM1   bits[ 25:25 ] = 0    Clock disabled
    TPM0   bits[ 24:24 ] = 1    Clock enabled
    PIT    bits[ 23:23 ] = 0    Clock disabled
           bits[ 22:16 ] = 0
           bits[ 15:15 ] = 0
           bits[ 14:2  ] = 0
    DMAMUX bits[  1:1  ] = 0    Clock disabled
    FTF    bits[  0:0  ] = 1    Clock enabled
```

SIM_SOPT2	0x03000000

Bit Fields

0000	00	11	00000	0	0	0	00000000	000	0	0000

```
SIM_SOPT2 = 3000000

System Options Register 2

Bit Field Values:
                 bits[ 31:28 ] = 0
    UART0SRC     bits[ 27:26 ] = 0  Clock disabled
    TPMSRC       bits[ 25:24 ] = 3  MCGIRCLK clock
                 bits[ 23:19 ] = 0
    USBSRC       bits[ 18:18 ] = 0  External bypass clock (USB_CLKIN).
                 bits[ 17:17 ] = 0
    PLLFLLSEL    bits[ 16:16 ] = 0  MCGFLLCLK clock
                 bits[ 15:8  ] = 0
    CLKOUTSEL    bits[  7:5  ] = 0  Reserved
    RTCCLKOUTSEL bits[  4:4  ] = 0  RTC 1 Hz clock is output on the RTC_CLKOUT pin.
                 bits[  3:0  ] = 0
```

MCG_C1	0x06

00	000	1	1	0

Description

```
MCG_C1 = 6

MCG Control 1 Register

Bit Field Values:
    CLKS     bits[  7:6  ] = 0  Encoding 0 - Output of FLL or PLL is selected (depends
on PLLS control bit).
    FRDIV    bits[  5:3  ] = 0  If RANGE 0 = 0 , Divide Factor is 1; for all other
RANGE 0 values, Divide Factor is 32.
    IREFS    bits[  2:2  ] = 1  The slow internal reference clock is selected.
    IRCLKEN  bits[  1:1  ] = 1  MCGIRCLK active.
    IREFSTEN bits[  0:0  ] = 0  Internal reference clock is disabled in Stop mode.
```

00000000000000000000000000	0	0	0	0	01	000

TPM0_SC	0x00000008

Description

```
TPM0_SC = 8

Status and Control

Bit Field Values:
          bits[ 31:9  ] = 0
    DMA   bits[  8:8  ] = 0 Disables DMA transfers.
    TOF   bits[  7:7  ] = 0 LPTPM counter has not overflowed.
    TOIE  bits[  6:6  ] = 0 Disable TOF interrupts. Use software polling or DMA
request.
    CPWMS bits[  5:5  ] = 0 LPTPM counter operates in up counting mode.
    CMOD  bits[  4:3  ] = 1 LPTPM counter increments on every LPTPM counter clock
    PS    bits[  2:0  ] = 0 Divide by 1
```

TPM0_MOD	0x00007fff

0000000000000000	0111111111111111

PORTD_PCR0	0x00000105
PORTD_PCR1	0x00000105
PORTD_PCR2	0x00000105
PORTD_PCR3	0x00000105
PORTD_PCR4	0x00000101
PORTD_PCR5	0x00000101
PORTD_PCR6	0x00000101
PORTD_PCR7	0x00000101

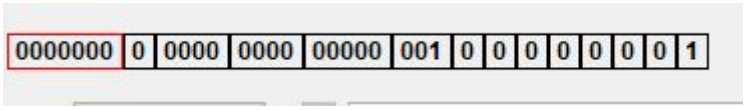
For PORTD_PCR0 to PORTD_PCR3 the configuration of the registers is the next.

Bit Fields

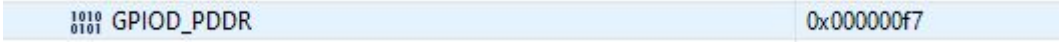
0000000	0	0000	0000	00000	001	0	0	0	0	0	1	0	1

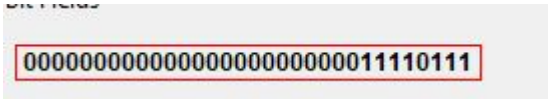
```
PORTD_PCR3 = 105

Pin Control Register n

Bit Field Values:
         bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
         bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = 0  Interrupt/DMA request disabled.
         bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
         bits[  7:7  ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
         bits[  5:5  ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
         bits[  3:3  ] = 0
    SRE  bits[  2:2  ] = 1  Slow slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 0  Internal pullup or pulldown resistor is not enabled on the
corresponding pin.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
pin, if the corresponding Port Pull Enable field is set.
```

For PORTD_PCR4 to PORTD_PCR7 the configuration of the registers is the next.



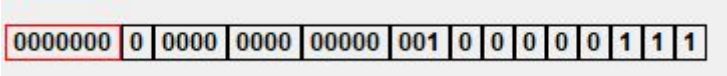

```
PORTD_PCR4 = 101

Pin Control Register n

Bit Field Values:
         bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
         bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = 0  Interrupt/DMA request disabled.
         bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
         bits[  7:7  ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
         bits[  5:5  ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
         bits[  3:3  ] = 0
    SRE  bits[  2:2  ] = 0  Fast slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 0  Internal pullup or pulldown resistor is not enabled on the
corresponding pin.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
pin, if the corresponding Port Pull Enable field is set.
```





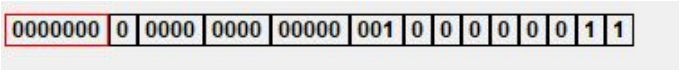
PORTC_PCR0	0x00000107
PORTC_PCR1	0x00000107
PORTC_PCR2	0x00000107
PORTC_PCR3	0x00000103
PORTC_PCR4	0x00000103
PORTC_PCR5	0x00000103
PORTC_PCR6	0x00000103
PORTC_PCR7	0x00000103

For PORTC_PCR0 to PORTC_PCR2 the configuration of the registers is the next.

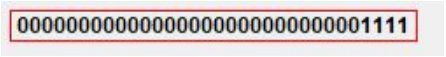



```
PORTC_PCR0 = 107

Pin Control Register n

Bit Field Values:
         bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
         bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = 0  Interrupt/DMA request disabled.
         bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
         bits[  7:7  ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
         bits[  5:5  ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
         bits[  3:3  ] = 0
    SRE  bits[  2:2  ] = 1  Slow slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 1  Internal pullup or pulldown resistor is enabled on the
corresponding pin, if the pin is configured as a digital input.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
pin, if the corresponding Port Pull Enable field is set.
```

For PORTC_PCR3 to PORTC_CR7 the configuration of the registers is the next.

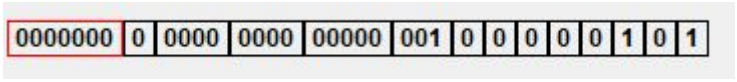



```
PORTC_PCR7 = 103

Pin Control Register n

Bit Field Values:
         bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
         bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = 0  Interrupt/DMA request disabled.
         bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
         bits[  7:7  ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
         bits[  5:5  ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
         bits[  3:3  ] = 0
    SRE  bits[  2:2  ] = 0  Fast slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 1  Internal pullup or pulldown resistor is enabled on the
corresponding pin, if the pin is configured as a digital input.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
```



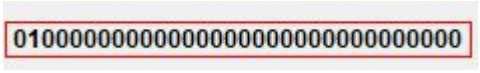
PORTE_PCR3	0x00000105
PORTE_PCR4	0x00000105
PORTE_PCR5	0x00000105

For PORTE_PCR3 to PORTE_CR5 the configuration of the registers is the next.



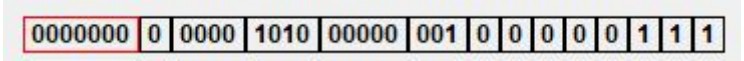

```
PORTE_PCR3 = 105

Pin Control Register n

Bit Field Values:
         bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
         bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = 0  Interrupt/DMA request disabled.
         bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
         bits[  7:7  ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
         bits[  5:5  ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
         bits[  3:3  ] = 0
    SRE  bits[  2:2  ] = 1  Slow slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 0  Internal pullup or pulldown resistor is not enabled on the
corresponding pin.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
```

NVIC_ISER	0x40000000



PORTA_PCR1	0x000a0107
PORTA_PCR2	0x000a0107

For PORTA_PCR1 to PORTE_CR2 the configuration of the registers is the next.

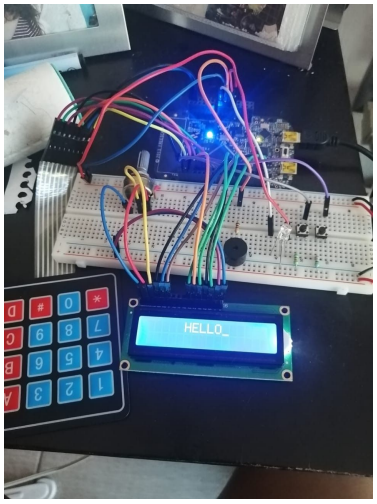


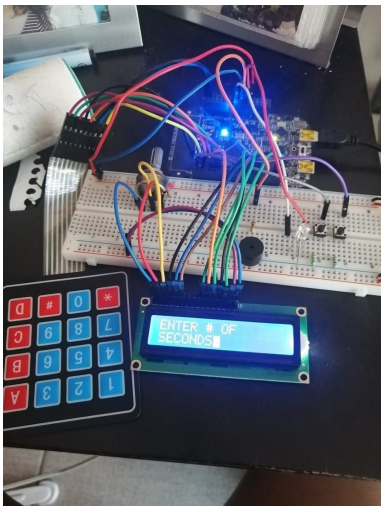
```
PORTA_PCR1 = 655623

Pin Control Register n

Bit Field Values:
        bits[ 31:25 ] = 0
    ISF  bits[ 24:24 ] = 0  Configured interrupt is not detected.
        bits[ 23:20 ] = 0
    IRQC bits[ 19:16 ] = 10 Interrupt on falling edge.
        bits[ 15:11 ] = 0
    MUX  bits[ 10:8  ] = 1  Alternative 1 (GPIO).
        bits[  7:7   ] = 0
    DSE  bits[  6:6  ] = 0  Low drive strength is configured on the corresponding pin,
if pin is configured as a digital output.
        bits[  5:5   ] = 0
    PFE  bits[  4:4  ] = 0  Passive input filter is disabled on the corresponding pin.
        bits[  3:3   ] = 0
    SRE  bits[  2:2  ] = 1  Slow slew rate is configured on the corresponding pin, if
the pin is configured as a digital output.
    PE   bits[  1:1  ] = 1  Internal pullup or pulldown resistor is enabled on the
corresponding pin, if the pin is configured as a digital input.
    PS   bits[  0:0  ] = 1  Internal pullup resistor is enabled on the corresponding
```

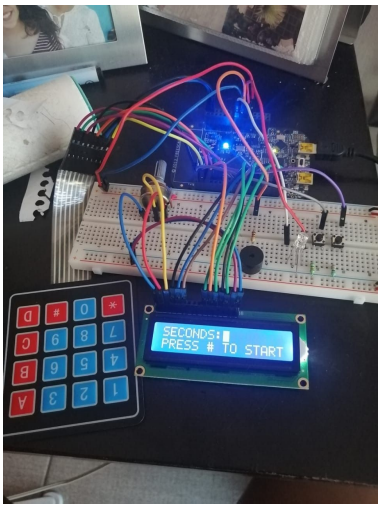
GPIOA_PDDR	0x00000000

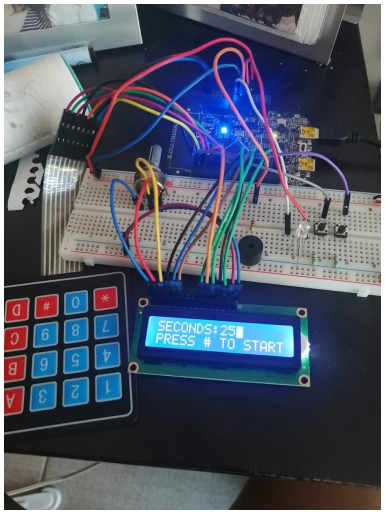
```
GPIOA_PDDR = 0

Port Data Direction Register

Bit Field Values:
    PDD bits[ 31:0  ] = 0   Pin is configured as general-purpose input, for the GPIO
function.
```

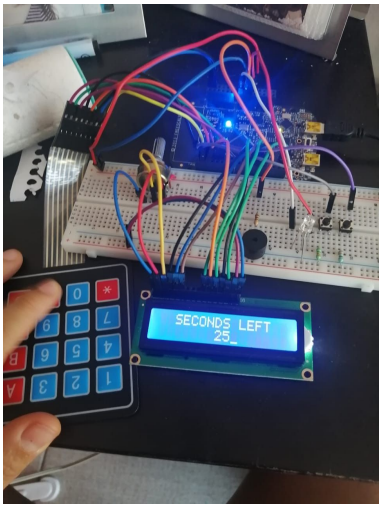
Pictures:

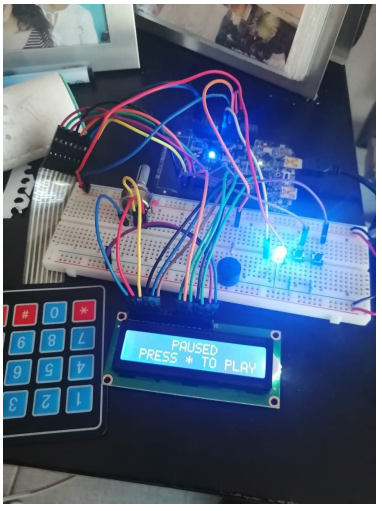


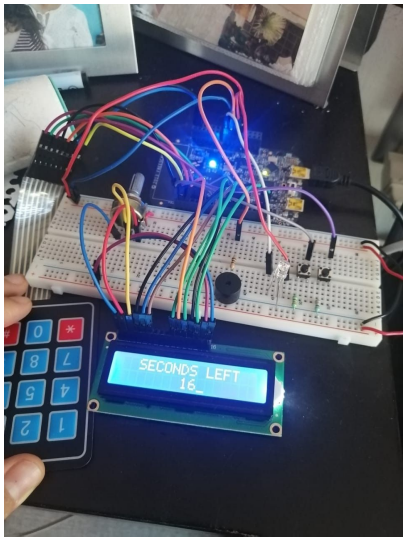


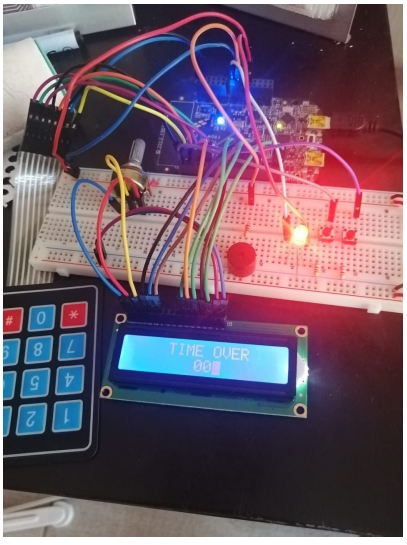












Video: https://youtu.be/TUdzXIvpkbw