Universidad de Costa Rica

Escuela de Ingeniería Eléctrica

IE-0624: Laboratorio de Microcontroladores

Laboratorio 3

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11 de mayo de 2022

Índice

1. Introducción **2**

2. Nota teórica **2**

2.1. Arduino 1 . . . 2

2.2. Microcontrolador . . . 2

3. Desarrollo/Análisis de resultados **3**

3.1. Diseño y Máquina de Estados . . . 3

3.2. Implementación . . . 3

3.3. Simulación . . . 3

3.4. Implementación del Firmware . . . 3

4. Conclusiones y recomendaciones **3**

4.1. Recomendaciones . . . 3

4.2. Conclusiones . . . 3

5. Anexos **3**

5.1. Firmware . . . 3

5.2. Datasheet PIC2F675 . . . 3

Índice de figuras

1. Ejemplo diagrama MFE.[1] . . . 2

2. Diagrama Microcontrolador .[2] . . . 2

1. Introducción

https://github.com/Marlon-Lazo-Coronado/Labo3-mictrocontroladores

2. Nota teórica

2.1. Arduino 1

imagenes_redes/L10.PNG

Figura 1: Ejemplo diagrama MFE.[1]

2.2. Microcontrolador

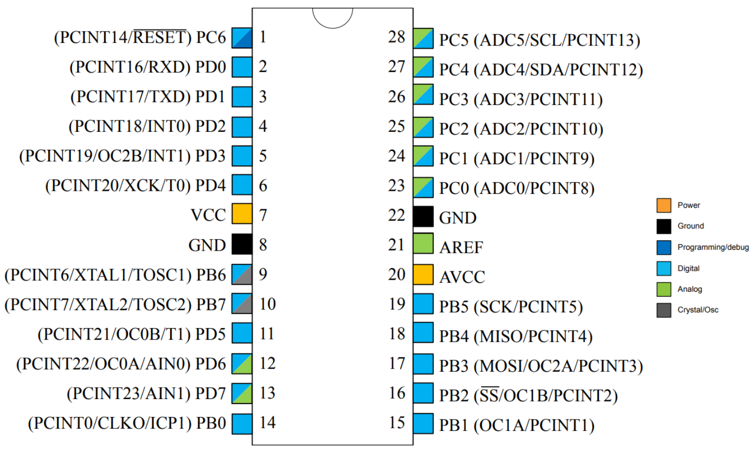

Figura 2: Diagrama Microcontrolador .[2]

```
GIMSK |= ( 1 << PCIE2);
 PCMSK2 = 0b00000001 ;
 GIMSK |= ( 1 << PCIE1);
 PCMSK1 = 0b00000001 ;
```

Ahora, para habilitar los pines B0-B7 como salidas para encender los leds, se seteó el registro DDRB cuya, para esto, se debe de poner e 1 el bit correspondiente al pin de salida, en nuestro caso se utilizó una forma compacta mediante operaciones OR y desplazamientos de las variables PB0-PB5.

3. Desarrollo/Análisis de resultados

3.1. Diseño y Máquina de Estados

3.2. Implementación

3.3. Simulación

3.4. Implementación del Firmware

4. Conclusiones y recomendaciones

4.1. Recomendaciones

4.2. Conclusiones

Referencias

[1] E. V. Quesada, *Máquinas de estado finito y autómatas.* Universidad Nacional de Costa Rica, 2021.

[2] "Which smtp port to use for email? common email ports."

5. Anexos

5.1. Firmware

```
#include <avr/io.h>
#include <avr/interrupt.h>
#include <util/delay.h>

int state = 0;
int request_botton = 0;
```


```
#include <avr/io.h>
#include <avr/interrupt.h>
#include <util/delay.h>

int state = 0;
int request_botton = 0;
```


5.2. Datasheet PIC2F675

Table 13-4. Start-up Times for the Low Power Crystal Oscillator Clock Selection

Oscillator Source / Power Conditions	Start-up Time from Power-down and Power-save	Additional Delay from Reset (V_{CC} = 5.0V)	CKSEL0	SUT[1:0]
Ceramic resonator, fast rising power	258 CK	14CK + 4.1ms[1]	0	00
Ceramic resonator, slowly rising power	258 CK	14CK + 65ms[1]	0	01
Ceramic resonator, BOD enabled	1K CK	14CK[2]	0	10
Ceramic resonator, fast rising power	1K CK	14CK + 4.1ms[2]	0	11
Ceramic resonator, slowly rising power	1K CK	14CK + 65ms[2]	1	00
Crystal Oscillator, BOD enabled	16K CK	14CK	1	01
Crystal Oscillator, fast rising power	16K CK	14CK + 4.1ms	1	10
Crystal Oscillator, slowly rising power	16K CK	14CK + 65ms	1	11

Note:

1. These options should only be used when not operating close to the maximum frequency of the device, and only if frequency stability at start-up is not important for the application. These options are not suitable for crystals.
2. These options are intended for use with ceramic resonators and will ensure frequency stability at start-up. They can also be used with crystals when not operating close to the maximum frequency of the device, and if frequency stability at start-up is not important for the application.

Related Links

Low Power Crystal Oscillator on page 50

13.4. Full Swing Crystal Oscillator

This Crystal Oscillator is a full swing oscillator, with rail-to-rail swing on the XTAL2 output. This is useful for driving other clock inputs and in noisy environments. The current consumption is higher than for the Low Power Crystal Oscillator. Note that the Full Swing Crystal Oscillator will only operate for V_{CC}=2.7-5.5V.

Some initial guidelines for choosing capacitors for use with crystals are given in Table 13-6. The crystal should be connected as described in *Clock Source Connections*".

The operating mode is selected based on the fuses CKSEL[3:1] as shown in the table:

Table 13-5. Full Swing Crystal Oscillator operating modes

Frequency Range[1] [MHz]	CKSEL[3:1]	Recommended Range for Capacitors C1 and C2 [pF]
0.4 - 20	011	12 - 22

Note:

1. If the crystal frequency exceeds the specification of the device (depends on V_{CC}), the CKDIV8 Fuse can be programmed in order to divide the internal frequency by 8. It must be ensured that the resulting divided clock meets the frequency specification of the device.

For the Crystall Oscillator connections refer to Low Power Crystal Oscillator.

Table 13-6. Start-Up Times for the Full Swing Crystal Oscillator Clock Selection

Oscillator Source / Power Conditions	Start-Up Time from Power-down and Power-save	Additional Delay from Reset (V_{CC} = 5.0V)	CKSEL0	SUT[1:0]
Ceramic resonator, fast rising power	258 CK	14CK + 4.1ms[(1)]	0	00
Ceramic resonator, slowly rising power	258 CK	14CK + 65ms[(1)]	0	01
Ceramic resonator, BOD enabled	1K CK	14CK[(2)]	0	10
Ceramic resonator, fast rising power	1K CK	14CK + 4.1ms[(2)]	0	11
Ceramic resonator, slowly rising power	1K CK	14CK + 65ms[(2)]	1	00
Crystal Oscillator, BOD enabled	16K CK	14CK	1	01
Crystal Oscillator, fast rising power	16K CK	14CK + 4.1ms	1	10
Crystal Oscillator, slowly rising power	16K CK	14CK + 65ms	1	11

Note:

1. These options should only be used when not operating close to the maximum frequency of the device, and only if frequency stability at start-up is not important for the application. These options are not suitable for crystals.
2. These options are intended for use with ceramic resonators and will ensure frequency stability at start-up. They can also be used with crystals when not operating close to the maximum frequency of the device, and if frequency stability at start-up is not important for the application.

Related Links

Low Power Crystal Oscillator on page 50

13.5. Low Frequency Crystal Oscillator

The Low-frequency Crystal Oscillator is optimized for use with a 32.768kHz watch crystal. When selecting crystals, load capacitance and crystal's Equivalent Series Resistance (ESR) must be taken into consideration. Both values are specified by the crystal vendor. The oscillator is optimized for very low power consumption, and thus when selecting crystals, consider the Maximum ESR Recommendations:

Table 13-7. Maximum ESR Recommendation for 32.768kHz Crystal

Crystal CL [pF]	Max. ESR [kΩ][(1)]
6.5	75
9.0	65
12.5	30

Note:

1. Maximum ESR is typical value based on characterization.

The Low-frequency Crystal Oscillator provides an internal load capacitance at each TOSC pin: