17.384 Microprocessors B
Lab 2
Spring 2011

Timers and Interrupts

Lab Report

See separate report form located on the course webpage. This form should be completed during the performance of this lab.

Objectives

1) To familiarize the student with Timers and Interrupts utilizing the the PIC24HJ32GP202 microcontroller and the Microchip PIC24 C compiler. An LED will be flashed utilizing a timer, interrupt service routine will be developed to flash the LED, and a LED will be controlled by a switch also using interrupts.

Materials

PIC24 and Voltage Regulator Circuit (*Parts only needed if not previously constructed*)

☐	1	Breadboard	
☐	1	Oscilloscope	
☐	1	Voltmeter	
☐	1	PICkit ™ 2	
☐	2	6x1 0.1" pitch R/A long-tail connector	S1132E-06-ND (DK)
☐	1	PIC24HJ32GP202, microcontrollers - P/N PIC24HJ32GP202-I/SP-ND (DK)	
☐	1	Wall transformer 6V, 1 A	T978-P7P-ND (DK)
☐	1	Power connector	CP-2519-ND (DK)
☐	1	9 volt battery (needed only if not using the Wall Transformer)	
☐	1	9 volt battery clip (if using a 9 volt battery)	
☐	1	LM2937-3.3 low-dropout regulator 3.3 V	LM2937ET-3.3-ND (DK)
☐	1	Slide switch	EG1903-ND (DK)
☐	1	500 mA fast-acting axial fuse	F2311-ND (DK)
☐	3	0.1 microfarad capacitor (104)	
☐	2	10 µF tantalum radial, < 5 ohms ESR	478-1839-ND (DK)
☐	1	LED	
☐	1	910 Ω axial resistors	(any supplier)
☐	1	10 kΩ axial resistor	(brown black orange)
☐	1	Pushbutton switch	P8009S-ND (DK)

Switch Circuit (*Same parts used in Lab #1*)

☐	1	Pushbutton switch	P8009S-ND (DK)
☐	1	LED	
☐	1	470 Ω axial resistors	(yellow violet brown)

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WARNINGS AND PRECAUTIONS

1) Never remove the PIC24HJ32GP202 from an energized circuit

2) Do not construct circuits while energized

3) Follow electrical safety precautions

Source File Locations

1. Microchip PIC24 C compiler (C30 compiler)

LIB30 Archiver
C:|Program Files|Microchip|mplabc30|v3.25|bin|pic30-ar.exe

MPLAB ASM 30 Assembler
C:|Program Files|Microchip|mplabc30|v3.25|bin|pic30-as.exe

MPLAB C30 C Compiler
C:|Program Files|Microchip|mplabc30|v3.25|bin|pic30-gcc.exe

MPLAB Link30 Object Linker
C:|Program Files|Microchip|mplabc30|v3.25|bin|pic30-ld.exe

Background Information

This lab is very similar to Lab #1, except the student will utilize interrupts and timers on the PIC24HJ32GP202 microcontroller to control and LED and detect switch actions.

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Pre-Lab Preparation

1. Download Lab # 2 from the course website. Read and understand the lab.

2. Read the various course reference materials (PIC24HJ32GP202 data sheet, PIC24 Family Reference Manual, Microchip PIC24 C Compiler manual and review the PICkit ™ 2, etc).

Procedure

Objective 1. INITIAL START-UP CIRCUIT (*Not required if accomplished in Lab #1*)

a. Review lab Warnings and Precautions.

b. Pin-out for the PIC24HJ32GP202 is shown in Figure 1.

c. Pin-out for the LM2937-3.3 is shown in Figure 2a. 10µF capacitor terminals are shown in Figure 2b.

d. Review the "Prototyping Walkthrough for PIC24HJ32GP202 Startup Schematic" file located on the Class Webpage. This document provides additional guidance when constructing your circuit.

e. Construct the circuit shown in Figure 3 on your breadboard.

1. Locate your voltage regulator circuit in a corner of your board as this circuit will be required throughout the semester.

2. **DO NOT** install the PIC24HJ32GP202 at this time

f. Apply power (either a 9 volt wall transformer or a 9 volt battery) to the Power On/Off switch.

g. Using the voltmeter and an oscilloscope (if available), verify that +3.3 volts is at the output of the LM2937-3.3 regulator and is clean and free of interference.

h. Verify that L1 is on. This will be a visual aid in determining if voltage is present (when the LED is turned on).

i. Power down the circuit.

j. Install the PIC24HJ32GP202.

Objective 2. FLASHING LED USING TIMER2

a. **NOTE … same connections accomplished in Lab #1.** Connect one push button switch input (connected to RB13) which is low when pressed and one LED (connected to RB14) which is lit when the PIC's output pin is high. Configure the push button input for low true operation with the internal pull-up enabled, see Figure 5.

b. Compose a program in "C" to flash the LED connected to RB14 once power is applied to the system using Timer2 for the delay. The LED shall flash at a rate of approximately once per sec. NOTE … flash rate should be close to once per second.

c. Include the required Class Required Header Code, Figure 4, in your software.

d. Save your program as Lab_2A.c

e. Program the PIC24HJ32GP202 using the PICkit ™ 2 connected to J1

f. Troubleshoot as required to correct all hardware and software issues.

g. If required, have the instructor view your working circuit.

h. Insert a copy of your code, Lab_2A.c at the end of the lab report in the space provided as well as email a copy to the instructor.

Objective 3. FLASHING LED USING TIMER2

a. Repeat Objective 2 using interrupts in "C" to flash the LED along with using Timer2 for the delay. The LED shall flash at a rate of approximately once per sec. NOTE … flash rate should be close to once per second.

b. Include the required Class Required Header Code, Figure 4, in your software.

c. Save your program as Lab_2B.c

d. Program the PIC24HJ32GP202 using the PICkit ™ 2 connected to J1

e. Troubleshoot as required to correct all hardware and software issues.

f. If required, have the instructor view your working circuit.

g. Insert a copy of your code, Lab_2B.c at the end of the lab report in the space provided as well as email a copy to the instructor.

Objective 4. LED/SWITCH INPUT/OUTPUT

a. Connect one push button switch input (connected to RB13) which is low when pressed and one LED (connected to RB14) which is lit when the PIC's output pin is high. Configure the push button input for low true operation with the internal pull-up enabled, see Figure 5.

b. Compose a program written in "C" such that the LED connected to RB14 shall illuminate when the push button switch connected to RB13 is pushed on. It shall remain on until the push button switch is pushed again. This condition shall repeat endlessly. **USE INTERRUPTS TO DETECT THE SWITCH ACTION.**

c. Include the required Class Required Header Code, Figure 4, in your software.

d. Save your program as Lab_2C.c

e. Program the PIC24HJ32GP202 using the PICkit ™ 2 connected to J1

f. Troubleshoot as required to correct all hardware and software issues.

g. If required, have the instructor view your working circuit.

h. Insert a copy of your code, Lab_2C.c at the end of the lab report in the space provided as well as email a copy to the instructor.

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SUMMARY:

You developed Code that utilizes Timers and interrupts which will be used in many future applications.

Lab Notebook Requirements:

- Ensure that you have recorded all the data requested during the lab in your lab notebook as well as your lab report.

Lab Report:

1. Use template provided on the Class Web Site.

Figure 1 – PIC24HJ32GP202 Pin-Out Diagram

28-Pin SDIP, SOIC

■ = Pins are up to 5V tolerant

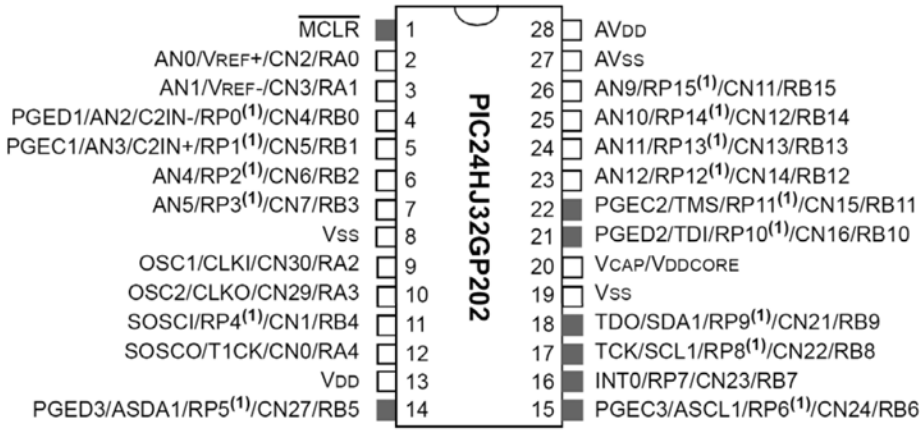


Figure 2a – Top View – LM2937-3.3

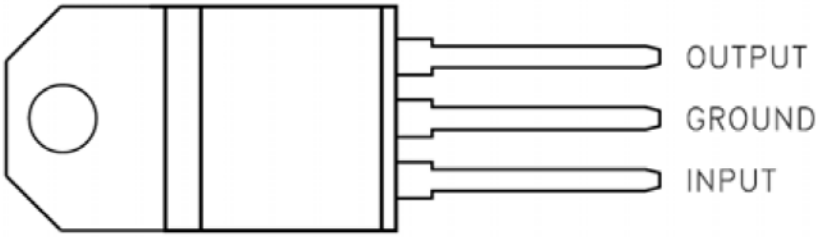


Figure 2b – 10µF Tantalum Capacitor P/N 478-1839-ND

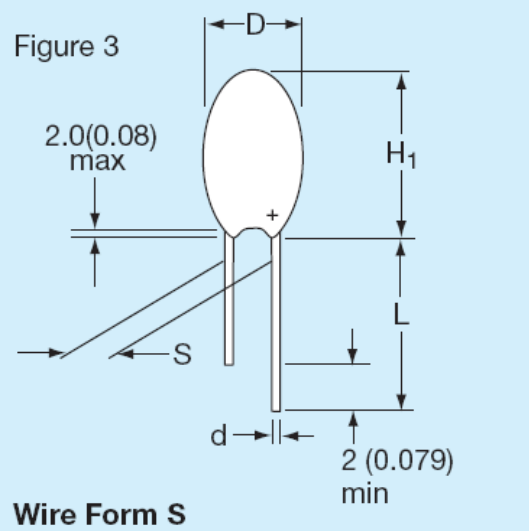
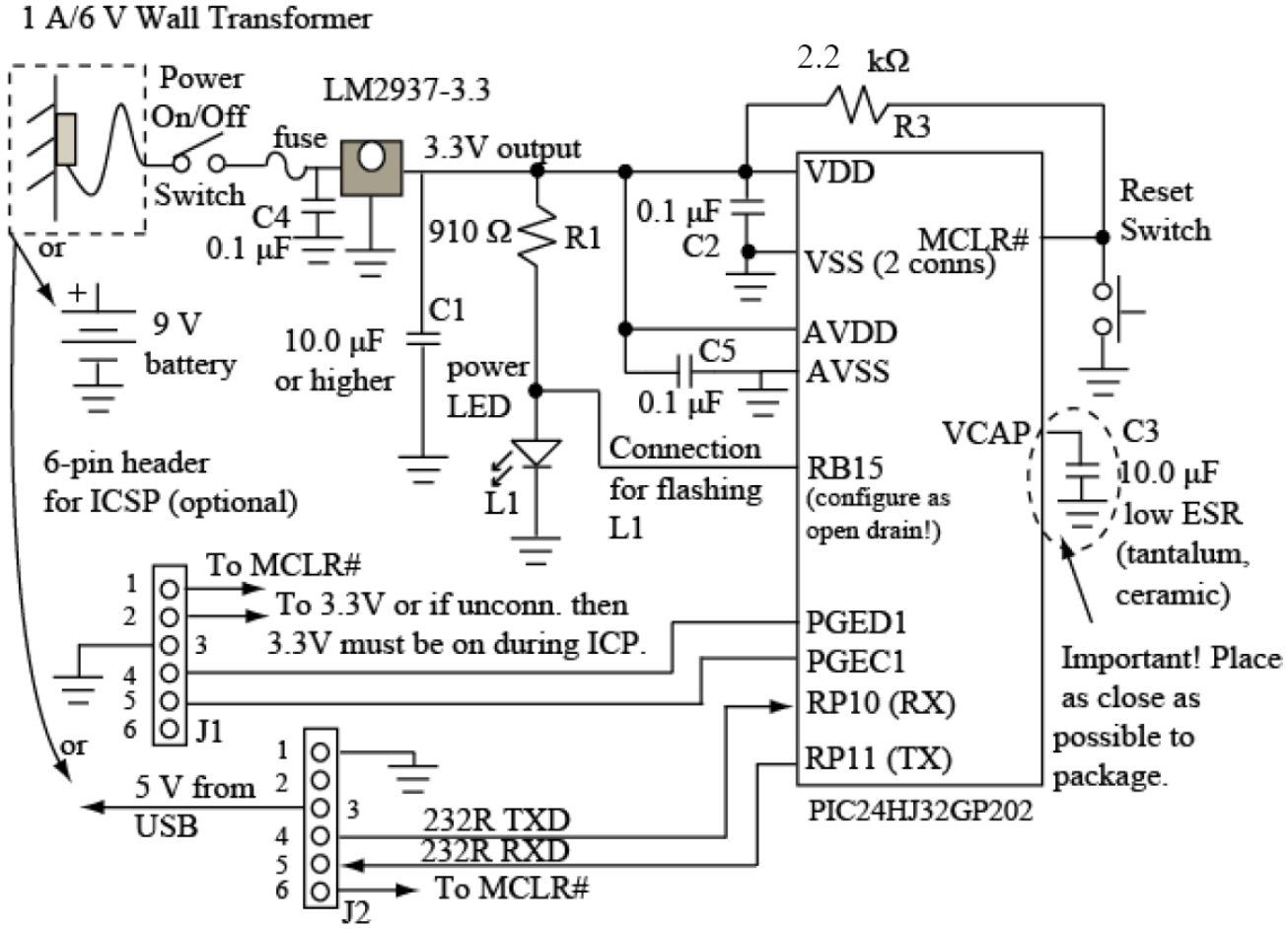


Figure 3 – PIC24HJ32GP202 Initial Start-up Schematic



6-pin header for FTDI TTL-232R-3.3V USB-to-TTL cable (PC serial communication link)

Figure 4 - Required Header Code

```
/*******************************************************
*
* Program Title:     xxxx
*
* Program File Name: Lab_XA.c
*
* Microprocessors B 17.384
*
* xxxxxxxx - Put in Semester (i.e. Spring 2011) here
*
* xxxxxxxx - Put in your name here
*
* xx/xx/xx - Put date here
*
*******************************************************/
```

Figure 5 – RB13 and RB14 Connections