17.384 Microprocessors B
Lab 3
Spring 2011

PIC24/24LC515 EEPROM Interface Using I^2C

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 interface the PIC24HJ32GP202 microcontroller and the Microchip 24LC515 Serial EEPROM via the I^2C serial bus. Data will be written to and read from the EEPROM. Data will be displayed on a LED bargraph display.

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 and LED Circuit (Figure 5)

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

EEPROM Circuit (Figure 6)

□	1	Microchip 24LC515 EEPROM	24LC515-I/P-ND (DK)
□	2	2.2 kΩ axial resistors	(red red red)

Bargraph Circuit (Figure 8)

□	1	Bargraph	
□	10	470 Ω axial resistors	(yellow violet brown)

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

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Background Information

We shall utilize a 24LC515 EEPROM to demonstrate the I^2C serial bus to the PIC24HJ32GP202 microcontroller. Emphasis needs to be on the I^2C serial bus connections as well as the communications required to write and read data to/from the EEPROM.

I^2C communication is as follows …

1. Master initiates a start condition
2. Master sends the 7-bit unique address of the device
3. Master outputs the read or write bit
4. Slave sends an acknowledge bit
5. Byte of data is exchanged followed by an acknowledgement. Data exchange will continues until all data is sent
6. Transaction ends with the master device causing a stop condition

Pre-Lab Preparation

1. Download Lab # 3 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, 24LC515 EEPROM, and review the PICkit ™ 2, etc). Datasheet links are located on the course webpage.

Procedure

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

NOTE: This objective is only required if the circuit shown in Figure 1 has not been previously constructed on your breadboard. Skip to Objective 2 breadboard is wired properly.

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.

k. Add the components shown in Figure 5.

Objective 2. WIRING THE 24LC515 EEPROM AND BARGRAPH CIRCUITS

a. Add the circuit shown in Figure 6 to your breadboard. ***Do not*** disconnect any prior connections unless specifically told.

b. Pin-out for the 24LC515 is shown in Figure 7.

c. Add the Bargraph circuit shown in Figure 8 to your breadboard. Note … only 8 LEDs need to be wired (D0 thru D7). Others can be wired for future use, if desired.

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Objective 3. 24LC515 EEPROM *WRITE* PROGRAM

a. Compose a program in "C" to perform the following tasks (see step b for some programming requirements and suggestions):

1. "Write" the following values, which will be stored in an array within your program) to the 24LC515 lower memory addresses (address boundaries 0000h to 7FFFh):

   0000 0000
   0000 0001
   0000 0010
   0000 0011

2. "Write" the following values, which will be stored in an array within your program, to the 24LC515 upper memory addresses (within address boundaries 8000h to FFFFh):

   0000 0100
   0000 0101
   0000 0110
   0000 0111

3. Your program will execute once. At the end of the EEPROM programming sequence, the LED connected to RB14 will flash indicating successful EEPROM programming.

b. The following software requirements/suggestions need to be incorporated into your code (those labeled as required MUST be in your code):

1. REQUIRED --- Include the required Class Required Header Code, Figure 4, in your software.

2. SUGGESTED --- review the textbook's "C" code. Incorporate required Code directly into your code vice utilizing header files as the textbook's code does.

3. Utilize the I2C communication protocol for proper communications between the 24LC515 EEPROM and the PIC24HJ32GP202 microcontroller.

c. Save your program as Lab_3A.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_3A.c at the end of the lab report in the space provided as well as email a copy to the instructor.

Objective 4. 24LC515 EEPROM *READ* PROGRAM

a. Compose a program in "C" to perform the following tasks (see step b for some programming requirements and suggestions):

1. "Read" and display on the LED Bargraph the following values, which were written to the 24LC515 lower memory addresses, address boundaries 0000h to 7FFFh, in Objective 3:

   0000 0000
   0000 0001
   0000 0010
   0000 0011

2. "Read" and display on the LED Bargraph the following values, which were written to the 24LC515 upper memory addresses, address boundaries 8000h to FFFFh, in Objective 3:

   0000 0100
   0000 0101
   0000 0110
   0000 0111

3. Your program will execute indefinitely. Address contents will display for one (1) second before proceeding to the next address.

b. The following software requirements/suggestions need to be incorporated into your code (those labeled as required MUST be in your code):

1. REQUIRED --- Include the required Class Required Header Code, Figure 4, in your software.

2. SUGGESTED --- review the textbook's "C" code. Incorporate required Code directly into your code vice utilizing header files as the textbook's code does.

3. SUGGESTED --- the LED bargraph is wired exactly like the PICkit 1 which reduces the number of output pins required. However, as you may recall from Microprocessors A, we will light only one LED at a time at a sufficient speed that it appears that all required LEDs are on. This was called strobing. You may want to review the Analog-to-Digital lab that we utilized strobing for code details.

4. REQUIRED --- Utilize the I2C communication protocol for proper communications between the 24LC515 EEPROM and the PIC24HJ32GP202 microcontroller.

c. Save your program as Lab_3B.c

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

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

f. Verify correct values are displayed on the LED Bargraph.

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

h. Insert a copy of your code, Lab_3B.c at the end of the lab report in the space provided as well as email a copy to the instructor.

SUMMARY:

You developed Code that utilizes a 24LC515 EEPROM that demonstrated the I^2C serial bus to the PIC24HJ32GP202 microcontroller capabilities. We wrote and read data to/from the EEPROM, which can be used in many future applications.

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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.

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Figure 1 – PIC24HJ32GP202 Pin-Out Diagram

28-Pin SDIP, SOIC

■ = Pins are up to 5V tolerant

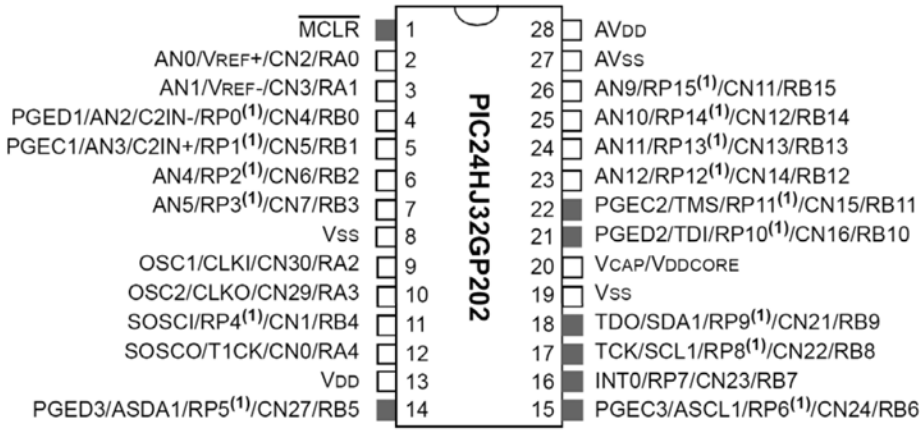


Figure 2a – Top View – LM2937-3.3

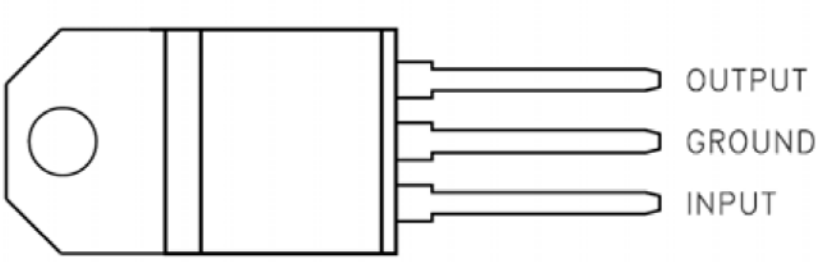


Figure 2b – 10µF Tantalum Capacitor P/N 478-1839-ND

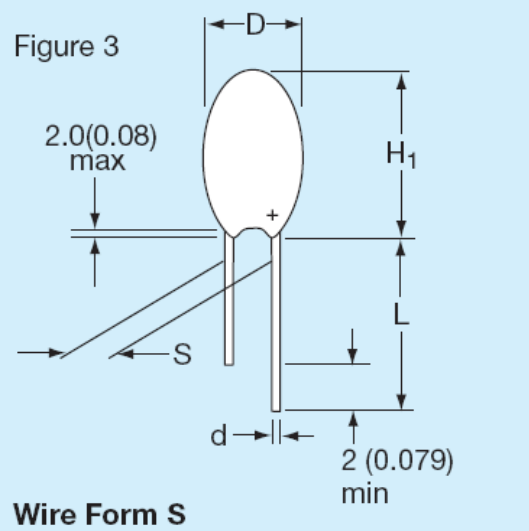
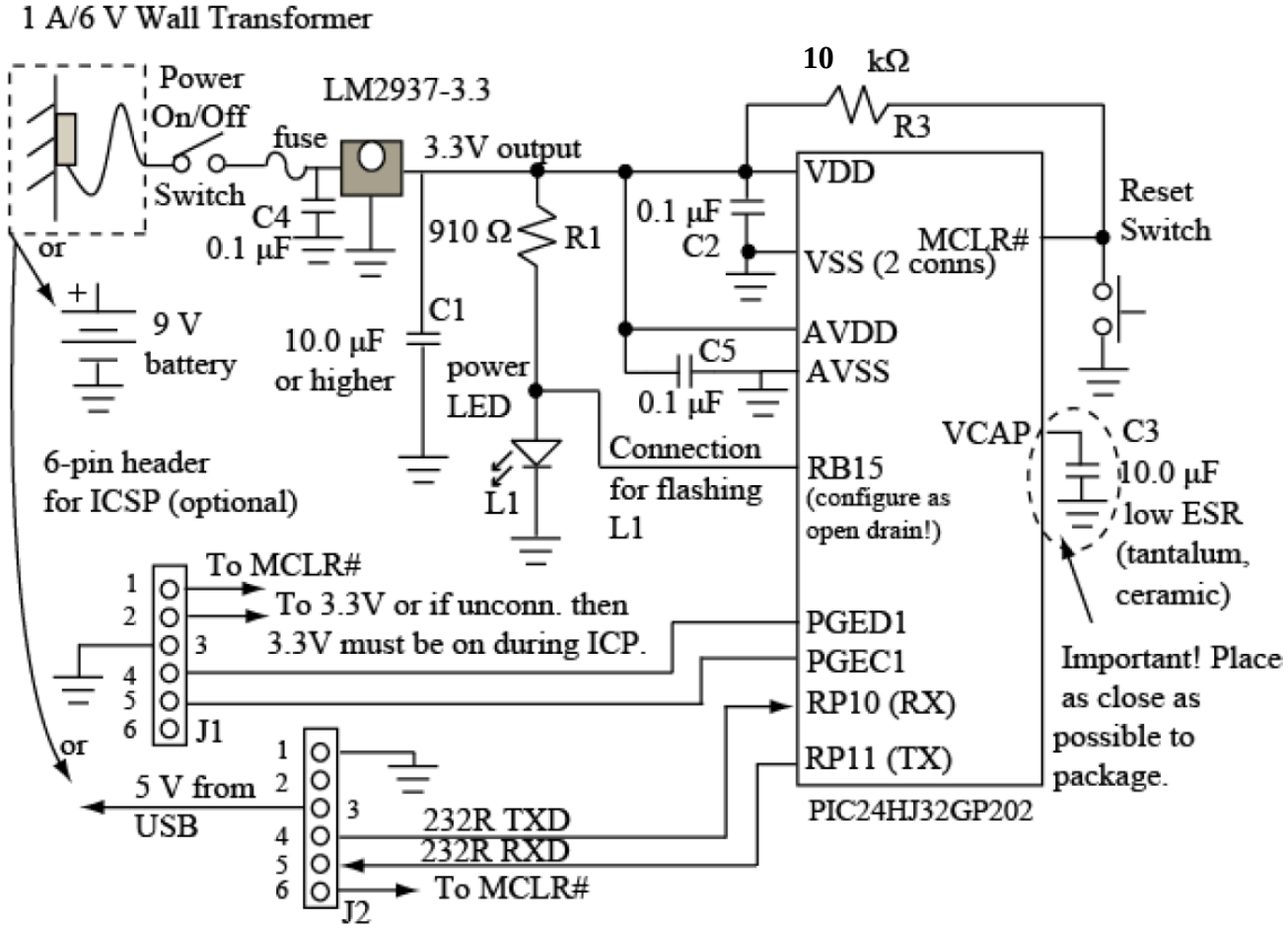


Figure 3 – PIC24HJ32GP202 Initial Start-up Schematic



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

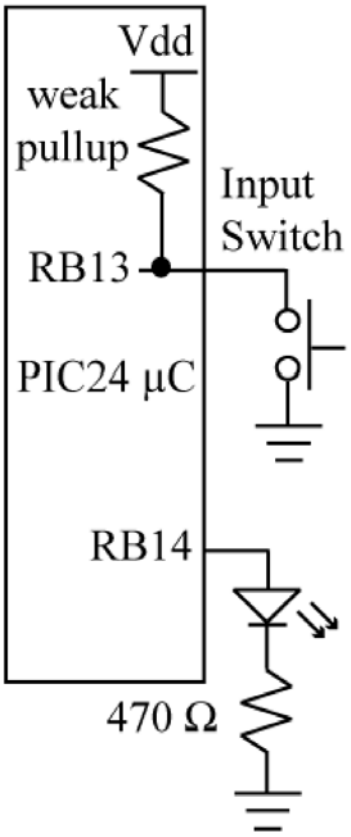


Figure 6 – 24LC515 EEPROM Connections

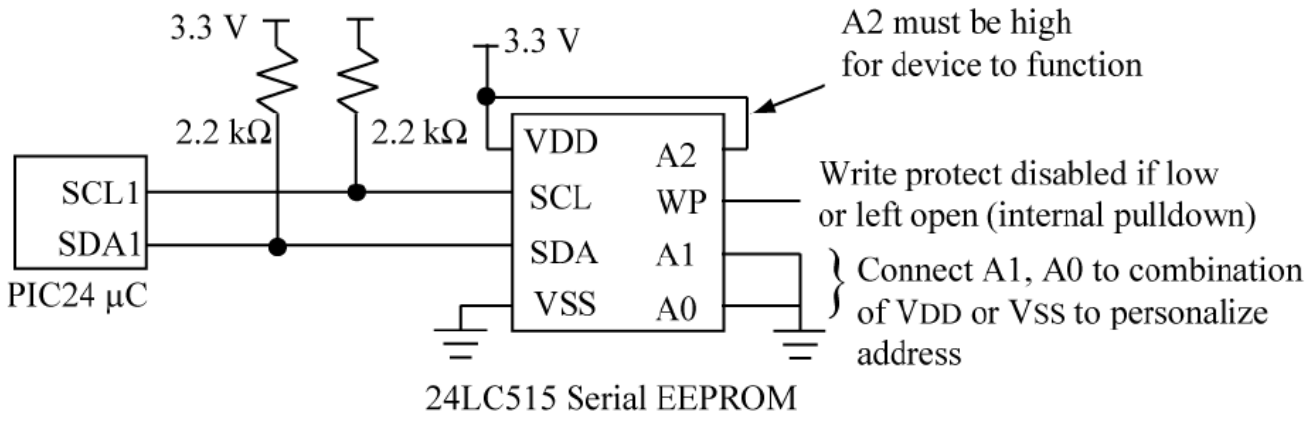


Figure 7 – 24LC515 Pin-out

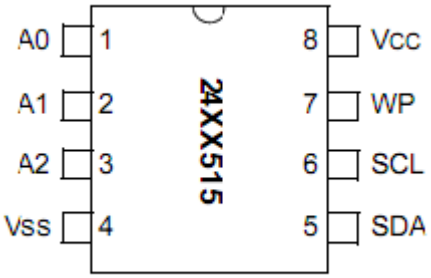


Figure 8 – Bargraph Connections