Topic - Digital Loops & Digital I/O

Objectives

- Write assembly code in AVR Studio 5.
- Build and download a hex file to an AVR microcontroller.
- Calculate execution time for an assembly code.

Preparation

- Review the tutorials on the AVR microcontroller digital I/O ports on **AVR-Tutorials.com**:
  http://www.avr-tutorials.com/digital/about-avr-8-bit-microcontrollers-digital-io-ports
  http://www.avr-tutorials.com/digital/digital-input-output-assembly-programming-atmel-8-bits-avr-microcontrollers

- Review the tutorials on calculating execution time for assembly code on **AVR-Tutorials.com**:
  http://www.avr-tutorials.com/assembly/calculating-execution-time-sequential-code
  http://www.avr-tutorials.com/assembly/calculating-execution-time-code-single-loop

Laboratory Procedures

1. Obtain a breadboard and the necessary components and construct the circuit in **Figure 1**.

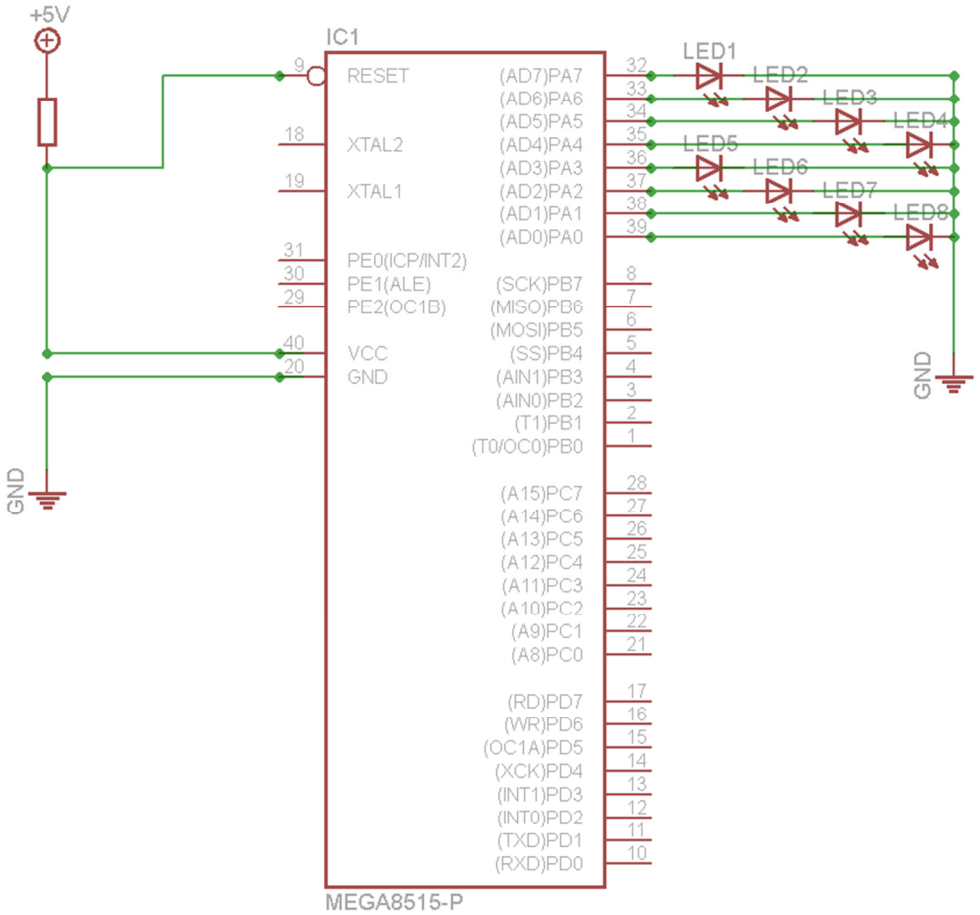

Figure 1

2. Analyze the code in **Figure 2**. How would the LEDs behave if this code was downloaded to and running on the microcontroller? .....

```
.include      "m8515def.inc"

              LDI    R16, 0xFF
              OUT    DDRC, R16

loop:         LDI    R16, 0x00
              OUT    PORTC, R16

              LDI    R16, 0xFF
              OUT    PORTC, R16

              RJMP   loop
```

Figure 2

3. Start AVR studio 5. Create a new assembly project selecting the ATMega8515 as the microcontroller for this project.

4. Type the code given in **Figure 2**, generate the hex file and download it to the microcontroller in the circuit from part 1. Ensure that the microcontroller is program to use its internal oscillator you can set it to 4MHz for this experiment.

5. Power-up your circuit and describe the behavior of the LEDs. .....

6. Does your expected observation from part 2 differ from that of part 5? ☐Yes ☐No

7. If you answer for part 6 is yes give an explanation for the difference. .....

8. Now modify your code to reflect the changes in **Figure 3**. Generate the new hex file and download it to the microcontroller.

9. Power-up your circuit and describe the behavior of the LEDs. .....

10. Give an explanation why the LEDs blink using one code and does not using the other code. ....

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```
.include      "m8515def.inc"

              LDI    R16, 0xFF
              OUT    DDRC, R16

loop:         LDI    R16, 0x00
              OUT    PORTC, R16

              LDI    R17, 0xFF
dly1:         LDI    R18, 0xFF
loop1:        DEC    R18
              BRNE   loop1
              DEC    R17
              BRNE   dly1

              LDI    R16, 0xFF
              OUT    PORTC, R16

              LDI    R17, 0xFF
dly2:         LDI    R18, 0xFF
loop2:        DEC    R18
              BRNE   loop2
              DEC    R17
              BRNE   dly2

              RJMP   loop
```

Figure 3

11. Calculate the execution time for the delay loop **dly1.** (Note: include the load instruction for R17).

12. Design and write an assembly code in the space provided below that if downloaded to the microcontroller in Figure 1 will simulate a lit LED running back and forth indefinitely.

13. Verify that your code works by typing the code in AVR Studio 5. Generate the hex file and download it to the microcontroller.

14. Ensure that you demonstrate the working of your code to the Lecturer or the Lab Personnel and obtain their verification signature.

Verification: _____

Code Worked: ☐Yes ☐No Signed .....
Lecturer or Demonstrator

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