ENGR 270 LAB #2 – Input/output and Watchdog Timer Operation

Objective

Application of Microprocessor in accepting external input, processing data and producing external output using assembly language.

Related Principles

- Computer Organization and Design
- Microprocessors
- Hardware and Software Interface
- Digital Design
- Assembly language

Equipment

- Windows-based PC with MPLAB Simulation Solutions Software
- USB hard disk or other removable drives
- Microchip PICKit programmer

Supplies

- Proto Board
- PICmicro (18F1220)
- One 8-DIP Switch
- 3 LEDs
- 1K resisters

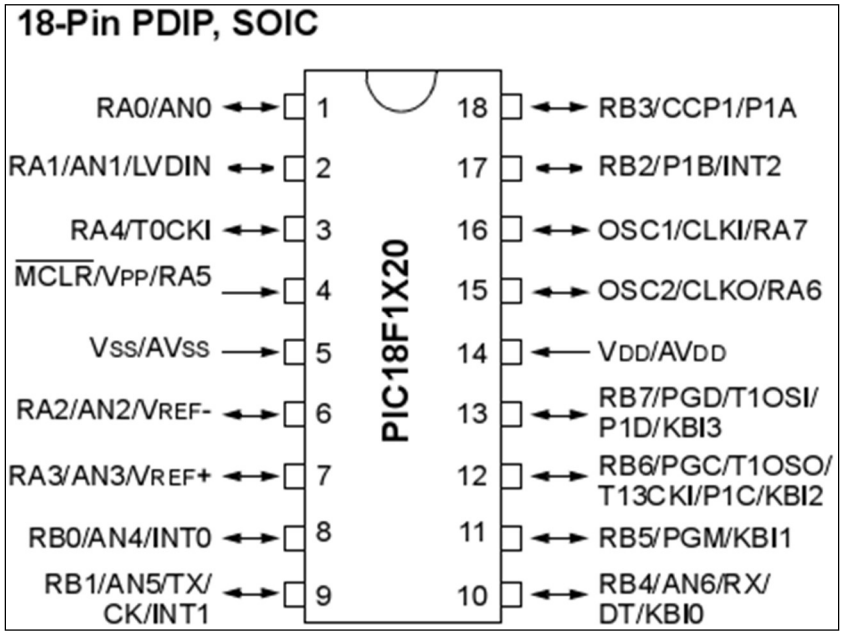
Preparation/Background

All the programs are expected to use assembly language. In this lab, you are expected to write assembly programs that accept input, process the data and output the results.

Input and Output operations are fully described in Chapter 3 of Computer Organization and Microprocessors textbook. Even more information is available in the PICmicro Data Sheet.

Specifically, you need to be familiar with the following concepts:

Pin out and Packaging for PICmicro (PIC18F1220)



Each pin can be configured to perform a variety of functions, for example Pin 8 may be an I/O port (RB0), I/O port (AN4), external Interrupt 0 (INT0). This type of multi-use is common in microcontroller with high level of functionality but it is less common in general purpose microprocessors.

The two pins whose definition is constant are pins 5 and 14 which are power and ground:

Pin 5 Ground (0 V)
Pin 14 Power (5 V)

- External Pin Set up as general purpose I/O Ports
  External I/O ports are multiplexed with an alternate function from other modules on the PICmicro. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin. Each port has three registers for its operation. These registers are:

  - TRIS register (data direction register)
    TRISA address is 0xF92
    TRISB address is 0xF93

  - PORT register (reads the levels on the pins of the device)
    PORTA address is 0xF80
    PORTB address is 0xF81

  - ADCON1 register (output latch)
    ADCON1 address is 0xFC1

  - PortA, TRISA and LATA Registers
    PORTA is an 8-bit wide, bidirectional port. Reading the PORTA register reads the status of the pins,

whereas writing to it will write to the port latch.

	RA7	RA6	RA5	RA4	RA3	RA2	RA1	RA0
Port A Register bits:	b7	b6	b5	b4	b3	b2	b1	b0
I/O Pins:	p16	p15	p4	p3	p7	p6	p2	p1
Alternative Uses:	"Each I/O pin may be configured for multiple uses, refer to pin definitions earlier in the chapter for a list of Alternative uses for each pin"							

The corresponding data direction register is TRISA. Setting a TRISA bit (= 1) will make the corresponding PORTA pin an input. When the pin is set to input it will be in a high-impedance mode. Clearing a TRISA bit (= 0) will make the corresponding PORTA pin an output. In this mode the contents of the output latch will be available on the selected external I/O pin.

Any instruction that specifies a file register as part of the instruction performs a Read-Modify-Write (R-M-W) operation. The register is read, the data is modified and the result is stored according to either the instruction or the destination designator 'd'. A read operation is performed on a register even if the instruction writes to that register. It is important to consider the impact of a read on the configuration before using read-modify-write instruction.

- Example of initializing PortA

```
CLRF    PORTA     ; Initialize PORTA by clearing output data latches
MOVLW   0x7F
MOVWF   ADCON1    ; Configure A/D for digital I/O
MOVLW   0xF0      ; Value used to initialize data direction
MOVWF   TRISA     ; Set RA<3:0> as outputs RA<7:4> as inputs
```

➢ PortB, TRISB and LATB Registers
PORTB is an 8-bit wide, bidirectional port. Reading the PORTB register reads the status of the pins, whereas writing to it will write to the port latch.

	RB7	RB6	RB5	RB4	RB3	RB2	RB1	RB0
Port B Register Bits:	b7	b6	b5	b4	b3	b2	b1	b0
I/O Pins:	p13	p12	p11	p10	p18	p17	p9	p8
Alternating Uses:	"Each I/O pin may be configured for multiple uses, refer to pin definitions earlier in the chapter for a list of Alternative uses for each pin"							

The corresponding data direction register is TRISB. Setting a TRISB bit (= 1) will make the corresponding PORTB pin an input. When the pin is set to input it will be in a high-impedance mode. Clearing a TRISB bit (= 0) will make the corresponding PORTB pin an output. In this mode the contents of the output latch on the selected pin.

Any instruction that specifies a file register as part of the instruction performs a Read-Modify-Write (R-M-W) operation. The register is read, the data is modified and the result is stored according to

either the instruction or the destination designator ‘d’. A read operation is performed on a register even if the instruction writes to that register. It is important to consider the impact of a read on the configuration before using read-modify-write instruction.

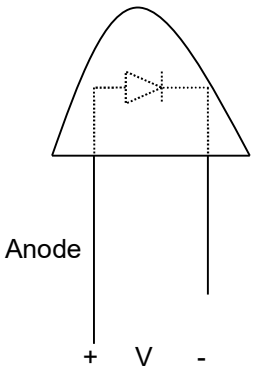
- Example of initializing PortB

```
CLRF    PORTB       ; Initialize PORTB by clearing output data latches
MOVLW   0x7F
MOVWF   ADCON1      ; Configure A/D for digital I/O
MOVLW   0xCF        ; Value used to initialize data direction
MOVWF   TRISB       ; Set RB<3:0> as inputs, RB<5:4> as outputs and; RB<6:7> as input
```

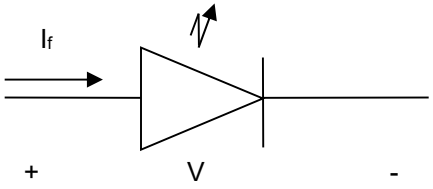
❖ RB5, Pin 11 (PortB, Bit 5)
Pin 11 is also used for Low Voltage Programming (LVP) and must be explicitly disabled in order to make pin 11 a digital I/O pin. LVP can be disabled at the start of the program by writing 0 to LVP, bit 2 of CONFIG4L register (located at address 0x300006). This can be done either by using table write or from MPLAB menu Configure > Configure Bits.

❖ Watch Dog Timer (WDT)
Watch Dog Timer resets the processor if it is not cleared once every 400 msec. You can clear the WDT by using the instruction “CLRWDT”. Another option is to disable the WDT at the start of the program by writing 0 to WDT, bit 0 of CONFIG2H register (located at address 0x300003). This can be done either by using table write or from MPLAB menu Configure > Configure Bits.

❖ LED Usage
Light Emitting Diode (LED) is used as indicator in many applications from power on/off light to traffic signal lights. LED lamination, current and power specifications vary depending on design and application. LEDs used in this lab are specified below (Lumex SSL-LX5093LXX):



Packaging Configuration

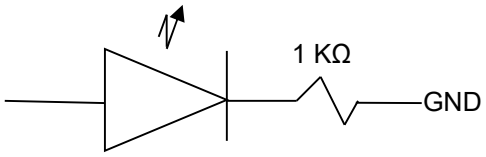


Functional Diagram

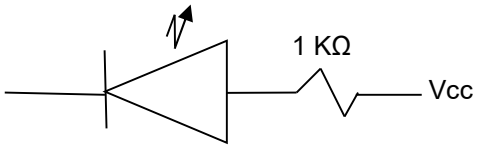
Rating: I_f < 30 mA at 2.5 Volts
Typical: +5 V at 1= 5 ma

Example Configurations:

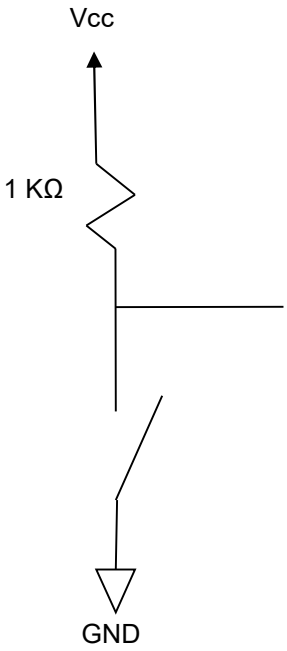
LED turns on with high input:



LED turns off with high input:



❖ Switch Usage



Output = 0 *when switch is closed.*
1 *when switch is opened.*

Experiment #1

Using PICmicro, MPLab IDE and Lab kit, implement and test a circuit that accepts two, 2-bit binary input and output the sum as a 3-bit binary value.

Input operands (A_1A_0) and (B_1B_0) are simulated using DIP switches and should be connected to PICmicro input pins 9,8,18 and 17 respectively. And the resulting output ($R_2R_1R_0$) should be produced on PICmicro pins 13, 12, 11 and displayed using LEDs.

The program should only write to output port if the value of input has changed.

This experiment requires that you review your high level design (flow chart or pseudo code) and demonstrate your system to the instructor upon completion. Include the approval signature in your report.

Hints:

1. *Read the background notes carefully and make sure that LVP and WDT is disabled.*
2. *MCLR pin must be high for PICmirco normal operation.*
3. *Frequent (0.5 seconds) writing to PortA and PortB causes invalid values on the output pins.*

This experiment requires that you review your high level design (flow chart or pseudo code) and schematics with the instructor prior to start and upon completion, demonstrate your system to the instructor.

Report Requirements

All reports must be computer printed (formulas and diagrams may be hand drawn) and at minimum include:

For each experiment:

a) Clear problem statement; specify items given and to be found.
b) Specific responses to each question asked in the experiment.
c) Documentation of resulting high level design, disassembled code, system diagram, schematics and any other supporting material.

For the report as a whole

a) Cover sheet with your name, course, lab title, date of completion and your teammates' name.
b) Lessons learned from this lab.
c) A new experiment and expected results which provide additional opportunity to practice the concepts in this lab.