

# **EE 361L Digital Systems and Computer Design Laboratory**

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## **Working with the PIC16F84 – A Quick and Dirty Tutorial**

Version 2.0

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This document is a quick and dirty tutorial on programming the PIC16F84A microcontroller using the C programming language.

- ❑ MPLAB IDE is a user-friendly environment provided by Microchip (manufacturers of PIC micro-controllers) for program compilation, simulation & testing and programming the micro-controllers.
- ❑ HI-Tech PICC compiler is used to compile source programs in C and works seamlessly with the MPLAB IDE.

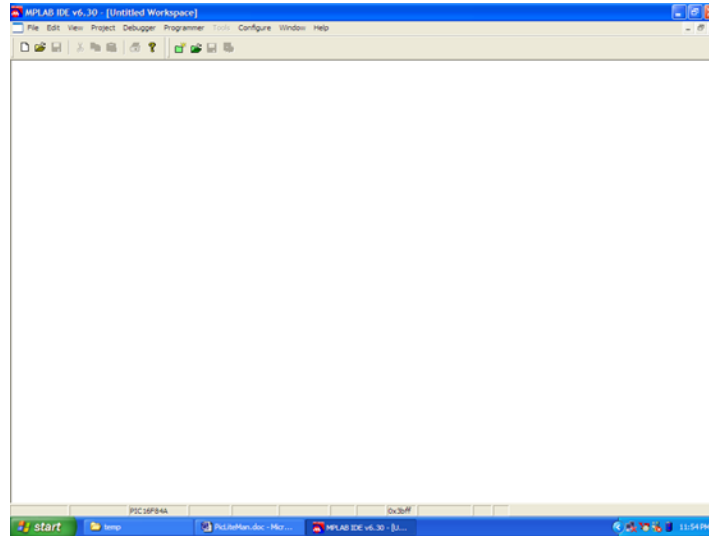
Section I provides an introductory tutorial on the MPLAB IDE using the sample C program given for Lab 2.1. Section II provides basic information on simulation in the MPLAB IDE environment followed by another section on programming the micro-controller using the PICSTART hardware device.

For complete information on the MPLAB IDE, please refer to the MPLAB IDE Simulator & Editor User's Guide at the following URL:

<http://www.microchip.com/download/tools/picmicro/devENV/manual/51025e.pdf> .

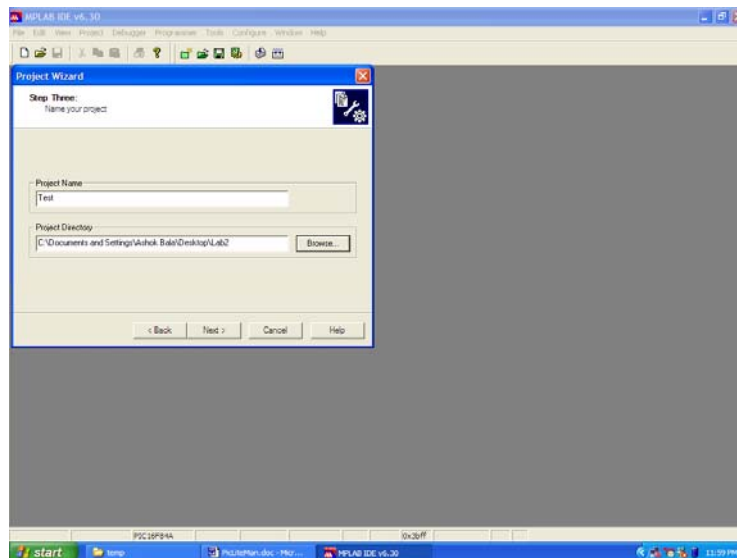
## I. Using the MPLAB Integrated Development Environment (IDE)

1. Start MPLAB IDE. You will get the window as shown in Figure 1.



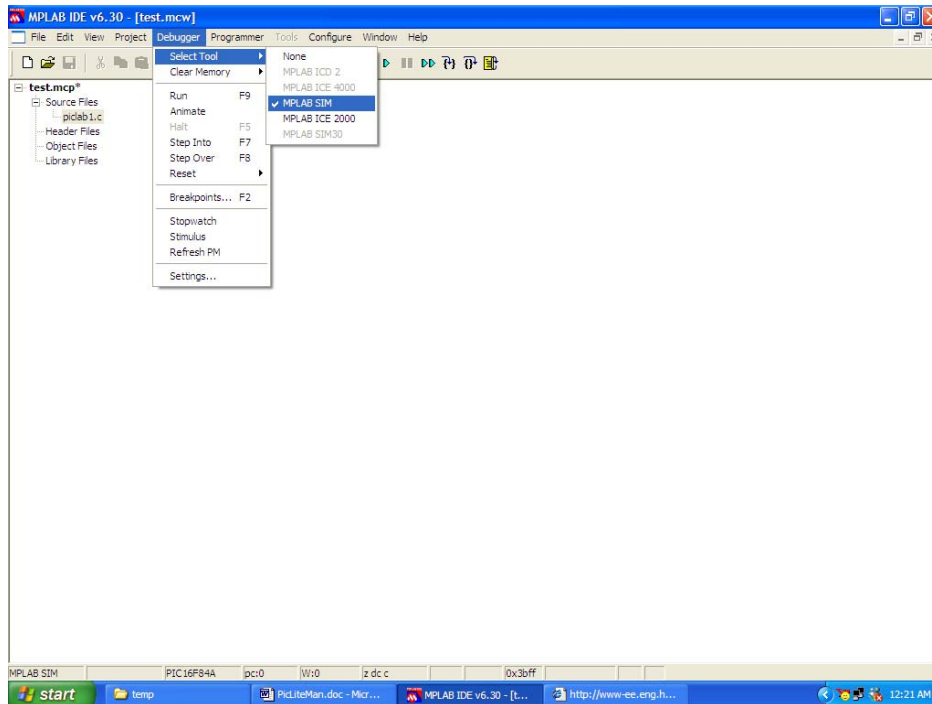
**Figure 1. Screen shot of MPLAB IDE.**

2. Go to the icon **Project** and click on the **Project Wizard (Project->Project Wizard)**. Select the PIC16F84A device. The IDE asks you to choose the compiler, linker and assembler. *Choose the HI-TECH PICC Toolsuite*. The IDE now asks for a Project name and the destination directory for the files of the Project.



**Figure 2. Screen shot of Project Wizard.**

3. Add the source file <<piclab1.c>> to the Source file by right-clicking on the **Source Files** icon on the Project window. Click on the icon **Debugger** and on the **Select Tool** icon. Choose *MPLAB Sim* (**Debugger->SelectTool->MPLAB Sim**). This enables the user to simulate his/her programs after the *compilation* process.

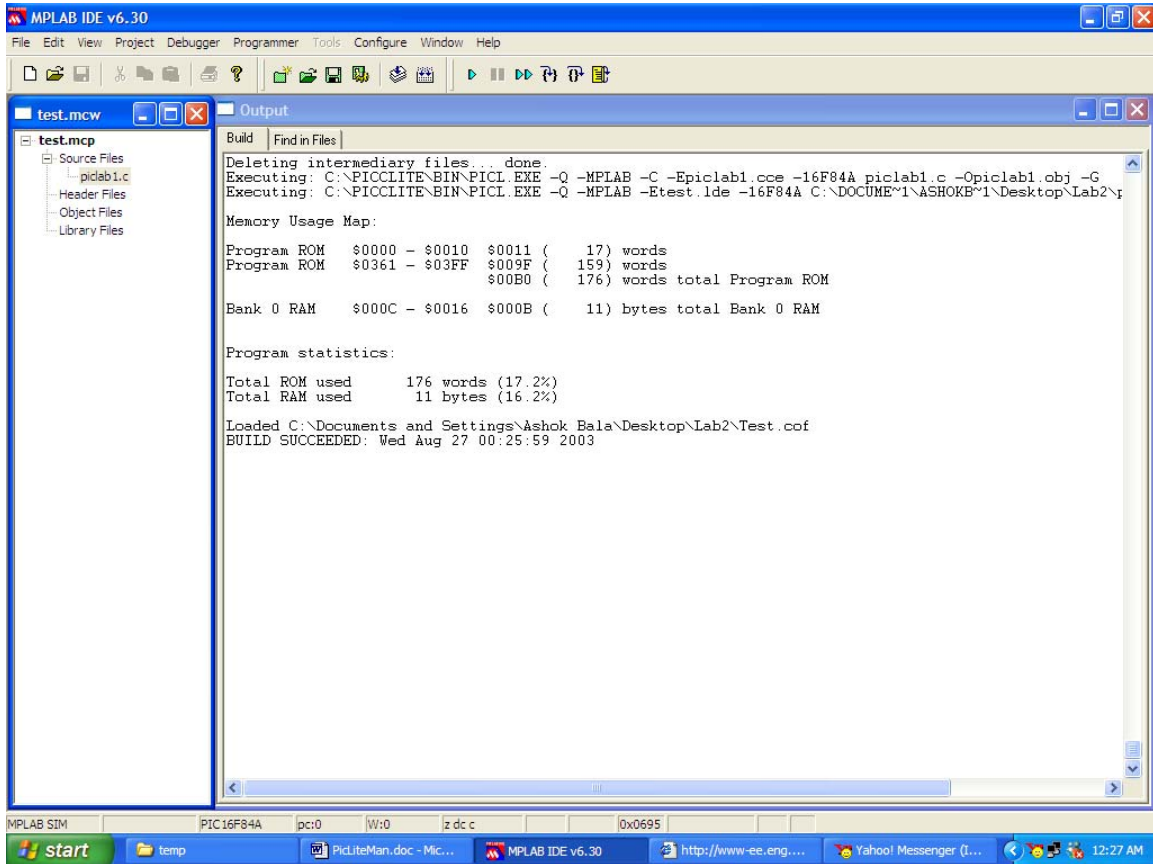


**Figure 3. Adding Source files & Initialising MPLAB Sim.**

4. Click on the icon **Project**. Click on the **Build All** icon (**Project->Build All**). You should get a screen that looks like Figure 4 if the build is successful. In short, this is the compilation process and is quite similar to the other C compilers that you might have used. If the build is unsuccessful, check for syntax errors and the build options (**Project->Build Options**). The build option provides the user with some control parameters for deriving the object files.

Congratulations, you have successfully finished the orientation to the MPLAB IDE. As a reminder, this tutorial intended to provide instructions for the first-time user of MPLAB IDE. For complete information on the capabilities of the MPLAB IDE, please visit the Microchip website at <http://www.microchip.com>. The next section

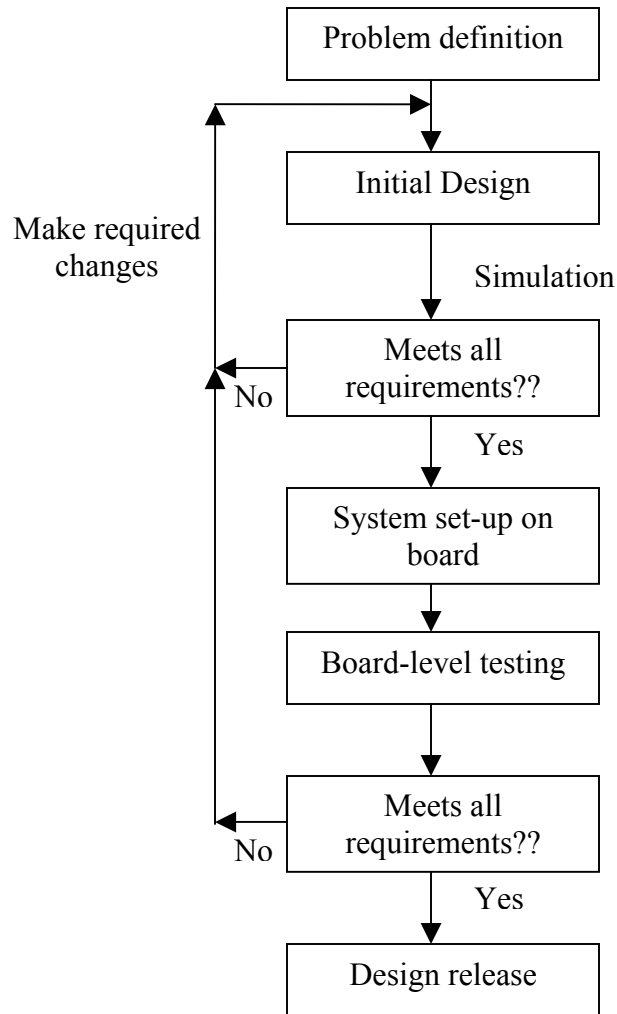
contains basic information on Simulation using the MPLAB IDE, followed by a section on programming the micro-controller using the PICSTART hardware.



**Figure 4. Successful compilation & build.**

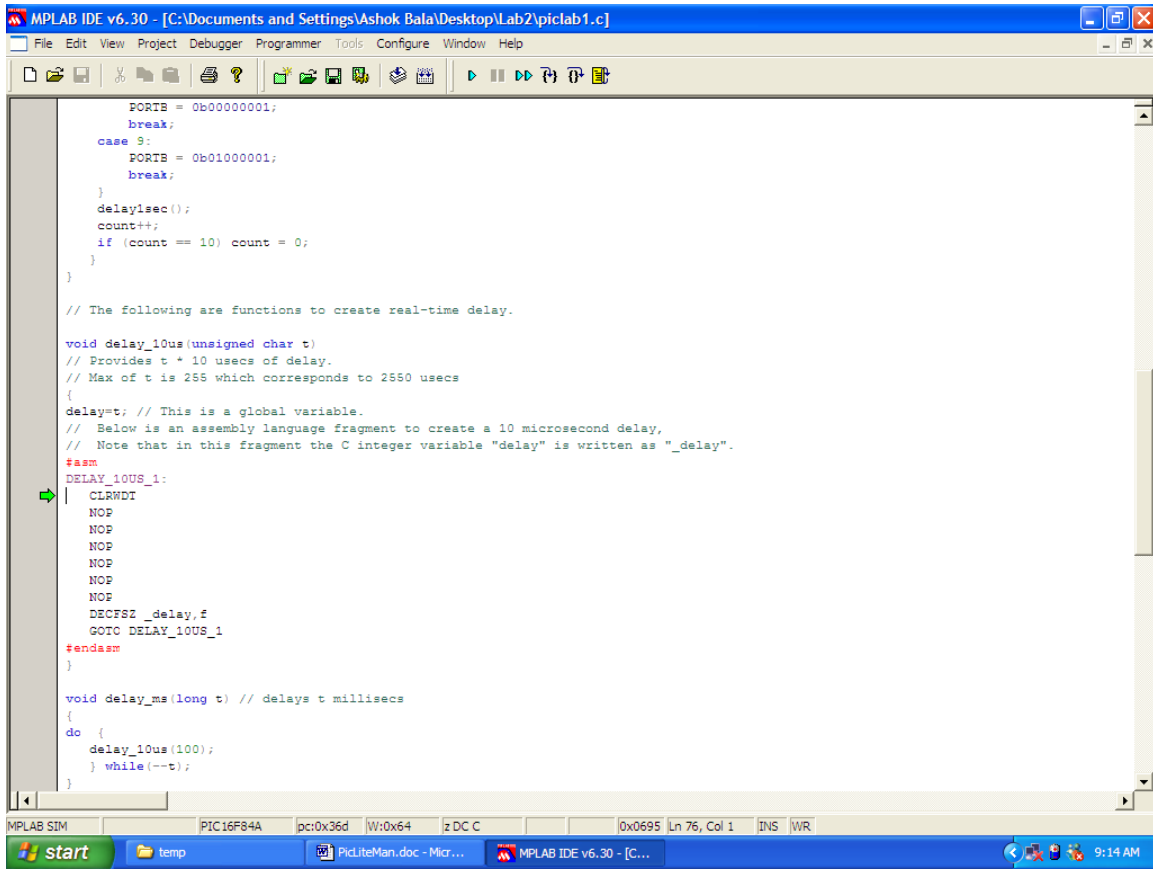
## II. Simulation

Simulation in the MPLAB IDE provides the user with the ability to check for program-correctness. The design process is shown below in Figure 5. As you can see, Simulation reduces the overhead and the costs involved for a design review and incorporating changes to meet the design requirements.



**Figure 5. Design process.**

1. After the build is complete, click on the icon **Debugger** of the IDE. Click on **Animate (Debugger->Animate)**. The IDE executes your C program (actually, the machine code but it keeps track of the association) and highlights which statement of your C program is being currently executed as in Figure 6. Click on **Debugger**, you will find commands like **Run, Halt, Step Over, Step Into, Reset** and **Stop Watch**. Explore these commands.



**Figure 6. Animation.**

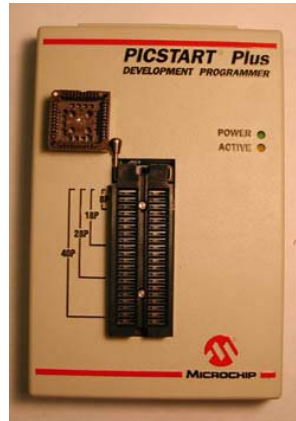
- Click on the icon **View** on the main command line. You will find icons **Disassembly**, **Hardware Stack**, **Program Memory**, **File Registers**, **EEPROM**, **Watch** and **Special function registers**. Explore these commands.

### III. Programming using the PICSTART PLUS hardware

Once your simulation is complete and you are satisfied that your design works the way you wanted it to be, you are ready to download the machine code on to the microcontroller (Re-usability?). The BUILD process produces a file of the format called the HEX format, which is a standard from Intel.

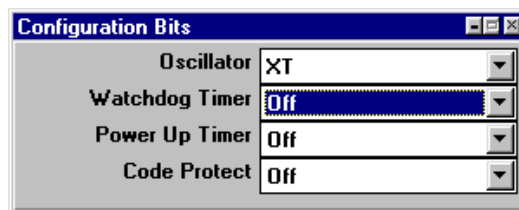
First, make sure that the programmer hardware is connected to the computer. The hardware looks like the device shown in Figure 7. You are required to place the micro-

controller on to the programmer hardware in the right way. Refer to instructions on the programmer for placement of the micro-controller.



**Figure 7. PICSTART Plus**

1. From the main menu of the MPLAB IDE, select **Programmer->Select Programmer->PICSTART Plus**.
2. Select **Configure->Configuration Bits**. Set the configuration bits as shown in Figure 8. Also make sure **Configure->Device** lists PIC 16F84A as the device. If not, change it to the PIC 16F84A.



**Figure 8. Configuration Bits Window**

3. From the programmer menu, enable the programmer (**Programmer->Enable Programmer**). If the programmer hardware is connected properly, you would be able to execute all the following commands:
  - *Blank Check*: This checks if the micro-controller is blank.

- *Program:* This is used to program the PIC micro-controller. The HEX file in the project is downloaded through the cable on to the micro-controller.
- *Verify:* This verifies that the program has be loaded properly into the micro-controller.
- *Read:* This will read the contents of the PIC micro-controller.

Once the *Program* operation is successful, the user can place the micro-controller on his/her system and evaluate if the system design is complete.