



## Programming Lab 1B

# Space Invaders

Topics: Introduction to the programming environment

Prerequisite Reading: Chapter 1 & Appendix B  
Revised: December 10, 2021

 Click to view the setup directions

 Click to download Lab1B-Main.c

 Click to download Lab1B-SpaceInvaders.s

**Objective:** The purpose of this lab is merely to get acquainted with the workspace environment, how to compile the main program (Lab1B-Main.c), assemble the assembly language file (Lab1B-SpaceInvaders.s) that contains functions called by the main program, link them together with the run-time library (library.a) to create an the executable image file (output.bin), and transfer it to the single-board computer. You are **not** expected to write any code – just to become familiar with the tools.

### Assignment:

1. Click on the first (top) yellow link above to view the software installation instructions. Follow the directions to install the workspace. If you are using your own personal computer, download and install the compiler and (if your computer is running Microsoft Windows) GNU make and GNU grep for Windows
2. Download the files Lab1B-Main.c and Lab1B-SpaceInvaders.s and store them in the src directory of your workspace folder. Use the following instructions to build and test the Lab 1B sample program:
3. **Windows Only:** Double-click on the file named setup.bat that is located in your workspace folder. This will open a command line window with the root of the workspace folder as the current directory.
4. **Linux and OS X Only:** Open a terminal window and change the current directory to the root of the workspace directory.
5. Enter the command “make”. This will run the compiler, the assembler and the linker, producing the final program in a file named output.bin. The make program uses a text file named “makefile” that describes how to compile, assemble, and link the program components together. It is designed to compile any C source code files, and assemble any assembly language source code files, that it finds in the src directory. Doing so will produce corresponding object files in the obj directory. The make program will then link these object files with the run-time library (library.a) to produce the executable image file (output.bin); these are both located in the root of the workspace directory.
6. Connect the single board computer to the desktop computer using a mini-USB cable. A window will open as if you had inserted a USB thumb drive. Into that window, copy the file output.bin from the root directory of your workspace to the window that just opened. The board will automatically load and execute your program.
7. If everything proceeds normally, you will first be presented with some instructions and then should see the Space Invaders game on the display of the board as shown at right. Tilt the board left or right to move your gun and push the blue pushbutton to fire a bullet. Basic timing functions are implemented in the assembly language file; everything else is implemented in the main program.

