CS1021 Lab #0
Getting Started with ARM Assembly Language Programming Tools

30 September 2016

Working in Pairs

The lab exercises for CS1021 require you to work in pairs.

- You should use one workstation and choose one person to type.
- Switch roles each week.
- Submit one solution per pair using Blackboard.
- **Both of you must maintain your own copy of everything that you work on and submit.**
- **Read the Marking Scheme and Regulations that apply to CS1021 Labs (available on the CS1021 Blackboard site).**

General Tips Before Starting

- You are required to keep your own copy of all the coursework you submit.
- You should use your network file store (`U:` drive) or a USB "memory stick" to store your CS1021 lab exercises, assignments and other programs.
- DropBox (`http://www.dropbox.com`) is a good way to backup your important coursework files and get access to them at home.
- Do not store your projects on the local hard disk (`C:` or `D:`) of lab computers. They will probably not be there when you return.
- Create a folder on your network file store (`U:`) or USB memory stick (e.g. called `CS1021Projects`) and store each of your projects in its own folder.
- Always maintain backup copies of all of your coursework, particularly when working on larger assignments.

Using the Keil µVision IDE

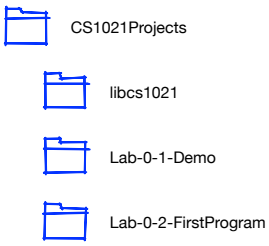
1. Log in to the computer using the username and password you were given.

2. Create a folder for your CS1021 projects on your network file store or on a USB stick. Call it `CS1021Projects`.

3. Download `libcs1021.zip` from the CS1021 Blackboard site (`http://mymodule.tcd.ie`) and extract the zip file to your `CS1021Projects` folder.

4. Download the µVision projects for this lab from the CS1021 Blackboard site (called `Lab-0.zip`) and extract the zip file to your `CS1021Projects` folder.

   After extracting the .zip files, your `CS1021Projects` folder structure must look like this:

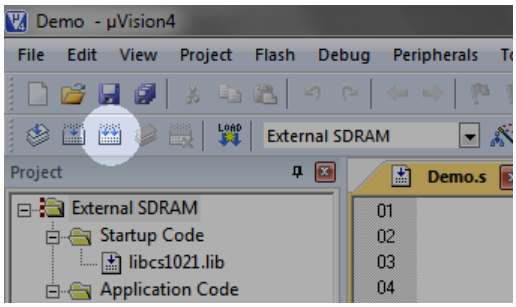


   If it doesn't look like this, you may need to move some folders around.

5. Open µVision 4 (Start Menu – All Programs – Keil uVision 4). (You can also use µVision 5 but it is less convenient for step-by-step debugging, as we will see later.)

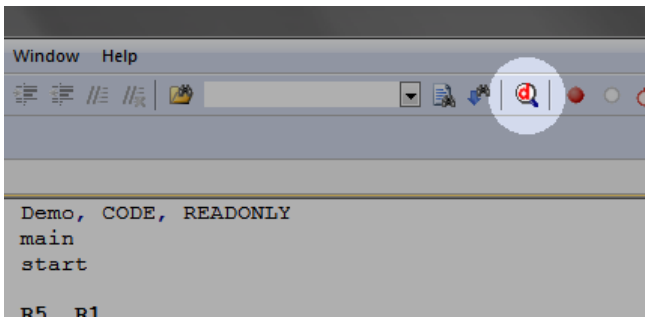
6. From the **Project** menu, select **Open Project...** and browse to the `Lab-0-1-Demo` folder that you extracted above. Select the `Demo` project and click **Open**.

7. Click the **Rebuild all target files** icon or select **Rebuild all target files** from the **Project** menu.



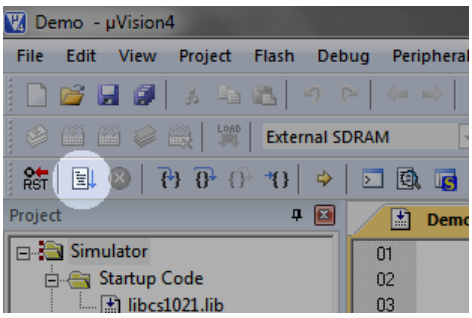
   Some text should appear at the bottom of the screen, ending in `0 Error(s), 0 Warning(s).`

8. Execute the Demo program by clicking the **Start/Stop Debug Session** icon or selecting **Start/Stop Debug Session** from the **Debug** menu.

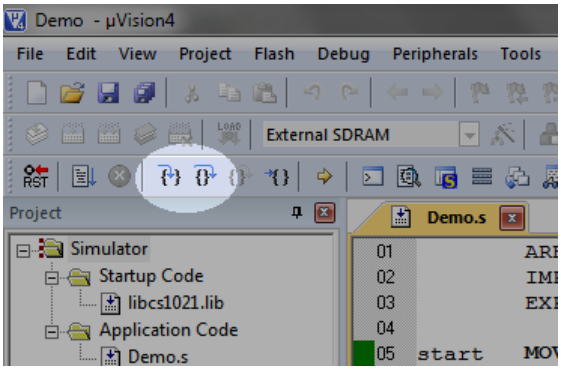


You should see a window containing an ARM Assembly Language program with a yellow arrow beside the line containing the word `start`. The yellow arrow is the Program Counter (PC) and shows the next instruction to be executed. The processor is "halted" waiting for you to start the program.

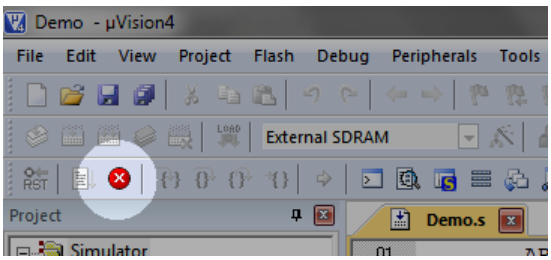
9. Run the program by clicking the **Run** icon or selecting **Run** from the **Debug** menu.



Alternatively, you can step through the program one instruction at a time by clicking the **Step** or **Step Over** icons or selecting **Step** or **Step Over** from the **Debug** menu.



You can halt the program by clicking the **Stop** icon or selecting **Stop** from the **Debug** menu.



You can stop the Debug session by clicking **Start/Stop Debug Session** again or by clicking the **Start/Stop Debug Session** icon.

Full documentation for the µVision IDE is available on-line from Keil:

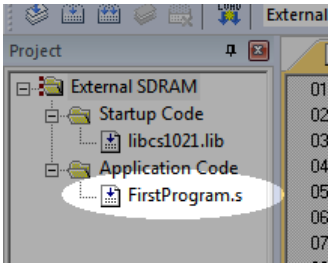
`http://www.keil.com/support/man/docs/uv4/`

Writing your first program

Follow the steps below to write and execute the program listed at the end of Tutorial #1.

1. Open the `Lab-0-2-FirstProgram` project in µVision by selecting **Open Project...** from the **Project** menu as before and browsing to the `Lab-0-2-FirstProgram` folder.

2. In the µVision IDE, in the **Project** window on the left-hand side, you should see a list of files. Double-click the `FirstProgram.s` file to open and edit it.



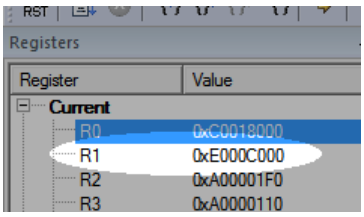
3. Beginning on the line immediately after `start`, type in the following program listed below. Do not enter the line numbers (1, 2, 3, etc.). Insert a tab at the start of each line (i.e. before typing `MOV` or `ADD`) using the TAB key. (You may find it useful to set the size of a TAB to be 8 spaces rather than 4. This will improve the readability of your programs. In the **Edit** menu, choose **Configuration...** and under **ASM Files:**, change the Tab size to 8.)

```
1       MOV R0, R1
2       ADD R0, R0, R0
3       ADD R0, R0, R0
4       ADD R0, R0, R0
```

4. Save your changes to the file.

5. Rebuild the project and execute it using the same sequence of steps that you used to build and execute the Demo program above.

6. Before running the program, you need to give the program some input. The only input required is the value in `R1`. Click on the value shown beside `R1` in the **Registers** window and press the F2 key to edit the value. Enter a value (e.g. 2) and press the RETURN key.



7. Run the program by clicking the run icon, as described above for the Demo program.

8. Stop the program by clicking the red **halt** icon. What value do you observe in `R0`? What does the program do?

9. **To verify that you can submit assignments using the CS1021 Blackboard site, use the site to upload your FirstProgram.s file as your solution to Lab #0.** You should upload FirstProgram.s only. Do not upload any other files and do not place the .s file in a compressed archive (.zip file). You should upload your solution by 23:59 on Wednesday 5 October 2016.