

Lab Assignment 1—Ready, Set, Go!

Introduction to the AVR Microcontroller

Overview

In this lab you will get acquainted with the **ReadyAVR-64** development board (a.k.a. the *ReadyAVR*). This board is based on the popular ATmega128A microcontroller from Atmel. In this lab you will use the **Atmel Studio** Integrated Development Environment along with the **Atmel-ICE JTAG programmer** to compile and download an assembly language program into the ATmega128A, and you'll use **PuTTY**, a very popular serial-port terminal emulator, to communicate between a PC and the code running on the ReadyAVR.

Administrative Information

You'll be issued a lab kit to use this semester. **You are responsible for the items in your kit and will need to return everything at the end of the semester, so please handle with care.** You can store your kit in F103 when not in use, or you can take it with you and work on projects outside of lab. To work outside the lab you'll need to download and install **Atmel Studio** on your own computer. Version **v7.0.1645** is installed on the lab computers, and can be downloaded at <https://www.microchip.com/en-us/tools-resources/archives/avr-sam-mcus>. When installing, it will try to upgrade you! Uncheck "Install latest version of the product" to get the supported version. If you decide to use a newer version, **be sure it's backward compatible with the version in the lab!** Also, Studio 7 is a Windows-only product—there is currently no support for OS X or Linux. 😞

Background: ATmega128A Specifications

Using the ATmega128A datasheet, the ReadyAVR-64 user's manual, and the Atmel 8-bit AVR Instruction Set (available on Canvas in the Files | Docs folder), answer the following questions.

1. Define the following acronyms:
 - a. ADC -
 - b. PWM -
 - c. USART -
 - d. EEPROM -
 - e. SRAM -
2. What is the operating voltage range of the ATmega128A microcontroller?
3. What is the allowable input power supply voltage for the ReadyAVR-64 board?
4. In theory, how many ADD instructions can be stored in ATmega128A Flash memory?
5. List at least **two different types** of *input* devices available on the ReadyAVR-64.
6. List at least **two different types** of *output* devices available on the ReadyAVR-64.

Lab Procedure:

The steps below will show you how to create a new **Atmel Studio “solution”** named **EECE3624Labs** to hold your lab projects this semester. Each lab assignment will be a separate Atmel Studio “project” stored within the EECE3624Labs solution. You’ll also use **GitHub Classroom** to create a remote Lab01 “starter code” repo, and you’ll use **Git Shell** to clone that repo to your local storage device. Once the lab code is saved locally, you’ll configure your ReadyAVR board, connect it to your computer along with the Atmel-ICE programmer, and use Atmel Studio to assemble, download, and run the Lab01.asm program on your ReadyAVR.

1. Setup top level solution for all lab projects
 - Open Atmel Studio and select **File→New→Project**
 - select **Atmel Studio Solution**
 - Name the solution something like “**EECE3624Labs**” and set the Location field (personal storage device (e.g. D:\, **where “D” is replaced by the drive letter of your device**; Laptop drive (e.g. C:\)).
 - o Make sure the “Create directory for solution” box is checked
 - click “OK” to create the empty solution.
(Remember: You’ll use a *single solution* all semester containing *separate projects* for each lab.)
2. You should have received an email from your instructor containing a GitHub link associated with this lab.
 - click that link to be taken to a **GitHub Classroom** page
 - you’ll see an “Accept this assignment” link. Click that link
 - o provide your GitHub username and password if needed
 - o GitHub Classroom will create a remote Lab01 assignment repository for you, pre-populated with some starter code.
 - o Once the repo has been created, a link similar to <https://github.com/EECE3624-S2021/lab01-YourGitHubUserName> will be shown, where your GitHub user name will appear as part of the repo name.
 - Simply click that link to view your new remote GitHub repo.
 - **(Remember: “remote” means in your GitHub cloud account.)**

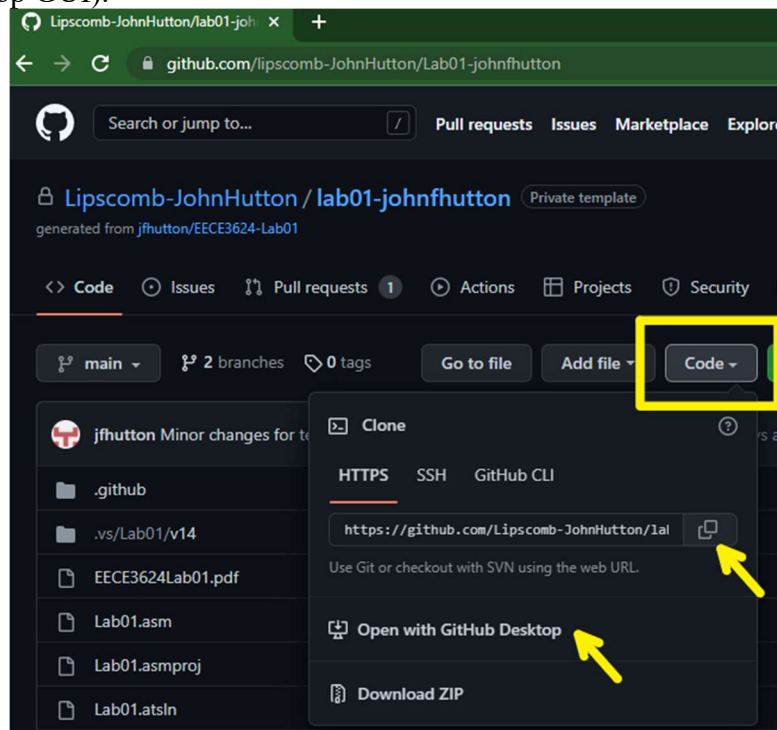
A few things to note. First, you have full read/write access to this repo but the owner is an organization named **EECE3624-F2022**, not you. Future assignment repos will also be owned by **EECE3624-F2022** and will have URLs similar to the one shown in the previous paragraph but with new lab numbers (e.g. <https://github.com/EECE3624-F2022/lab01-YourGitHubUserName>).

Second, assignment repos are **private**, and only you and your instructor have access to them, so don’t share the repo with other students. Third, these repos are remote, so **you’ll need to create local repos** to stage and commit any code changes you make (described below). And, of course, you should periodically add, commit, and push local changes to the remote assignment repo.

Once you’ve completed a lab, the remote repo becomes part of your submission. Therefore, **do not rename or delete the remote assignment repository**, as it will become **ungradable**.

3. With GitHub opened to your remote assignment repo, use one of the two options under the Code button.

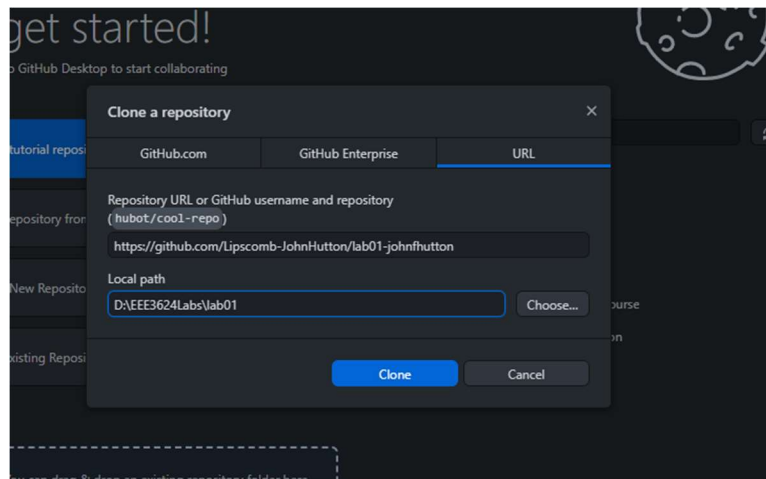
(NOTE: There are always more ways that could work, but we will look at cmd line or GitHubDesktop GUI).



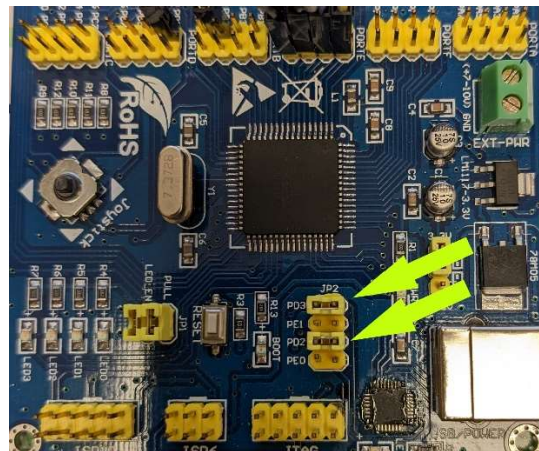
- Option 1: Use Git Shell

Following what we did last week, if you copy the https line (top yellow arrow), then you can use the same command window and the git command line to clone the database.

- Open **Git Shell** and navigate to your lab location from step #1 (D:\EECE3624Labs).
 - Enter the following command to create a new Lab01 directory inside the solution directory and clone the remote repo.
 - D:\EECE3624Labs> git clone <remote-repo-URL> <local-repo-name>
- Option 2: Use GitHubDesktop
- (NOTE: This assumes you have loaded GitHubDesktop apart from the last lab - <https://desktop.github.com/>)
- Click the 2nd yellow arrow “Open with GitHubDesktop”
 - The remote repro should be populated correctly
 - Update the local path to where you want the files



4. With the EECE3624Labs solution open in **Atmel Studio**
 - R-click on the solution name (in Solution Explorer)
 - click **Add | Existing Project**
 - browse to D:\EECE3624Labs\Lab01 and select the Lab01.asmproj file.
(This will add the Lab01 project to the current solution.)
 - R-click on the newly added Lab01 project and select **Set as StartUp Project**.
 - Then R-click on the Lab01.asm assembly file and select **Set as EntryFile**.
(In later labs, be sure to do this for the latest lab project and startup file or you'll end up compiling and running an older lab's code!)
5. Locate the JP2 pin block on the ReadyAVR board and make sure the two PD2 pins are connected via 2-pin jumper. Ensure the two PD3 pins are connected via a 2-pin jumper as well.



6. Plug in all the necessary cables
 - Attach the Atmel-ICE programmer to the ReadyAVR board's JTAG port. Pay very close attention to the connector orientation. **THIS IS IMPORTANT! When in doubt, ask!**
 - Next connect the Atmel-ICE to the PC using a micro-USB cable
 - Finally, connect the ReadyAVR board to the PC using a USB A/B cable



7. In **Atmel Studio**, double-click on the **Lab01.asm** filename in Solution Explorer to open the file for editing.
 - Click on **Project**→**Lab01 Properties**
 - choose **Tool** from the left-hand menu
 - Select your **Atmel-ICE** device as the debugger/programmer (should auto-select)
 - Set the Interface to JTAG (should auto select)
 - Finally, select **File**→**Save All** to save any unsaved settings.
8. Open **PuTTY** on the PC
 (If you have not installed, go to
<https://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html>)
 (If you have a mac, here are some options, but I have not checked them:
<https://www.ssh.com/academy/ssh/putty/mac>)
 - choose **Connection | Serial**, and set the proper COM channel
 (use the Windows Device Manager to determine this, or run Dr. Nordstrom's `comports.bat` file found in the Lab01 repo and/or the class share)
 - o **9600** baud
 - o **No** parity
 - o **8** data bits
 - o **1** stop bit
 - Select **Terminal** and set **Local echo** to "**Force off**" and **Local line editing** to "**Auto**".
 (Consider strongly saving this PuTTY configuration for future use—very handy for future labs!)
9. Click the green ► triangle on the AVR Studio menu bar to assemble, download, and run the code on the ReadyAVR. When it runs, you'll see a welcome message displayed on PuTTY.
10. Begin typing characters in the **PuTTY** window and notice that all printable characters are displayed and that non-printable characters (e.g. Enter, Backspace, etc.) operate as expected. Also, LED0 on the ReadyAVR board should blink whenever you type a character.
11. Experiment with type characters into PuTTY. Briefly explain what happens on screen and on the ReadyAVR board when the following keys are pressed:
 - a. Letters, numbers, punctuation, spacebar, tab, and Enter

b. Arrows, backspace, and ESC

c. The RESET button on the ReadyAVR board

12. Study the Lab01.asm program (especially the comments!)

- **Draw a flowchart with 10 or less shapes** that describes the logic of this echo server application.
 - o Be sure to capture the “infinite loop” nature of the code
 - o Use **legal flowchart symbols**. See the *gliffy* link below for flowchart help.
 - **Draw.io** (<https://drawio-app.com/>) is a free could tool like MS Visio for electronically doing a flow chart.
 - o Include the flow chart in your report!

Report:

This is a **one-week lab**.

- No git push is required as you do not need to develop any of your own code
- Lab report is required.
 - o Answer all questions
 - o Include flow chart
 - o Required to use the template.(File→Labs→EECE3624_Lab_Report_Template-Unpopulated.dotx. More template instructions are n the EECE3624_Lab_Report_Template-Instructions.dotx)
 - o Have fun!

Helpful documents and links:

www.avrfreaks.net – A great user group and source of **much** information on AVR processors. Signing up for an account (free, and required to post messages) is highly recommended.

<http://www.avrfreaks.net/index.php?name=PNphpBB2&file=viewtopic&t=70673> – A very good starting point for understanding and programming AVR microcontrollers. Very highly recommended.

<http://www.youtube.com/user/AtmelCorporation> – The Atmel channel. Many great videos.

<https://www.gliffy.com/blog/how-to-flowchart-basic-symbols-part-1-of-3/> – Flowchart help.

<http://draw.io> – A great, free charting tool.