

ECEN 5803- Mastering Embedded System Architecture

Homework set 3P

Due Date: 2021/10/11

Practical Homework:

This section gives an introduction to the NUCLEO – F401RE board. Read the content given below and once that is done, refer to the Homework5_1 doc and the Homework5.zip to perform this section of the homework. Be sure to answer the questions at the end.

INTRODUCTION

NUCLEO-F401RE

Affordable and flexible platform to ease prototyping using a STM32F401RET6 microcontroller.



The STM32 Nucleo board provides an affordable and flexible way for users to try out new ideas and build prototypes with any STM32 microcontroller line, choosing from the various combinations of performance, power consumption and features. The Arduino™ connectivity support and ST Morpho headers make it easy to expand the functionality of the STM32 Nucleo open development platform with a wide choice of specialized shields. The STM32 Nucleo board does not require any separate probe as it integrates the ST-LINK/V2-1 debugger/programmer.

MICROCONTROLLER FEATURES

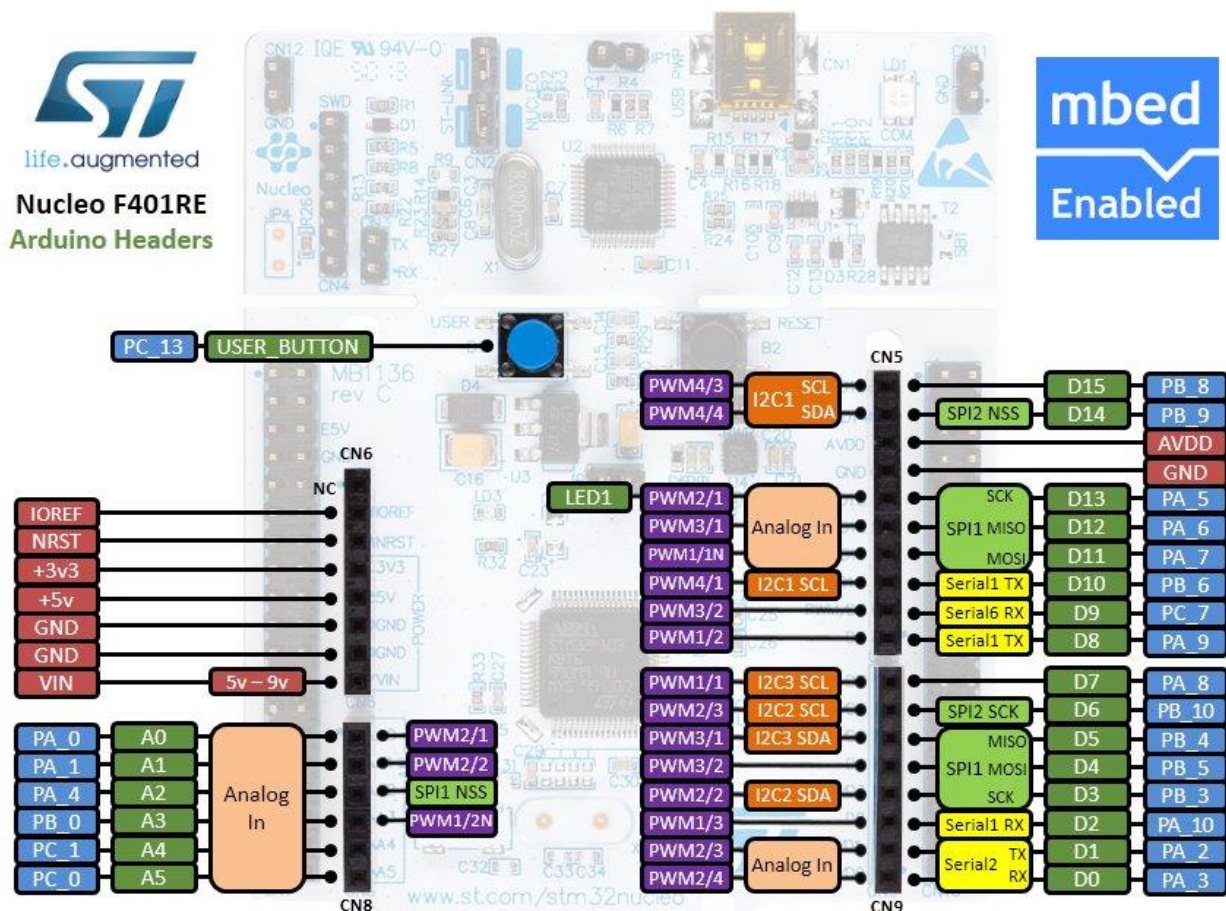
- STM32F401RET6 in LQFP64 package
- ARM®32-bit Cortex®-M4 CPU
- 84 MHz max CPU frequency
- VDD from 1.7 V to 3.6 V
- 512 KB Flash
- 96 KB SRAM
- GPIO (50) with external interrupt capability
- 12-bit ADC with 16 channels
- RTC
- Timers (8)
- I2C (3)
- USART (3)
- SPI (3)
- USB OTG FS
- SDIO

NUCLEO FEATURES

- Two types of extension resources
 - Arduino Uno Revision 3 connectivity
 - STMicroelectronics Morpho extension pin headers for full access to all STM32 I/Os
- On-board ST-LINK/V2-1 debugger/programmer with SWD connector
 - Selection-mode switch to use the kit as a standalone ST-LINK/V2-1
- Flexible board power supply
 - USB VBUS or external source (3.3 V, 5 V, 7 - 12 V)
 - Power management access point
- User LED (LD2)
- Two push buttons: USER and RESET
- USB re-enumeration capability: three different interfaces supported on USB
 - Virtual Com port
 - Mass storage (USB Disk drive) for drag'n'drop programming
 - Debug port

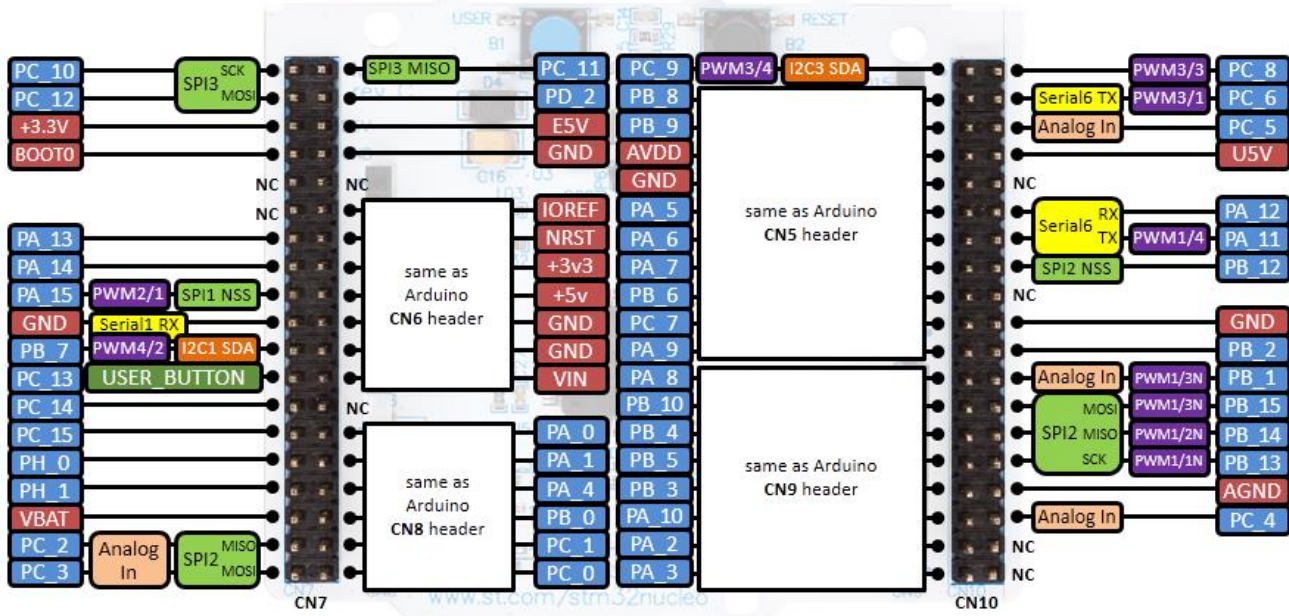
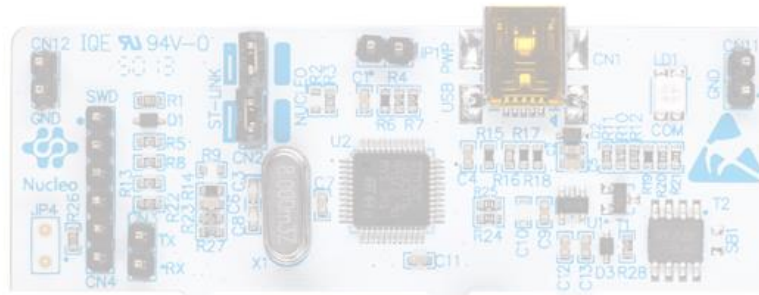
NUCLEO PINOUT

ARDUINO-COMPATIBLE HEADERS



MORPHO HEADERS

These headers give access to all STM32 pins.



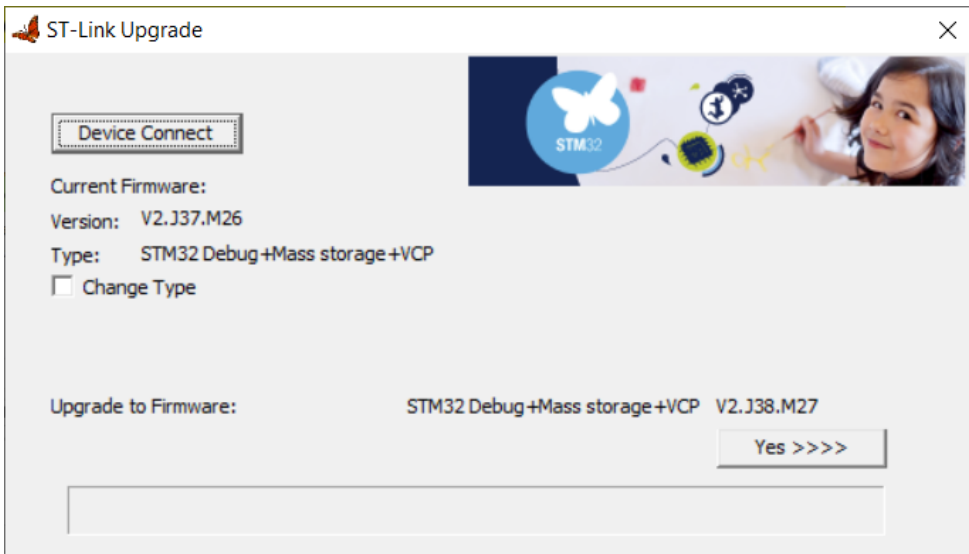
GETTING STARTED

This video shows how to get started with ARM mbed Integrated Development Environment using STM32 Nucleo platform:

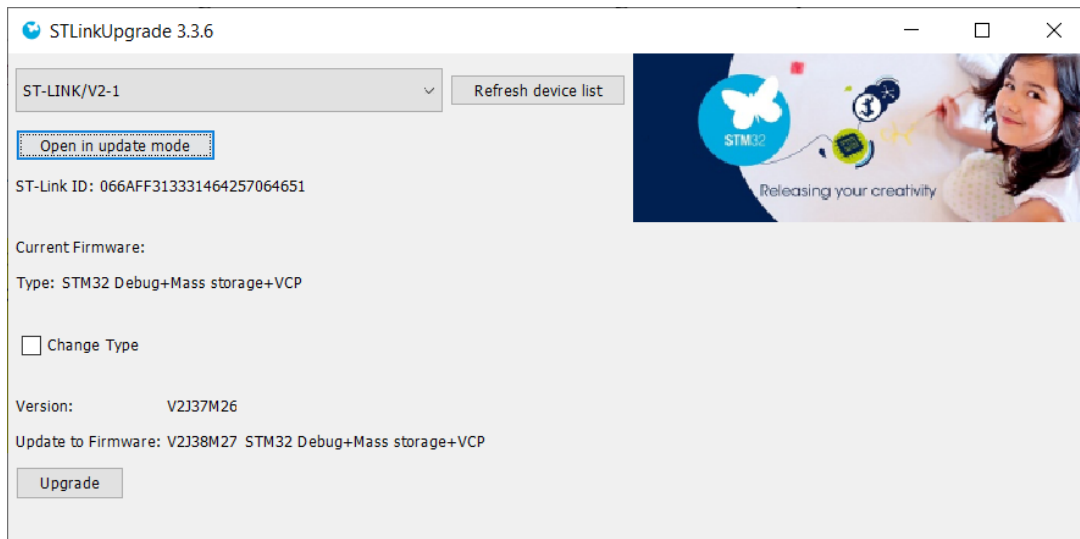
<https://youtu.be/BrMw5TNQROo>

NUCLEO ST-LINK/V2 DRIVER INSTALLATION AND FIRMWARE UPGRADE – VERY IMPORTANT!

- Install the ST-LINK/V2 driver before connecting the Nucleo board to your PC the first time. Follow this [LINK](#) for all details.
- For optimum performances, ensure that the Nucleo ST-LINK/V2 firmware is upgraded to the latest version. Follow this [LINK](#) for all details. You can also unzip the files with the upgrade on Canvas en.stsw-link... .zip
- For Windows, run the STLinkUpgrade.exe, you should see this window:

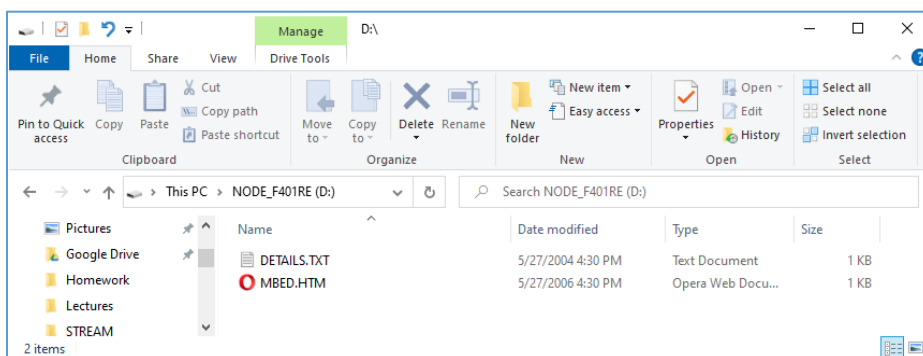


- CAUTION: the upgrade software STLinkUpgrade.exe in the link may not work on your system. The program to run then is listed as STLinkUpgrade.jar. After plugging in your board, running it will give you this window:

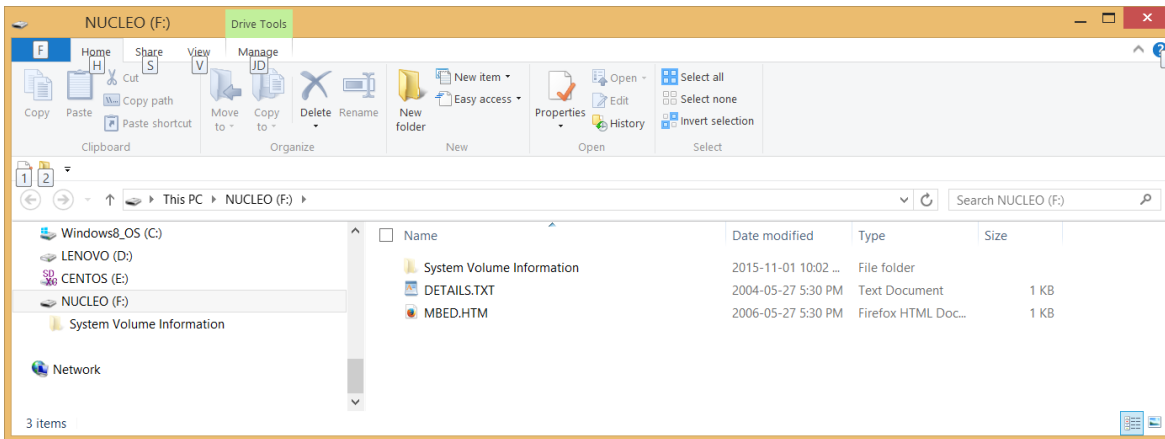


You must click on “Open in update mode” to perform the update. Note that the latest version is V2J38M27. Many boards will have V2J24M4 or similar initially, so need to be updated.

When you are successful, you will see this window when connecting to the Nucleo board:



Or you may see this:



TECHNICAL REFERENCES

For more information, please refer to:

- [STM32F401RE Microcontroller](#)
- [Nucleo board](#)
- [SDK changes log](#)

I. SETUP MBED

GETTING STARTED WITH MBED

1. CONNECT YOUR MBED-ENABLED NUCLEO 401RE TO A PC

Use the USB lead to connect your Nucleo 401RE to a PC, using the miniUSB connector. The power LED light will come on, indicating it has power. After a few seconds of activity, the PC will recognize the mbed Microcontroller as a standard USB drive.

2. CLICK THE MBED.HTM LINK TO GET LOGGED IN

Go to the new USB Drive, and click MBED.HTM to open it in a web browser.

If you do not have an mbed account, choose "Signup", and create your mbed Account. Otherwise, log in with your normal username and password.

This will give you access to the website, tools, libraries and documentation.

3. HAVE FUN!

II. SETUP MDK

REQUIREMENTS

- Software:
 - Keil MDK

- If have not already done this in Project 1, you can download a free version of Keil MDK-ARM tool (MDK-Lite) here: <https://www.keil.com/arm/demo/eval/arm.htm>. You do not need a serial number or license key for this version.

- Hardware:

- Nucleo F401RE: <http://mbed.org/platforms/ST-Nucleo-F401RE/>

HARDWARE SETUP

To enable the download and debugging features on your Nucleo F401RE board, use the following steps to upgrade the firmware:

1. Download the firmware from: <http://mbed.org/teams/ST/wiki/Nucleo-Firmware>
2. Follow the steps on the web page.

More details on debugging can be found at:

<https://mbed.org/blog/entry/Debugging-on-mbed-enabled-platforms/>

LOADING A PROJECT INTO MDK



Project files are displayed in File Explorer with the Microvision icon, shown above. To load a project into MDK, do one of the following:

- Menu: Within MDK, select menu item Project->Open Project..., navigate to the project directory, and select the .uvproj file.
- File Explorer: double click on the .uvproj file.

Note that for all lab exercises, the Keil MDK project has been created for you, so that you can simply open and modify using Keil MKD as required.


Alternatively, you can use the mbed online compiler to create and develop a project (follow this link <http://mbed.org/handbook/mbed-Compiler> for details on how to do this). The online project can also be downloaded and ported to Keil MDK running on your local machine (see http://www.keil.com/apnotes/docs/apnt_207.asp for details on how to do this).

BUILDING THE PROJECT



Build the project using one or more of the following toolbar buttons (listed from left to right):

- Translate current file (e.g. compile or assemble)
- Build the target files whose source files have changed and create output file
- Rebuild all of the target files and create output file
- You may need to install the hardware support package for your platform. This can be done by clicking the

package installer button in Keil MDK: 

DOWNLOADING THE PROGRAM IMAGE TO THE MICROCONTROLLER PROGRAM MEMORY (FLASH MEMORY)

Download the program to the MCU flash using one of these methods:



- Toolbar button:
- Menu: Flash->Download
- Accelerator keys: Alt+A+D

Note: if the download fails, please check:

- The firmware has been installed on mbed board (hardware setup)
- Install Keil MDK5 legacy support (<http://www.keil.com/download/files/mdkcm510.exe>)

USING THE DEBUGGER

Begin or end a debugger session using one of these methods:



- Toolbar button:
- Menu: Debug->Start/Stop Debug Session
- Accelerator keys: ctrl+F5



Control the target program execution with the following toolbar buttons (shown from left to right above):

- Reset MCU
- Run program execution (F5)
- Stop program execution
- Step one line in program, entering a subroutine (F11)
- Step one line in program, executing and returning from a subroutine (F10)
- Step out of current function (ctrl+F11)
- Run to cursor (ctrl+F10)

Right-clicking on a line of code will bring up a context menu with various options, including:

- Setting and clearing breakpoints
- Adding a variable to a watch window
- Navigating to definitions or uses of symbols (functions and variables)

The View menu can be used to open different windows to help in debugging, including:

- Disassembly
- Symbols
- CPU registers
- Call stack
- Variable watch windows
- Memory windows
- System viewer (MCU and peripheral control registers)

PRACTICAL QUESTIONS:

1. From Canvas, download the word document Homework5_1.docx and Homework5.zip.
2. Follow the Homework5_1 directions, **pages 8 through 10 only.**
3. Where (at what address) does the Reset handler begin?
4. How much memory is used by the code?
5. Run the mBed Nucleo Example display_time. Set the time to the current time, and combine this with you're the mBed Nucleo Example printf to print the current time to a terminal window on your PC. Capture a screen shot of the terminal window.

Grading Rubric

[10 points] Practical Homework

[3 points] Question 3

[2 points] Question 4

[5 points] Question 5. Correct code and screenshot.