How to Setup an Embedded Development Environment
in CLion for STM32x-series Microcontrollers (MCUs):

A guide for enthusiasts and professionals

Latest Revision: *Jason Bentley* on *04/30/2021*

B.S.E.E. Candidate in the UW ECE Dept., Embedded Systems

SUMMARY

This instruction manual will focus primarily on installing the necessary software and firmware. The software and firmware described in this manual is necessary if the user wishes to develop on the STM32x-series microcontrollers using the third-party IDE, CLion. This manual will guide you through the step-by-step process of installing and implementing the software, packages, and tools necessary to start firmware development in CLion (specifically for the STM32x-series of MCUs). Furthermore, this manual will also briefly guide you through the steps of setting up your first CLion project for STM32x firmware development. It is not necessary to follow the steps of this manual in chronological order to successfully setup your development environment (unless stated otherwise), however it is recommended that you do. Some steps will be left out because there are several detailed manuals readily available online for said steps. In such cases, this manual will provide link(s) to these manuals.

INTRODUCTION

The STM32x series of MCUs are a powerful platform for firmware development. ST, the company which produces the STM32x series, has a native eclipse-based IDE: STM32CubeIDE. ST's IDE allows developers a quick-and-easy onramp into STM development. However, as with any OEM IDE, the functionality of STM32CubeIDE is limited for advanced users and professionals. Many professionals will opt to develop in CLion instead. Likewise, hobbyists who have heard of CLion's functionality may also decide to begin developing in CLion. Unfortunately, getting setup in CLion is no simple task and even the professional developer may struggle without help. This manual is designed to be easy to follow for all skill levels of developers – from beginners to industry pros. The sections of this manual can be completed non-sequentially. However, this is not recommended and may result in errors. Upon completion of this manual, you will successfully have setup a CLion development environment for developing Firmware of STM32x-series MCUs.

ASSUMPTIONS

- The reader is developing on either a NUCLEO32 board, NUCLEO64 board, or an STM32 breakout with integrated STLink and USB connectivity. (For more information on STLink please visit: https://www.st.com/en/development-tools/st-link-v2.html)

- If the reader is developing on a PCBA without integrated STLink then we assume the reader has developed their own custom PCBA and is aware of how to properly connect, and use, an external STLink module.

- The reader has a basic understanding of the Windows 10/11 file system and how to use it (i.e., copy files, move files, extract files, save files, etc.

- The reader is either familiar with the C programming language or otherwise has access to learning materials such as YouTube, Khan Academy, online/in-person classes, etc.

CAUSTIONS AND WARNINGS

- This manual is intended only for windows 10/11 users.

- It is generally *recommended* to restart your Windows 10/11 system after installing new software, packages, or tools. This manual will explicitly state when a system restart is *required*.

- During parts of the following setup process, you will disable your antivirus software. It is vital that you re-enable your anti-virus software immediately when this manual instructs you to do so.

- This manual does not account for any bugs or issues which may arise from taking intermediary steps to install the required software, which are not explicitly stated in this manual.

INSTRUCTIONS

Section 1: Installing CLion

1. *Navigate to* https://account.jetbrains.com/login *.*

2. *Enter your email address under the "Create JetBrains Account" prompt, click "Sign Up" and follow the steps in your browser window to create a new JetBrains account.* Once completed you will see a page which says, "No Available Licenses". You can ignore this for now.

3. *Navigate to* https://www.jetbrains.com/clion/download/#section=windows*. Ensure that the blue dropdown menu next to "Download" has ".exe" selected. If ".exe" is selected, then click on "Download"*

4. *Save the installer file. Take note of the file name and location.*

5. *Once download is complete, navigate to the downloaded .exe file and double click on it to start the installer.* Windows may request permission to allow the file to make changes to your system, click "yes".

6. *Choose your install location, then click "Next".*

7. *Check all the boxes in the "Installation Options" and click "Next".* (See Figure 1)
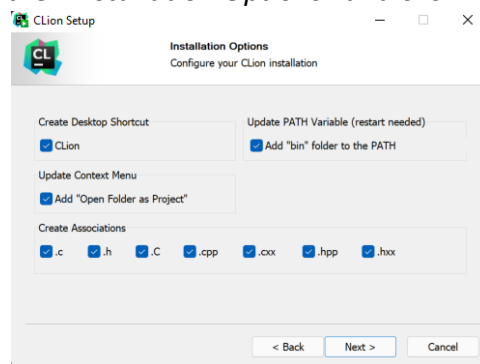

Figure 1. Proper installation options selected.

8. *In the "Choose Start Menu Folder" pop-up click on "Install"*

   Allow CLion to Install. When the install is finished, choose "I want to manually reboot later", then click "Finish". **Reboot is required before opening the CLion software. If you choose to open the software immediately after installation, then please reboot your system now.**

1.1.0   Activating Your License

- If you are a student and downloading CLion as part of an educational technology package, then please see Section 1.1.1.
- If you are a professional, or have access to JetBrains software through your organization, please see section 1.1.2.
- If you plan to buy a subscription to CLion, please see section 1.1.3.
- If you plan to use the 30-day trial subscription of CLion, please see section 1.1.4.

1.1.1   Educational User-License

1. *Log into your JetBrains account (https://account.jetbrains.com/login)*
2. *Click on "Apple for a free student or teacher license".*
3. *Click on the blue "Apply now" button.*
4. *Fill out the fields with your information and ensure that you are **using your school email address.** Agree to the "JetBrains Account Agreement" and click on the blue "APPLY FOR FREE PRODUCTS" button. You do not need to consent to JetBrains using your private information. If you are under 13, then also select "I am under 13 years old" before continuing.*
5. *You will shortly receive an email with from JetBrains with a "Confirm Request" link. Click on the "Confirm Request" link. You will be taken to another window confirming your approval and informing you that you will receive another email.*
6. *You will receive another email from JetBrains with a "Activate Educational License" link. Click on the "Activate Educational License" link.*
7. *Click accept. On the following window you will be asked to log into your JetBrains account. When you log in you will see a "JetBrains Product Pack for Students. You have successfully registered with an Educational User-License.*

8. *After restarting your computer, open the CLion software. Select "I do not have a previous version of CLion, or I do not want to import my settings" and then click "OK".*

9. *A "CLion License Activation" window will appear. Select "Activate" and "JetBrains" account. Then enter the username and password you used to register for your user-license. Click "Activate"*

10. *Agree to the CLion User Agreement and click "Continue".*

11. *Click "Don't Send" in the Data Sharing pop-up.*

12. *You have successfully downloaded and installed CLion.*

1.1.2   Enterprise User-License

To register for an Enterprise, or organizational, user license please contact your organization's technology department for further instructions.

1.1.3 Private User-License

1. *Log into your JetBrains account (https://account.jetbrains.com/login)*

2. *Click on "Purchase product license(s)".*

3. *Find "CLion" and click on "Buy".*

4. *Accept the "JetBrains Account Agreement" and then click on the blue "PROCEED AS NEW CUSTOMER" button.*

5. *Select your subscription type (monthly or annual). Enter your personal and payment information. Agree to the purchase terms and subscription license. When you are ready click on the blue "ORDER AND PAY" button.*

6. *You will receive and email confirming your order. Carefully review this email.* You may also receive a link to complete your software activation. In this case, click on the link and follow in the onscreen instructions to finish your user-license registration.

7. *To complete your user license activation please refer to 1.1.1 (Educational User-License) and follow step 8 through step 12.*

1.1.4 Trial User-License

1. *After restarting your computer, open the CLion software. Select "I do not have a previous version of CLion, or I do not want to import my settings" and then click "OK".*

2. *A "CLion License Activation" window will appear. Select "Evaluate for free" and "JetBrains" account. Then enter the username and password you used to register your JetBrains account. Click "Activate"*

3. *Agree to the CLion User Agreement and click "Continue".*

4. *Click "Don't Send" in the Data Sharing pop-up.*

5. *You have successfully downloaded and installed CLion.* ==NOTE: Your user-license will expire after 30 days, and you will no longer have access to the software. At this point you will either need to purchase a user-license.==

Section 2: Installing STM32CubeMX, STLink USB Drivers, and STLink Firmware Upgrade

2.1.0 Installing STM32CubeMX

1. *If you do not already have an account registered with ST then navigate to* https://www.st.com/cas/login *and create an account.*

2. *Navigate to:* https://www.st.com/en/development-tools/stm32cubemx.html *and click on "Get Software", then click "Get Latest" located to the right of "STM32CubeMX-Win".*

3. *Download the installer, run it, and follow on the on-screen prompts to install STM32CubeMX.*

4. *The STM32CubeMX installer may ask if you would like to open the software after installation is complete. Select the option to <u>NOT</u> open the software once download is complete.* You may open the software is you would like to explore, but it is not intended to function as a standalone application. Therefore, STM32CubeMX will not have any useful functionality in this configuration.

2.2.0 Installing STLink USB Drivers

1. *If you do not already have an account registered with ST then navigate to* https://www.st.com/cas/login *and create an account.*

2. *Navigate to* https://www.st.com/en/development-tools/stsw-link009.html *and click on "Get Software".*

3. *Next to "STSW-LINK009 click on "Get Latest" and download the installer.*

4. *Once the download is complete navigate to the downloaded file and double click on it. Once inside the folder, find the installer called "dpinst_amd64" and double click on it to run it.*

5. *Follow the onscreen prompts to complete the installation of the drivers.*

2.3.0 Installing STLink Firmware Upgrade

1. *Navigate to https://www.st.com/en/development-tools/stsw-link007.html and click on "Get Software".*

2. *Next to "STSW-LINK007" click on "Get Latest" and download the installer.*

3. *Ensure that your STM32x-series MCU is connected to your computer via USB cable.* If you are using a breakout without an integrated STLink, or your own custom PCBA design, then you must communicate with USB via an external STLink module. If you are using a NUCLEO board then STLink is integrated onto the board, and you only need a USB cable to connect the board to the computer.

4. *Once the download is complete navigate to the downloaded file and double click on it. Then double click on "Windows".*

5. *Double click on "ST-LinkUpgrade" to run the installed and finish the STLink Firmware Upgrade.*

6. *Run the installer and follow on the onscreen prompts to complete the STLink Firmware Upgrade.*

Section 3: Installing openOCD, GNU Arm Toolchain, and MinGW

**BEFORE PROCEDING IT IS RECOMMENED THAT YOU DISABLE YOUR ANTIVIRUS REAL-TIME THREAT DETECTION.**

Go to: Windows > Settings > Privacy & Security > Windows Security > Virus & threat protection > manage settings (under "Virus & threat protection settings") > Toggle "Real-time protection" off. (See Figure 2)

Figure 2. Real-time protection turned off.

3.1.0 openOCD

1. *Navigate to* https://github.com/xpack-dev-tools/openocd-xpack/releases/
2. *Find the link "xpack-openocd-0.11.0-4-win32-x64.zip", click on the link and download it.* (See Figure 3)
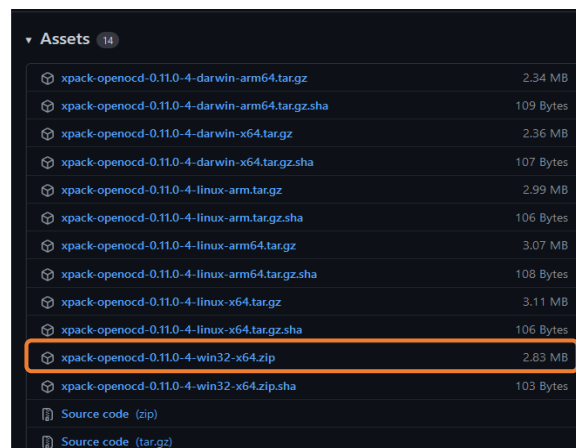
Figure 3. Orange square shows the correct file to download.

3. *Once your download is complete, extract the downloaded file to a new directory.* We recommend creating a new directory on your C drive which you will extract all your source code too. For example, you would extract "xpack-openocd-0.11.0-4-win32-x64.zip" to C://user/jow/documents/embedded-stuff.

4. *You have now successfully installed openOCD.*

3.2.0 GNU Arm Toolchain

1. *Navigate to:* https://developer.arm.com/tools-and-software/open-source-software/developer-tools/gnu-toolchain/downloads *and scroll down until you see "Windows (mingw-w64-i686) hosted cross toolchains.*

2. *Double click on "gcc-arm-11.2-2022.02-mingw-w64-1686-arm-none-eabi.zip" and download it.*

3. *Extract the downloaded file to your directory of choice.* If you have not already done so, then as stated in section 3.1.3, we recommend creating a directory which will hold all your source code.

4. *In Windows search "path" and then click on "Edit the system Environment variables. Then on the bottom right-hand corner of the pop-up click on "Environment Variables…"*

5. *Under "User variables…" click on "Edit" and then in the next pop-up window click on "New". Then add the path for the /bin folder of the file you downloaded and save in step 3 above. Then click "OK".*

6. *You have now successfully installed the GNU Arm Toolchain.*

ONCE THESE STEPS ARE COMPLETE IT IS <u>STRONGLY</u> RECOMMENED THAT YOU IMMEDIATELY <u>RE-ENABLE</u> YOUR ANTIVIRUS REAL-TIME THREAT DETECTION.

3.3.0 MinGW

1. *Navigate to: https://sourceforge.net/projects/mingw/ and at the stop of the page click on the green "Download Now" button.*

2. *Navigate to: https://www.osradar.com/how-to-install-mingw-on-windows-10/ and follow the step-by-step instructions on how to properly install MinGW.* Note: The provided instructions **will** work properly for Windows 11 users as well.

3. *You have now successfully installed MinGW.*

Section 4: Creating a New Project in CLion

1. *If you have not already restarted your computer after downloading CLion, then restart it now. Otherwise, you may proceed to the next step.*

2. *Open CLion.*

3. *Click on the "New Project" button in the center of the screen.*

4. *In the pop-up window choose a location and a name for your new project select "STM32CubeMX". Enter a name and location for your project, then click on "Create".*

5. *Once the window loads to go File > settings > Build, Execution, Deployment > Embedded Development.*

6. *To the right of "openOCD Location" click on the three dots ("…") and find "openocd.exe" in the "bin" folder of your extracted "xpack-openocd-0.11.0-4" directory. Click "OK".* (See Figure 4)
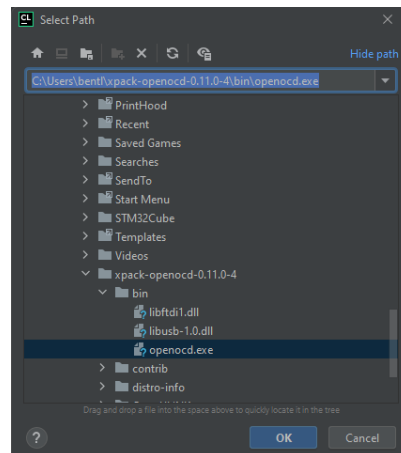
Figure 4. The location of the openocd.exe file.

7. *To the right of "Stm32CubeMX Location:" click on the three dots ("…") and find "STM32CubeMX.exe". Click "OK". If you installed STM32CubeMX in the default location, then you will most likely find this in C:\Program Files\STMicroelectronics\ STM32Cube\STM32CubeMX.*

8. *Click on "Test" next to both location entry fields. If you entered the correct path, then you will see something similar to Figure 5:*
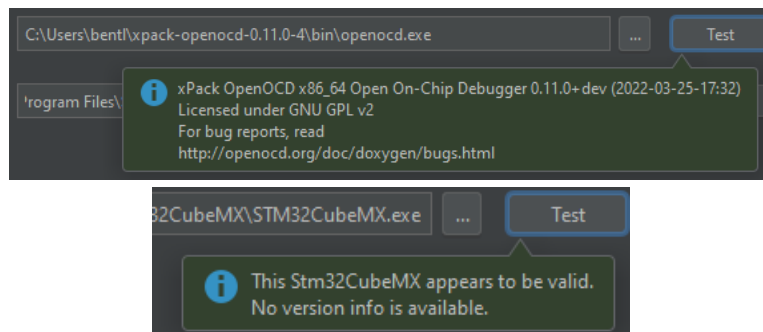
Figure 5. Successful tests of file locations.

9. While you are still in settings click on "Toolchains", under "Build, Execution, Deployment".

10. In the upper left-hand corner click on the "+", and then select "system".

11. In the next pop-up you will see three empty fields which say, "Not found, please install this package". (See Figure 6)
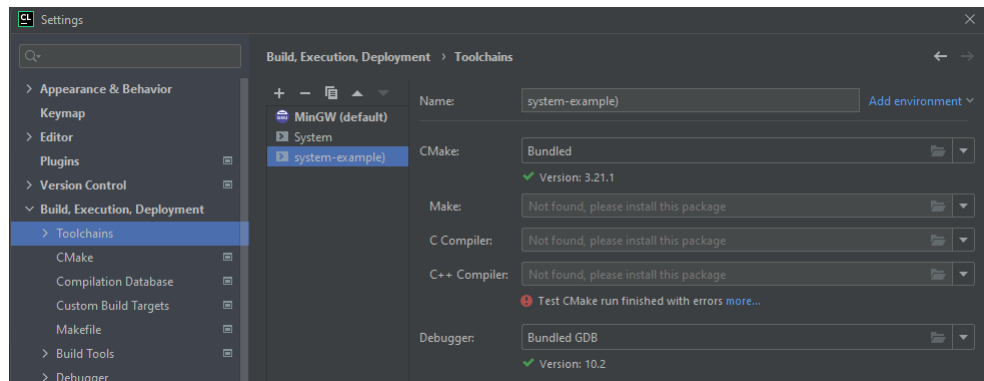

Figure 6. New "System" toolchain before adding Make, C Compiler, and C++ Compiler.

12. Click on the folder next to each field and find the necessary packages. (See Figure 7)

   a. **Make:** this will be the mingw32-make.exe file which can be found in C:\MinGW\bin\mingw32-make.exe

   b. **C Compiler:** This will be the arm-none-eabi-gcc.exe file which will be found in C:\...\gcc-arm-11.2-2022.02-mingw-w64-i686-arm-none-eabi\bin\arm-none-eabi-gcc.exe. This will be found in the file you used in step 3.2.3

c. **C++ Compiler:** This will be the arm-none-eabi-g++.exe file and will be found in the same folder as the above step.
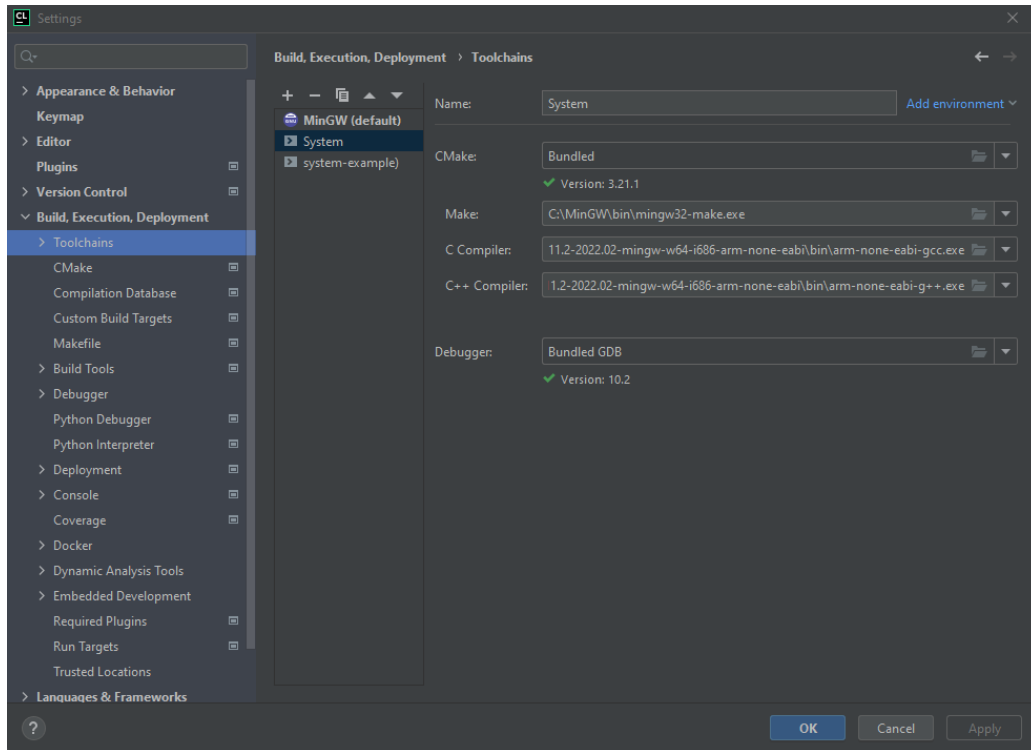

Figure 7. The "System" Toolchain after adding the proper file lcoations.

13. *Remove all other toolchains, except for the one you created in step 12, by clicking on them and then clicking the "-" button located next to the "+" button from step 10.*

14. *In the center of the screen click on "Open with STM32CubeMX" and allow CubeMX to open.*

15. *In STM32CubeMX go to Help > Updater Settings > Connection Parameters. Select "Use System Proxy Parameters" and at the bottom of the pop-up enter your ST.com account username and password. Click on Check Connection, then click "OK".*

16. *Click on "Home" in the upper left-hand corner and then click on "ACCESS TO MCU SELECTOR" if you are developing on a bare-metal MCU, or click on "ACCESS TO BOARD SELECTOR" if you are developing on a development board.*

17. *Scroll to find your MCU or board and click on it. Then in the upper right-hand corner click on "Start Project" > "Yes".* (See Figure 8)
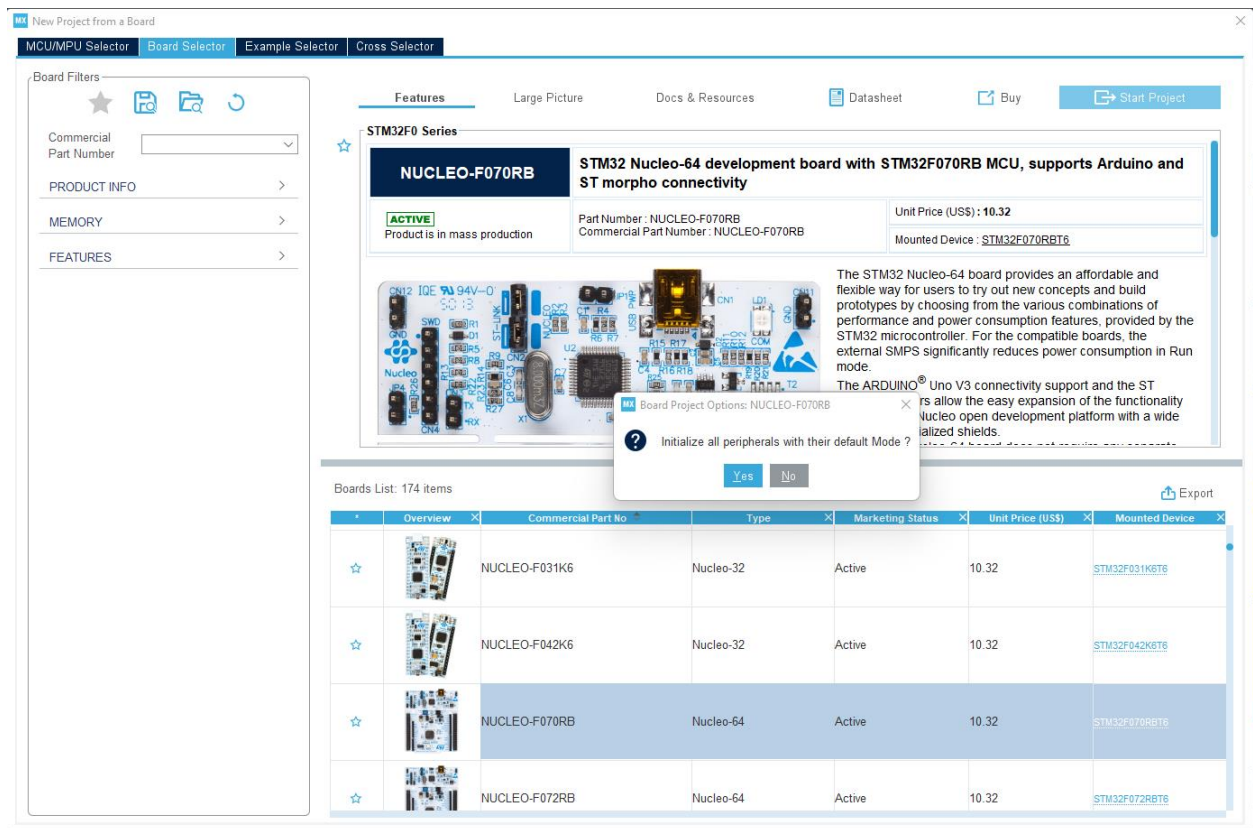
Figure 8. Selecting your hardware in STM32CubeMX and starting a new project

18. *Click on "Project Manager". Enter a suitable name for you project and a location to save the files. Then ensure "Generate Under Root" is selected. Click on "GENERATE CODE". (See Figure 9)*
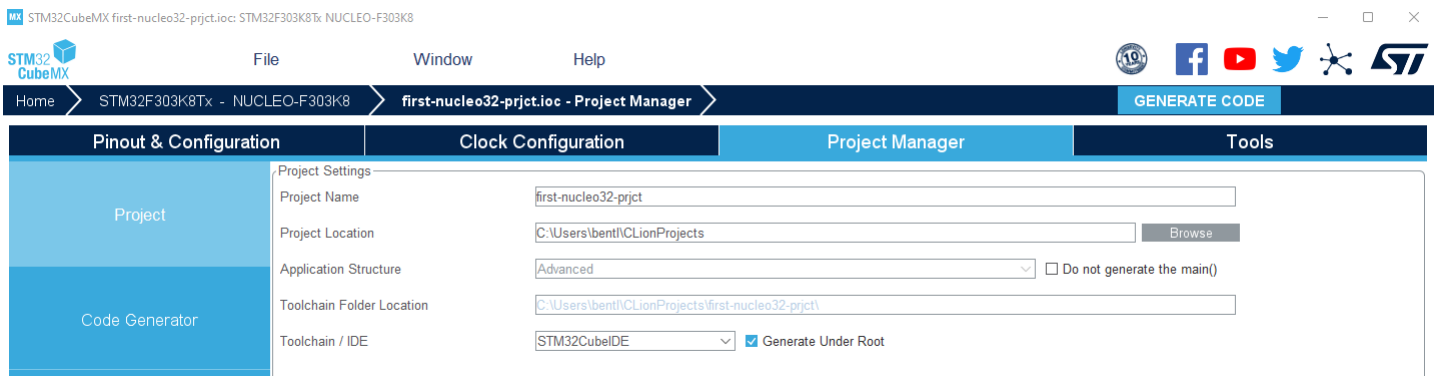

Figure 9. Configuring the "Project Manager".

19. *You will then be asked to choose a "Board Config File" from a list of files. Scroll until you find the model-name and number of you particular hardware, select it, and then click "OK".*

20. *You have now successfully setup your CLion development environment for STM firmware development. To upload your firmware to your hardware first ensure it is properly connected to your computer and then click on the "Run" play-button in the upper right-hand corner of CLion.* (See Figure 10)
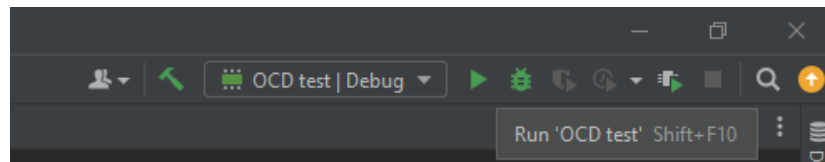

Figure 10. Downloading your firmware onto your hardware.

Conclusion

You have now succesfully installed all of the necessary software and packages, and have created your first CLion firmware development project. Understanding how to setup CLion for firmware development will allow you to easily setup other IDEs for specific development requriements. While the particular software and packages referenced in this manual are necessary for firmware development on the STM32x series of MCUs, the same steps can be used to step up other IDEs for other hardware. By understanding the process described in the manual you will be able to not only create amazing new devices using the powerful CLion IDE, but you will also have a foundational understanding of what it means to setup a development environement.

Appendix A

This manual is intended to guide you through the steps of setting up the CLion IDE for STM32x firmware development. STM32x's firmware is generally written in the C programming language. C is low-level programming language which allows you very fine control of your hardware. If you are new to the C programming language, then below are a few great jumping-off points to get you started on your C journey.

C Programming Tutorial for Beginners [3]:

https://www.youtube.com/watch?v=KJgsSFOSQv0

Getting Started with STM32 and Nucleo [2]:

https://www.youtube.com/playlist?list=PLEBQazB0HUyRYuzfi4clXsKUSgorErmBv

Learn C Programming [4]:

https://www.programiz.com/c-programming

C Tutorial [6]:

https://www.w3schools.com/c/index.php

The C Programming Language [1]:

https://docs.google.com/viewer?a=v&pid=sites&srcid=ZGVmYXVsdGRvbWFpbnxnanVoYWN8Z3g6NTFiY2ExMDdkYTI5YmRmZA

References

[1] B. W. Kernighan and D. M. Ritchie, *The C programming language*. Englewood Cliffs, N.J.: Prentice Hall, 2016.

[2] Digi-Key, "Getting Started with STM32 and Nucleo - YouTube," *www.youtube.com*, Sep. 30, 2020. https://www.youtube.com/playlist?list=PLEBQazB0HUyRYuzfi4clXsKUSgorErmBv (accessed Apr. 30, 2022).

[3] freeCodeCamp.org, "C Programming Tutorial for Beginners," *YouTube*. Aug. 15, 2018. Accessed: Apr. 30, 2022. [YouTube Video]. Available: https://www.youtube.com/watch?v=KJgsSFOSQv0

[4] Programiz, "Learn C (Introduction and Tutorials to C Programming)," *Programiz.com*, 2019. https://www.programiz.com/c-programming (accessed Apr. 30, 2022).

[5] Roger, "How to Install MinGW on Windows 10," *OSradar*, Oct. 29, 2020. https://www.osradar.com/how-to-install-mingw-on-windows-10/ (accessed Apr. 30, 2022).

[6] W3 Schools, "C Tutorial," *www.w3schools.com*. https://www.w3schools.com/c/index.php (accessed Apr. 30, 2022).