

NEEEICUM

núcleo de estudantes de engenharia
eletrônica industrial e computadores
da universidade do minho

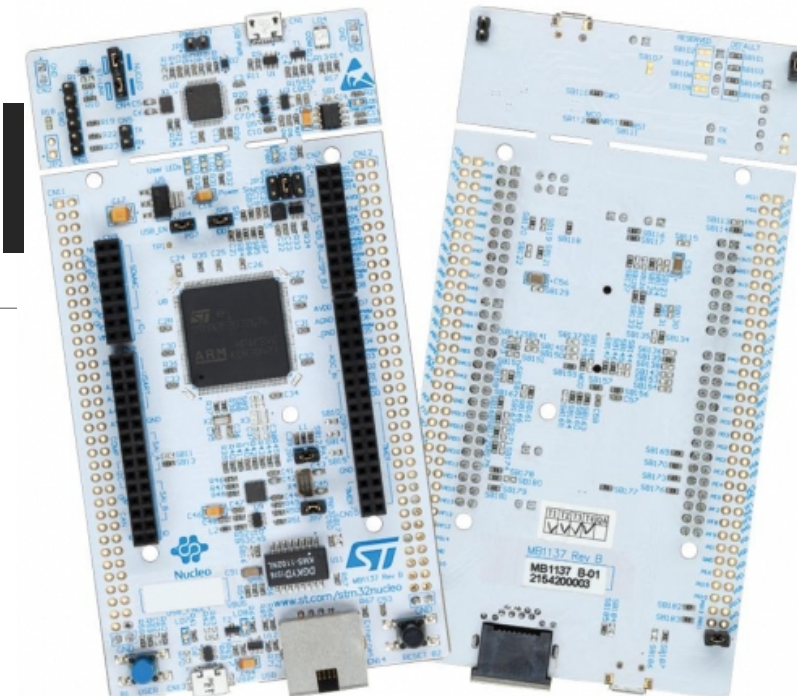
ESRG

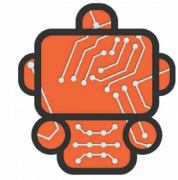
EMBEDDED SYSTEMS
RESEARCH
GROUP

STM 32 F767ZI

TOOLS SET UP AND BASIC CONCEPTS

ÁLVARO LEITE
NOV 2019





Requirements

Computer with Windows OS

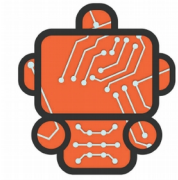
Internet connection

15 Gb of free space on disk

Micro-USB cable

STM32 development board

Java Runtime Environment (JRE)



Agenda

Skill level: Beginner

Why STM32?

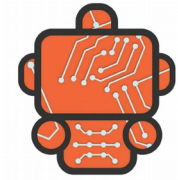
Choosing the IDE

What tools are needed?

ST-LINK/V2

Keil MDK-ARM

STM32CubeMX



Agenda

Skill level: Beginner

Create the first Project

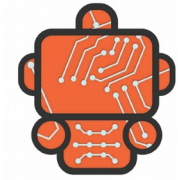
Compile the program and Flash the board

Terminal

File Tree

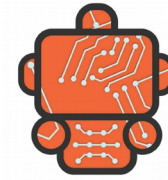
Resources

Conclusion



Why STM32?

- 32 bits professional development board
- Cheap to buy and develop with
- Same toolchain and API through all ranges of products
- Cross compatibility
- Lots of documentation
- And much much more...



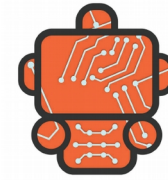
Choosing the IDE

During the course we will use the Keil ARM IDE as our main IDE. However there are other alternatives that you may consider using in the future.

The decision to use the Keil ARM IDE was made based in your past experiences, and in the well known performance achieved by those IDE.

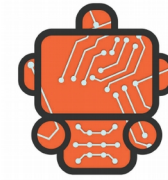
A recent alternative for non Windows OS, is the STM32CubeIDE, if you want use that IDE, you must assume all responsibility about that. You can find a installation guide at this link: <https://bit.ly/330GSHS>

If you want to install the Keil continue, if you want to install STM32CubeIDE, go to slide 27.



What tools are needed?

- ST-LINK/V2: It's a ST tool that provides capabilities to load code to the board and on-chip debug functionalities.
- STM32CubeMX: It has a graphical software configuration tool that allows the generation of C initialization code using graphical wizards. And it makes developers' lives easier by reducing development effort, time and cost.
- Keil ARM: It's an IDE that combines project management, run-time environment, build facilities, source code editing and program debugging in a single powerful environment.



ST-LINK/V2

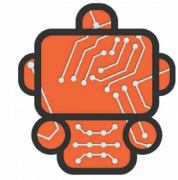
The ST-LINK/V2 is an in-circuit debugger and programmer for the STM8 and STM32 microcontroller families. The single wire interface module (SWIM) and JTAG/serial wire debugging (SWD) interfaces are used to communicate with any STM8 or STM32 microcontroller located on an application board.

<https://bit.ly/2MCx4zI>

ST-LINK/V2

Get Software

Part Number	Supplier	Download
+ STSW-LINK009	ST	Get Software

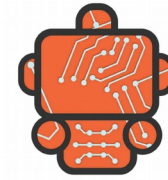


ST-LINK/V2

Install it after download

If your computer has a 32 bits system use “dpint_x86.exe”

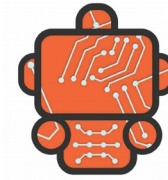
If your computer has a 64 bits system use “dpint_amd64.exe”



Keil MDK-ARM

The MDK-ARM is a complete software development environment for Cortex™-M, Cortex-R4, ARM7™ and ARM9™ processor-based devices. MDK-ARM is specifically designed for microcontroller applications, it is easy to learn and use, yet powerful enough to deal with demanding embedded applications.

<https://www.keil.com/download/product/>



Keil MDK-ARM



Download Products

Select a product from the list below to download the latest version.



MDK-Arm

Version 5.24a (July 2017)

Development environment for Cortex and Arm devices.



C51

Version 9.57 (November 2017)

Development tools for all 8051 devices.



C251

Version 5.59 (October 2016)

Development tools for all 80251 devices.

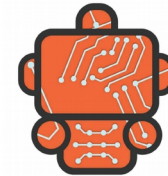


C166

Version 7.56 (October 2016)

Development tools for C166, XC166, & XC2000 MCUs.

Keil products use a [License Management](#) system - without a current license the product runs as a Lite/Evaluation edition with a few [Limitations](#).

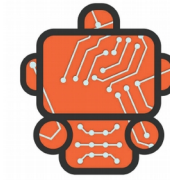


Keil MDK-ARM

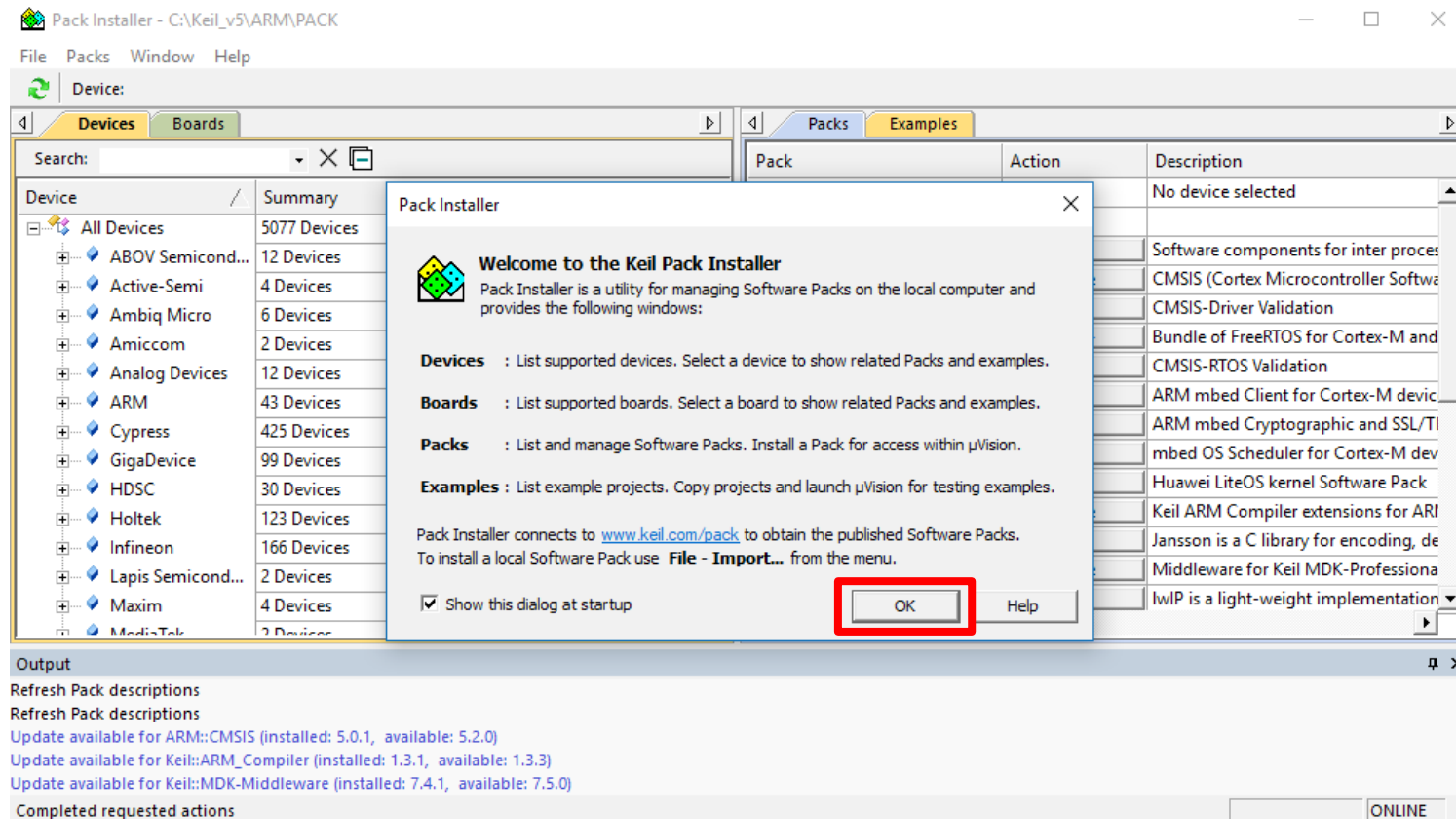
After download install it

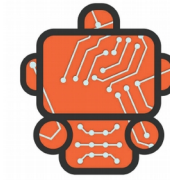
And open Keil for the first time





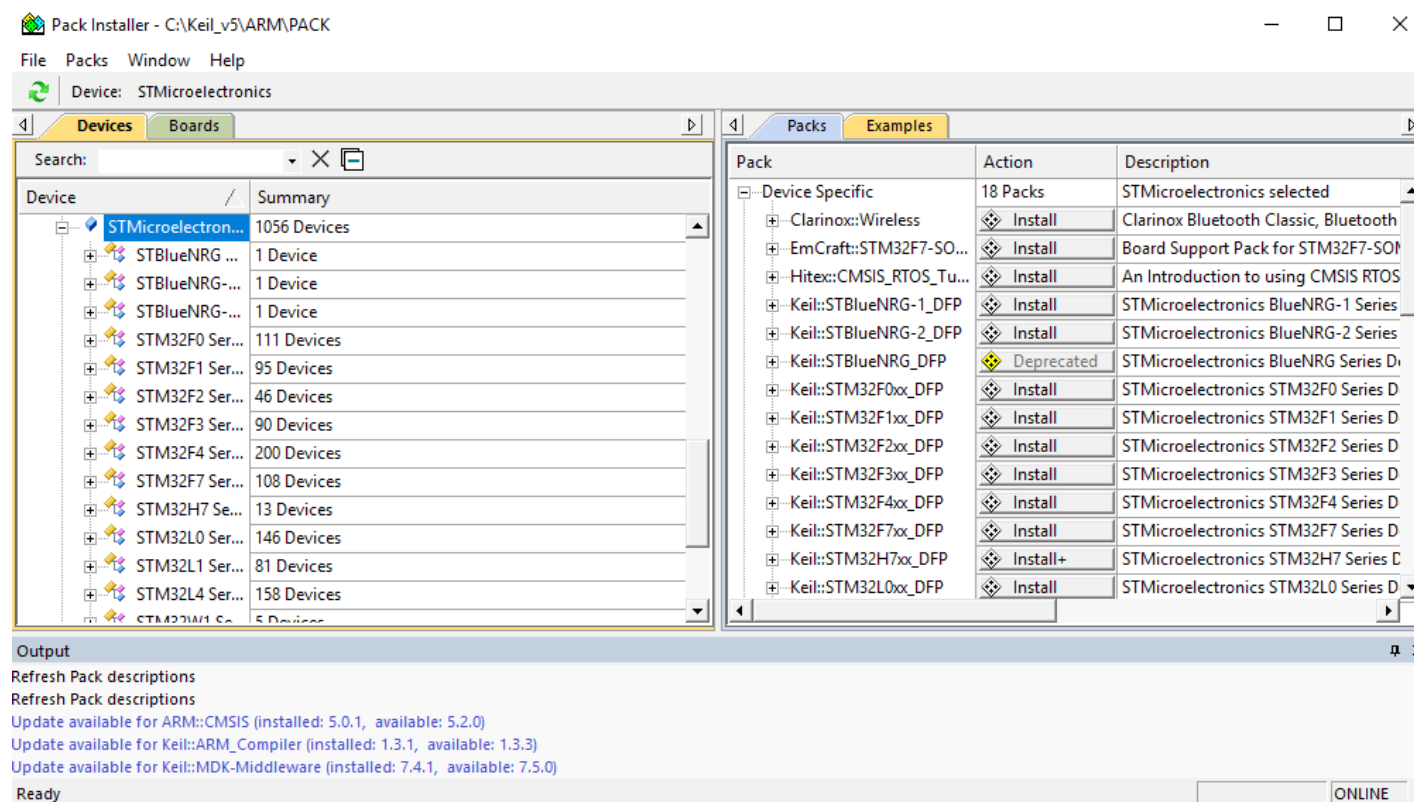
Keil MDK-ARM





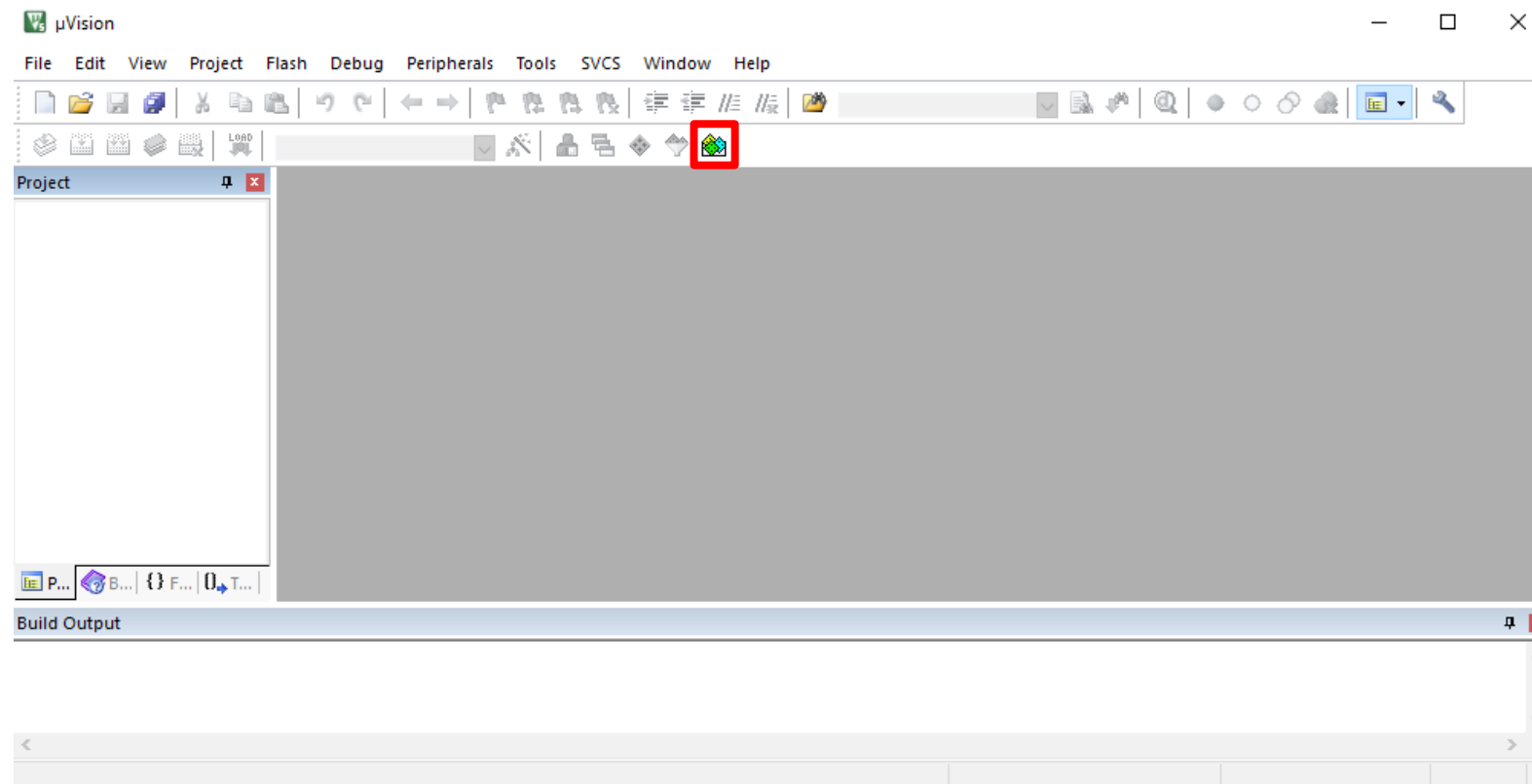
Keil MDK-ARM

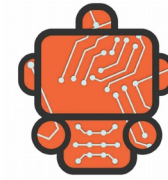
If you don't see this menu...



Keil MDK-ARM

Click here...





Keil MDK-ARM

In “Device” tab select: STMicroelectronics -> STM32F7 Series -> STM32F767 -> STM32F767ZI

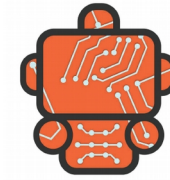
If you still don't see this menu wait until the update finishes

The screenshot shows the Keil MDK-ARM interface. On the left, the 'Device' tab is active, displaying a tree view of STM32F7 Series devices. The 'STM32F767ZI' device is selected, showing its specifications: ARM Cortex-M7, 216 MHz, 512 kB RAM, 4 MB ROM. On the right, the 'Packs' window is open, showing a list of 22 packs. The 'ARM::CMSIS' pack is highlighted, and its details are shown in the right pane. The 'Output' window at the bottom shows the status 'Ready' and 'ONLINE'.

Device	Count
STM32F4 Series	200 Devices
STM32F7 Series	108 Devices
STM32F722	10 Devices
STM32F723	9 Devices
STM32F732	5 Devices
STM32F733	6 Devices
STM32F745	10 Devices
STM32F746	16 Devices
STM32F756	8 Devices
STM32F765	12 Devices
STM32F767	12 Devices
STM32F767BG	1 Device
STM32F767BI	1 Device
STM32F767IG	2 Devices
STM32F767II	2 Devices
STM32F767NG	1 Device
STM32F767NI	1 Device
STM32F767VG	1 Device
STM32F767VI	1 Device
STM32F767ZG	1 Device
STM32F767ZI	1 Device
STM32F768	1 Device
STM32F769	8 Devices

Pack	Action	Description
ARM::AMP	Install	Software components for inter processor communication (Asymmetric Multi Processing ARM)
ARM::CMSIS	Update	CMSIS (Cortex Microcontroller Software Interface Standard)
ARM::CMSIS-Driver_Val...	Install	CMSIS-Driver Validation
ARM::CMSIS-FreeRTOS	Install+	Bundle of FreeRTOS for Cortex-M and Cortex-A
ARM::CMSIS-RTOS_Val...	Install	CMSIS-RTOS Validation
ARM::mbedClient	Install	ARM mbed Client for Cortex-M devices
ARM::mbedTLS	Install	ARM mbed Cryptographic and SSL/TLS library for Cortex-M devices
ARM::minar	Install	mbed OS Scheduler for Cortex-M devices
Huawei::LiteOS	Install	Huawei LiteOS kernel Software Pack
Keil::ARM_Compiler	Update	Keil ARM Compiler extensions for ARM Compiler 5 and ARM Compiler 6
Keil::Jansson	Install	Jansson is a C library for encoding, decoding and manipulating JSON data
Keil::MDK-Middleware	Update	Middleware for Keil MDK-Professional and MDK-Plus
lwIP::lwIP	Install	lwIP is a light-weight implementation of the TCP/IP protocol suite
Micrium::RTOS	Install	Micrium software components
Oryx-Embedded::Midd...	Install	Middleware Package (CycloneTCP, CycloneSSL and CycloneCrypto)
RealTimeLogic::SharkS...	Install	Version 1.0.0 (latest on website): all and super fast pre-compiled SharkSSL TLS library for Cortex-M
RealTimeLogic::SMQ	Install	Simple Message Queues (SMQ) is an easy to use IoT publish subscribe connectivity protocol
redlogix::redBlocks-Si...	Install	C Target Library for the redBlocks WYSIWYG SiL Simulator (supports flexible hardware simu
rt-thread::rtthread	Install	rt-thread software components
wolfSSL::wolfSSL	Install	Light weight SSL/TLS and Crypt Library for Embedded Systems
YOGITECH::fRSTL_AR...	Deprecated	!!! DEPRECATED Product !!! YOGITECH fRSTL Functional Safety EVAL Software Pack for ARM
YOGITECH::fRSTL_ST...	Deprecated	!!! DEPRECATED Product !!! YOGITECH fRSTL Functional Safety EVAL Software Pack for STM3

Output
Refresh Pack descriptions
Refresh Pack descriptions
Ready
ONLINE



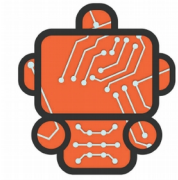
Keil MDK-ARM

And install the following 5 packs

The screenshot shows the Keil MDK-ARM interface with the 'Packs' window open. The 'Packs' window displays a list of available software packs, with five specific packs highlighted by red rectangles:

- Keil::STM32F7xx_DFP** (Up to date): STM32F7677I1Tx selected. Description: STMicroelectronics STM32F7 Series Device Support, Drivers and Examples.
- ARM::CMSIS** (Up to date): CMSIS (Cortex Microcontroller Software Interface Standard).
- ARM::CMSIS-Driver_Val...** (Up to date): CMSIS-Driver Validation.
- Keil::ARM_Compiler** (Up to date): Keil ARM Compiler extensions for ARM Compiler 5 and ARM Compiler 6.
- Keil::MDK-Middleware** (Up to date): Middleware for Keil MDK-Professional and MDK-Plus.

The 'Devices' window on the left shows a list of STM32F7 series devices, with STM32F7677I1Tx selected.



STM32CubeMX

STM32Cube includes STM32CubeMX, a graphical software configuration tool that allows the generation of C initialization code, for STM32 microcontrollers very easily, using graphical wizards.

<http://www.st.com/en/development-tools/stm32cubemx.html>



STM32CubeMX

Get Software

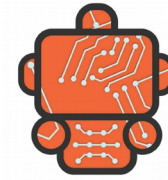
Part Number ▲	General Description	Software Version ◆	Download	Previous versions ◆
+ STM32CubeMX	STM32Cube initialization code generator	5.3.0	Get Software	Select version ▼

STM32CubeMX

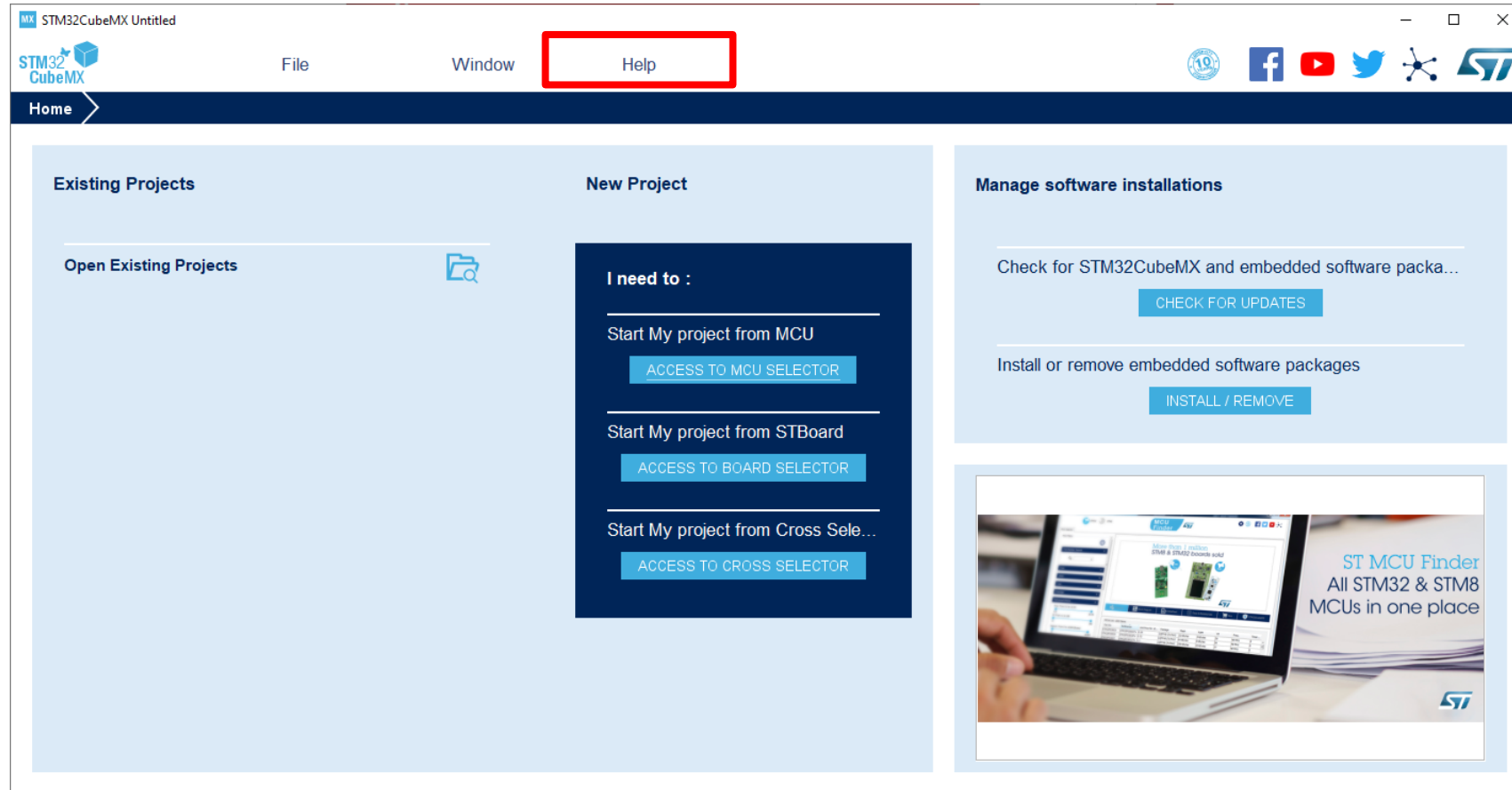
Install Cube after download

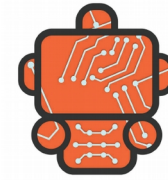
It requires Java Runtime Environment

Open STM32CubeMX when installation is finished

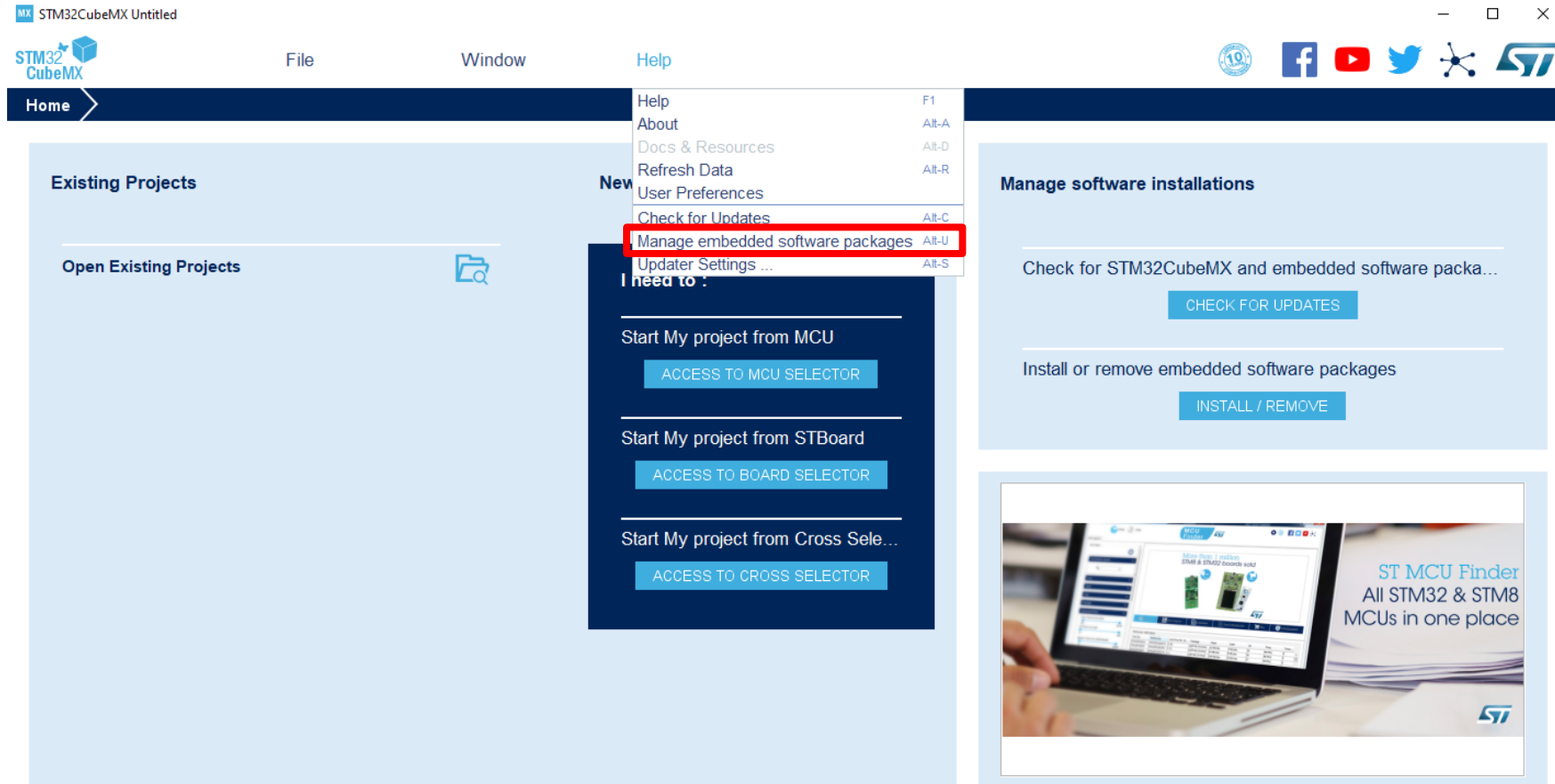


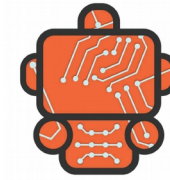
STM32CubeMX





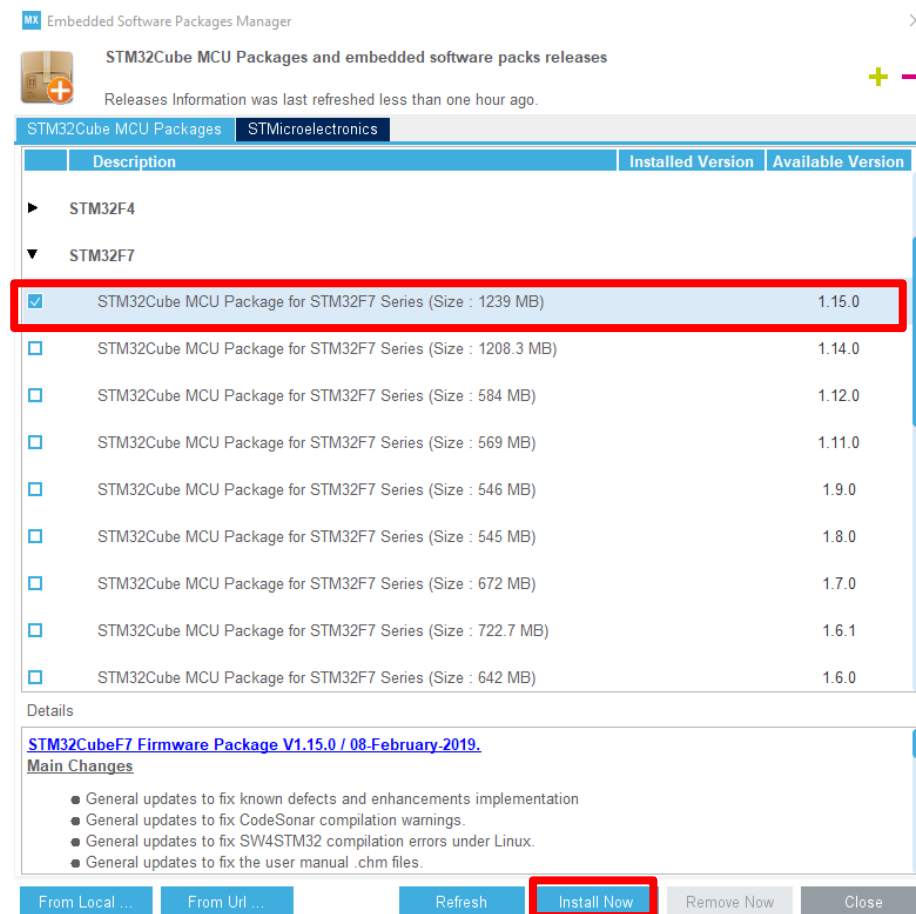
STM32CubeMX





STM32CubeMX

Select these:



Click “Install”

STM32CubeMX

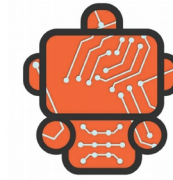
And... that's it. Installation complete.

If you want to gain some space on disk, deleting some installation's wastes, continue, otherwise jump to page 27.

Cleaning

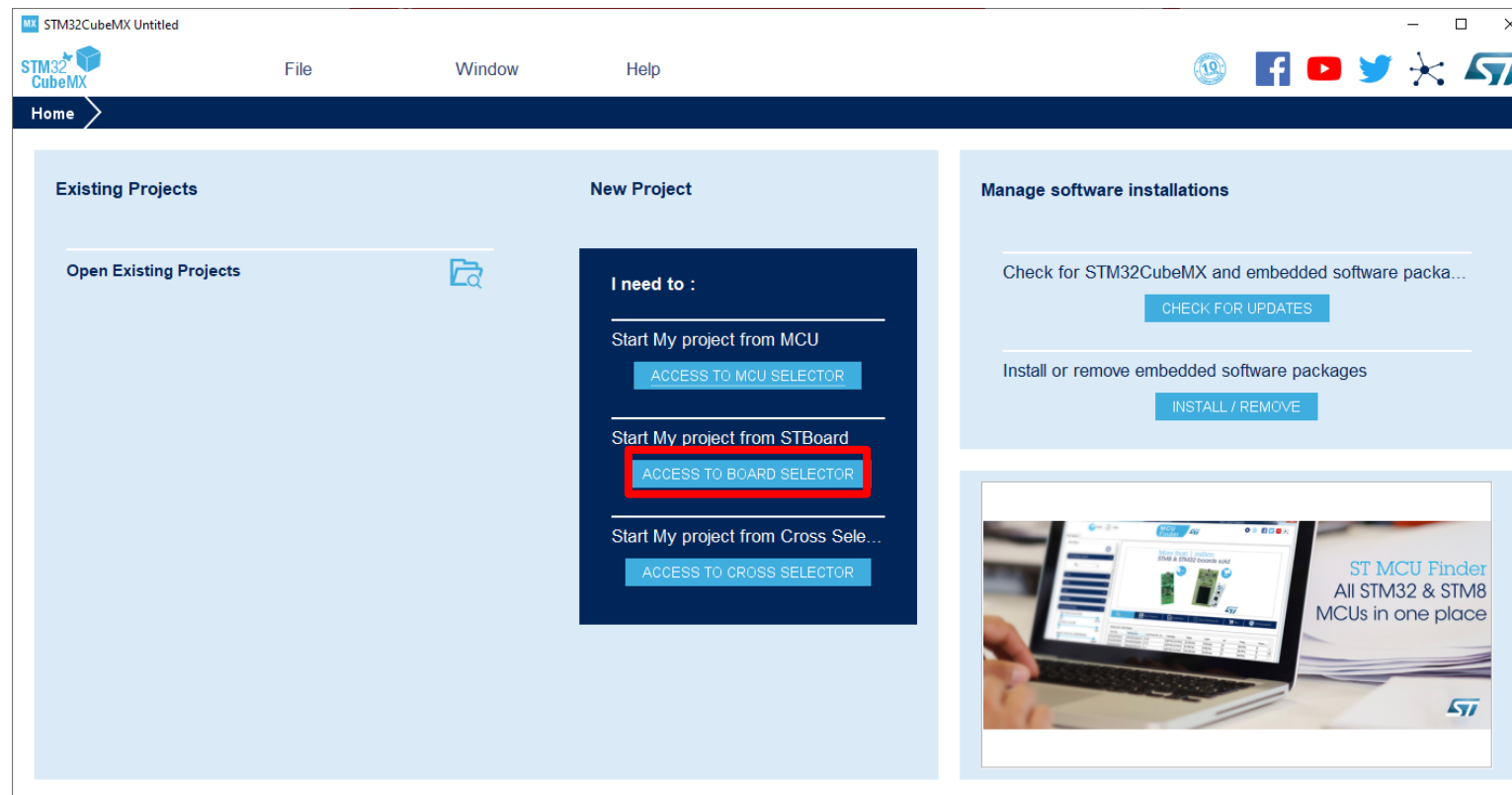
In “C:\Keil_v5\ARM\PACK\.Download” delete all files

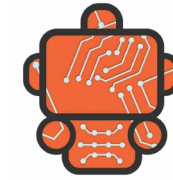
In “C:\Users\[username]\STM32Cube\Repository” delete all the **.zip** files



Create the first Project

Open STM32CubeMX. Select “Access to Board Selector”.





Create the first Project

Search for “767”, and double click in “Nucleo-F767ZI”.

MX New Project from a Board

MCU/MPU Selector | Board Selector | Cross Selector

Board Filters

Part Number Search

Vendor

Type

MCU/MPU Series

Other

Price = 23.0

Oscillator Freq. = 0 (MHz)

Peripheral

- Accelerometer
- Analog I/O
- Arduino Form Factor
- Audio Line In
- Audio Line Out
- Battery
- Button
- CAN
- Camera
- Compass
- Custom Form Factor
- Digital I/O
- Ethernet
- Gyroscope
- IoT
- Joystick
- LCD Display (Graphics)

New multicore STM32MP1 Series for Industrial and IoT applications

STM32MP1

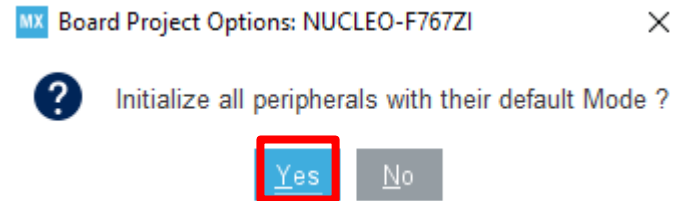
OpenSTLinux Distribution

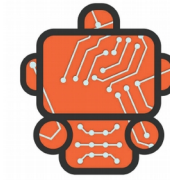
Boards List: 1 item

	Overview	Part No.	Type	Marketing Status	Unit Price (US\$)	Mounted Device
☆		NUCLEO-F767ZI	Nucleo144	Active	23.0	STM32F767ZITx

Create the first Project

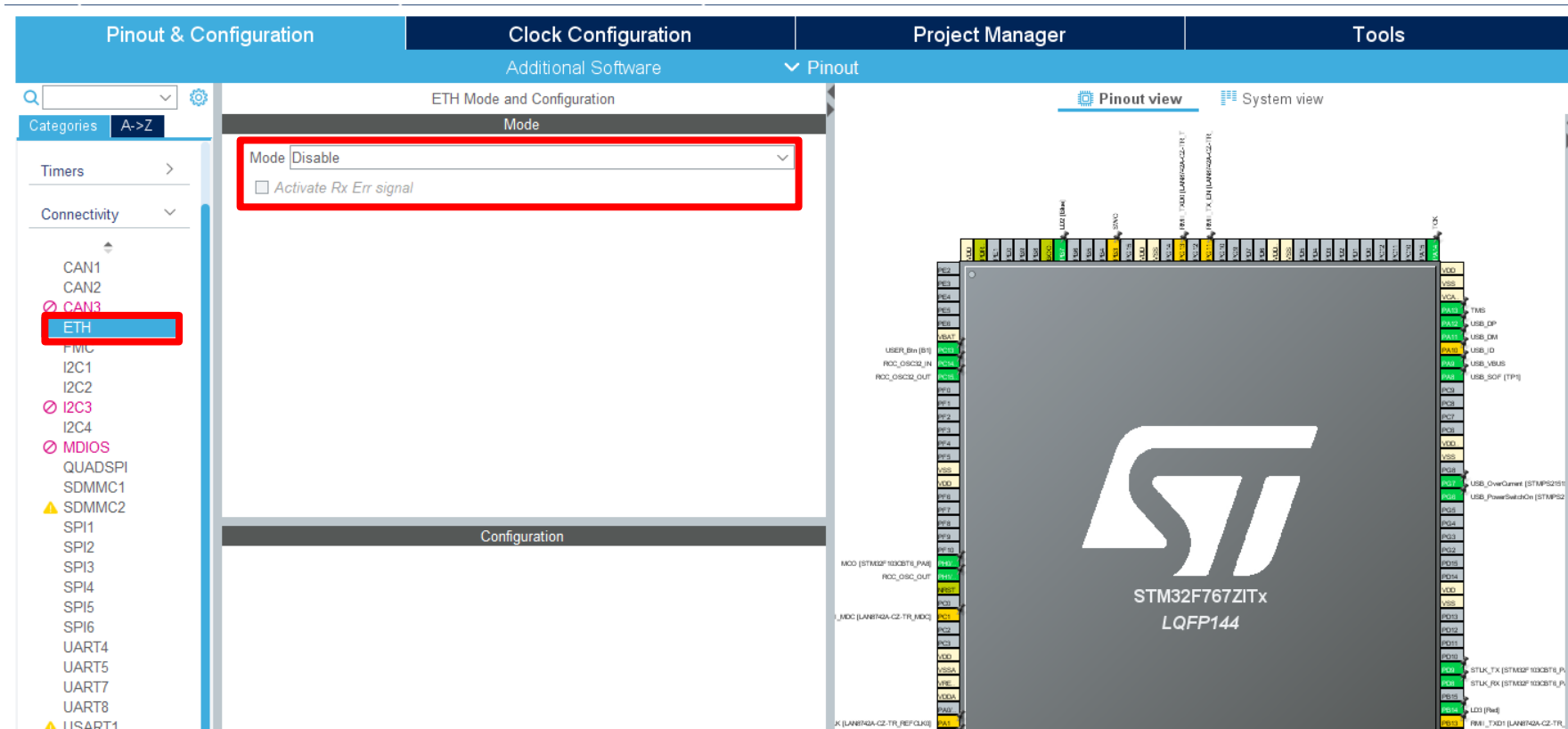
Initialize all peripherals in default mode.

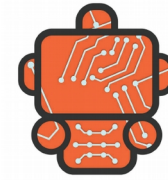




Create the first Project

Disable the Ethernet peripheral.

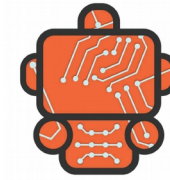




Create the first Project

Disable the USB peripheral.

The image shows the STM32CubeMX software interface. On the left, the 'Connectivity' tree lists various peripherals. 'USB_OTG_FS' is highlighted with a red box. The main panel, titled 'USB_OTG_FS Mode and Configuration', shows the 'Mode' dropdown set to 'Disable', also highlighted with a red box. Below it, the 'Configuration' section is visible. On the right, the 'Pinout view' shows the physical pin connections for the STM32F767ZITx LQFP144 package, with labels for various pins and their functions.



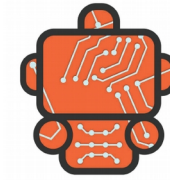
Create the first Project

Go to “Project Manager”, give a name to the project, choose the location of the project, set the structure to advanced, and set the Toolchain to “MDK-ARM V5”.

The screenshot shows the STM32CubeIDE interface with the 'Project Manager' tab selected. The breadcrumb navigation at the top reads: Home > STM32F767ZITx - NUCLEO-F767ZI > Untitled - Project Manager. A 'GENERATE CODE' button is visible in the top right. The left sidebar has 'Project' and 'Code Generator' sections. The main area displays the 'Project Settings' dialog with the following fields highlighted by red rectangles:

- Project Name:** Blinking_LED
- Project Location:** C:\Users\Alvaro\Documents\STM32\Blinking_Led (with a 'Browse' button)
- Application Structure:** Advanced (dropdown menu)
- Toolchain Folder Location:** C:\Users\Alvaro\Documents\STM32\Blinking_Led\Blinking_LED\
- Toolchain / IDE:** MDK-ARM V5 (dropdown menu)

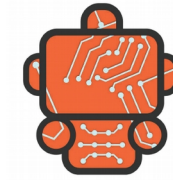
There are also two checkboxes: 'Do not generate the main()' and 'Generate Under Root', both of which are currently unchecked.



Create the first Project

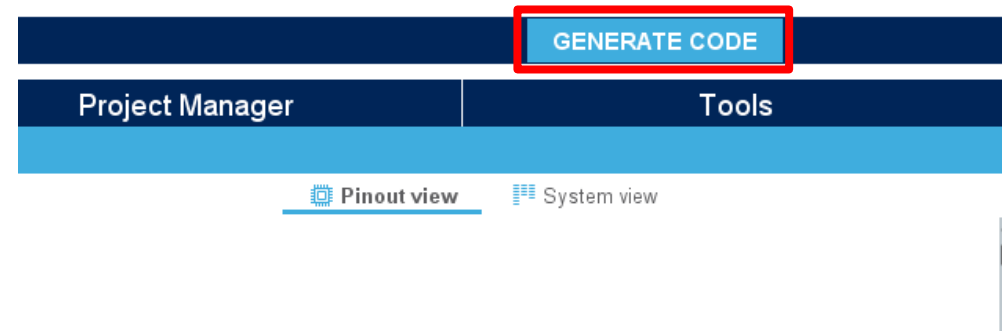
Under “Code Generator” select “Copy only the necessary library files”, and “Generate peripheral initialization as a pair of ‘.c/.h’ files per peripheral”.

Pinout & Configuration	Clock Configuration	Project Manager	Tools
Project	<p>STM32Cube MCU packages and embedded software packs</p> <ul style="list-style-type: none"><input type="radio"/> Copy all used libraries into the project folder<input checked="" type="radio"/> Copy only the necessary library files<input type="radio"/> Add necessary library files as reference in the toolchain project configuration file		
Code Generator	<p>Generated files</p> <ul style="list-style-type: none"><input checked="" type="checkbox"/> Generate peripheral initialization as a pair of '.c/.h' files per peripheral<input type="checkbox"/> Backup previously generated files when re-generating<input checked="" type="checkbox"/> Keep User Code when re-generating<input checked="" type="checkbox"/> Delete previously generated files when not re-generated		
	<p>HAL Settings</p> <ul style="list-style-type: none"><input type="checkbox"/> Set all free pins as analog (to optimize the power consumption)<input type="checkbox"/> Enable Full Assert		

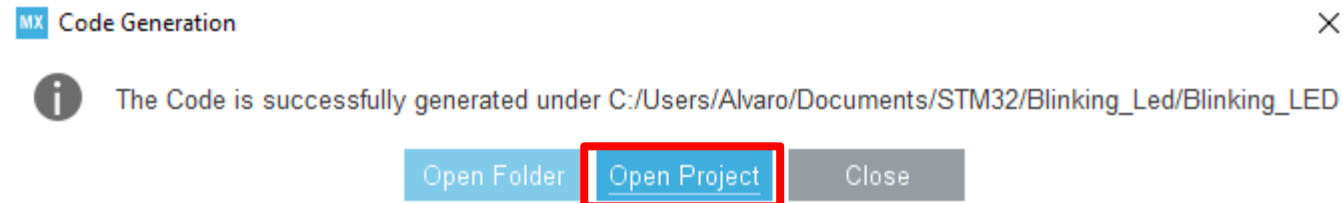


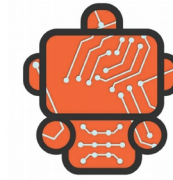
Create the first Project

Generate the code.



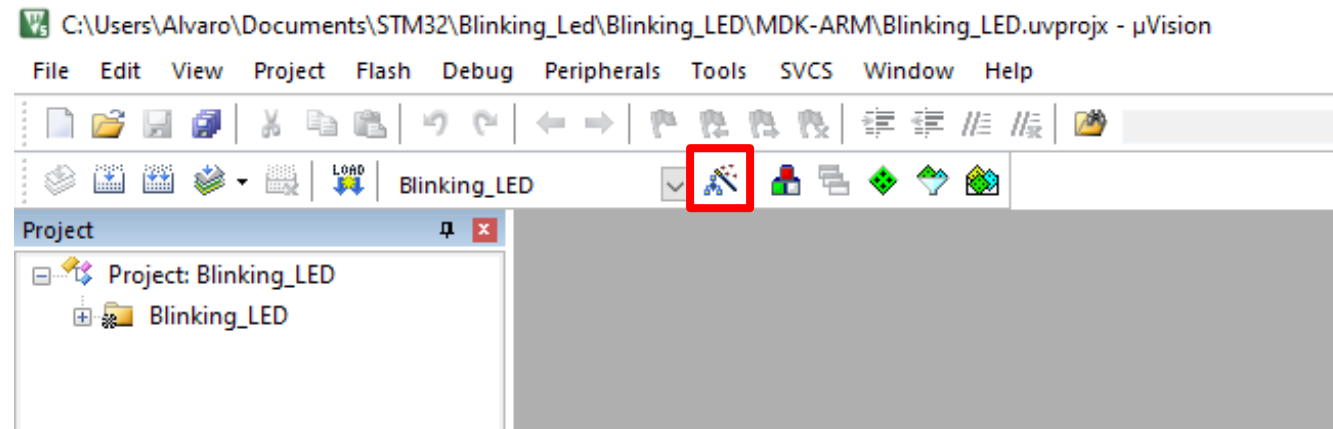
And Open the Project

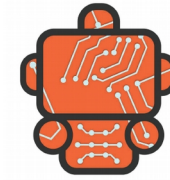




Create the first Project

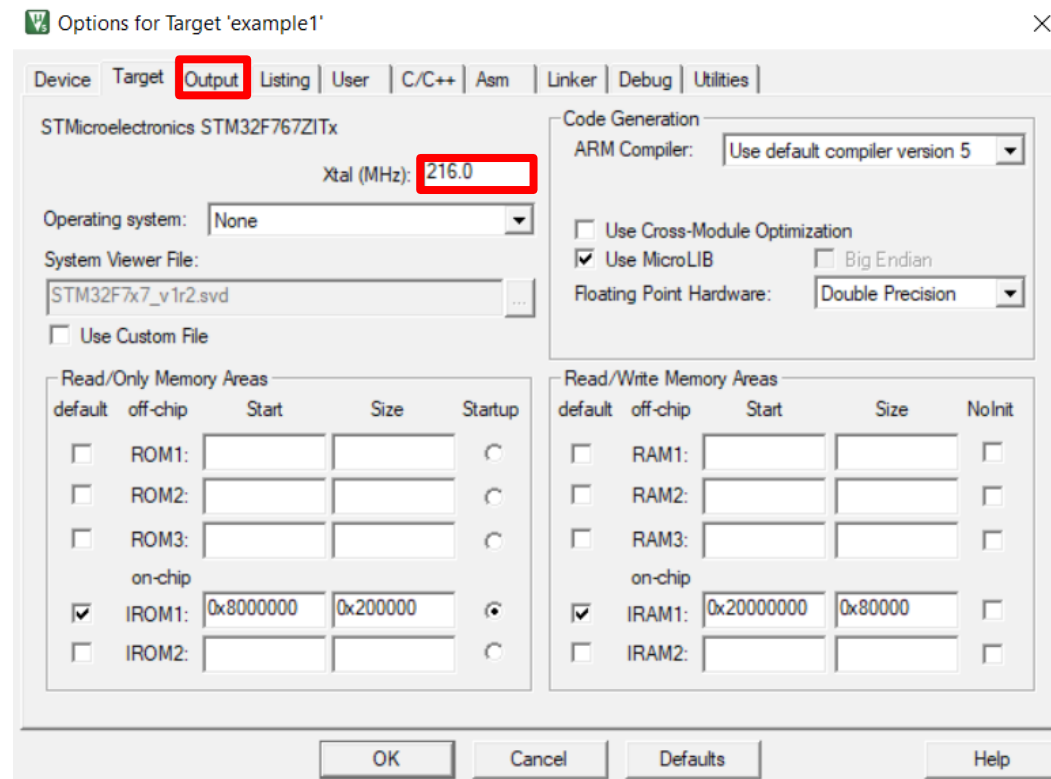
Open the settings menu.

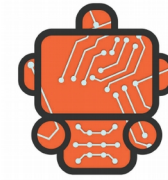




Create the first Project

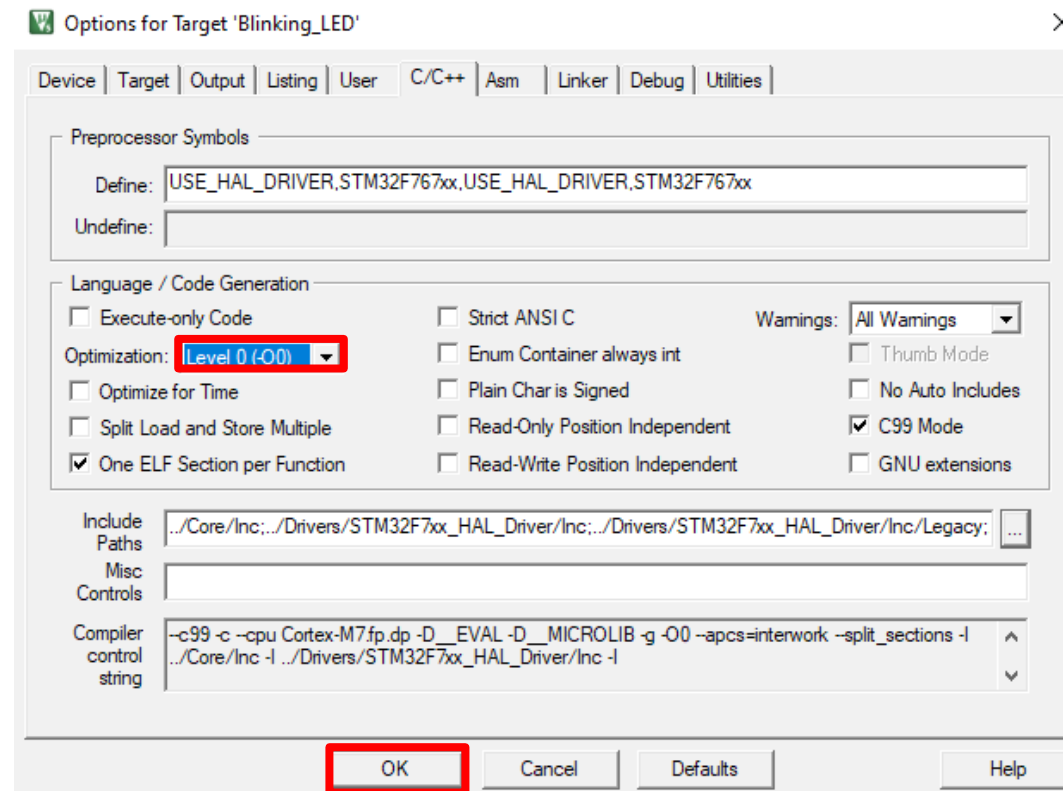
Under Outup tab, set Xtal to 216.

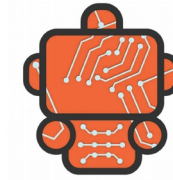




Create the first Project

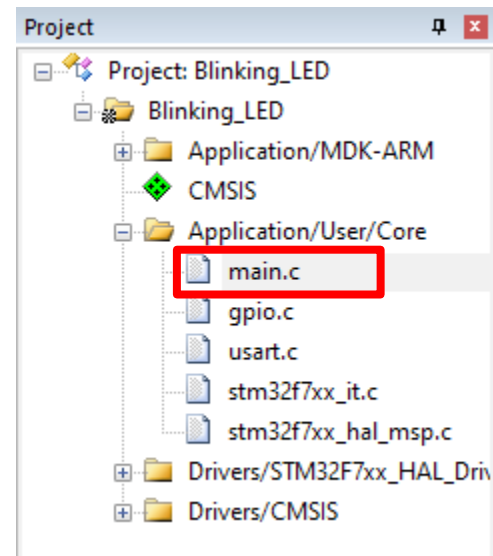
Under C/C++ tab, set the optimization level to 0.

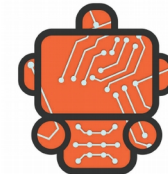




Create the first Project

Open the main.c file

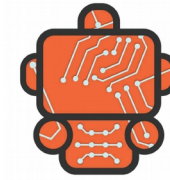




Create the first Project

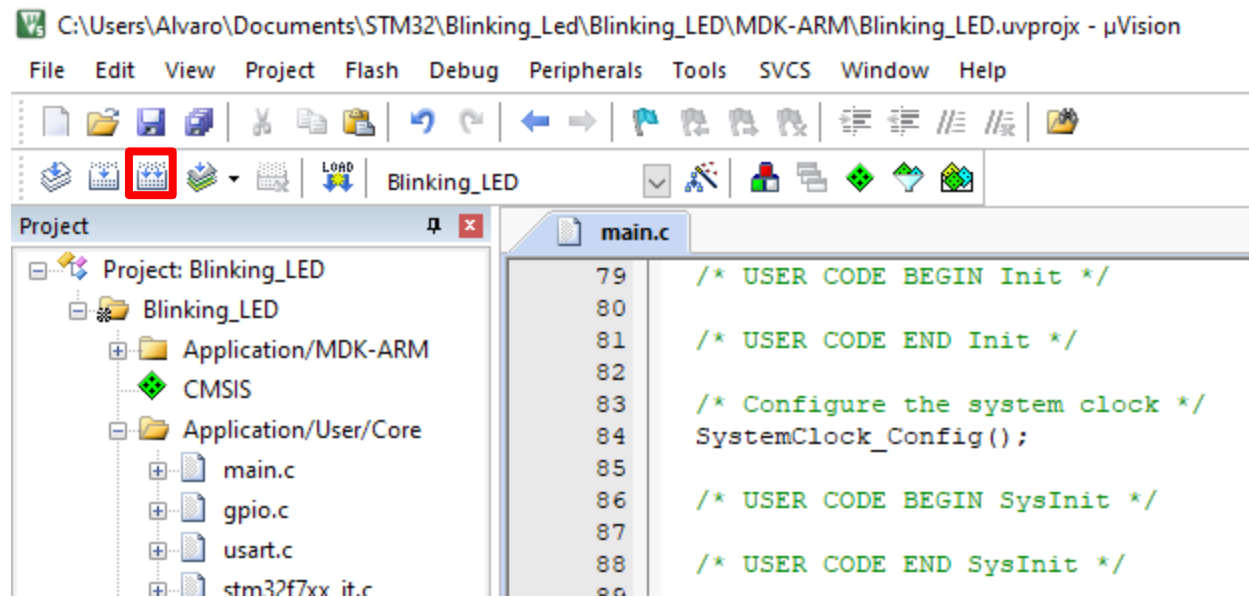
Add those two lines of code at lines 101 and 102.

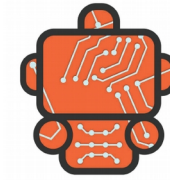
```
97      /* Infinite loop */
98      /* USER CODE BEGIN WHILE */
99      while (1)
100     {
101         HAL_GPIO_TogglePin(GPIOB, GPIO_PIN_7);
102         HAL_Delay(1000);
103         /* USER CODE END WHILE */
```



Compile a program

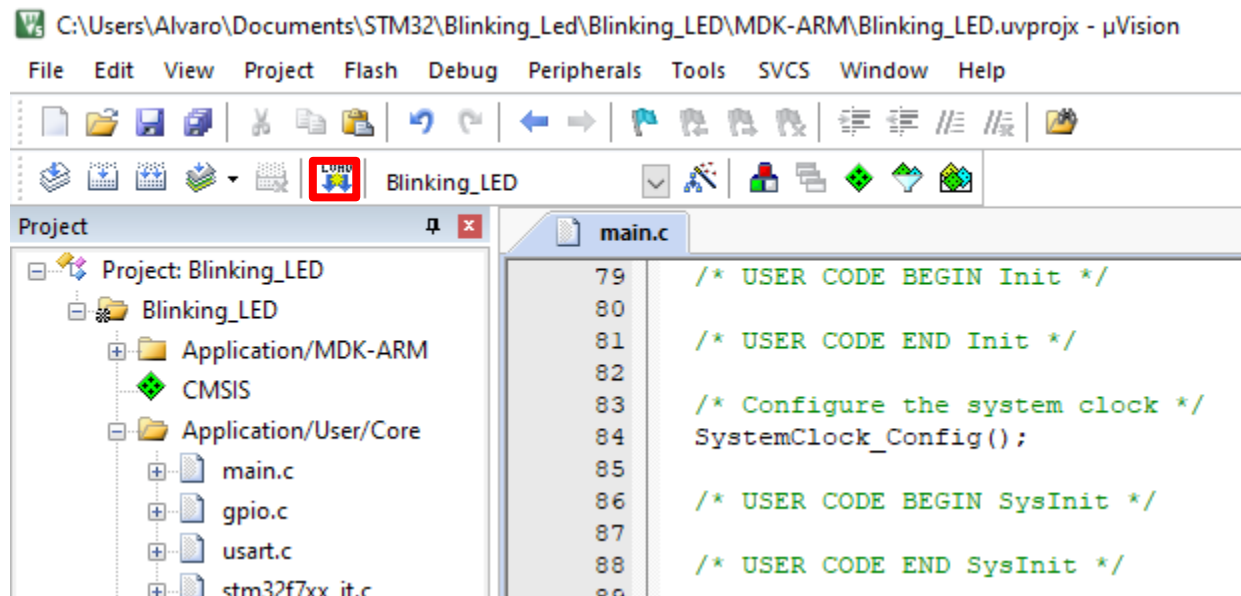
To compile all target files (this is going to take a while)





Flash the board

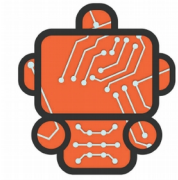
Connect the development board to your pc through a micro USB cable (don't use the connection next to the ethernet port)



Flash the board

When the flash is finished press the reset button on the board (black button)

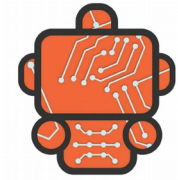
The blue LED should blink at a frequency of 0,5Hz.



Terminal

A good terminal is very convenient if you want work with serial port.
You can use termite or this terminal:

<https://sites.google.com/site/terminalbpp/>

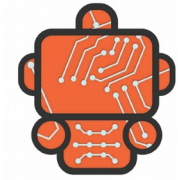


File tree

Inside the project Directory, there are many sub directories and files, some of the most important are:

- **Drives:** where the CubeMX puts the drivers, you don't need to touch here
- **Inc:** where the user header files are, and where you should put all the header files you will create

(continues on the next page)

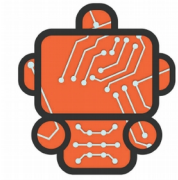


File tree

- **MDK-ARM:** where all the files for the Keil configurations and the output files of the compilation are, at this moment you only should touch the file with the extension **.uvprojx** (this file open the keil project)
- **Src:** where the user source files are, and where you should put all the source files you will create
- **.ioc:** STM32CubeMX file, contains all the Cube info for the project
- **.gitignore:** to specify intentionally untracked files to be ignore by git

Resources

The following slides have some documentation that you should have with you every time you are working with the development board, in order to consult some information in case of doubts.



Resources

STM32F76xxx and STM32F77xxx advanced Arm[®]-based

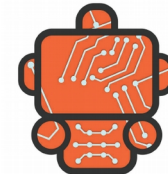
<https://bit.ly/2SrZbQS>

Description of STM32F7 HAL and Low-layer drivers

<https://bit.ly/2JsqPcE>

STM32CubeMX for STM32 configuration and initialization C code generation

<https://bit.ly/2OXkEmM>



Resources

STM32F7 Series and STM32H7 Series Cortex® -M7 processor
programming manual

<https://bit.ly/2qiOYJC>

STM32 Nucleo-144 boards

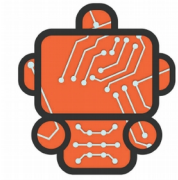
<https://bit.ly/2Df5i6S>

Getting started with STM32F7 Series MCU hardware development

<https://bit.ly/2StPQIj>

General-purpose timer cookbook

<https://bit.ly/2ITtSKB>



Conclusion

Now you should have all tools installed and configured.

You should know how to create a project, compile and flash the board

Good work