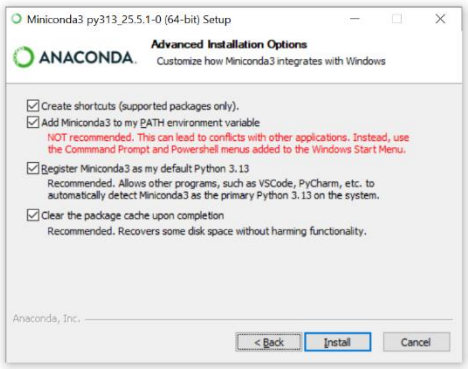
Software Installation Guide for Theoretical Part

This guide explains how to install the software required for working with mathematical models and synthesizing controllers using the Control System Toolbox in Python.

Windows

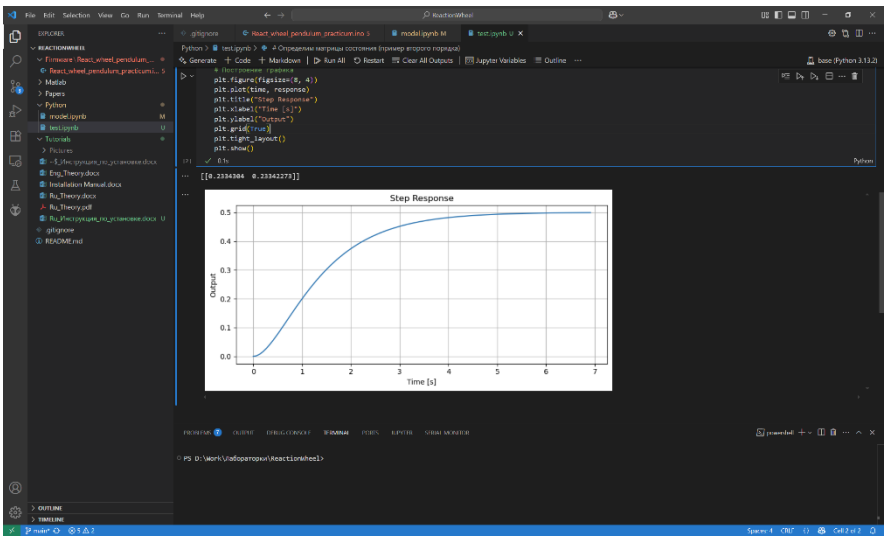
1. Install VSCode development environment using the instructions: https://code.visualstudio.com/docs/setup/windows
2. Update Python to the latest version:
   - Go to https://www.python.org/downloads/ and download the latest version.
   - Run the installer as administrator and follow the installation wizard.
3. Install Miniconda:
   - Visit https://www.anaconda.com/download/success and download the **Miniconda installer**.
   - Run the installation wizard. On the *Advanced Installation Options* screen, check all the boxes – even if warnings appear.



   - Click **Install** and wait for installation to complete.
4. Open the Anaconda Prompt and install the necessary libraries:

```
conda install -c conda-forge slycot
conda install numpy
conda install matplotlib
conda install -c conda-forge scipy
conda install -c conda-forge control
```

5. Download the repository: https://github.com/voltbro/ReactionWheel
6. Open VSCode, go to **File -> Open Folder**, and select the downloaded repository folder.
7. Verify the setup:
   - Open file *Python/test.ipynb*.
   - In the top-right, click *Select Kernel -> Select Another Kernel -> Python Environments -> base (Python 3.13.2)*.
   - Click *Run All*. If a step response plot appears below, everything is working correctly.



Ubuntu

1. Install VSCode:

   ```
   sudo snap install --classic code
   ```

2. Update Python to the latest version: https://cloudbytes.dev/snippets/upgrade-python-to-latest-version-on-ubuntu-linux
3. Install Miniconda3 via instruction https://www.anaconda.com/docs/getting-started/miniconda/install#linux
4. Open Anaconda Prompt and install all the required libraries:

   ```
   conda install -c conda-forge slycot
   conda install numpy
   conda install matplotlib
   conda install -c conda-forge scipy
   conda install -c conda-forge control
   ```

5. Download the repository: https://github.com/voltbro/ReactionWheel
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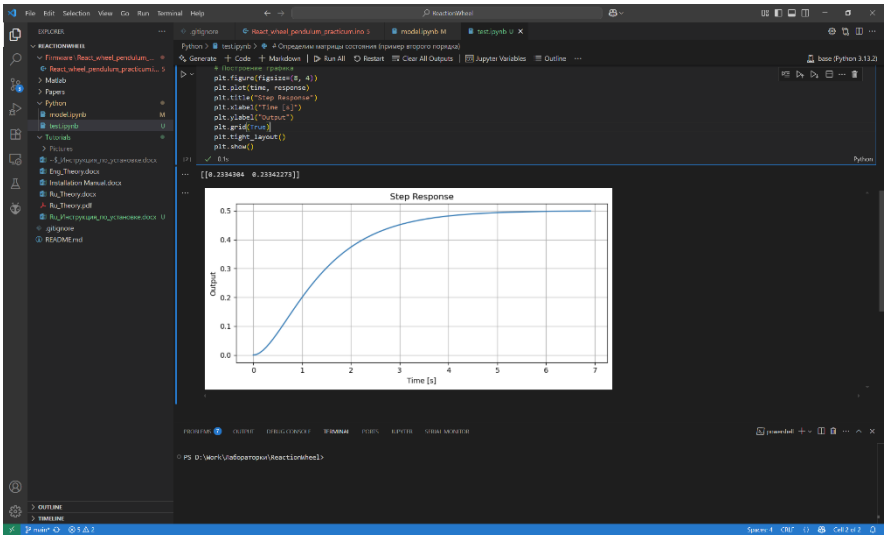


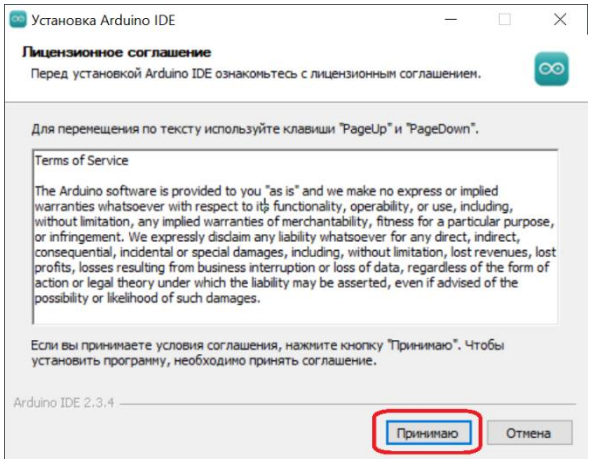
Software Installation for Hardware Experiments

This guide explains how to install the software needed to program the microcontroller used for controlling the reaction wheel inverted pendulum.

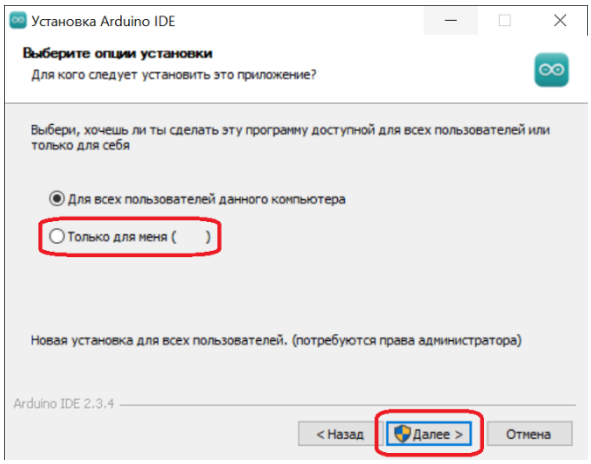
Windows

Installing Arduino IDE

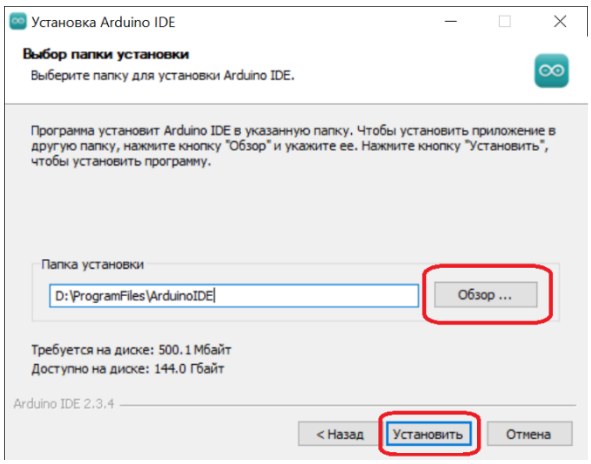
1. Go to https://www.arduino.cc/en/software
2. Download Arduino IDE 2.3.4 for Windows 64-bit.
3. Run the installer and follow these steps:
   - Accept the license agreement.



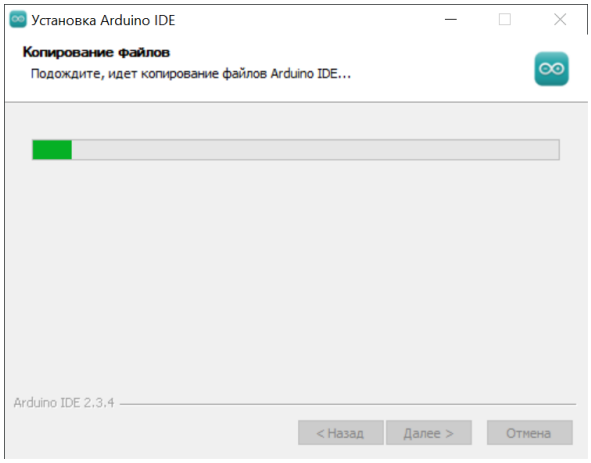
   - Choose **Install for me only**, then click **Next**.



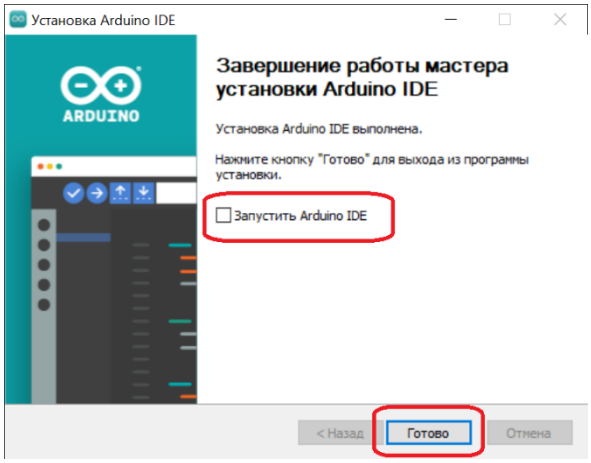
   - Optionally change the installation path, then click **Install**.



- Wait for the installation to complete.



- Uncheck **Run Arduino IDE** and click **Finish**.



Ubuntu

1. Install Arduino IDE using [this instruction]
2. Grant read/write permission for serial port `/dev/ttyACM0`. Close Arduino IDE, open the terminal, and enter:
   ```
   ls -la /dev | grep ttyACM0
   ```
3. Add your user account to the `dialout` group:
   ```
   sudo usermod -a -G dialout <your username>
   ```
   In our case, the username is `robot`, so the command looks like this:
   ```
   sudo usermod -a -G dialout robot
   ```

4. Set read/write permissions:
   `sudo chmod a+rw /dev/ttyACM0`
5. Verify that the permissions are set:
   `ls -la /dev | grep ttyACM0`

Common Issues in Ubuntu When Using the Arduino IDE

1. **Error:** avrdude: ser_open(): can't open device "/dev/ttyACM0": Permission denied
   Failed uploading: uploading error: exit status 1
   Cause: You did not set read/write permissions for the appropriate port (in Ubuntu, /dev/ttyACM0).
   Solution: Go back to the previous section and set the necessary permissions.
2. **Error:** Unable to open a sketch from the *Examples* folder. This may happen if the sketch file has a `.pde` extension instead of `.ino`.
   Solution: Navigate to the directory containing the sketch you want to open. For example, the *HelloWorld* sketch from the `ros_lib` library is located in:
   `Arduino/libraries/ros_lib/examples/HelloWorld`.
   Rename the sketch file by changing the `.pde` extension to `.ino`.
3. **Error**: ST-LINK error (DEV_CONNECT_ERR)Error: Problem occurred while trying to connect
   Solution: This issue is addressed on StackOverflow. Don't forget to reboot your computer afterward.

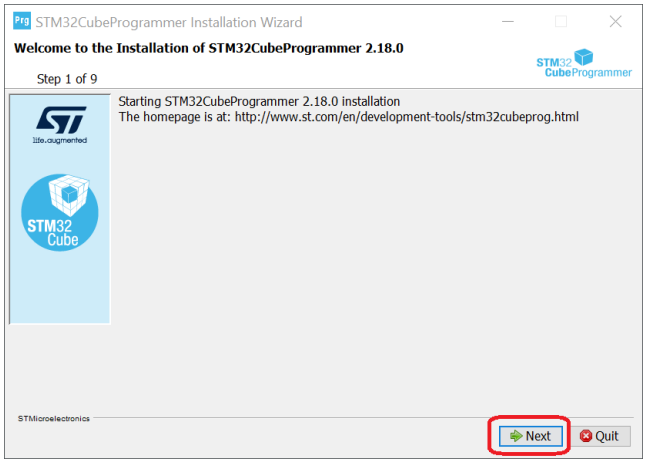
If you encounter any other issues, try searching for a solution on google.com. If all else fails and the issues are related to Arduino, we recommend installing **Arduino IDE 1** using the Ubuntu application manager.

Installing STM32CubeProg

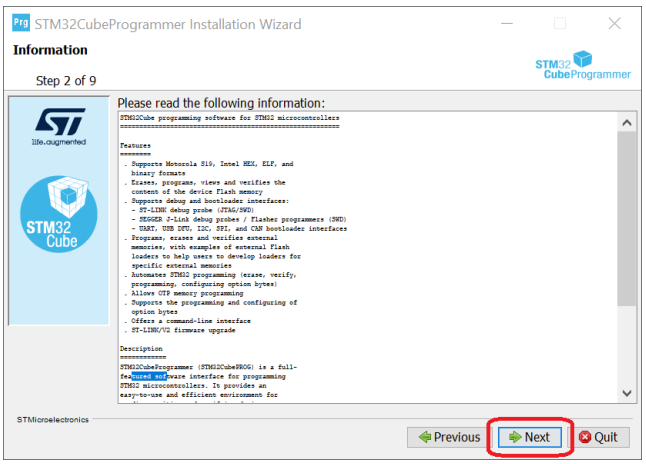
Windows

To flash STM32 microcontrollers, a programmer is required. The STM32CubeProgrammer utility is used for this purpose.

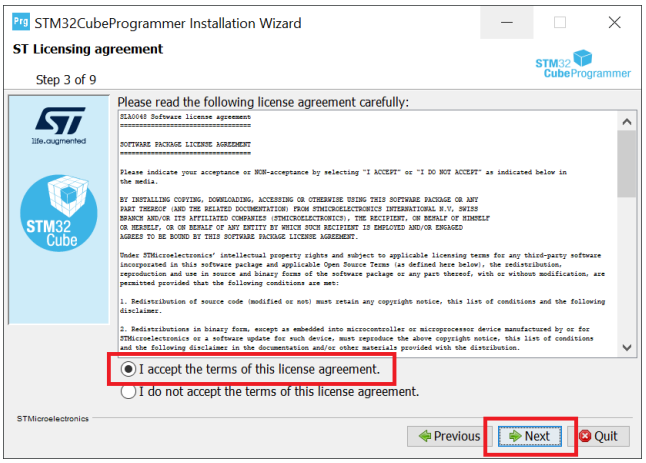
1. Go to https://www.st.com/en/development-tools/stm32cubeprog.html
2. Download STM32CubeProgrammer 2.19.0 for Windows 64-bit.
3. Run the installer:
   - Grant administrator access when prompted.
   - Click **Next** through the wizard.



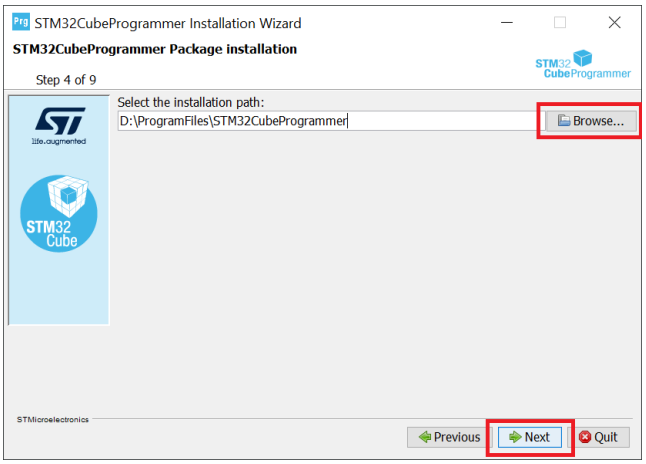
   - Accept the installation information.



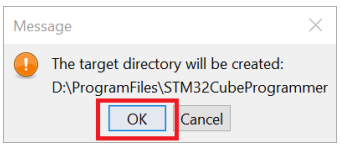
- Accept the license agreement.



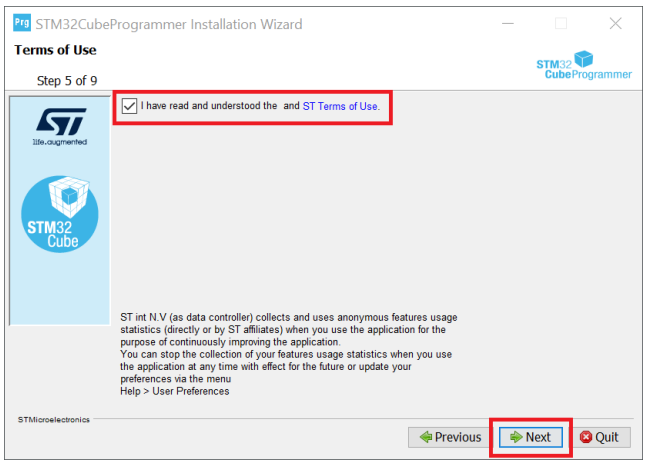
- Choose the installation folder.



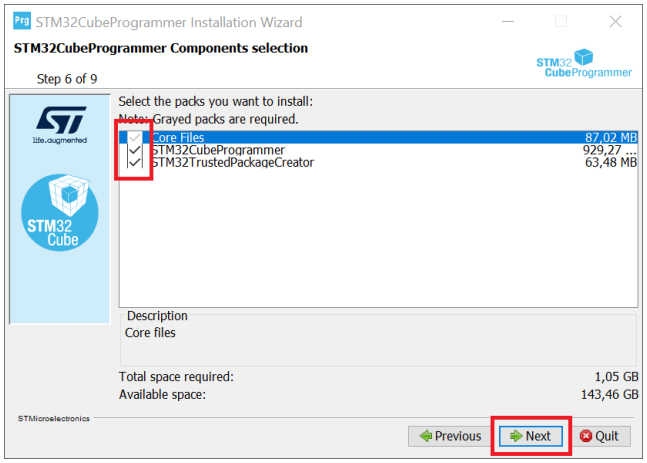
- If the folder doesn't exist, click **OK** to create it.



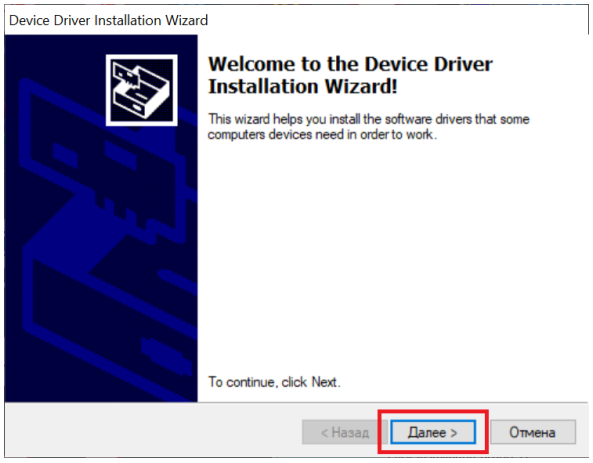
- Check the box **I have read and understand…**, then click **Next**.



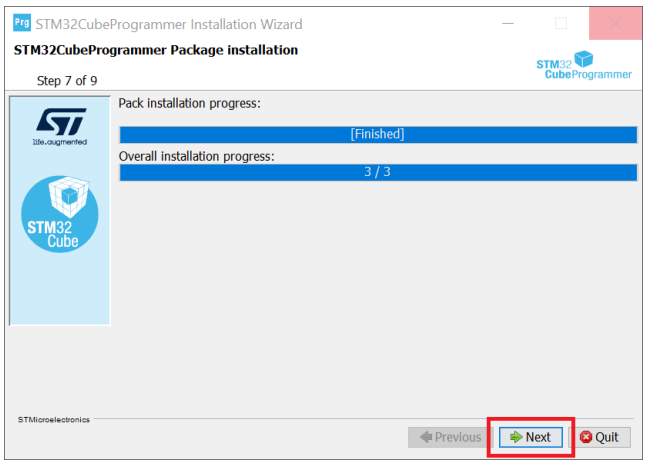
- Make sure all components are selected and click **Next**.



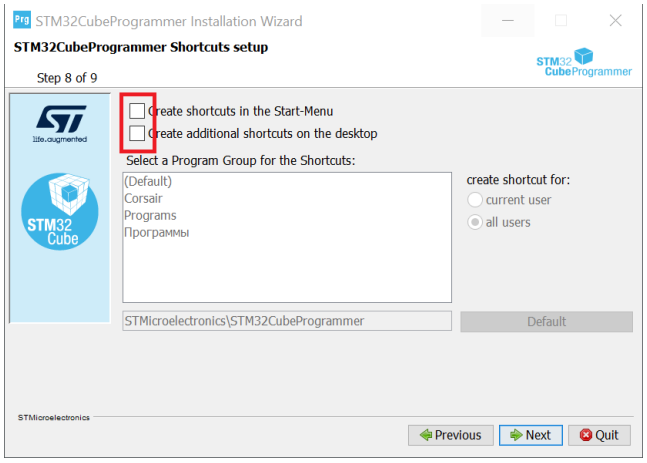
- During the installation, a device driver wizard will appear:



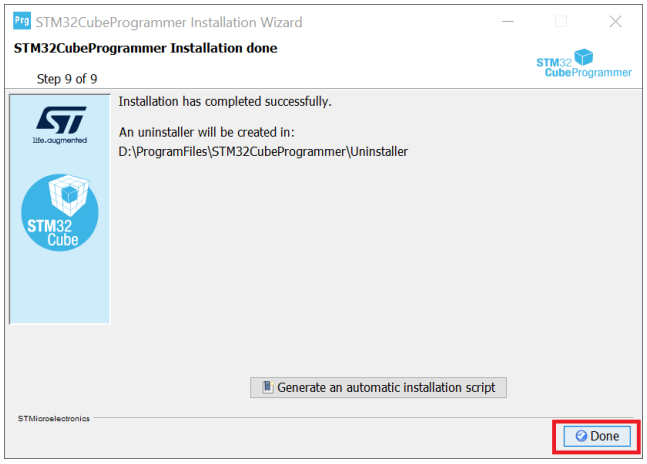
- Click **Next → Install → Finish**.
- After installation, click **Next**.



- Uncheck all boxes.



- Click **Done** in order to finish installation process.



Ubuntu

The install process is the same as installation on Windows. After installation add udev rules. You can do it using this guide.

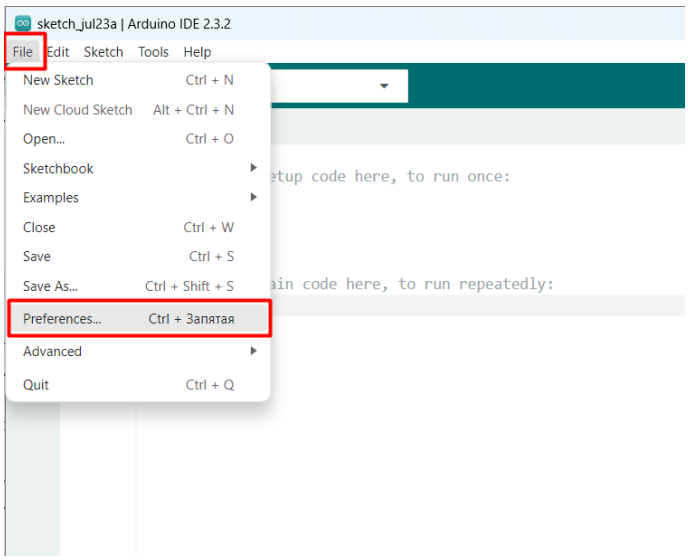
In the end run the command:

```
sudo udevadm control --reload-rules
```

Installing STM32duino Library

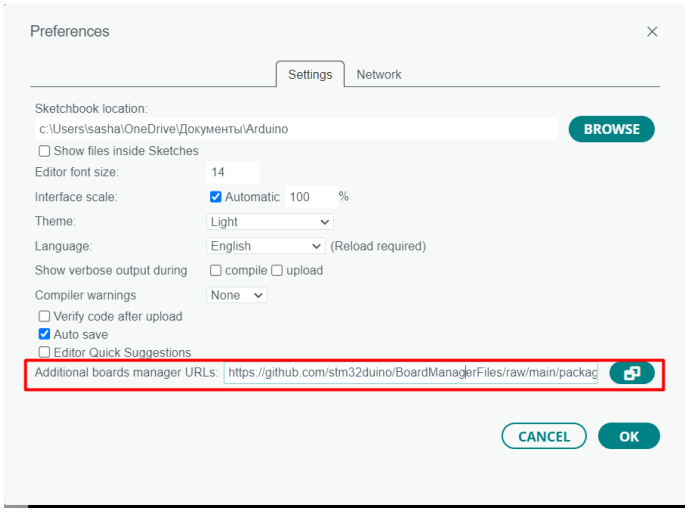
To enable Arduino IDE support for STM32 microcontrollers:

1. Open Arduino IDE and go to **File -> Preferences**.



2. In the Additional Boards Manager URLs field, add the following URL:

https://github.com/stm32duino/BoardManagerFiles/raw/main/package_stmicroelectronics_index.json

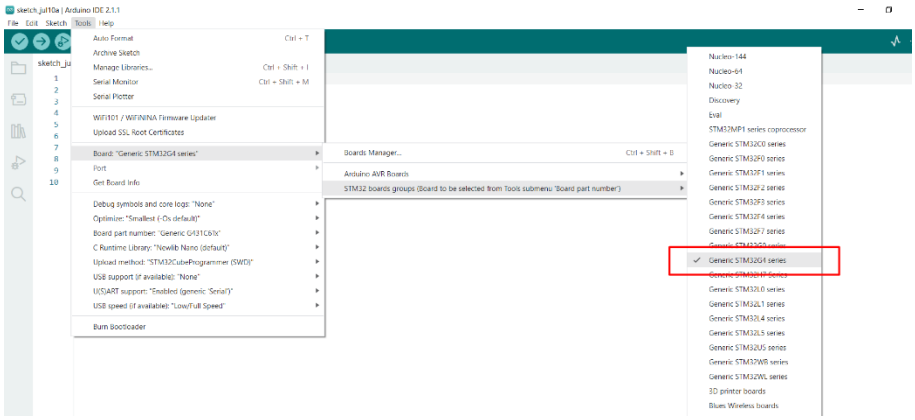


3. Click **OK**.
4. In the main window, go to **Tools -> Board -> Board Manager**.
5. Search for STM32, then install STM32 MCU based boards.

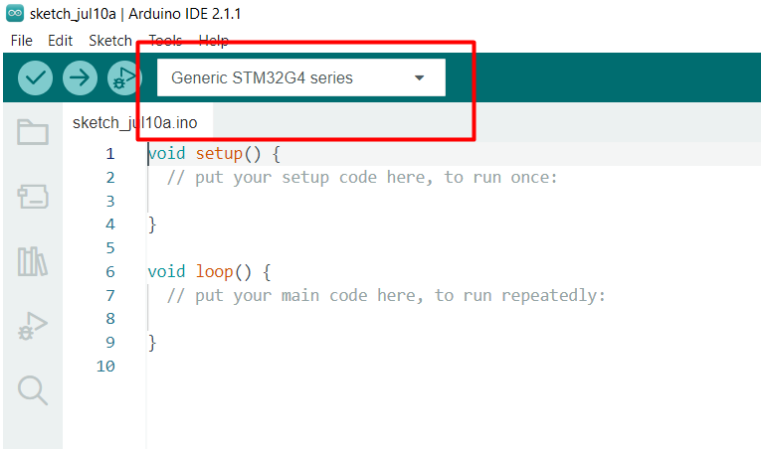
Arduino IDE Configuration

To work with STM32G474RE-based modules like VBCoreG4:

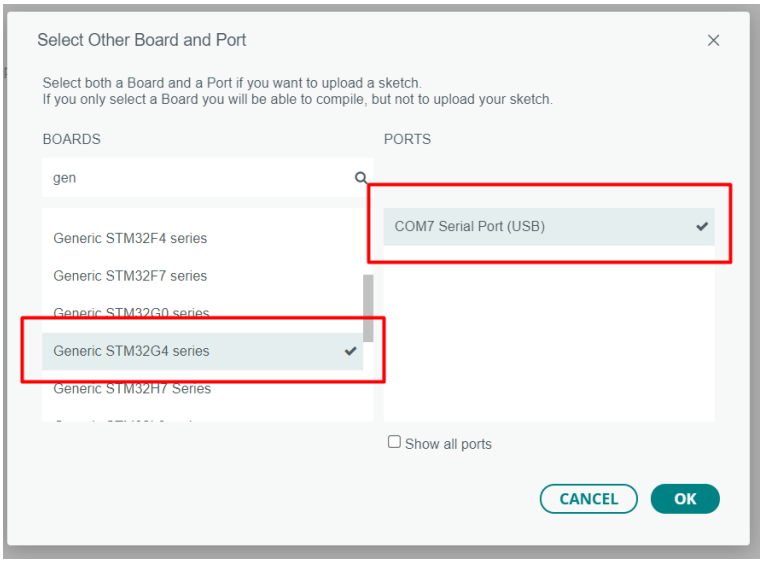
1. Go to **Tools -> Board -> STM32 MCU based boards -> Generic STM32G4 series**.



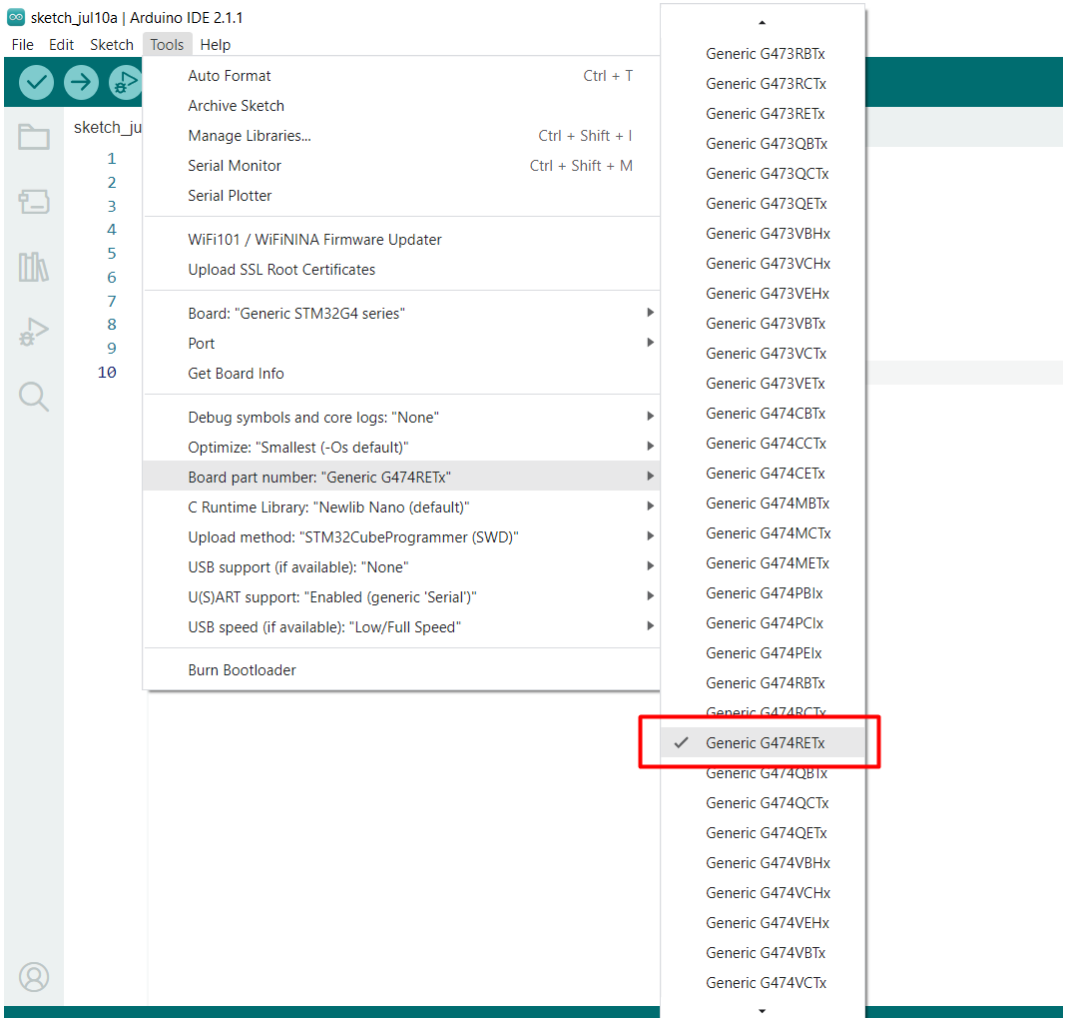
2. Make sure the same board series is shown in the list of board where firmware is going to be uploaded



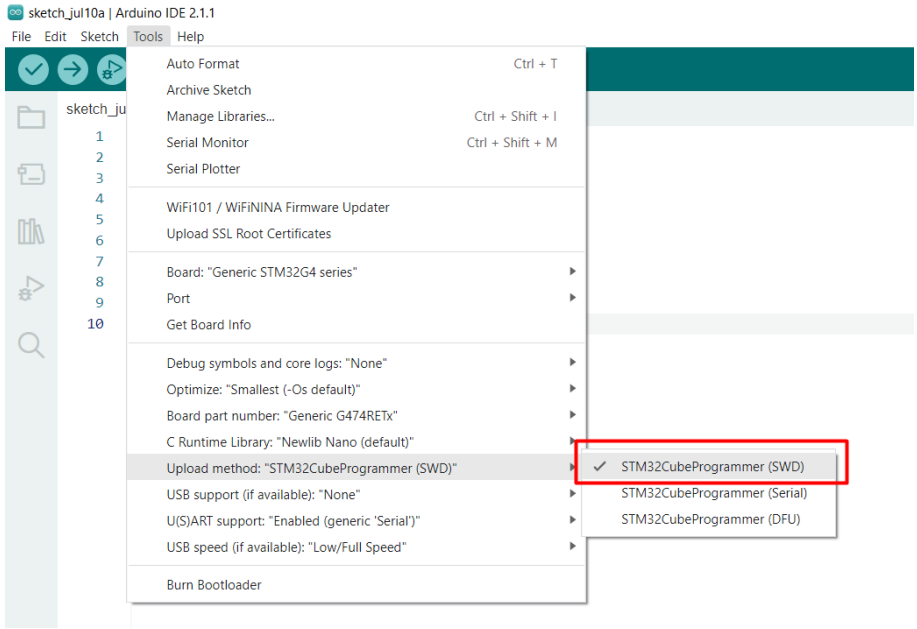
3. If needed, click the arrow at the bottom of the board list and select **Select Other Board and Port**. Choose the correct board and click OK.



4. Set board part number: **Tools -> Board part number -> Generic G474RETx**



5. Set upload method: **Tools -> Upload method -> STM32CubeProgrammer (SWD)**



Installing VBCoreG4 System Library

To ensure compatibility with the VBCore VB32G4 board:

1. Download the library from https://github.com/VBCores/VBCoreG4_arduino_system

2. Copy the VBCoreG4_arduino_system folder into your Arduino libraries directory. Typical locations:

   C:\Program Files (x86)\Arduino\libraries

   C:\Users\username\Documents\Arduino\libraries

3. If unsure, check **File -> Preferences in Arduino IDE → Sketchbook** location shows where the libraries folder is.

Installing Additional Libraries

1. Install the SimpleFOC library (for brushless motor control).

   Follow the instructions: https://docs.simplefoc.com/library_download

2. Install AS5600 sensor library:
   - Go to https://github.com/Seeed-Studio/Seeed_Arduino_AS5600 and download the repository as a ZIP file.
   - In Arduino IDE, go to **Sketch -> Include Library -> Add .ZIP Library** and select the downloaded file.

Congratulations!

You have successfully installed and configured all tools needed for developing software for the VBCore VB32G4 microcontroller modules.