How to use STM32 motor control SDK v6.0 workbench

Introduction

The STM32 motor control software development kit (MC SDK) is part of the STMicroelectronics motor-control ecosystem. It is referenced as X-CUBE-MCSDK or X-CUBE-MCSDK-FUL according to the software license agreement applied. It includes:

- ST MC FOC firmware library for permanent magnet synchronous motor (PMSM) field-oriented control (FOC)
- ST MC 6-step firmware library
- ST motor profiler
- ST motor pilot
- ST MC workbench software tool, a graphical user interface (GUI) for the configuration of MC SDK firmware library parameters

This user manual explains how to use the ST MC workbench software tool included within the MC SDK firmware version 6.0.

1 General information

The ST MC workbench software tool is part of the MC SDK that is used for the development of motor control applications running on STM32 32-bit microcontrollers, based on the Arm® Cortex®-M processor.

The ST MC workbench provides the user with an easy and friendly way to configure his MC application software matching his hardware setup.

When completed, the user can directly generate his project which is compatible with the STM32CubeMX usage for a further MC application extension.

The ST MC workbench runs on a PC system using Windows® and requires a USB Type-A connector.

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2 Related documents

Documents available from Arm® infocenter website

- Cortex®-M0 Technical Reference Manual
- Cortex®-M3 Technical Reference Manual
- Cortex®-M4 Technical Reference Manual

Documents available from *www.st.com* or your STMicroelectronics sales office

- STM32F0xx datasheets
- STM32F3xx datasheets
- STM32F4xx datasheets
- STM32G4xx datasheets
- STM32G0xx datasheets
- STM32F7xx datasheets
- STM32H7xx datasheets
- STM32L4xx datasheets

Motor control reference documents

Table 1 presents the documentation that helps to get a deeper understanding of the STMicroelectronics motor control solution.

Table 1. Reference documentation

Reference	Document
[AN5143]	Application note *How to migrate motor control application software from SDK v4.3 to SDK v5.x*
[AN5166]	Application note *Guidelines for control and customization of power boards with STM32 MC SDK v5.0*
[AN5464]	Application note *Position control of a three-phase permanent magnet motor using X-CUBE-MCSDK or X-CUBE-MCSDK-FUL*
[DB3548]	Data brief *STM32 MC SDK software expansion for STM32Cube*
[UM2374][(1)]	User manual *Getting started with STM32 motor control SDK v5.x*
[UM2380][(1)]	User manual *Getting started with STM32 motor control SDK v5.x*
[UM2392]	User manual *STM32 motor control SDK v5.0.0 firmware*
[UM2916]	User manual *MCSDK - 6-step firmware examples: insights of the firmware and how to customize it*
[UM3016]	User manual *STM32 MC SDK motor profiler*
[UM3026][(1)]	User manual *Getting started with STM32 motor control SDK v6.0*
[UM3027][(1)]	User manual *Workbench tools for STM32 motor control SDK 6.0*
[wiki]	Refer to the motor control pages at the wiki.st.com/stm32mcu STMicroelectronics wiki site

1. *UM3026 and UM3027 are respectively the evolutions of UM2374 and UM2380 for MC SDK 6.0.*

3 ST motor-control workbench

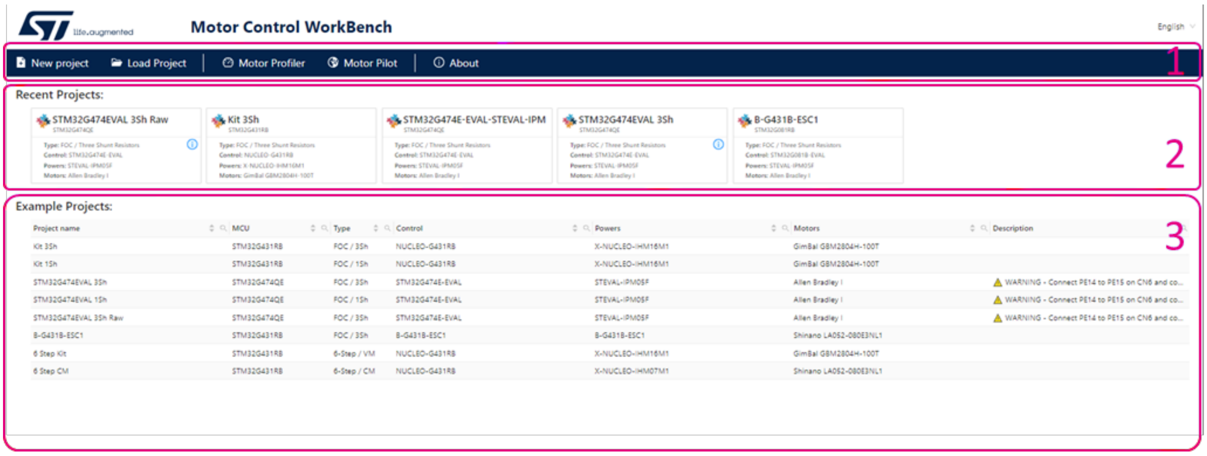
Launch the ST motor-control workbench software tool by clicking either its icon (Figure 1) or running directly from the installation folder.

Figure 1. ST MC workbench – Icon

The ST MC workbench GUI presents the following home area (start-up page) where there are the following sections:

1. The user buttons area (Area 1 in Figure 2) to start either a new project or load a previous one, as well as launch the ST Motor Profiler or Motor Pilot software tools.
2. The recent projects area (Area 2 in Figure 2) to load a user's recent project.
3. The example projects area (Area 3 in Figure 2) to load a project example.

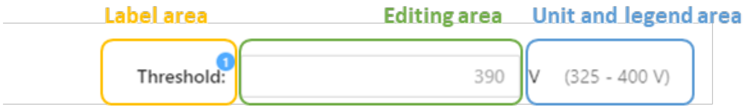
Figure 2. ST MC workbench – GUI (Home view)



3.1 Editing field behavior

One of the common developing paths in the ST MC workbench is the editing and combo field behavior. Each edit or combo field has the following format and behavior:

Figure 3. ST MC workbench – Editing field



Label area

In this area, the field name is shown with optionally a number notification bullet that shows specific notes on the field. The bullet must be info (Blue), warning (Orange), or error (Red), and the specific messages pop up on the bullet mouse over.

Editing area

In this area, the user can set its value. The field (Edit or combo) assumes different styles depending on its editing state:

- Field with default value: No value specified by the user (Value in light grey). The default value can be changed silently by the application itself.

Edit fields	Combo fields

- Field with default value in editing mode (Value in light grey): The user can edit its value. The user can transform the default value into an explicit user value by clicking the upper-right small icon ( ).

Edit fields


- Field with explicit user value (Value in black): The explicit user value cannot be recalculated by the application. The user can reset the field to its default value by pressing the upper-right small icon ( ).

Edit fields	Combo fields
	

- Field with error on value (Value in red): The user must review the field or reset the field to its default pressing the upper-right small icon.

Edit fields	Combo fields
	

Unit and legend area

This area is optional: It indicates the unit or the legend of the field, meaning the valid range.

3.2 New project wizard

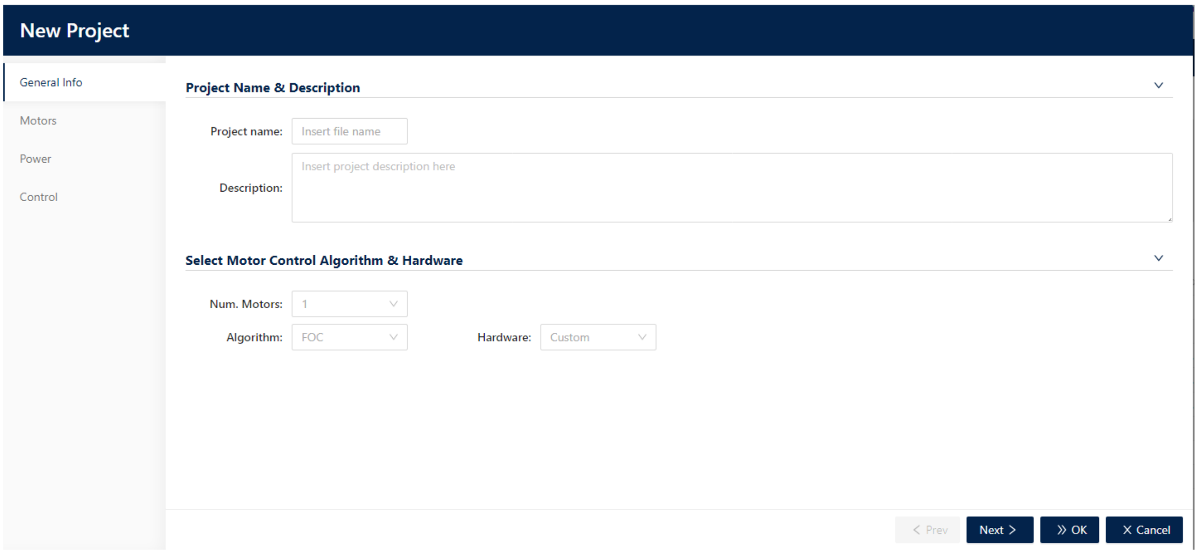
When clicking the *New Project* button (Figure 2. ST MC workbench – GUI (Home view)), a window pops up that helps the user to define step-by-step the project configuration ().

3.2.1 General Info

In the *General Info* step the user can set the following info:

- Project *Name & Description*
  - Insert a *Project name* (Optional field), if specified it is used as the default file name in *save as…*.
  - Insert a *Description* (Optional field).
- Select *Motor Control Algorithm & Hardware*
  - Selects *Num. Motors* usage.
  - Selects *Algorithm* type, such as FOC or 6-step.
  - Selects the ST *Hardware* type boards:
    - *Custom* if the system is composed of a control evaluation board together with a power evaluation board.
    - *Kit* if the ST board is an ST MC kit, meaning P-NUCLEO-IHM003.
    - *Inverter* if the ST board is a complete inverter board (Single board with both power and control electronics).

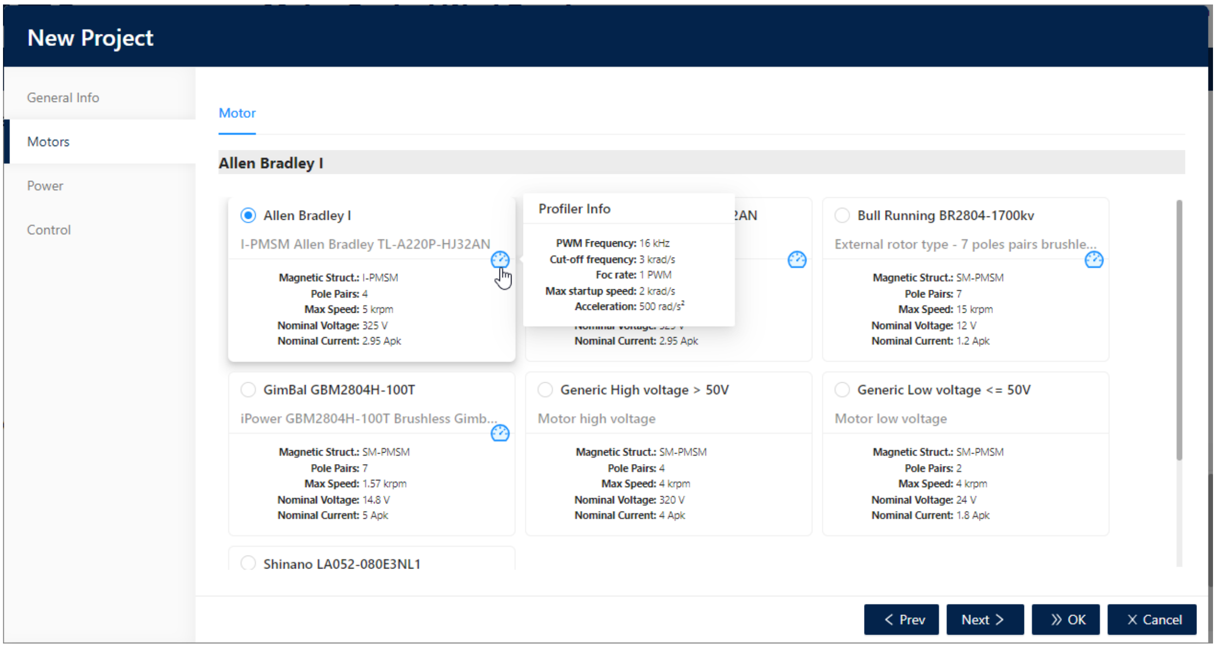
Figure 4. ST MC workbench – New project window



3.2.2 Motors

In the *Motors* step, the user selects the motor to use in the project. The user can select a *Generic Motor* or a *Profiled Motor*. The *Profiled Motor*s are identified by an icon (Refer to the example in Figure 5). This step is not available in case the user selects as *Hardware* an ST MC kit (Refer to the example in Figure 9. ST MC workbench – New project window – Kit). The list provides a set of motors delivered with the application as well as the user motors.

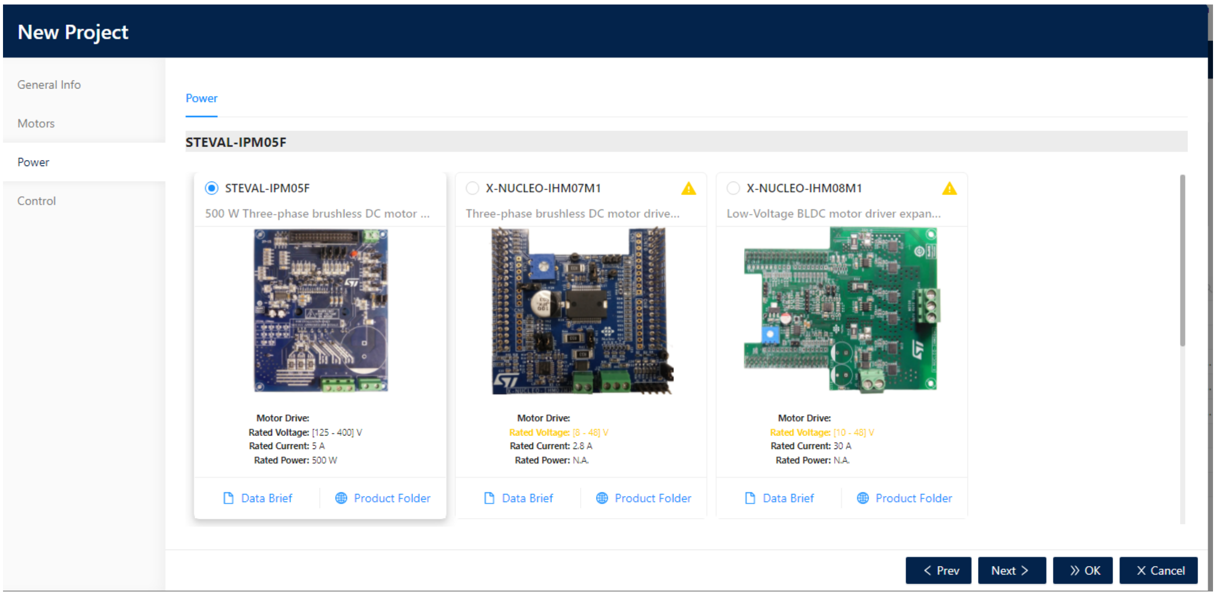
Figure 5. ST MC workbench – New project window – Motors



3.2.3 Power board

In the *Power* step, a list of available power boards is shown. The power boards are sorted by compatibility with the previously selected motor supply. A yellow warning triangle is shown if the board output power supply is not properly compatible with the motor.

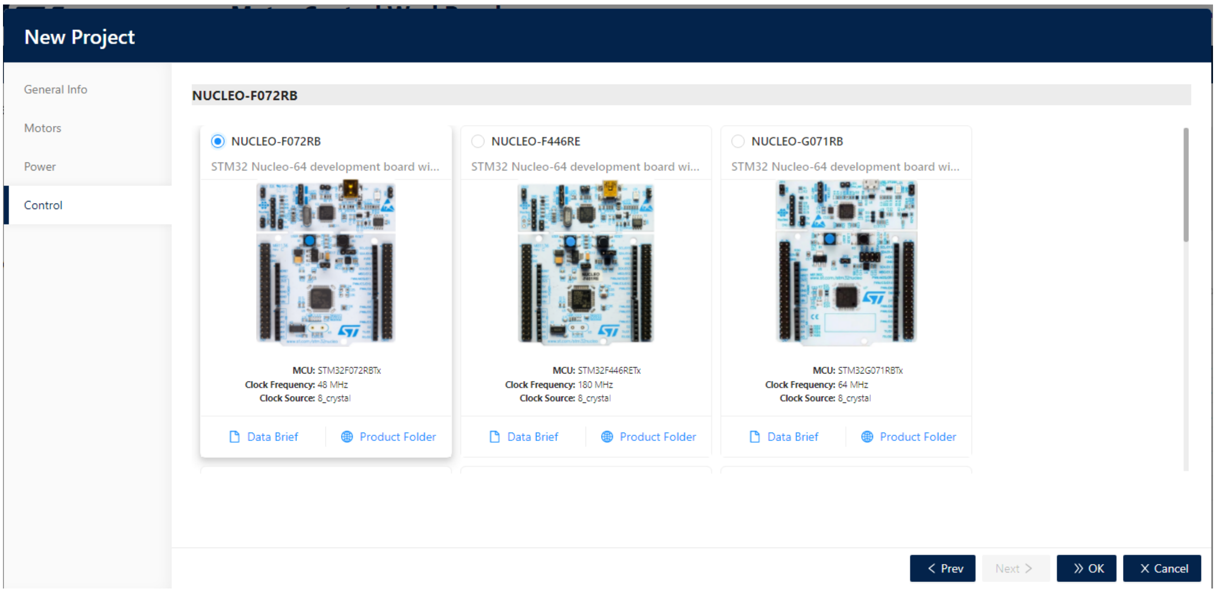
Figure 6. ST MC workbench – New project window – Power



3.2.4 Control board

In the *Control* step, a list of supported control boards is proposed. The list is sorted by compatibility with the selected power. An extra *Bridge* step is shown if the connectors for power and control are not compatible and require an adapter board.

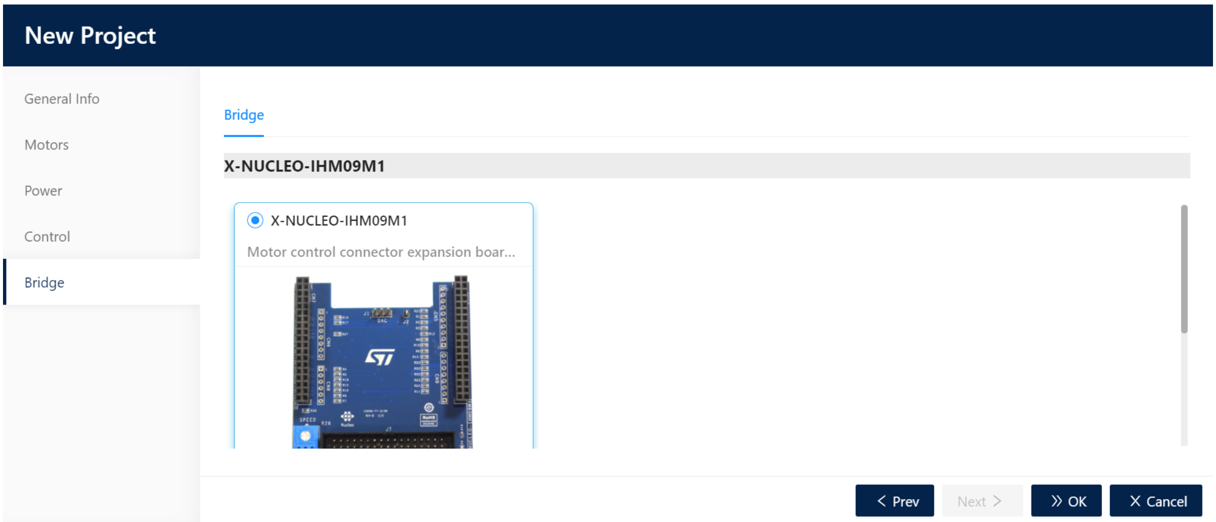
Figure 7. ST MC workbench – New project window – Control



3.2.5 Bridge

In the *Bridge* step, a list of available adapters is shown to be selected. The bridge selection allows the usage of boards (power and control) that are not directly connectable because they have different connectors, such as ST morpho or motor-control connectors.

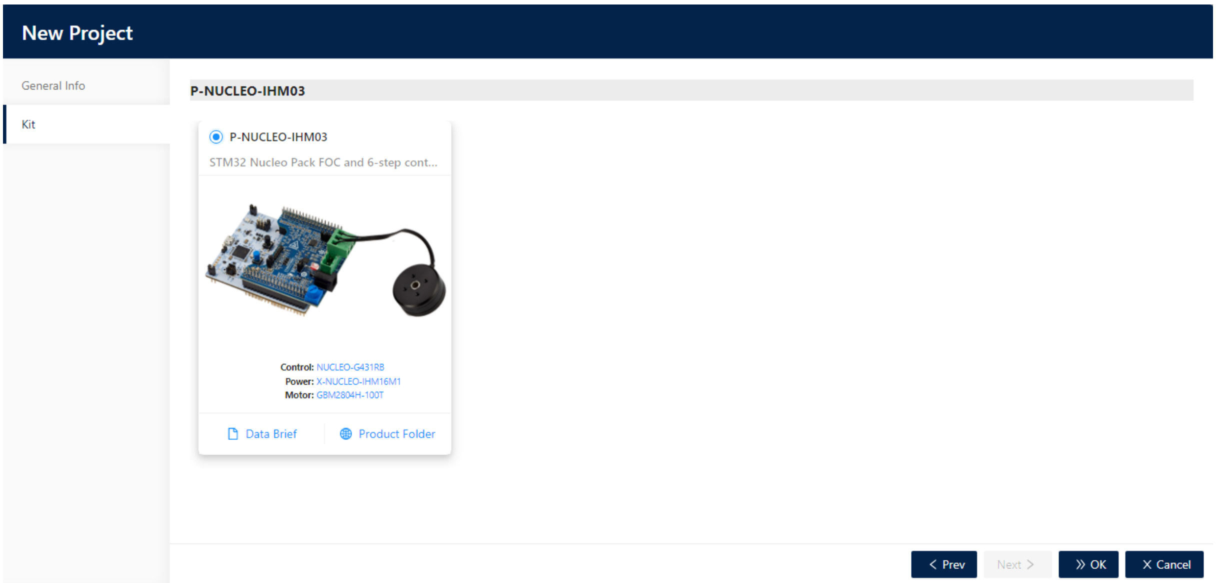
Figure 8. ST MC workbench – New project window – Bridge



3.2.6 Kit

The *Kit* step allows the selection of available supported kits. A kit is composed of a control board, a power board, and a motor.

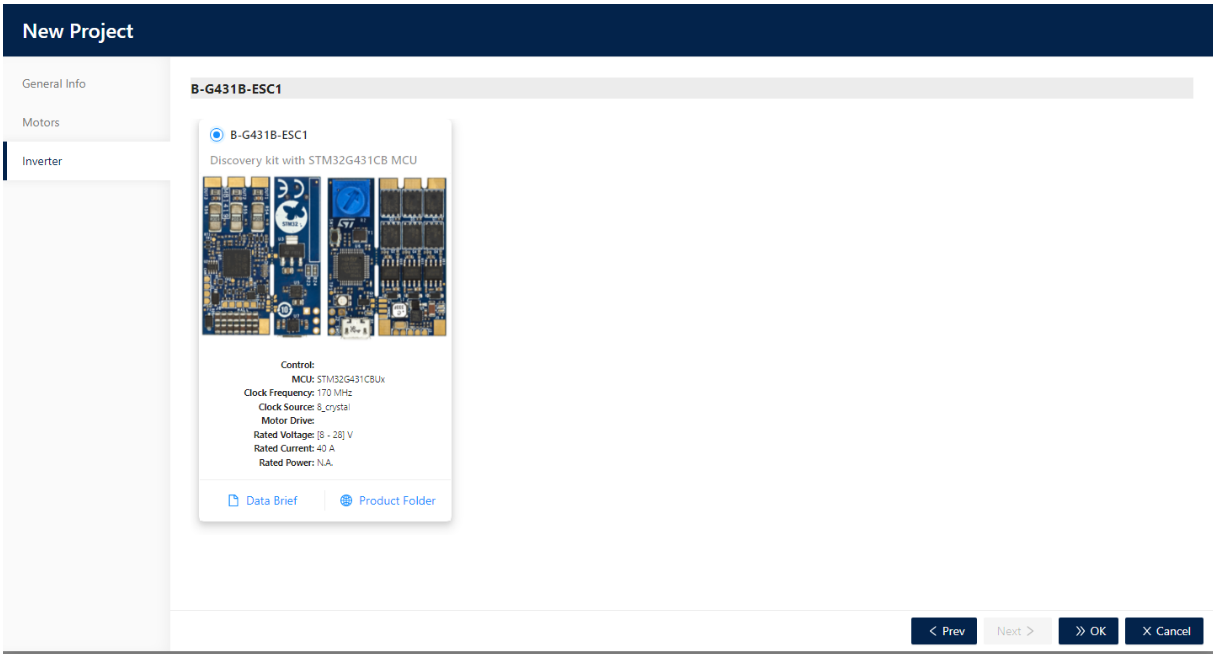
Figure 9. ST MC workbench – New project window – Kit



3.2.7 Inverter

The *Inverter* step allows the selection of available inverters. The inverter is a complete board, meaning a single board with both power and control parts.

Figure 10. ST MC workbench – New project window – Inverter

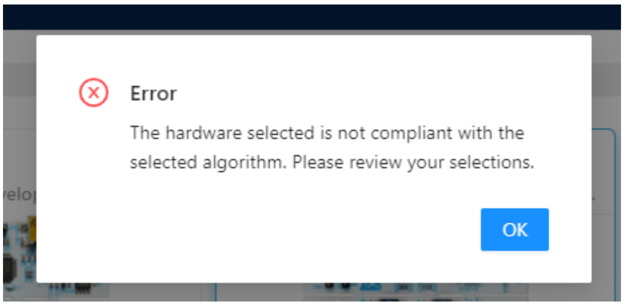


3.2.8 Creating the project

At the end of the new project wizard, the user can click on the *OK* button to create the project. All hardware must be explicitly selected by the user and depends on the hardware type field.

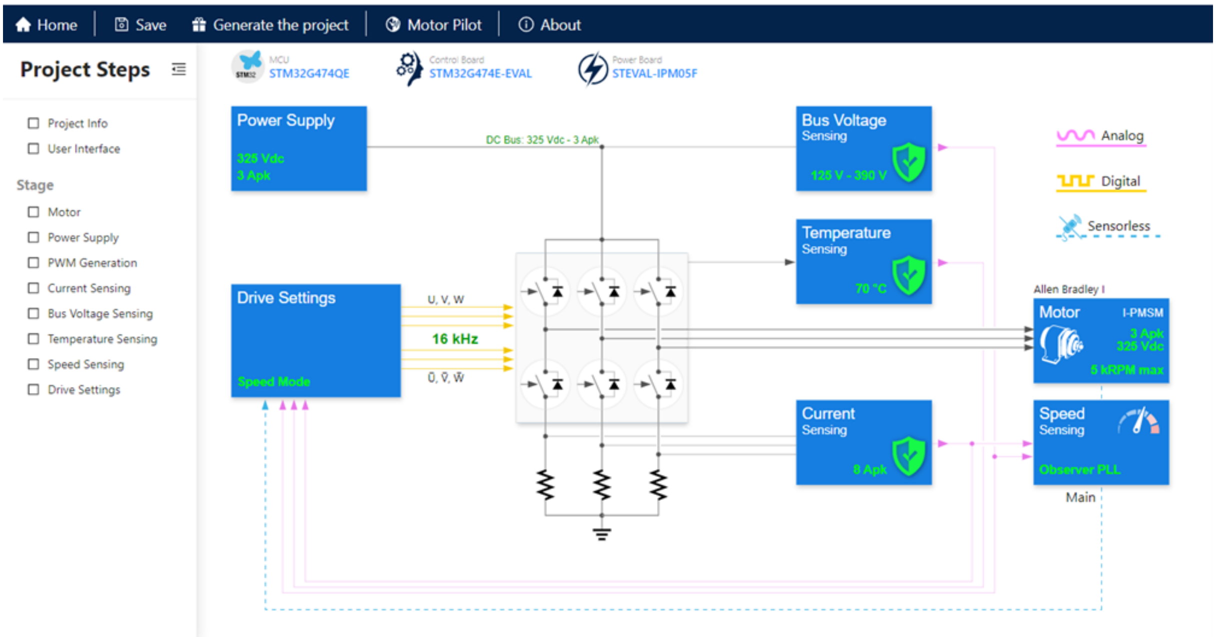
A post-selection procedure is executed to check if the configuration allows the creation of the project. If the user selection is not valid a dialog pops up to inform the user that the choices do not allow the project creation and ask to refine them (Figure 11).

Figure 11. ST MC workbench – New project creation error



Otherwise, the user selection is valid, a motorcontrol project is created, and the project view (Figure 12) is shown with all the information that depends on the selected boards and motor.

Figure 12. ST MC workbench – Project view



3.3 Loading an existing project

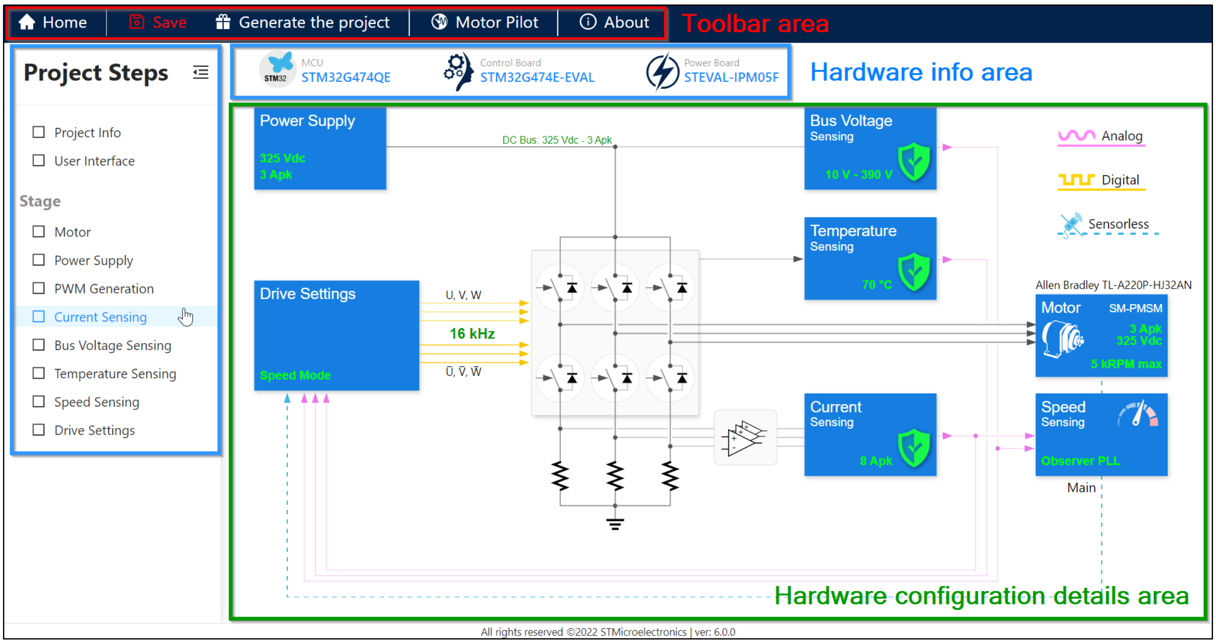
When clicking the *Load Project* button (Figure 2. ST MC workbench – GUI (Home view)), a system dialog window appears and the user can select the project file (`.stwb6`) to load. The loaded project appears in the *Project view* (Figure 12) where the user can refine it.

3.4 Project view

The project view is composed by:

- The toolbar area
- The hardware area info
- The Project Steps area to select the hardware part to parametrize:
  - The motor,
  - The power supply,
  - The PWM generation,
  - And other parameters.
- The hardware configuration details area. This is used to fine-tune the selected hardware functionality and view all the main info and protection at a first glance.

Figure 13. ST MC workbench – Project view (Global view)



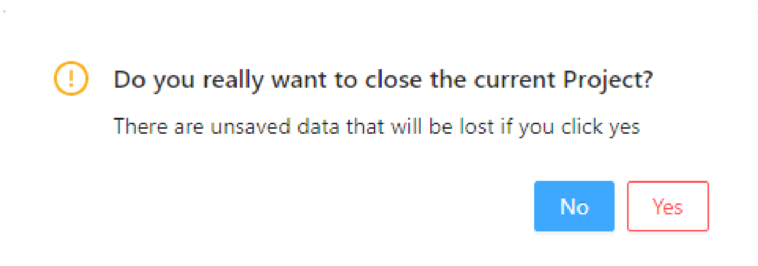
3.4.1 Toolbar area

The toolbar area is useful to control application navigation, project saving, and generation.

3.4.1.1 Home

Clicking Home provides the user with an easy way to close the current project and come back to the home view (Figure 2. ST MC workbench – GUI (Home view)). When not already saved, a confirmation window pops up (Figure 14) asking the user to save the current project or not, as well as to cancel the action, then go back to the hardware configuration window (Figure 13).

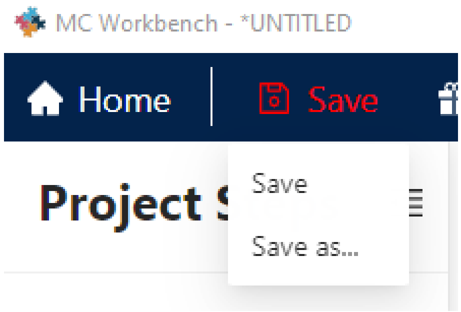
Figure 14. ST MC workbench – Close project confirmation window



3.4.1.2 *Save*

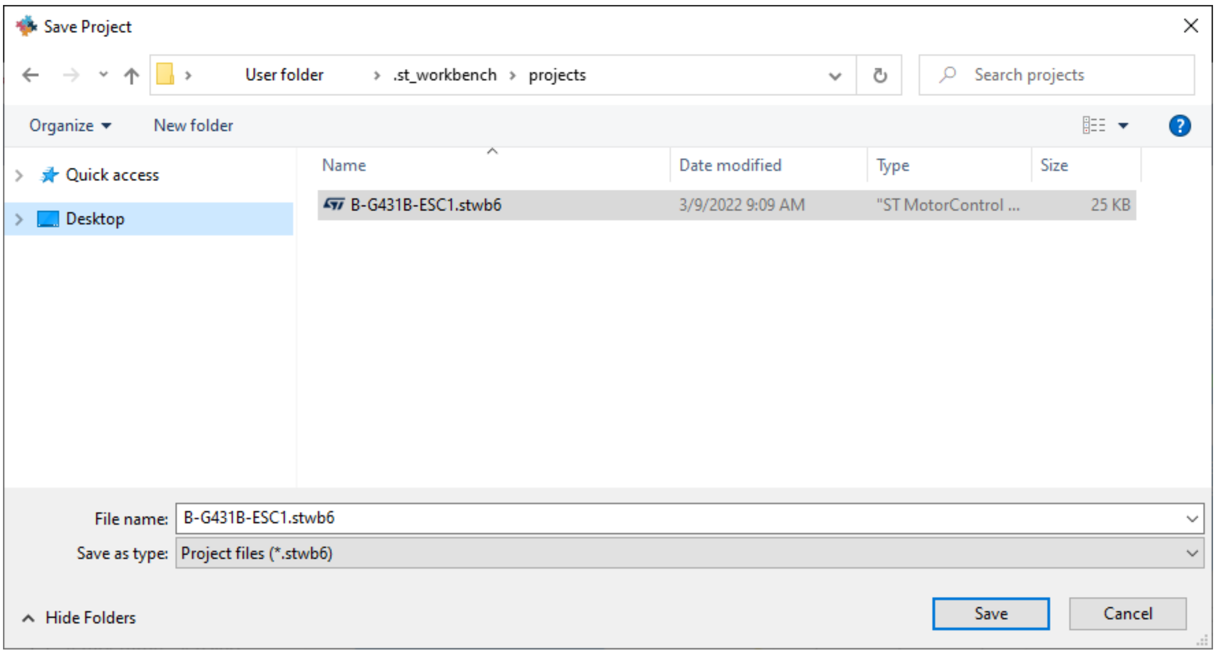
Click Save to open the *Save* menu.

Figure 15. ST MC workbench – Save menu



- *Save*: Saves the user's current project. When not already saved, a file manager window pops up to save the user's current project as a new one (Figure 16).
- *Save as…*: Saves the user project as a new file. A file manager window pops up to save the user project as a new one (Figure 16).

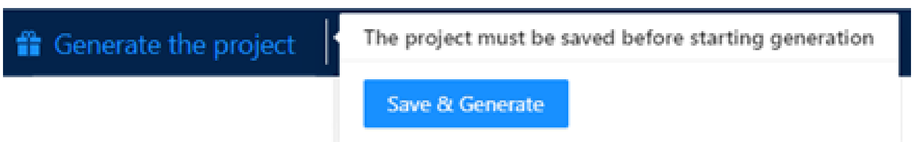
Figure 16. ST MC workbench – Project save as window



3.4.1.3 *Generate the project*

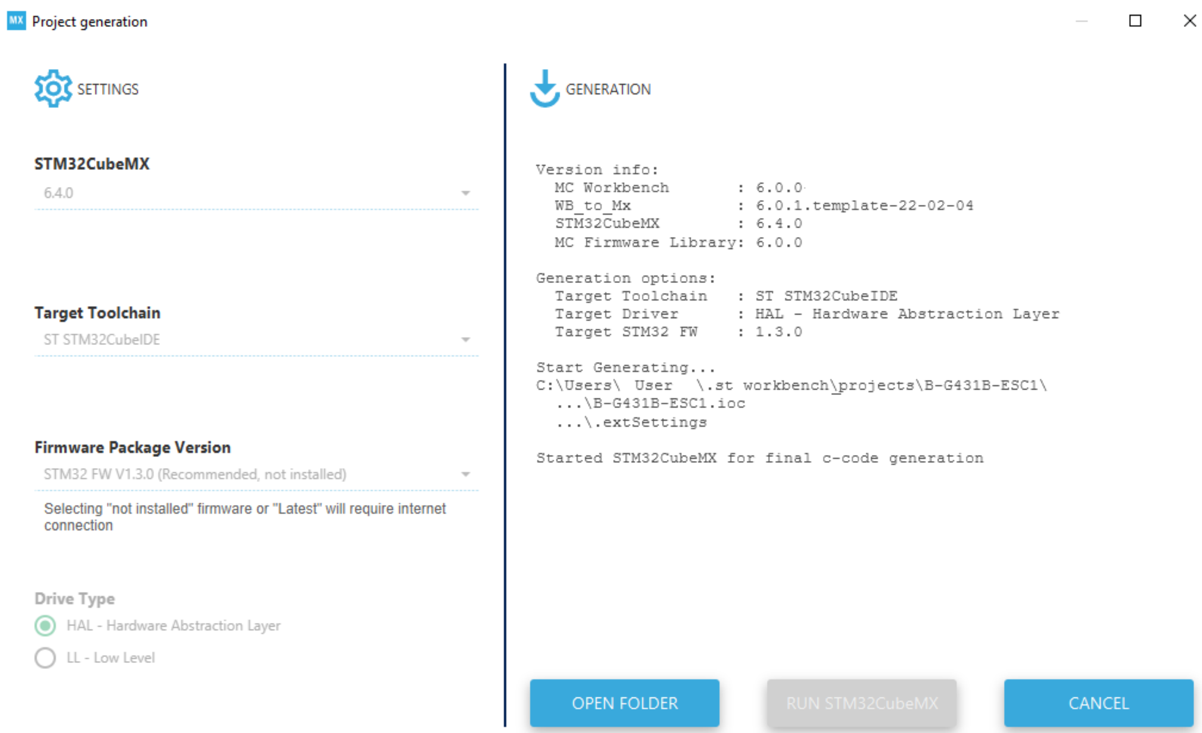
Clicking Generate the project generates the user application project files. If the project file is not already saved, an information window pops up to indicate that this project needs to be saved before to generate. Use the *Save & Generate* button to save and generate.

Figure 17. ST MC workbench – Save and generate



A window pops up (Figure 18) to allow the user to select the target toolchain, firmware package version, drive type, and generate the motor-control firmware application throw the selected STM32CubeMX.

Figure 18. ST MC workbench – Project generation



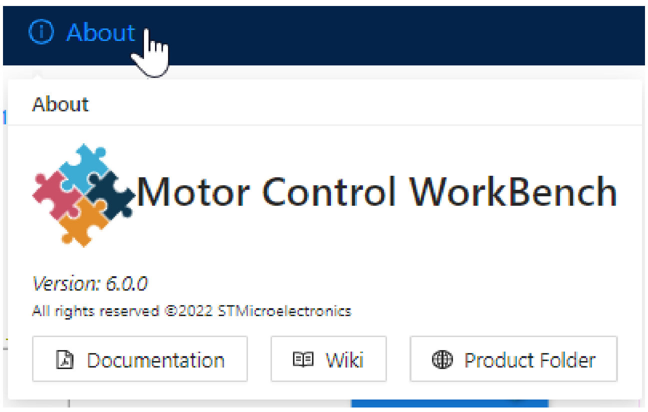
3.4.1.4 *Motor Pilot*

Clicking the *Motor Pilot* toolbar button launches the motor pilot application.

3.4.1.5 *About*

Clicking the *About* menu opens a window showing some application information and useful links.

Figure 19. ST MC workbench – About



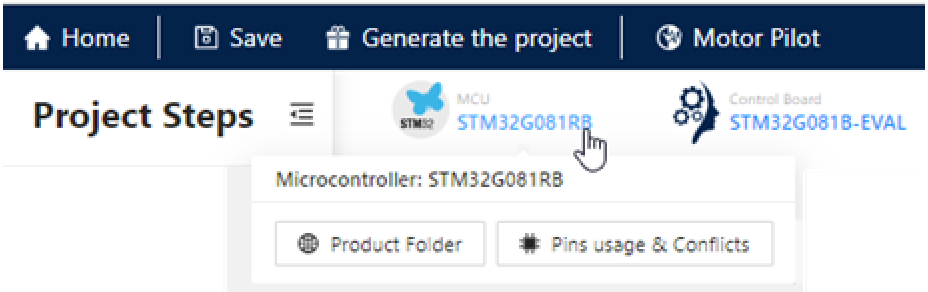
3.4.2 Hardware information area

Hardware information for the current project is presented in this area.

3.4.2.1 MCU pin usage and conflicts

Moving over MCU a window pop-up is shown (Figure 20):

Figure 20. ST MC workbench – MCU



- *Product Folder*: Clicking it opens the product folder page for the MCU selected.
- *Pin usage & Conflicts*: To control the pin assignment of the MCU and receive feedback about the pin conflicts (Figure 21).

Figure 21. ST MC workbench – Pin usage & Conflicts

Pins usage & Conflicts

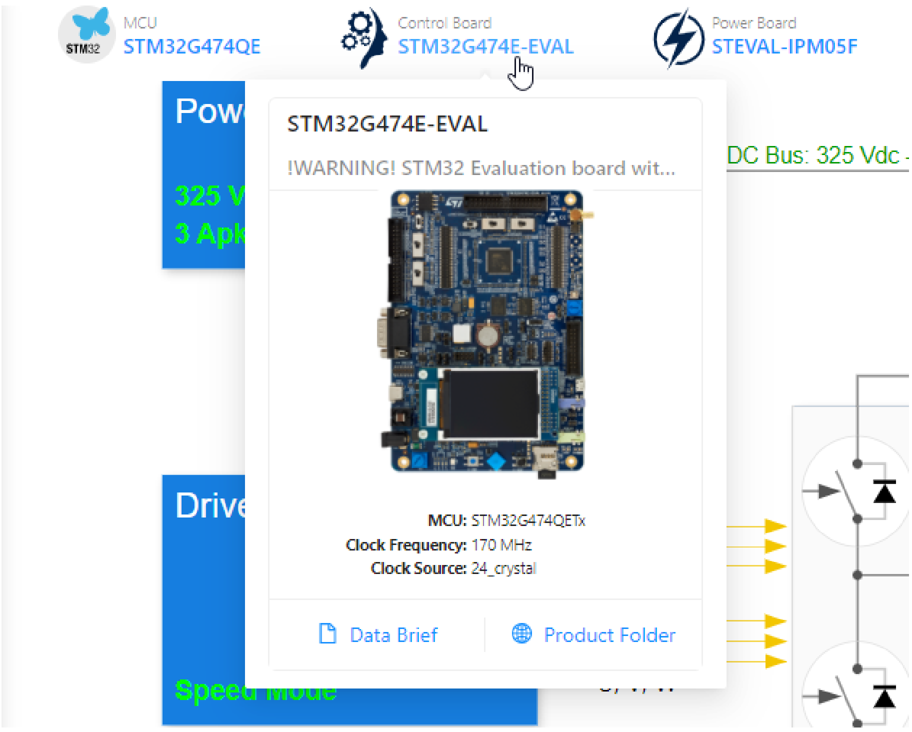
Conflicts	IP	Channel	Pin	Signal name
	USART3	TX	PC10	UART_TX
	USART3	RX	PC11	UART_RX
	ADC1	IN1	PA1	VBUS
	ADC1	IN3	PA3	TEMPERATURE_NTC
	TIM1	CH1	PA8	PWM_CHU_H
	TIM1	CH2	PA9	PWM_CHV_H
	TIM1	CH3	PA10	PWM_CHW_H
	TIM1	CH1N	PD2	PWM_CHU_L
	TIM1	CH2N	PD3	PWM_CHV_L
	TIM1	CH3N	PD4	PWM_CHW_L
	ADC1	IN2	PA2	CURRENT_AMPL_U
	ADC1	IN6	PA6	CURRENT_AMPL_V
	ADC1	IN11	PB10	CURRENT_AMPL_W
	TIM1	BK	PB12	OC_TRIGGER

3.4.2.2 Control Board

Moving over *Control Board* a window pops up to give general information about the control board selected and it shows:

- *Data Brief* folder: Clicking it opens the relative data brief.
- *Product Folder*: Clicking it opens the relative product folder page.

Figure 22. **ST MC workbench – Control board**



3.4.2.3 *Power board*

Moving over *Power Board*, a window pops up, gives general information about the selected power board, and shows:

- *Data Brief* folder: Clicking it opens the relative data brief page.
- *Product Folder*: Clicking it opens the relative product folder page.

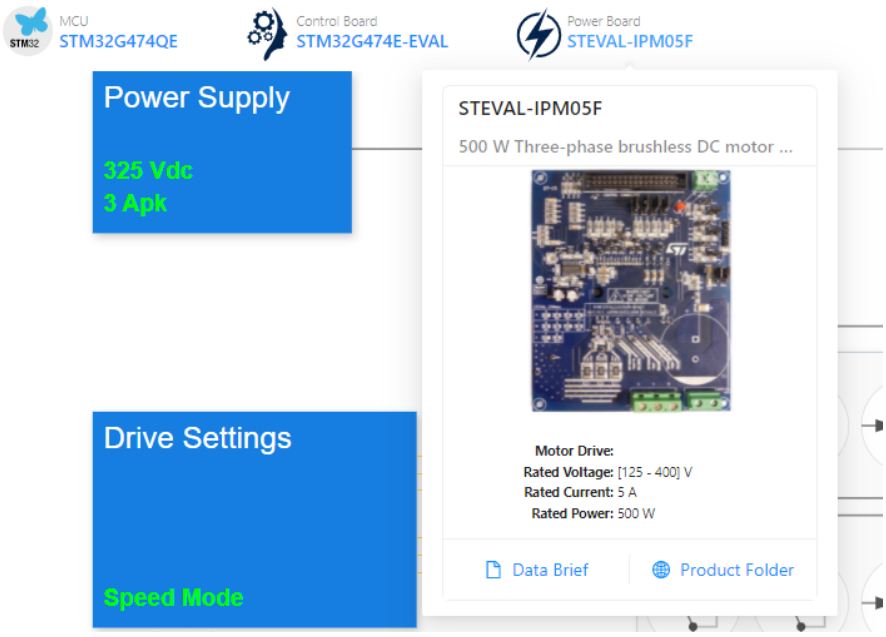


Figure 23. ST MC workbench – Power board

3.4.3 Project steps and hardware configuration details

All the hardware configurations alternatives depend on the hardware selected and are accessible from the wizard steps. The wizard steps are available from the left application pane (*Project Steps* area) as well as from the hardware configuration details area (main project view) by clicking the boxes. The information shown in the schematic is aligned with the wizard steps choices.

3.5 Project wizard

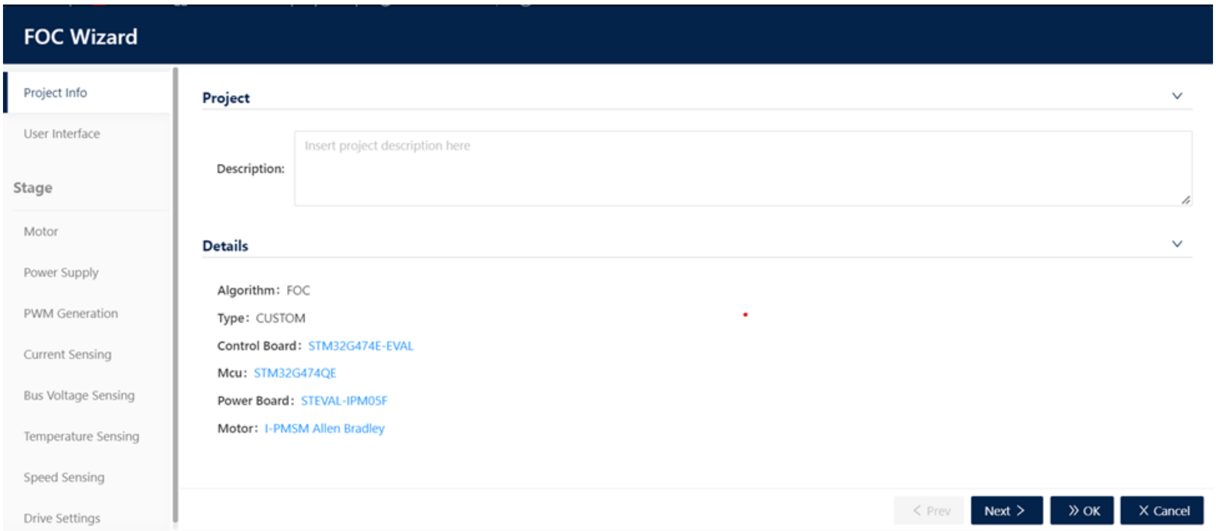
The project wizard is accessible from the left pane items or the relative main schematic view. Clicking one of these items displays the full wizard pops up and the relative step. The wizard is customized depending on the selected algorithm and in any case all the steps are available, and the user can move over all of them. The project wizard is the smart way to customize and configure the motor-control application for the hardware selected. Each wizard step contains several checks and info that help the user to make the right configurations. In case of errors, the wizard does not allow the project update and asks the user to fix the errors before applying the changes. In any case, if there are errors, the firmware project generation is not allowed.

The step sequence on the wizard has a special meaning: the values of a field on a step can depend only on fields on previous steps (and not for the forward steps). The field sequence dependency is also followed inside each step: it is from top to bottom and from left to right.

3.5.1 Product Info

This is a common step where the user can set the project description, to better identify the project, specifying project characteristics and extra-user information. The project description is also visible as a small pop-up icon in the recent project list (Area 2 in Figure 2. ST MC workbench – GUI (Home view)).

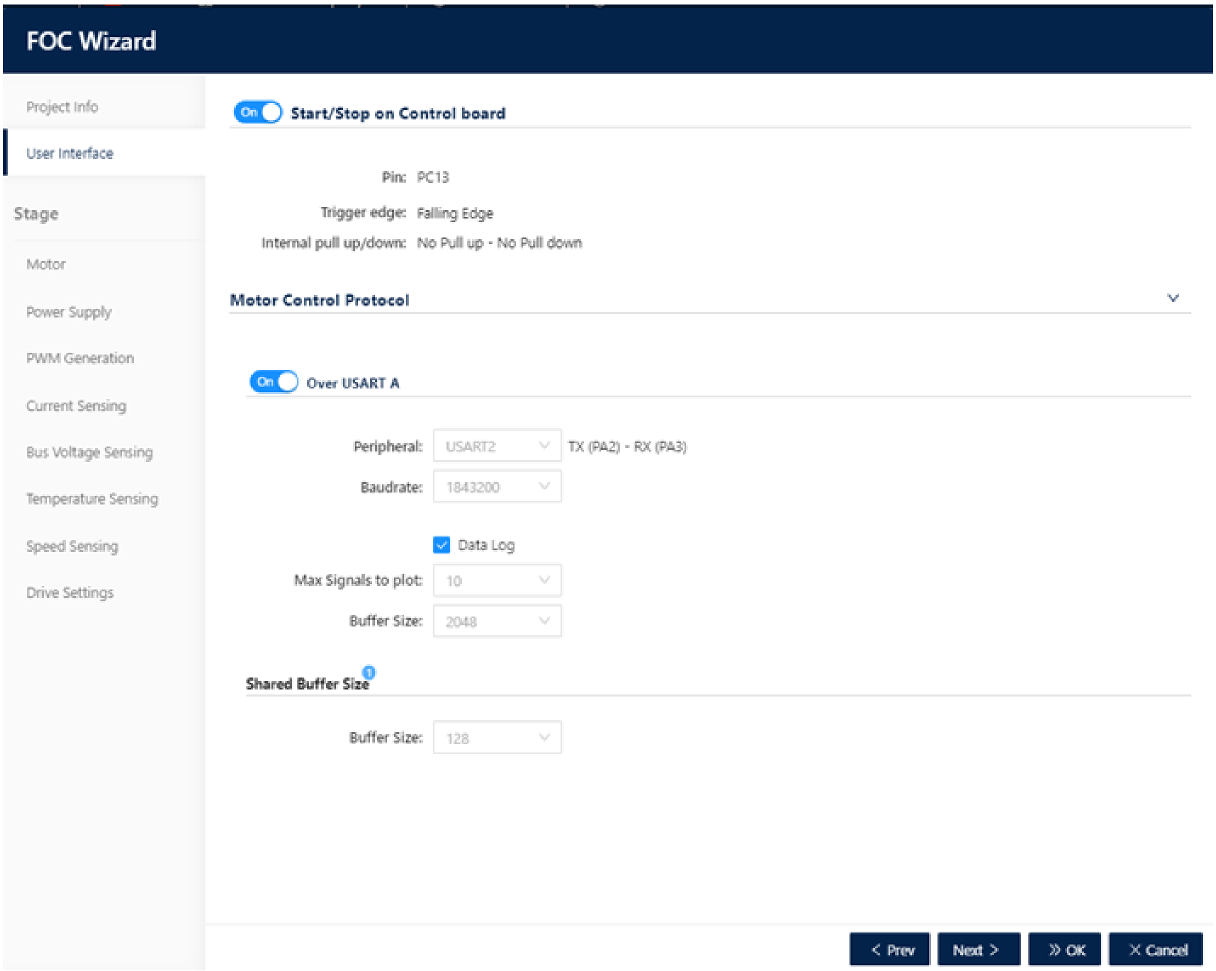
Figure 24. **ST MC workbench – Project Info**



3.5.2 User Interface

This is a common step where the user can configure the *Start and Stop button* and the *Motor Control Protocol (MCP)*, if these features are available for the selected hardware.

Figure 25. **ST MC workbench – User interface**



The user can change only the configurations that are available for the specific selected hardware. In the case shown in Figure 25, the Start/Stop is available only on the PC13 pin. If the hardware selected allows more possibilities a combo is available to allow the user to select the right pin to use. The Start/Stop feature can be disabled if the user does not want to use it.

3.5.3 Motor

This step is relative to the motor parameters. The default values are loaded from the selected motor during the creation of the project (Figure 5. ST MC workbench – New project window – Motors). The user can modify each motor parameter (Figure 26) and activate and configure the Hall sensor or quadrature encoder for the used motor (Figure 27).

Figure 26. ST MC workbench – Motor

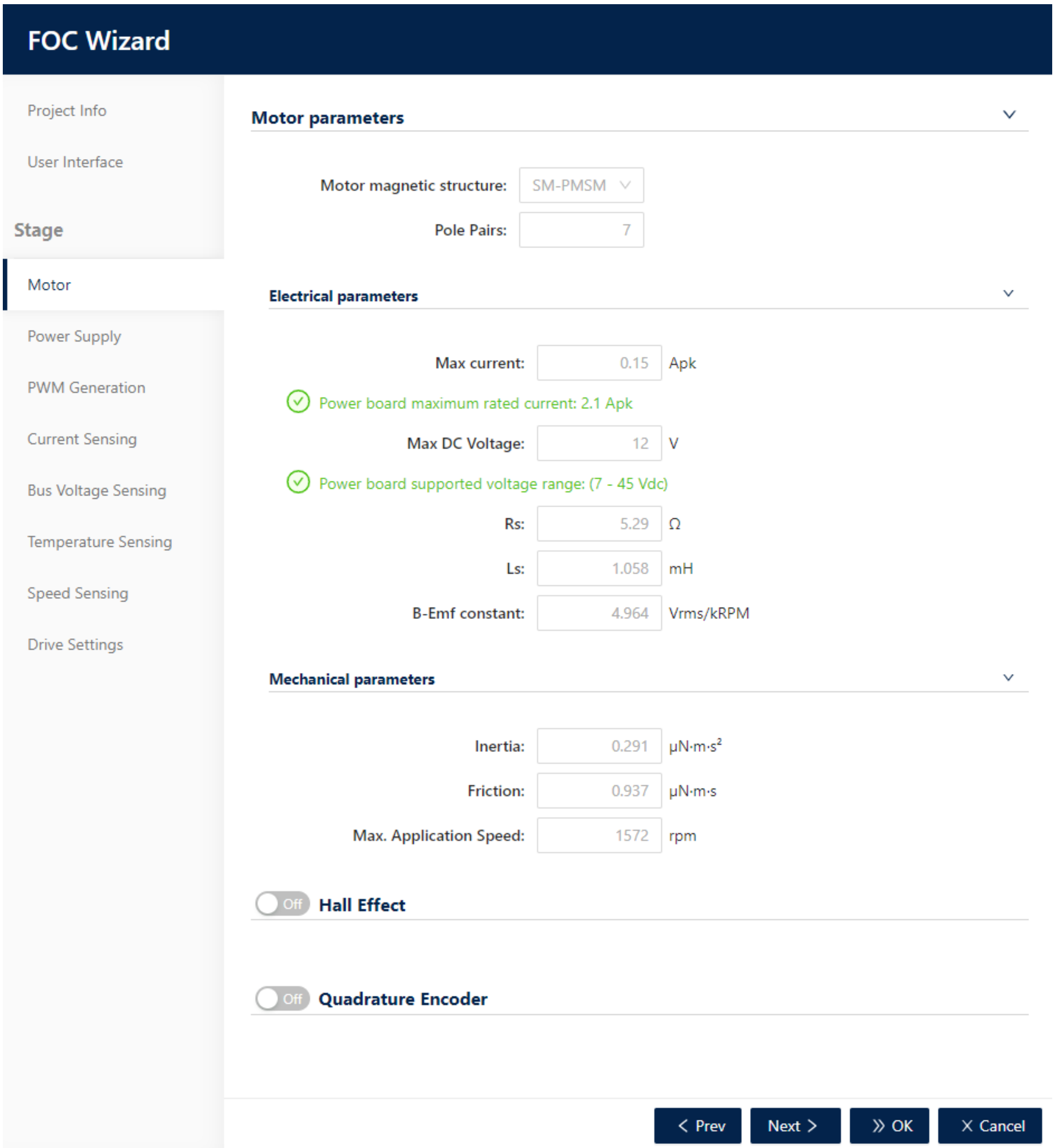
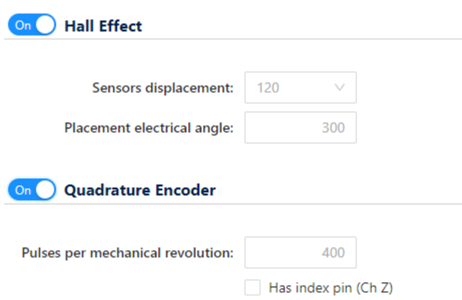


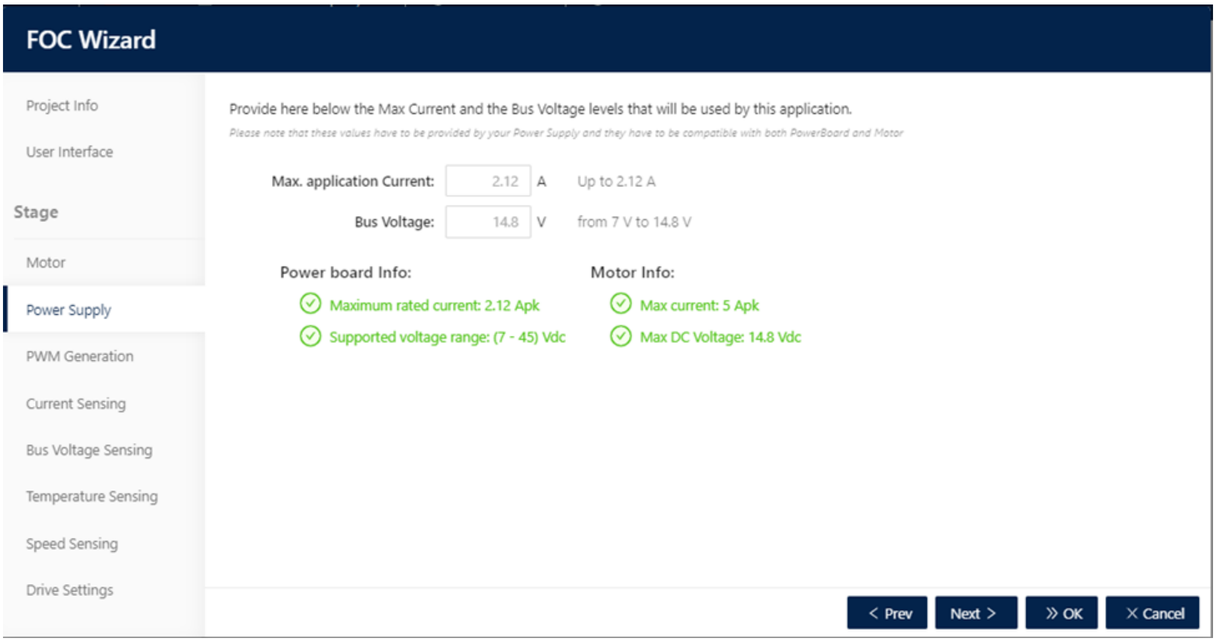
Figure 27. ST MC workbench – Motor – Hall effect – Quadrature encoder



3.5.4 Power Supply

In this step, the *Max. application Current* and the *Bus Voltage* levels that are used by the application can be set. The values in this step must be the ones provided by the power supply and must be compatible with the power board and motor.

Figure 28. ST MC workbench – Power supply



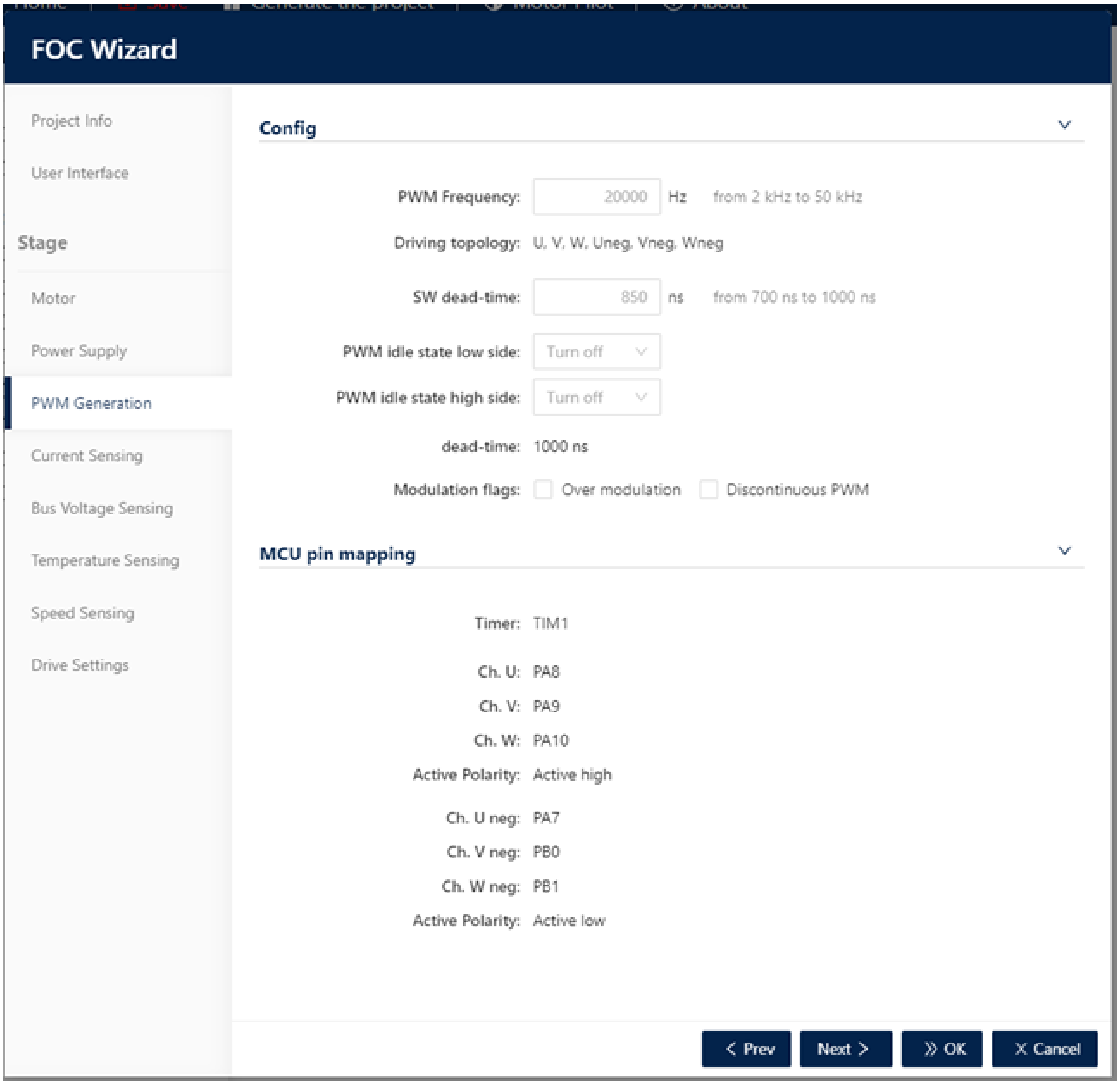
3.5.5 PWM Generation

In this step, the user can select the PWM driving topology available for the selected hardware, PWM frequency, modulation flags, and the MCU pin configuration for the topology used. For different driving topologies, different configurations are available.

3.5.5.1 *High and low side topology*

Figure 29 shows the step for high and low side driving topology.

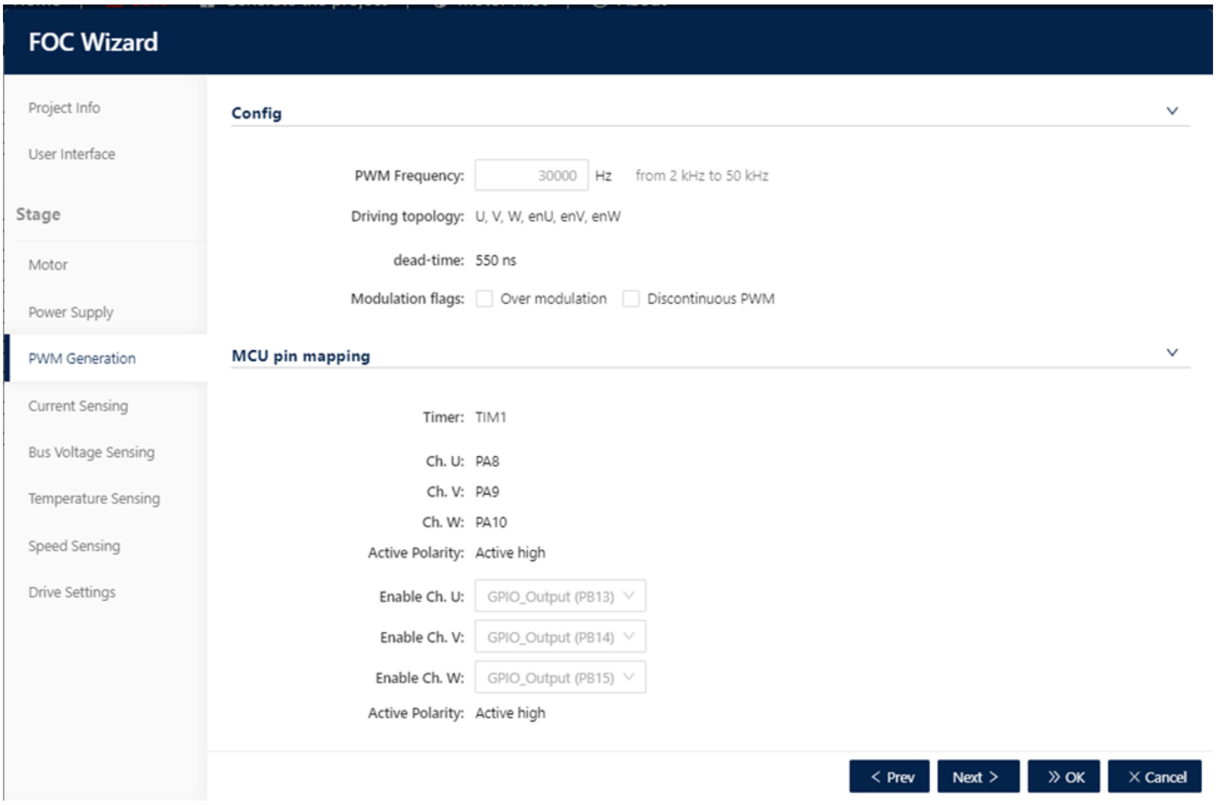
Figure 29. ST MC workbench - PWM Generation - High and low side



3.5.5.2 *High side and three-enable topology*

Figure 30 shows the step for the high side and three-enables driving topology.

Figure 30. ST MC workbench – PWM generation – High side and three enables



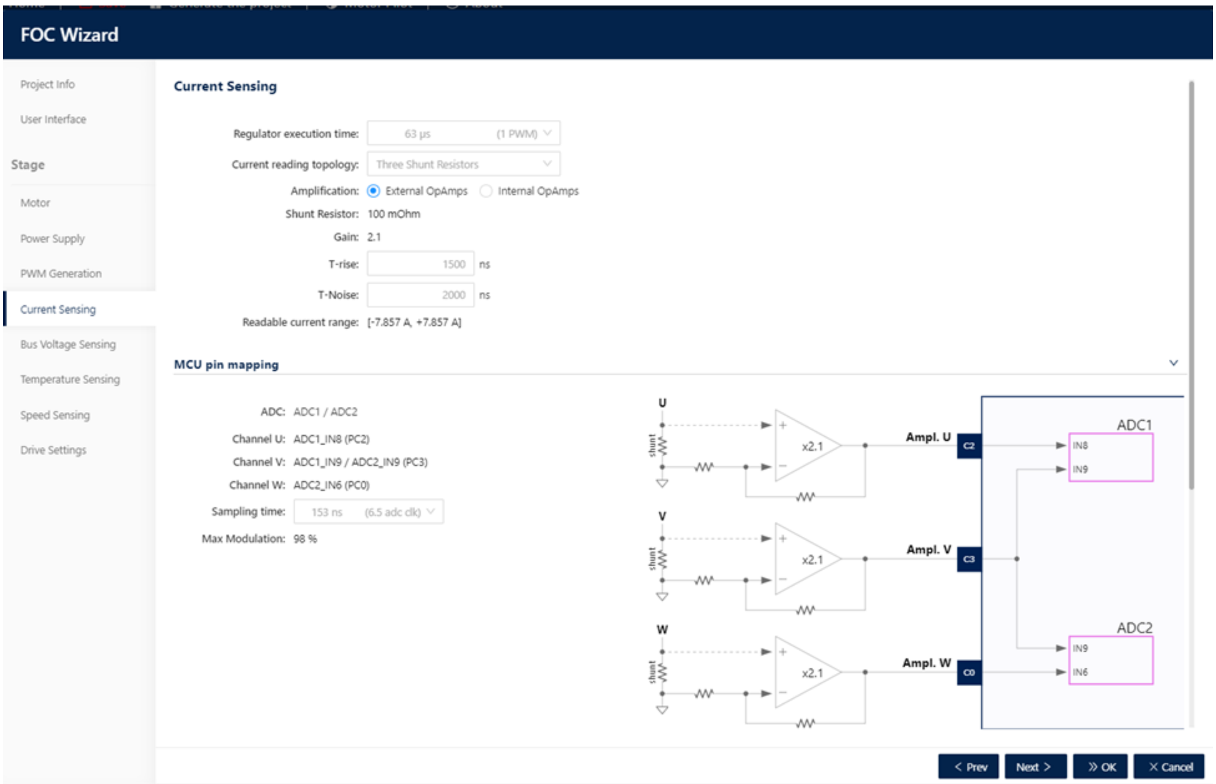
3.5.6 Current Sensing

In this step, the user can select the available current reading topology and amplification (Figure 31). Depending on topology, amplification, and gain, the user is prompted with the relative fields to set and MCU Pin for that configuration, a schema shows the configuration graphically selected. The information on the step depends also on the selected algorithm (FOC or 6-step).

3.5.6.1 *FOC 3-shunt external amplification*

In this Current Sensing topology, the user can set the regulator execution time, T-Rise, and T-Noise. The current amplification in this case is done on the power board. Figure 31 shows the configuration.

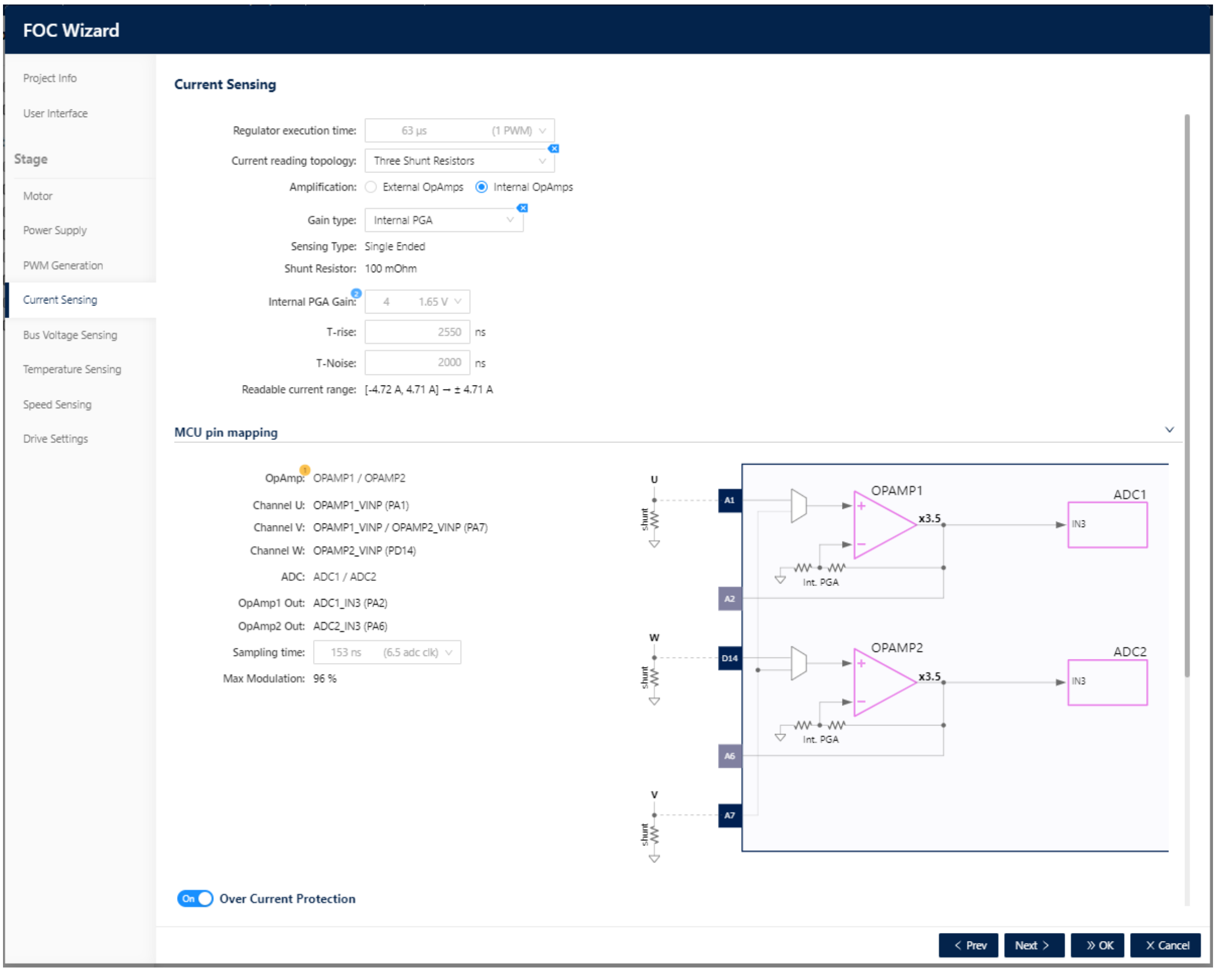
Figure 31. ST MC workbench – Current sensing – FOC 3-shunt external amplification



3.5.6.2 *FOC 3-shunt internal amplification - Internal Gain*

In this Current Sensing topology, the user can set the regulator execution time, the internal PGA gain factor, the T-Rise and T-Noise. In this case, the current amplification is done using an internal MCU operational amplifier. Figure 32 shows the configuration.

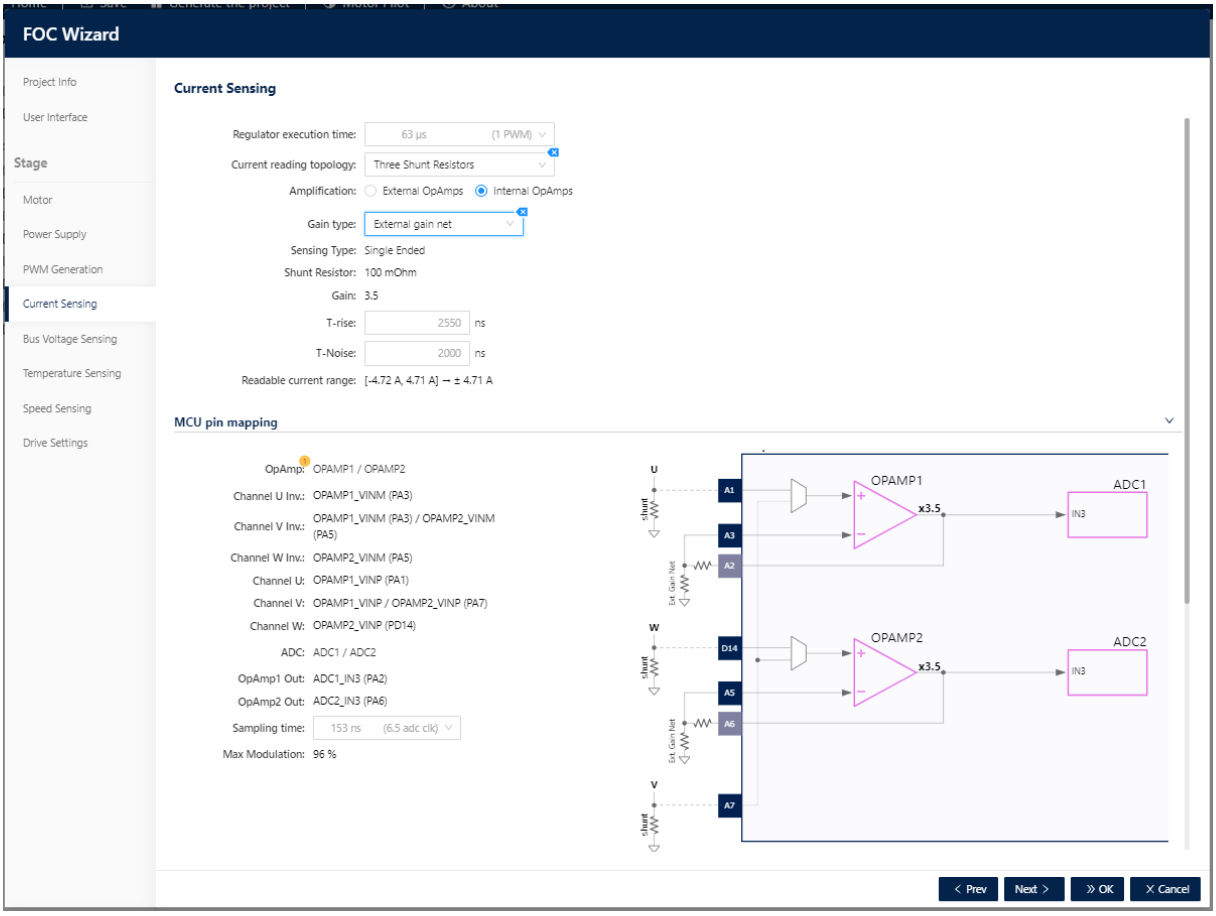
Figure 32. ST MC workbench – Current sensing – FOC 3-shunt internal amplification – Internal gain



3.5.6.3 *FOC 3-shunt internal amplification - External gain*

In this current-sensing topology, the user can set the regulator execution time, and the T-Rise and T-Noise. In this case, the current amplification is done using an internal MCU operational amplifier. The gain depends on the gain net in the control board. Figure 33 shows the configuration.

Figure 33. ST MC workbench – Current sensing – FOC 3-shunt internal amplification – External gain



3.5.6.4 6-step current mode

This is only available for the 6-step algorithm and the user can enable or disable the current mode. The current mode can be enabled only if the feature is available for the selected hardware (Figure 34). By default, the current mode is disabled (Figure 35).

Figure 34. ST MC workbench – 6-step – Current mode

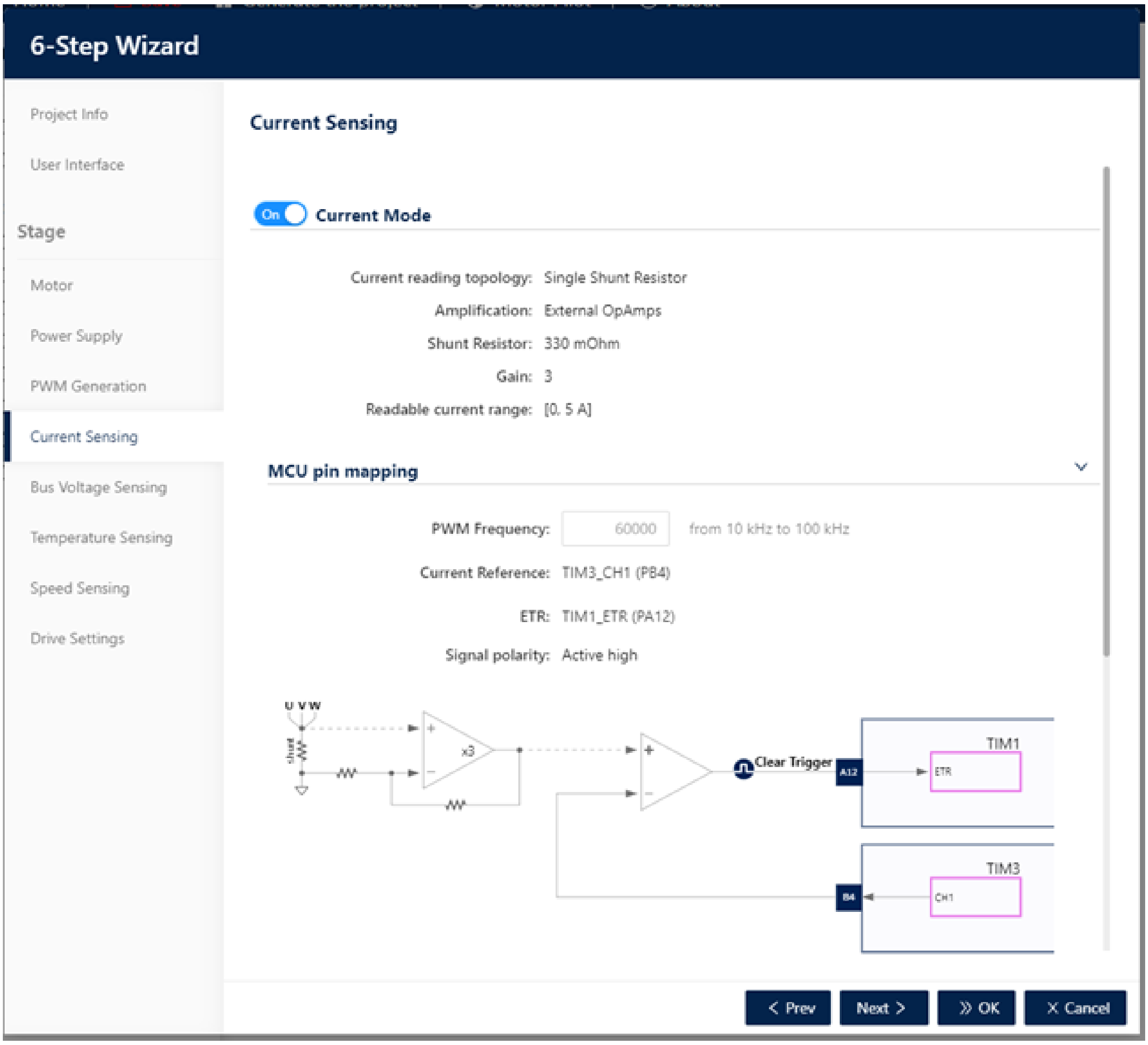
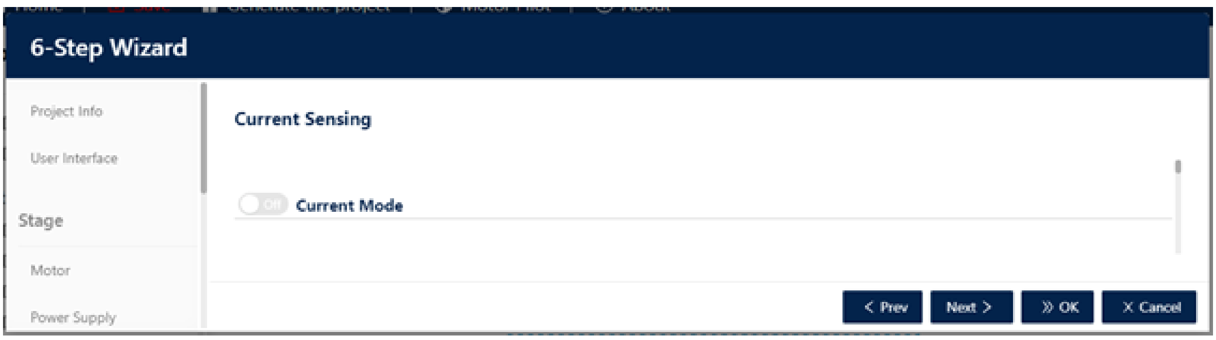


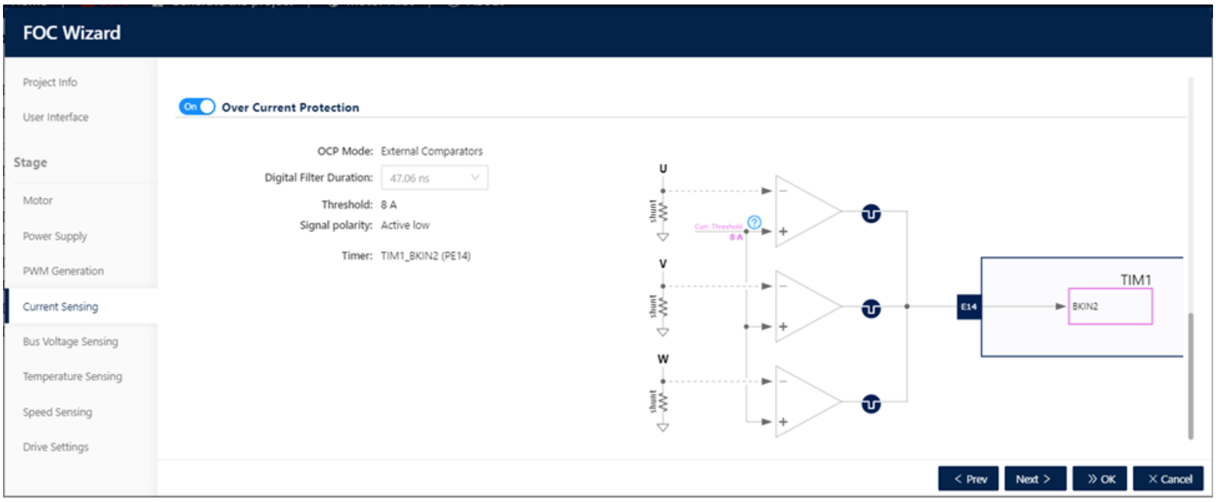
Figure 35. ST MC workbench – 6-step – Current mode disabled



3.5.6.5 *Over-current protection*

From the Current Sensing step, the user can enable and configure also the over-current protection (OCP) shown in Figure 36 the settings depend on the available OCP mode for the selected hardware. A *generic* schema will show the hardware connections between signals and the MCU.

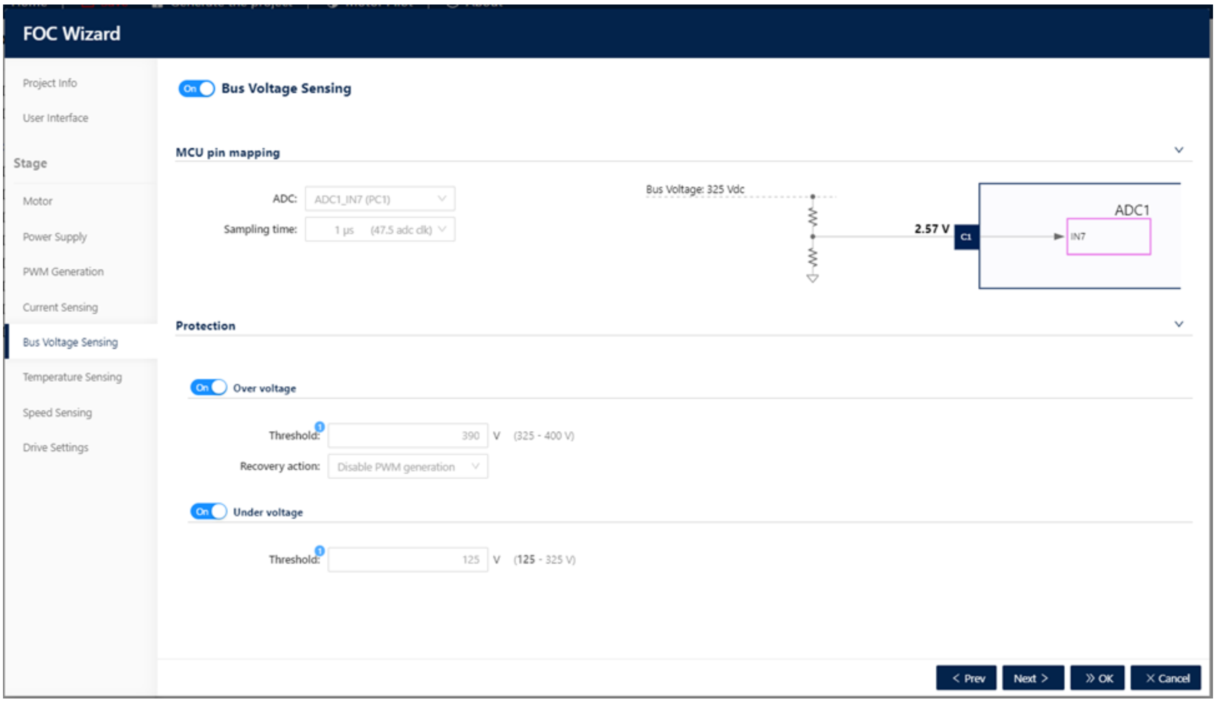
Figure 36. **ST MC workbench – Current sensing – Over-current protection**



3.5.7 Bus voltage sensing

In the *Bus Voltage Sensing* step, the user can configure the sensing of bus voltage if available for the hardware specified, and the relative Over Voltage and/or Under Voltage protection.

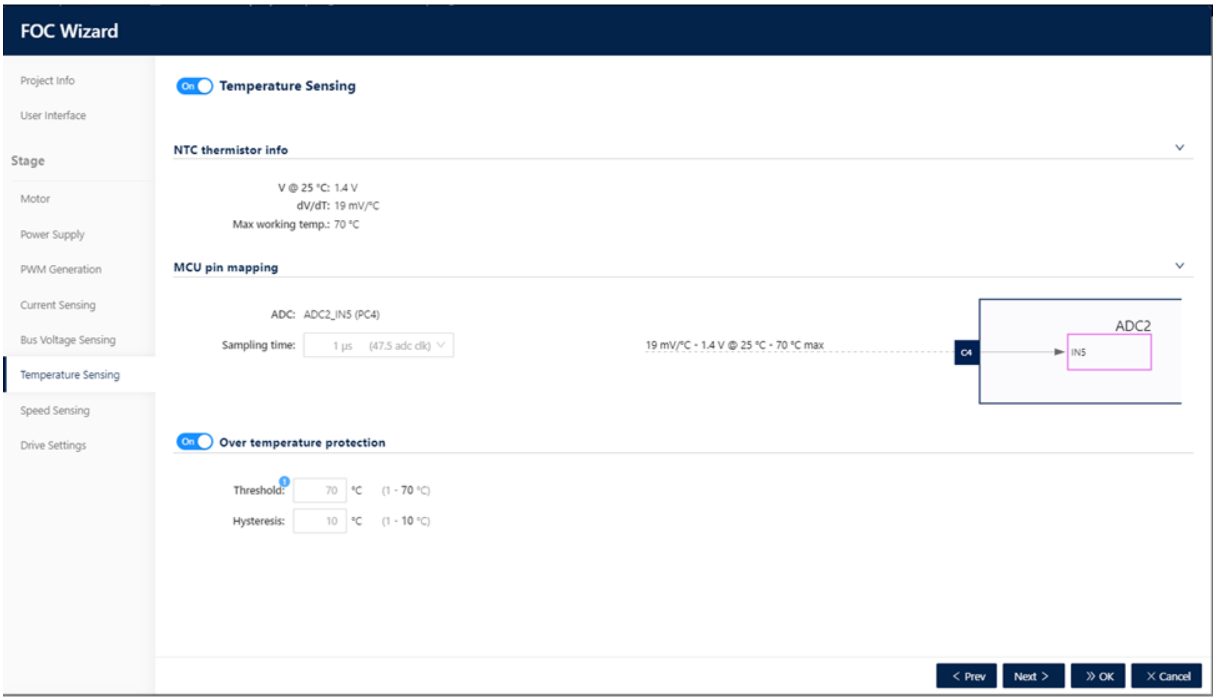
Figure 37. **ST MC workbench – Bus voltage sensing**



3.5.8 Temperature sensing

In the *Temperature Sensing* step, the user can configure the sensing of temperature if available for the specified hardware and the relative Over Temperature protection.

Figure 38. ST MC workbench – Temperature sensing



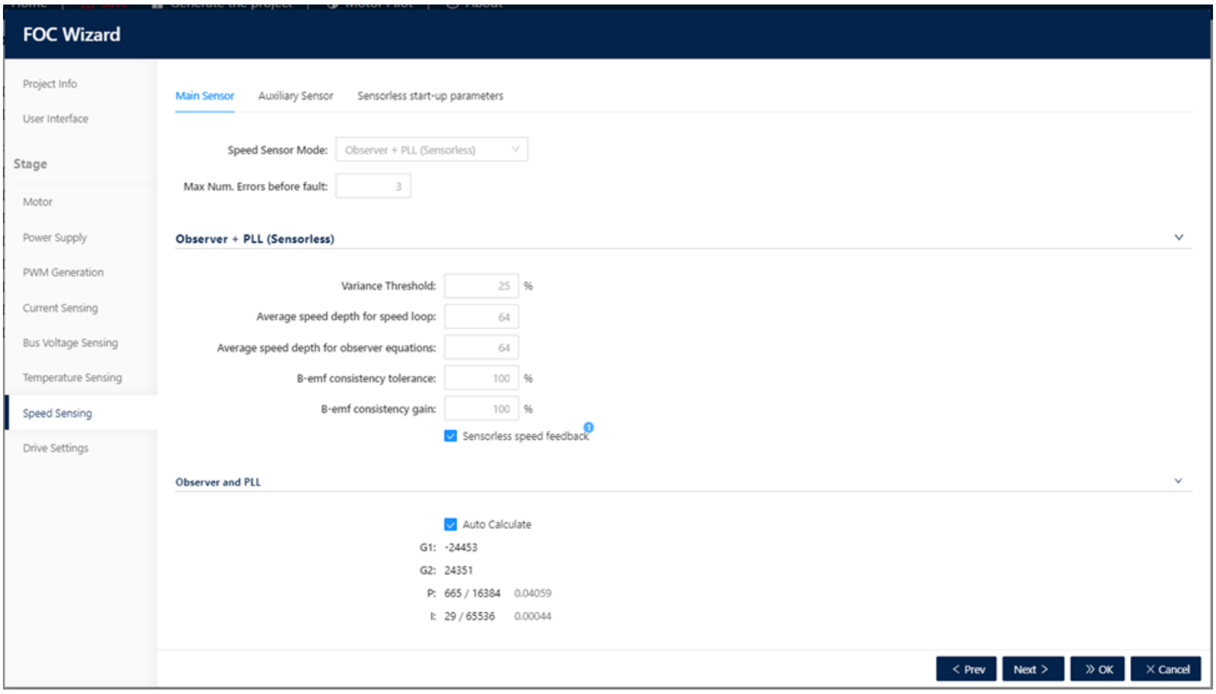
3.5.9 Speed-sensing

In the *Speed-Sensing* step, the user can select the speed sensing to use. There are different speed sensing modes that are available for both main and auxiliary sensors. The auxiliary sensor is optional and disabled by default. The speed sensing modes depend on the selected algorithm (FOC or 6-step).

3.5.9.1 *FOC observer with PLL (Sensorless)*

This speed sensing mode is the default for the main sensor and is always available.

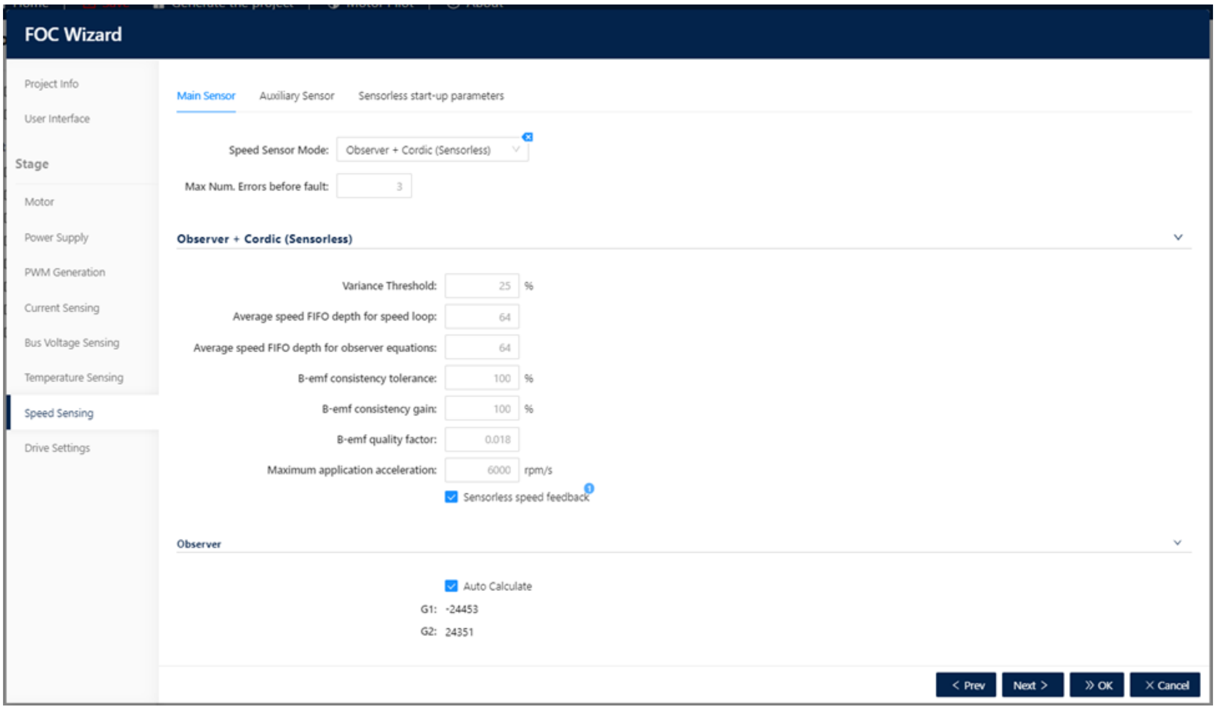
Figure 39. ST MC workbench – Speed-sensing – Observer PLL



3.5.9.2 *FOC observer with Cordic (Sensorless)*

This speed sensing mode is always available.

Figure 40. ST MC workbench – Speed-sensing – Observer Cordic



3.5.9.3 *FOC quadrature encoder*

This speed-sensor mode depends on hardware availability and motor capability. The motor must have the sensor enabled and the feature must be supported by the hardware.

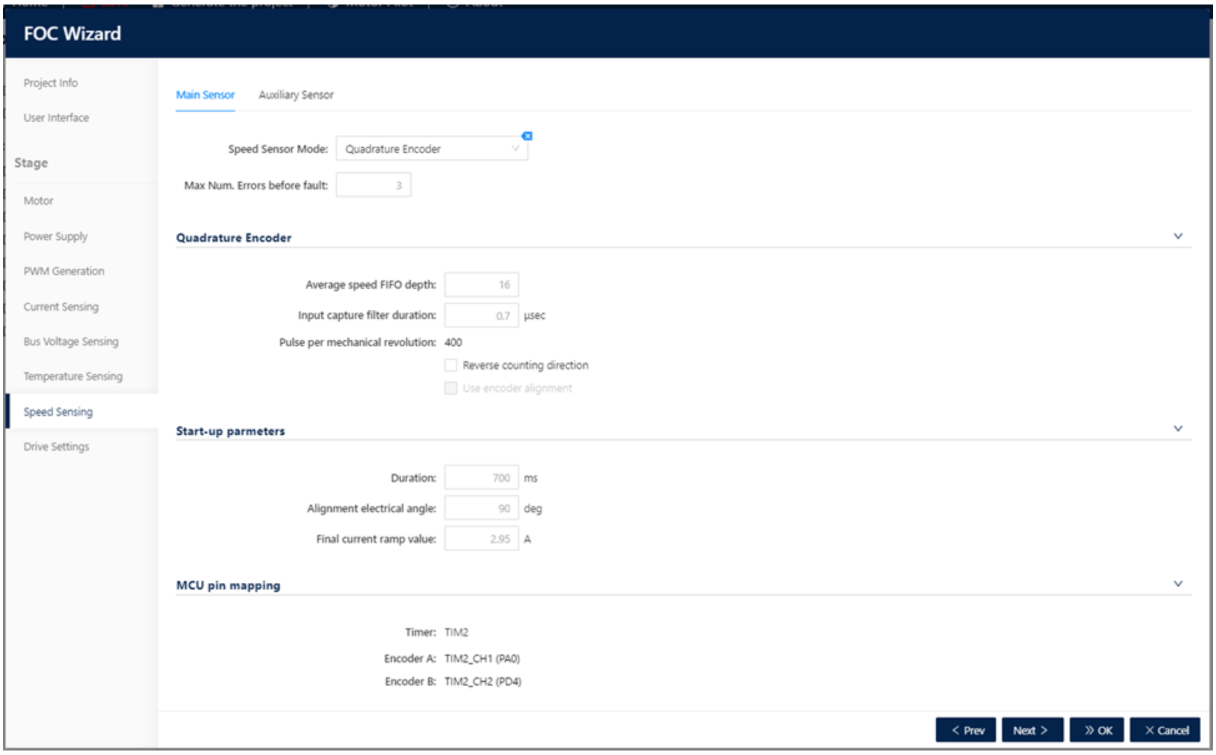
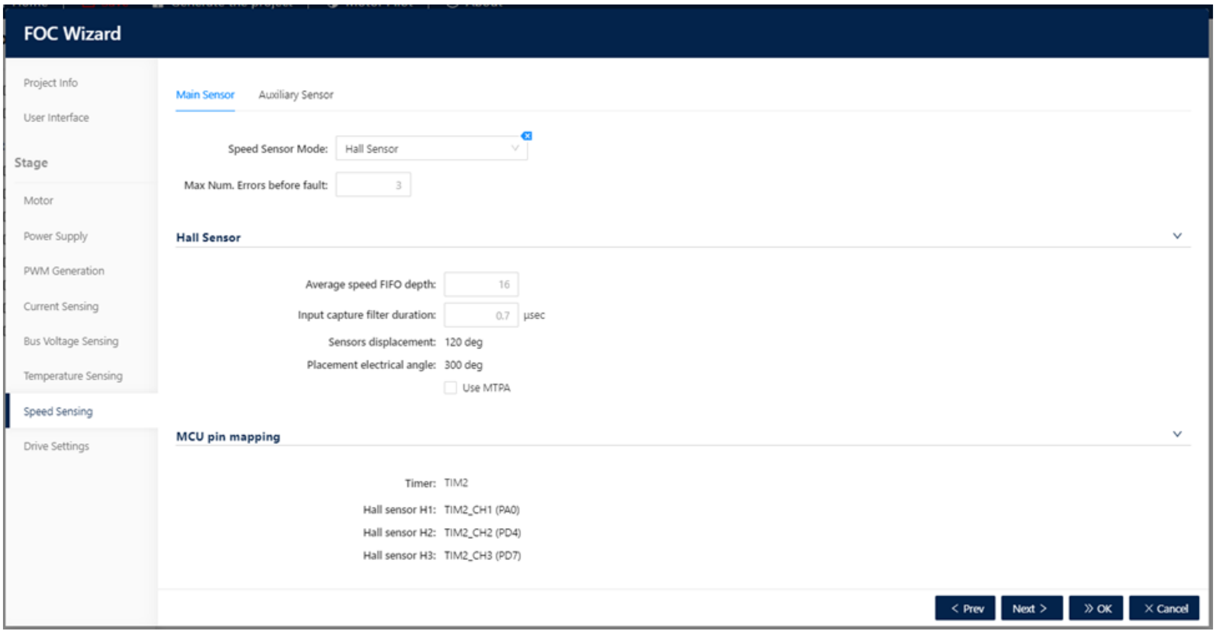


Figure 41. ST MC workbench – Speed-sensing – Quadrature encoder

3.5.9.4 *Hall sensor*

This speed sensor mode depends on hardware availability and motor capability. The sensor must be enabled for the motor and the hardware must support the feature. This speed sensor mode can be used in FOC and 6-step algorithms.

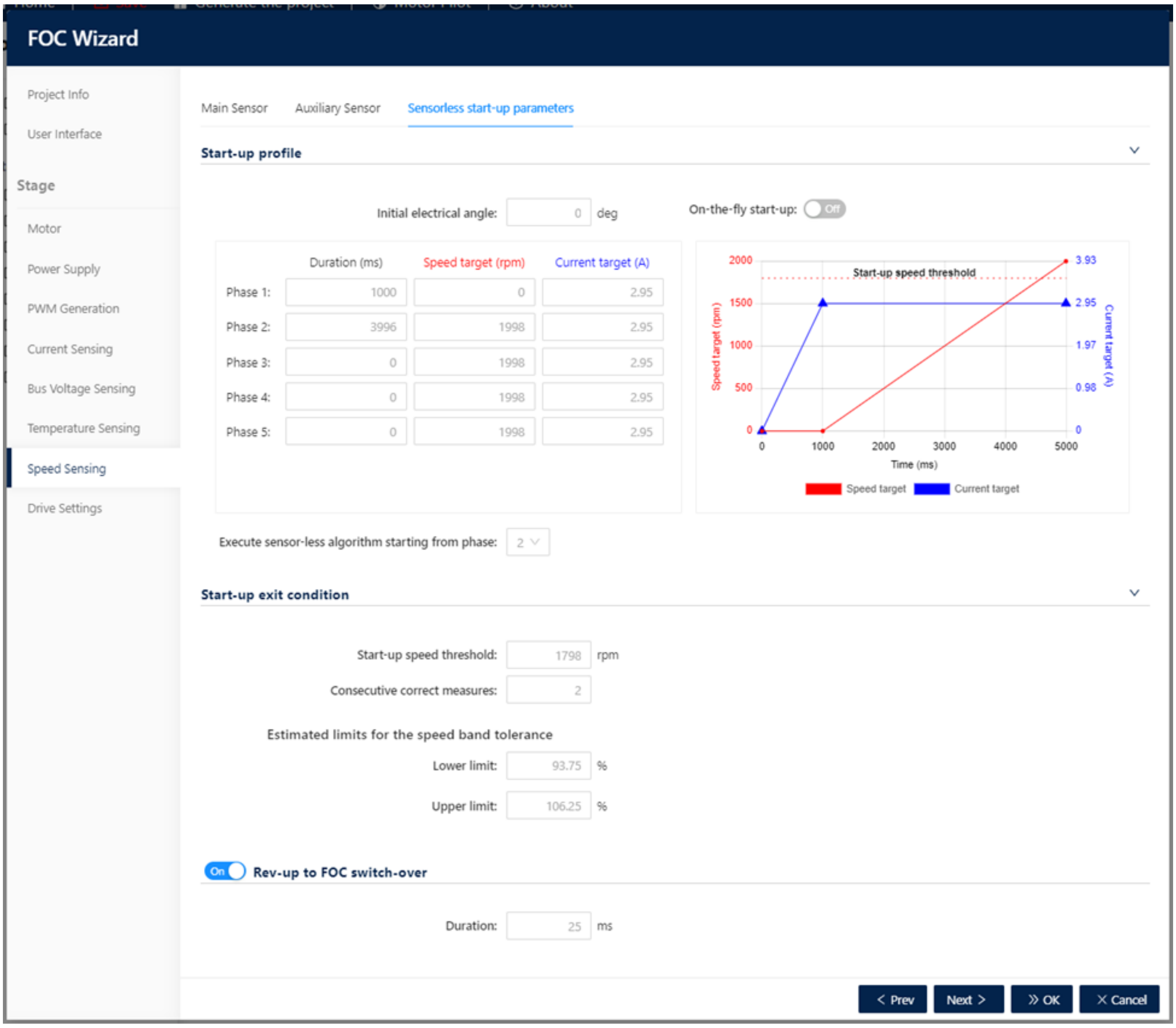
Figure 42. ST MC workbench – Speed-sensing – Hall sensor



3.5.9.5 *FOC sensor-less start-up parameters*

The settings of the sensor-less start-up parameters are available only if the main sensor selected is sensorless (Observer with PLL or observer with Cordic).

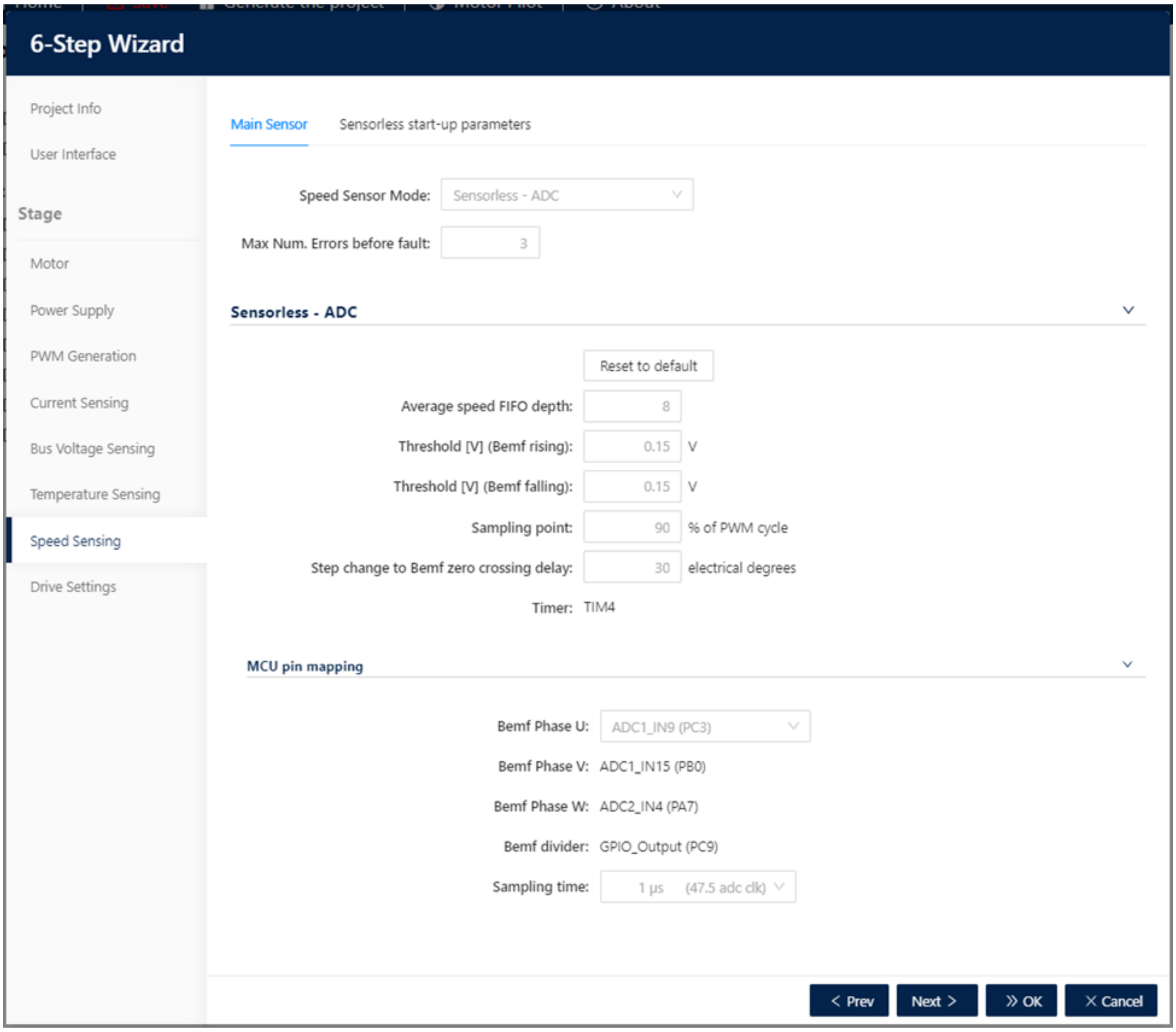
Figure 43. ST MC workbench – Speed-sensing – Sensor-less start-up parameters



3.5.9.6 *6-step sensor-less ADC*

Sensor-less ADC is a specific speed-sensing mode for the 6-step algorithm.

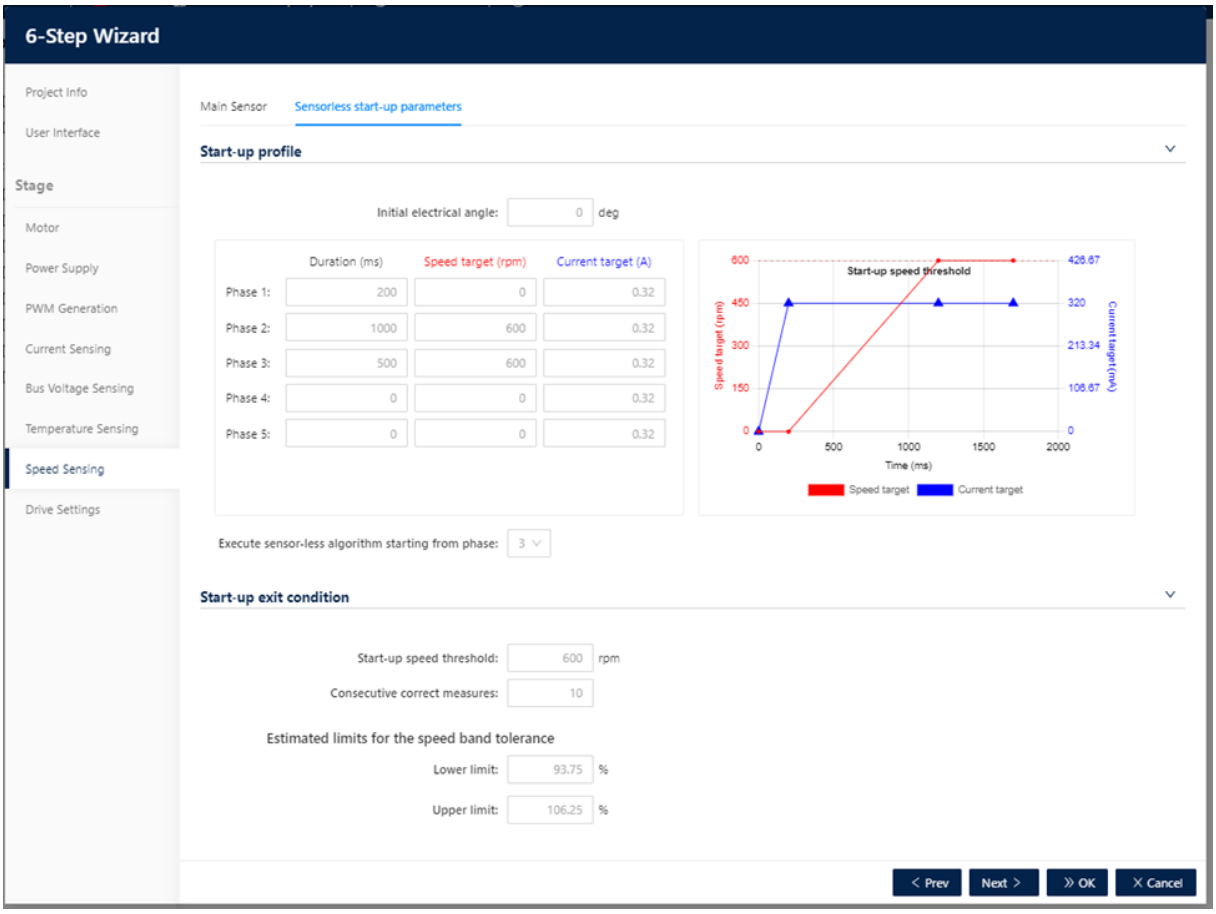
Figure 44. **ST MC workbench – 6-step sensor-less ADC**



3.5.9.7 *6-step sensorless start-up parameters*

The 6-step algorithm has specific *Sensorless Start-up parameters* settings, available if the selected speed-sensing mode is sensor-less-ADC.

Figure 45. ST MC workbench – 6-step – Sensor-less – Start-up parameters



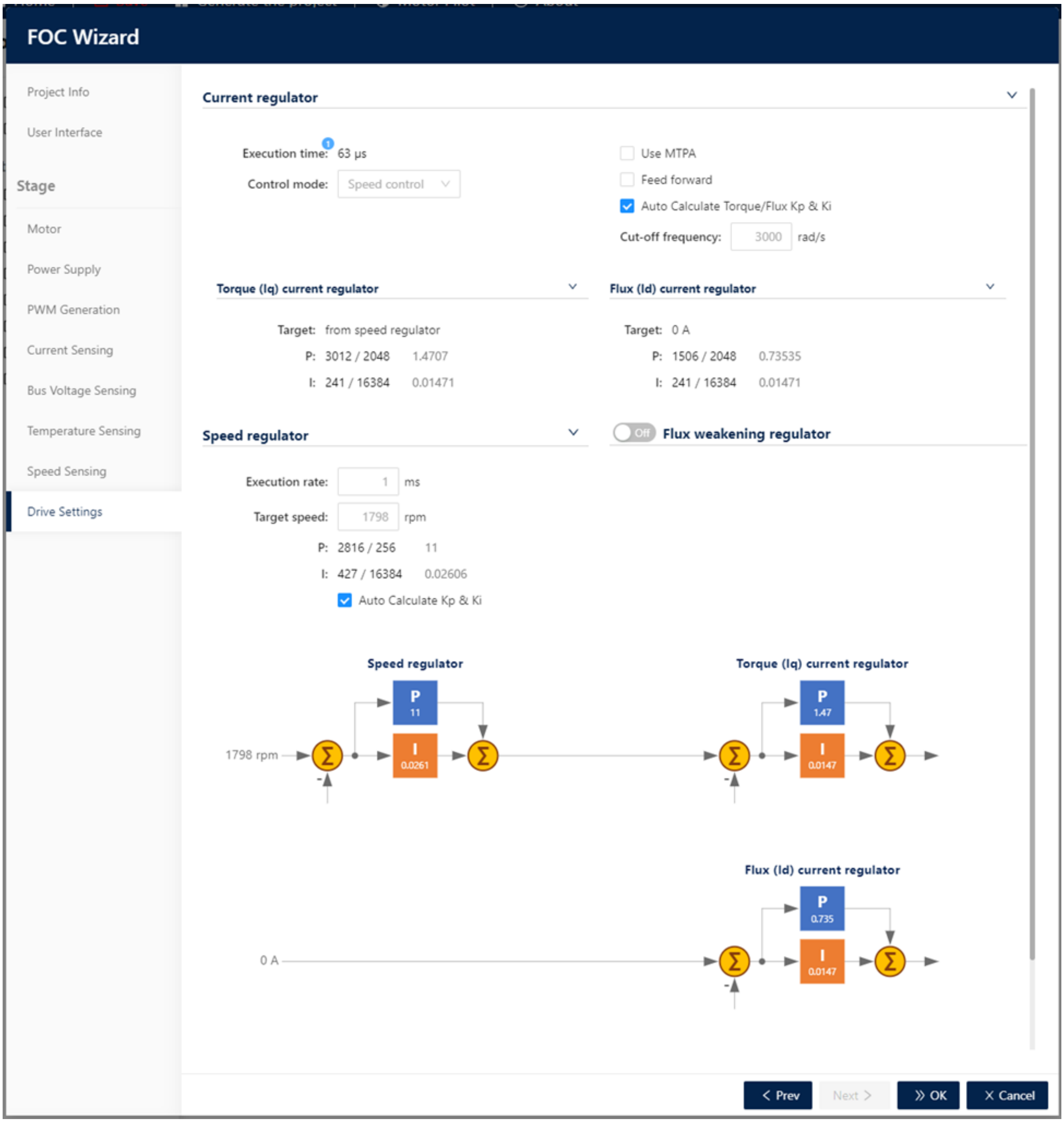
3.5.10 Drive settings

In the *Drive Settings* step, the user can configure the current regulator as one of the following three control modes.

3.5.10.1 *Speed control*

This *Drive Settings* mode is always available.

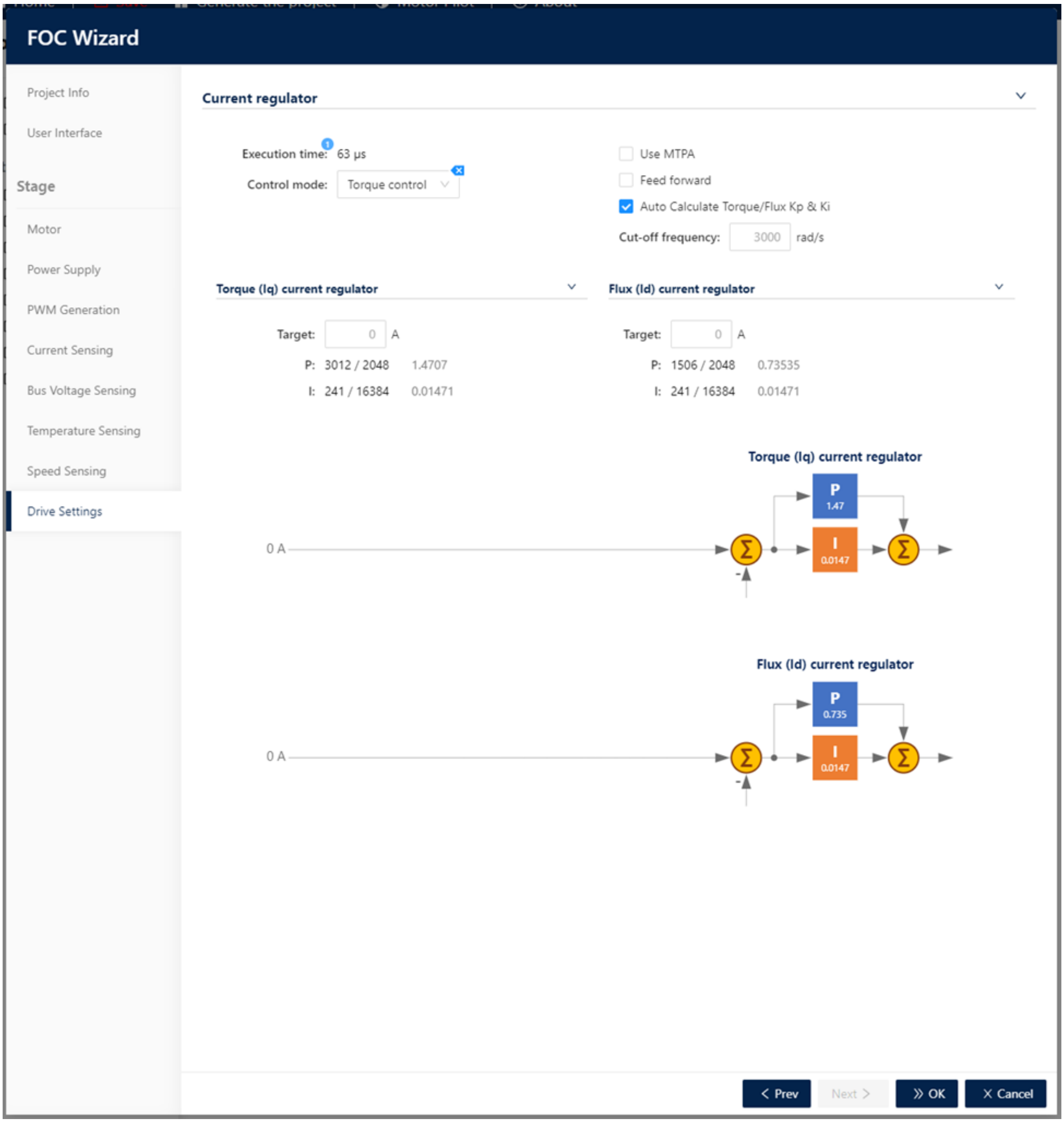
Figure 46. ST MC workbench – Drive settings – Speed control



3.5.10.2 *Torque control*

This *Drive Settings* mode is always available.

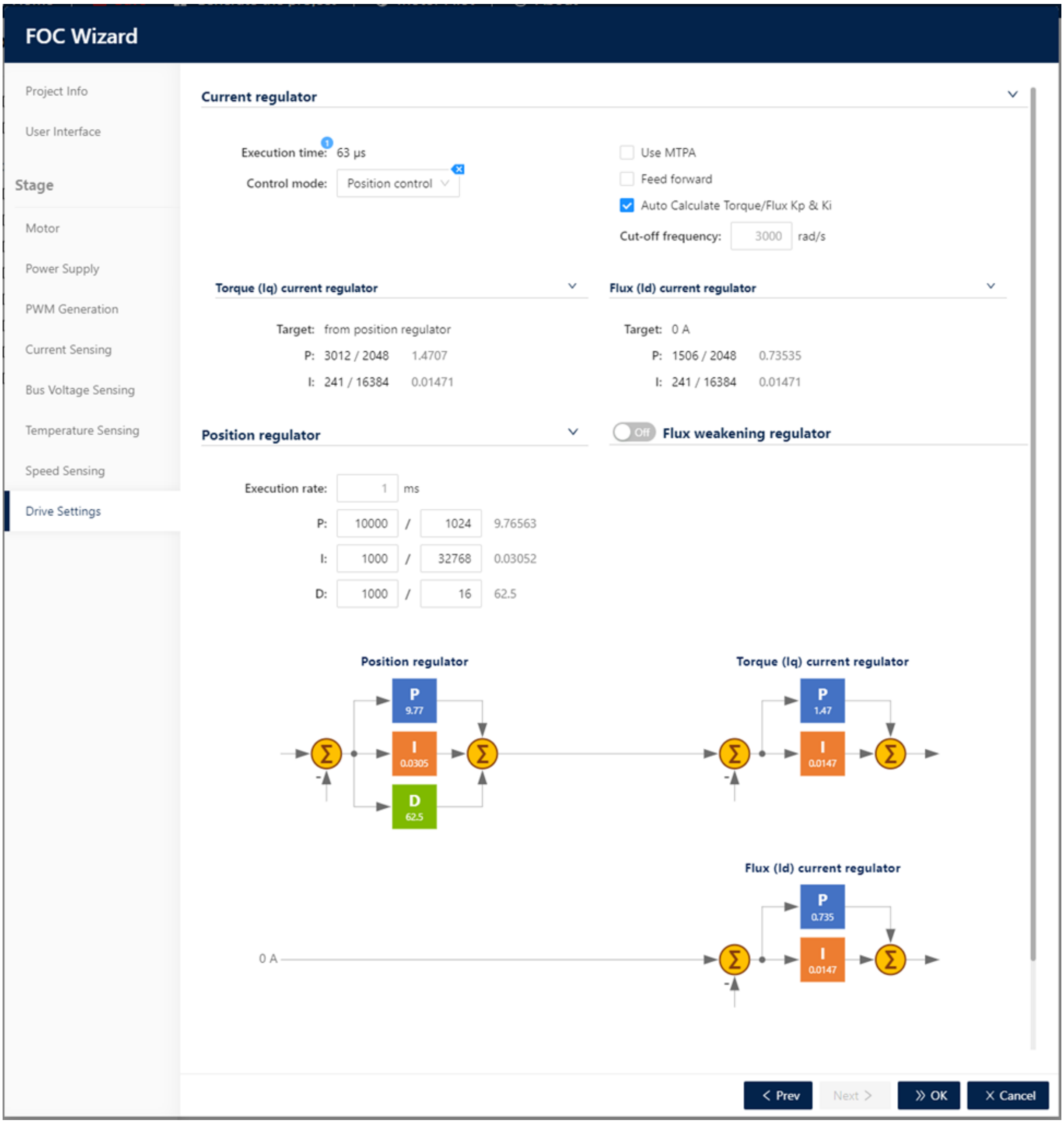
Figure 47. ST MC workbench – Drive Settings – Torque control



3.5.10.3 *Position control*

This *Drive Settings* mode is available only if the quadrature encoder is selected as the main speed-sensing sensor.

Figure 48. ST MC workbench – Drive settings – Position control



Revision history

Table 2. **Document revision history**

Date	Revision	Changes
27-Apr-2022	1	Initial release.

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