

STM32 PMSM FOC SDK

Frequently-asked questions (FAQ)

- **Question:** What is the **STM32 MC SDK**?
- **Answer:** The ST Motor Control Ecosystem includes the STM32 MC SDK ([STSW-STM32100](#)), a software development kit which speeds up the evaluation and development of FOC (field-oriented control) systems for permanent magnet synchronous motor (PMSM) applications.
- The STM32 MC SDK is based on the 32-bit STM32F MCU family and includes:
 - STM32 PMSM FOC Motor Control firmware library
 - ST Motor Control Workbench, a PC graphical user interface (GUI) for firmware library parametrization and real-time monitoring
 - Motor Profiler, a PC tool able to automatically measure motor parameters and manage them inside the Motor Control firmware library via the ST Motor Control Workbench.

- **Question:** What's changed in the ST MC SDK from the previous version?
- **Answer:** Release Note [RN0085](#) lists the changes of each release.

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- **Question:** Where can I find the ST Motor Control community forum?
- **Answer:** The forum can be found at the link below. Once you have registered, you can post questions to the Motor Control forum.

<https://community.st.com/community/power-management-and-motor-control>

Question: How can I create a Motor Control project?

Answer: The Motor Control Project consists of the FW working folder which contain the files generated from the Workbench.

1. Copy the contents of the STM32 PMSM FOC LIB folder from

C:\Program Files (x86)\STMicroelectronics\FOC SDK\v4.3\STM32 PMSM FOC LIB

into your “working folder”.

Note: This is to avoid to change the content of the original SDK folders. It is warmly suggested to create a user’s working folder.

The configuration files (.h) must be generated in the “SystemDriveParams” folder of your FW library working folder.

2. Click the generation button:

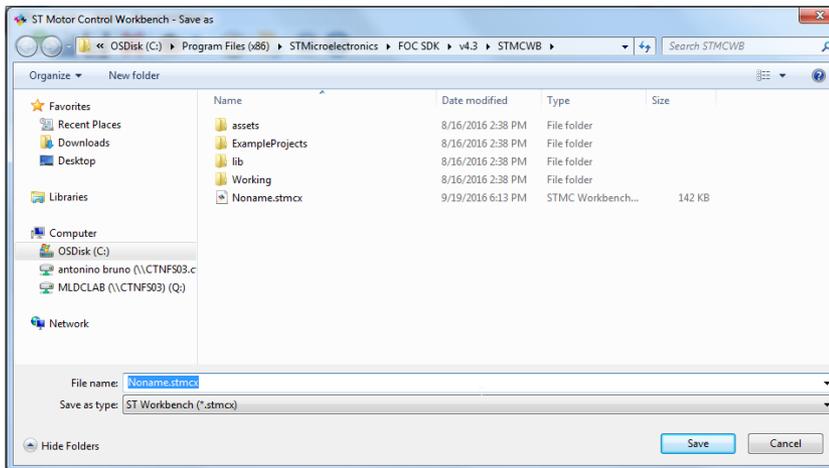


3. Save your MC Workbench Project (if you have never saved it):

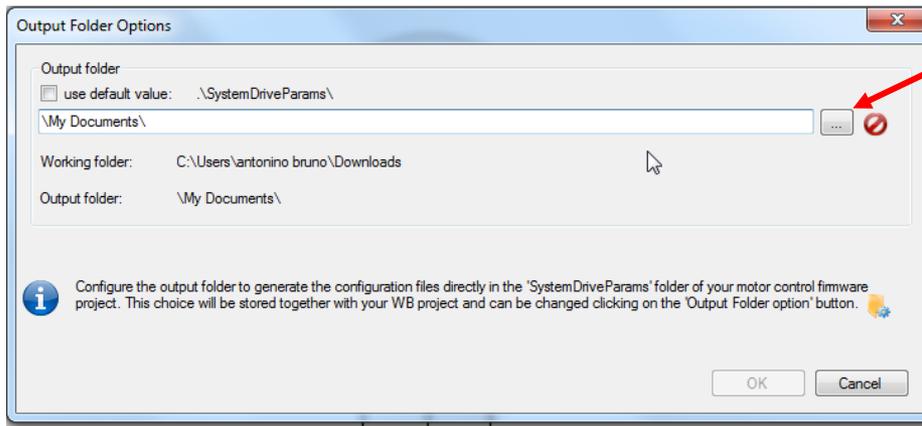
It is recommended to save in your `.\WorkingFolder\Web` repository

You can have more copies of the "WEB" subfolder and rename them with the application name(s).

The "Common" subfolder can be a single subfolder shared for all copies of the "WEB" subfolder(s).



4. Generate the parameter files in your working folder:



Set the SystemDriveParams folder path in your working folder, for example:
.\WorkingFolder\STM32 PMSM FOC LIB\Web**SystemDriveParams**

Note: Now the output folder of the MC workbench is set for the following generations.

Warning!

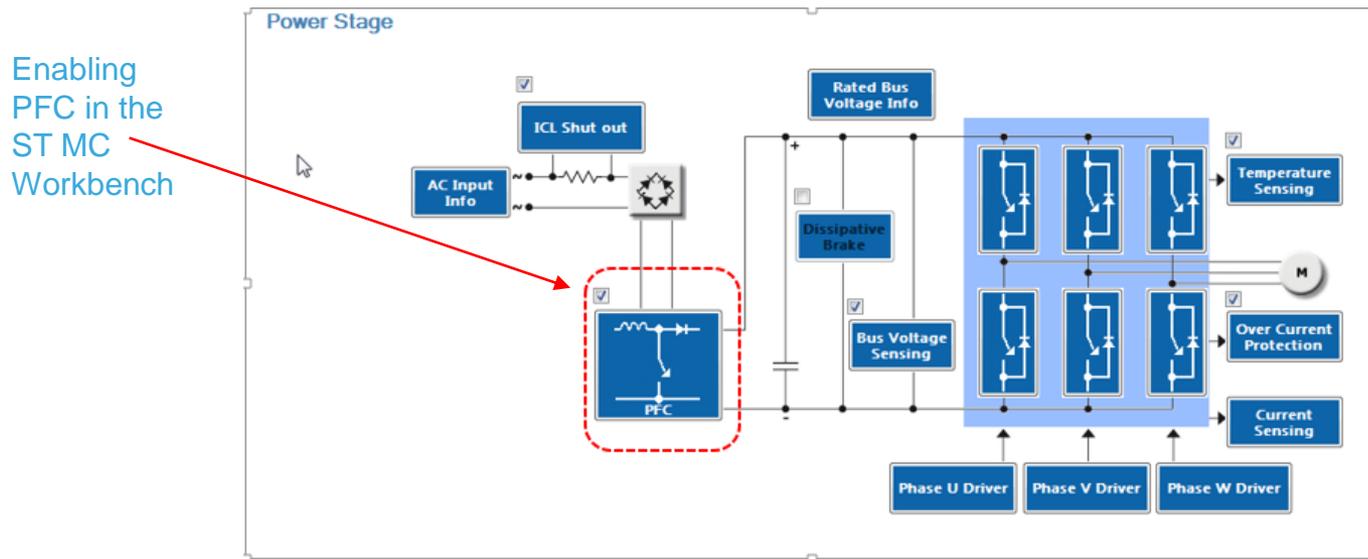
You can change the Output folder by clicking the output folder options.



- **Question:** How can I work with a project made using an older version of the MC Workbench?
- **Answer:** Starting with STM32 PMSM FOC SDK v4.3, the installation does not erase the previous version. If you want to work with an older project, you have 2 options:
 1. Continue working with the same SDK version as the project.
 2. Open the old project with the new MC Workbench (SDK v4.3) and click yes to convert the project when asked.
NOTE: It is recommended to ensure that all parameters are correct after the conversion.

- **Question:** When creating a MC application project, where can I find a project framework for a particular IDE (IAR, KEIL, ...)?
- **Answer:** You can find prepared projects for IAR and KEIL IDEs for STM32F0, F1, F2, F4 microcontrollers in the “..\Project\” folder. You can also find API examples and RTOS support.

- **Question:** Does the STM32 PMSM FOC SDK support the Power Factor Corrector (PFC) stage? And how does it work?
- **Answer:** Yes, the SDK supports the PFC stage. The FOC SDK is able to drive up to 2 PMSM motors and the PFC stage when using compatible hardware.



For more information, refer to UM1052, UM1053, UM1080.

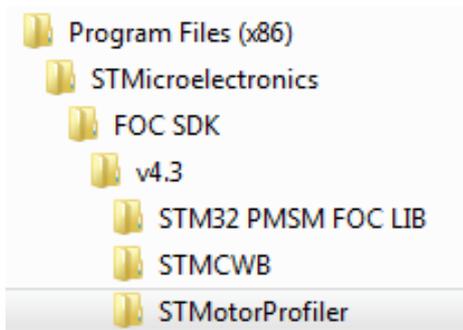
- **Question: What is the Motor Profiler tool?**
- **Answer:** The Motor Profiler tool is a new algorithm (based on STM32F30x and STM32F4 MCUs) able to automatically measure the electrical characteristics of PMSM motors. It can be used to run an unknown motor from scratch in only few minutes.

The “Motor Profiler” algorithm determines the correct motor parameters needed to configure the STM32 PMSM FOC firmware library: stator resistance (R_s), stator inductance (L_s), B-EMF constant, inertia and friction.

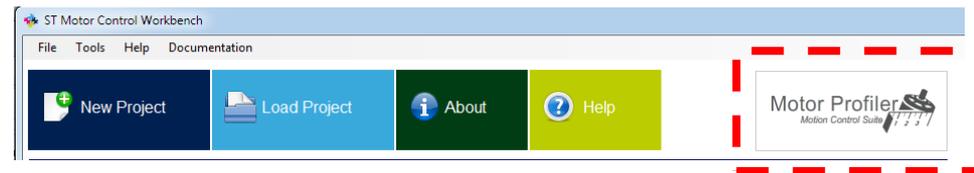
The Motor Profiler tool only works with certain ST boards. Please check the boards listed in the Motor profile tool.

- **Question:** How do I open the Motor Profiler?
- **Answer:** There are 2 ways to open the Motor Profiler:
 1. Start menu
 2. Desktop icon

1. From the “STMotorProfiler” installation folder



2. From ST Motor Control Workbench



- **Question:** The Motor Profiler does not recognize my motor. What should I do?
- **Answer:** Try the following points:
 - Make sure the nominal voltage is applied.
 - Select the power stage with the correct current range.
 - Enter the value of the nominal motor speed parameter or play with this value.
 - Decrease the value of the nominal current parameter.
 - Decrease the applied bus voltage.

- **Question: What is the best PWM and FOC frequency setting?**
- **Answer:** The selection of the PWM / FOC frequency is a compromise between the available speed and switching losses. In the case of either a high-speed or low-inductance motor, you have to use a higher frequency; for example, 30 kHz. For other cases, a frequency of approximately 16 kHz should be sufficient. You have to check the maximum PWM frequency possible for the selected MCU. When using a low-inductance motor, it is possible to use the FOC execution rate and a high PWM rate, which saves CPU load or lets you migrate to a lower performance MCU. (For example, when PWM = 20 kHz, an execution rate of 2 means that the FOC algorithm runs at 10 kHz.)

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- **Question: Why doesn't my motor start immediately?**
- **Answer: There are two possible reasons:**
 - 1st case: Alignment has been applied. This sets the static vector and waits until the rotor moves into alignment.
 - 2nd case: "On-the-Fly start-up" has been switched on. Before any controlled movement starts, a detection phase is executed. If a rotation is detected, the motor starts running without the start-up ramp; otherwise, it continues with the normal start-up phase (alignment, ramp-up, ...).



- **Question: What start-up ramp settings should I use to start my motor?**
- **Answer:** We recommend using the following parameters:
 - Speed ramp duration set to 3000 ms
 - Speed ramp final value set to 30% of the maximum motor speed
 - Current ram final value set to $\frac{1}{2}$ of nominal motor current
 - Include alignment before ramp-up
 - Alignment duration set to 2000 ms
 - Alignment current set to $\frac{1}{2}$ of nominal motor current
 - Minimum start-up output speed set to 15% of maximal motor speed

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- **Question: A “FOC duration” fault message appears and the motor does not even try to start. What should I do?**
- **Answer:** The FOC execution rate is too high and there is not enough time for it to be calculated. In Drive settings, decrease the ratio between the PWM frequency and Torque and flux regulator execution rate (e.g. increase the Torque and flux regulator execution rate by one).

- **Question:** The “Over current” fault message appears and the motor does not even try to start. What should I do?
- **Answer:** We recommend the following:
 - 1st case: An incorrect current sensing topology has been selected in the power stage → current sensing.
Solution: Select the correct current sensing configuration.
 - 2nd case: The current sensing parameters are incorrect.
Solution: Verify and correct the power stage parameters.
 - 3rd case: The current regulation loop bandwidth is too high for the motor.
Solution: In the Drive parameters menu, open the Drive settings and decrease the current regulation bandwidth (normally down to 2000 rad/sec for a 3-shunt topology and 1000 rad/s for a 1-shunt topology). The maximum current regulation loop bandwidth values are typically 9000 rad/sec for a 3-shunt topology and 4500 rad/sec for a 1-shunt topology.



- **Question:** A “Speed feedback” message appears after motor acceleration. What should I do?

In this case, the rotor moves and accelerates according to the ramp-up profile, but then it stops and a “Speed feedback” fault message appears.

- **Answer:** Use speed ramps. Having a target speed that gradually goes from the start-up output speed to the final target speed with an optimized ramp duration time will avoid abrupt variations of torque demand that could cause an incorrect B-EMF estimation.

A mix of the following problem sources may also be occurring:

- 1st case: Observer gain G2 is too high and this makes speed reconstruction a bit noisy (for the selected speed PI gains). Possible solutions include:
 - 1st solution: Decrease observer gain G2 by successive steps: /2, /4, /6, /8.
 - 2nd solution: Run motor in Torque mode. If there is no trouble in Torque mode, it means that speed regulator gains are not optimal and you should try to trim gain values.
- 2nd case: Often the issue is that the start-up has been validated too early. In this case, open the Start-up parameters menu, and increase the consecutive successful start-up output test value (normally to not more than 4-5) with a minimum start-up output speed set to 15% of the maximum application speed (if required, you can decrease it later).



- **Question:** The motor initially moves but then it doesn't rev-up and the "Start-up failure" fault message appears. What should I do?
- **Answer:** Typically this happens because not enough current is provided to the motor to enable it to accelerate.
 - 1st case: Decrease the acceleration rate: in the *Start-up parameters* menu, open the *Speed ramp duration* and set the *Speed ramp final value* to approximately 30% of the maximum application speed.
 - 2nd case: Increase the start-up current: in the *Start-up parameters* menu, open the *Current ramp initial* and *final* values and set *Motor* → *Nominal current*. Enabling 'Alignment phase' (at least at the beginning of the development) makes the start-up more deterministic; start by using a setting that is half of the nominal current (approx. 2000 ms).

- **Question:** How can I use the Application Programming Interface (API) to control the motor from my application?
- **Answer:** The MC firmware library includes an Application Programming Interface (API) that specifies how software components should interact with each other. You can find descriptions in our documentation and you can learn from several API examples. These API examples are included in the install. Prepared projects are located as “other projects” inside the “WEB\Project\..” folder.

- **Question: Is there a dual motor control function?**
- **Answer:** ST's PMSM FOC SDK supports the control of two PMSM motors using a single MCU.

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- **Question: What is the best current range?**
- **Answer:** The best case is that the maximum current applied to the motor in the application is also in the power stage's current range. In most cases, an application's maximum current (torque) is different from the motor's maximum current.
Usually we can spin a motor with a power stage with a smaller power range.
It is recommended to perform the calculation with the power requested by the application.

- **Question: How can I debug my motor control application?**
- **Answer:** A standard debug function cannot be used with the MC application because the rotor's position is lost during break points or when the program is stopped. (The magnetic field is calculated by running the MC firmware.)
You can use DAC, emulated DAC by PWM or USART communication modes to debug your application. The DAC can generate a voltage proportional to the internal signals such as currents, B-EMF voltage, reconstructed angle, ... and it is also possible use an oscilloscope to visualize waveforms while the motor is spinning.
It is recommended to dedicate one or two pins of the DAC output and two pins of the UART for debug purposes.

- **Question: Which solution is better for 3-phase PMSM / BLDC motors, FOC or 6-step control?**
- **Answer:** The benefits of using an FOC solution includes increased energy efficiency, improved response time of speed control, precise position control, and less acoustical noise.

- **Question:** What should I do when the motor runs but the current is not at all sinusoidal?
- **Answer:** This means that the speed PI gain values are incorrect. Decrease the Kp gain (and look at the Ki evaluating speed regulation over/under-shooting during transients).

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- **Question:** What are some simple hints for tuning the PI regulator?
- **Answer:** One of the possible ways to tune the speed PI regulator is to run the motor connected to the Workbench, display the plot window and make the necessary changes to the speed. For example, you can change the requested speed to a value between 2000 and 4000 rpm. The plot window lets you see if the real speed oscillates around the requested value or not.
 - If the regulated variable oscillates around a given value, then decrease the KI or increase the KP.
 - If the trend of the regulated variable is too slow or instable, then increase the KI.

- **Question: Which is better, a 1-shunt or 3-shunt current measurement?**
- **Answer:** A 1-shunt current measurement has the advantage of being the cheapest solution. For motors that require measuring the current of two phases simultaneously (i.e. low-inductance motors), we recommended using the 3-shunt current measurement.

- **Question:** What should I do when the rotor moves and accelerates following the ramp-up profile, but then it stops and the ‘Start-up failure’ fault message appears?
- **Answer:** This may be the result of a combination of the following issues:
 - 1st case: The observer gain G2 value is too high and makes speed reconstruction a bit noisy (never recognized as reliable).
 - 1st solution: Decrease the observer gain G2 by successive steps: /2, /4, /6, /8.
 - 2nd solution: Enlarge Drive parameters → Speed / position feedback management → variance threshold: modify the value as to make the “rotor locked check” less ‘demanding’ (up to 80% for PLL and 400% for CORDIC).
 - 2nd case: The “window” where the reliability of the estimation is checked is too small.
 - 1st solution: Increase the speed ramp final value to approximately 40% of the maximum application speed.
 - 2nd solution: Decrease the minimum start-up output speed to 10% of the maximum application speed.

Thanks

