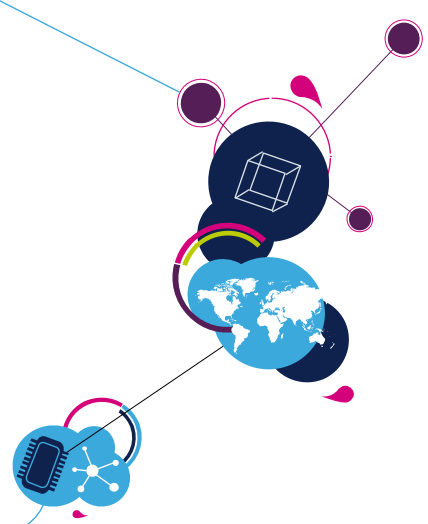
STM32 PMSM FOC SDK FAQ



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ST Motion Control Ecosystem
Easy Plug and Spin

F.A.Q. 1

- **FAQ- Question: What is the STM32 MC SDK?**

- **FAQ- answer:** The ST Motor Control Ecosystem includes also the STM32 MC SDK (STSW-STM32100) a software development kit which speed up the evaluation and development of FOC (Field oriented control) for Permanent Magnet Synchronous Motor (PMSM) applications. The STM32 MC SDK is based on STM32F, the ST 32 bit MCU family and it is composed of the:
  - STM32 PMSM FOC, motor control firmware library
  - ST MC Workbench, PC Graphical User Interface (GUI) for FW library parametrization and real time monitoring
  - Motor Profiler, PC tools able to measure the Motor Parameter automatically and to manage it inside the MC FW library through ST MC Workbench.

F.A.Q. 2

- **FAQ- Question: ST MC SDK changes from latest version?**
- **FAQ- answer:** Please, referring to Release Note RN0085

F.A.Q. 3

- **FAQ- Question: ST Motor Control Forum.?**
- **FAQ- answer:** On the following link after under registration you can post question to the Motor Control Forum:

  https://my.st.com/public/STe2ecommunities/motordriver_ics/default.aspx

F.A.Q. 4 (1/3)

FAQ- Question: How to create a Motor Control project?

FAQ- answer: the Motor Control Project is composed by FW working folder which contain the files generated from the Workbench.

1. copy the content of folder STM32 PMSM FOC LIB from

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

   in your “working folder”

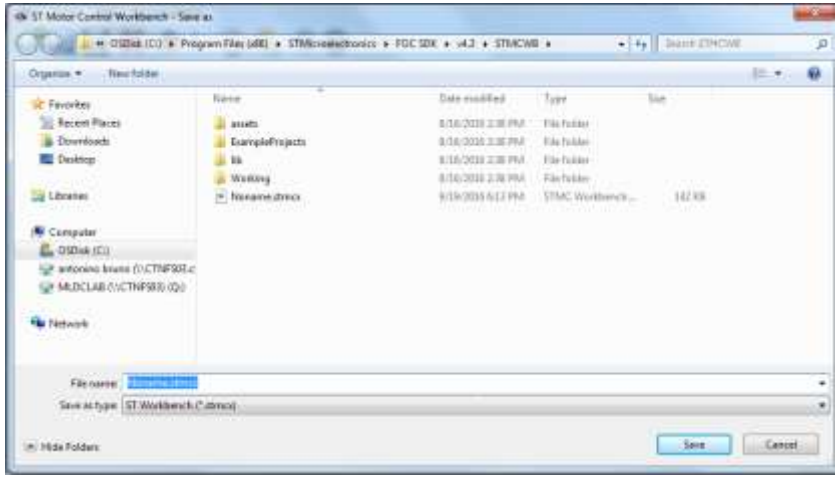
NB this is to avoid to change the content of the original SDK folders.
It is warmly suggest to create a user’s working folder

F.A.Q. 4 (2/3)

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

2. Click in the generation button:

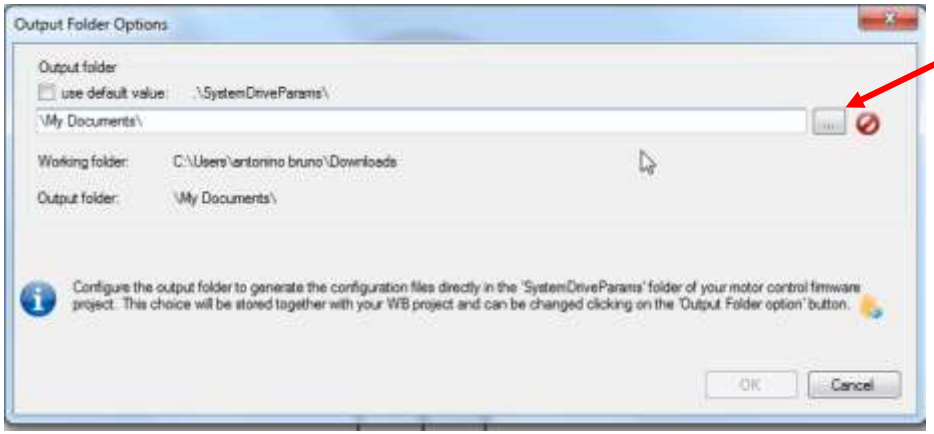
3. Save your MC Workbench Project (if you have never saved it):



It is recommended to save in your .\WorkingFolder\

F.A.Q. 4 (3/3)

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**

NB **Now the output folder of the MC workbench is set for the next generations**

Warning!

You can change the Output folder clicking in the output folder options

F.A.Q. 5

- **FAQ- Question:** **How to handle project of made with old version of MC Workbench?**

- **FAQ- answer:** starting from STM32 PMSM FOC SDK v4.3 the installation does not erase the previous version so the user if want to work with his old project has 2 options:
  1. Continuing to work with the same SDK version of the project
  2. To load the project MC Workbench (SDK v4.3) and click yes for the conversion.
     NB) It is recommended that all parameters changed are the both versions.

F.A.Q. 6

- **FAQ- Question:** **MC application project - Can I get an project framework for particular IDE (IAR, KEIL, …)?**

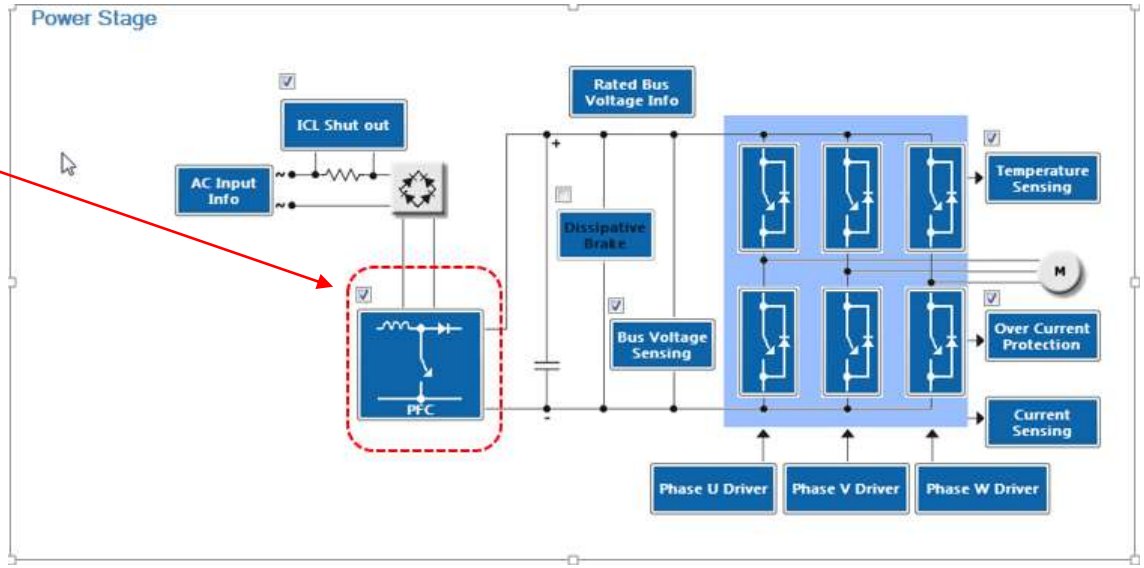
- **FAQ- answer:** The user can start from prepared projects for IAR and KEIL for STM32F0, F1, F2, F4 family: they are in the folder "..\Project\"
  There is also project with API examples and project with RTOS support.

F.A.Q. 7

- **FAQ- Question: the STM32 PMSM FOC SDK support Power Factor Corrector (PFC) stage? And how does it work?**

- **FAQ- Answer:** yes it support PFC.
  The FOC SDK is able to drive up to 2 PMSM Motor and the PFC stage if the users are working with a compatible Hardware.

Enabling PFC in the ST MC Workbench



For more information refer to UM1052, UM1053, UM1080 and “Hands on” documentations

F.A.Q. 8

- **FAQ- Question: What is the Motor Profile Tool?**

- **FAQ- answer:** is a new algorithm (based on STM32F30x and STM32F4) able to auto-measure the electrical parameters of PMSM motors. It can be used to achieve the run of an unknown motor from the scratch in few minutes.
  The “Motor Profiler” algorithm will determine the motor parameters needed to configure STM32 PMSM FOC FW library: Stator resistance Rs; Stator inductance Ls; Back EMF Constant, Inertia and Friction.

  The Motor profiler works with some selected ST boards.

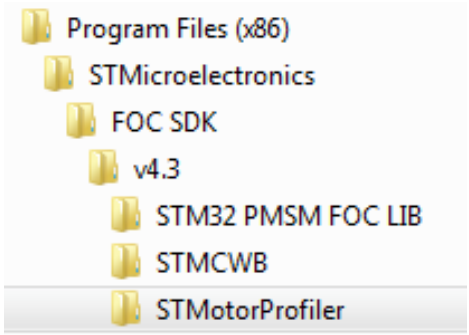
F.A.Q. 9

- **FAQ- Question: How to open Motor Profiler?**

- **FAQ- answer:** Two ways to open the Motor profiler:
  1. Start menu
  2. Desktop icon

From ST Motor Control Workbench

From the “STMotorProfiler” installation folder



For more information refer to UM1052, UM1053, UM1080 and “Hands on” documentations

F.A.Q. 10

- **FAQ- Question: Motor Profiler - Not able to recognize the motor**

- **FAQ- answer:** the user can check if:
  - Apply nominal voltage.
  - Select the power stage with proper current range.
  - Fill nominal motor speed parameter or play with this value.
  - Decrease nominal current parameter.
  - Decrease applied bus voltage.

F.A.Q. 11

- **FAQ- Question: PWM and FOC frequency**

- **FAQ- answer:** The selection of PWM / FOC frequency is compromise between available speed and switching losses. In case of high speed motor or low inductance motor then you have to use higher frequency for example 30 kHz. In other case frequency about 16 kHz should be sufficient. You have to check possible maximal PWM frequency for selected MCU. In case of low inductance motor it is possible to use FOC execution rate and high PWM rate which saves CPU load or let to migrate to lower performance MCU. (e.g. PWM = 20 kHz, The execution rate 2 means the FOC algorithm runs with frequency 10 kHz.)

F.A.Q. 12

- **FAQ- Question: Motor does not start immediately**

- **FAQ- answer:**
  - 1st case: Alignment has been applied.
    (Sets the static vector and waits until the rotor moves / aligns into this position)
  - 2nd case: “On-the-Fly start-up” has been switched on.
    Then before any controlled movement starts the detection phase, if detect the rotation, then starts running without the start-up ramp, if not, then continues with start-up (alignment, ramp-up, …).

F.A.Q. 13

- **FAQ- Question: How to start a motor – Start-up ramp setting**

- **FAQ- answer:** the recommendation is set those parameters:
  - Speed ramp duration to 3000 ms
  - Speed ramp final value to 30% of maximal motor speed
  - Current ram final value set from ½ of nominal motor current
  - Include alignment before ramp-up
  - Alignment duration set to 2000ms
  - Alignment current set from ½ of nominal motor current
  - Minimum start-up output speed to 15% of maximal motor speed

F.A.Q. 14

- **FAQ- Question: FOC duration' fault message appears and the motor do not even try to start**

- **FAQ- answer:** The FOC execution rate is too high and computation cannot fit in time.
  In Drive settings, decrease ratio between PWM frequency and Torque and flux regulator execution rate (e.g. increasing Torque and flux regulator execution rate by one)

F.A.Q. 15

- **FAQ- Question: “Over current” fault message appears and the motor do not even try to start**

- **FAQ- answer:** the recommendation is set those parameters:

  1st case: Wrong current sensing topology has been selected in power stage → current sensing

  Solution: Select right current sensing configuration.

  2nd case: Wrong current sensing parameters

  Solution: Check power stage parameters

  3rd case: Current regulation loop bandwidth is too high for this HW

  Solution: In drive parameters → drive settings decrease current regulation bandwidth (normally down to 2000 rad/sec for 3shunt topology and 1000 rad/s for single shunt topology) Typical current regulation loop bandwidth max values are 9000 rad/sec for 3-shunt, 4500 rad/sec for 1-shunt.

F.A.Q. 16

- **FAQ- Question: “Speed feedback” after the acceleration**
  The rotor moves and accelerate following the ramp-up profile but then it stops and the fault message ‘Speed feedback’ appears.

- **FAQ- answer:** Use speed ramps: having a target speed gently going from the start-up output speed to the final target and relevant ramp duration time will avoid abrupt variations of torque demand that could spoil B-emf estimation:
  A mix of following problem sources can 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.
    - 1st solution: Decrease observer gain G2 by successive steps: /2, /4, /6, /8.
    - 2nd solution: Run motor in torque mode, if trouble doesn’t appears in torque mode, it means that speed regulator gains are not optimal, try to trim gain values. (It is described in different point).
  - 2nd case: Often issue is the start-up has been validated too early. Solution: Increase *Start-up parameters* *consecutive successful start-up output test* (normally to not more than 4-5) being *minimum start-up output speed* set to 15% of maximum application speed (if required, decreased it later).

F.A.Q. 17

- **FAQ- Question: Motor doesn't rev-up "Start-up failure" - Motor initially moves but then doesn't rev-up, then fault message 'Start-up failure' appears.**

- **FAQ- answer:** Typically this happens because of the current provided to the motor is not enough for making it accelerate so fast.
  1st case: Decrease acceleration rate by increasing *Start-up parameters → speed ramp duration* (being *Start-up parameters → speed ramp final value* set to about 30% of maximum application speed).
  2nd case: Increase start-up current by increasing *current ramp initial* and *final* values up to *motor → nominal current.* Enabling 'Alignment phase' (at least at the beginning of the development) makes start-up more deterministic, use around 2000ms, half of nominal current as first settings.

F.A.Q. 18

- **FAQ- Question: Application programming interface - How can I control the motor from my application?**

- **FAQ- answer:** Part of our library is the API. An Application Programming Interface (API) specifies how software components should interact with each other. You can find descriptions in our documentation and you can learn from several API examples. Those API examples are included in the installation. There is prepared project for STM32F1 family. It is located as other projects inside the folder "WEB\Project\..".

F.A.Q. 19

- **FAQ- Question: “Dual motor control”**
- **FAQ- answer:** ST PMSM FOC SDK can do support the control of two PMSM by one MCU

F.A.Q. 20

- **FAQ- Question: Current range - What is the best current range?**
- **FAQ- answer:** The best case is that the maximal current applied to the motor in the application is also current range of power stage. The maximal current (torque) in application is in most of cases different of the maximal current of the motor.
  Usually we can spin a motor with power stage with smaller power range.
  It is recommended to perform the calculation with requested power in the application.

F.A.Q. 21

- **FAQ- Question: Debug possibility - How can I debug the motor control application?**

- **FAQ- answer:** In the MC application cannot use standard debug functionality. (Break points or stopping program, because during the break lose the rotor position. The magnetic field is calculated by running MC FW.) You can use DAC, emulated DAC by PWM or USART communication.
  DAC can generate proportional voltage to internal signals as currents, B-emf voltage, reconstructed angle, … and it is possible to visualize waveforms by scope during the motor spin.

  It is recommended to dedicate one or two pins of DAC output and two pins of UART for debug purposes.

F.A.Q. 22

- **FAQ- Question: FOC vs six-step - What is the better solution for three phase PMSM / BLDC – the FOC or six-step control?**

- **FAQ- answer:** The FOC has some benefits: better energy efficiency, responsive time of speed control, precise position control, lower acoustical noise..

F.A.Q. 23

- **FAQ- Question: Not sinusoidal current - Motor runs but current are not sinusoidal at all?**

- **FAQ- answer:** Speed PI gains are incorrect.
  Decrease Kp gain (and act on Ki evaluating speed regulation over/under shooting during transients)

F.A.Q. 24

- **FAQ- Question: Tuning of PI regulator <simple hints> - How to tune PI regulator?**

- **FAQ- answer:** One of the possible way is to tune the speed PI regulator is run the motor connect it to the Workbench switch the plot window and make the steps changes in requested speed. For example change requested speed between values 2 000 rpm and 4 000 rpm. In the plot windows you can recognize if real speed oscillate around requested value or if react too slow.
  - If regulated variable oscillates around a value, then decrease KI or increase KP.
  - If the trend of regulated variable is to slow or not stabilize, then increase KI.

F.A.Q. 25

- **FAQ- Question: 1-shunt vs 3-shunt - What is better choice 1-shunt or 3-shunt current measurement?**

- **FAQ- answer:** The 1-shunt current measurement is the cheapest solution. Some motors require current measurement of two phases simultaneously i.e. low inductance motors. We recommended for it 3-shunt.

F.A.Q. 26

- **<u>FAQ- Question:</u> Motor accelerate but then stop “Start-up failure”- The rotor moves and accelerate following the ramp-up profile but then it stops and the fault message ‘Start-up failure’ appears.**

- **<u>FAQ- answer</u>:** A mix of following problem sources can be occurring).
  - 1st case: Observer gain G2 is too high and this makes speed reconstruction a bit noisy (never recognized as reliable).

    1st solution: Decrease observer gain G2 by successive steps: /2, /4, /6, /8.

    2nd solution: Enlarge Drive parameters Speed / position feedback management → variance threshold so as to make 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 smal.

    1st solution: Increase speed ramp final value to around 40% of maximum application speed.

    2nd solution: Decrease minimum start-up output speed to 10% of maximum application speed

Thanks

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