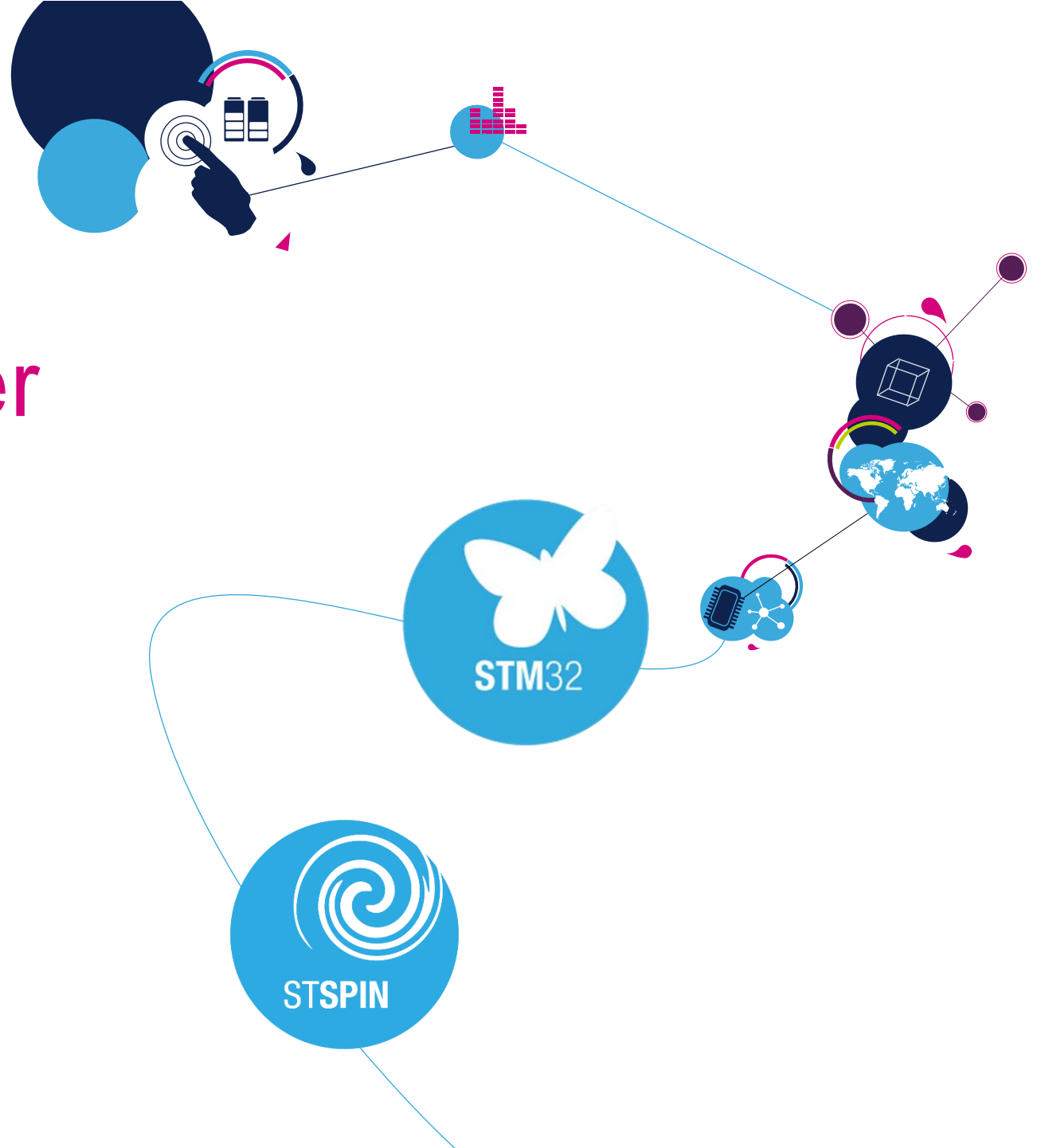




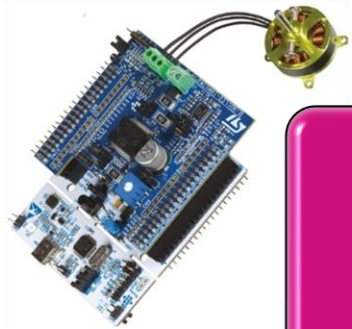
ST Motor Profiler





Motor Control Development Workflow

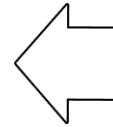
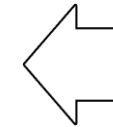
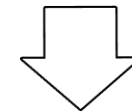
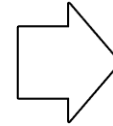
#2 – Motor Characterization 2



Hardware Setup



Motor Characterization





LAB 2 tasks

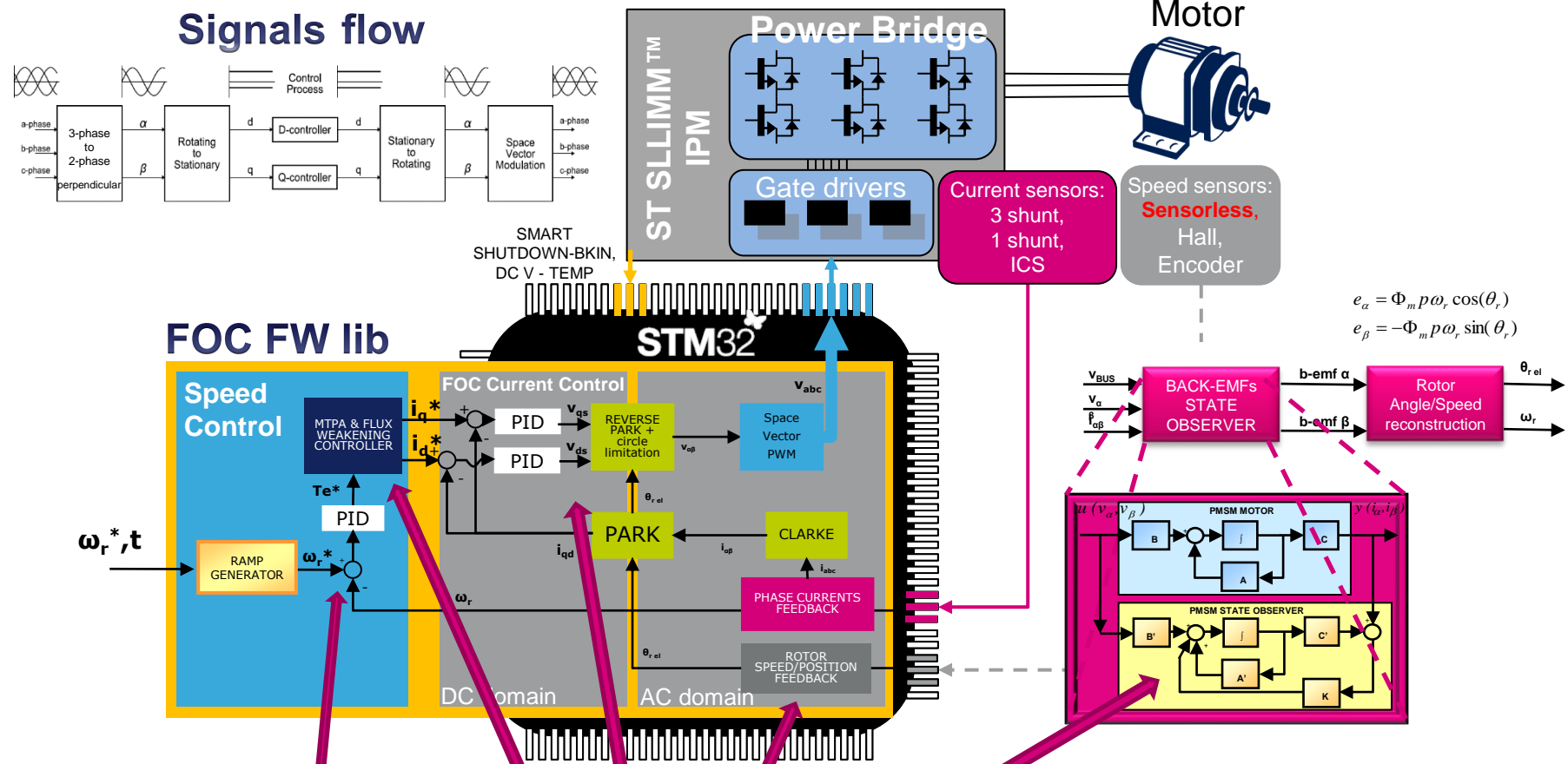
3

- What is ST Motor Profiler?
- Automating Characterization of Three Phase BLDC Motor with the ST Motor Profiler
- Tip and Tricks how to work with the ST Motor Profiler

Hands-On
section



What is necessary for MC application?



Mechanical parameters

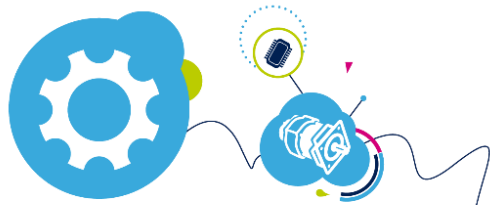
Electrical parameters

- The algorithms require electrical and mechanical parameters to define the used model of the motor
- To tune the current regulators
- To tune the speed regulator
- For Sensorless state observer algorithm
- For additional features



Motor Profiler

5



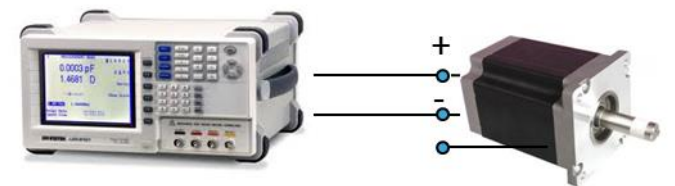
ST Motion Control Ecosystem
Easy Plug and Spin



- Plug & Spin your Motors in only few minutes
 - With STM32 Motor Control Software Development Kit (MCSDK)
 - With ST Control and Power Boards

Manual measurement or “Motor Profiler”?

- **You can measure / observe the motor parameters manually**
 - You can find more information in MOOC “Measurements of Motor Parameters” on [udemy.com](https://www.udemy.com/course/measurements-of-motor-parameters/)
- **Sometimes it can be hard to start the evaluation of motor control solution**
 - Measuring of the motor parameters can require specific skills and equipment
 - Tuning of the regulators can be empirical
 - Finding the proper acceleration for the startup is not easy
 - Many trials and errors can occur before 1st run of the motor



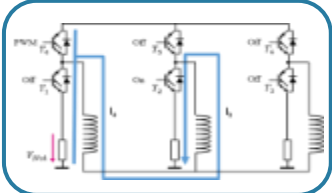


ST Motor Profiler

- Very easy and fast procedure
 - ST Motor Profiler has specific adaptive algorithms (repetitive) to find the best result
 - Motor can spin in less than one minutes in the best case

Motor stopped

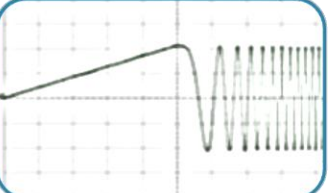
- R_s measurement
- L_s measurement
- Current regulators set-up



10 sec

Open loop

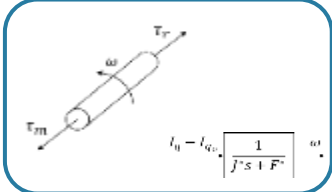
- K_e measurement - B_{EMF} constant
- Sensorless state observer set-up
- Switch over



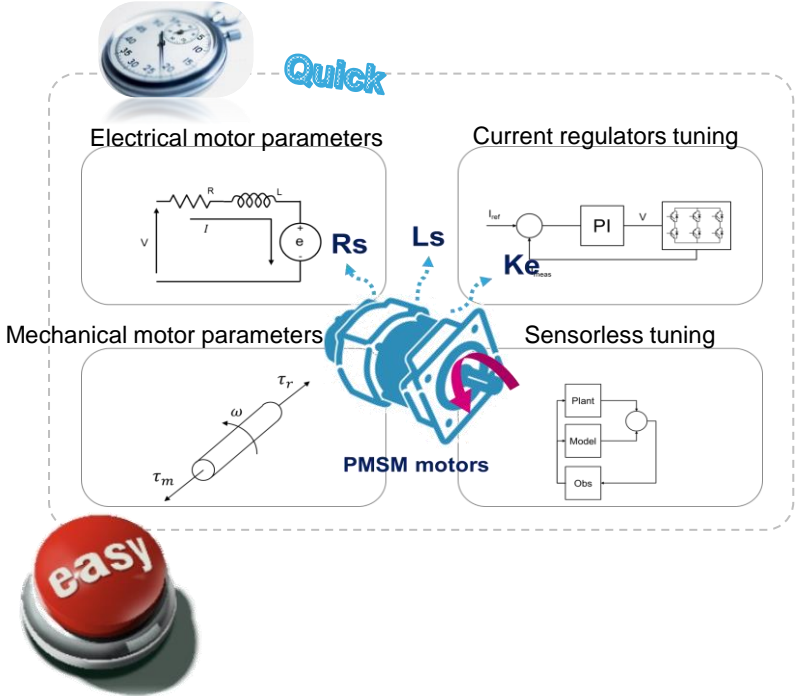
5 sec

Closed loop

- Friction coefficient measurement
- Moment of inertia measurement
- Speed regulator set-up



45 sec





Motor Profiler - What can't be measured?

User must know or measure manually:

(It requires additional tools)

- **Motor pole pairs** (mandatory)
- Maximum application speed
- Maximum current
- Vbus voltage
- (Motor anisotropy Lq/Ld ratio)

SM-PMSM

The screenshot shows the configuration interface for an SM-PMSM motor. It includes the following fields and options:

- Pole Pairs:** An empty input field with a red border and a link "how to detect...".
- Speed and Current limits:** A section header.
- Max Speed:** Input field containing "16000" RPM.
- Max Current:** Input field containing "2.8" Apk, with a range of "0.28 - 2.8 Apk" shown to the right.
- VBus:** Input field containing "48" V, with a range of "8 - 48 V" shown to the right.
- Magnetic:** Radio buttons for "SM-PMSM" (selected) and "I-PMSM".

I-PMSM

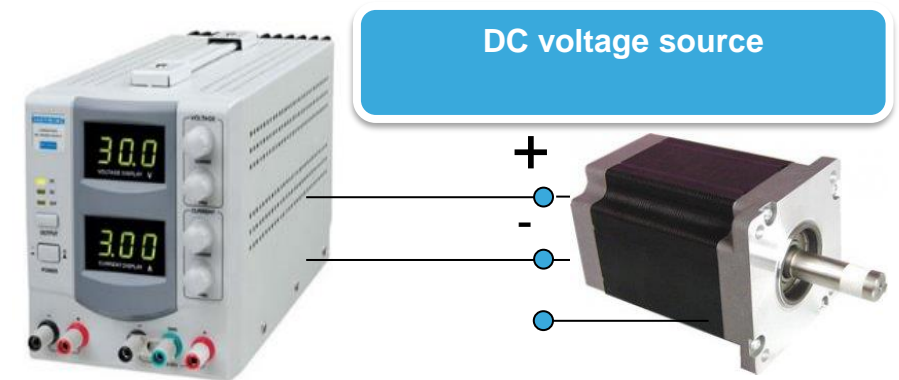
The screenshot shows the configuration interface for an I-PMSM motor. It includes the following fields and options:

- Magnetic:** Radio buttons for "SM-PMSM" and "I-PMSM" (selected).
- Ld/Lq ratio:** Input field containing "1", with a range of "0.001 - 10" shown to the right.

BLDC motor – Pole pairs number

- Usually, it's provided by motor supplier, but ...
- In case it is not or if you would like to double check it
 - You can connect a DC power supply between two motor phases with a limited current
 - Check the rotor and try to find stable position
 - You can increase the current up to nominal one in case you are not able to find a stable position
 - The number of rotor stable positions in one mechanical turn represents the number of pole pairs

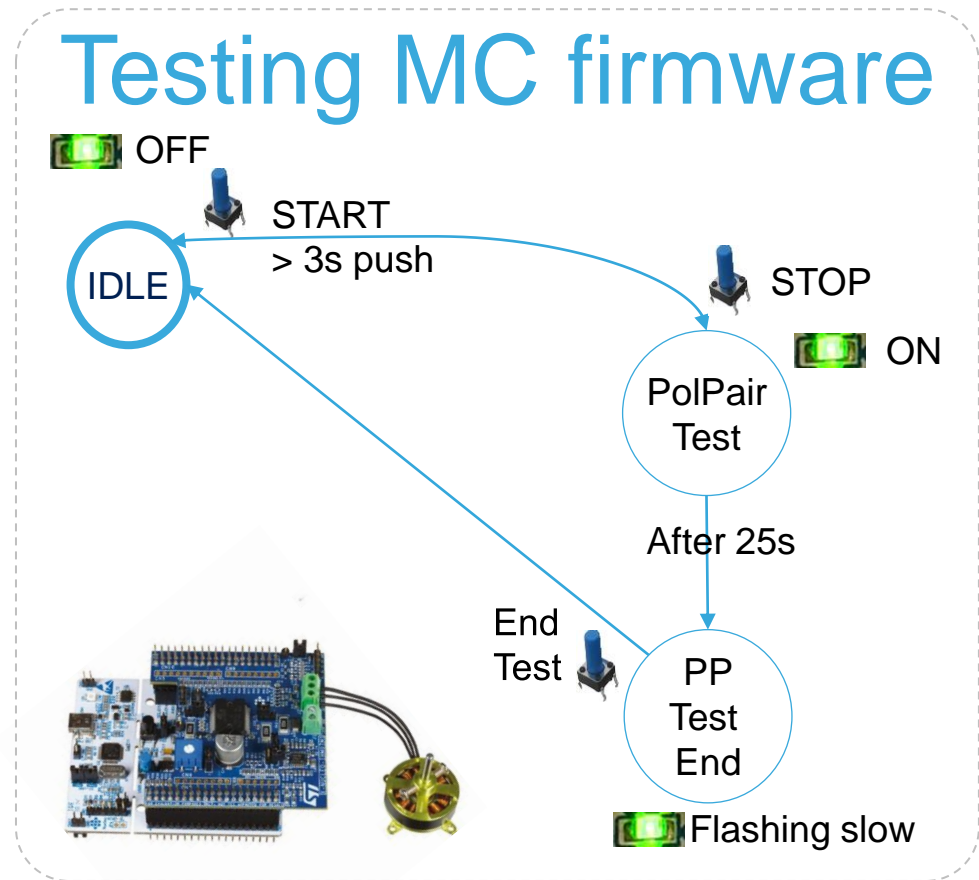
• Or ...



BLCD motor – Pole pairs number (FW)

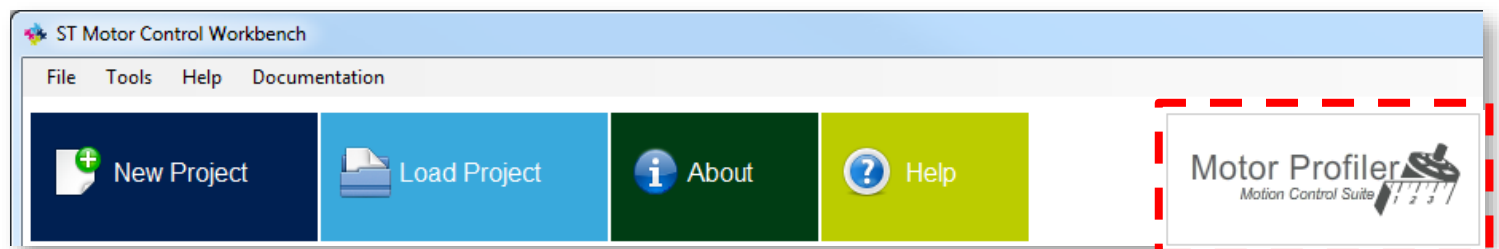
- We have prepared for you a special test FW
- You can use the provided HW setup (Nucleo F303RE & IHM16 boards)
- Including already loaded test FW
- Now you only need to start the test FW for pole pairs measurement
 - Press blue button for 3 seconds
 - Rotate the rotor by hands (you should notice some resistance)
 - The number of rotor stable positions in one mechanical turn represents the number of pole pairs (PP)

Remember the number of PP or write it down!



Open the Motor Profiler

- Open the Motor Profiler
 - Directly by desktop icon
 - or with item in Windows Start menu
- or by the dedicated button in the MC Workbench



Select the HW boards

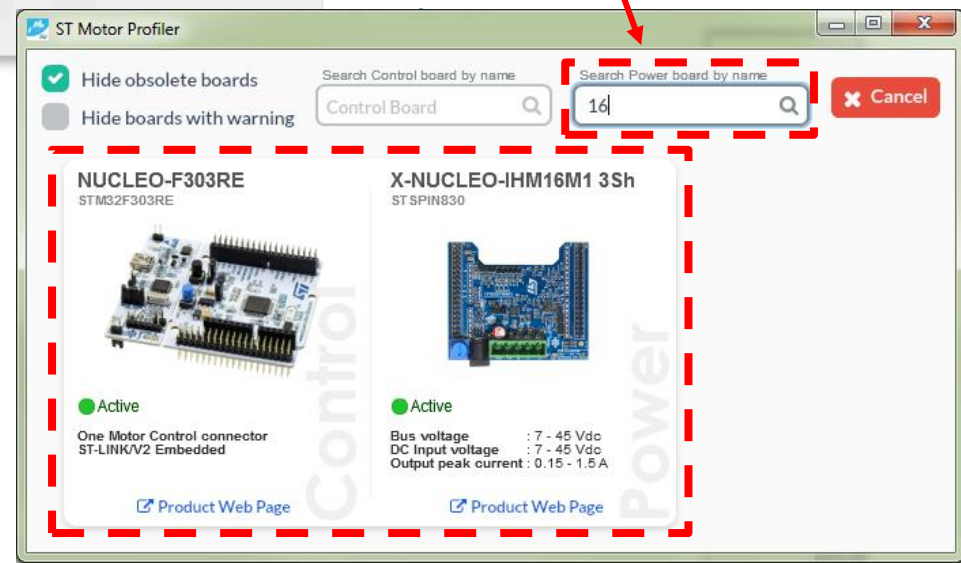
- Click on button “Select Boards” to display the list of supported boards
 - The Motor Profiler feature can be used only with the listed systems

- Selection of the **NUCLEO-F303RE** and **X-NUCLEO-IHM16 3Sh**



- Use the search filter for Power Board
- Type number 16

- Click on the Nucleo F303 + IHM16 boards picture



Why do we use 3-shunt setup?



- It is recommended to use the 3-shunt topology
 - to achieve better current measurement
 - consequentially better performance of Motor Profiler Algorithm.
- This is especially true for low-inductance motors
 - like dron motors and high speed motors.

How to check the board Jumpers link inside the Motor Profiler

Motor Profiler
Motion Control Suite

⊕ **NUCLEO-F303RE**
STM32F303RE

⊕ **X-NUCLEO-IHM16M1 3Sh**
STSPIN830

One Motor Control connector
ST-LINK/V2 Embedded

Bus Voltage: 7 - 45 Vdc
Output peak current: 0.15 - 1.5 A

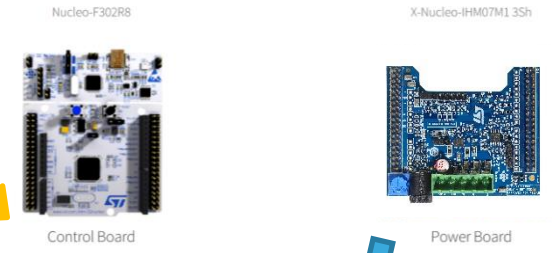
[Product Web Page](#)

[Product Web Page](#)

Remember to properly configure the boards in Motor Control mode

Open Board configuration window by clicking on this text/link

Board Configuration



Control Board

Step 1

1. Remove jumper JP1.
2. Plug-in jumper JP5 as shown for power supply from USB connector of ST-LINK/V2.
3. Check that LD3 is turned ON.

Step 2

Power Board

Step 1

1. Plug-in jumpers J5 and J6 as shown for three shunt configuration.

Step 2

1. Remove jumper JP

ST Motor Profiler (MP) setup

- Few parameters shall be inserted by the user
- Motor pole pairs (mandatory) - **Fill your measured number of pole pairs**
7 pole pairs
- Maximum application speed - **1600 rpm**
- Maximum peak current - **0.15 Apk** (zero to peak)
- Expected bus voltage - power plugs has 12V
it is not necessary reduce it - let it empty
- Type of motor - we do not know
use SM-PMSM



Pole Pairs: [how to detect...](#)

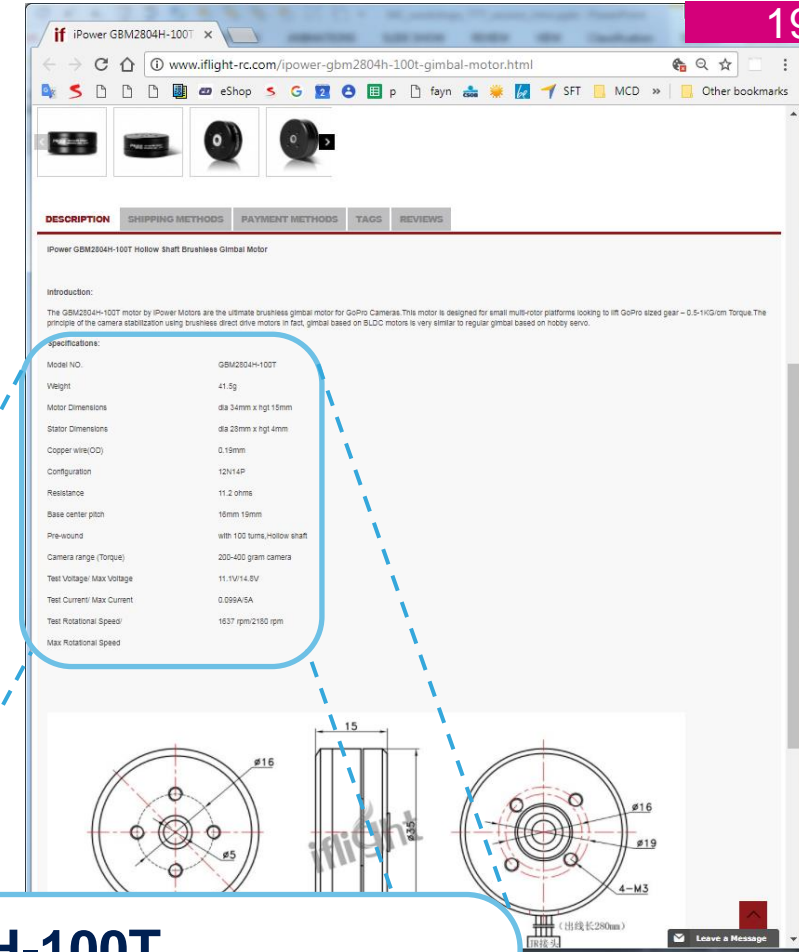
Speed and Current limits

Max Speed: RPM

Max Current: Apk 0.1 - 2.12 Apk

VBus: V 7 - 45 V

Magnetic: SM-PMSM I-PMSM



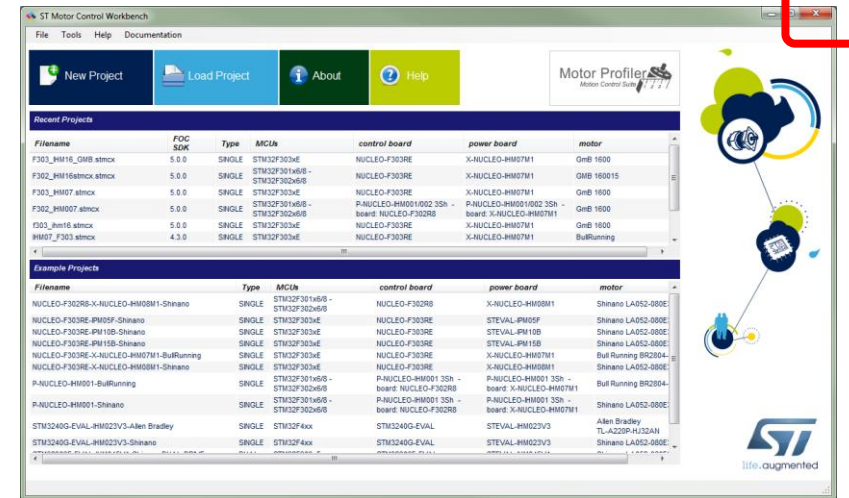
GBM2804H-100T

- 3-phase motor
 - 11.1V / 14.8V Test / Max Voltage
 - 0.099A / 5A_{RMS} Test / Max Current
 - 1637 / 2180 rpm Test / Max Speed
 - 12N14P Configuration

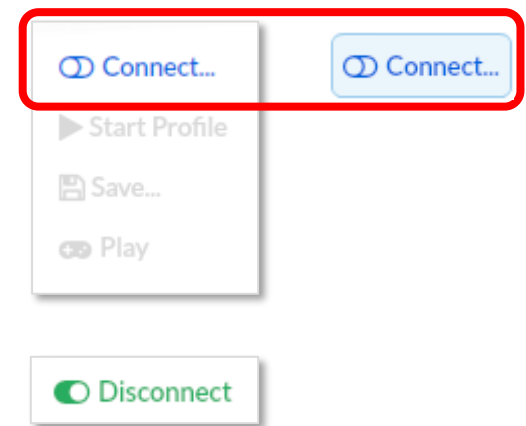
Connect MP to your Hardware



- Make sure to close the Workbench application
 - The Workbench can block the ST Link communication



- Click on the “Connect” button
 - If communication with the board is successful, the icon and related text color will become green



MP info / faults during the connection



Connection error

- Check the USB connection
- Warning, FW upgrade required
 - The MP needs proper FW, Confirm to Upgrade the FW
- Warning, Device family board mismatch
 - Return back to selection of the boards and select right board the „NUCLEO-F303RE“ and „X-NUCLEO-IHM16“
- Under voltage error

- Check the setting of the power plug – 12V and the connection to your hardware

Please, follow the displayed instructions

ST Motor Profiler

ST life.augmented

Motor Profiler Motion Control Suite

NUCLEO-F302R8 STM32F302R8T6

X-NUCLEO-IHM07M1 3Sh L6230PD

One Motor Control connector ST-LINK/V2 Embedded

Bus Voltage: 8 - 48 Vdc Output peak current: 0.28 - 2.8 A

Pole Pairs: 7 [how to detect...](#)

Speed and Current limits

Max Speed: 16000 RPM

Max Current: 2.8 Apk 0.28 - 2.8 Apk

VBus: 48 V 8 - 48 V

Magnetic: SM-PMSM I-PMSM

Remember to properly configure the boards in Motor Control mode

Disconnect

Start Profile

Save...

Play

Electrical Model

Mechanical Model

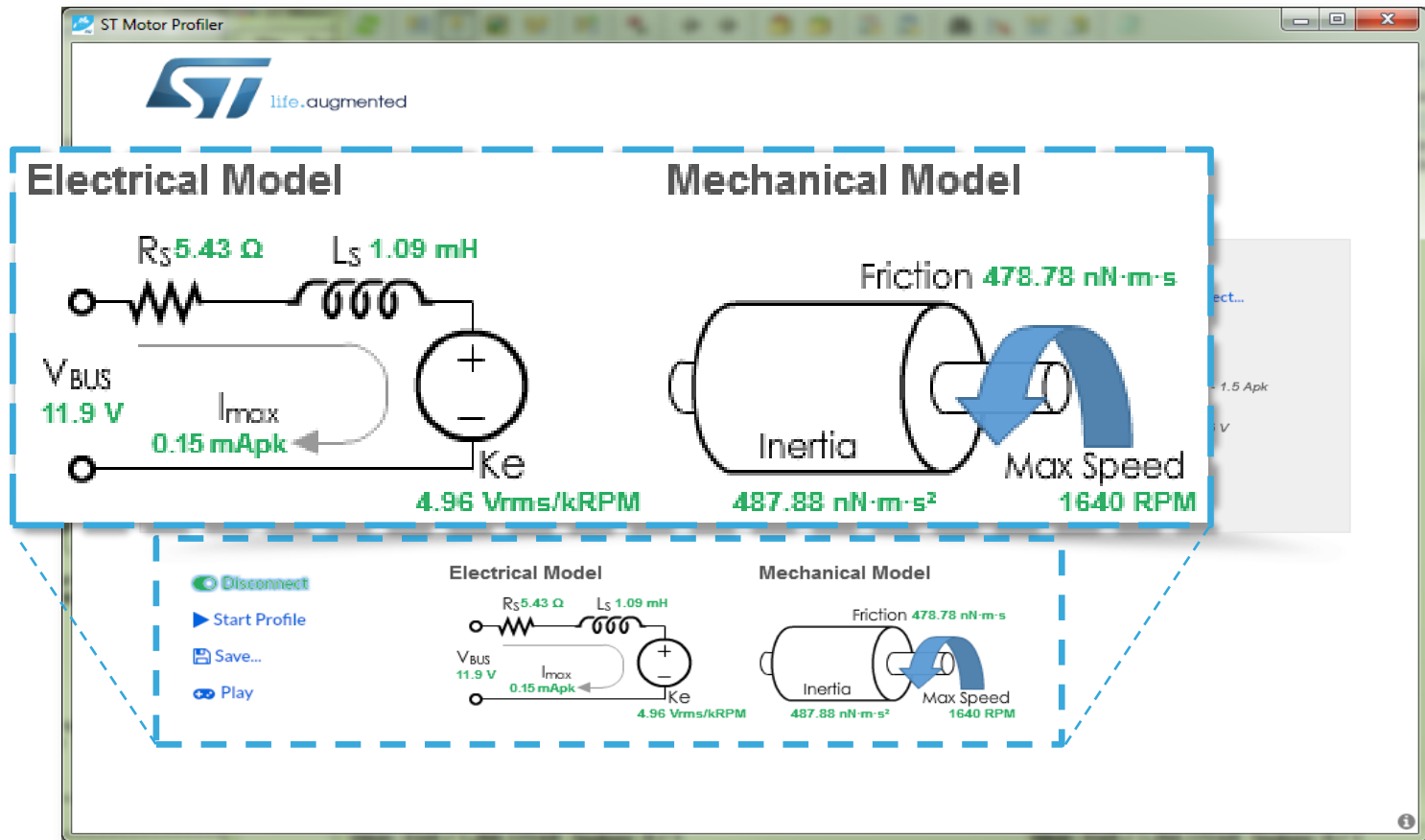
Friction

Inertia

Max Speed

Profiling and its results

- Motor Profiler finishes Profiling
- Electrical model at first
 - It can be restarted
 - with reduced current
 - with slower start-up ramp
- Mechanical model is next
 - It can be restarted
 - again with reduced current



- You can „Play“ with the motor now
 - Start the motor
 - Control the motor's speed
 - Reverse the spin direction
 - Modify the acceleration slope
- The „Play Mode“ handles faults and restarts motor if needed

The screenshot displays a software interface for motor control. At the top, there are two models: the **Electrical Model** and the **Mechanical Model**. The Electrical Model shows a circuit with a resistor $R_s = 0.19 \Omega$, an inductor $L_s = 0.01 \text{ mH}$, a voltage source $V_{BUS} = 12.02 \text{ V}$, and a current $I_{max} = 1.06 \text{ Apk}$. The Mechanical Model shows a motor with **Friction** of $756.38 \text{ nN}\cdot\text{m}\cdot\text{s}$ and **Inertia**. Below these models is a control panel titled **Play with Motor**. It features a **Start** button (disabled) and a **Stop** button (active). The **Maximum Acceleration** is set to 3000 RPM/s . A speed slider is shown with a range from -15910 to 15910 RPM, and the current speed is 7900 RPM . On the right, a **Faults** section lists several fault types with status indicators: Over voltage, Under voltage, Overheat, Startup failure, Speed feedback, and Over current. At the bottom left, a green dot indicates the motor is **Connected**. At the bottom right, there is a red **Done** button.

Save motor parameters

- Save the observed parameters

- Write down your name „**GimBal**“, and description of the motor „**Motor profiled during Workshop - 1th May 2018 10:30**“

- The parameters can be reused with other hardware in the future

The screenshot displays a software interface for motor profiling. On the left, a control panel includes buttons for 'Disconnect', 'Start Profile', 'Save...' (highlighted with a red dashed box), and 'Play'. To the right, two models are shown: an 'Electrical Model' with parameters $R_s = 0.19 \Omega$, $L_s = 0.01 \text{ mH}$, $V_{BUS} = 12.02 \text{ V}$, $I_{max} = 1.06 \text{ Apk}$, and $K_e = 1.09 \text{ Vrms/kRPM}$; and a 'Mechanical Model' with parameters 'Friction $756.38 \text{ nN}\cdot\text{m}\cdot\text{s}$ ', 'Inertia $450.05 \text{ nN}\cdot\text{m}\cdot\text{s}^2$ ', and 'Max Speed 15860 RPM '. A red dashed arrow points from the 'Save...' button to a 'Save' dialog box. The dialog box contains a text field with 'GimBal', a larger text area with 'Motor profiled during Workshop - 1th May 2018 1030', and a 'Save' button.

Motor not recognized by Motor Profiler

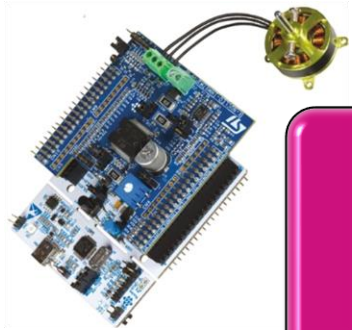


- Make sure the proper voltage is applied for this motor
- Use a power board with a proper voltage range for your motor (Low / High voltage)
- Select the power stage with the correct current range
- Reconfirm the pole pair number is correct
- Double or half the maximum motor speed parameter or play with this value
- Decrease the value of the maximum current parameter
- Hold motor in hand for better results (fix position)

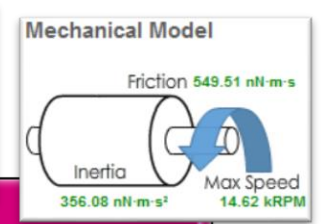
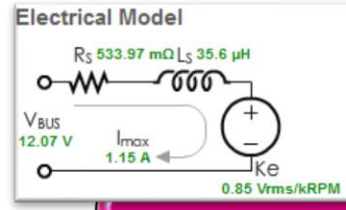


Motor Control Development Workflow

#2 – Motor Characterization 27



Hardware Setup



Motor Characterization

Motor Profiler
Motion Control Suite

