Motor Control Basic
with ST Motor Control SDK

Industrial Motor Control Competence Center
최현우 과장

Agenda

Introduction of
Motor Control Competence Center

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Motor Control Competence Center mission

Create and Promote innovative, convenient and mature Motor Control System Solutions to Design and Partner with our Regional Customers in order to leverage on the whole ST product portfolio for Industrial Applications in order to boost revenues growth in the market segment

- **SYSTEM R&D**
  - HW Reference Design, Application Boards
  - FW Application Modules for the ST MC Library
  - System Solutions
- **CUSTOMER SUPPORT**
  - Evaluation & Training with ST Tools
  - ST Kit Product Selection (in cooperation with TM)
  - Schematics; Layout review; Tuning (in cooperation with FAE)
- **PARTNERSHIP**
  - Overall Motor Control System expertise
  - Partnership & new algorithms;
  - Customer's IP porting to ST platforms
- **NPP, NSP, GAP**
  - Products validation in-application: feedback to divisions
  - New Product, New Solution Proposals: specification / roadmap
  - Inter-divisional / strategic MKT / Joint Labs: information & technology

Motor Control Competence Center
Major focus sectors

Motor Control Competence Center

Motor Control

Home & Professional Appliances
Airconditioning
WM -fridge–DW -blenders
Ceiling Fan–Rangehood

Products
STM32 MCU / STSPIN32Fxxx Family of SIP, IGBT, IPM, MOSFET, Gate Drivers, STSPIN, Sensors, Imaging, Connectivity

Automation
Servo – robot handler - fan door – shutters - conveyors Textile machine - pump

Products
STM32Fxxx Family of SIP, IGBT, IPM, MOSFET Gate Drivers, STSPIN, Sensors, Imaging

Industrial transportation
Scooter – forklift – golfcart
Elevator

Products
STM32Fxxx Family of SIP, IGBT, IPM, MOSFET Gate Drivers, STSPIN, Sensors

Tools
Power tools, garden tools

Products
ST32Fxxx Family , IGBT, IPM, MOSFET
Gate Drivers,
STSPIN/MEMS/Sensors

Consumer
vacuum&robot cleaner, balance board,ESC, EduRobot,Fitness

Products
STM32Fxxx Family of SIP, IGBT, IPM, MOSFET
Gate Drivers, STSPIN, ToF, Sensors, connectivity

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Motor Basic Theory

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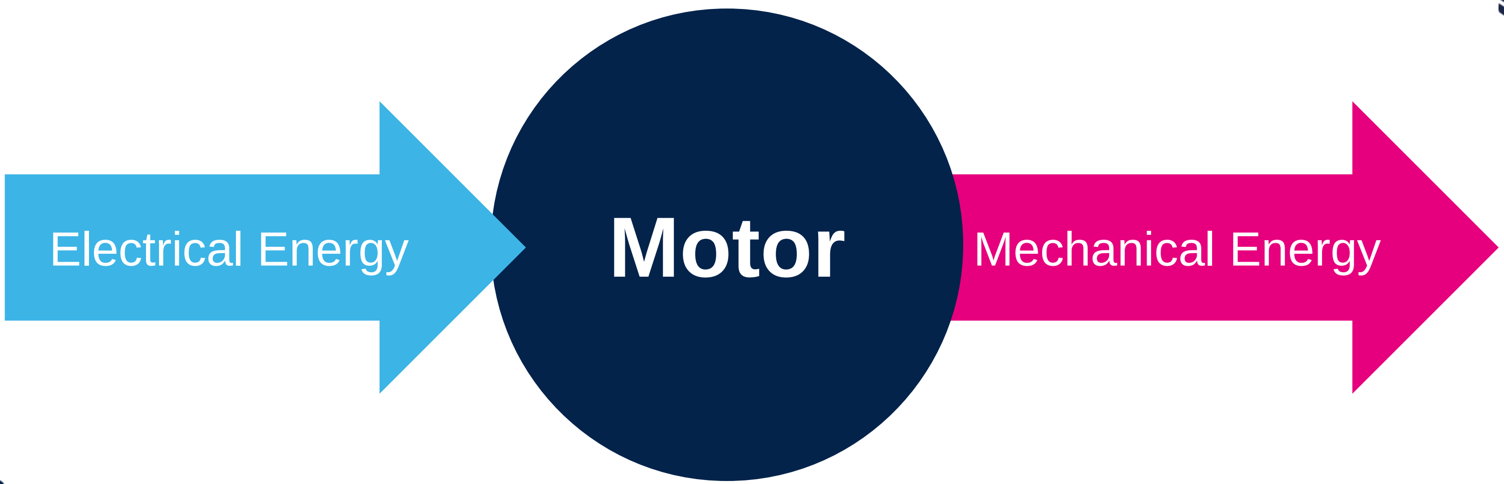
Motor Definition

An electric motor is a device converting electrical energy into mechanical energy

This conversion is usually obtained through the generation of a magnetic field by means of a current flow into on or more coils



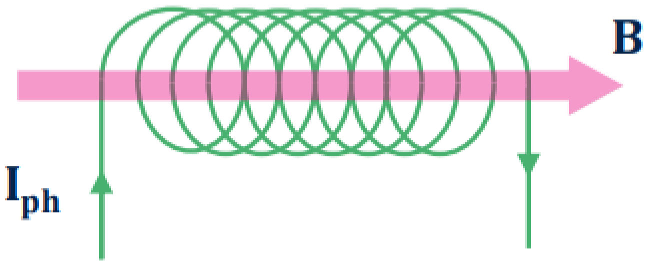
Magnetic Field Generation

The rotation is obtained thanks to the attractive force between two magnetic fields:

- One field is located on the rotor (the moving part)
- The second magnetic field is located on the stator (the body of the motor)

Usually, one of the two is generated by a permanent magnet while the other one is generated through an electromagnet (coil)

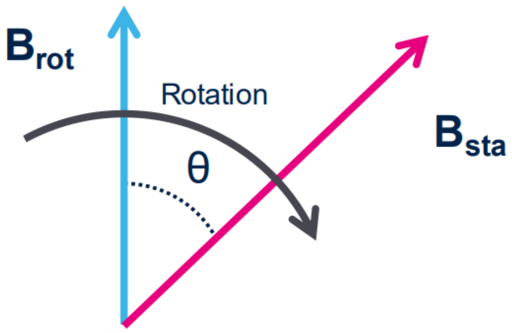
The relation between electrical energy (current) and magnetic field generated by a coil is obtained through the following formula:



$$B = k \cdot I_{ph}$$

Torque and Angle

The **output torque** of an electrical motor depends on the intensity of the rotor and stator magnetic field and on their phase relation:



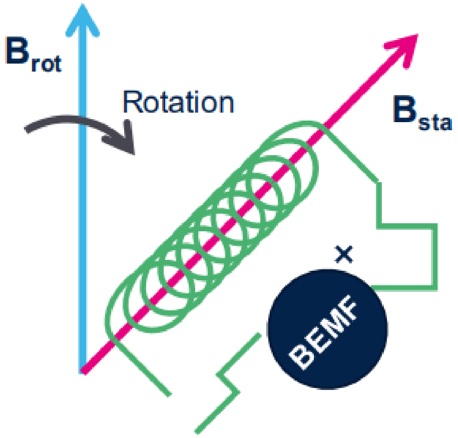
$$T_q \propto B_{rot} \cdot B_{sta} \cdot \sin\theta \propto \boldsymbol{I_{ph}} \cdot \mathbf{sin}\, \boldsymbol{\theta}$$

The angle **θ** between the two magnetic field is named **load angle**.

The **maximum output torque**, and then the **maximum efficiency**, is obtained when the **load angle is 90˚**.

Back Electromotive Force

The rotation of the rotor magnetic field (B_{rot}) causes a variation of the magnetic flux in the solenoid.



Consequently, an electromotive force is generated that counteracts the magnetic flux change (Lenz's law).

This effect is named **back electromotive force** (a.k.a. **BEMF**) and it is proportional to the motor speed according to the formula:

$$V_{BEMF} = k_e \cdot Speed$$

Basic Principle

The electric motor operation is based on following points:

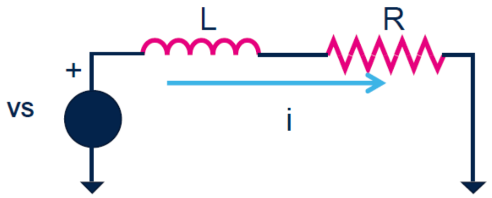
- At least one of the two **magnetic field** is generated by a coil carrying a current
- **Phase relation** between the rotor and stator magnetic field (i.e. the load angle) must be always grater than 0˚ in order to keep the motor in motion (negative angles reverse the rotation).
- Output **torque** depends to both coil **current** and **load angle**.
- Motor rotation causes a **back electromotive force (BEMF)** opposing the motion itself.

Inductive Load

Motor expressed as inductive load

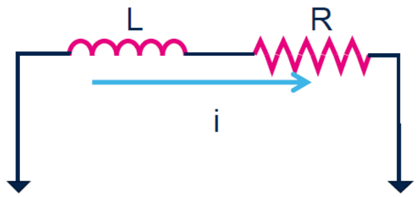
An inductive load can be represented as an LR series which stores energy in the form of current

Applying a voltage to the load, it is possible to change the amount of current stored into the inductance.



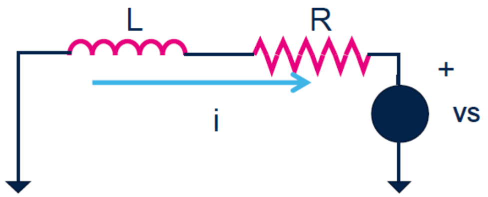
Scenario 1 (ON time)
Inductance is charged applying a voltage:

$$i(t) = \frac{V_S}{R} + \left(i(0) - \frac{V_S}{R}\right) \cdot e^{-t \cdot R/L}$$



Scenario 2 (slow decay)
Inductance is discharged shorting the leads:

$$i(t) = i(0) \cdot e^{-t \cdot R/L}$$



Scenario 2 (fast decay)
Inductance is discharged shorting the voltage:

$$i(t) = -\frac{V_S}{R} + \left(i(0) + \frac{V_S}{R}\right) \cdot e^{-t \cdot R/L}$$

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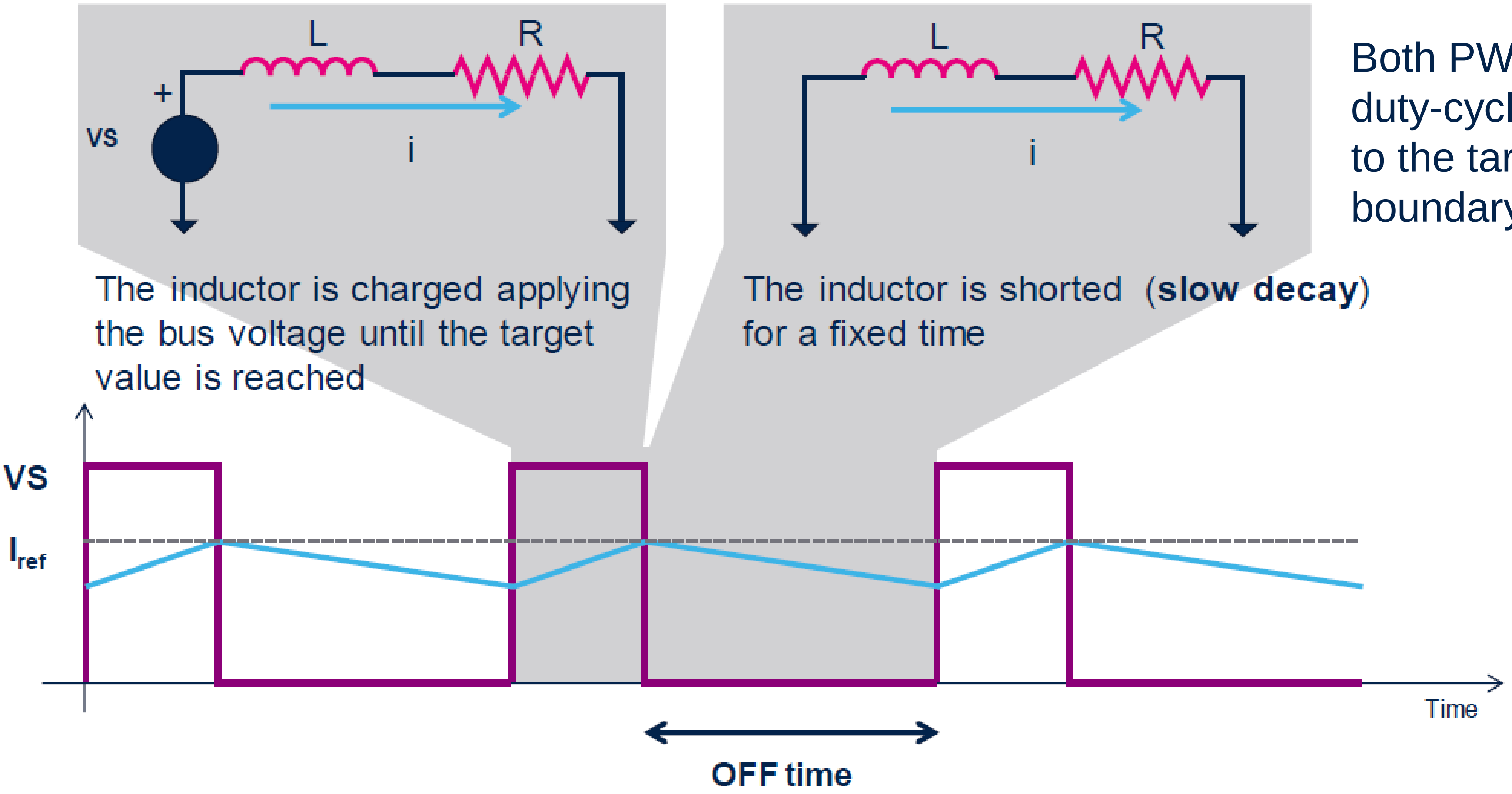
PWM current control basics

The most common method to control the current is the **fixed OFF time** method.

It is a **closed-loop** approach which implies the measurement of the controlled current.



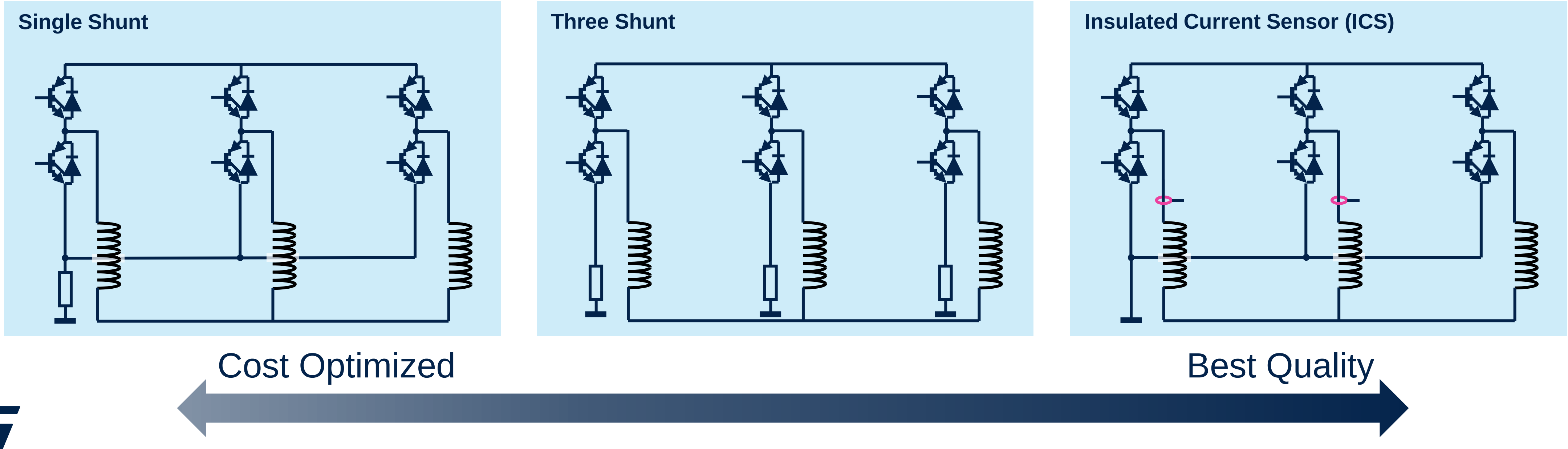
Both PWM frequency and duty-cycle changes according to the target current and boundary conditions.

Current Sensing

To measure the motor phase currents a conditioning network is required.

The STM32 FOC SDK supports three current sensing network

- Insulated current sensor (ICS)
- Three shunts
- Single shunt

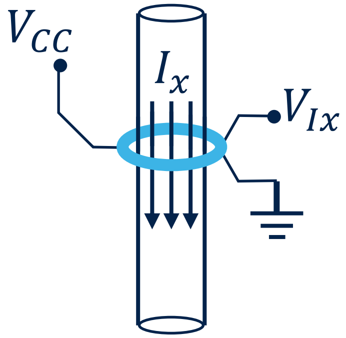


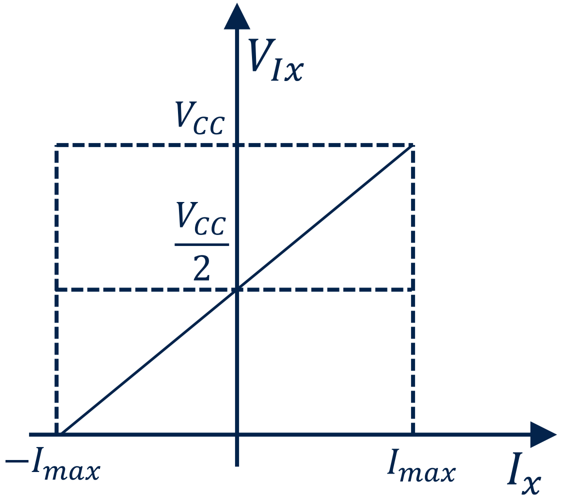
Insulated Current Sensing

Insulated current sensor is used to measure directly two of the motor phase currents.

Usually, ICS is provided with the adapting network.

It is important to choose the proper sensor according the range of current to be covered.



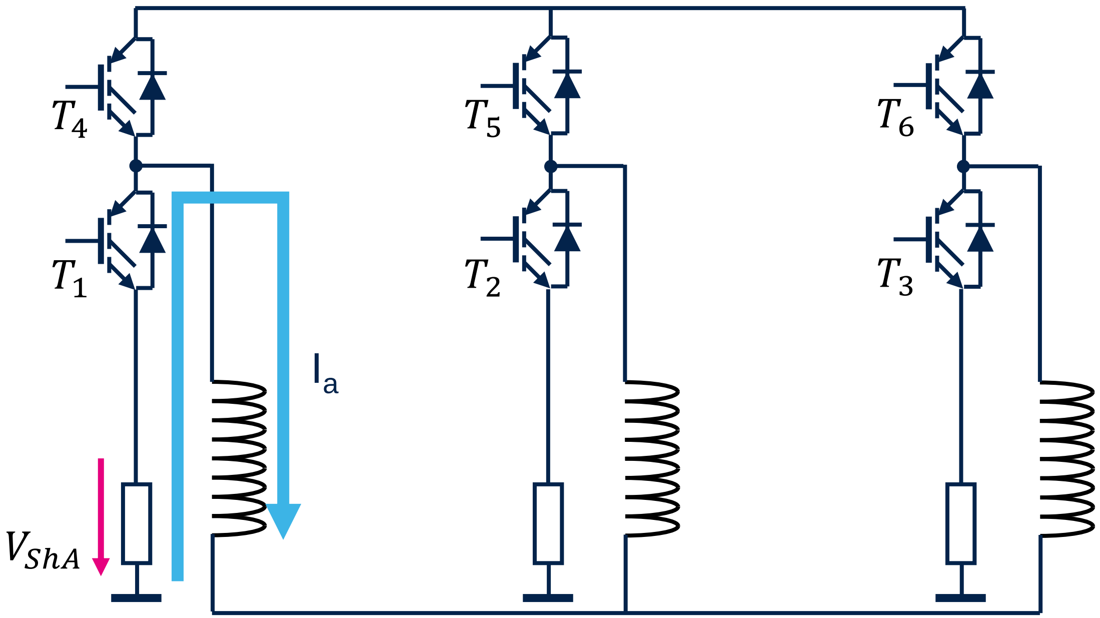


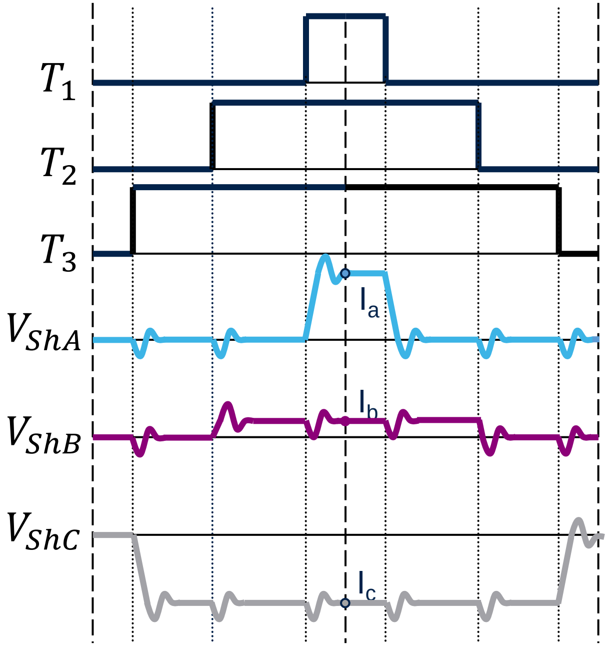
Three Shunt Current Sensing

Current flows into the shunt when the relative low side switches is closed.

According to the PWM duty cycles,
the voltage on shunt resistor is proportional to the motor phase currents after a stabilization time.

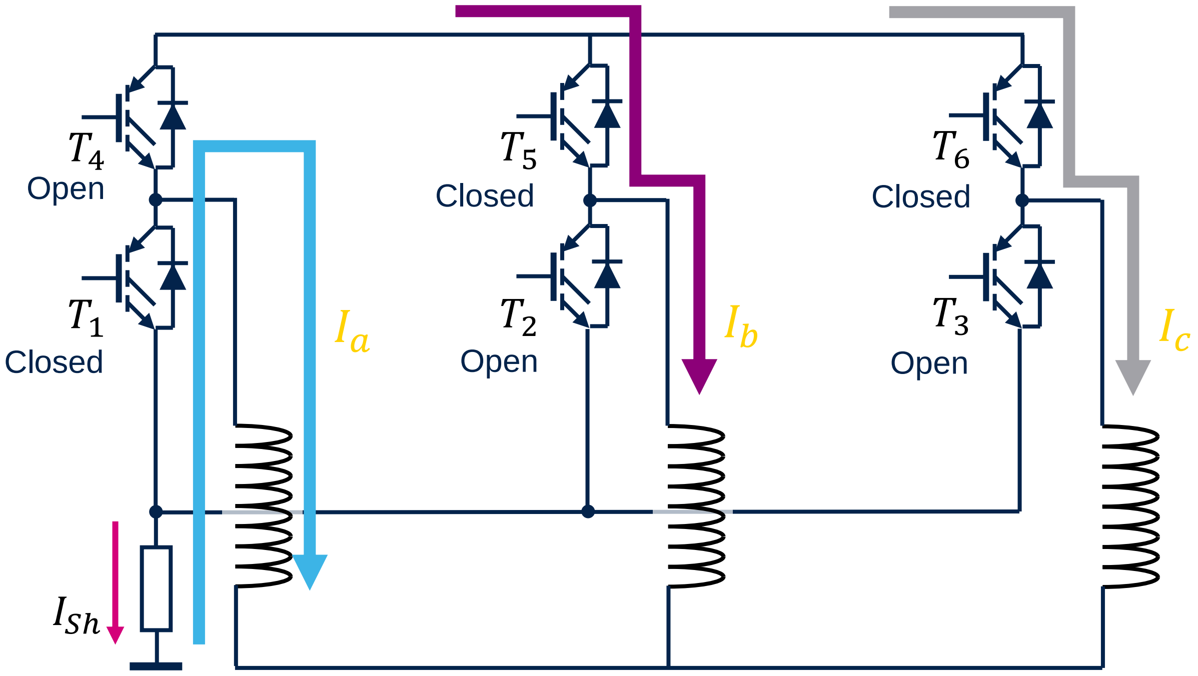
The third can be computed using: $Ia+Ib+Ic=0$





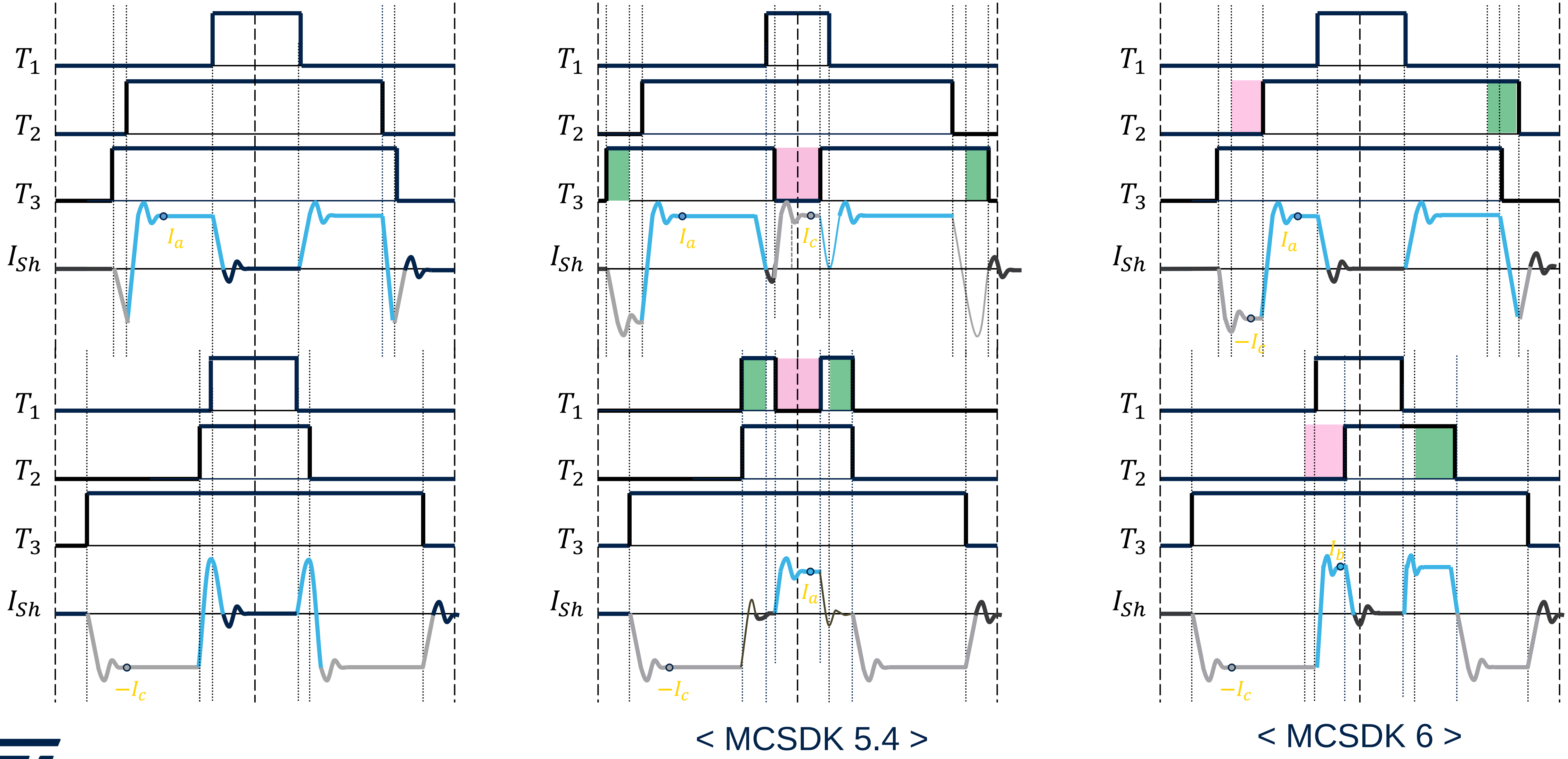
Single Shunt Current Sensing

For each combination of the low side switches, the current that flows in the shunt resistor is indicated in the table



T_1	T_2	T_3	I_{Sh}
Open	Open	Open	0
Open	Close	Close	I_a
Open	Open	Close	$-I_c$
Close	Open	Close	I_b
Close	Open	Open	$-I_a$
Close	Close	Open	I_c
Open	Close	Open	$-I_b$
Close	Close	Close	0

Single Shunt Current Sensing



Control Method (Six-step / FOC)

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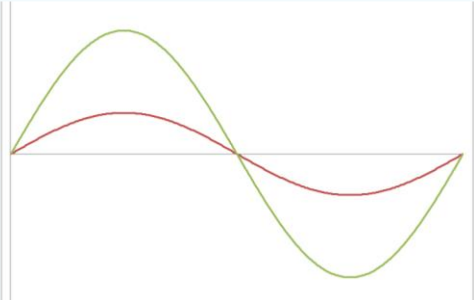
PMSM vs BLDC

PMSM (Permanent Magnet Synchronous Motor)

- Rotor houses permanent magnets
    - On the surface → SPMSM (Surface Mounted PMSM)
    - Buried within the rotor → IPMSM (Interior PMSM)
- Stator excitation frequency must be synchronous with rotor electrical speed
- Rotation induces sinusoidal Back Electro-Motive Force (BEMF) in motor phases
- Gives best performances (torque steadiness) when driven by sinusoidal phase current

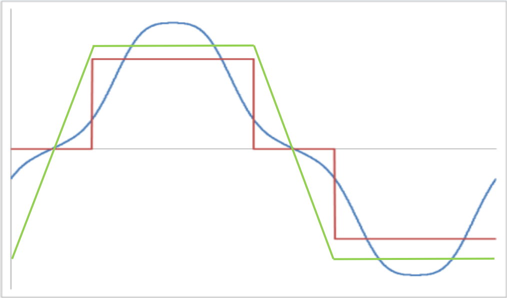


Typical B-emf shape

Optimum current shape

BLDC (Brushless DC Motor)

- Rotor houses permanent magnets
- Stator excitation frequency must be synchronous with rotor electrical speed
- Rotation induces trapezoidal Back Electro-Motive Force (BEMF) in motor phases
- Gives best performances (torque steadiness) when driven by rectangular phase current
- Generally, nowadays, BLDC magnetization is same as PMSM
- No difference between BLDC and PMSM practically



Ideal B-emf shape

Typical B-emf shape

Optimum current shape

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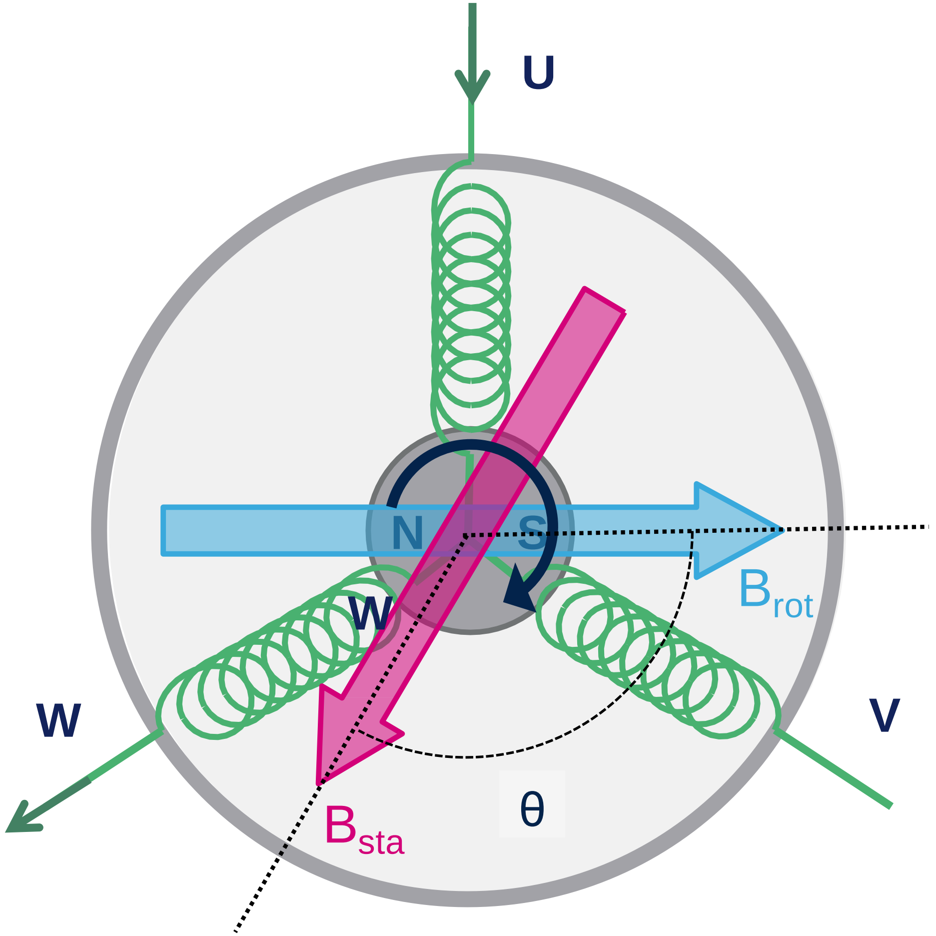
Three-phase BLDC/PMSM

Basics – load angle and rotation

The torque applied to the motor is proportional to the sine of the **load angle** (θ).

When the rotor magnetic field approaches the stator one, the torque is reduced.



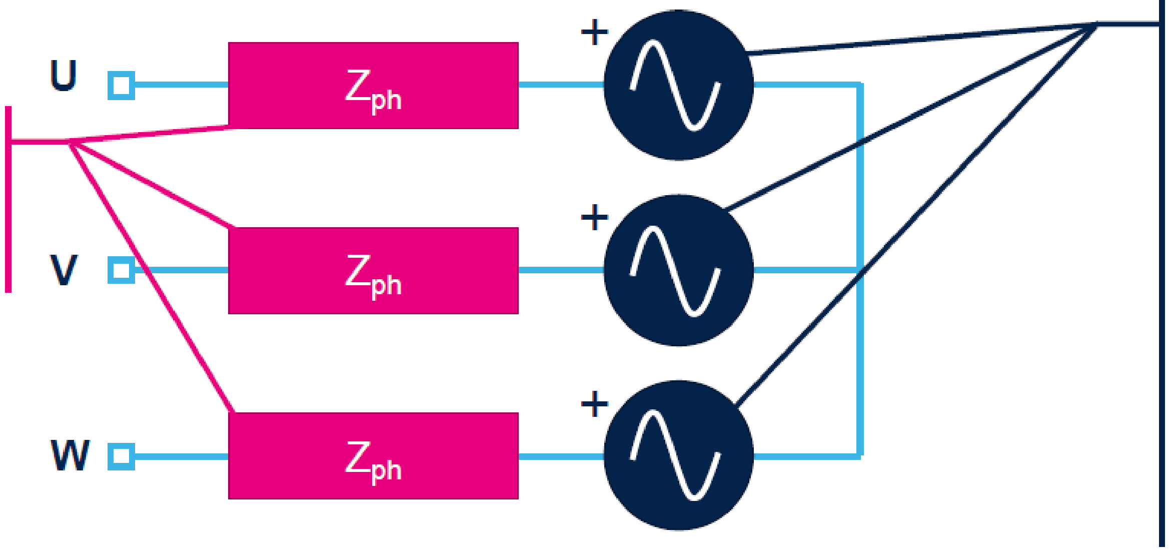
In order to keep the motor in motion, it is necessary to change the direction of the stator magnetic field.

Three-phase BLDC/PMSM

Basics – electrical model

Phase impedance

$$\mathbf{Z_{ph} = R_{ph} + j\omega L_{ph}}$$



Back electromotive force generators.

BEMFs are three sine wave voltages(*) delayed from each other by 120˚.

The sinewave amplitude is proportional to the motor speed:

$$V_{BEMF} = \mathrm{k_e} \cdot Speed$$

Three-phase BLDC/PMSM

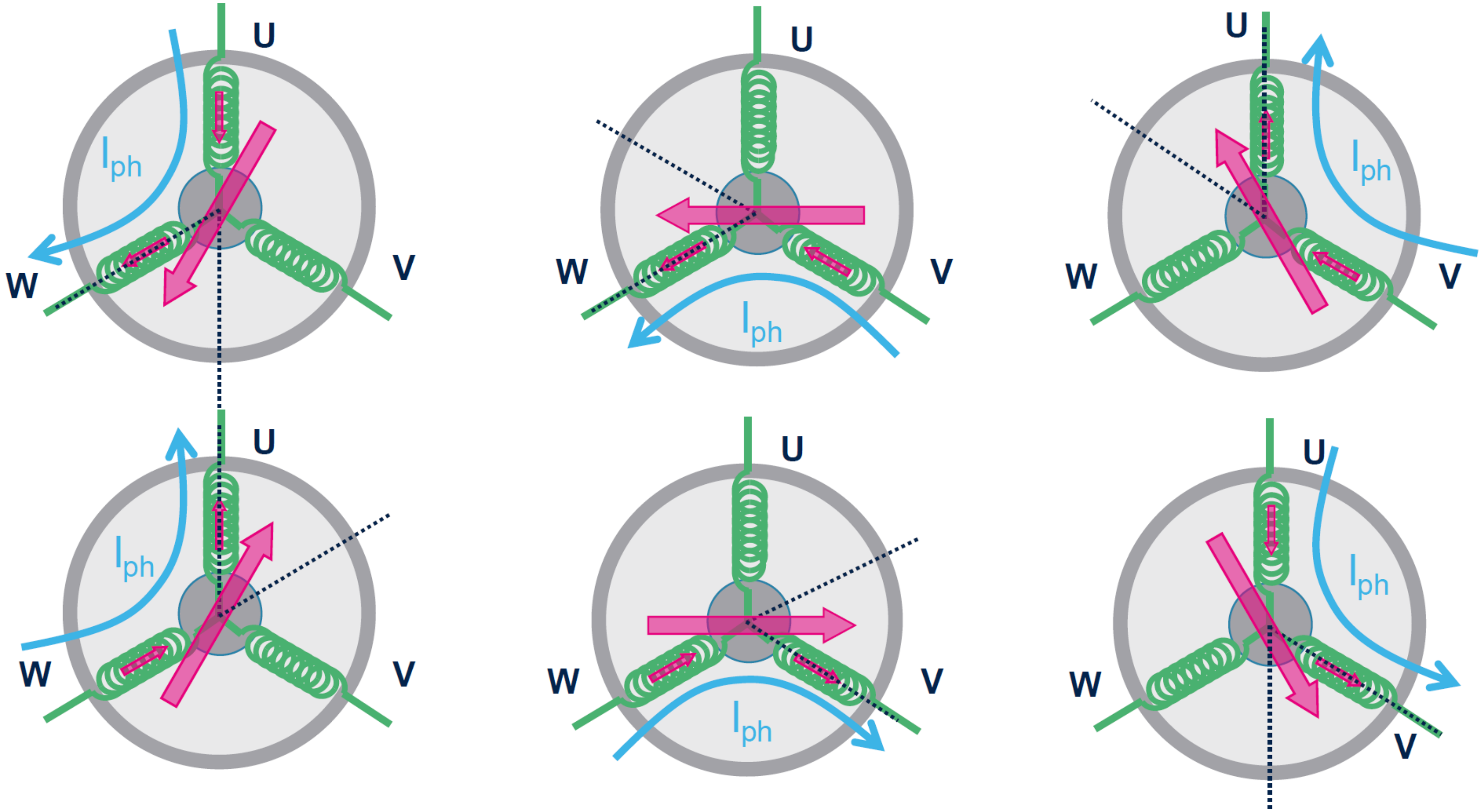
6-step driving – rotor position

The **6-step driving** imposes a current between two of the three phases leaving the third one floating.

In this way the stator magnetic field can be positioned in **6 discrete directions**.

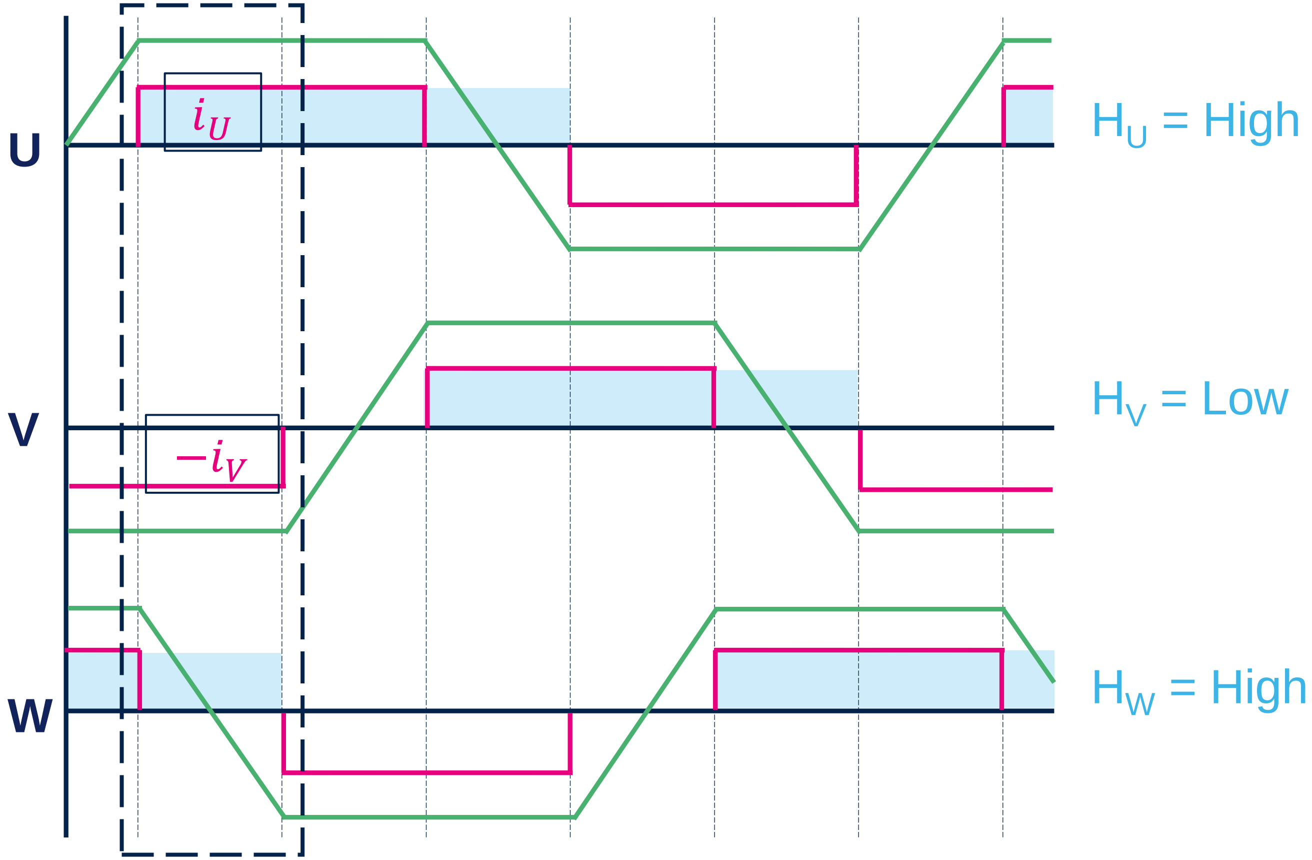
The scanning of the 6 driving combinations of the six step is synchronized by the **rotor position**.

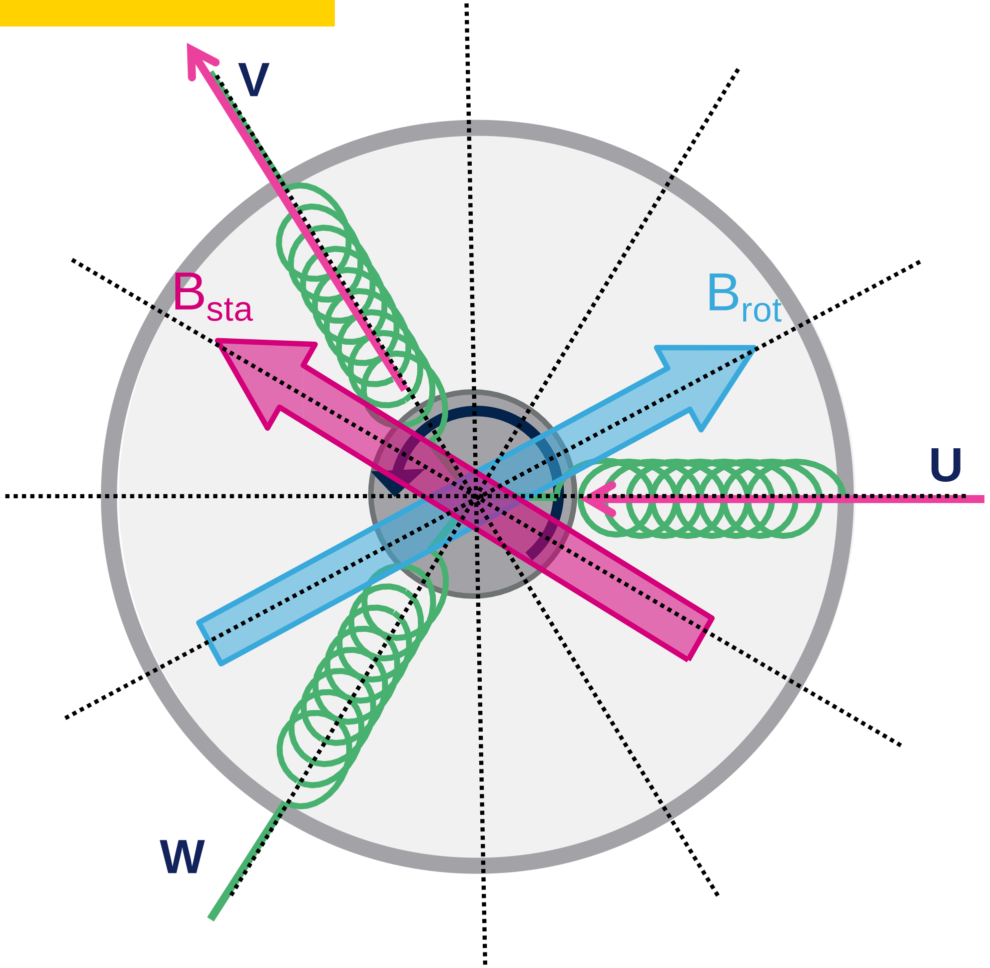
The rotor position can be monitored through Hall sensors or using a BEMF sensing technique (sensorless)



Three-phase BLDC/PMSM

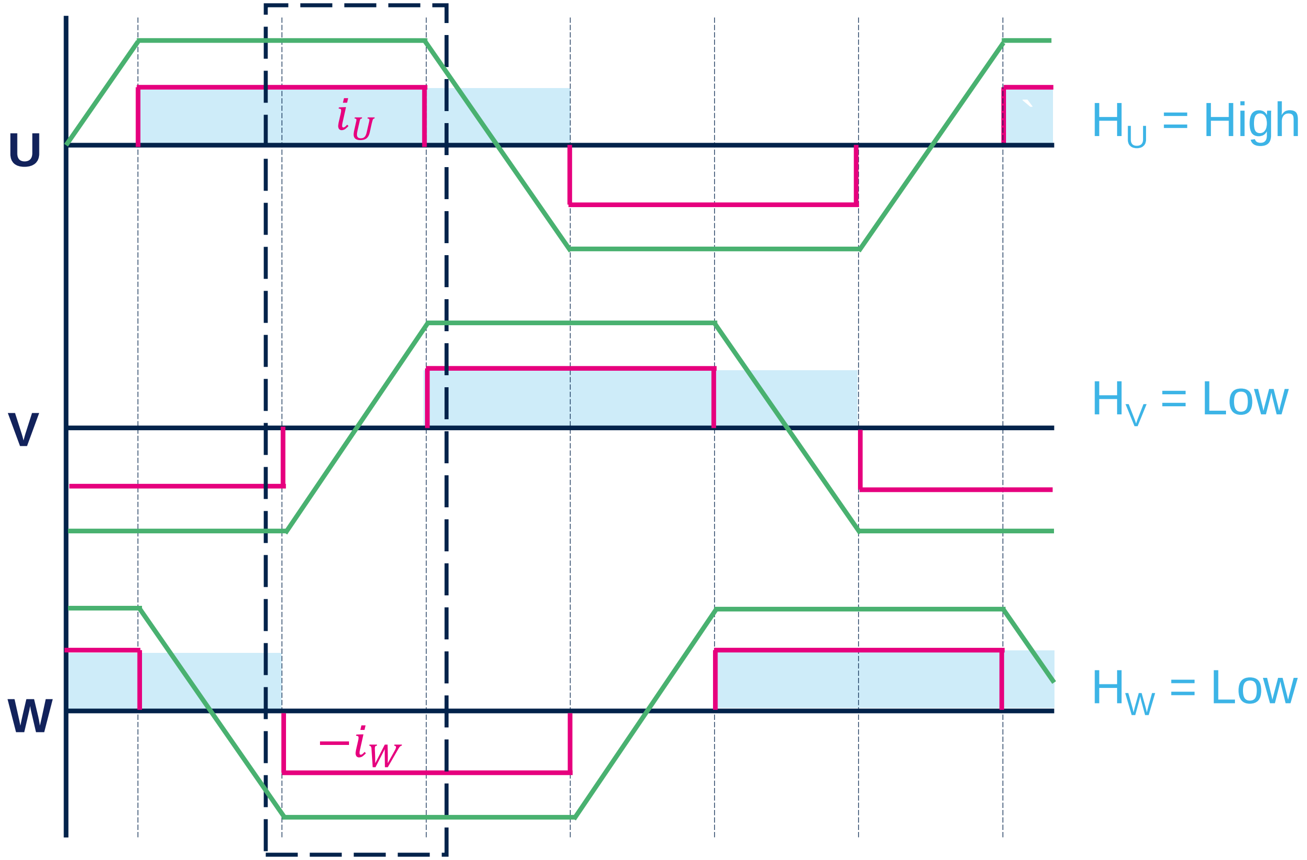
6-step driving – Hall sensors feedback (30˚ - 90 ˚)

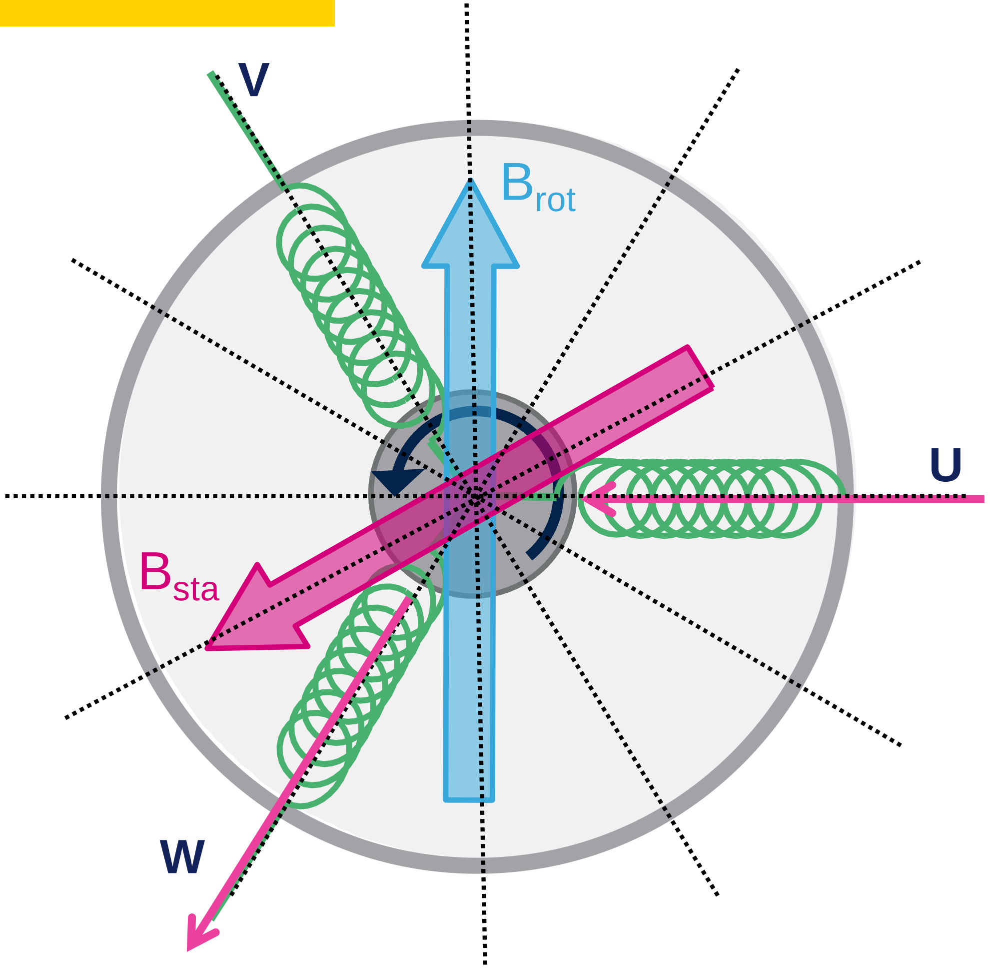




Three-phase BLDC/PMSM

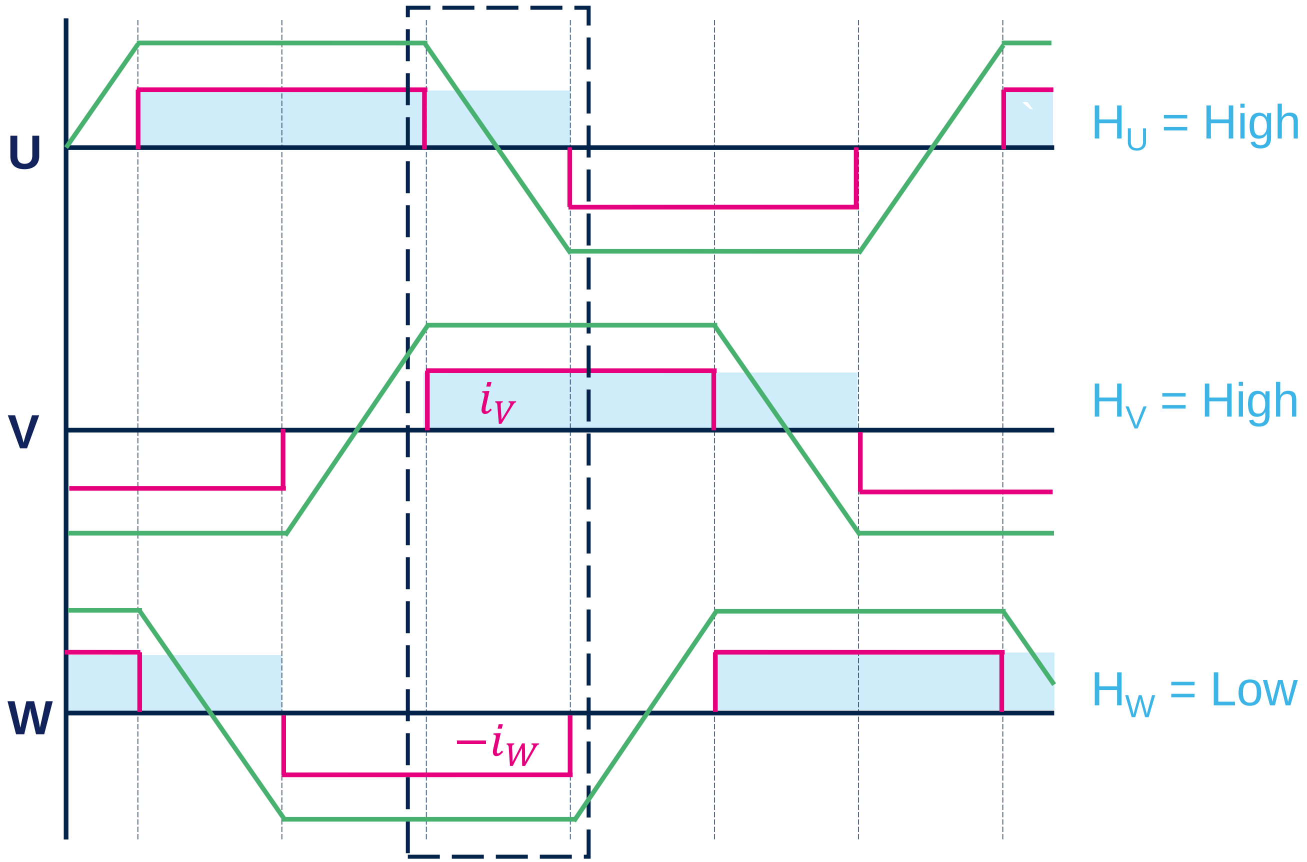
6-step driving – Hall sensors feedback (90˚ - 150 ˚)

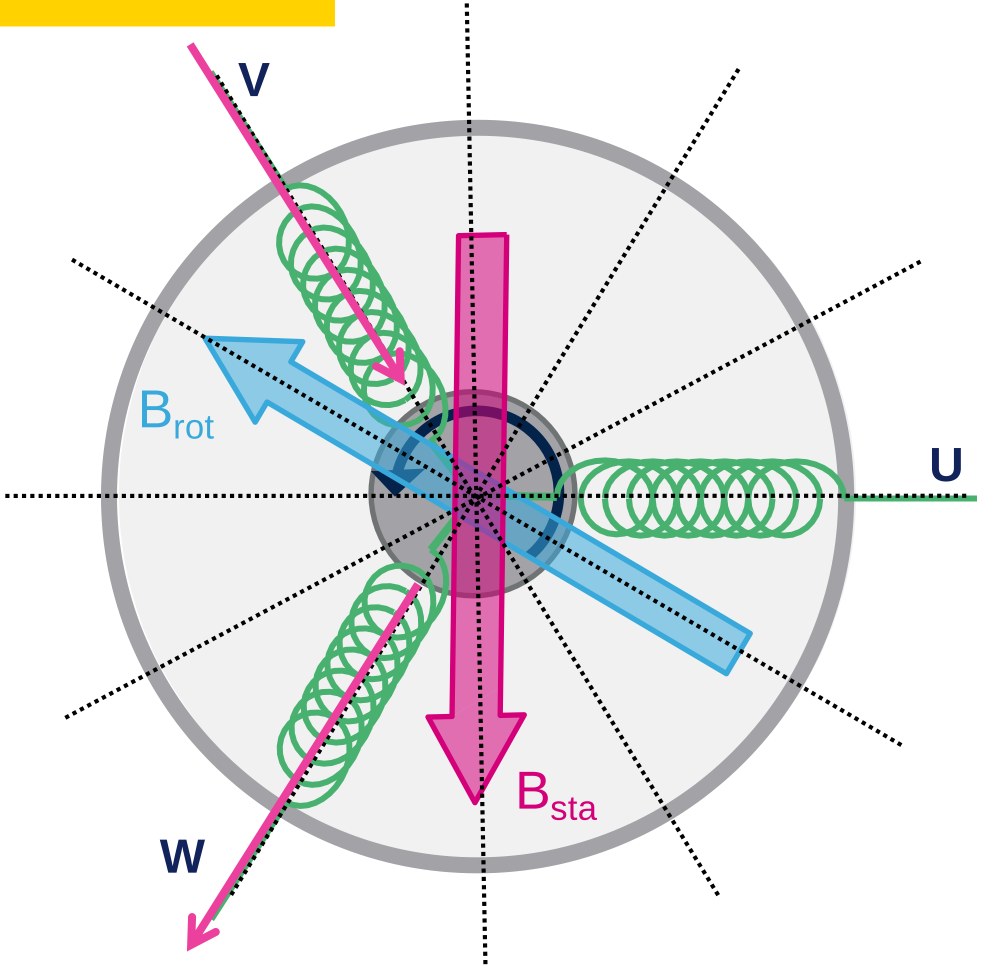




Three-phase BLDC/PMSM

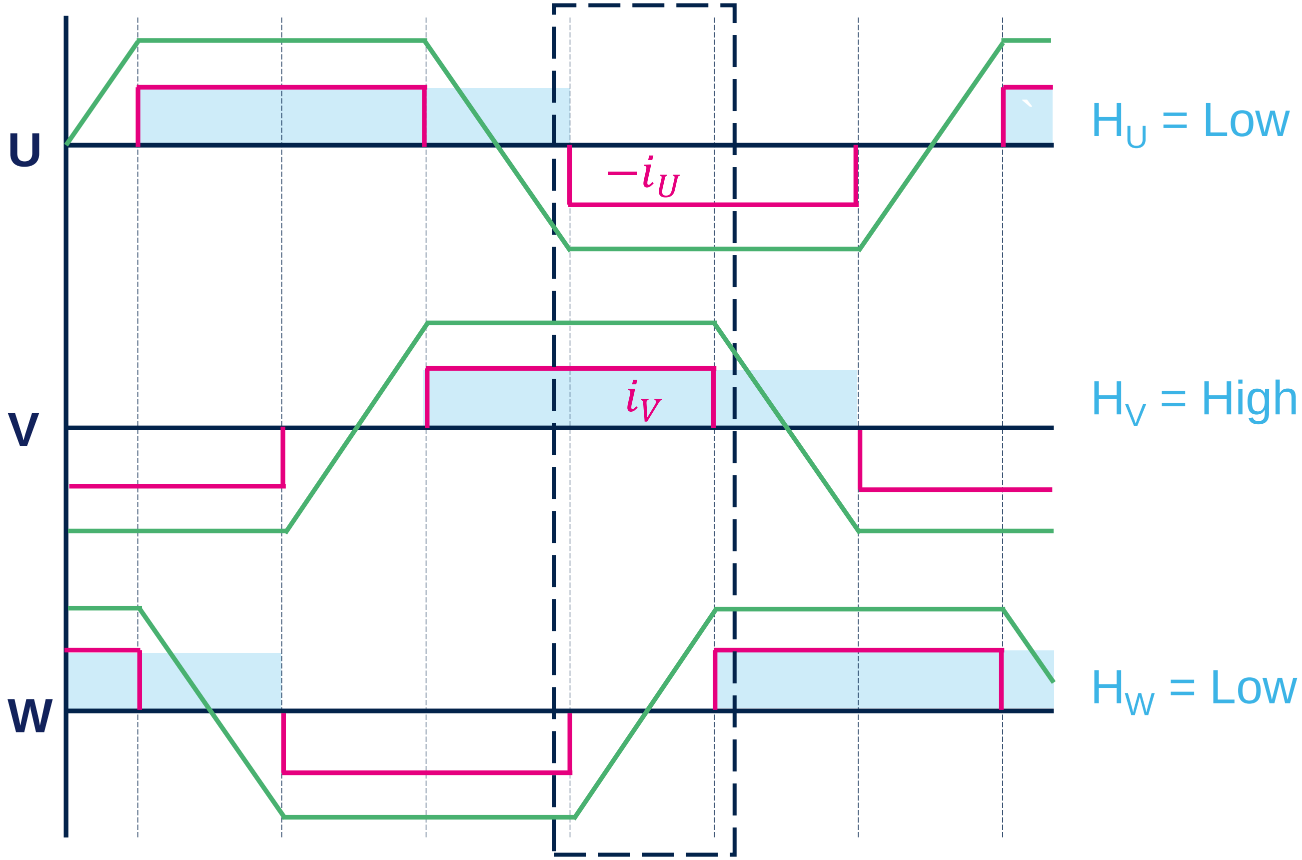
6-step driving – Hall sensors feedback (150˚ - 210 ˚)

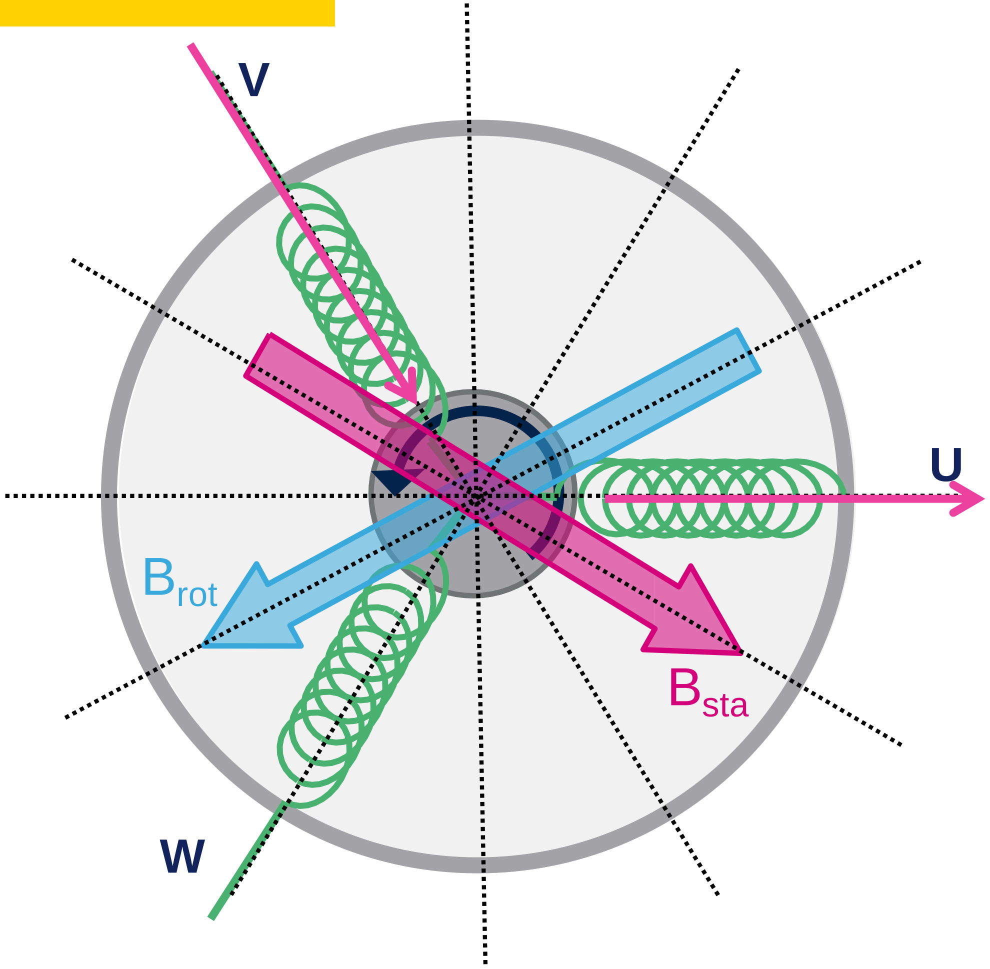




Three-phase BLDC/PMSM

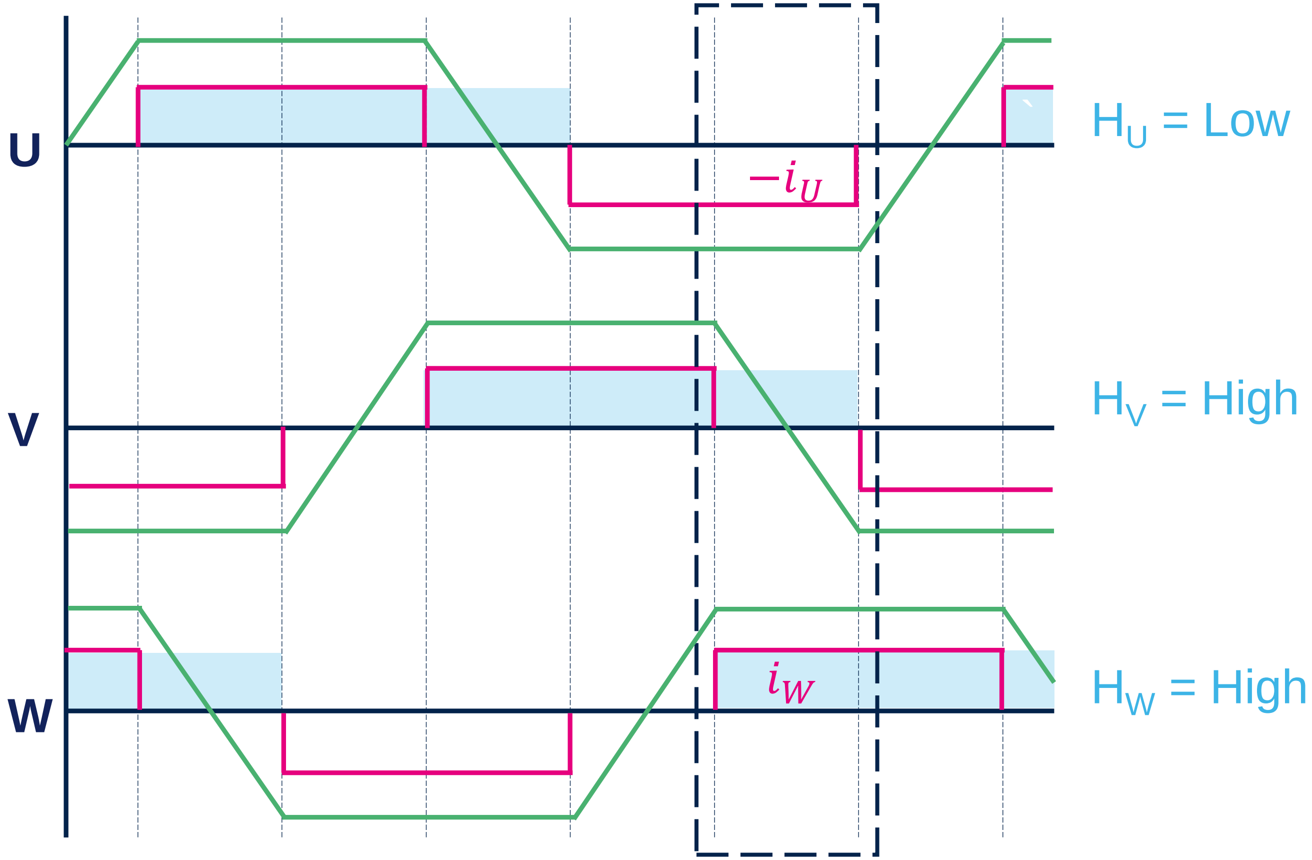
6-step driving – Hall sensors feedback (210˚ - 270 ˚)

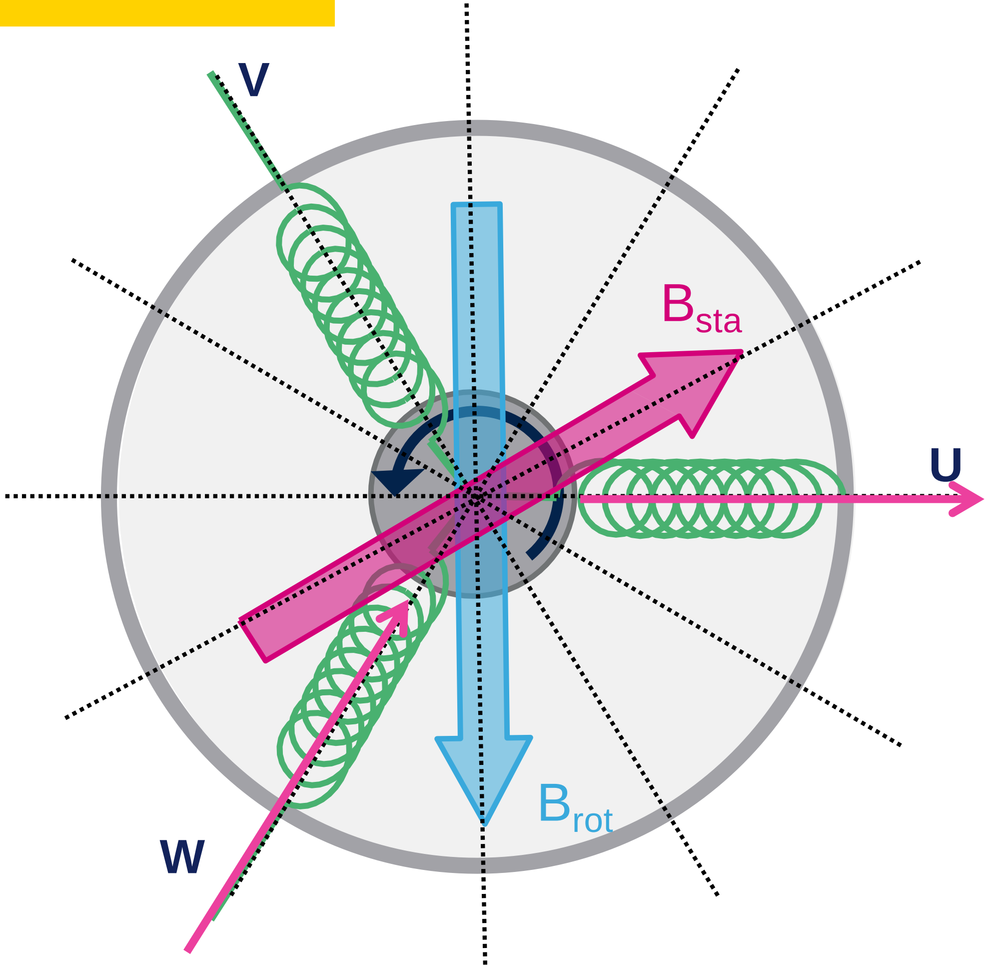




Three-phase BLDC/PMSM

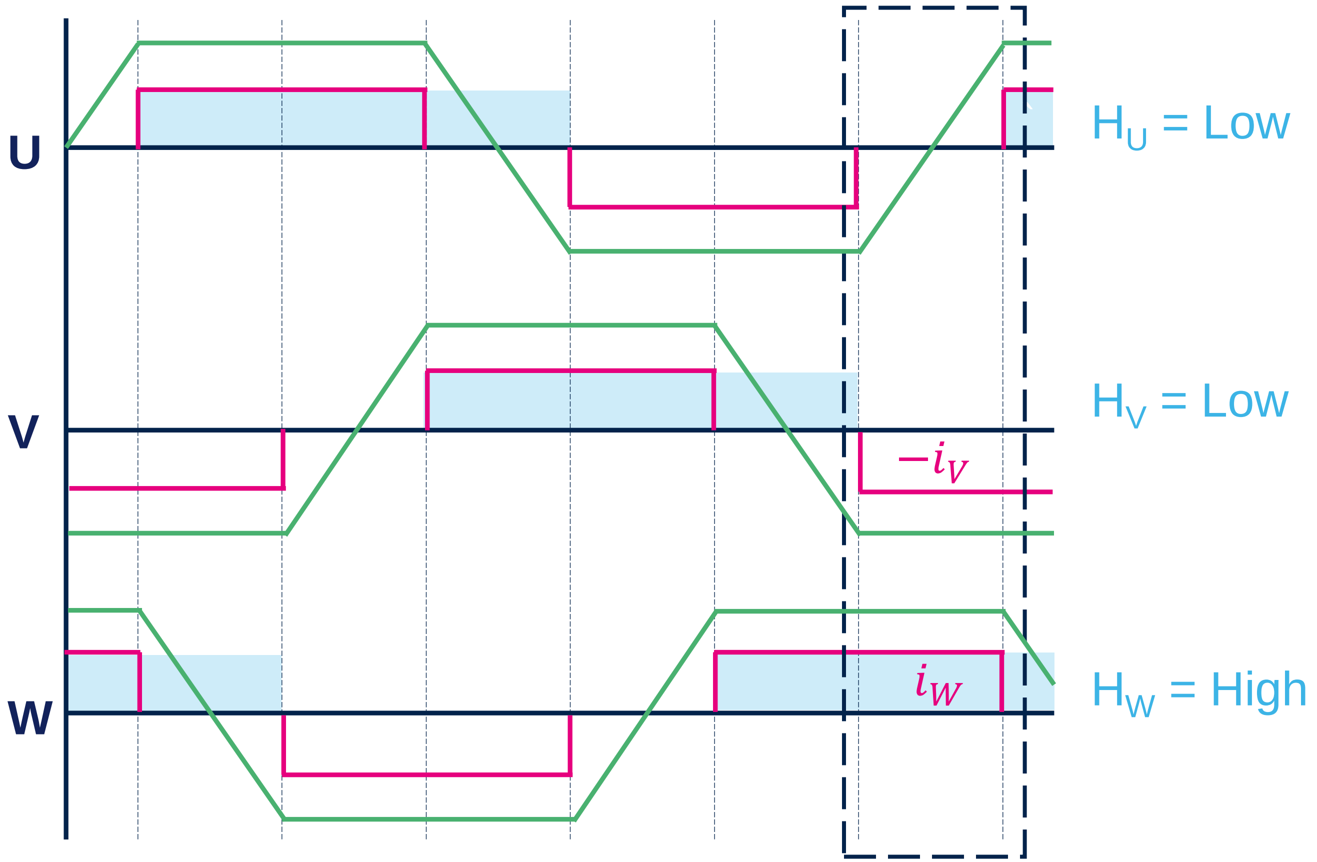
6-step driving – Hall sensors feedback (270˚ - 330 ˚)

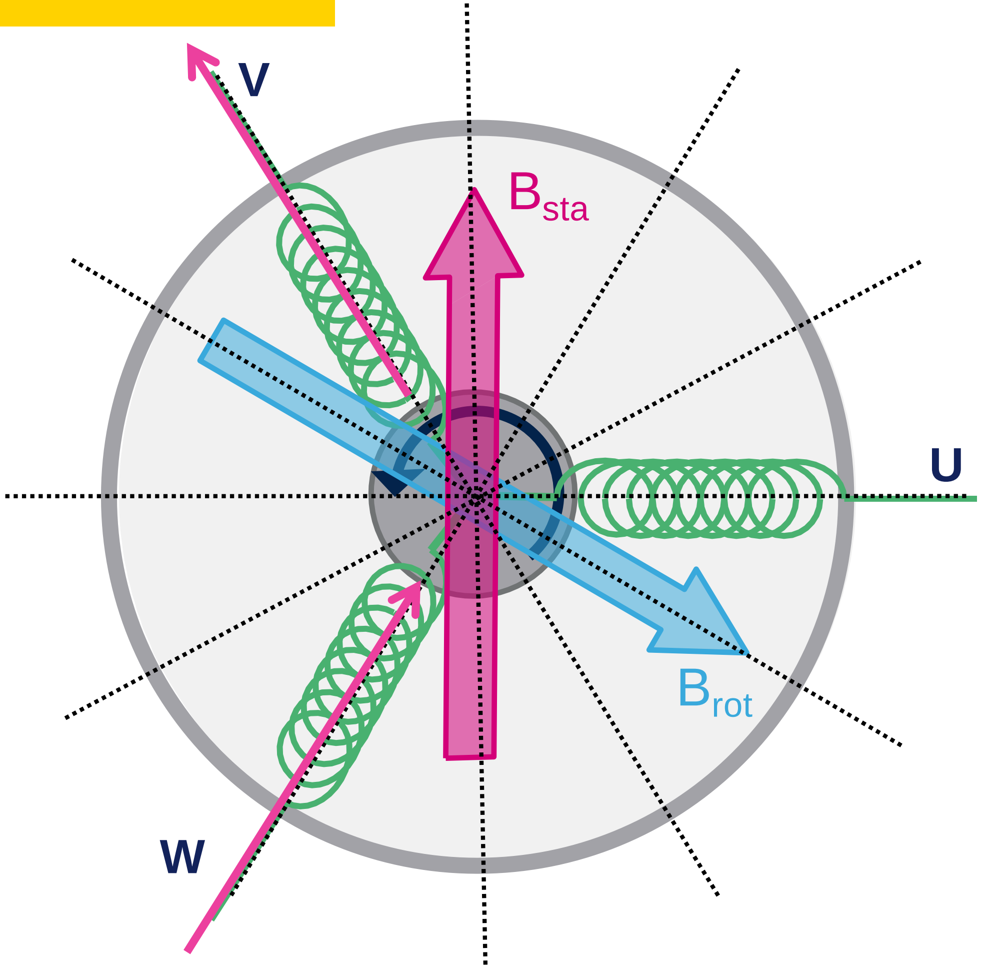




Three-phase BLDC/PMSM

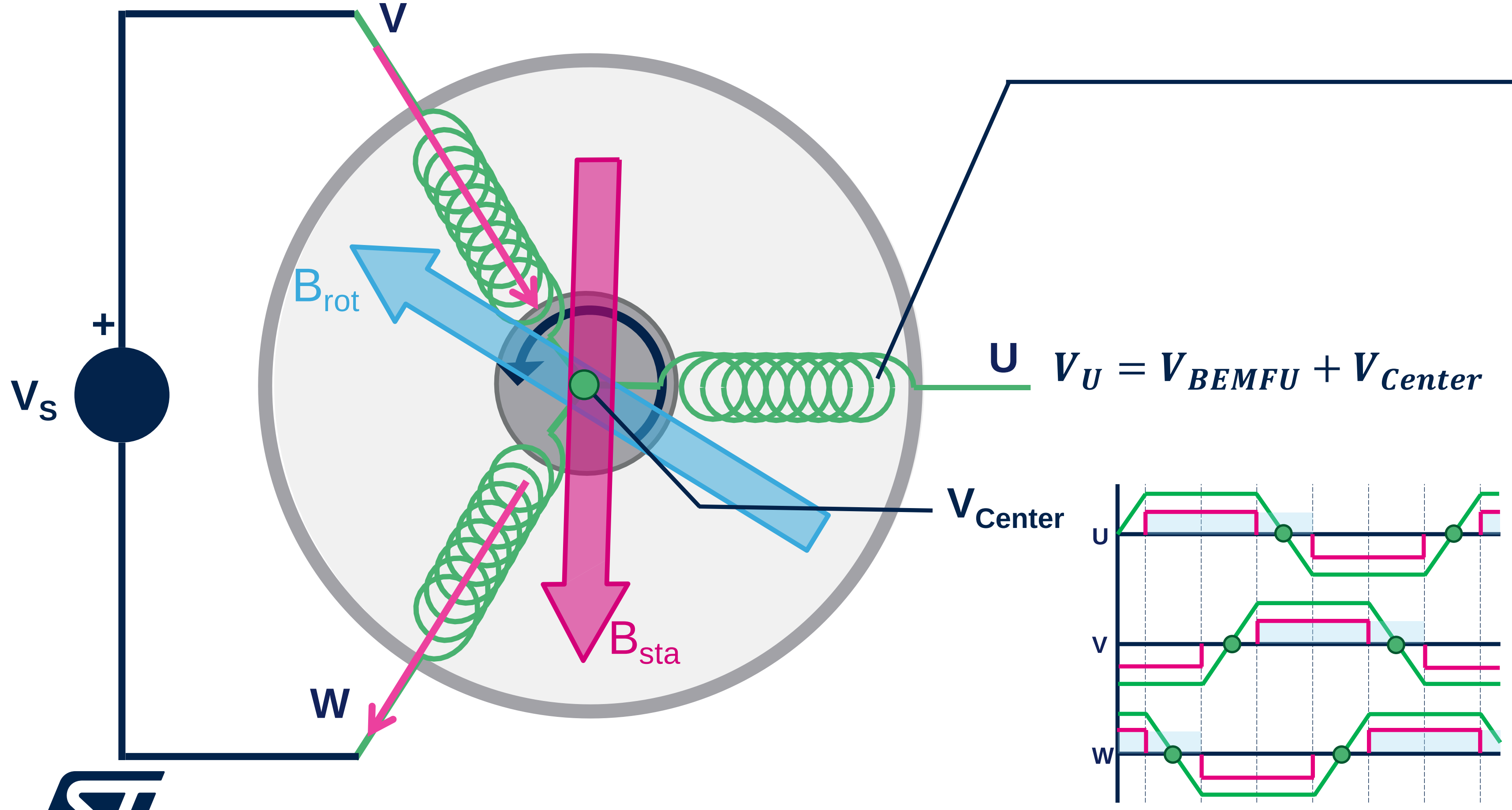
6-step driving – Hall sensors feedback (330˚ - 30 ˚)





Three-phase BLDC/PMSM

6-step driving – sensorless driving



$V_U = V_{BEMFU} + V_{Center}$

When the magnetic field of the rotor crosses the unloaded phase, the respective BEMF voltage changes polarity (zero-crossing)

The sensorless driving detects the BEMF zero-crossing measuring the voltage on the floating phase

In order to detect the zero-crossing of the BEMF the center-tap voltage must be know.

Some motors makes the center tap available. In other cases, it can be reconstructed through the phase voltages.

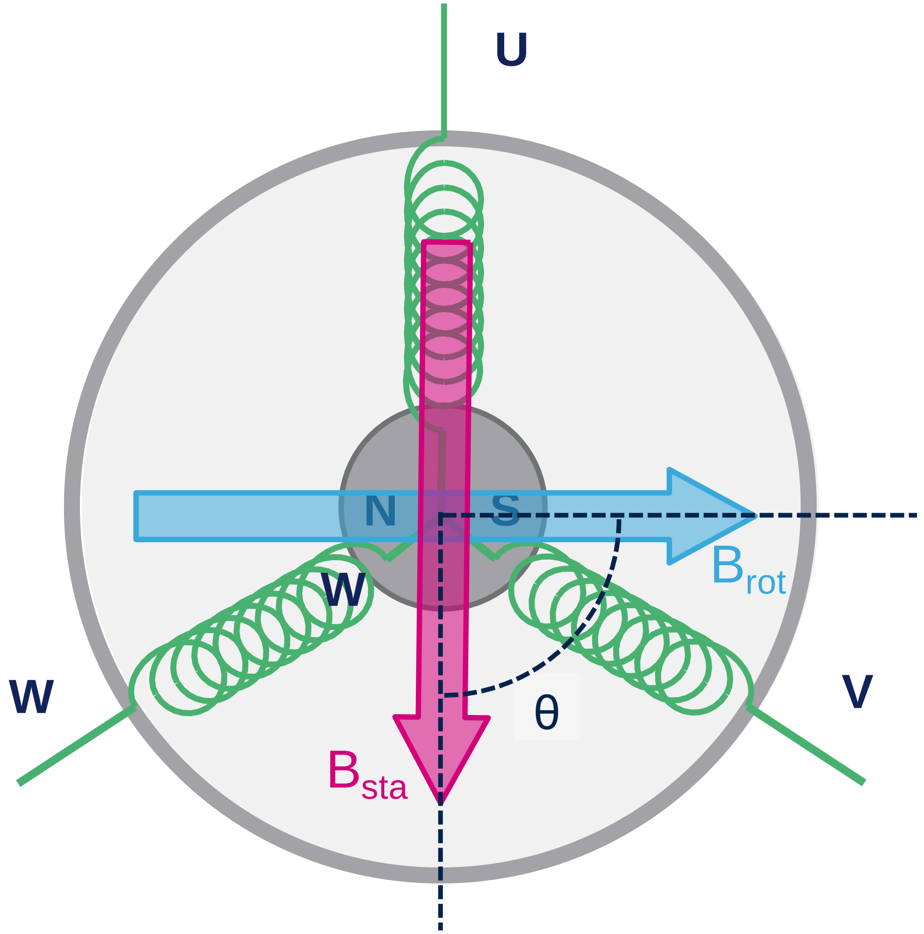
Three-phase BLDC/PMSM

Field Oriented Control

The **Field Oriented Control (FOC)** algorithm allows to obtain the maximum performance from a BLDC/PMSM motor.

The objective of the algorithm is to control the vector components of the stator magnetic field (i.e. the phase currents) in order to obtain the target **intensity** and **phase relation** with the rotor magnetic field.

$$T_q \propto B_{rot} \cdot B_{sta} \cdot \sin\theta \propto \boldsymbol{I_{ph}} \cdot \boldsymbol{\sin\theta}$$



Three-phase BLDC/PMSM

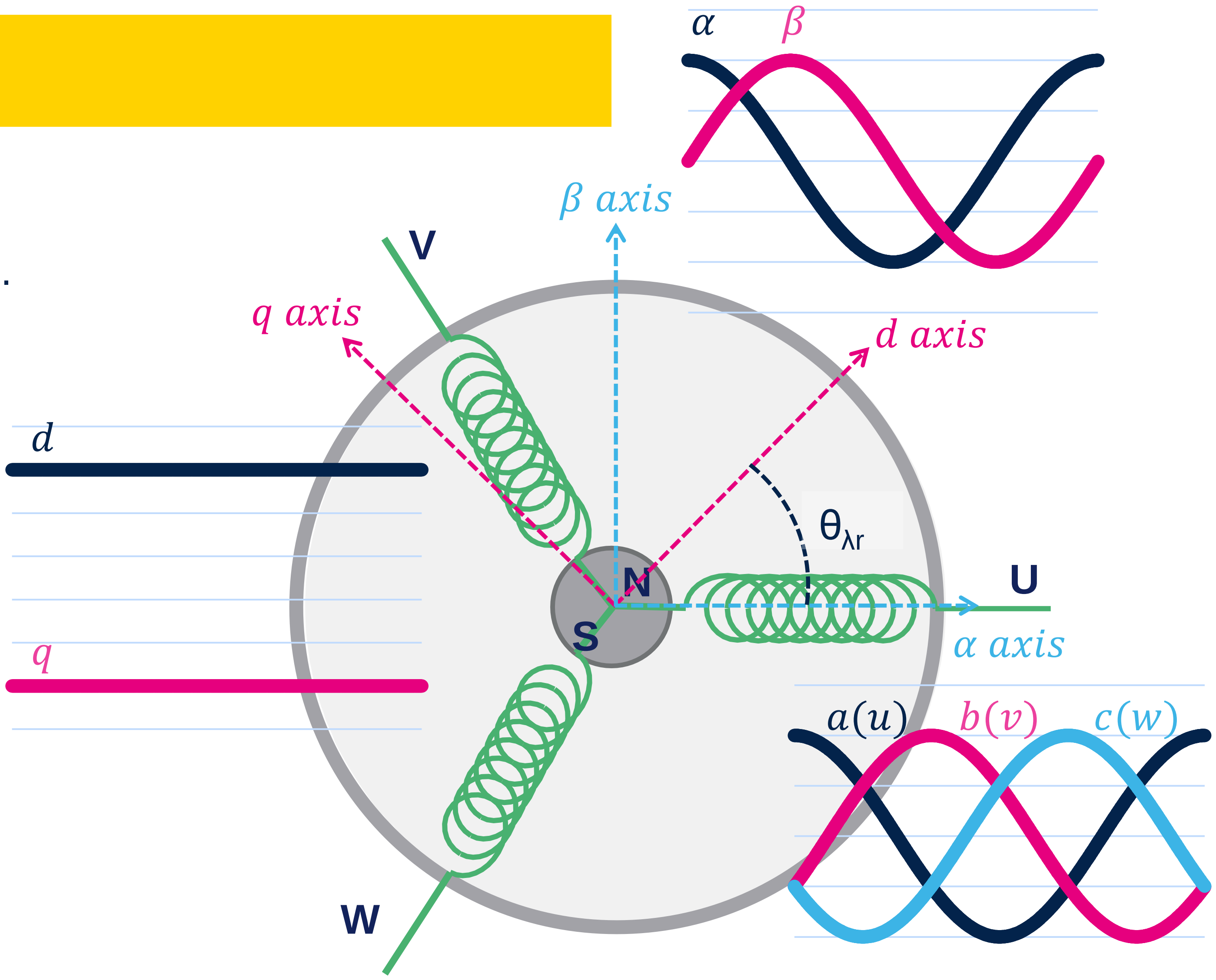
Field Oriented Control

D-Q rotation reference frame
d-q reference frame is a projection of a, b, c variables.
Control factors can be reduced from three to two.
($a - b - c$ to $d - q$)

The d-axis and q-axis have independence
by being orthogonal.

D-axis (Direct Axis)
Aligned with rotor flux vector.
Control **flux density** (i.e. Flux(field) Weakening)

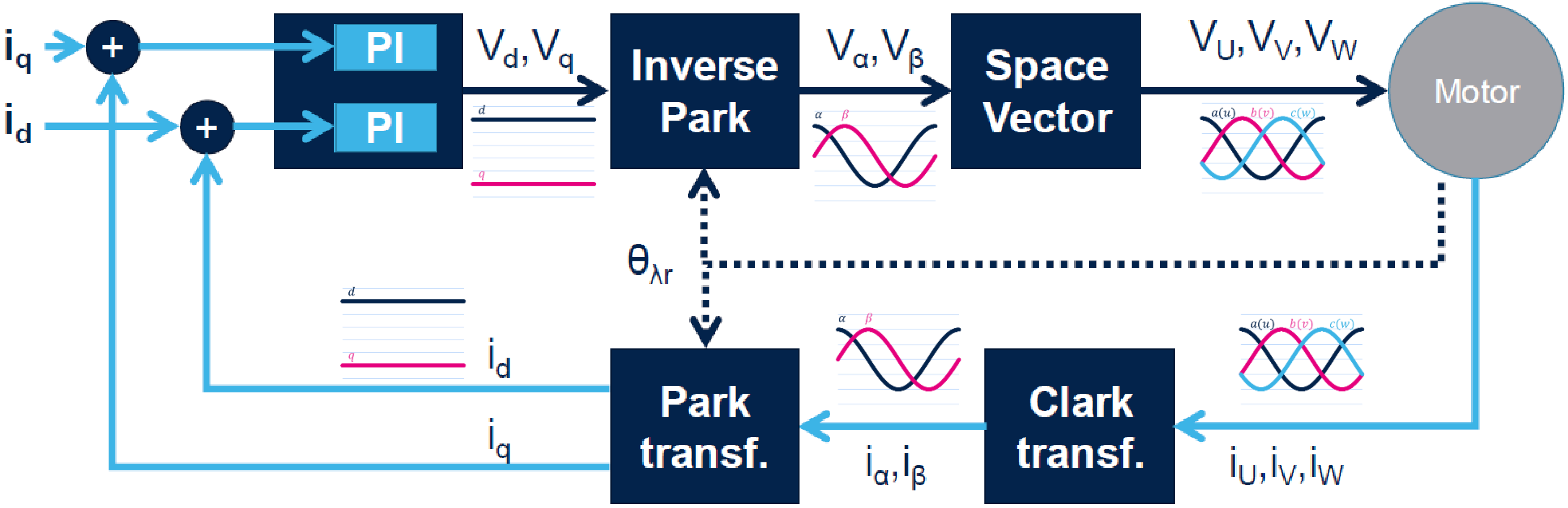
Q-axis (Quadrature Axis)
Aligned perpendicularly to the d-axis
Control **torque** directly

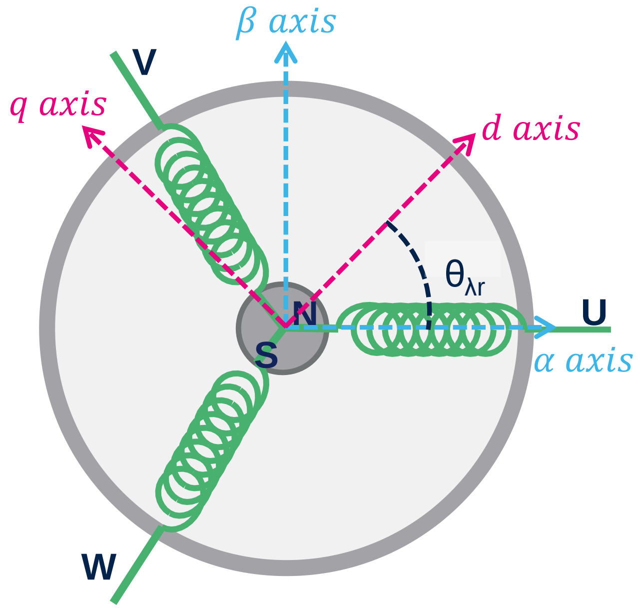


Three-phase BLDC/PMSM

Field Oriented Control

$$V_{\alpha ref} = V_{dref}\cos(\theta_{\lambda r}) - V_{qref}\sin(\theta_{\lambda r})$$
$$V_{\beta ref} = V_{dref}\sin(\theta_{\lambda r}) - V_{qref}\sin(\theta_{\lambda r})$$





$$i_{ds} = i_{\alpha s}\cos(\theta_{\lambda r}) + i_{\beta s}\sin(\theta_{\lambda r})$$
$$i_{qs} = -i_{\alpha s}\sin(\theta_{\lambda r}) + i_{\beta s}\cos(\theta_{\lambda r})$$

$$i_{\alpha s} = i_U$$
$$i_{\beta s} = \frac{1}{\sqrt{3}} i_U + \frac{2}{\sqrt{3}} i_V$$

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Three-phase BLDC/PMSM

Field Oriented Control – pros & cons

Pros

- Can control the **efficiency** of the system imposing a **load angle** (direct component of the current)
- **Smooth operation** thanks to the sinusoidal driving

Cons

- Implies **complex calculations** which cannot be performed by low level microcontrollers
- Needs the **information** of the rotor flux (i.e. expensive sensors or more complex calculations)

ST Motor Control SDK

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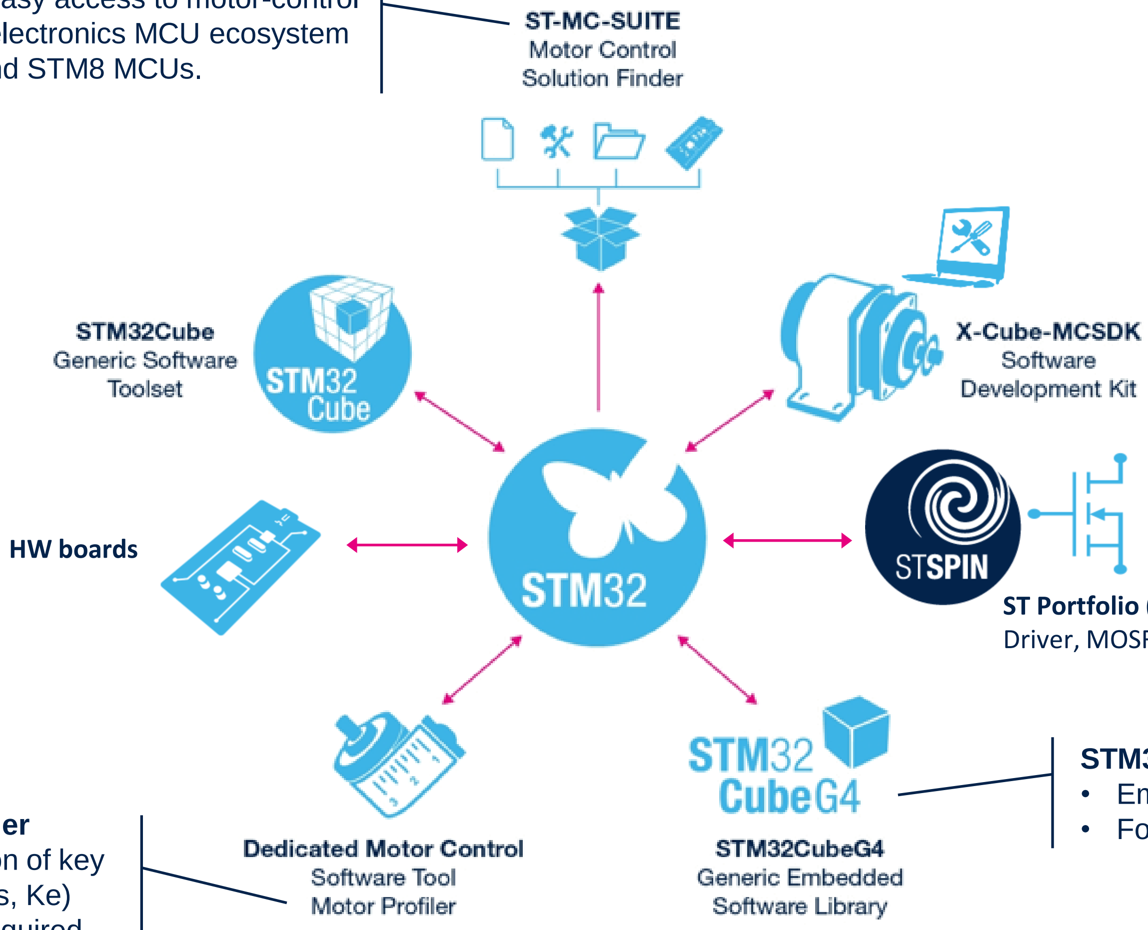
STM32 for Motion Control – Ecosystem

Motor Control Suite
- Online tool that provides easy access to motor-control resources in the STMicroelectronics MCU ecosystem
- For STM32, STSPIN32 and STM8 MCUs.

Visit the STM32 Motor control dedicated web page:
www.st.com/content/st_com/en/stm32-motor-control-ecosystem.html



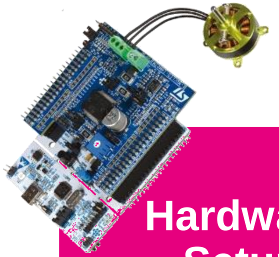
ST Portfolio (Power)
Driver, MOSFet, IGBT, Protection Diods…

Motor Control SW Dev. Kit (SDK)
- Motor Control FW lib: full feature library
- Motor Control Workbench: Graphical (GUI) configurator/monitor
- For STM32, STSPIN32 MCUs.

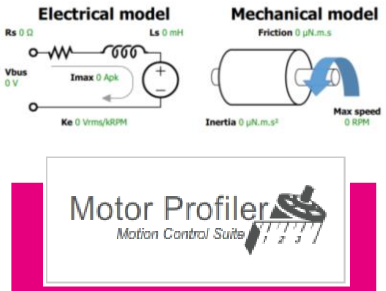
STM32Cubexx
- Embedded software bricks
- For all STM32xx (flagship for Motor Control: STM32G4)

Motor Control Profiler
- Automatic detection of key parameters (Rs, Ls, Ke)
- Zero equipment required
- For STM32 MCUs.

MCSDK work-flow



Hardware Setup

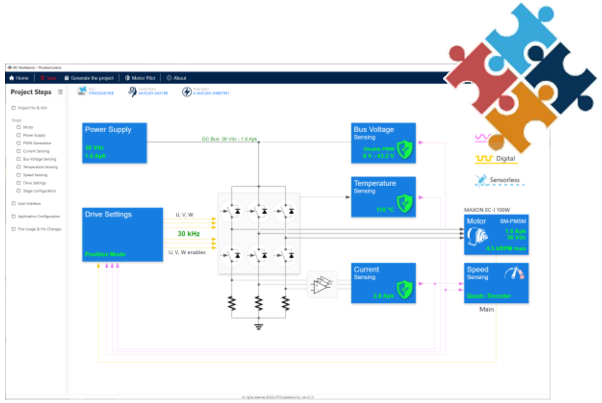


Motor Characterization

ST Motor Control Workbench

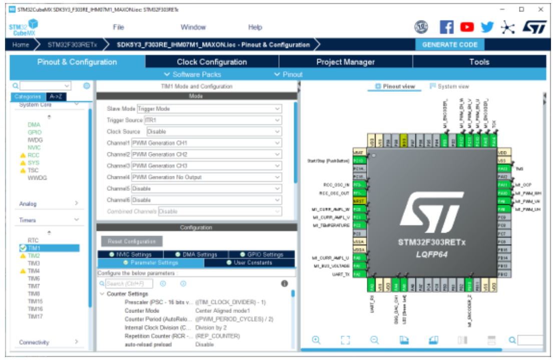
System Configuration GUI

Motor Control Workbench



Project Configuration

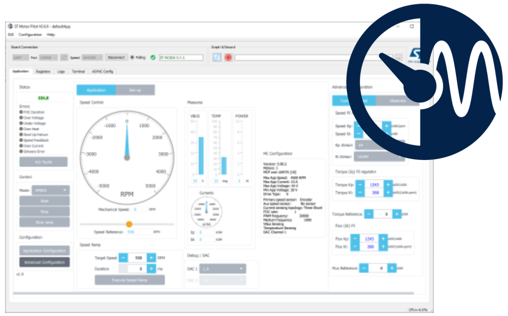
CubeMX & IDE



STM32 CubeMX

Motor Drive Tuning GUI

Motor Control Workbench



STM32 CubeIDE

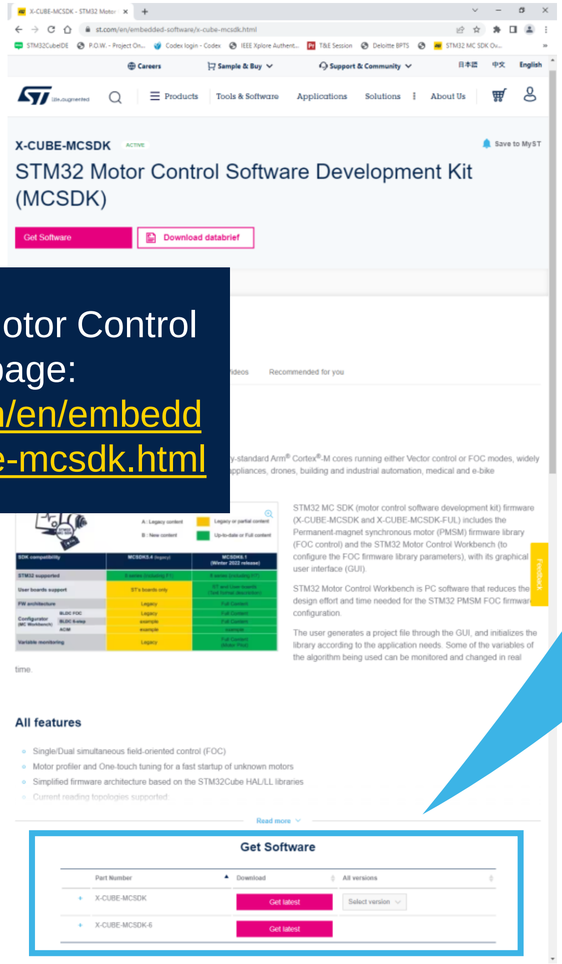
IAR SYSTEMS

KEIL Tools by ARM

Final Application Development

ST Motor Control SDK

Install MCSDK 6.1.0



Visit the STM32 Motor Control SDK web page: https://www.st.com/en/embedded-software/x-cube-mcsdk.html

MotorControl Workbench 6.1.0

Motor Pilot 6.1.0

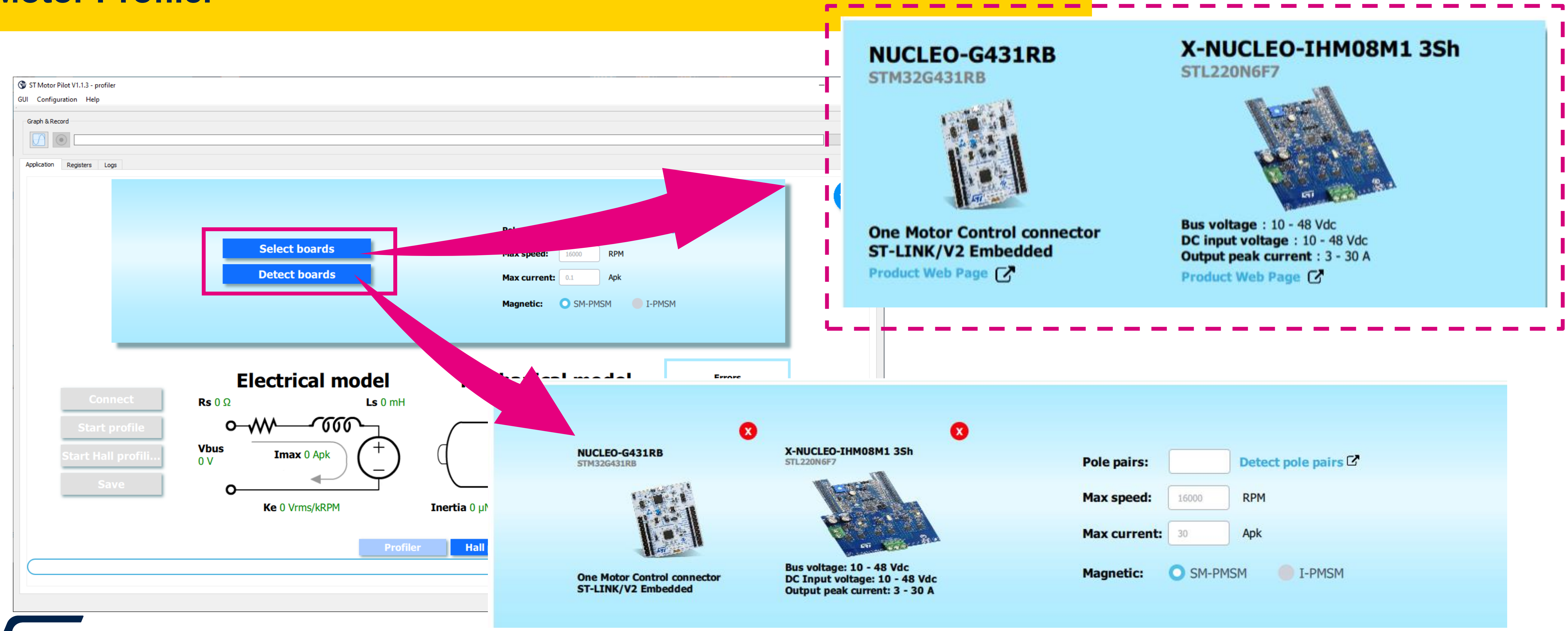
ST Motor Control SDK

Motor Profiler

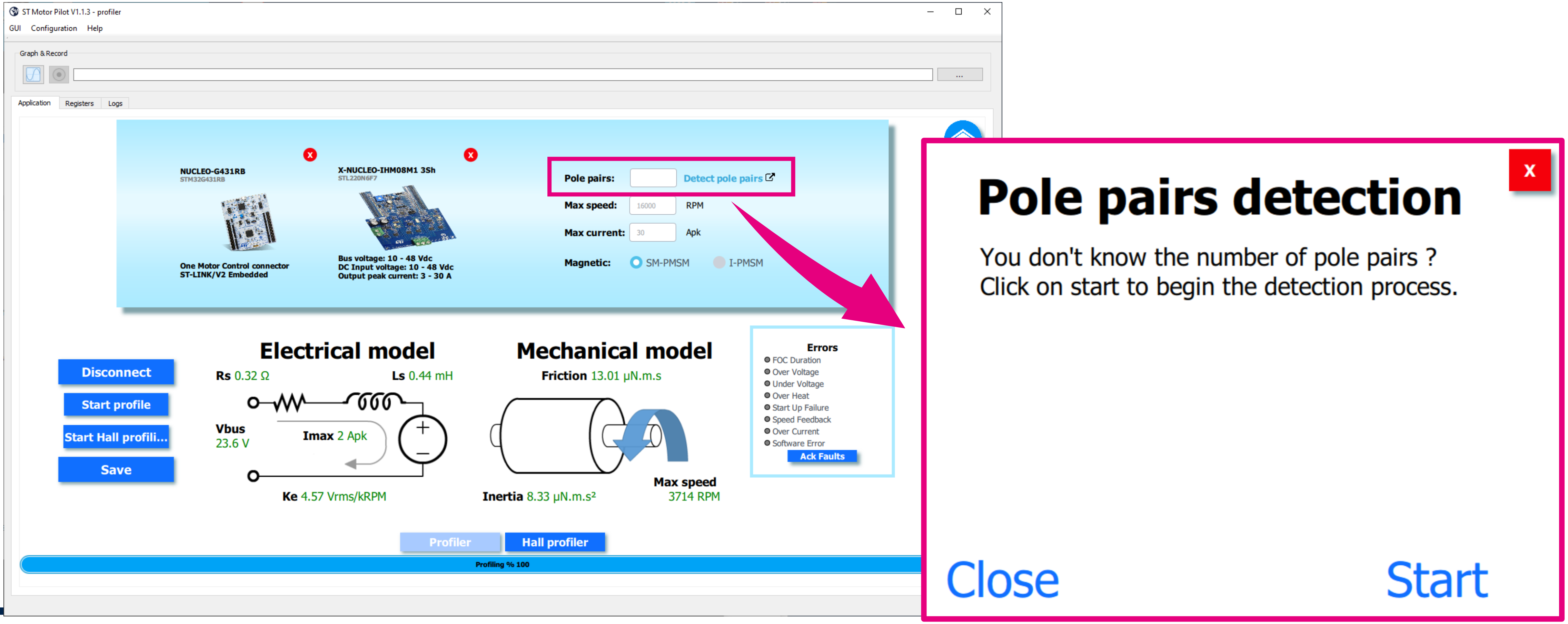
Motor Pilot 6.1.0

ST Motor Control SDK

Motor Profiler



Motor Profiler



Motor Profiler

Pole pairs detection

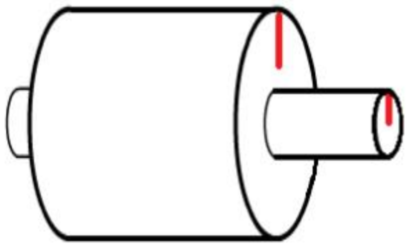
Before launching the detection,please check that your 3 phases are connected to the power board and set the current to 10% of the maximum current supported by the motor.

Current: 0.3 Apk

Back Next

Pole pairs detection

Apply a mark to the fixed part and the rotating part



Back Begin

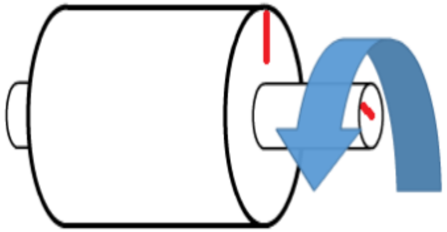
ST Motor Control SDK

Motor Profiler

Pole pairs detection

x

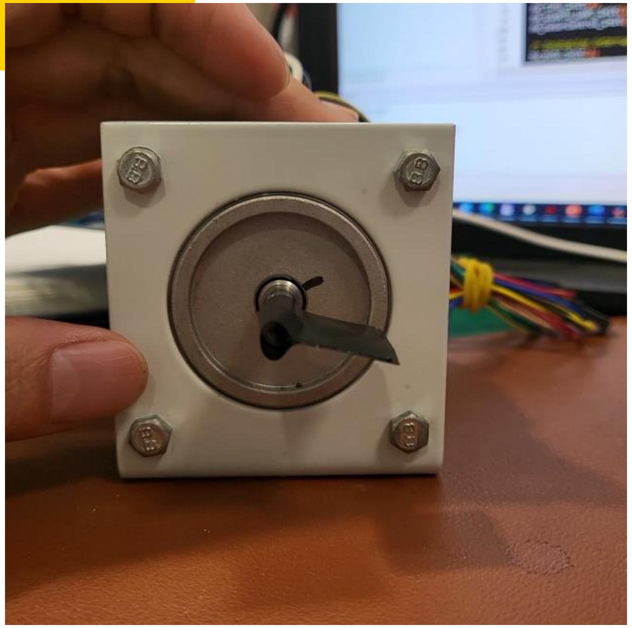
Spin your motor manually, the number of pole pairs is the number of notches you will feel during a complete mechanical rotation of the motor.



Need Help ?

12 s

Stop   Finish



Pole pairs: 2 Detect pole pairs

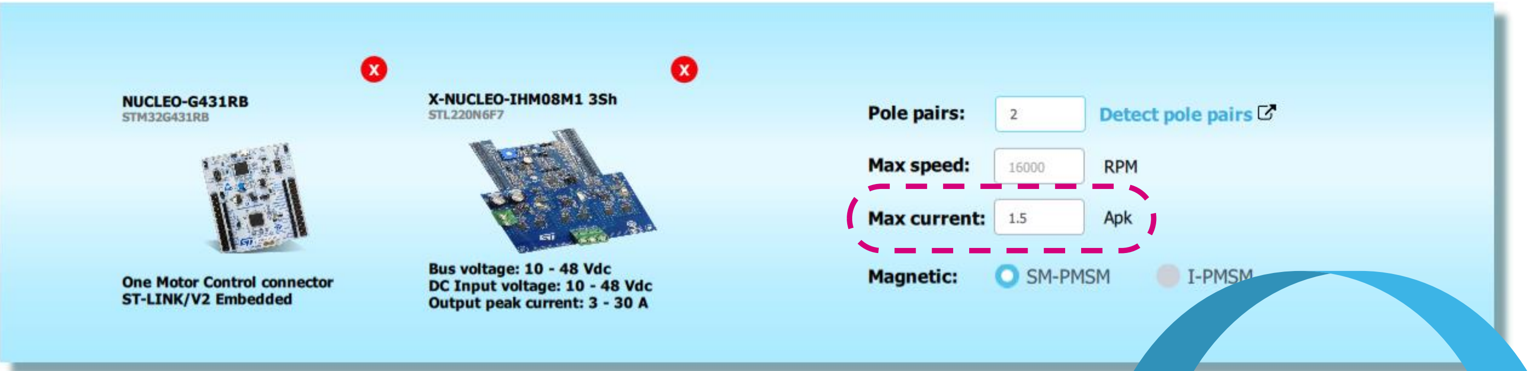
Max speed: 16000 RPM

Max current: 30 Apk

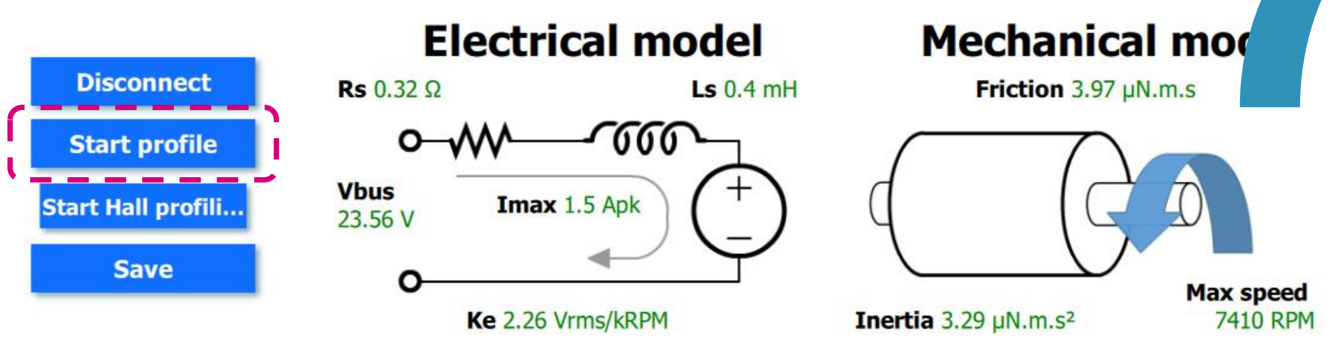
Magnetic: SM-PMSM I-PMSM

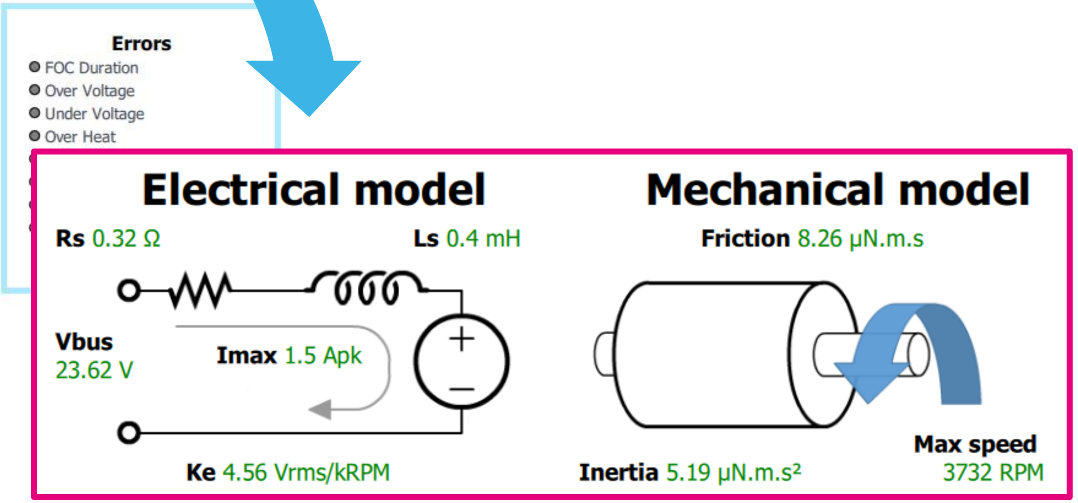
ST Motor Control SDK

Motor Profiler



- Motor turns automatically
- After 30-40 seconds, Motor parameters are updated.





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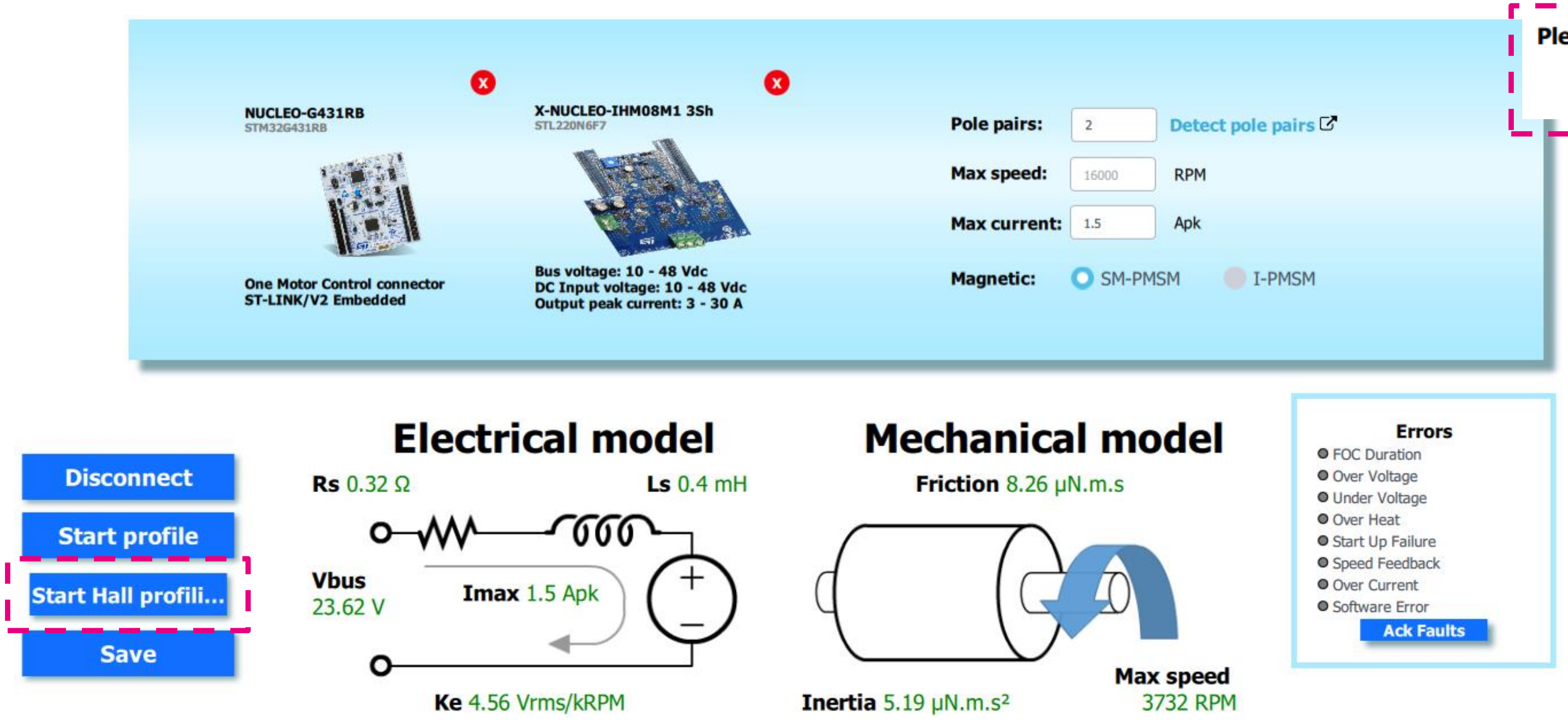
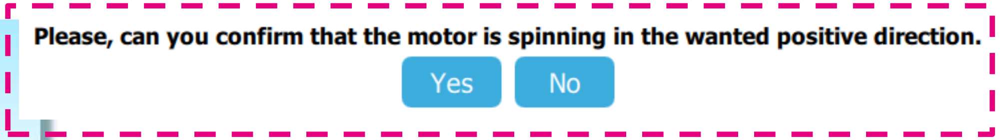
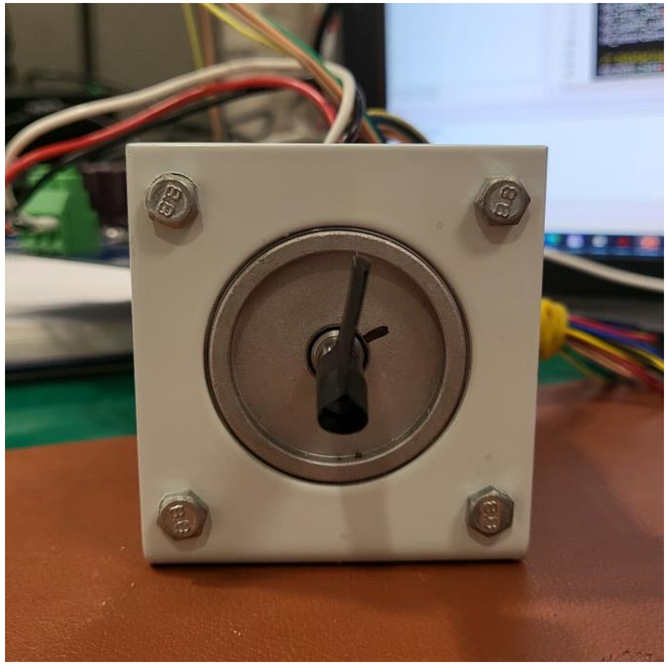
Motor Profiler



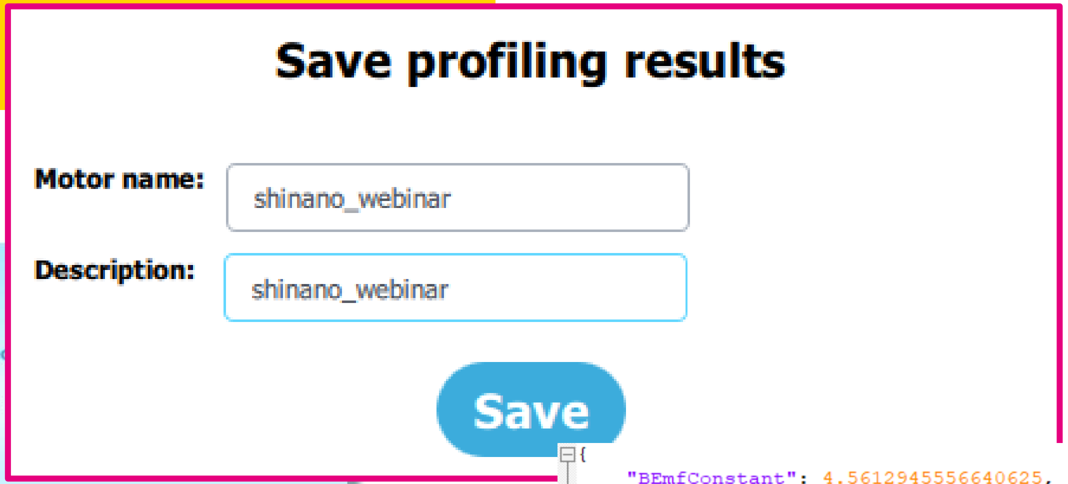


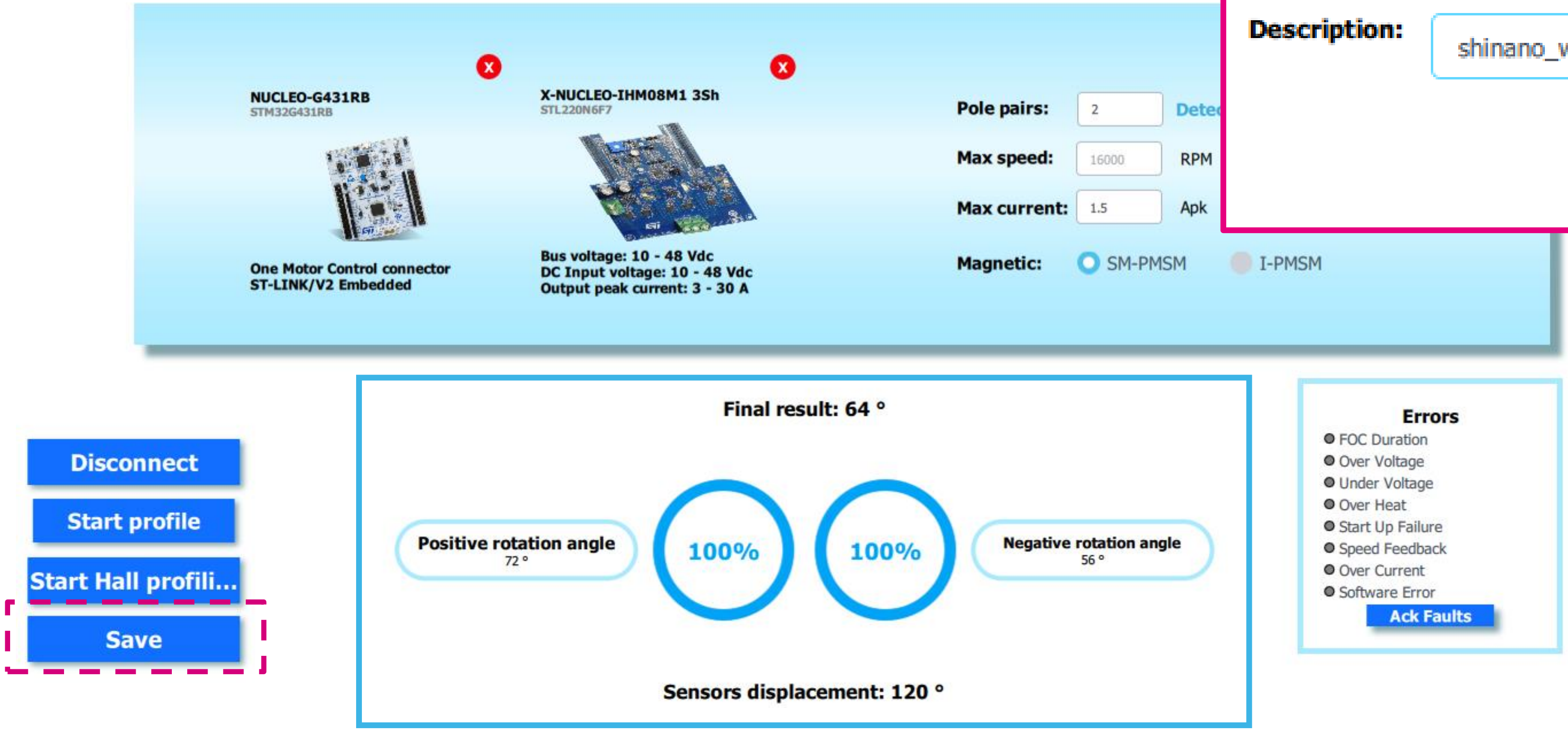


Motor Control
Competence
Center

ST Motor Control SDK

Motor Profiler



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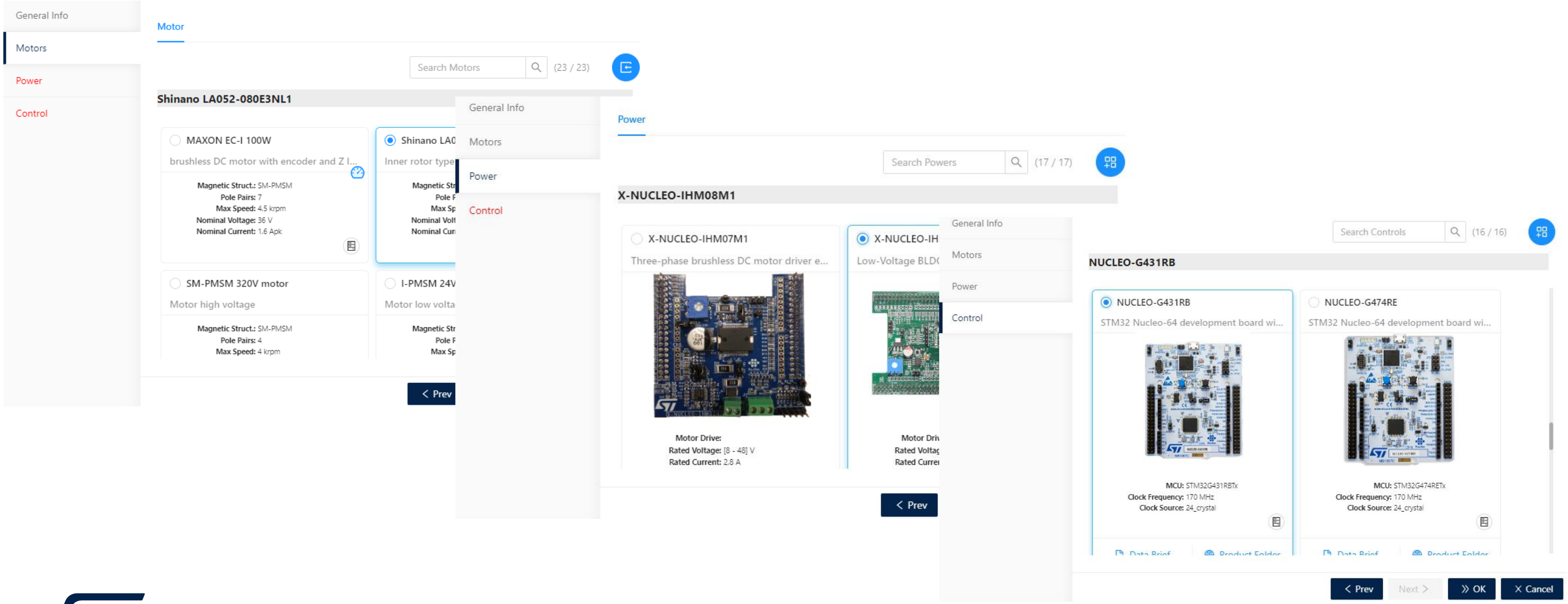
ST Motor Control SDK

MC Workbench

MotorControl
Workbench 6.1.0

ST Motor Control SDK

MC Workbench



ST Motor Control SDK

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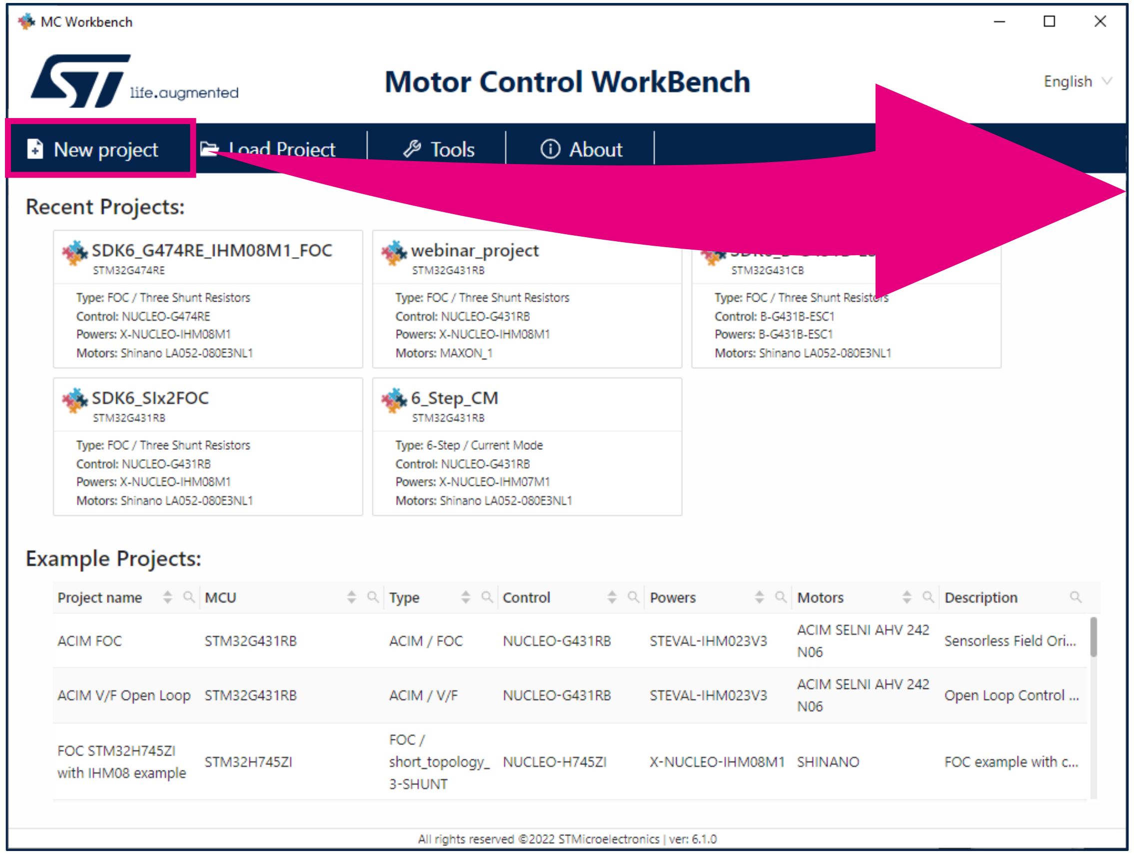

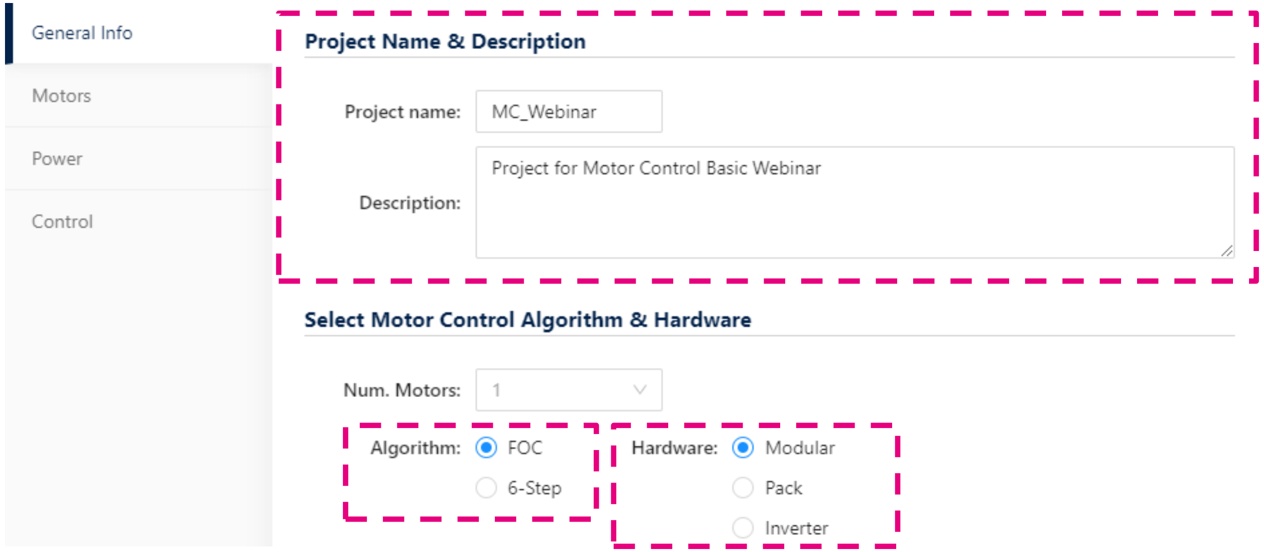

Modular : Control Board + Power Board + Motor
(i.e. NUCLEO + X-NUCLEO + Motor)

Pack : ST Modular Kit Product
(i.e. P-NUCLEO_IHM002/03)

Inverter : ST Inverter Product
(i.e. EVSPIN32G4, EVSPIN32F0601Q1)

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Motor Control
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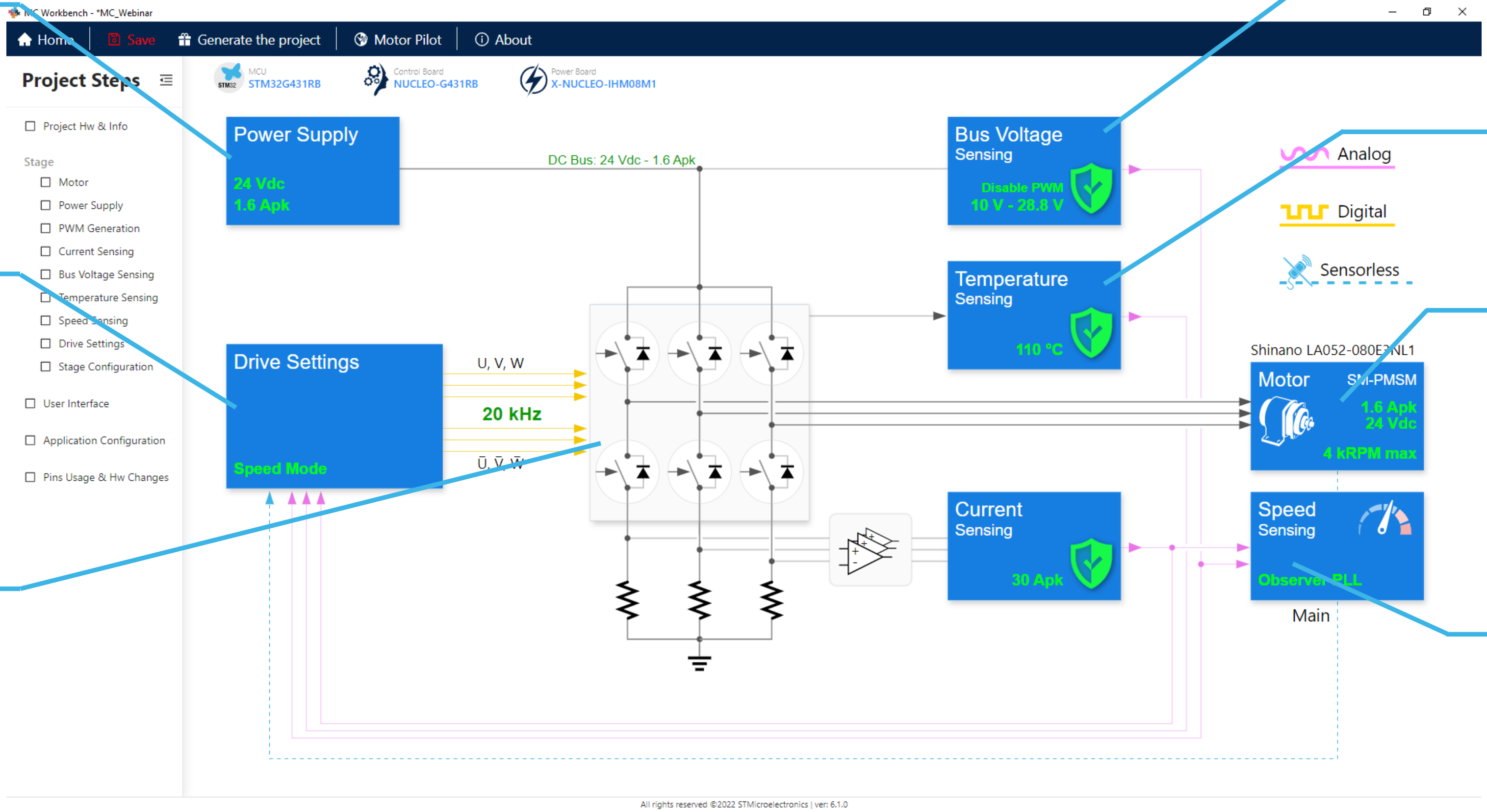
ST Motor Control SDK

MC Workbench

- Max. Current
- Bus Voltage

- Control Mode
  - Torque, Speed
  - (Position)
- Control Gain
- Feed forward
- Flux weakening

- PWM frequency
- Idle state
- Dead-time
- Bootcap config.
- Over modulation
- Discontinuous PWM



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- OVP/UVP
- Recovery action

- Temperature sensing
- OTP (Hysteresis)

- Motor type
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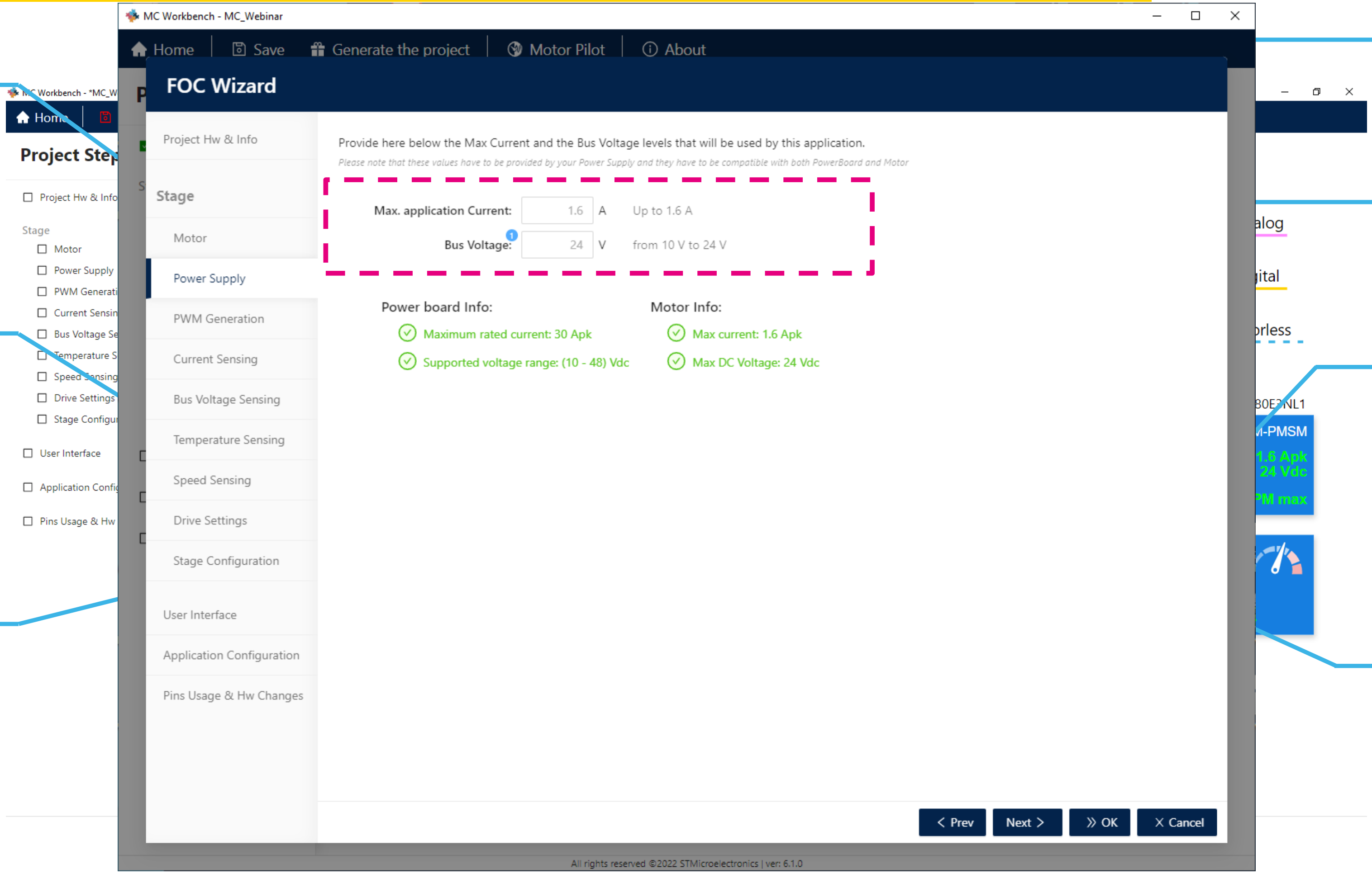

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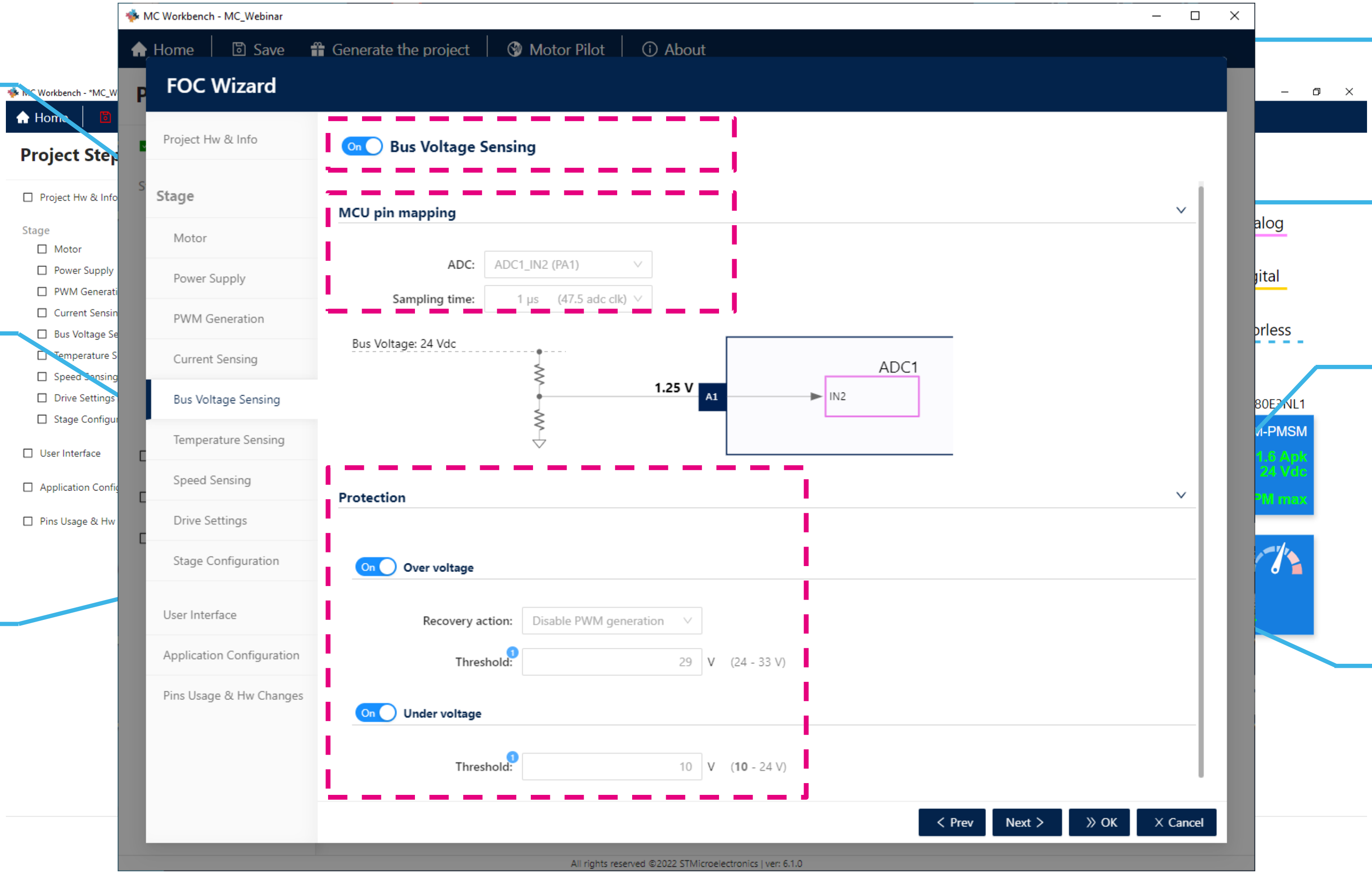

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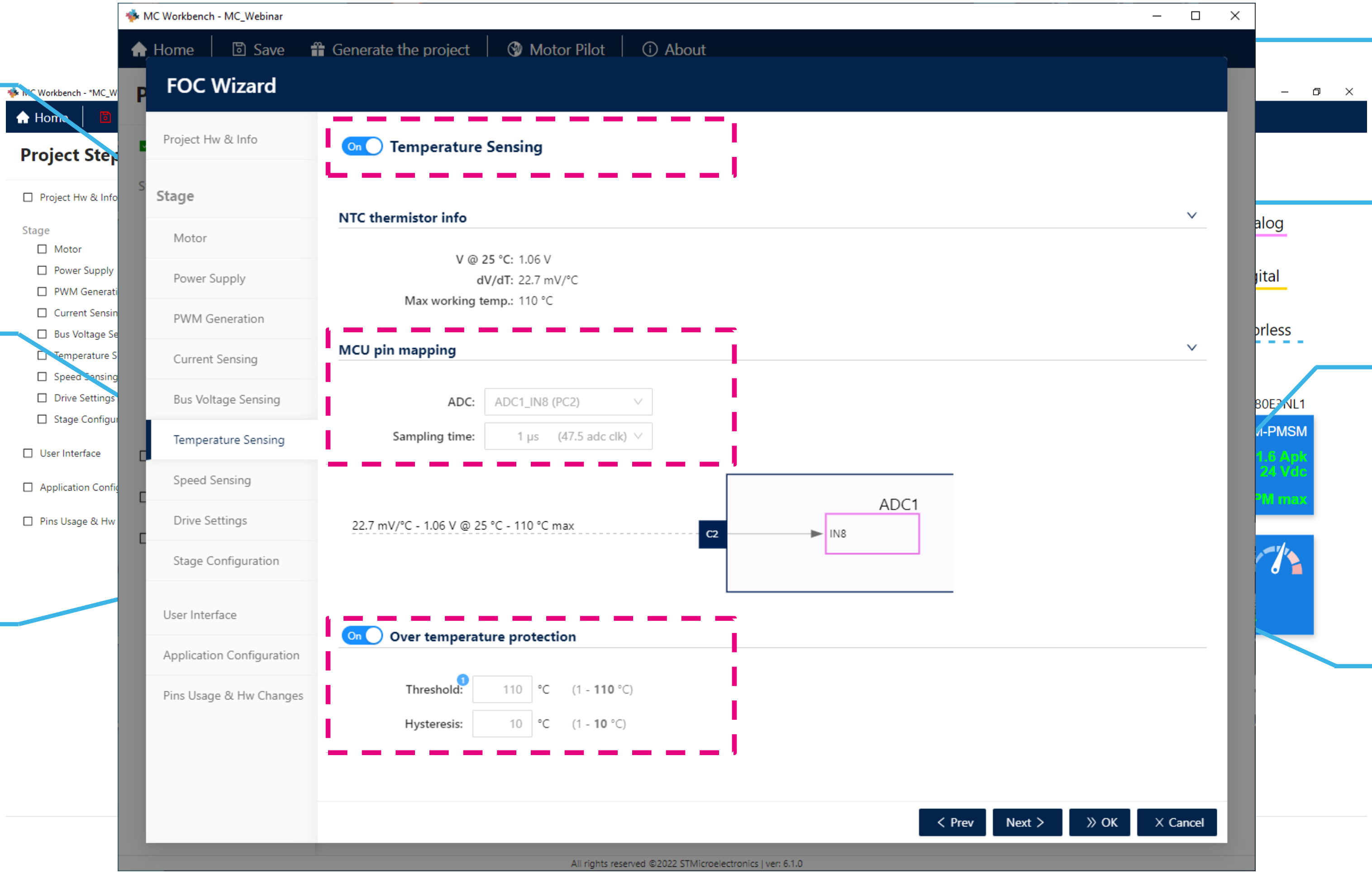

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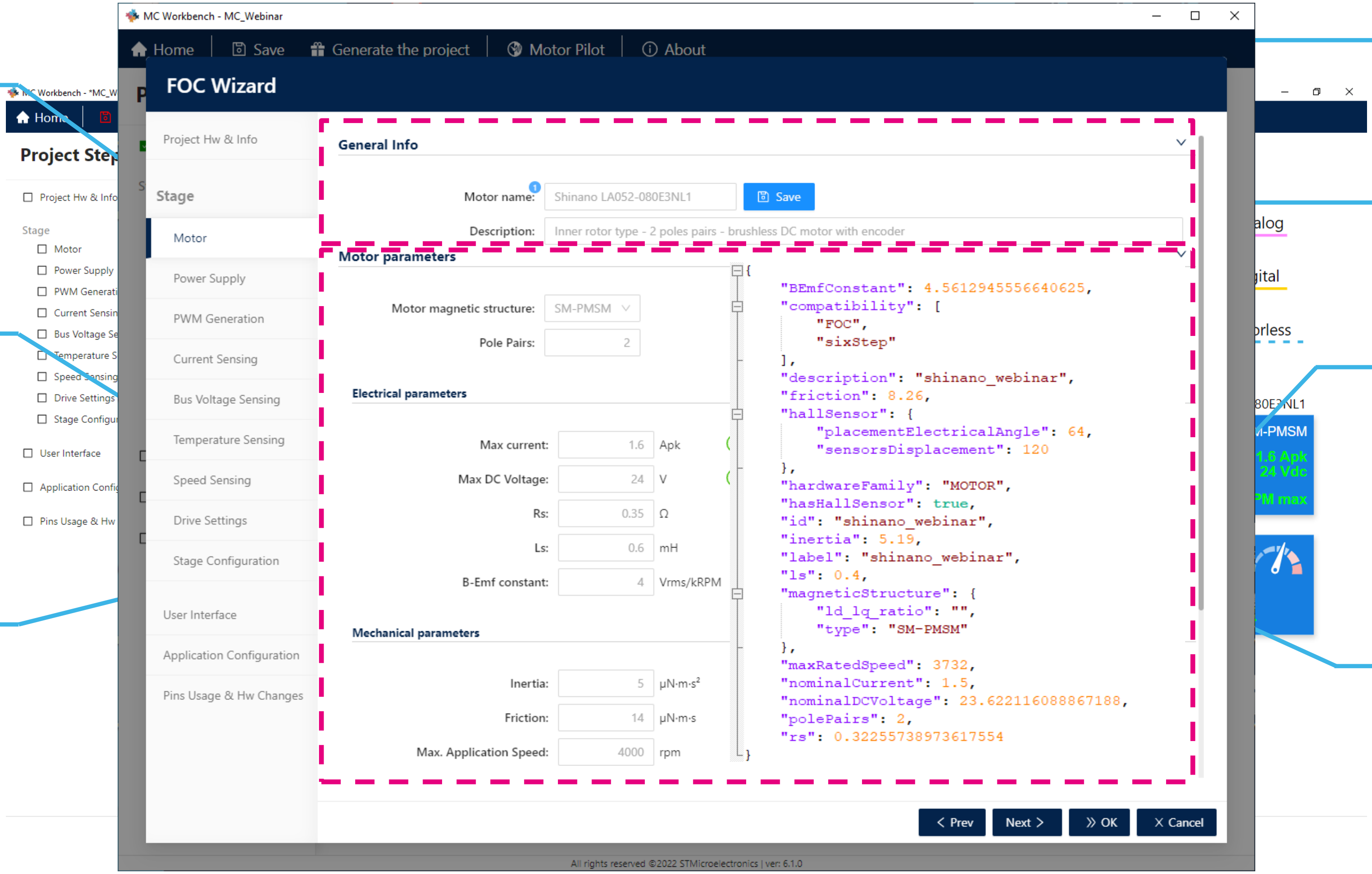

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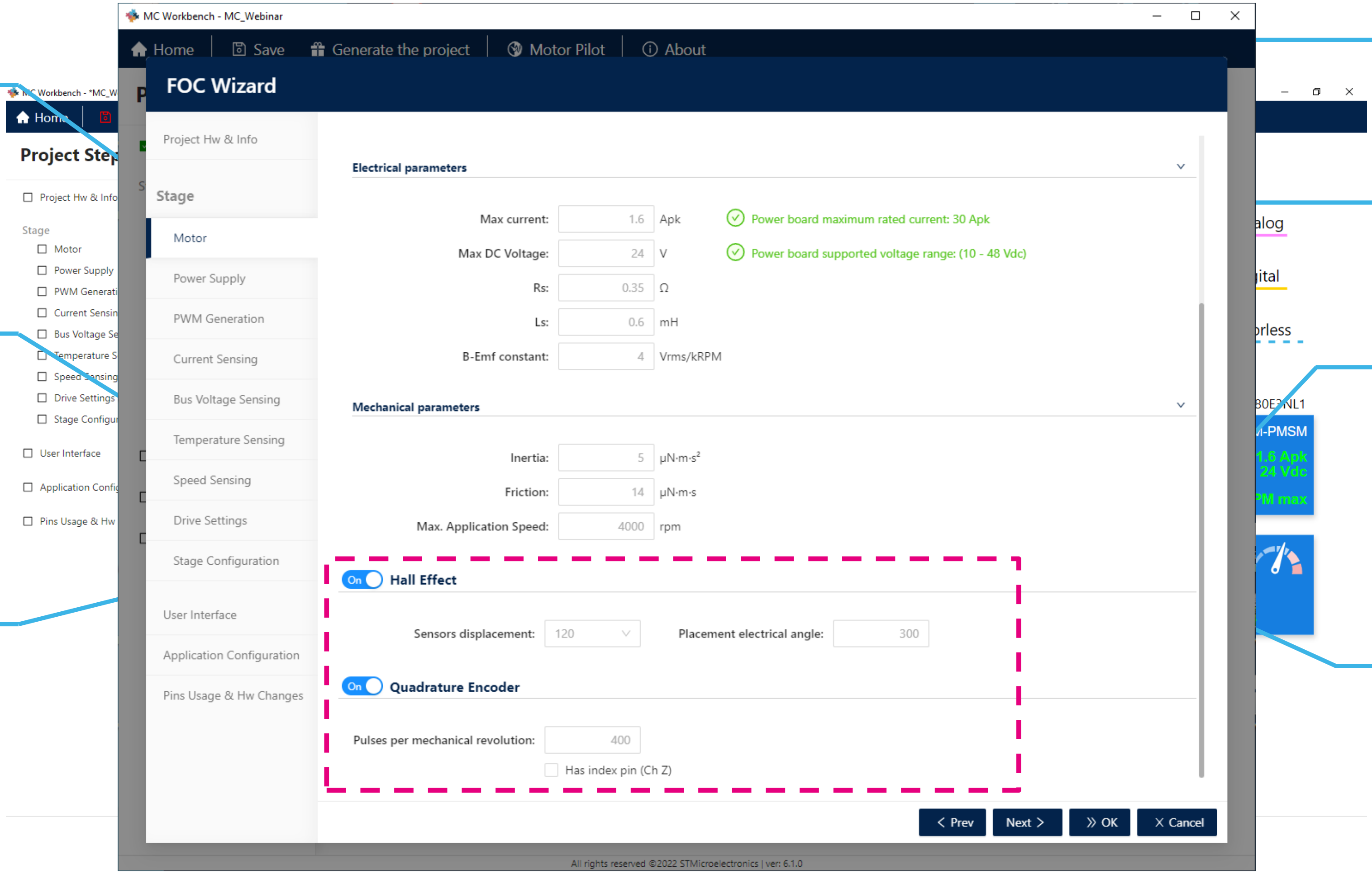

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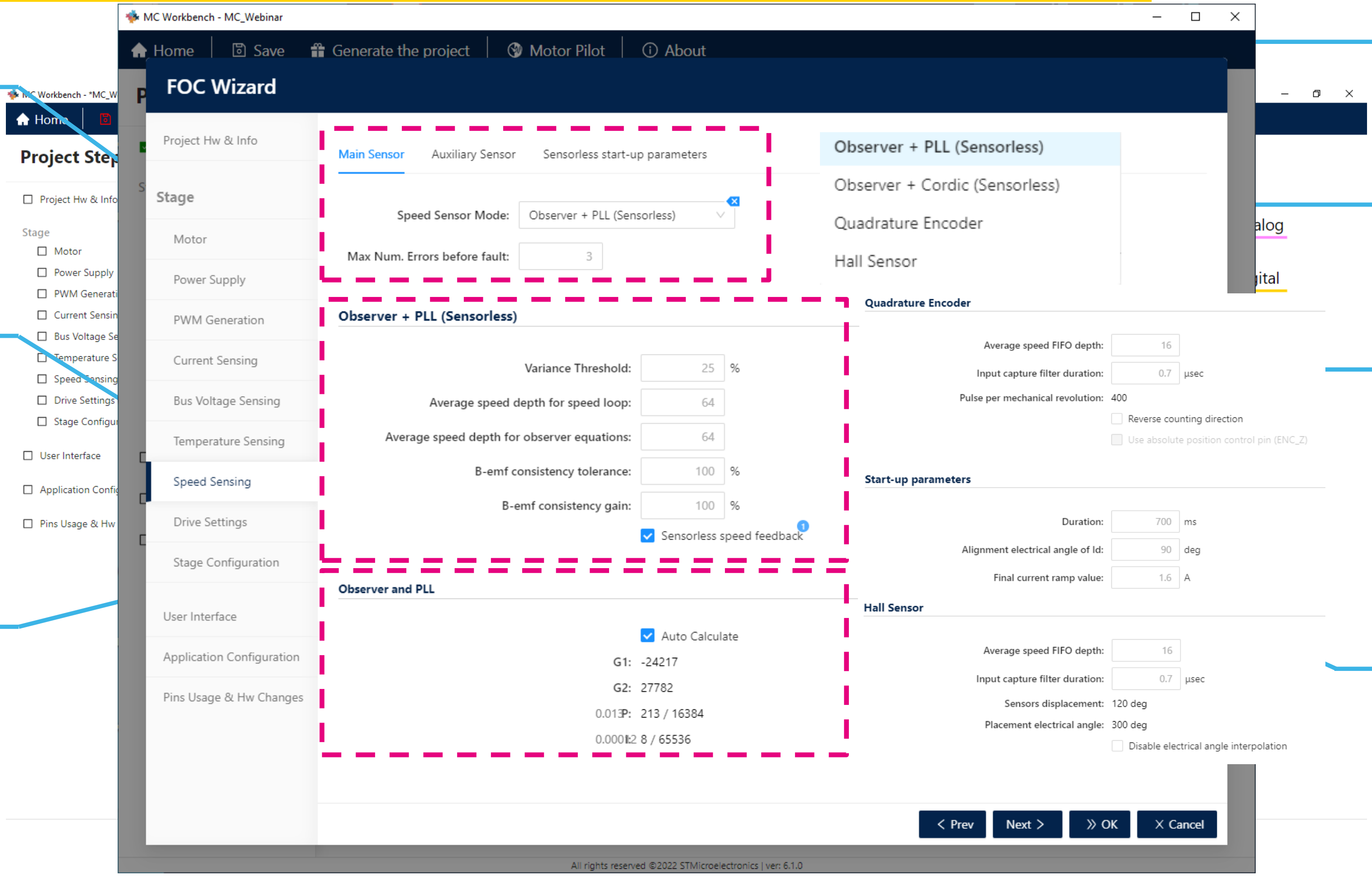

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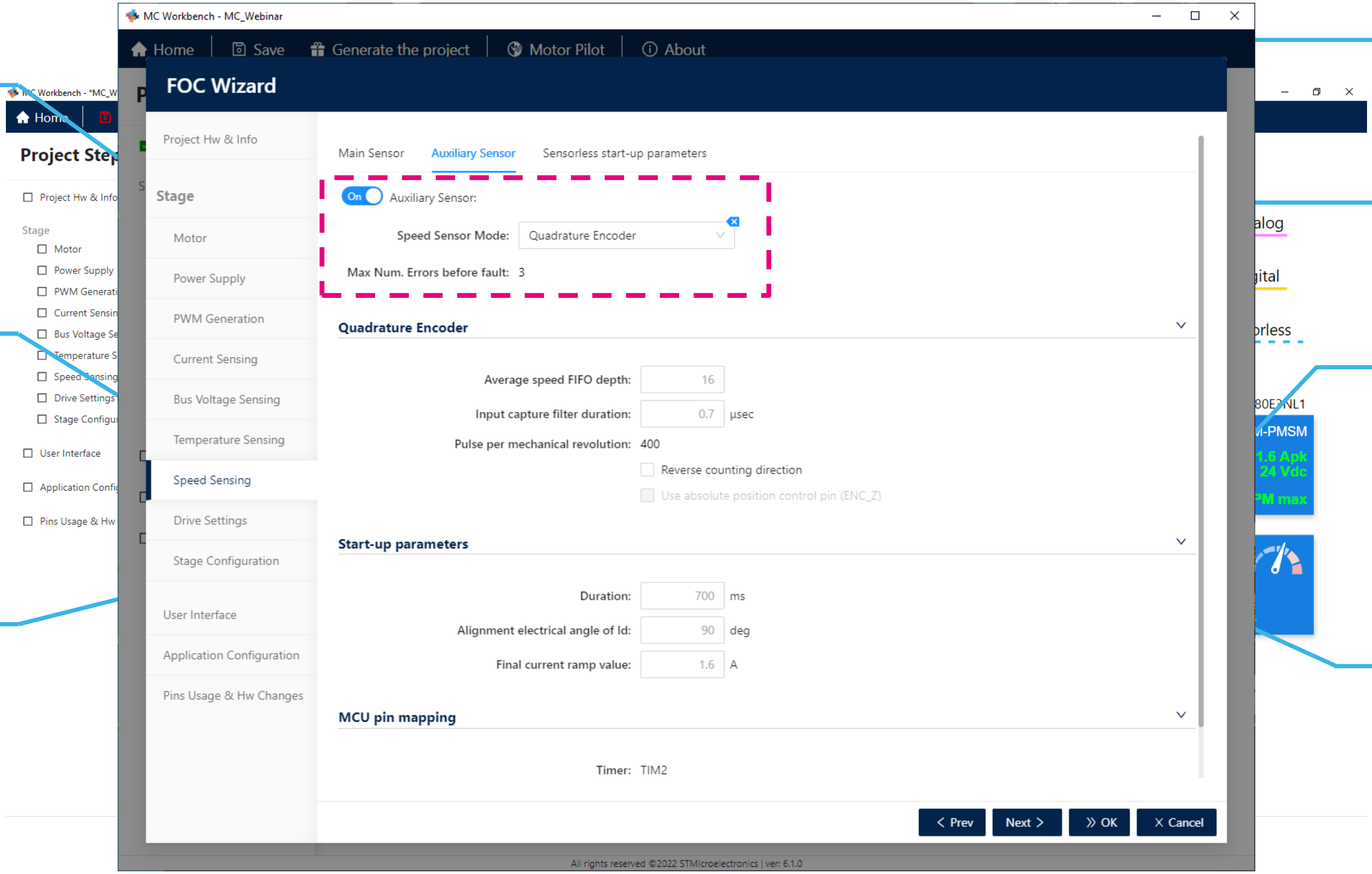

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Motor Control Competence Center

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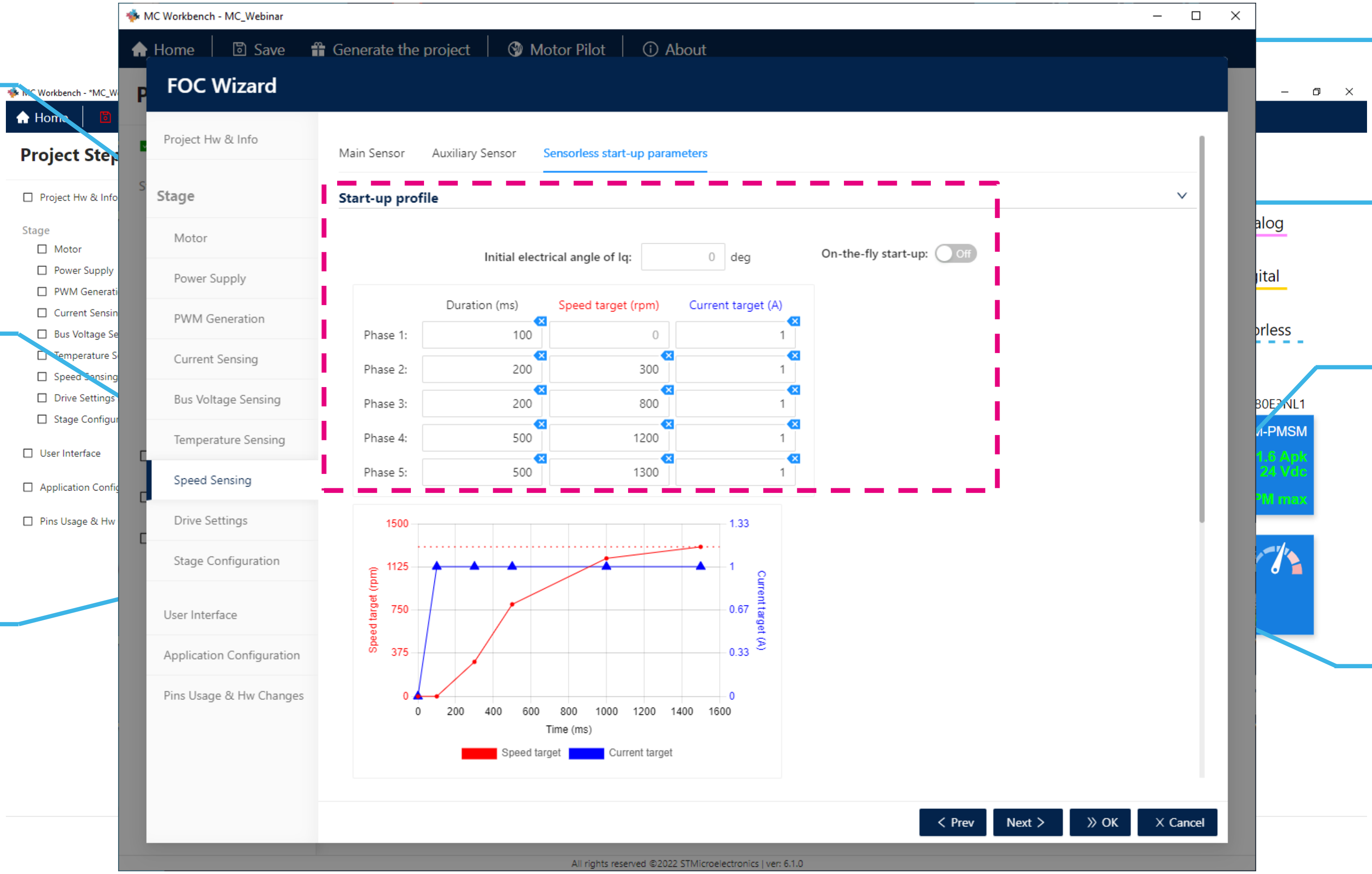

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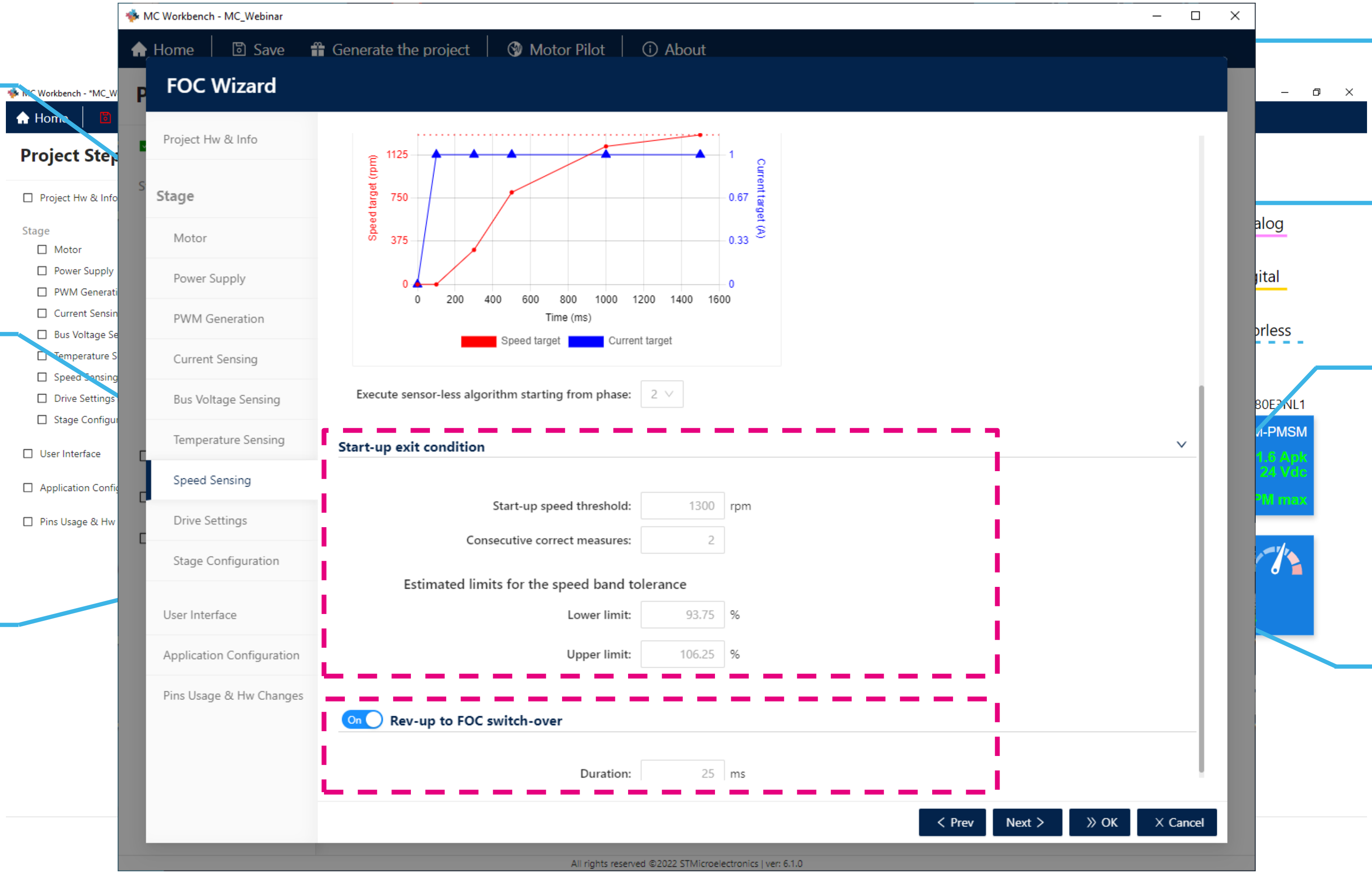

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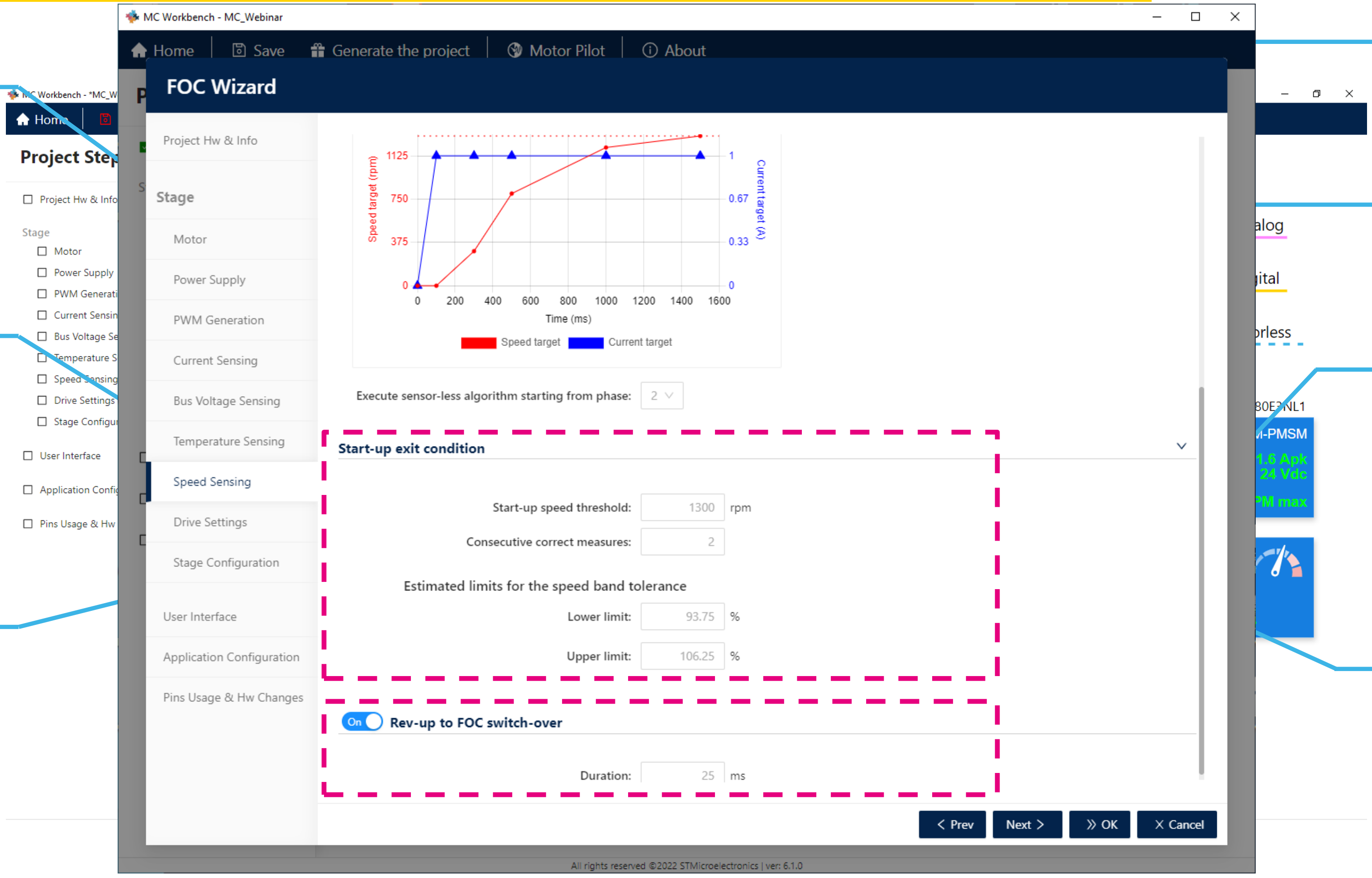

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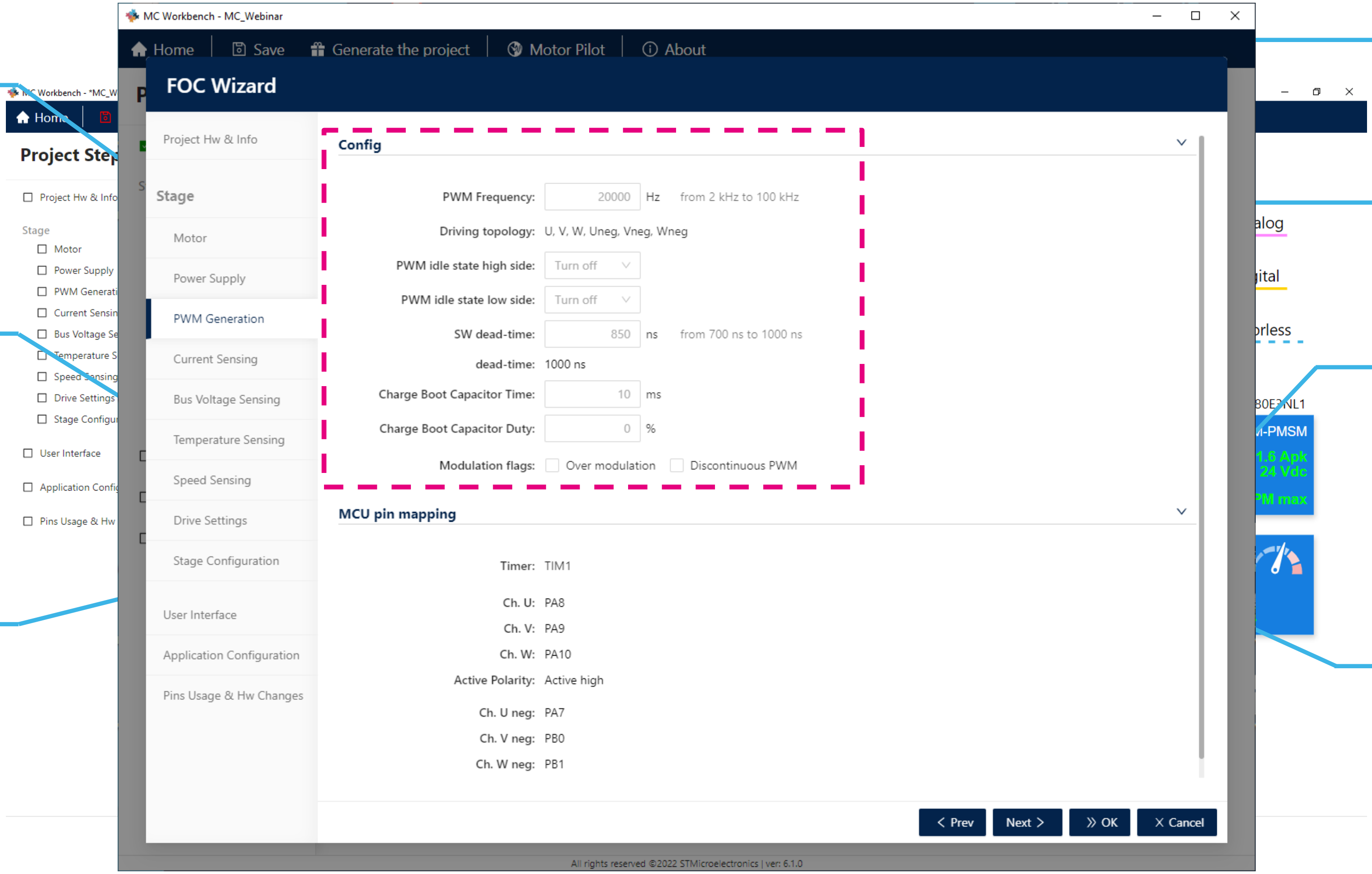

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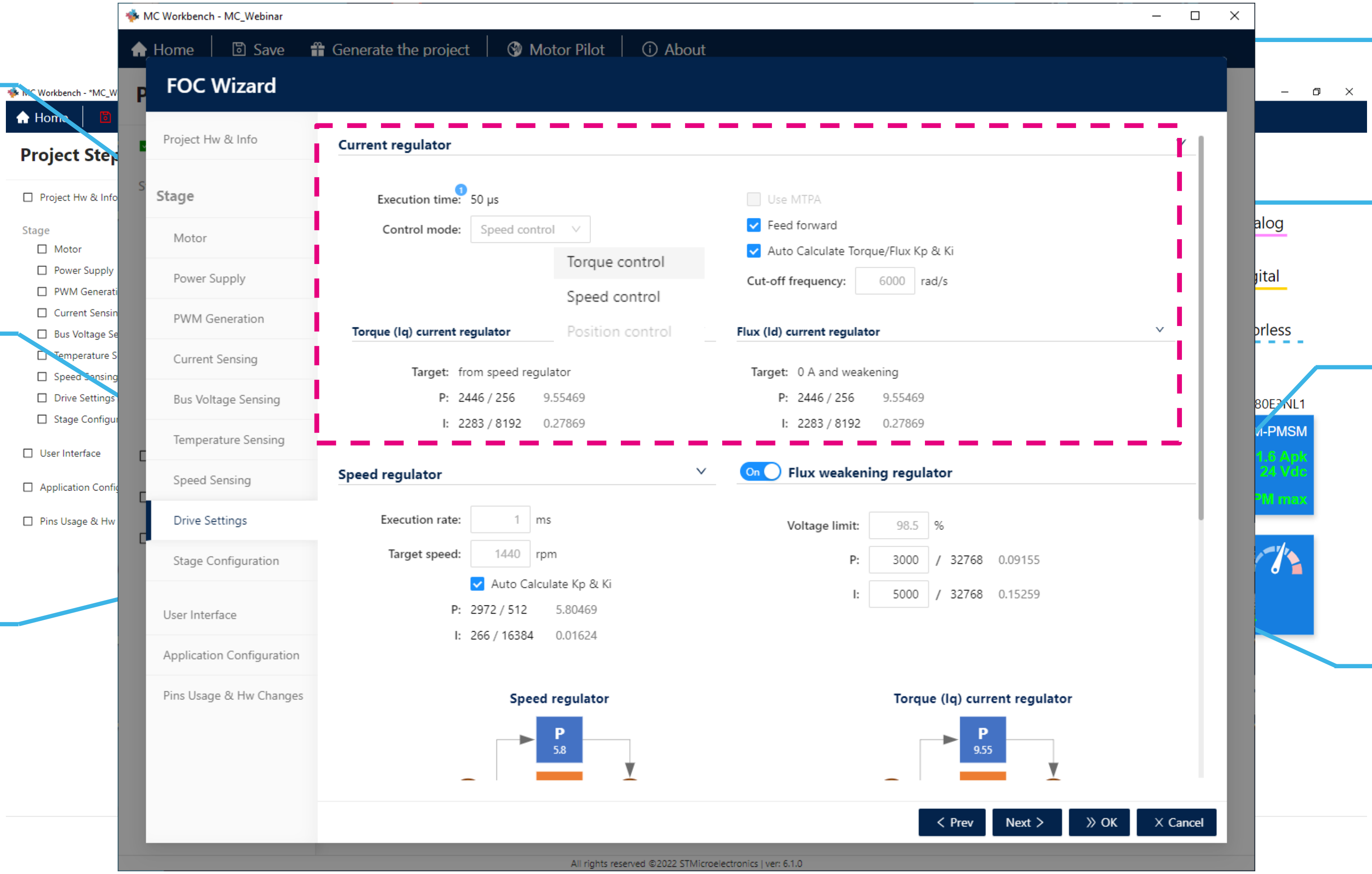

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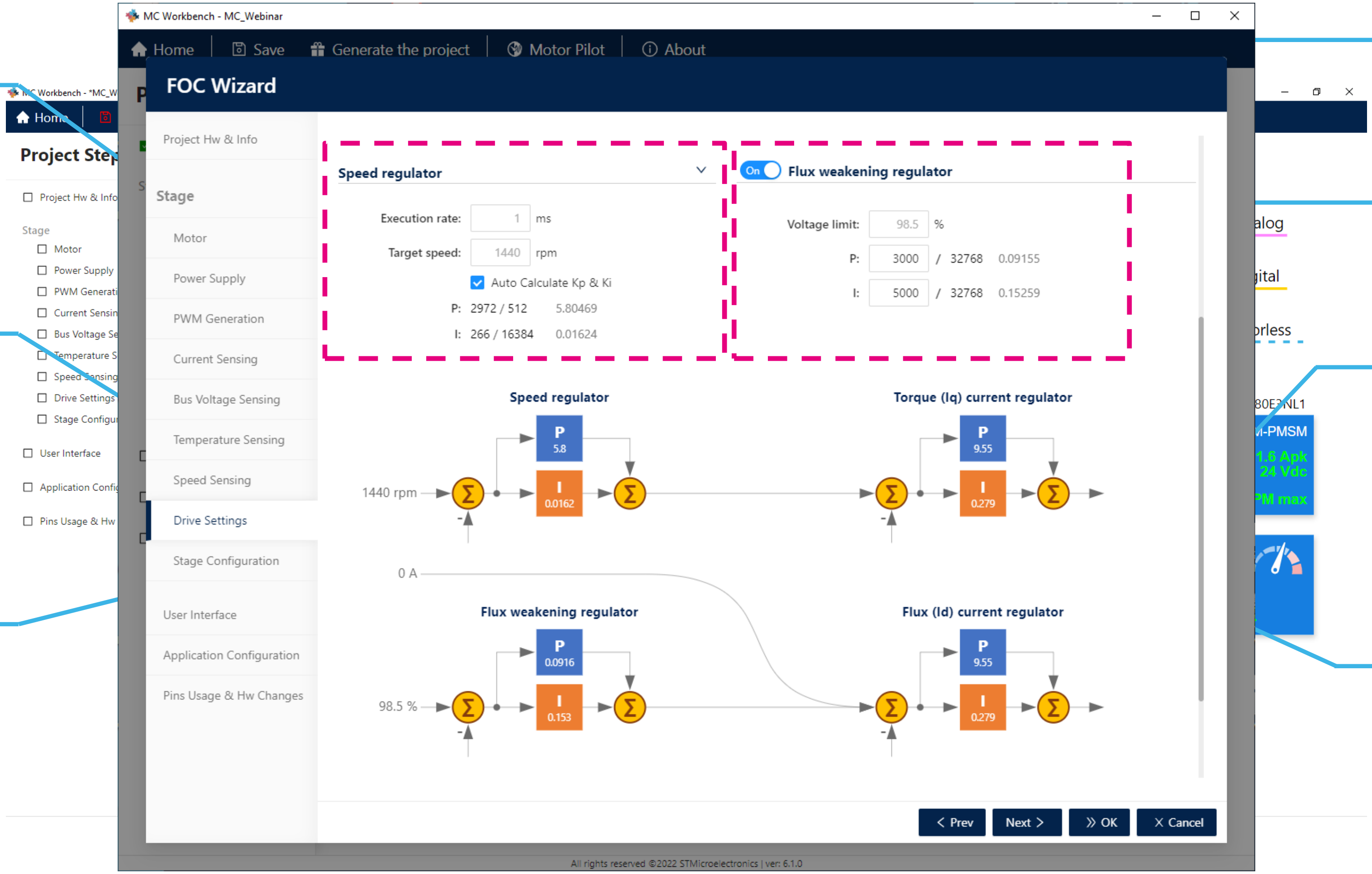

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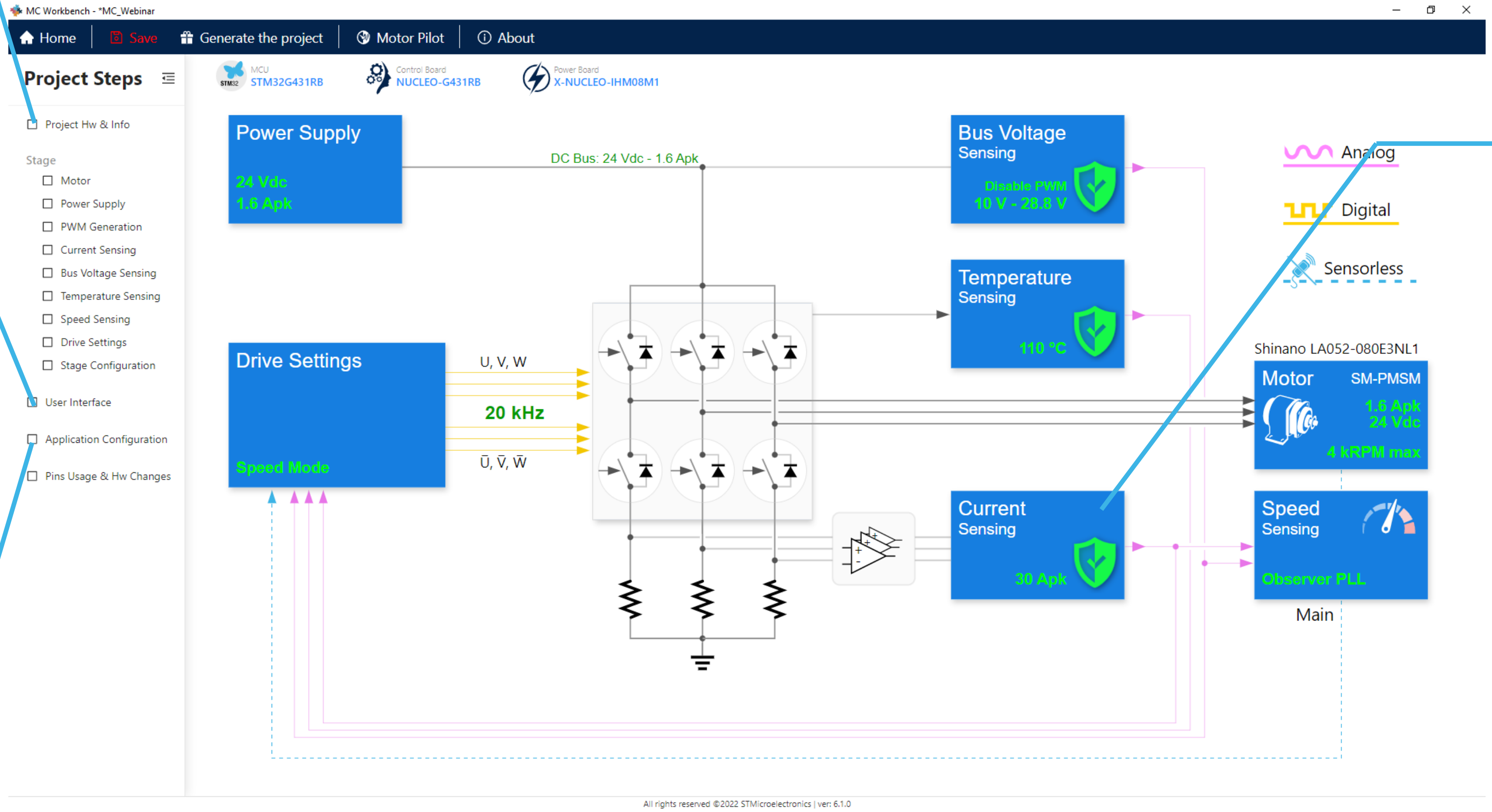
ST Motor Control SDK

MC Workbench

- Project info.
- Open projects
  - output folder
  - CubeMX

- Start/Stop button
- USART Protocol
  - MCU Pin-map
  - Baudrate
  - Buffer size

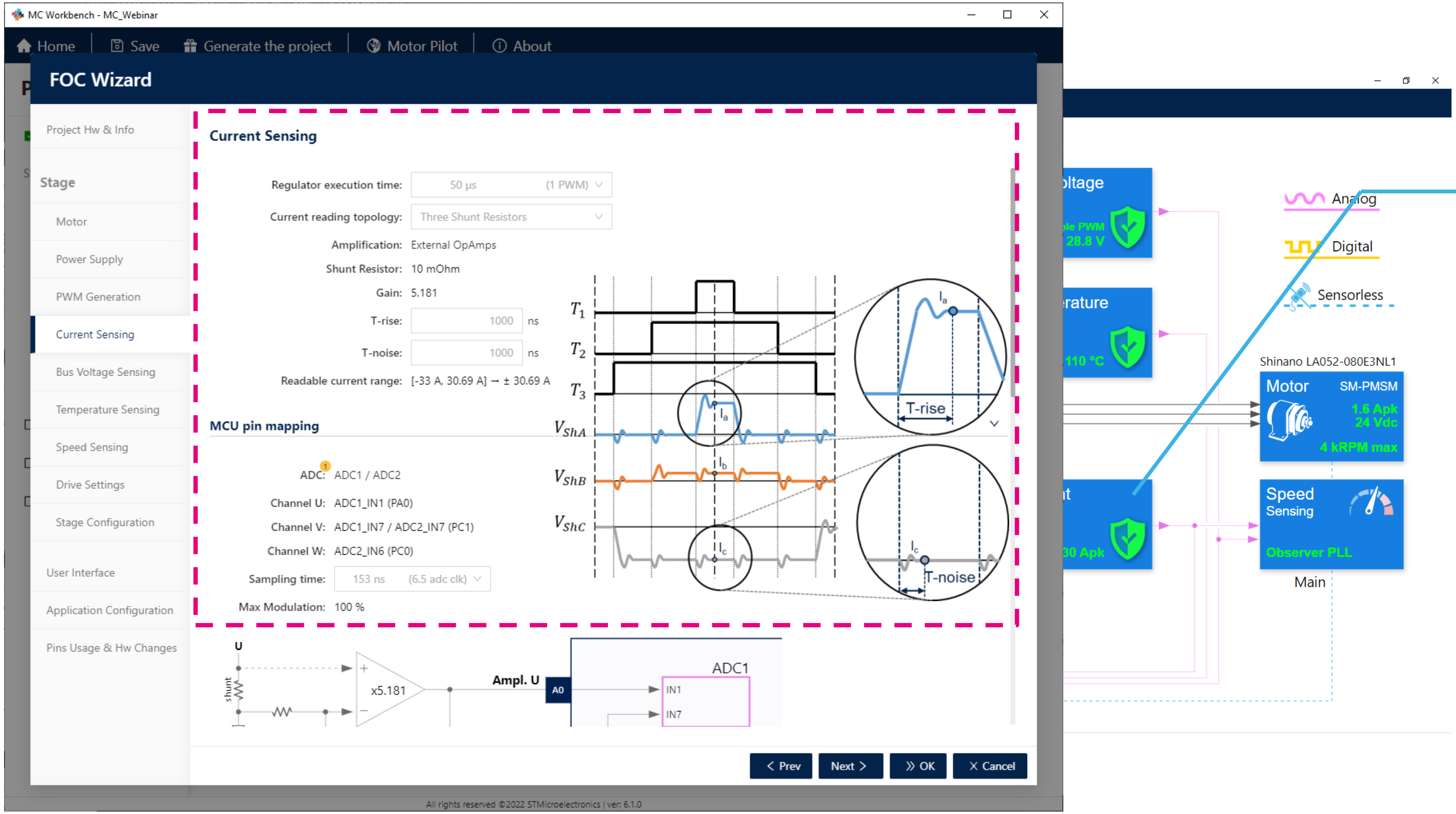
- FreeRTOS
- DAC



- FOC execution time
- Current sensing topology
  - Three shunt resistors
  - Single shunt resistors
- Switching characteristic
  - T-rise
  - T-noise
- Sampling time
- OVP

ST Motor Control SDK

MC Workbench



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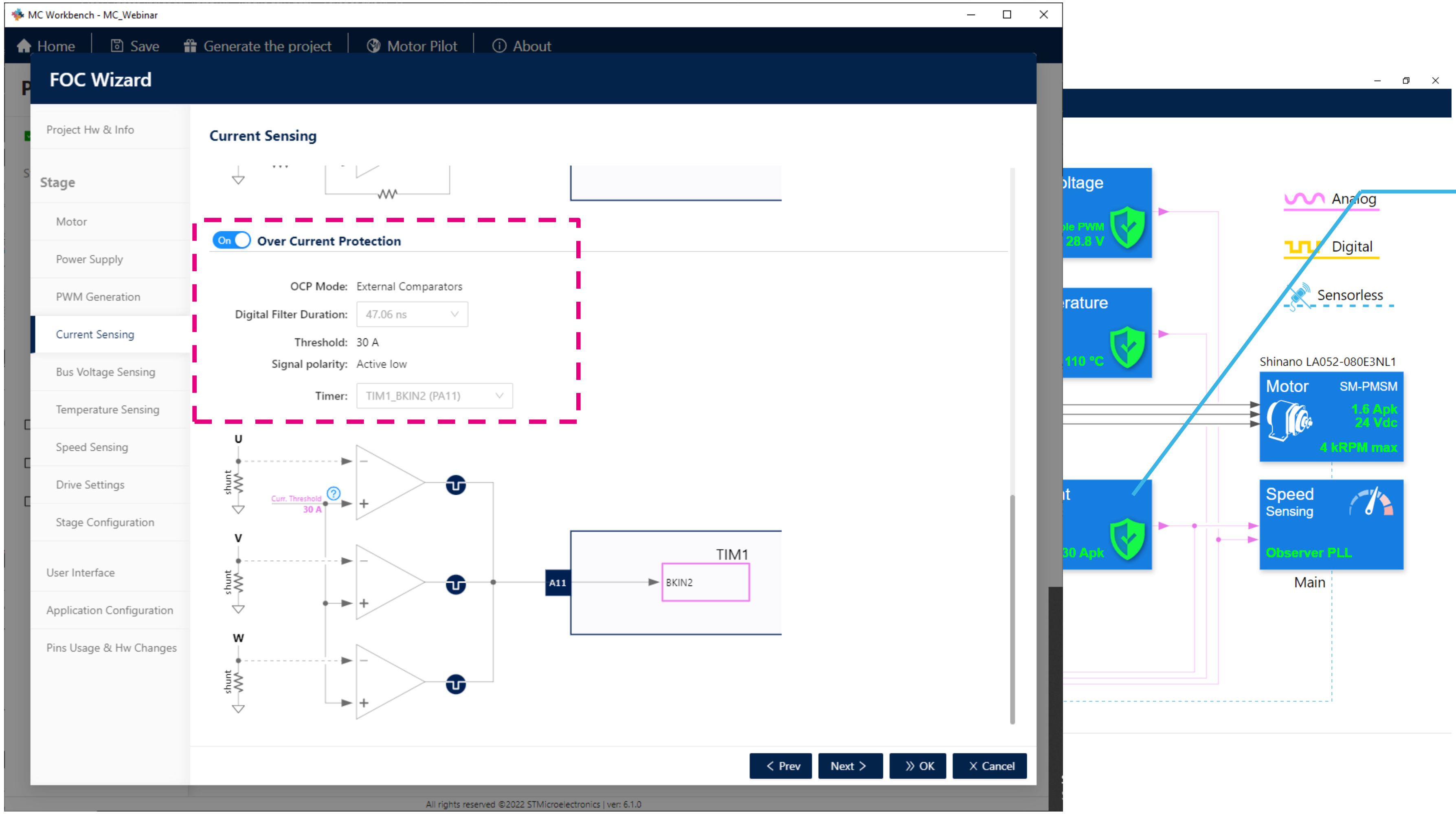

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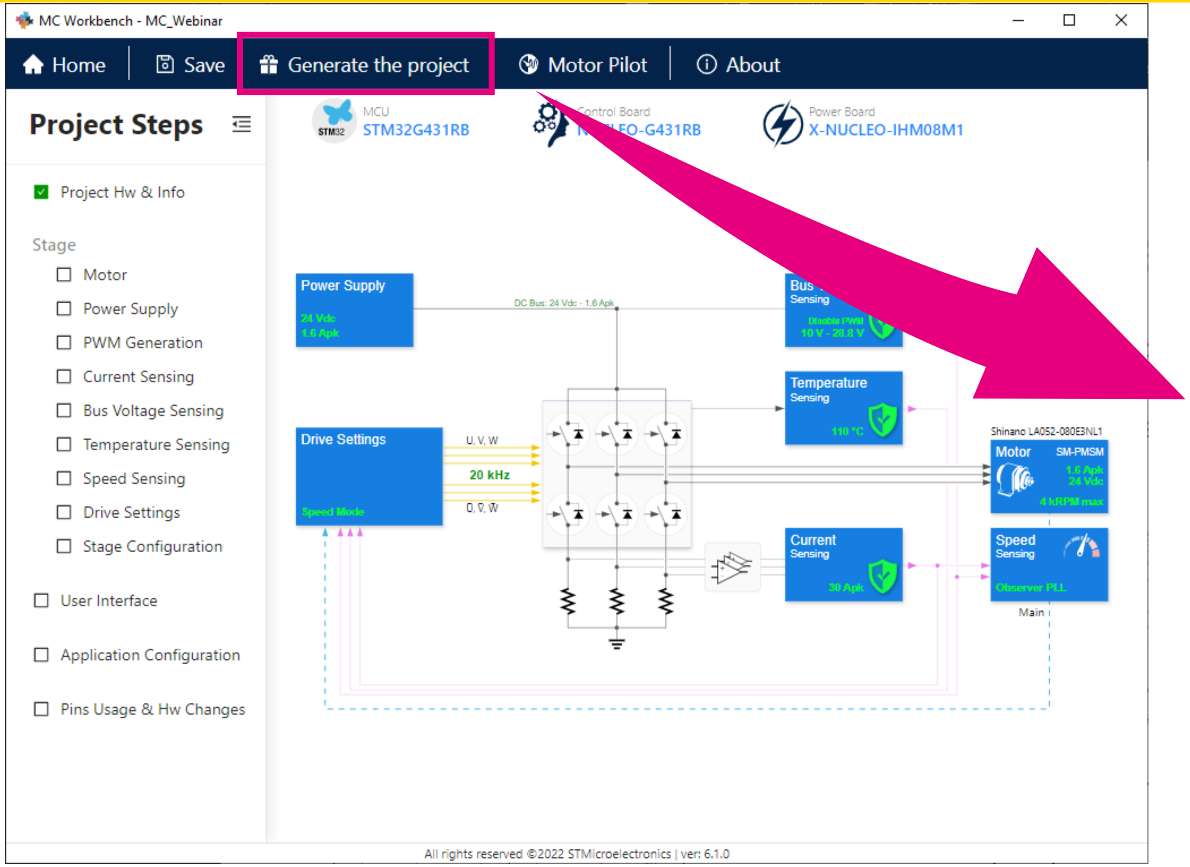
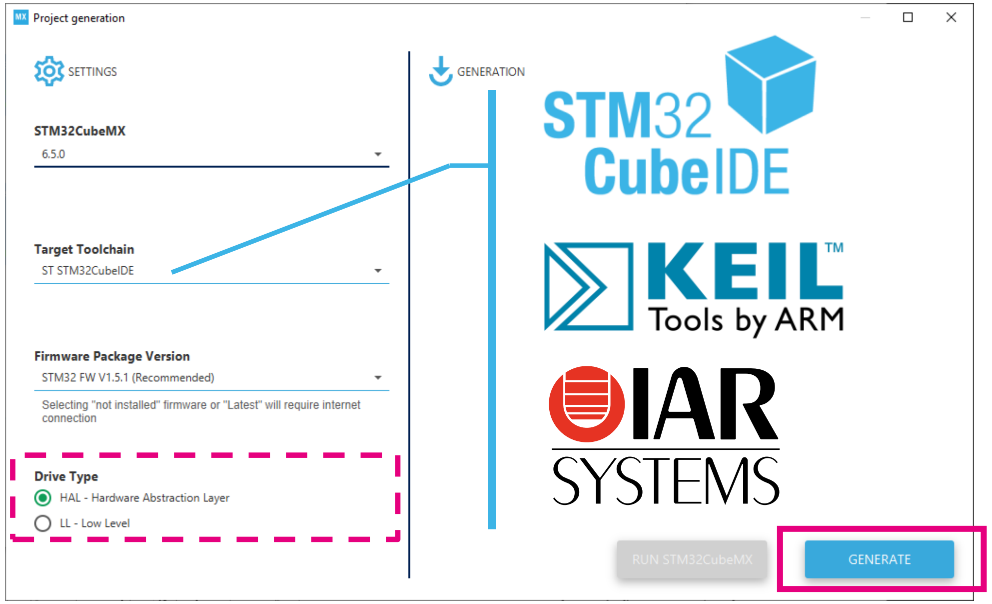




HAL (Hardware Abstraction Layer)

- High-level and feature-oriented API

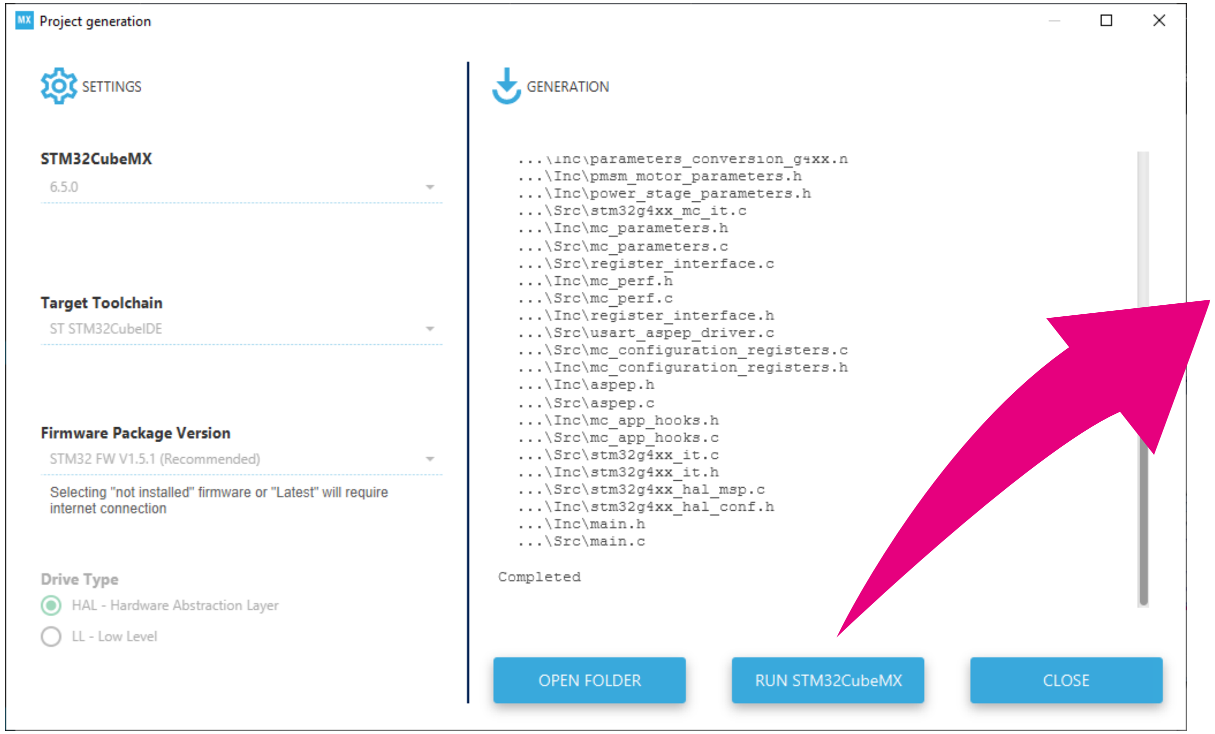
LL (Low Level)

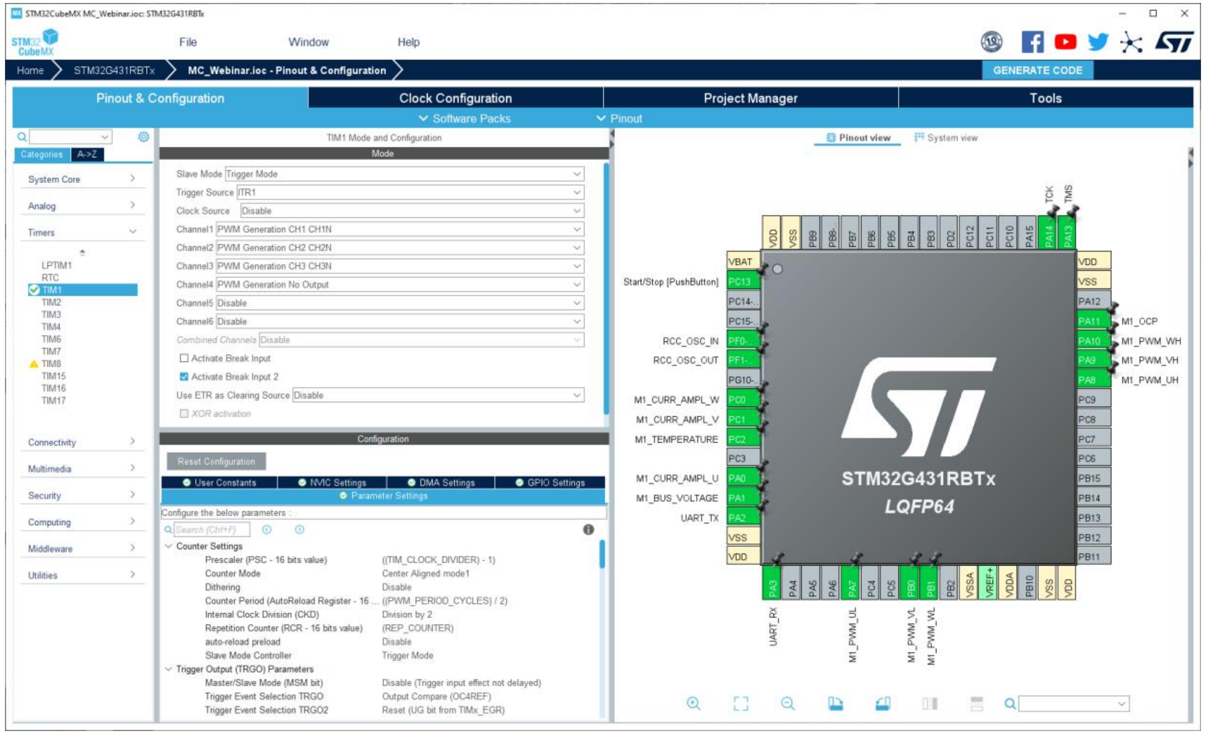
- low-level APIs at registers level

ST Motor Control SDK

MC Workbench

Open **STM32CubeMX** to see how the firmware settings for motor drives are made.

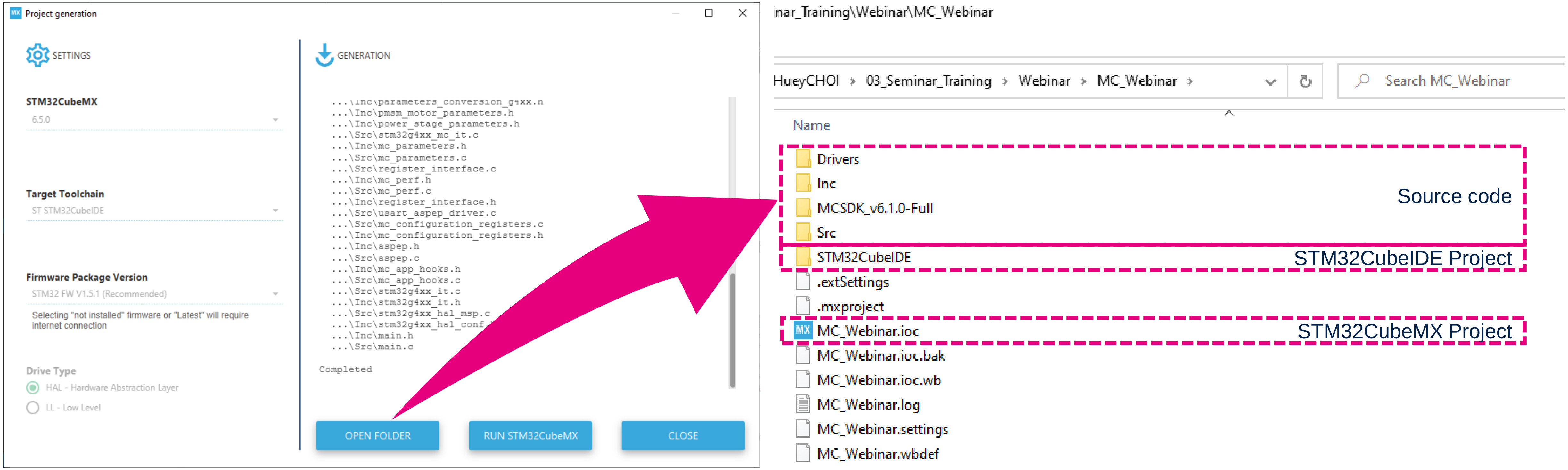




ST Motor Control SDK

MC Workbench

Generated folder consists of motor control **source code**, **STM32CubeMX** project and **IDE** project.



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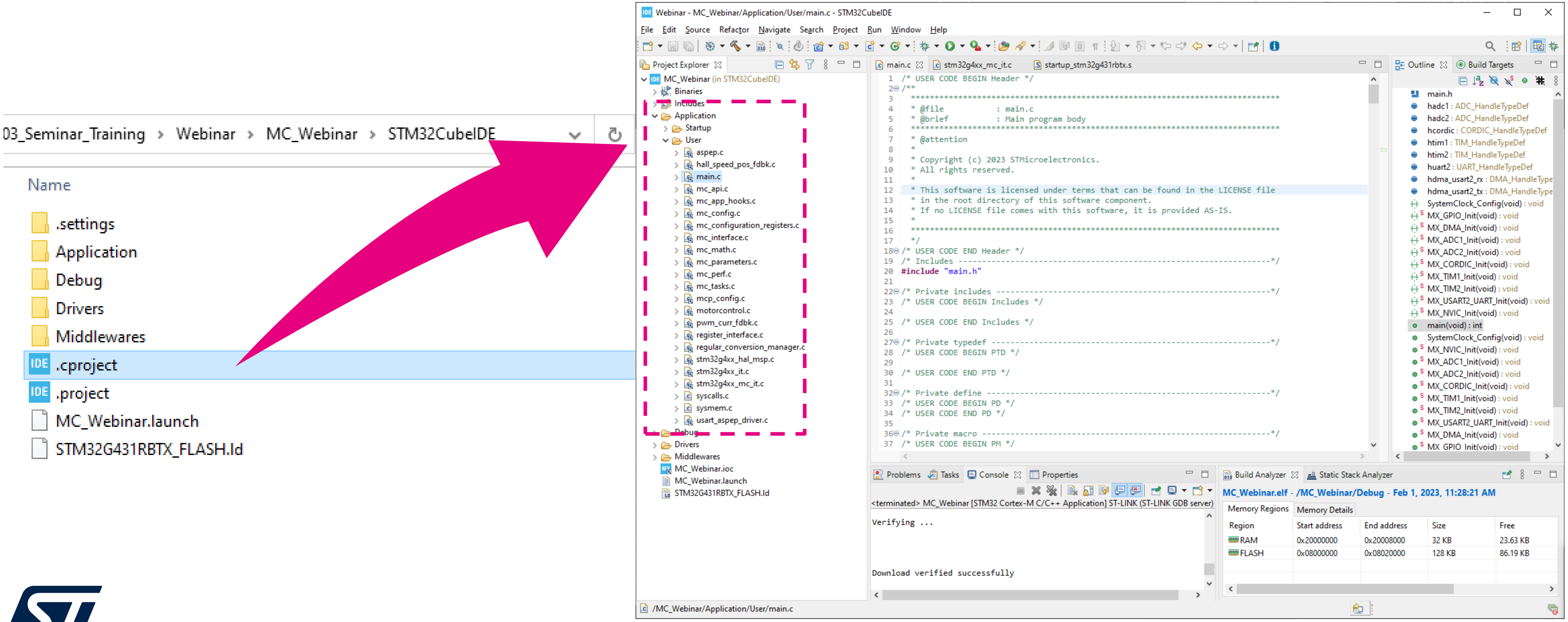
MC Workbench



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ST Motor Control SDK

MC Workbench

main.c

```c
  /* USER CODE BEGIN SysInit */

  /* USER CODE END SysInit */

  /* Initialize all configured peripherals */
  MX_GPIO_Init();
  MX_DMA_Init();
  MX_ADC1_Init();
  MX_ADC2_Init();
  MX_CORDIC_Init();
  MX_TIM1_Init();
  MX_TIM2_Init();
  MX_USART2_UART_Init();
  MX_MotorControl_Init();

  /* Initialize interrupts */
  MX_NVIC_Init();
  /* USER CODE BEGIN 2 */

  /* USER CODE END 2 */

  /* Infinite loop */
  /* USER CODE BEGIN WHILE */
  while (1)
  {
    /* USER CODE END WHILE */

    /* USER CODE BEGIN 3 */
  }
  /* USER CODE END 3 */
}

/**
  * @brief System Clock Configuration
  * @retval None
  */
void SystemClock_Config(void)
{
  RCC_OscInitTypeDef RCC_OscInitStruct = {0};
  RCC_ClkInitTypeDef RCC_ClkInitStruct = {0};

  /** Configure the main internal regulator output voltage
  */
```

User code initialization

stm32g4xx_mc_it.c

```c
/* USER CODE END PRIVATE */

/* Public prototypes of IRQ handlers called from assembly code ---------------*/
void ADC1_2_IRQHandler(void);
void TIMx_UP_M1_IRQHandler(void);
void TIMx_BRK_M1_IRQHandler(void);

void SPD_TIM_M1_IRQHandler(void);
void HardFault_Handler(void);
void SysTick_Handler(void);
void EXTI15_10_IRQHandler (void);

#if defined (CCMRAM)
#if defined (__ICCARM__)
#pragma location = ".ccmram"
#elif defined (__CC_ARM) || defined(__GNUC__)
__attribute__((section (".ccmram")))
#endif
#endif
/**
  * @brief  This function handles ADC1/ADC2 interrupt request.
  * @param  None
  * @retval None
  */
void ADC1_2_IRQHandler(void)
{
  /* USER CODE BEGIN ADC1_2_IRQn 0 */

  /* USER CODE END ADC1_2_IRQn 0 */

  // Clear Flags M1
  LL_ADC_ClearFlag_JEOS( ADC1 );

  (void)TSK_HighFrequencyTask();

 /* USER CODE BEGIN HighFreq */

 /* USER CODE END HighFreq  */

 /* USER CODE BEGIN ADC1_2_IRQn 1 */

 /* USER CODE END ADC1_2_IRQn 1 */
}
```

Motor control interrupt functions

Written user code between `/* USER CODE BEGIN xxxxx */` and `/* USER CODE END xxxxx */`, would not be removed after regeneration

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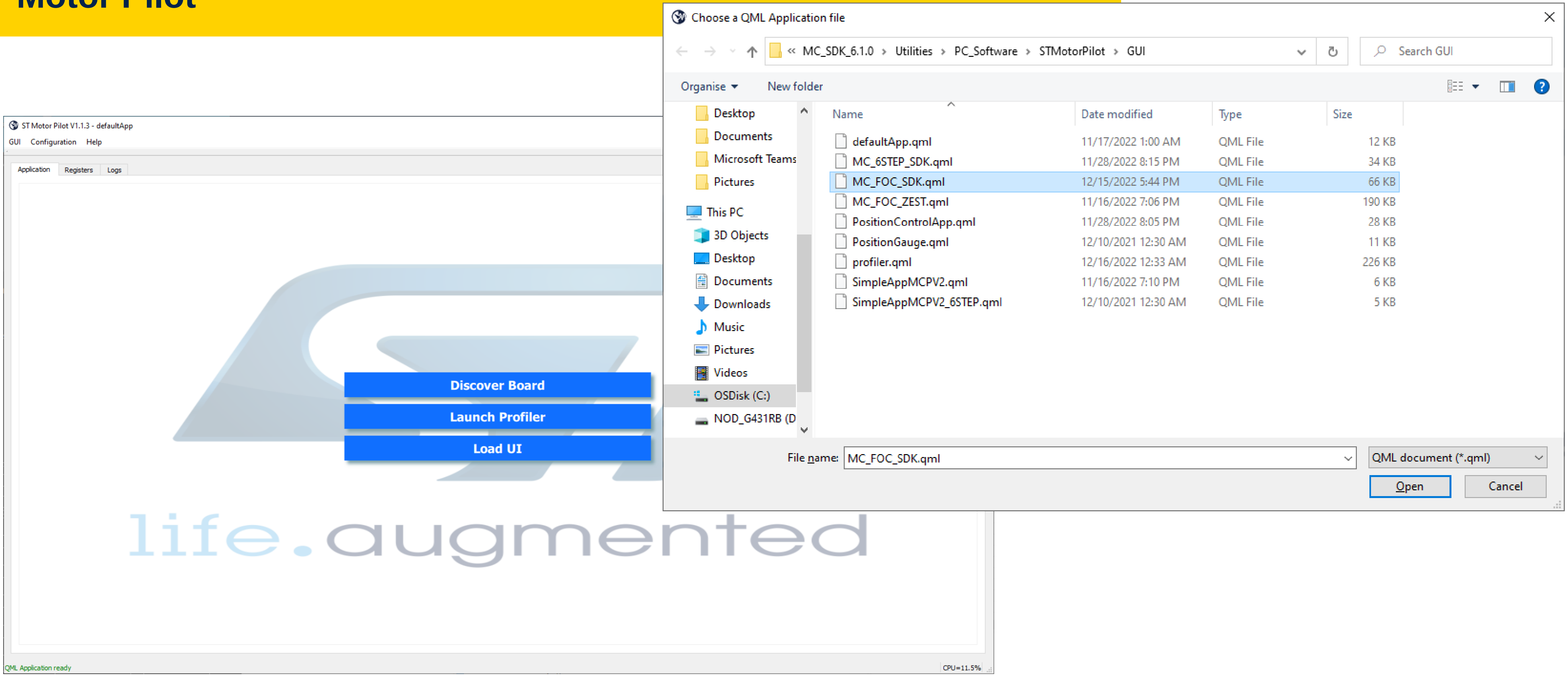
ST Motor Control SDK

Motor Pilot



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ST Motor Control SDK

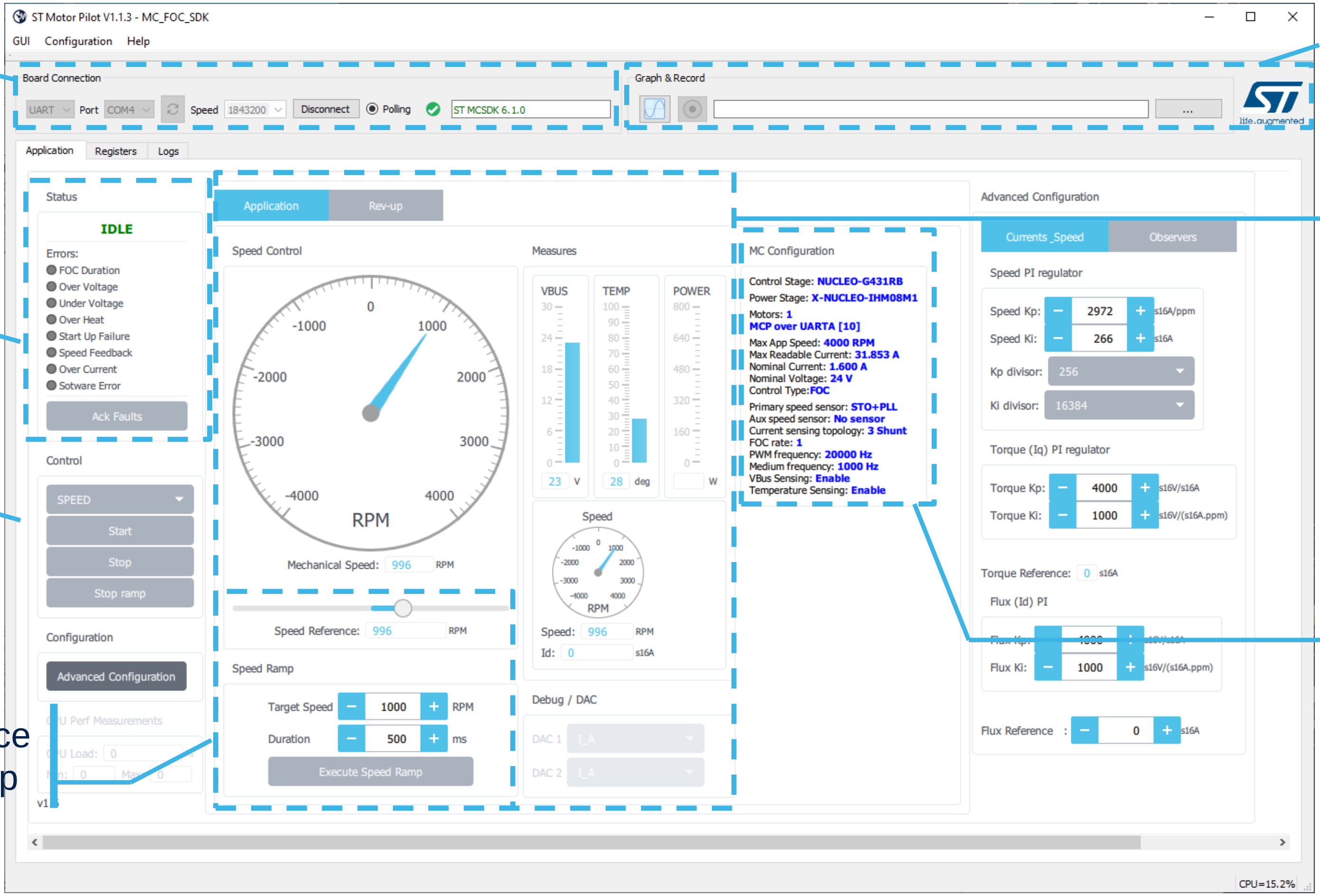
Motor Pilot

- Baudrate
- COM port
- Connection
- Version Info.

- Motor control status
- Clear fault

- Control mode
  - Current
  - Speed
- Start/Stop
- Stop speed ramp

- Speed reference
- Set speed ramp



- High resolution plotting
- Record log data

- Monitoring
  - Motor speed
  - Bus voltage
  - PCB temperature
  - Motor power
  - Speed/Current
- DAC Signal

- Motor control information
  - Board
  - Control Type
  - Sensor
  - Current sensing topology

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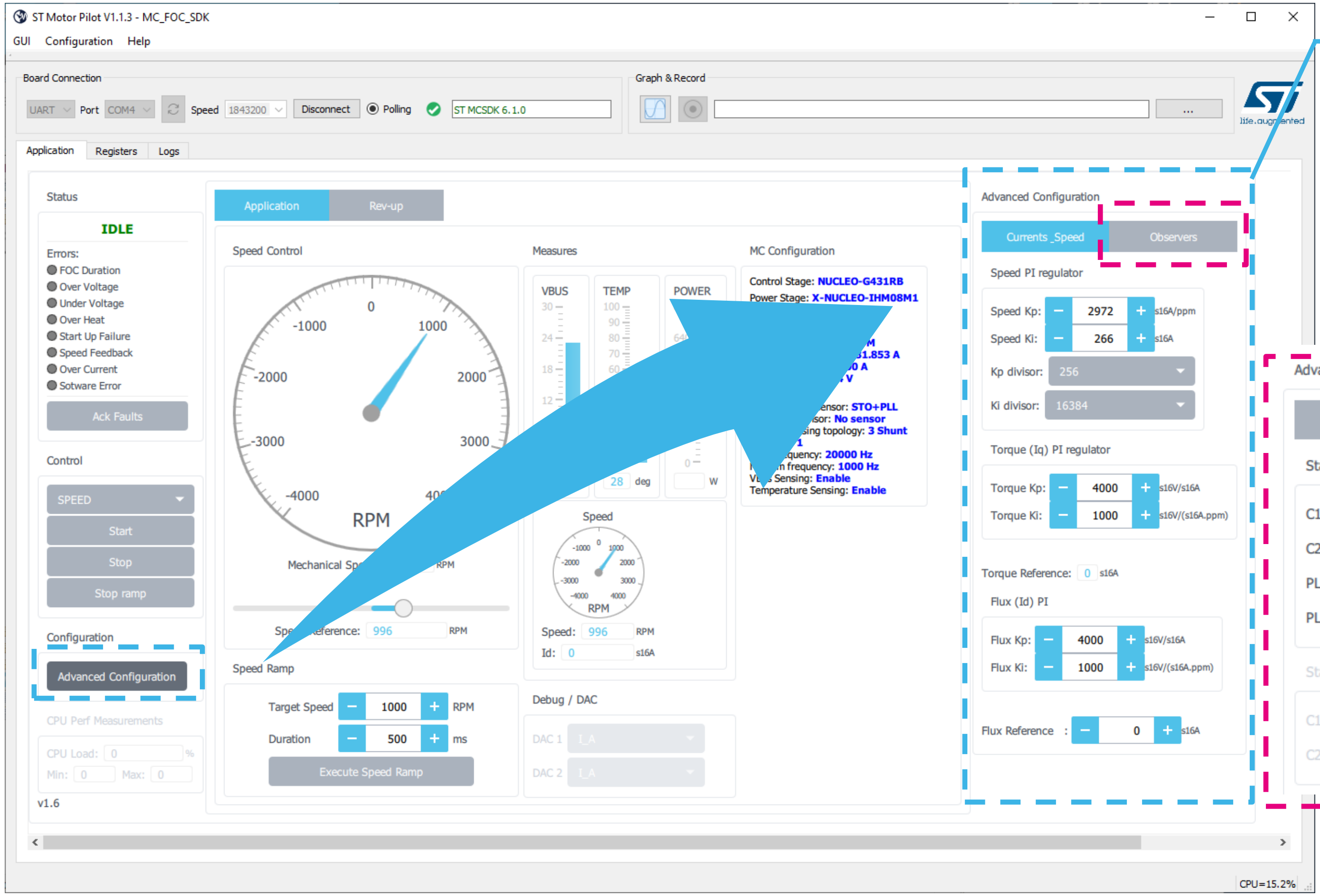
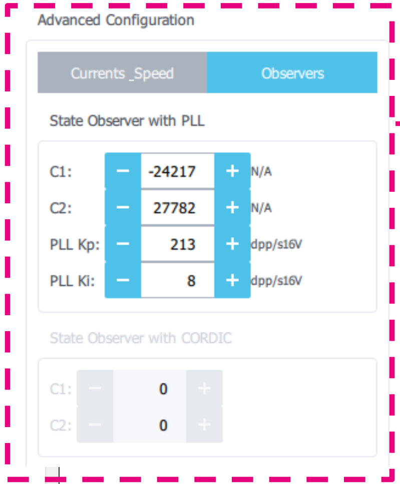
ST Motor Control SDK

Motor Pilot



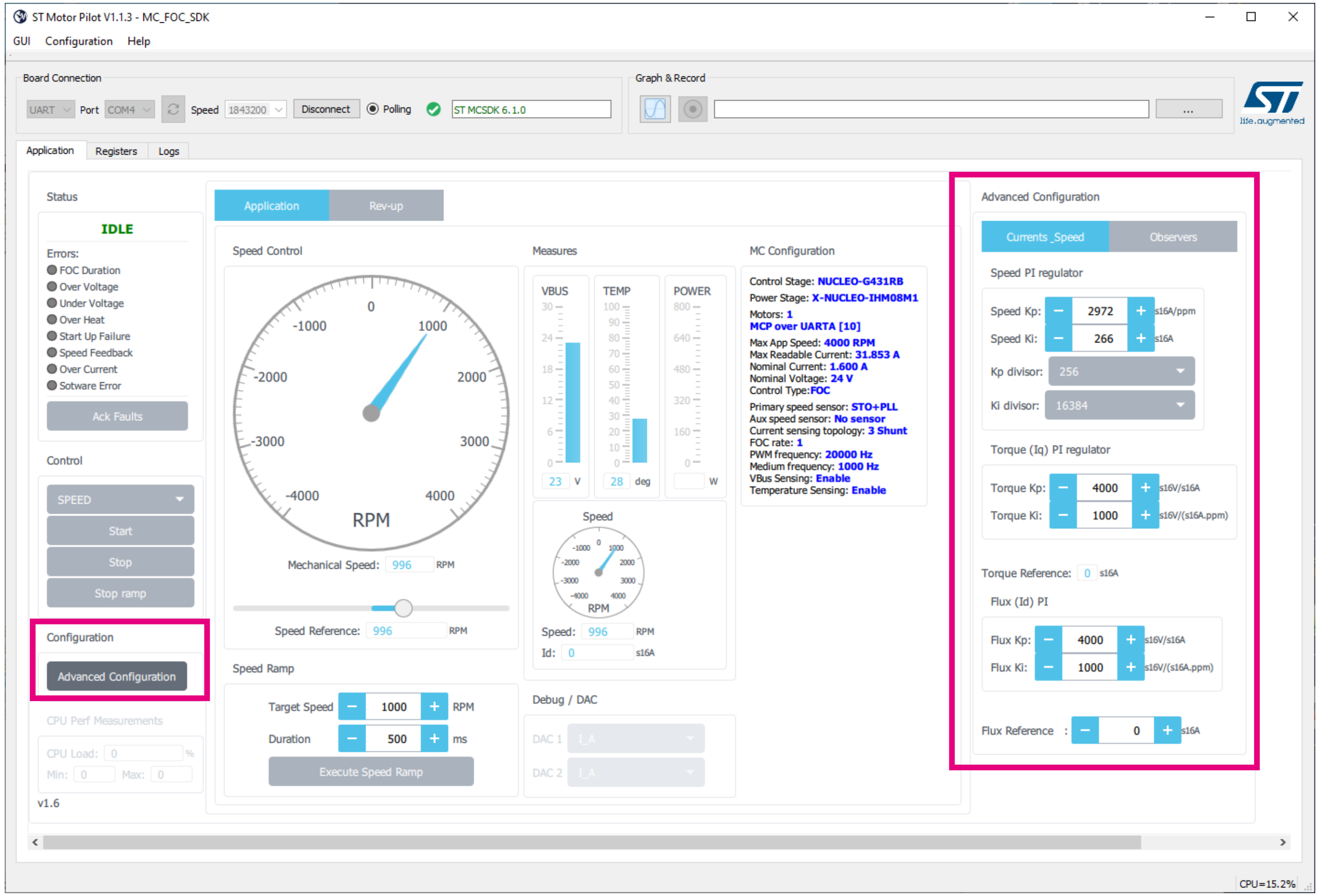
- Speed control gain
- Current(Torque) control gain
- Torque reference(I_q^{ref})
  - for Speed Control
- Flux weakening gain
- Flux weakening reference



- State observer gain
  - Change G2 value (/2, /4, /8,…) if tuning is required
- PLL gain

Motor Pilot

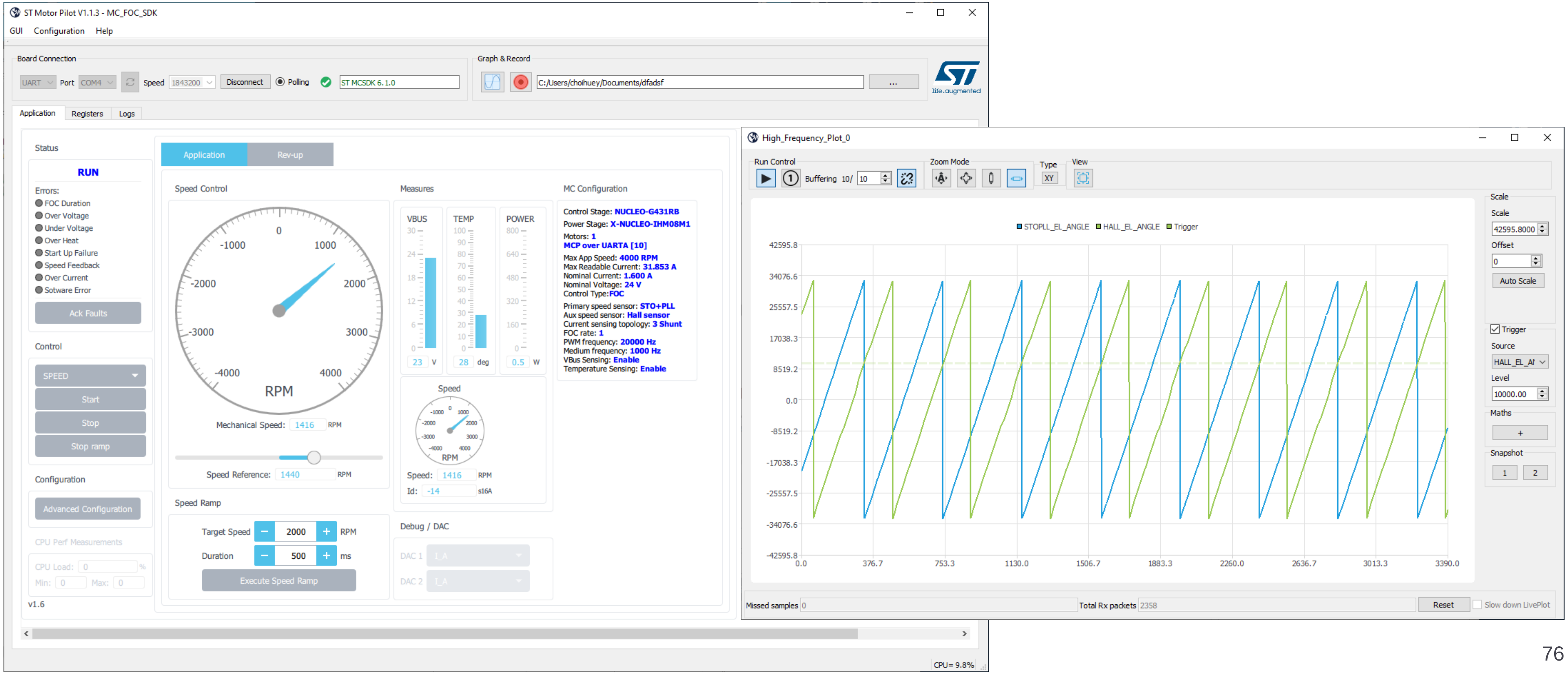
Project folder



Motor Control Competence Center

ST Motor Control SDK

Motor Pilot



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ST Motor Control SDK

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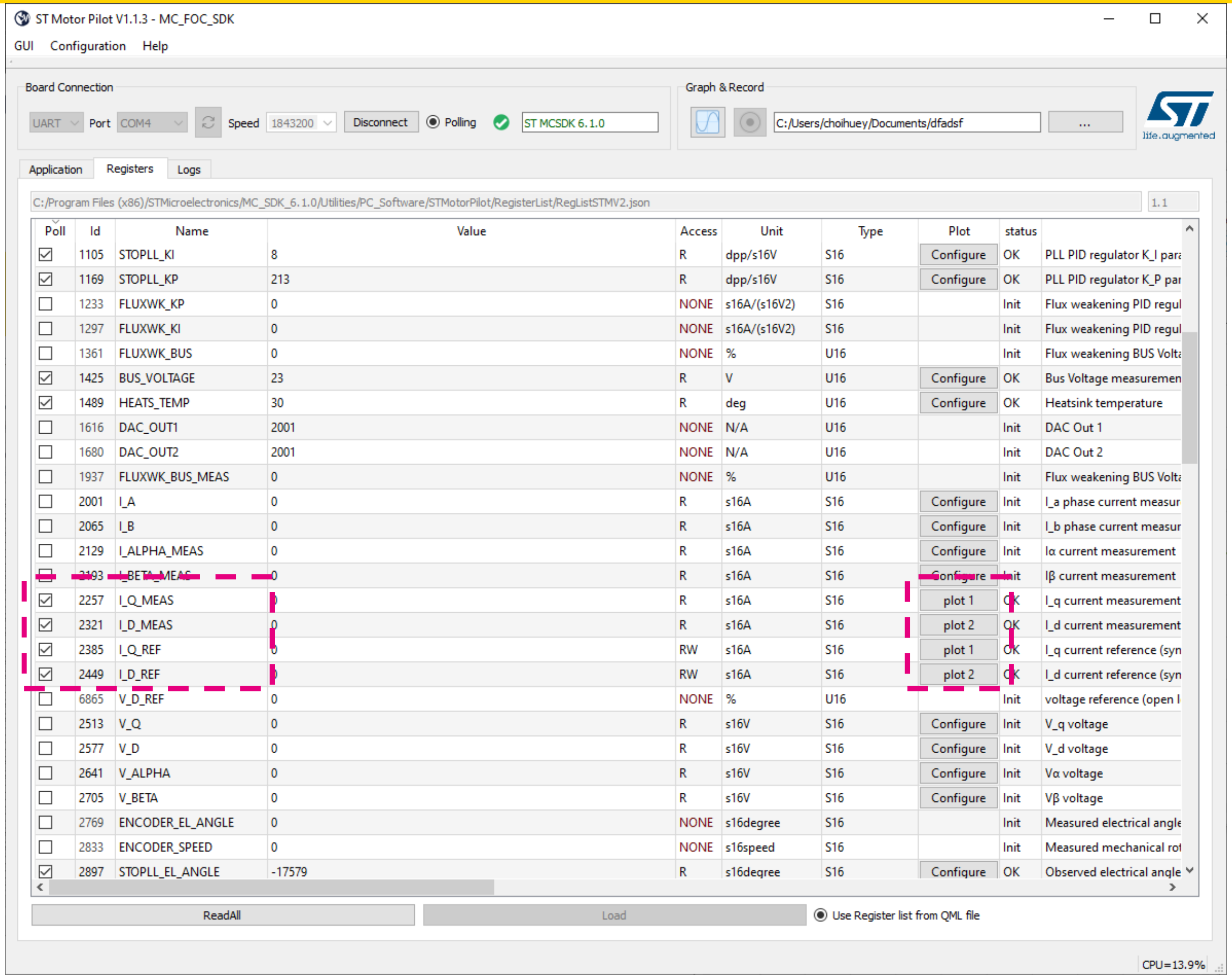
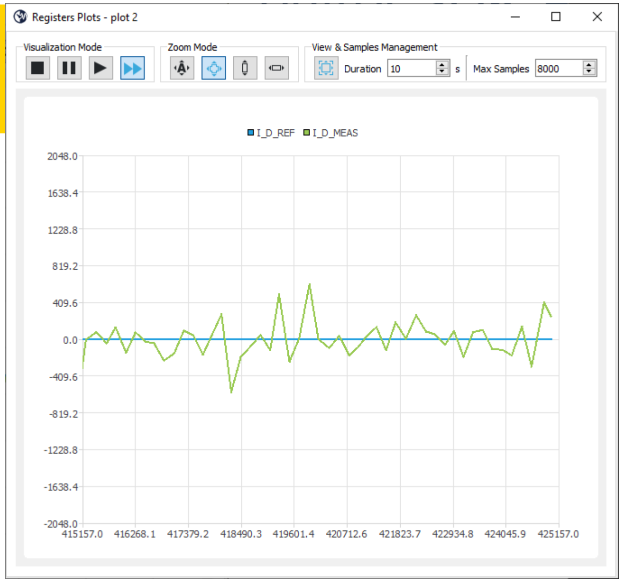
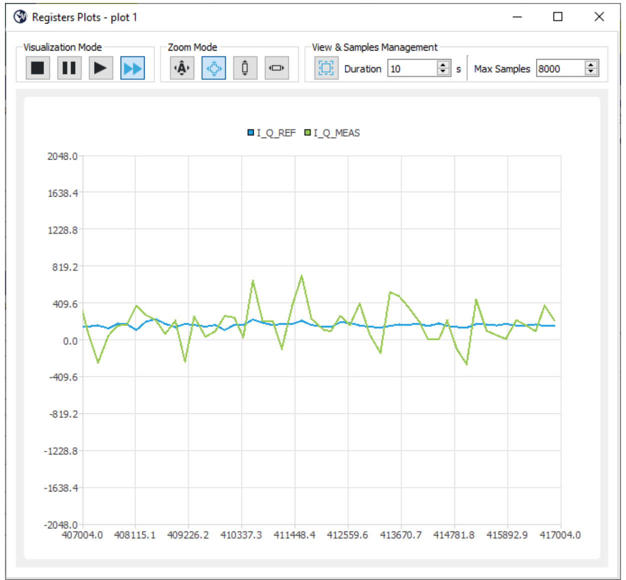
Motor Pilot







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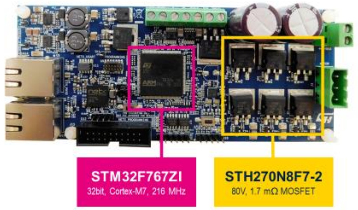
ST Motor Control Solutions

Solutions

STEVAL-ETH001V1

STM32 STDRIVE

Reference design for servo drive solution with Ethernet



- Based on STM32F767ZI (Cortex-M7)
- Three-phase motor drive inverter based on STDRIVE101 and STH270N8F7-2
- On-board DC-DC converter and linear regulator
- Max. power dissipation up to 700W
- NetX90 network controller
- RS485 interface for digital encoder and host interface
- Real-time communication via EtherCAT protocol
- Support firmware example inc. EtherCAT protocol

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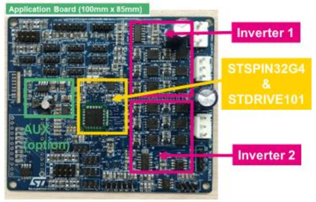
Dual Motor Control Platform with STSPIN32G4

Dual Motor Control Solution with STSPIN32G4 + STDRIVE101



- Integrated STM32G431 (Cortex-M4
- Operating Range : 5 – 75V; 200W
- FW & HW support for
  - Dual BLDC motor FOC control
  - Sensored/Sensoreless Algorithms
- Sensor feedback is supported
  - Hall/Encoder sensor for both motor
  - Compatible for both single and three shunt
- CAN, RS485 Protocols

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Commercial Air Conditioning 7kW

Triple motors, Interleaved dPFC with Single STM32G4 MCU

- STM32G4 based full platform control
  - Three BLDC motor FOC control
  - 1 Compressor + 2 Fans
  - Digital interleaved PCF, 2-stage, CCM
- SLLIMM® for IPM inverter power
- Trench Gate Field Stop IGBT ST proprietary technology
- VIPER31 Aux Power Supply section
- SJ MOSFET and STM32G4 HiRes timer for PFC High switching frequency 60 – 80 kHz

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EVALKIT-ROBOT-1

STM32 STDRIVE

Reference design for Robot

- Max operating ratings: 36V, $6A_{PK}$
- Based on STSPIN32F0A (Cortex-M0)
- Position control loop based on Field Oriented Control
- MODBUS communication is supported
- Maxon 100W 3-phase BLDC motor with 1024 pulse incremental encoder
- Extremely compact footprint (40mm x 40mm)
- Firmware example is provided from MCSDK

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Switched Reluctance Motor(SRM)

STM32 STDRIVE

Reference design for 3-phase vacuum cleaner SR motor

- MCU : STM32F303CBT
- Auxiliary power supplies
  - Flyback and linear converters : Viper26L, LD1117S50, SD1117S33C
- Gate Drivers : L6395D
- Asymmetric H-Bridge : STTH15RQ06, STGB30H65FB
- Sensorless with sliding mode observer(SMO)

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STEVAL-IHM023V3

STM32 STDRIVE

Reference design for Induction motor

- Operating Range: 125-400 VDC or 90-285 VAC
- Maximum output power for motors: up to 1 kW
- Regenerative brake control
- Tachometer/Hall/Encoder inputs
- Possibility to connect BEMF daughterboard for sensorless six-step control of BLDC motors
- Total dimensions of board: 127 mm x 180 mm
- SDK is supported with NUCLEO-G431RB

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MC Workbench

Motor Control WorkBench

English

New project | Load Project | Tools | About

Recent Projects:

MC_Webinar
STM32G431RB
Type: FOC / Three Shunt Resistors
Control: NUCLEO-G431RB
Powers: X-NUCLEO-IHM08M1
Motors: Shinano LA052-080E3NL1

SDK6_G474RE_IHM08M1_FOC
STM32G474RE
Type: FOC / Three Shunt Resistors
Control: NUCLEO-G474RE
Powers: X-NUCLEO-IHM08M1
Motors: Shinano LA052-080E3NL1

webinar_project
STM32G431RB
Type: FOC / Three Shunt Resistors
Control: NUCLEO-G431RB
Powers: X-NUCLEO-IHM08M1
Motors: MAXON_1

SDK6_B-G431B-ESC1
STM32G431CB
Type: FOC / Three Shunt Resistors
Control: B-G431B-ESC1
Powers: B-G431B-ESC1
Motors: Shinano LA052-080E3NL1

SDK6_SIx2FOC
STM32G431RB
Type: FOC / Three Shunt Resistors
Control: NUCLEO-G431RB
Powers: X-NUCLEO-IHM08M1
Motors: Shinano LA052-080E3NL1

Example Projects:

Project name	MCU	Type	Control	Powers	Motors	Description
ACIM FOC	STM32G431RB	ACIM / FOC	NUCLEO-G431RB	STEVAL-IHM023V3	ACIM SELNI AHV 242 N06	Sensorless Field Oriented Control of an...
ACIM V/F Open Loop	STM32G431RB	ACIM / V/F	NUCLEO-G431RB	STEVAL-IHM023V3	ACIM SELNI AHV 242 N06	Open Loop Control of an AC Induction ...
FOC STM32H745ZI with IHM08 example	STM32H745ZI	FOC / short_topology_ 3-SHUNT	NUCLEO-H745ZI	X-NUCLEO-IHM08M1	SHINANO	FOC example with control board STM3...
Electronic speed control on B-G431B-ESC1 kit	STM32G431CB	FOC / short_topology_ 3-SHUNT	B-G431B-ESC1	B-G431B-ESC1	SHINANO	Electronic speed control on B-G431B-E...
EVSPIN32G4 example	STSPIN32G4	FOC / short_topology_ 3-SHUNT	EVSPIN32G4	EVSPIN32G4	GIMBALL	EVSPIN32G4 example and PMSM SHIN...
Speed ramp with Potentiometer on P-NUCLEO-IHM003 kit	STM32G431RB	FOC / short_topology_ 3-SHUNT	NUCLEO-G431RB	X-NUCLEO-IHM16M1	GIMBAL GBM2804H-100T	Speed ramp with Potentiometer on P-...
Position Control feature example on NUCLEO-G431RB and MAXON Motor	STM32G431RB	FOC / short_topology_ 3-SHUNT	NUCLEO-G431RB	X-NUCLEO-IHM07M1	MAXON EC-I 100W	Example for Position control on NUCLE...
6-Step example on IHM03 pack and nominal bus voltage	STM32G431RB	hardware.AlgorithmType.6STEP / short_topology_	NUCLEO-G431RB	X-NUCLEO-IHM16M1	GimBal GBM2804H-100T	6-Step example on IHM03 pack and no...
6-Step example on NUCLEOG431+IHM07 in sensorless current mode	STM32G431RB	hardware.AlgorithmType.6STEP / short_topology_ 1-SHUNT	NUCLEO-G431RB	X-NUCLEO-IHM07M1	GimBal GBM2804H-100T	6-Step example on Gimbal motor nucle...
STSPIN32F0A FOC example on STEVAL-SPIN3201	STSPIN32F0A	FOC / short_topology_ 3-SHUNT	STEVAL-SPIN3201	STEVAL-SPIN3201	Bull Running BR2804-1700kv	STSPIN32F0A project with 3 shunts inv...

Solution

Reference design for ser

Reference design for Ro

tions

nditioning 7kW

AL-IHM023V3

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