

ST Motor Control Workbench

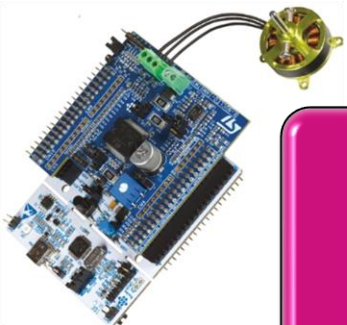
Lab 3: Motor Control Workbench flow with STM32CubeMX and STM32 TrueSTUDIO



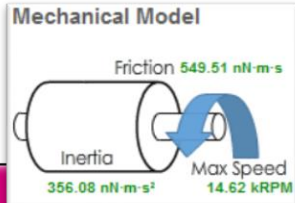
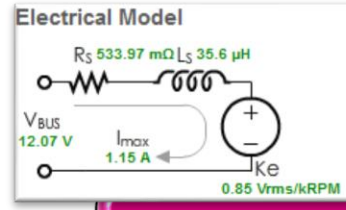


Motor Control Development Workflow

#3 – System Configuration 2



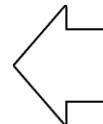
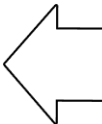
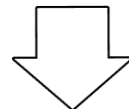
Hardware Setup



Motor Characterization
Motor Profiler
Motion Control Suite



System Configuration



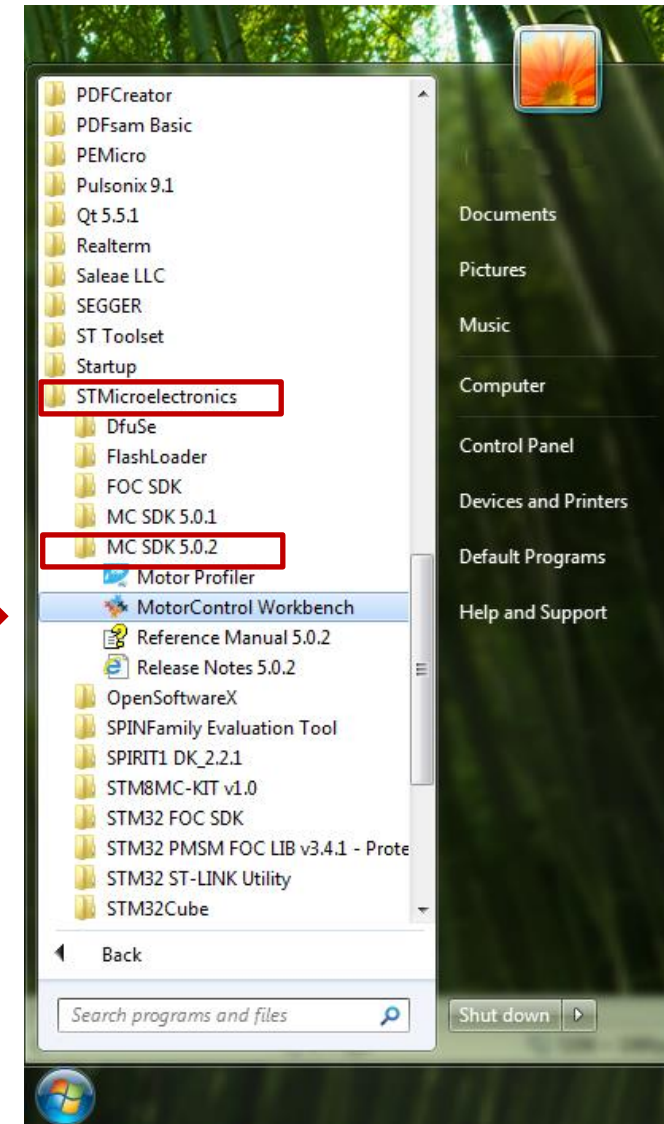
- Project system configuration using MC Workbench
- Generation of a project firmware
- Project compilation in IDE (ST TrueSTUDIO)

Create new project

- Open the **MC Workbench** application

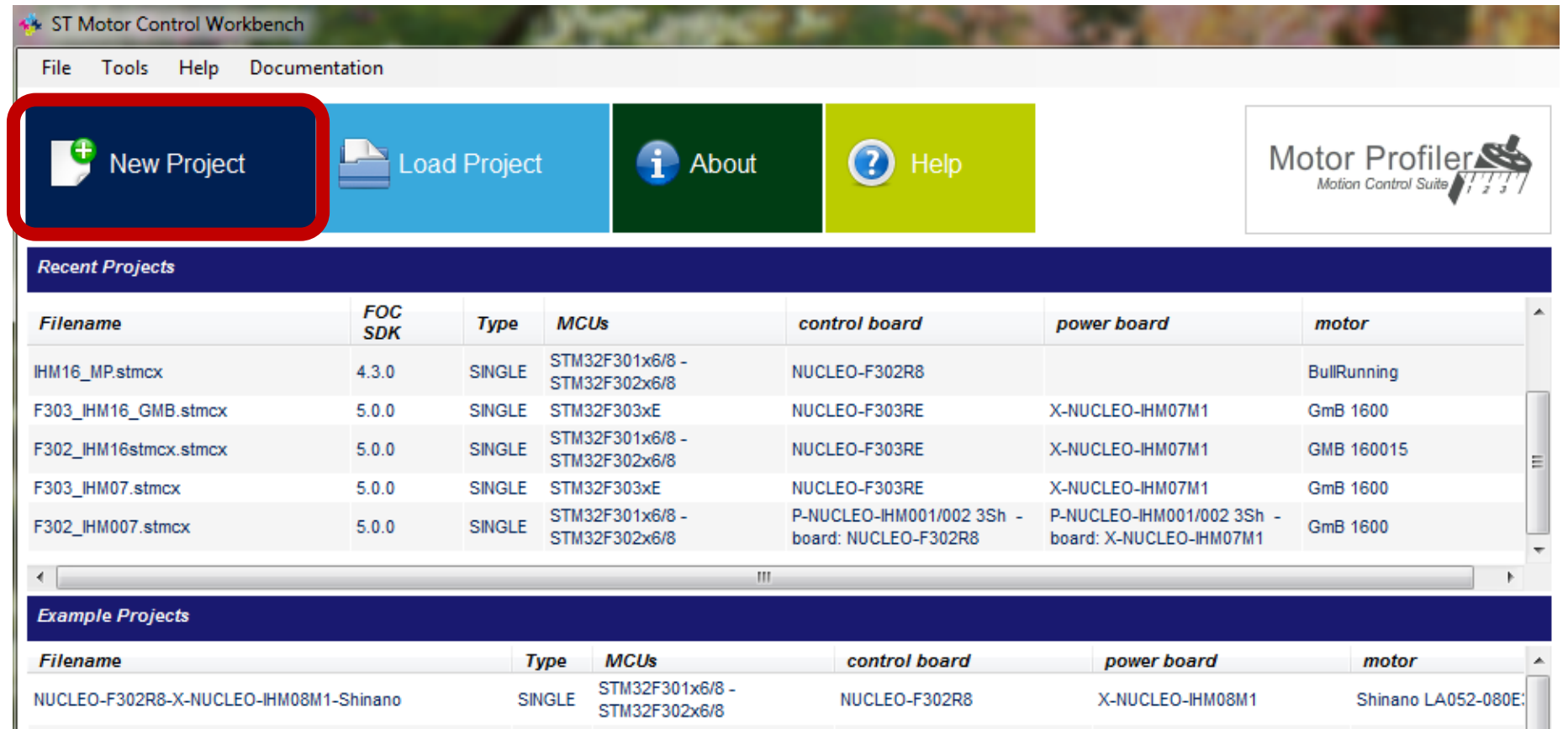


or



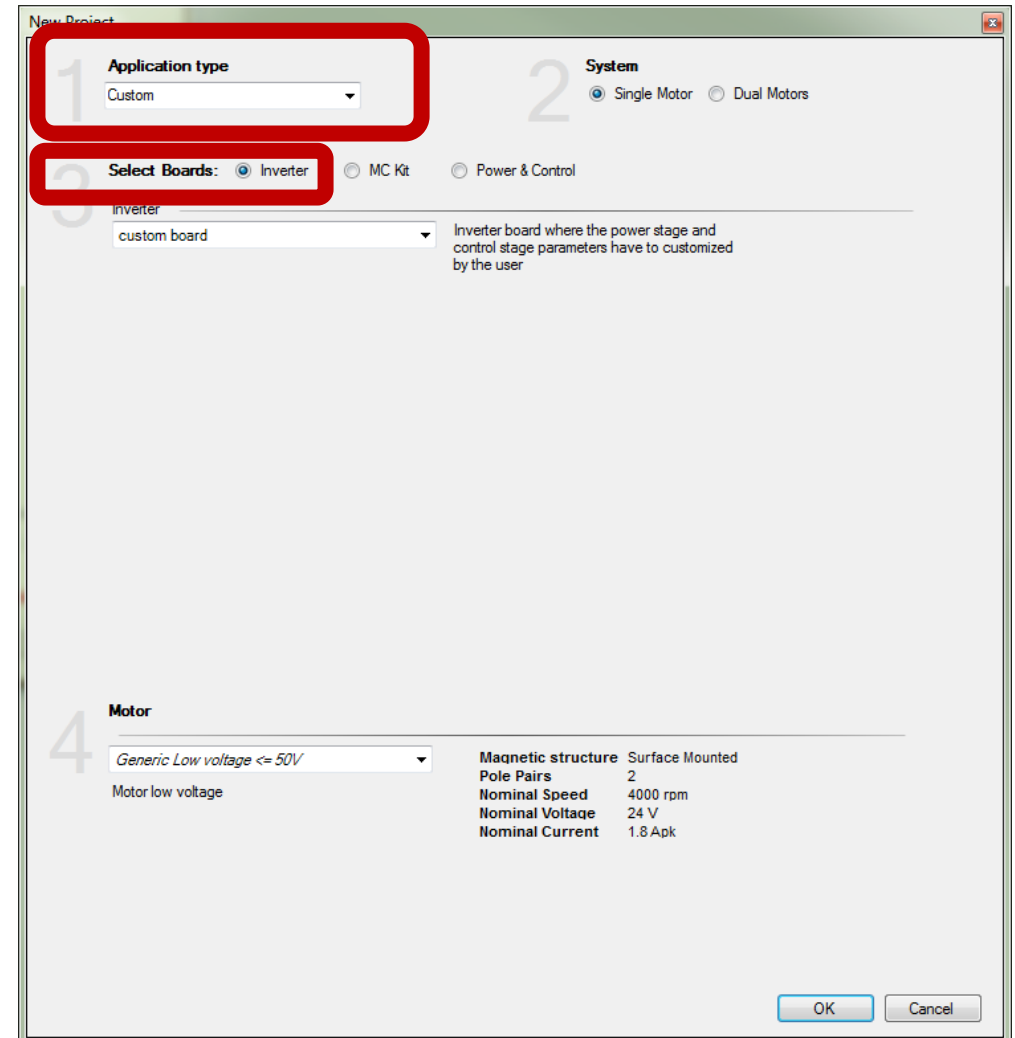
Create new project

- Press the button **New Project**



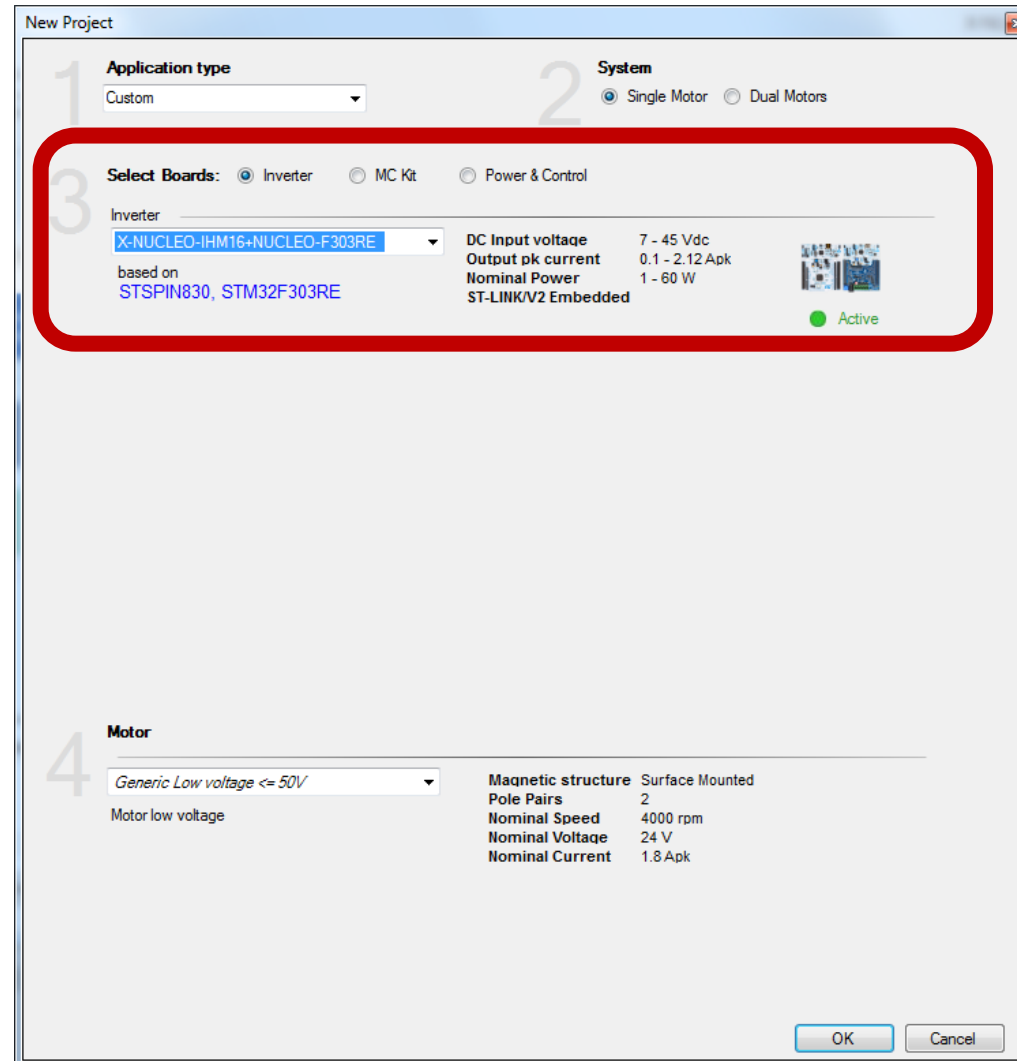
Select the Application type

- 1 – Select “**Custom**”
Application type
- 3 – Select “**Inverter**”
Select boards check box



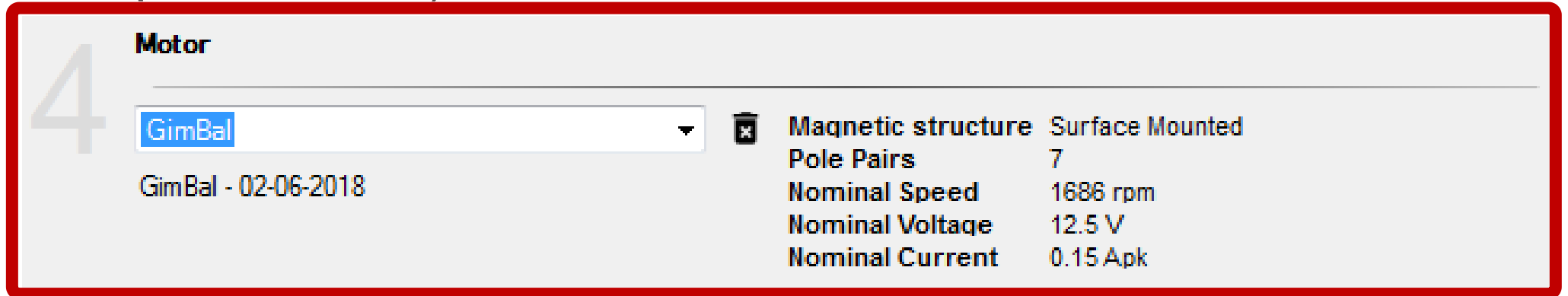
Use motor in MC Workbench

- Select “X-NUCLEO-IHM16+NUCLEO-F303RE” in Inverter part

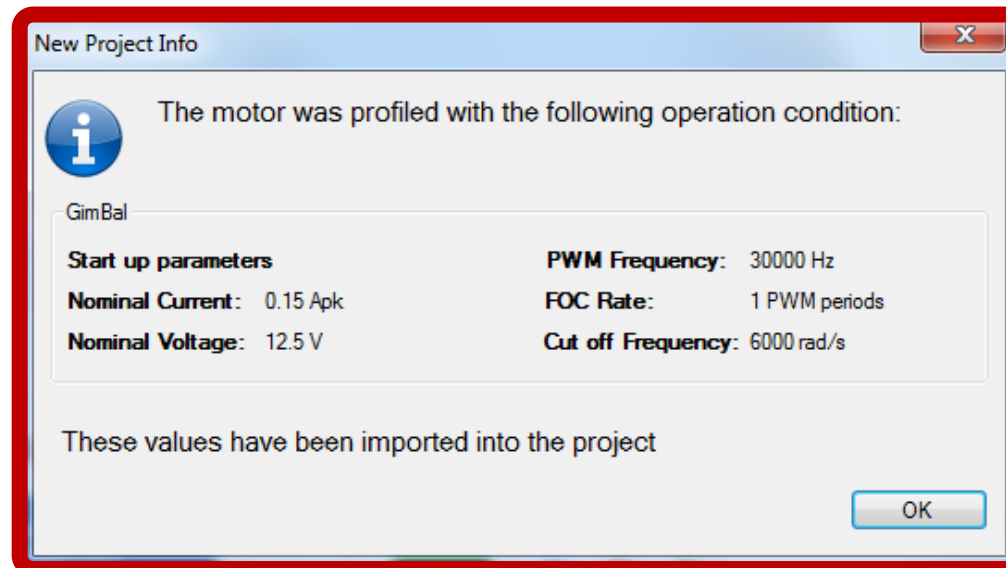


Select the motor

- Select your saved motor at the bottom of the window New Project.
(for example „*GimBal*“)

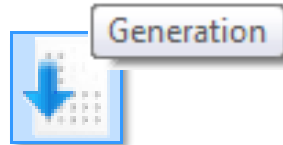


- Info windows



Generate the Firmware

- Click on the icon "Generation".



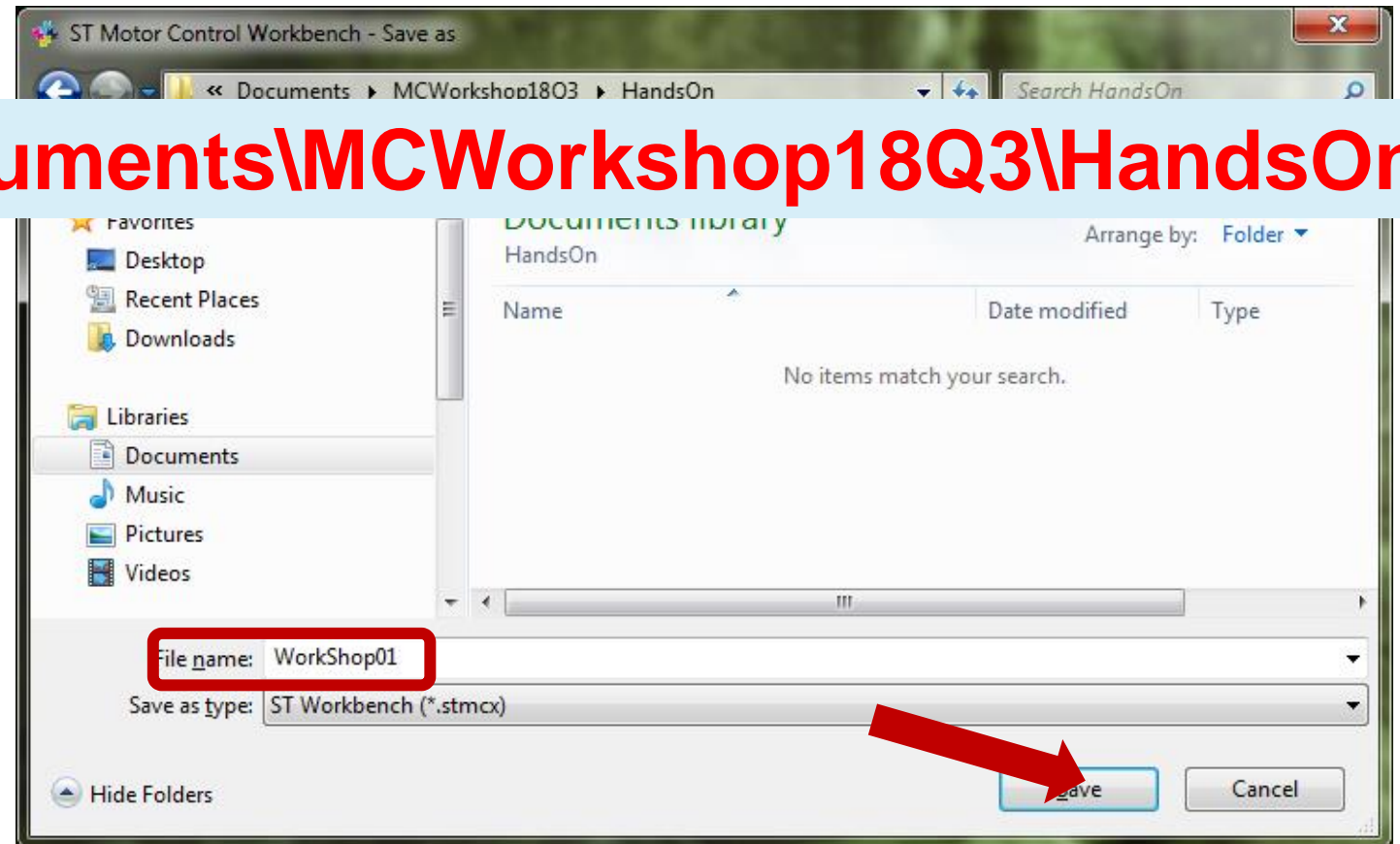
Variable	Motor	Uni
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Time	Motor	Id	Message
09:17:07			The 'PFC' is not supported in the FW for SDK5.x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa...
09:17:07			The 'Sensor-less (HFI+Observer)' is not supported in the FW for SDK5.x. All parameters will be disabled.
09:17:07			F2 mcus are not supported in the FW for SDK5.x
09:17:07			F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x

Generate the Firmware

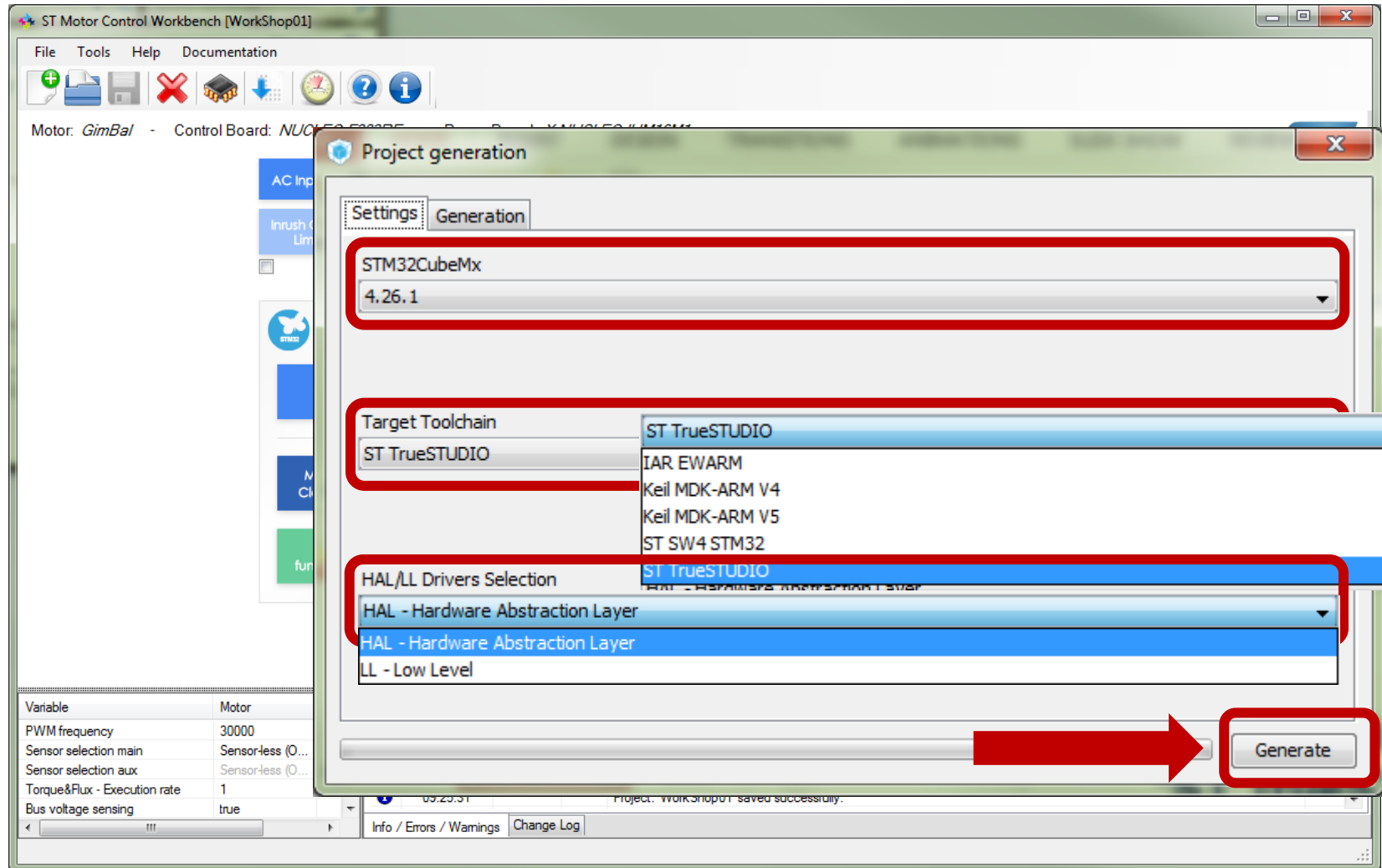
C:\Users\User Name\Documents\MCWorkshop18Q3\HandsOn

- Provide your Project Name
 - a) Select the “**HandsOn**” subfolder in the Documents...
 - b) Type “**WorkShop01**”
 - c) Click on the Save button

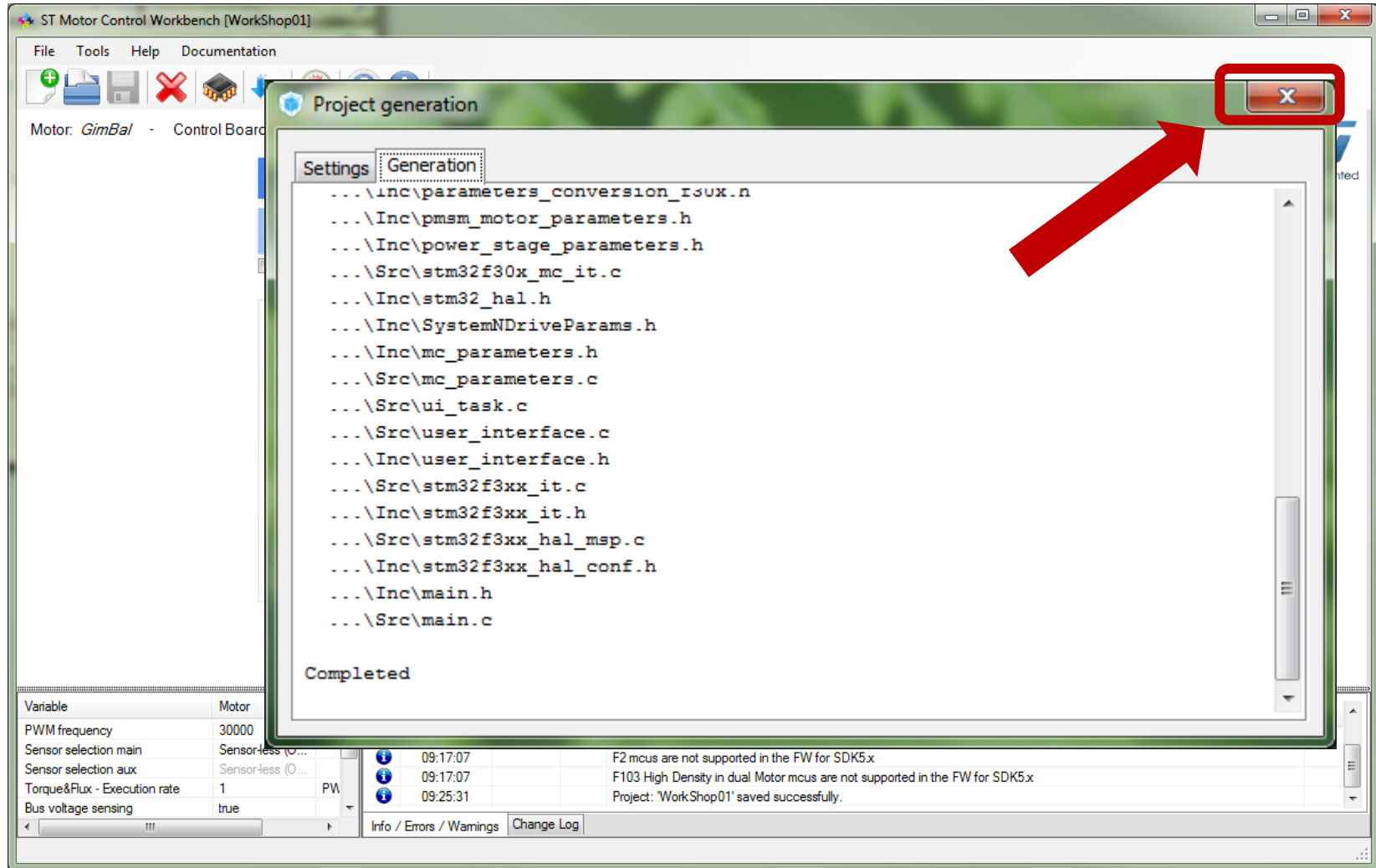


Project generation - Settings

- Select the proper version of STMCubeMX - “4.26.1”!
- Select Target toolchain “ST TrueSTUDIO”
- Select driver HAL/LL “HAL”
- Click on button **Generate**





- Close the Project generation by exiting at the upper right arrow.



Generate the code

- Code is generated. You can see the log table

	Time	Motor	Id	Message
	09:29:49			Generation files starting
	09:30:24			Project files generated on folder:'C:\Users\tadeas holler\Documents\MCWorkshop 18Q3\HandsOn\WorkShop01'

Info / Errors / Warnings Change Log

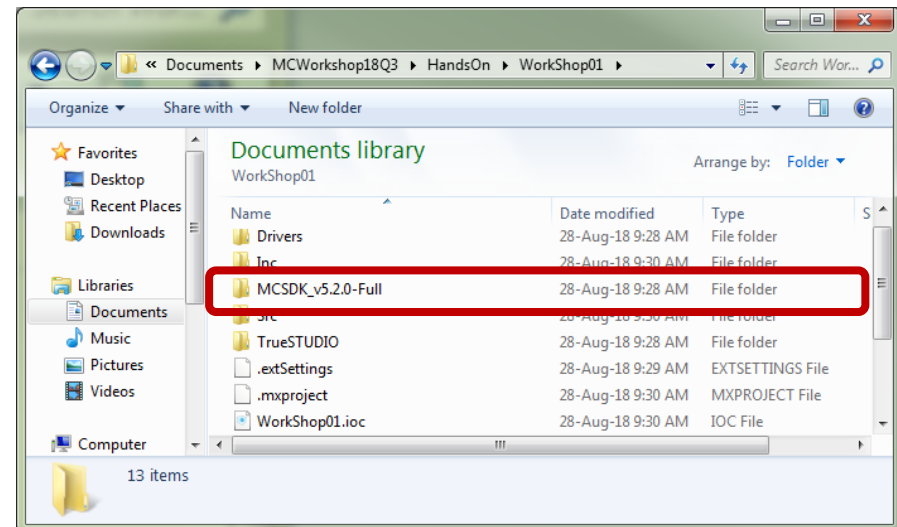
Open ST TrueSTUDIO – simple installation

- **Double click on the line “Project files generated on folder...”.**

	Time	Motor	Id	Message
	09:29:49			Generation files starting
	09:30:24			Project files generated on folder:'C:\Users\tadeas holler\Documents\McWorkshop18Q3\HandsOn\WorkShop01'

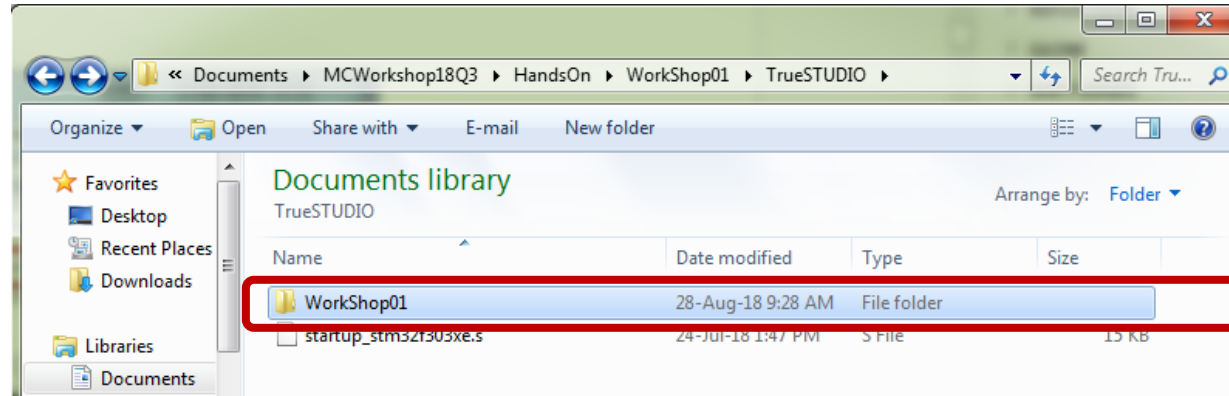
Info / Errors / Warnings Change Log

- **Double click on the “TrueSTUDIO”**

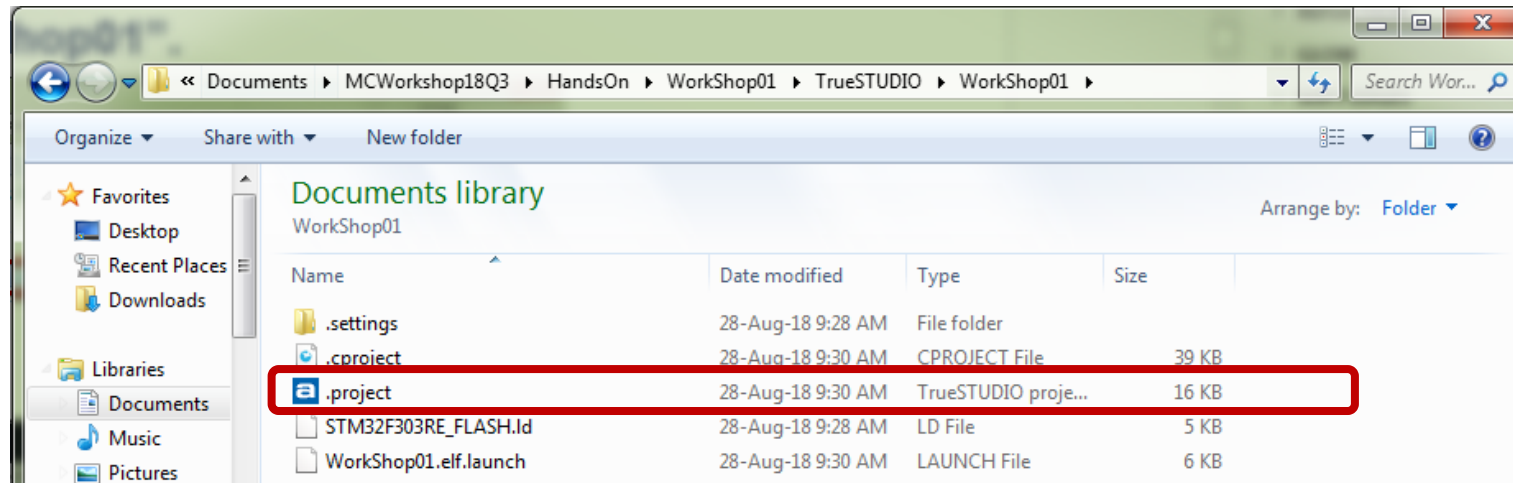


Open ST TrueSTUDIO – simple installation

- Double click on the **“WorkShop01”**.

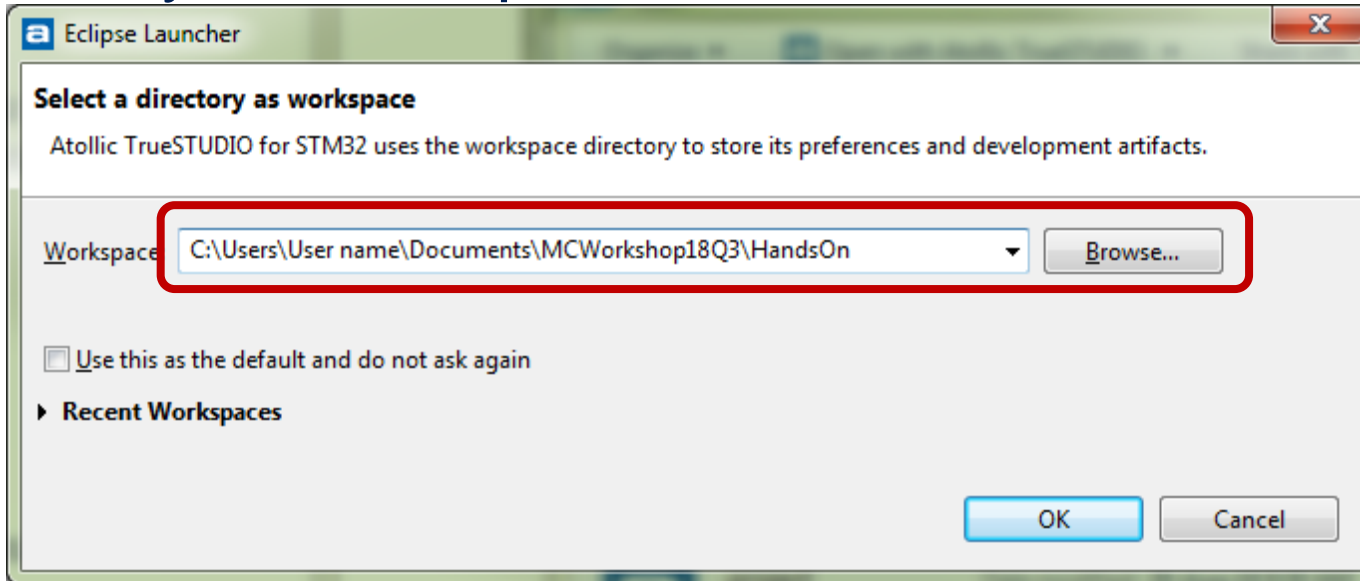


- Open the **“.project”**

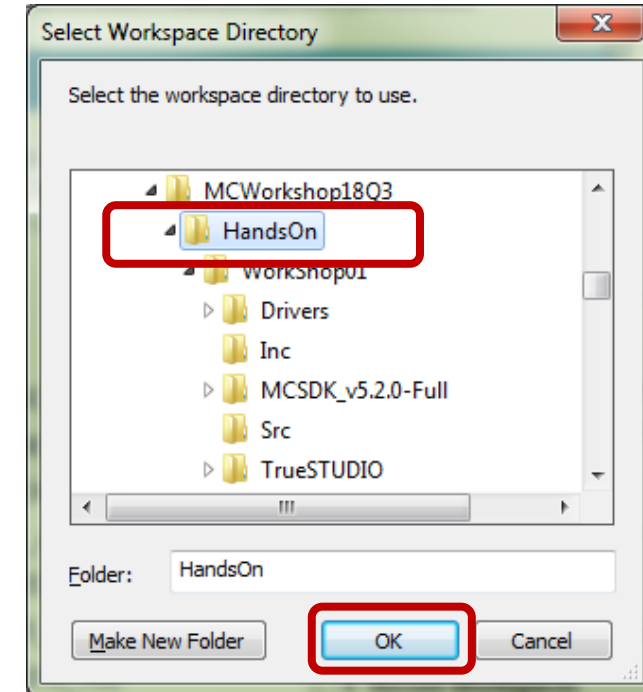


Open ST TrueSTUDIO – simple installation

- Select your workspace, click to the “**Browse...**”



- Select “**HandsOn**” located

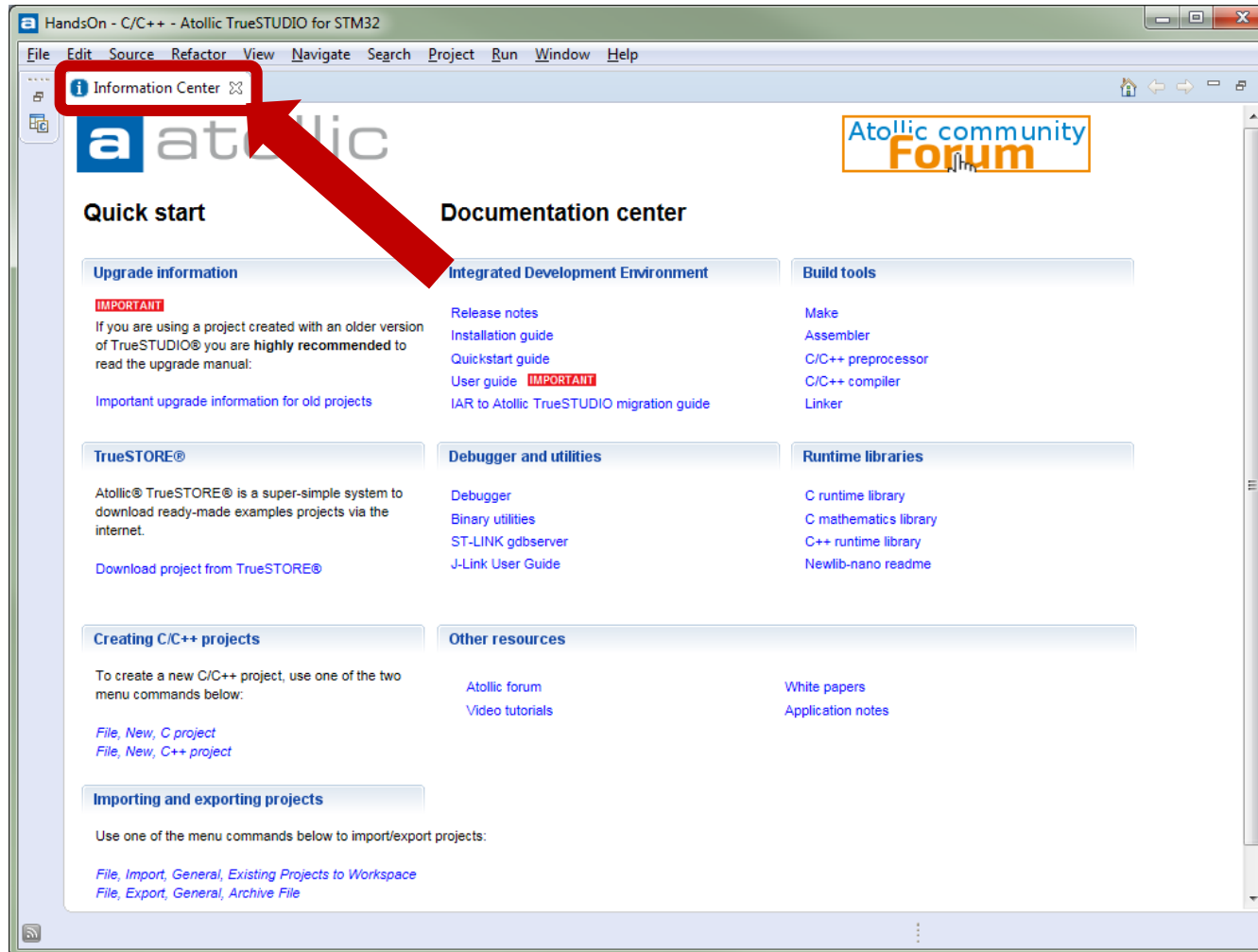


C:\Users\User Name\Documents\MCWorkshop18Q3\HandsOn

or you can select your folder and click OK

ST TrueSTUDIO – Close Information Center

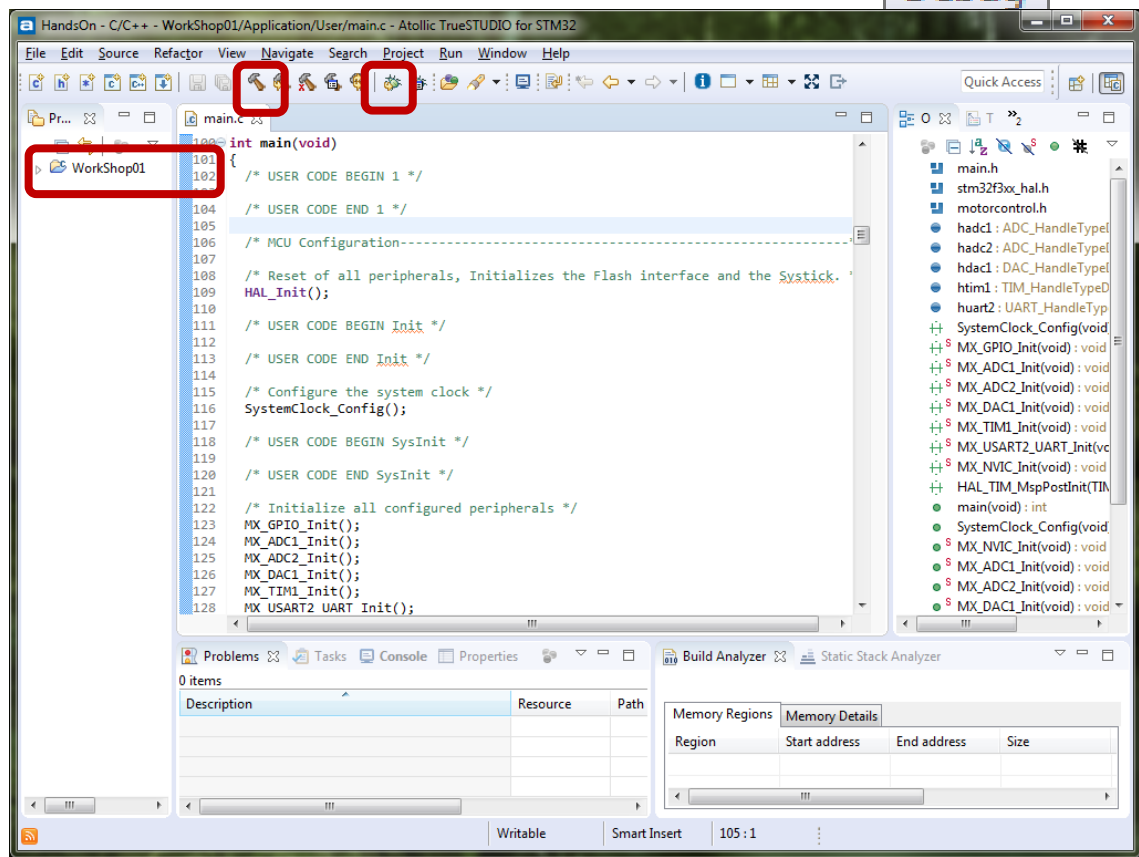
- Close “Information Center”



Upload & run MC Application

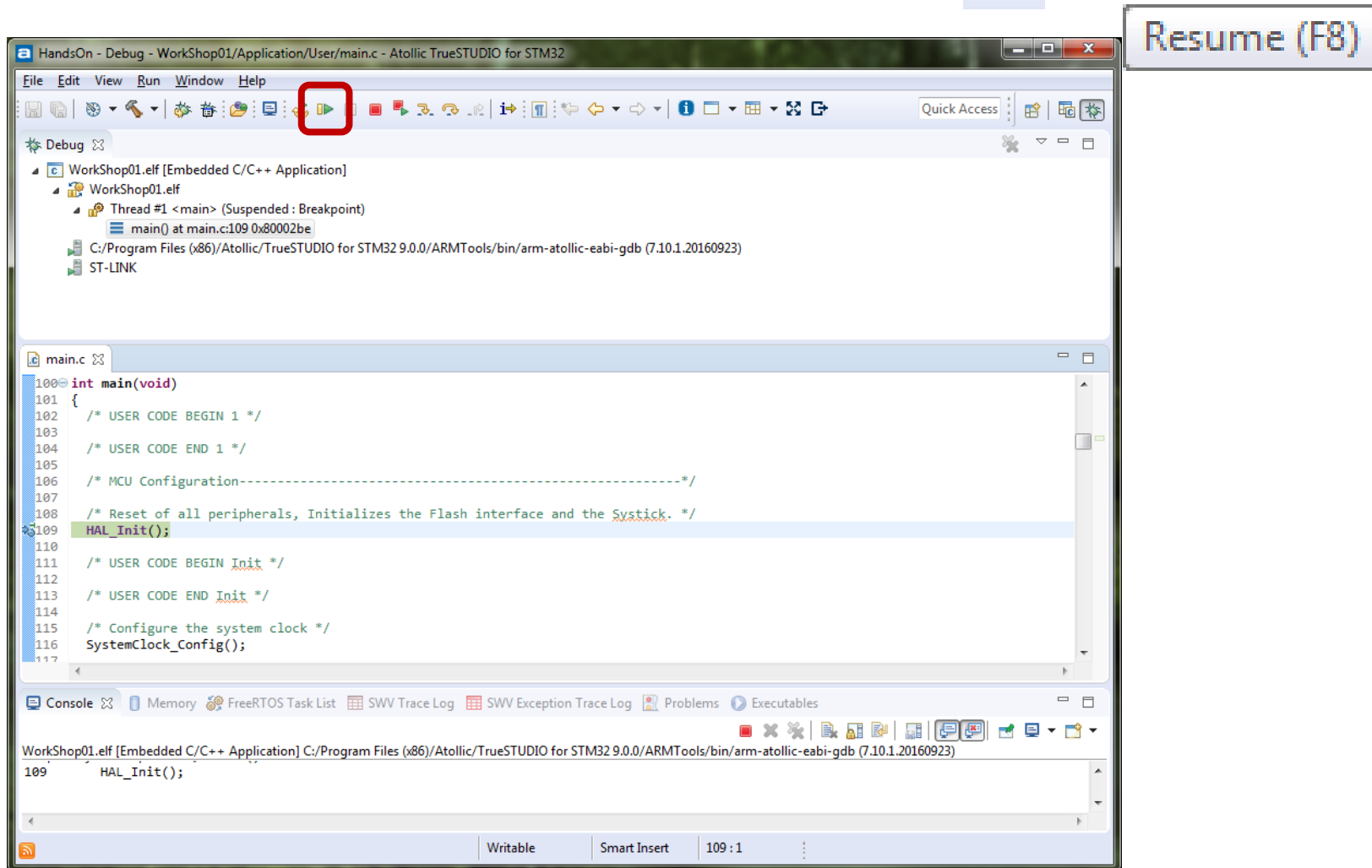
- Select project Workshop01 and click on the button **“Build”**  or **Ctrl+B**
- Click on the button **“Debug”**  or **F11**

Build 'Debug' for project 'MC_WorkShop_01'



Upload & run MC Application

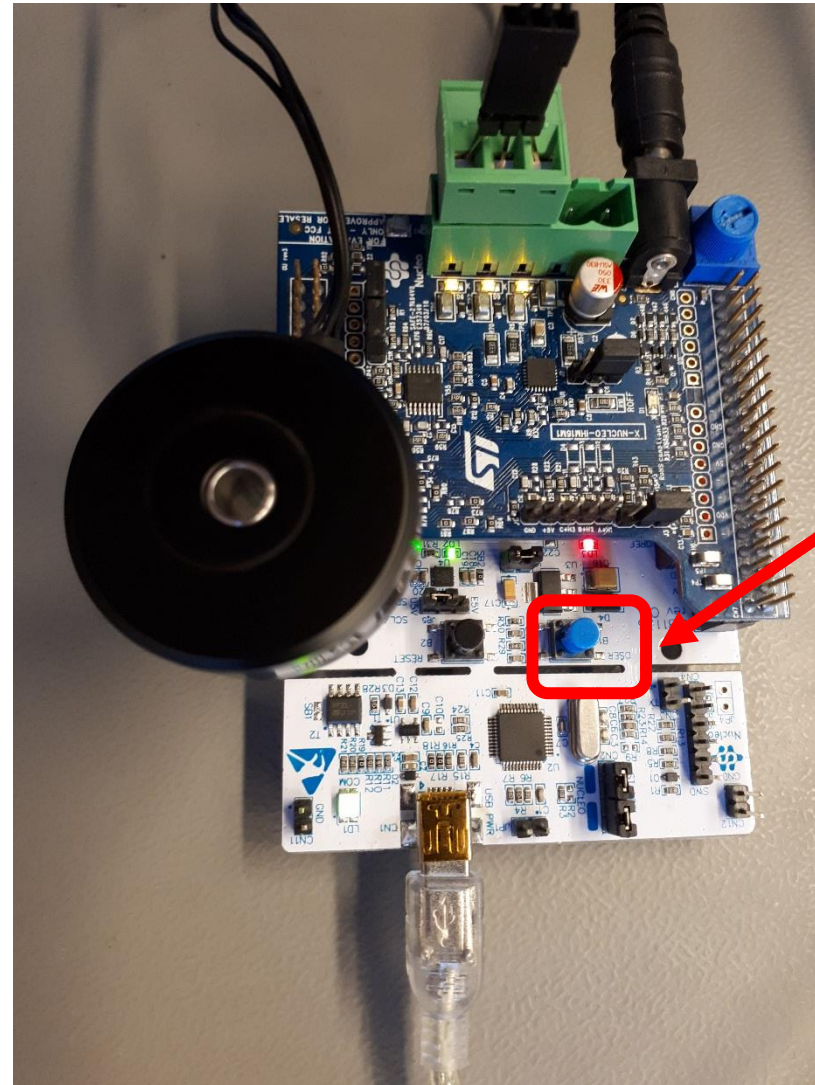
- After downloaded click on the “Resume”  or **F8**



The screenshot shows the Atollic TrueSTUDIO for STM32 IDE interface. The top toolbar contains various icons, with the 'Resume' icon (a green play button) highlighted by a red square. A callout box with a white background and a grey border points to this icon, containing the text 'Resume (F8)'. Below the toolbar, the 'Debug' window shows the application state: 'WorkShop01.elf [Embedded C/C++ Application]' is expanded to show 'Thread #1 <main> (Suspended : Breakpoint)' at 'main() at main.c:109 0x80002be'. The main editor window displays the source code for 'main.c', with line 109, 'HAL_Init();', highlighted. The bottom status bar shows '109:1'.

Test MC Application by blue USER button

- To run the motor, click on the blue USER button
- To stop click again

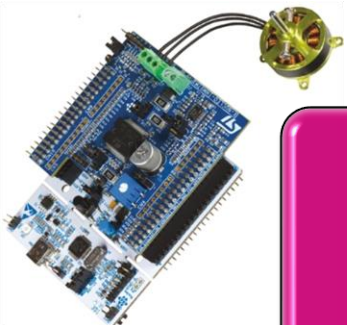


User Button



Motor Control Development Workflow

#3 – System Configuration 23



Hardware Setup

Motor Characterization

Electrical Model

R_s 533.97 mΩ L_s 35.6 μH

V_{BUS} 12.07 V

I_{max} 1.15 A

K_e 0.85 Vrms/kRPM

Mechanical Model

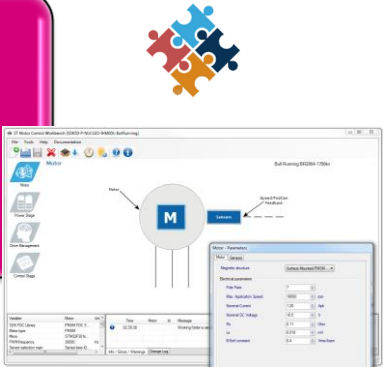
Friction 549.51 nN·m·s

Inertia 356.08 nN·m·s²

Max Speed 14.62 kRPM

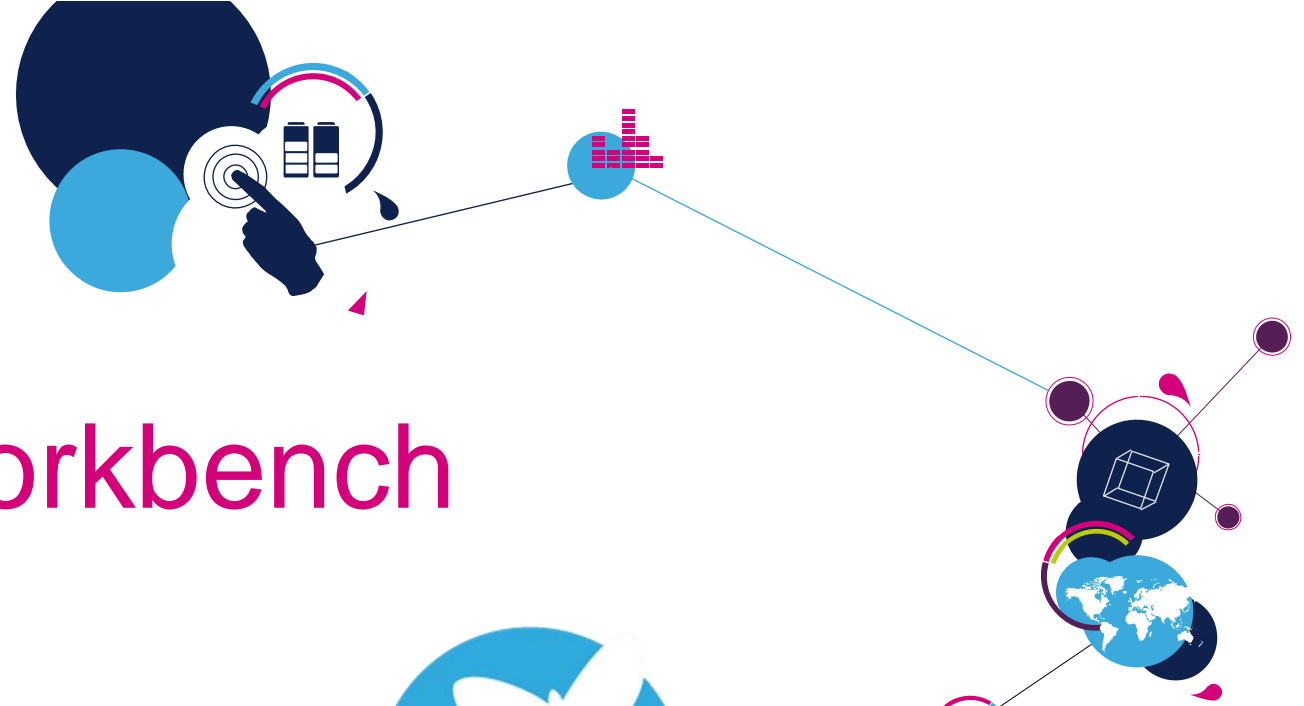
Motor Profiler
Motion Control Suite

System Configuration
Motor Control Workbench



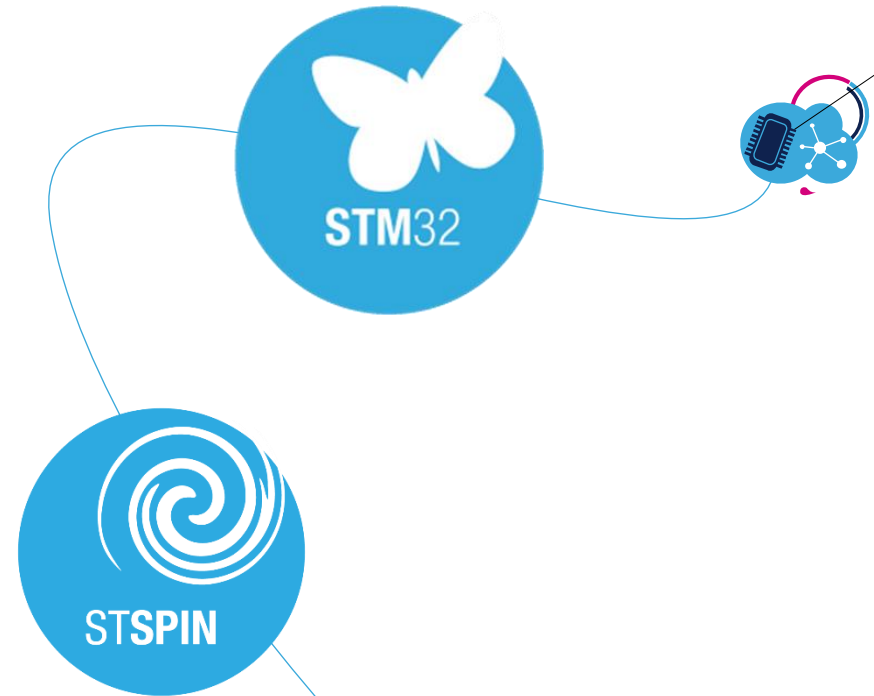
Project Configuration
CubeMX & IDE





ST Motor Control Workbench

Theory





Motor Control Workbench Splashpage

- List of example projects
- Motor Profiler button
- New project
- Load exist project
- About and Help

The screenshot shows the ST Motor Control Workbench splashpage. At the top, there are four navigation buttons: 'New Project', 'Load Project', 'About', and 'Help'. To the right is the 'Motor Profiler' logo. Below these are two tables: 'Recent Projects' and 'Example Projects'. The 'Example Projects' table is highlighted with a red border.

Filename	Type	MCUs	control board	power board	motor
WorkShop01.stmcx	SINGLE	STM32F303xE	NUCLEO-F303RE	X-NUCLEO-IHM16M1	GimBal
MCSDKv5.1.0_18216-IHM042-Shinano-Shinano.stmcx	DUAL	STM32F303xB	STEVAL-IHM042V1	STEVAL-IHM042V1	Shinano LA052-080E3NL1
SDK510-STM32F072EVAL-IHM28-HV_motor.stmcx	SINGLE	STM32F072x	STM32072B-EVAL	STEVAL-IHM028V2	Custom
SDK503-STM32F072EVAL-IHM28-HV_motor.stmcx	SINGLE	STM32F072x	STM32072B-EVAL	STEVAL-IHM028V2	Custom
Noname.stmcx	SINGLE	STM32F072x	NUCLEO-F072RB	X-NUCLEO-IHM07M1	Shinano LA052-080E3NL1

Filename	Type	MCUs	control board	power board	motor
NUCLEO-F303RE-X-NUCLEO-IHM16M1-GimBal	SINGLE	STM32F303xE	NUCLEO-F303RE	X-NUCLEO-IHM16M1	GimBal
NUCLEO-F302R8-X-NUCLEO-IHM08M1-Shinano	SINGLE	STM32F301x6/8 - STM32F302x6/8	NUCLEO-F302R8	X-NUCLEO-IHM08M1	Shinano LA052-080E3NL1
NUCLEO-F303RE-IPM05F-Shinano	SINGLE	STM32F303xE	NUCLEO-F303RE	STEVAL-IPM05F	Shinano LA052-080E3NL1
NUCLEO-F303RE-IPM10B-Shinano	SINGLE	STM32F303xE	NUCLEO-F303RE	STEVAL-IPM10B	Shinano LA052-080E3NL1
NUCLEO-F303RE-IPM15B-Shinano	SINGLE	STM32F303xE	NUCLEO-F303RE	STEVAL-IPM15B	Shinano LA052-080E3NL1
NUCLEO-F303RE-X-NUCLEO-IHM07M1-BullRunning	SINGLE	STM32F303xE	NUCLEO-F303RE	X-NUCLEO-IHM07M1	Bull Running BR2804-1700kv
NUCLEO-F303RE-X-NUCLEO-IHM08M1-Shinano	SINGLE	STM32F303xE	NUCLEO-F303RE	X-NUCLEO-IHM08M1	Shinano LA052-080E3NL1
P-NUCLEO-IHM001-BullRunning	SINGLE	STM32F301x6/8 - STM32F302x6/8	P-NUCLEO-IHM001 3Sh - board: NUCLEO-F302R8	P-NUCLEO-IHM001 3Sh - board: X-NUCLEO-IHM07M1	Bull Running BR2804-1700kv
P-NUCLEO-IHM001-Shinano	SINGLE	STM32F301x6/8 - STM32F302x6/8	P-NUCLEO-IHM001 3Sh - board: NUCLEO-F302R8	P-NUCLEO-IHM001 3Sh - board: X-NUCLEO-IHM07M1	Shinano LA052-080E3NL1
STM3240G-EVAL-IHM023V3-Allen Bradley	SINGLE	STM32F4xx	STM3240G-EVAL	STEVAL-IHM023V3	Allen Bradley TL-A220P-HJ32AN
STM3240G-EVAL-IHM023V3-Shinano	SINGLE	STM32F4xx	STM3240G-EVAL	STEVAL-IHM023V3	Shinano LA052-080E3NL1
STM32303E-EVAL-IHM045V1-Shinano-DUAL-DRIVE	DUAL	STM32F303xE	STM32303E-EVAL	STEVAL-IHM045V1	Shinano LA052-080E3NL1
STM32303E-EVAL-IHM045V1-Shinano-SINGLE-DRIVE	SINGLE	STM32F303xE	STM32303E-EVAL	STEVAL-IHM045V1	Shinano LA052-080E3NL1
STEVAL-SPIN3201-Shinano-SINGLE-DRIVE	SINGLE	STSPIN32F0	STEVAL-SPIN3201	STEVAL-SPIN3201	Shinano LA052-080E3NL1





Motor Characteristics

The screenshot displays the ST Motor Control Workbench interface. At the top, the title bar reads "ST Motor Control Workbench [Noname]*". Below it are menu options: File, Tools, Help, Documentation. A toolbar contains icons for file operations and help. The main area shows the configuration: Motor: GimBal, Control Board: NUCLEO-F303RE, Power Board: X-NUCLEO-IHM16M1. The ST logo and "life.augmented" text are in the top right.

The "Motor - Parameters" dialog box is open, showing the "Sensors" tab. The "Magnetic structure" is set to "Surface Mounted PMSM". The "Electrical parameters" section includes:

Parameter	Value	Unit
Pole Pairs	7	
Max. Application Speed	1632	rpm
Nominal Current	1.50	Apk
Nominal DC Voltage	12.0	V
Rs	5.48	Ohm
Ls	1.097	mH
B-Emf constant	4.9	Vms/krpm
Inertia	0.288	uN*m*s ²
Friction	0.630	uN*m*s

Below the parameters is a small motor icon. At the bottom of the dialog are "Save parameters" and "Done" buttons, with a red arrow pointing to the "Done" button.

To the right, a control block diagram shows a motor (M) connected to several sensing blocks: Bus Voltage Sensing, Dissipative Brake, Temperature Sensing, Current Sensing, Over Current Protection, and Speed Sensing. A red arrow points from the parameter dialog towards the motor. The diagram also shows a "Sensorless Main" block and a dashed line connecting to the "Speed Sensing" block.

At the bottom of the window, a status bar contains the following text: "FW for SDK5.x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa... is not supported in the FW for SDK5.x. All parameters will be disabled. FW for SDK5.x mcus are not supported in the FW for SDK5.x".



Motor Characteristics

The screenshot shows the ST Motor Control Workbench interface. At the top, the title bar reads "ST Motor Control Workbench [Noname]*". Below it is a menu bar with "File", "Tools", "Help", and "Documentation". A toolbar contains various icons for file operations and motor control. The main area displays the motor configuration: "Motor: GimBal", "Control Board: NUCLEO-F303RE", and "Power Board: X-NUCLEO-IHM16M1".

The "Motor - Parameters" dialog box is open, showing the "Sensors" tab. It includes the following settings:

- Hall sensors
 - Sensors displacement: 120 deg
 - Placement electrical angle: 300 deg
- Quadrature encoder
 - Pulses per mechanical revolution: 400

At the bottom of the dialog, there are "Save parameters" and "Done" buttons. A large red arrow points to the "Done" button.

To the right of the dialog is a circuit diagram showing a motor (M) with three phase lines (U, V, W) and a ground connection. The diagram includes several sensing blocks: "Bus Voltage Sensing" (checked), "Dissipative Brake", "Temperature Sensing" (checked), "Current Sensing", "Over Current Protection" (checked), and "Speed Sensing" (dashed line). The "Sensorless Main" block is also visible.

At the bottom right, there is a text area with the following content:

FW for SDK5x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa...
is not supported in the FW for SDK5x. All parameters will be disabled.
FW for SDK5x
mcus are not supported in the FW for SDK5x



Power Stage - PFC

ST Motor Control Workbench [Noname]*

File Tools Help Documentation

Motor: *GimBal* - Control Board: *NUCLEO-F303RE* - Power Board: *X-NUCLEO-IHM16M1*

Control Unit

- Firmware Drive Management
- MCU and Clock Freq.
- Digital I/O
- DAC functionality
- Analog Input and Protection

Drivers: Phase U, Phase V, Phase W

Rated Bus Voltage: 12 V (5 - 36 V)

Bus Voltage Sensing, Dissipative Brake, Temperature Sensing, Current Sensing, Over Current Protection, Speed Sensing

Variable	Motor	Unit
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Time	Motor	Id	Message
09:17:07			The 'PFC' is not supported in the FW for SDK5.x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa...
09:17:07			The 'Sensor-less (HFI+Observer)' is not supported in the FW for SDK5.x. All parameters will be disabled.
09:17:07			F2 mcus are not supported in the FW for SDK5.x
09:17:07			F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x

Info / Errors / Warnings Change Log





Power Stage – Inrush Current Limiter

The screenshot shows the ST Motor Control Workbench interface. A red arrow points to the 'Inrush Current Limiter' component in the hardware schematic. Another red arrow points to the 'Done' button in the configuration dialog. The dialog is titled 'Inrush Current Limiter' and contains the following settings:

- Hardware Settings:**
 - Polarity: Active low
- Additional Features:**
 - enable
 - Power on state: Active
 - Change state after: 1000 ms

At the bottom of the interface, there is a table with the following data:

Variable	Motor	Uni
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Below the table is a log window with the following entries:

Time	Motor	Id	Message
09:17:07			The 'PFC' is not supported in the FW for SDK5.x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa...
09:17:07			The 'Sensor-less (HFI+Observer)' is not supported in the FW for SDK5.x. All parameters will be disabled.
09:17:07			F2 mcus are not supported in the FW for SDK5.x
09:17:07			F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x



Power Stage - Correct Rated Bus Voltage

ST Motor Control Workbench [Noname]*

Motor: *GimBal* - Control Board: *NUCLEO-F303RE* - Power Board: *X-NUCLEO-IHM16M1*

Rated Bus Voltage: 12 V (5 - 36) V

Power Stage - Rated Bus Voltage Info

Rated Voltage

Min rated voltage: 6 V

Max rated voltage: 36 V

Nominal voltage: 12 V

Done

Variable	Motor	Unit
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Time	Motor	Id	Message
09:17:07			The 'PFC' is not supported in the FW for SDK5.x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa...
09:17:07			The 'Sensor-less (HFI+Observer)' is not supported in the FW for SDK5.x. All parameters will be disabled.
09:17:07			F2 mcus are not supported in the FW for SDK5.x
09:17:07			F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x



Power Stage - Bus Voltage Sensing

The screenshot shows the ST Motor Control Workbench interface. A dialog box titled "Power Stage - Bus Voltage Sensing" is open, showing a circuit diagram divided into a "Power Stage" and a "Control Stage".

Power Stage: A circuit diagram showing a bus voltage V_{Bus} connected to a resistor R_1 (180.00 kOhm). The other end of R_1 is connected to a second resistor R_2 (12.00 kOhm), which is connected to ground. The node between R_1 and R_2 is labeled V_{Bus} feedback. A third resistor R_3 is shown in parallel with R_2 and ground, with a checkbox next to it.

Control Stage: A block diagram of a motor driver (6M1) with a motor (M). The driver has three phases (U, V, W) and a common ground. The motor is connected to the driver's output. The driver is connected to a bus voltage V_{Bus} (5-36V). The driver has several sensing inputs: Bus Voltage Sensing, Dissipative Brake, Temperature Sensing, Current Sensing, Over Current Protection, and Speed Sensing. The motor has a "Sensorless Main" input.

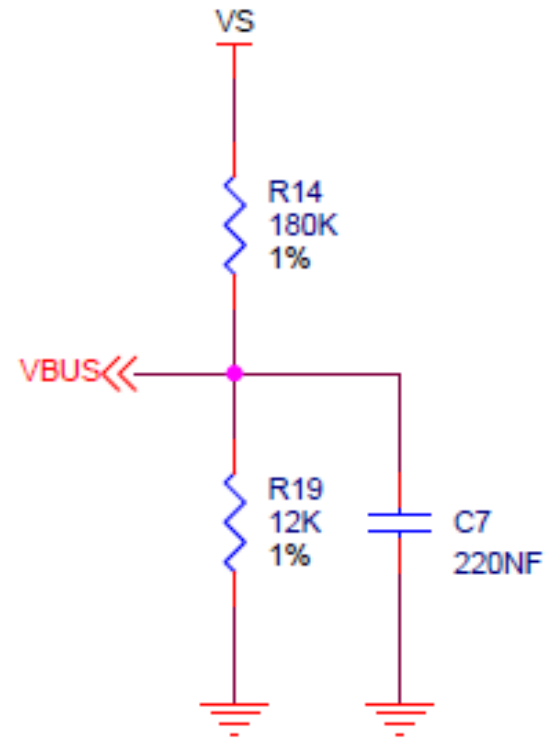
The dialog box has a "Bus voltage divider 1/..." field set to 16.00 and a "Done" button. A red arrow points from the "Done" button to the "Bus Voltage Sensing" block in the main diagram.

At the bottom of the window, there is a status bar with the following text:

- Torque&Flux - Execution rate 1 PW
- Bus voltage sensing true
- Info / Errors / Warnings Change Log
- 09:17:07 F2 mcus are not supported in the FW for SDK5.x
- 09:17:07 F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x



X-Nucleo-IHM16M1 Schematic, VBus





Power Stage – Temperature Sensing

The screenshot displays the ST Motor Control Workbench interface. On the left, a 'Temperature Sensing' configuration dialog is open, showing hardware settings and firmware protection options. A red arrow points from the 'Done' button in the dialog to the 'Temperature Sensing' block in the main diagram. The diagram shows a motor control circuit with various sensing blocks: Bus Voltage Sensing, Dissipative Brake, Temperature Sensing, Current Sensing, Over Current Protection, and Speed Sensing. A red arrow also points from the 'Temperature Sensing' block to a photograph of a physical motor control board on the right, where a component is circled in red.

Temperature Sensing Hardware Settings:

- Temperature sensing - V0: 579 mV
- Temperature sensing - T0: 25.0 °C
- $\Delta V/\Delta T$: 27.4 mV/°C
- Max working temperature on sensor: 110 °C

Firmware protection:

- Enable
- Over-Temperature:**
 - Set intervention threshold to power stage max working temperature
 - Over-temperature threshold: 110 °C
 - Hysteresis: 10 °C

Power Stage – Over Current Sensing

The screenshot displays the ST Motor Control Workbench interface. The main window shows a power stage diagram with a motor (M) and various sensing blocks: Bus Voltage Sensing, Dissipative Brake, Temperature Sensing, Current Sensing, Over Current Protection, and Speed Sensing. The bus voltage is set to 12 V (5 - 36 V). The motor is connected to three phases: Phase U (blue), Phase V (red), and Phase W (green). A red arrow points from the 'Over Current Protection' block in the diagram to the configuration dialog.

Power Stage - Over Current Protection

Over Current Protection

Comparator threshold: 0.50 V

Over current network gain: 0.3300 V/A

Expected over-current threshold: 1.5152 A

Over-current feedback signal polarity: Active low

More >>

Done

Variable	Motor	Uni
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Time	Motor	Id	Message
09:17:07			The 'PFC' is not supported in the FW for SDK5.x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa...
09:17:07			The 'Sensor-less (HFI+Observer)' is not supported in the FW for SDK5.x. All parameters will be disabled.
09:17:07			F2 mcus are not supported in the FW for SDK5.x
09:17:07			F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x



Power Stage – Current Sensing

Amplifying Network Gain Calculator

Parameters

Name	Value	Unit	Description
Imax	1.00	A	Desired maximum current
Vm	3.3	V	Reference voltage
R-shunt	0.330	Ohm	Shunt resistor value
P-rating	0.5	W	Shunt resistor maximum power rating
R1	680	Ohm	Resistance of the offset network
R2	2200	Ohm	Resistance of the feedback network
R4	2200	Ohm	"Non-inverting" feedback resistor
R5	2200	Ohm	"Non-inverting" feedback resistor
Vmcpu	3.3	V	MCU voltage

Result

Name	Value	Unit	Description
Overall gain	1.528		Overall gain of the amplifying network
Offset network attenuation	0.764		Signal attenuation due to the offset network
Op-amp gain	2.000		Gain of the operational amplifier
Vout (polarization)	1.559	V	Opamp output voltage (polarization)
Min Vout	1.055	V	Opamp output voltage (minimum)
Max Vout	2.063	V	Opamp output voltage (maximum)
Power dissipated on shunt	0.083	W	Power dissipated on the shunt resistor

Buttons: Export, Confirm, Cancel

Power Stage - Current Sensing

Current sensor and signal condition: **Three Shunt Resistors**

Current reading topology: **Three Shunt Resistors**

ICS gain: **Three Shunt Resistors**

Two Insulated Current Sensors

Shunt resistor(s) value: 0.330 ohm

Amplification on board:

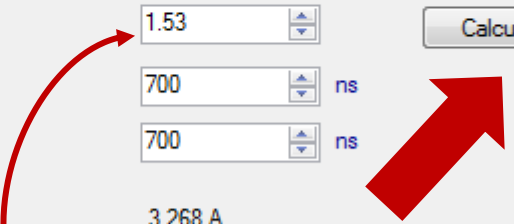
Amplifying network gain: 1.53

T-rise: 700 ns

T-noise: 700 ns

Max Readable Current: 3.268 A

Buttons: Calculate, Done





Power Stage – Power Switches

The screenshot shows the ST Motor Control Workbench interface. At the top, it displays the motor and board information: Motor: GimBal, Control Board: NUCLEO-F303RE, Power Board: X-NUCLEO-IHM16M1. The main diagram illustrates the power stage, including an AC input with an inrush current limiter and a PFC (Power Factor Correction) stage. The bus voltage is set to 12V (5-36V). The power stage consists of a three-phase inverter with six power switches (IGBTs or MOSFETs) and a motor (M). Various sensing and protection blocks are shown, including Bus Voltage Sensing, Dissipative Brake, Temperature Sensing, Current Sensing, Over Current Protection, and Speed Sensing. A red box highlights the power switches, and a red arrow points from the configuration dialog box to the 'Done' button.

Power Stage - Power Switches

Min dead-time: 700 ns
Max switching frequency: 50 kHz

Done

Variable	Motor	Unit
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Time	Motor	Id	Message
09:17:07			The 'PFC' is not supported in the FW for SDK5x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa...
09:17:07			The 'Sensor-less (HFI+Observer)' is not supported in the FW for SDK5x. All parameters will be disabled.
09:17:07			F2 mcus are not supported in the FW for SDK5x
09:17:07			F103 High Density in dual Motor mcus are not supported in the FW for SDK5x



Power Stage – Driving Signals

ST Motor Control Workbench [Noname]*

File Tools Help Documentation

Motor: *GimBal* - Control Board: *NUCLEO-F3*

AC Input Info
Inrush Current Limiter
Co
Drive
MCU and Clock Freq.
DAC functionality

Power Stage - Driving Signals Polarity - U Driver

High side driving signal
Polarity: Active high

Low side driving signal
Complemented from high side:
Polarity: Active high
HW inserted dead time: 800 ns

Driver enabling signal
signal:
Polarity: Active high

Force same values for U,V,W Driver
 Share signal enable
 use STGAP1S gap drive

Done

Variable	Motor	Uni
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Info / Errors / Warnings Change Log



Drive Management – Speed Position

ST Motor Control Workbench [Noname]*

File Tools Help Documentation

Motor: *GimBal* - Control Board: *NUCLEO-F303RE* - Power Board:

AC Input Info
Inrush Current Limiter
PFC

Control Unit

Firmware Drive Management

MCU and Clock Freq. Digital I/O

DAC functionality Analog Input and Protection

Variable Motor Uni
PWM frequency 30000 Hz
Sensor selection main Sensor-less (O...
Sensor selection aux Sensor-less (O...
Torque&Flux - Execution rate 1 PW
Bus voltage sensing true

Time Motor
09:17:07
09:17:07
09:17:07
09:17:07

Info / Errors / Warnings Chan

Drive Management Position Feedback Management

Main sensor Auxiliary sensor

Enable auxiliary sensor

Sensor selection Sensor-less (Observer+Cordic)

Max measurement errors number before fault 3

Observer+Cordic

Variance threshold 400.0 %
Average speed FIFO depth for speed loop 64
Average speed FIFO depth for observer equations 64
B-emf consistency tolerance 100.00 %
B-emf consistency gain 100.00 %
Maximum application acceleration 6000 rpm/s
B-emf quality factor 0.017

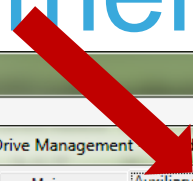
Manual editing enabled

Observer

G1 -22530
G2 18682

Back compatibility

Done





Drive Management – User Interface

ST Motor Control Workbench [Noname]*

File Tools Help Documentation

Motor: *GimBal* - Control Board: *NUCLEO-F303RE*

AC Input Info
Inrush Current Limiter

Control
Firmware Drive Manage
MCU and Clock Freq.
DAC functionality

User Interface

HW / Features MCU Pins

LCD ⓘ

- Available on Control Board
- Enable
 - Full
 - Light

Start/Stop Button

- Available on Control Board
- Enable

Serial Communication

- Available on Control Board
- Enable
 - Bidirectional
 - Fast unidirectional

CH1 M1 Ia

CH2 Ia

Done

Variable	Motor	Uni
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Info / Errors / Warnings Change Log



Drive Management – User Interface

ST Motor Control Workbench [Noname]*

File Tools Help Documentation

Motor: *GimBal* - Control Board: *NUCLEO-F303RE* - Power Board

AC Input Info
Inrush Current Limiter

Control Unit

Firmware Drive Management

MCU and Clock Freq. Digital I/O

DAC functionality Analog Input and Protection

Variable Motor Uni
PWM frequency 30000 Hz
Sensor selection main Sensor-less (O...
Sensor selection aux Sensor-less (O...
Torque&Flux - Execution rate 1 PW
Bus voltage sensing true

Time Motor
09:17:07
09:17:07
09:17:07
09:17:07

User Interface

HW / Features **MCU Pins**

Reserved MCU pins for user interface (LCD, joystick and user button)

STM32100B-EVAL	PB2, PB9, PB13-PB15, PD7, PD8, PD12, PD14, PD15, PE0, PE1
STM3210B-EVAL	PB2, PB9, PB13-PB15, PD7, PD8, PD12, PD14, PD15, PE0, PE1
STM3210E-EVAL	PD0, PD1, PD3-PD5, PD8-PD10, PD14, PD15, PE7-PE15, PF0, PG7, PG8, PG12-PG1
STM322xG-EVAL	PA0, PB6, PB9, PC10, PC11, PD0-PD15, PF8, PG10, PG12, PG15, PI2, PI8
STM324xG-EVAL	PA0, PB6, PB9, PC10, PC11, PD0-PD15, PF8, PG10, PG12, PG15, PI2, PI8
STM320518-EVAL	PA0, PA5, PA7, PB4, PB8, PC6-PC9, PF4
STM32303C-EVAL	PB5, PB14, PB15, PC13, PD5, PD6, PE0, PE6, PE7, PF9
STEVAL-IHM022V1	PB2, PB13-PB15, PD7, PD15, PG7, PG8, PG12, PG13, PG15
STEVAL-IHM039V1	PB2, PC10-PC12, PD7, PD11, PG0-PG7

Done

F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x



Drive Management – Start Up

ST Motor Control Workbench [Noname]*

File Tools Help Documentation

Motor: GimBal - Control Board: NUCLEO-F303RE

AC Input Info
Inrush Current Limiter

Control

Firmware
Drive Management

Start-up

MCU and
Clock Frequency

Additional

Sensors

DAC functionality

Variable Motor Uni
PWM frequency 30000 Hz
Sensor selection main Sensor-less (O...
Sensor selection aux Sensor-less (O...
Torque&Flux - Execution rate 1 PW
Bus voltage sensing true

Drive Management - Start-up parameters

Sensor-less rev-up settings

On-the-Fly startup

Profile

Basic
 Advanced customized

Include alignment before ramp-up

Duration 700 ms

Alignment electrical angle 90 deg

Final current ramp value 0.60 A

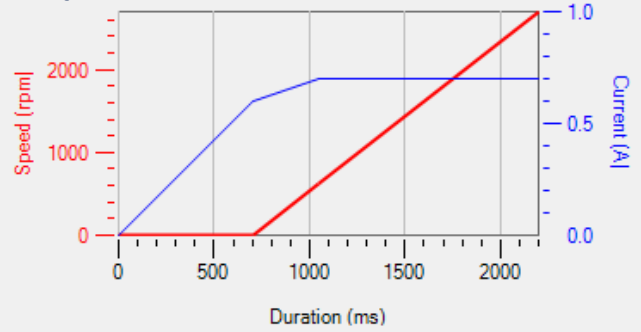

Speed ramp duration 1500 ms

Speed ramp final value 2700 rpm

Current ramp initial value 0.60 A

Current ramp final value 0.70 A

Current ramp duration 350 ms



Consecutive successful start-up output tests 2

Minimum start-up output speed 529 rpm

Estimated speed Band tolerance upper limit 106.25 %

Estimated speed Band tolerance lower limit 93.75 %

Rev-up to FOC switch-over

Enable

Duration 25 ms

Done



Drive Management – Start Up

ST Motor Control Workbench [Noname]*

Motor: GimBal - Control Board: ST-E303RE

AC Input Info
Inrush Current Limiter

Control

Firmware Drive Manag
Start-
Drive
MCU and Clock Freq Addit
Sensi
DAC functionality

Variable Motor Uni
PWM frequency 30000 Hz
Sensor selection main Sensor-less (O...
Sensor selection aux Sensor-less (O...
Torque&Flux - Execution rate 1 PW
Bus voltage sensing true

Drive Management - Start-up parameters

Sensor-less rev-up settings

On-the-Fly startup

Profile

Basic
 Advanced customized

Initial electrical angle 0 deg

	Duration (ms)	Final speed (rpm)	Final current (A)
1)	1000	0	1.50
2)	1176	588	1.50
3)	0	588	1.50
4)	0	588	1.50
5)	0	588	1.50

Execute sensor-less algorithm starting from 2

Consecutive successful start-up output tests 2

Minimum start-up output speed 529 rpm

Estimated speed Band tolerance upper limit 106.25 %

Estimated speed Band tolerance lower limit 93.75 %

Rev-up to FOC switch-over

Enable

Duration 25 ms

Done



Drive Management – Drive Settings

ST Motor Control Workbench [Noname]*

File Tools Help Documentation

Motor: GimBal - Control Board: NUCLEO-F303RE - Power Board: X-NUCLEO-IHM16M1

Drive Management - Drive Settings

PWM generation and current reading

PWM frequency: 30000 Hz

High sides PWM idle state: Turn-off

Low side signals and dead-time

SW inserted dead-time: 800 ns

Low sides PWM idle state: Turn-off

Speed regulator

Execution rate: 1.0 ms

3723 / 512 P
261 / 16384 I

Manual editing enabled

Default settings

Control mode: Speed control

Target speed: 529 rpm

Target stator current flux component: 0.00 A

Target stator current torque: 0.00 A

Torque and flux regulators

Execution rate: 1 PWM periods

Cut-off frequency: 6000 rad/s

Torque

3671 / 1024 P
2445 / 4096 I

Flux

3671 / 1024 P
2445 / 4096 I

Manual editing enabled

Info: Please, set the friction and inertia values in the Motor settings

Variable

- PWM frequency
- Sensor selection r
- Sensor selection a
- Torque&Flux - Exe
- Bus voltage sensin

Info / Errors / Warnings Change Log

Done



Drive Management – Additional Features

Motor: *GimBal* - Control Board: *NUCLEO-F303RE* - Power Board: *X-NUCLEO-IHM16M1*

AC Input Info
Inrush Current

PFC

Rated Bus Voltage
12 V (5 - 36 V)

Bus Voltage Sensing
Dissipative

Drive Management - Additional Features and PFC settings

- Flux weakening
- MTPA
- Feed Forward
- Sensorless speed feedback

Inrush Current Limiter

Done

Variable	Motor	Uni
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Time	Motor	Id	Message
09:17:07			The 'PFC' is not supported in the FW for SDK5.x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa...
09:17:07			The 'Sensor-less (HFI+Observer)' is not supported in the FW for SDK5.x. All parameters will be disabled.
09:17:07			F2 mcus are not supported in the FW for SDK5.x
09:17:07			F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x

Info / Errors / Warnings Change Log



Drive Management – Sensing Enabling

ST Motor Control Workbench [Noname]*

File Tools Help Documentation

Motor: GimBal - Control Board: NUCLEO-F303RE - Power Board: X-NUCLEO-IHM16M1

AC Input Info
Inrush Current Limiter
PFC
Rated Bus Voltage 12 V (5 - 36) V
Bus Voltage Sensing
Dissipative Brake

Drive Management - Sensing Enabling and Firmware Protections

DC Bus voltage sensing

- Enable
- Over-voltage**
 - Motor control
 - Enable
 - Set intervention threshold to power stage max rated voltage
 - Over-voltage threshold: 36 V
 - On over voltage: **Disable PWM generation**
 - On over-voltage, disable over-current protection by HW
- Under-voltage**
 - Enable
 - Set intervention threshold to power stage min rated voltage
 - Under-voltage threshold: 5 V
 - Disable PWM generation
 - Disable PWM generation
 - Switch on brake resistor
 - Turn on low side switches

Temperature Sensing AC Input Done

Variable
PWM frequency
Sensor selection main
Sensor selection aux
Torque&Flux - Execution rate
Bus voltage sensing true

09:17:07 F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x



Control Stage – MCU and CLK Selection

Motor: *GimBal* - Control B

Control Stage - MCU and Clock Frequency Selection

MCU selection

MCU TYPE: STM32F303xE

MCU package: LQFP64

Clock settings

Clock source: 8MHz External crystal/ceramic resonator

CPU frequency: 72 MHz

Supply voltage

Nominal MCU supply voltage: 3.30 V

Done

MCU selection dropdown list:

- STM32F303xE
- STM32F4xx
- STM32F303xB
- STM32F303xC
- STM32F303xE
- STM32F302xB
- STM32F302xC
- STM32F2xx
- STM32F103 High Density
- STM32F103 Medium Density
- STM32F103 Low Density
- STM32F100 Medium Density
- STM32F100 Low Density
- STM32F030x
- STM32F051x
- STM32F301x6/8 - STM32F302x6/8
- STM32F446xC-xE
- STM32F072x
- STM32F031x
- STSPIN32F0

Variable	Motor	Uni
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Time	Motor	Id	Message
09:17:07			The 'PFC' is not supported in the FW for SDK5.x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa...
09:17:07			The 'Sensor-less (HF1+Observer)' is not supported in the FW for SDK5.x. All parameters will be disabled.
09:17:07			F2 mcus are not supported in the FW for SDK5.x
09:17:07			F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x



Control Stage – Digital I/O

The screenshot displays the 'Control Stage - Digital I/O' configuration window in the ST Motor Control Workbench. The window is divided into several sections, each highlighted with a red border:

- Inverter driving signal selection:** Includes a 'Timer' dropdown set to 'TIM1', a 'Remap' dropdown set to 'Partial re-map', and a 'Pin Map' section with dropdowns for CH1 (A8), CH1N (A7), CH2 (A9), CH2N (B0), CH3 (A10), CH3N (B1), and BKIN2 (A11).
- Signal Enabler:** Features three channels (CH1, CH2, CH3) with 'Port' dropdowns set to 'GPIOC' and 'Pin' dropdowns set to 'C10', 'C11', and 'C12' respectively. A 'Share signal enable' checkbox is present at the bottom.
- Speed/position feedback:** Contains two sub-sections: 'Encoder interface' with 'Timer' (TIM2), 'Remap' (No remap), and 'Pin Map' (CH1: A15, CH2: B3); and 'Hall sensors interface' with 'Timer' (TIM2), 'Remap' (No remap), and 'Pin Map' (CH1: A15, CH2: B3, CH3: B10).
- Direct GPIO:** Includes 'DBO', 'ICL', and 'OCP disabling' sections, each with 'Port' (GPIOD) and 'Pin' (D5) dropdowns.
- PFC drive signal and feedback:** Includes 'Timer' (TIM3), 'auxiliary' dropdown, and 'Pin Map' for PWM (A7), AC Mains (A6), and OCS (D2).
- Serial communication:** Includes 'Channel' (USART2), 'Baudrate' (115200), 'Remap' (No remap), and 'Pin Map' for TX (A2) and RX (A3).
- Start/Stop Button GPIO:** Includes 'Port' (GPIOC), 'Pin' (C13), and 'Polarity' (Active low) dropdowns.

A red arrow points from the Start/Stop Button GPIO section towards a 'Done' button located at the bottom right of the configuration window.



Control Stage – DAC

ST Motor Control Workbench [Noname]*

Control Stage - DAC Functionality

DAC

CH1 Debug M1 **la** A4

CH2 Not used M1 lb -

Done

- la
- lb
- lalpha
- lbeta
- lq
- ld
- lq reference
- ld reference
- Vq
- Vd
- Valpha
- Vbeta
- Measured electrical angle
- Measured rotor speed
- Observer electrical angle (PLL)
- Observer rotor speed (PLL)
- Observer lalpha (PLL)
- Observer lbeta (PLL)
- Observer BEMF alpha (PLL)
- Observer BEMF beta (PLL)
- Observer electrical angle (CORDIC)
- Observer rotor speed (CORDIC)
- Observer lalpha (CORDIC)
- Observer lbeta (CORDIC)
- Observer BEMF alpha (CORDIC)
- Observer BEMF beta (CORDIC)
- User defined DAC 1
- User defined DAC 2
- HFI electrical angle
- HFI rotor speed

Variable	Motor	Uni
PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Time	Motor	Id	Message
09:17:07			The 'PFC' is not supported in the FW for SDK5.x excepted for SDK for 'STM32F103 High Density'. All parameters will be disa...
09:17:07			The 'Sensor-less (HFI+Observer)' is not supported in the FW for SDK5.x. All parameters will be disabled.
09:17:07			F2 mcus are not supported in the FW for SDK5.x
09:17:07			F103 High Density in dual Motor mcus are not supported in the FW for SDK5.x



Control Stage – Analog Input and Protection

ST Motor Control Workbench [Noname]*

File Tools Help Documentation

Motor: *GimBal* - Control Board: *NUCLEO*

AC Input In

Inrush Current Limiter

MCU Clock F

Variable Motor Unit

PWM frequency	30000	Hz
Sensor selection main	Sensor-less (O...	
Sensor selection aux	Sensor-less (O...	
Torque&Flux - Execution rate	1	PW
Bus voltage sensing	true	

Control Stage - Analog Input and Protection

Phase current feedback | Bus voltage feedback | **Temperature feedback** | PFC stage feedback

Sensing

Setting

Sampling Time: 7.5 ADC clk

Peripheral selection: ADC1

Pin map

ADC Channel: ADC12_IN8 (C2)

Done



Pin Check

The screenshot shows the ST Motor Control Workbench interface. The 'Pin Assignment' window is open, displaying a table of function-to-pin assignments. A red arrow points to the 'Check' button at the bottom of this window. Another red arrow points to the 'OK' button in a 'Pin assignment check ok!' dialog box that has appeared over the main interface.

Function	Port/Pin	Available port	Shared
Motor Control Timer (TIM1)			
CH1	A8	E9, A8	
CH2	A9	E11, A9	
CH3	A10	E13, A10	
BKIN	A11	C3, E14, A11	
Hall Sensors Interface Timer (TIM2)			
CH1	A15	A0, A5, A15...	
CH2	B3	A1, D4, B3	
CH3	B10	A2, B10, A9...	
Start/Stop button Pin (DIO - BTN)			
GPIO	C13	C13	
Driver Signal Enable (DIO - MCT - Enb)			
GPIO	C10	C10	
GPIO	C11	C11	
GPIO	C12	C12	
USART Channel (USART2)			
TX	A2	A2, A14, B3...	
RX	A3	A3, A15, B4...	
Phase current feedback ADC (ADC1/ADC2)			
ADC12_IN8	C2	C2	
ADC12_IN9	C3	C3	
ADC12_IN6	C0	C0	
Bus Voltage feedback ADC (ADC1)			
ADC1_IN2	A1	A1	
Temperature feedback ADC (ADC1)			
ADC12_IN8	C2	C2	
DAC (Debug)			
CH1	A4	A4	

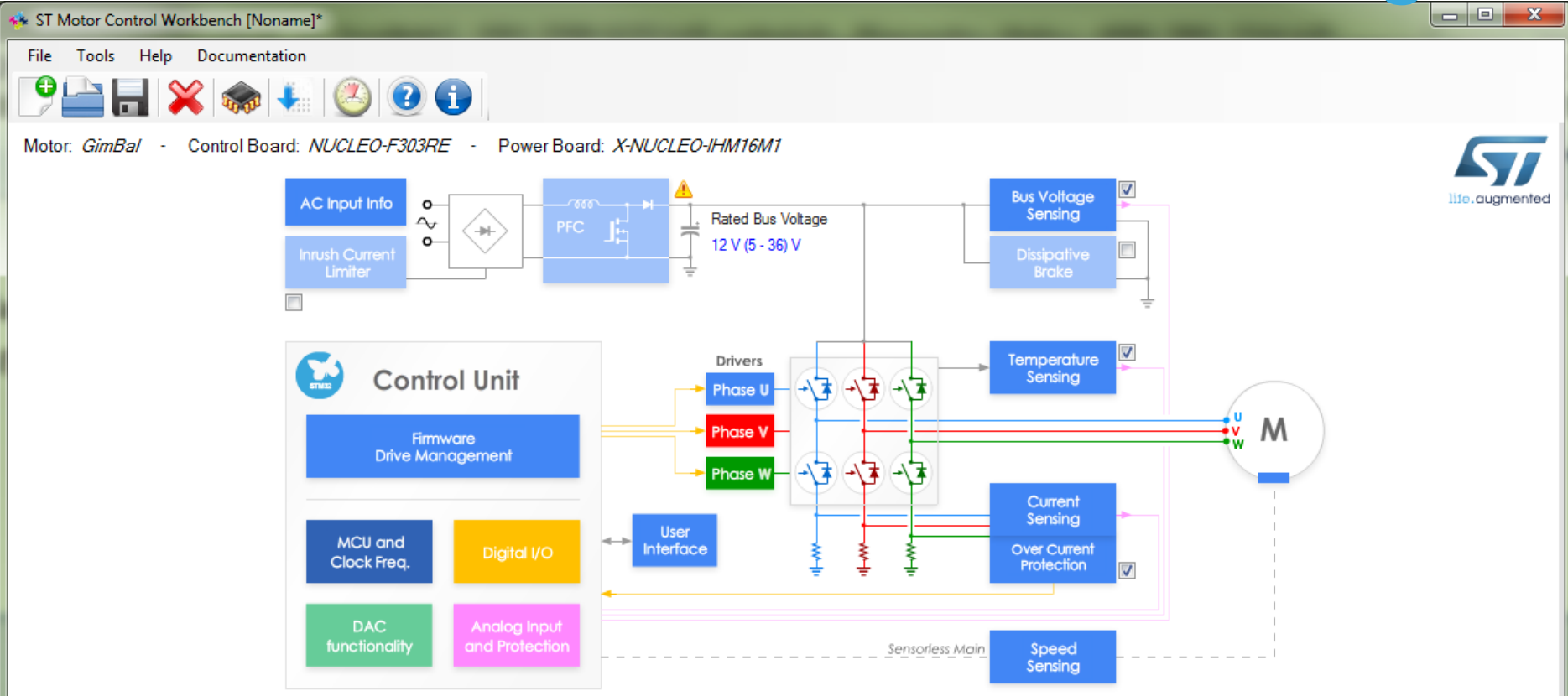
Conflicts:
-functions: 0
-pins: 1
Press check button for more information

Check Reset

Pin assignment check ok!
OK



Info, Error and Warning Log

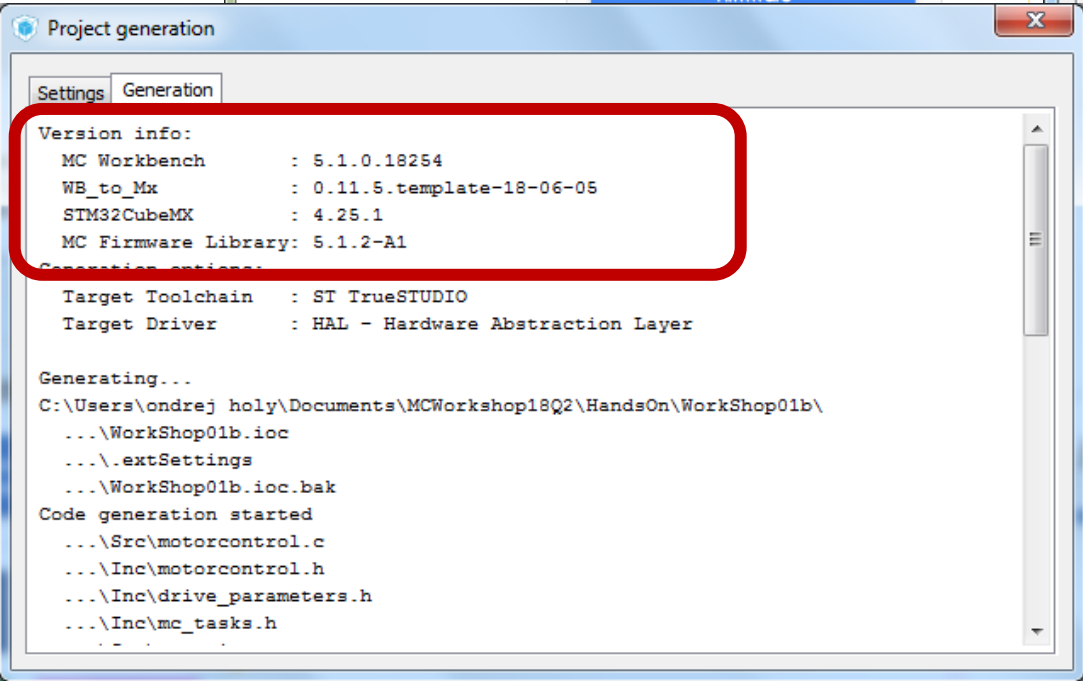
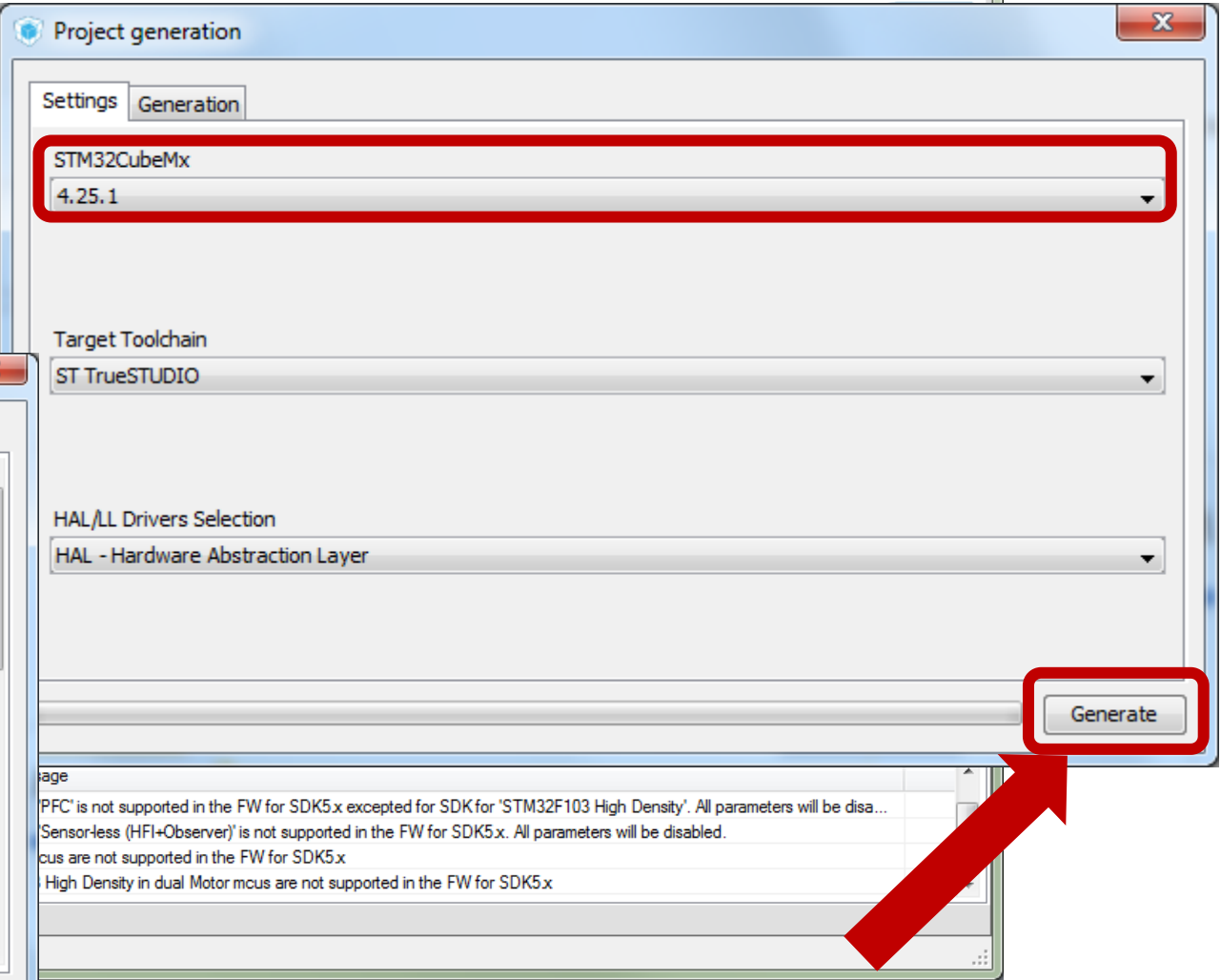
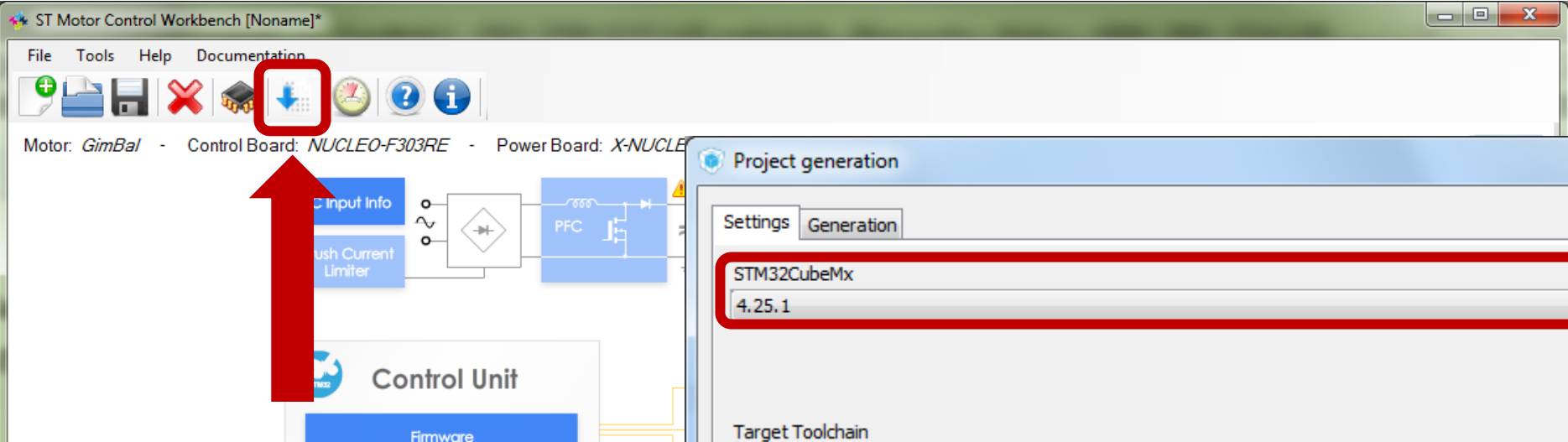


	Time	Motor	Id	Message
	11:18:38			Pin check done
	11:20:01	1		No over current protection selected
	11:20:33			C5 is used in: Phase current feedback ADC (ADC1/ADC2).ADC2_IN11, Bus Voltage feedback ADC (AD...

Info / Errors / Warnings Change Log



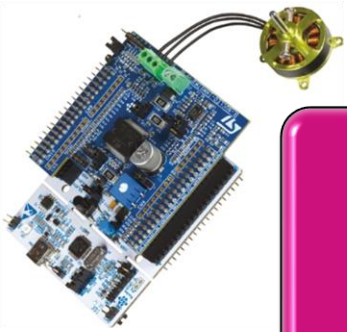
Generate Code





Motor Control Development Workflow

#4 – Project Configuration 60



Hardware Setup

Motor Characterization

Electrical Model

R_s 533.97 mΩ L_s 35.6 μH

V_{BUS} 12.07 V I_{max} 1.15 A

K_e 0.85 Vrms/kRPM

Mechanical Model

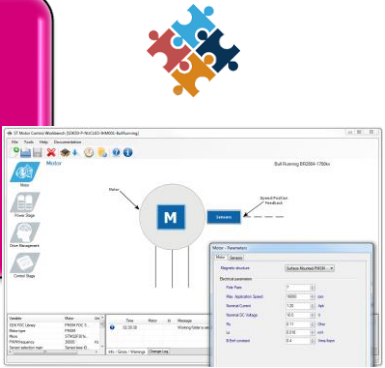
Friction 549.51 nN·m·s

Inertia 356.08 nN·m·s²

Max Speed 14.62 kRPM

Motor Profiler
Motion Control Suite

System Configuration
Motor Control Workbench



[Empty box]

[Empty box]

Project Configuration
CubeMX & IDE

