STM32 motor control firmware library

STM32 FOC PMSM SDK v3.0

Contents

Overview

STM32 FOC PMSM SDK v 3.0

Firmware library (free of charge)

- It implements the field oriented control (FOC) drive of 3-phase permanent magnet synchronous motors (PMSM), both surface mounted (SM-PMSM) and internal (I-PMSM)

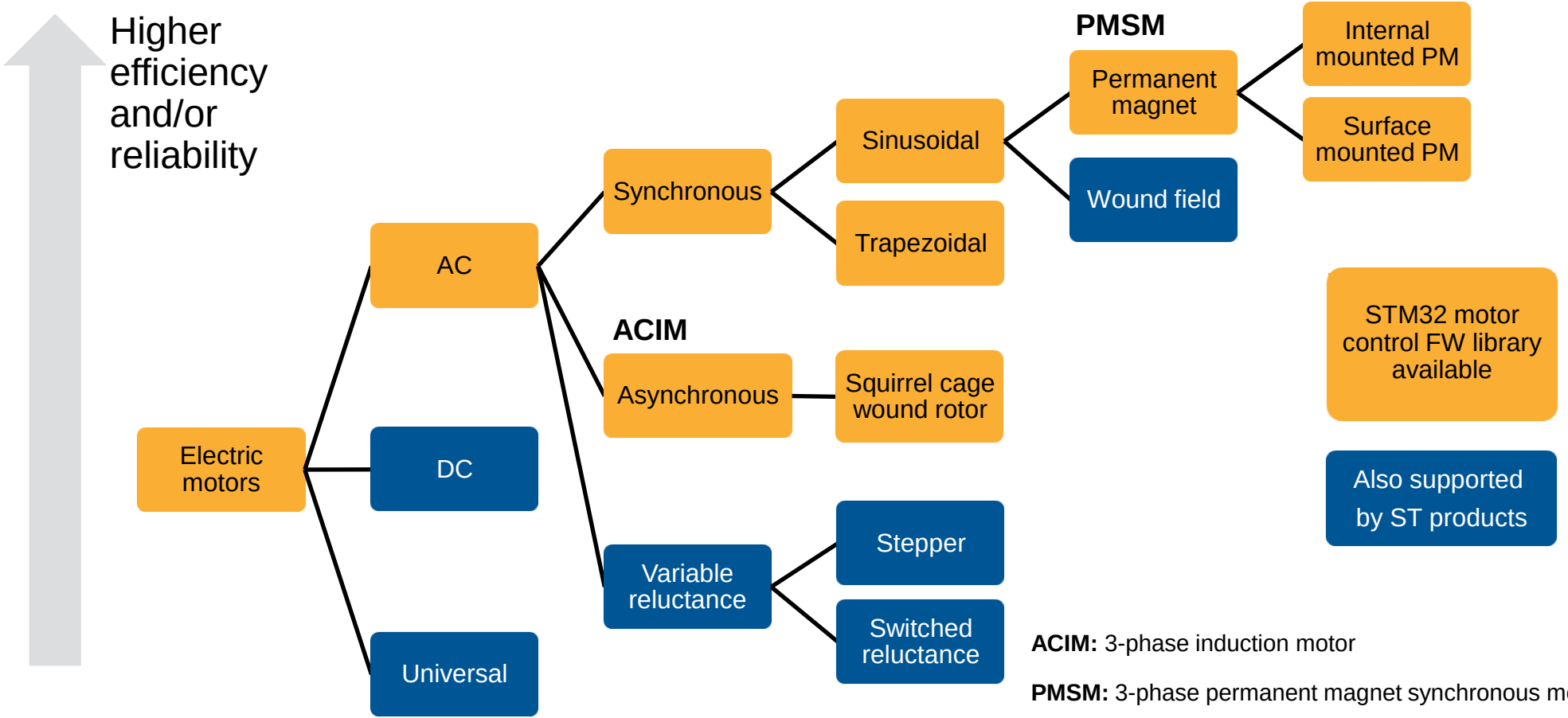
supporting

- STM32F103 microcontroller (STM32 performance line)
  - Medium-density devices (up to 256 Kbytes of Flash) or high-density devices (from 256 Kbytes to 1 Mbyte of Flash)
- STM32F100 microcontroller (STM32 value line)

in order to

- Quickly evaluate ST microcontrollers on 3-phase PMSM motor control applications
- Save time when developing motor control solutions to be run on ST microcontrollers

Electric motor control at ST

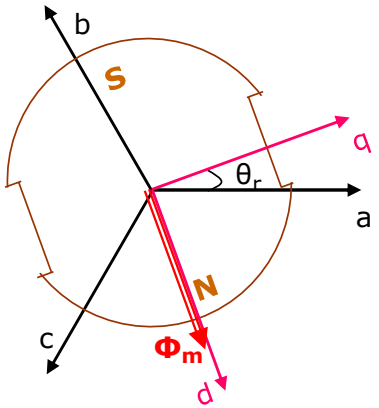


ACIM: 3-phase induction motor

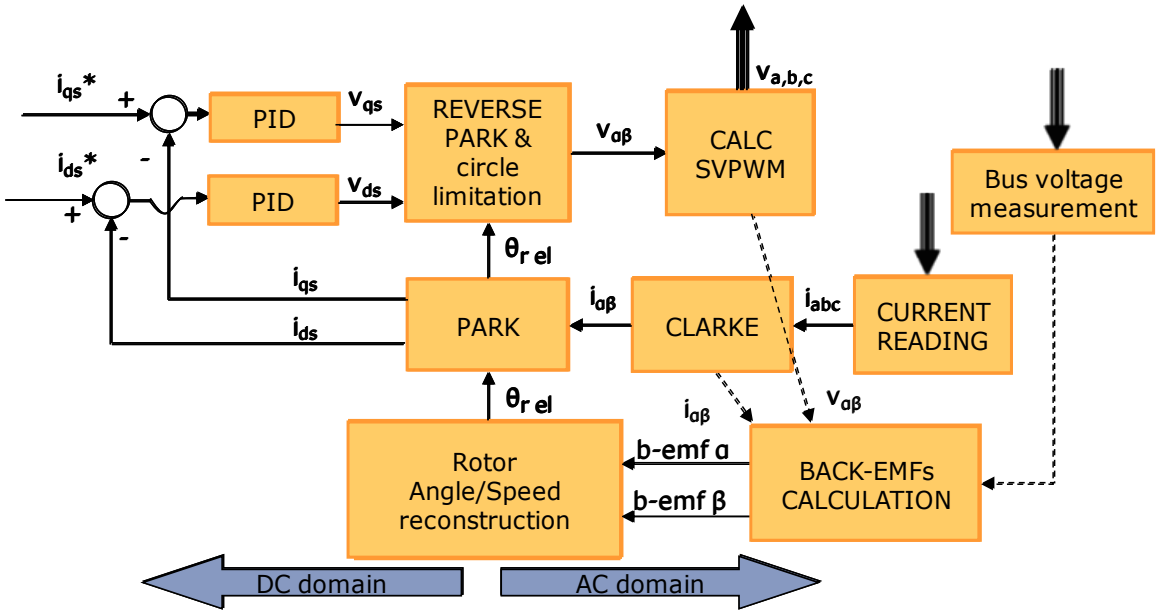
PMSM: 3-phase permanent magnet synchronous motor

Field oriented control (FOC)

- Mathematical technique used to achieve decoupled control of the flux and torque in a 3-phase motors



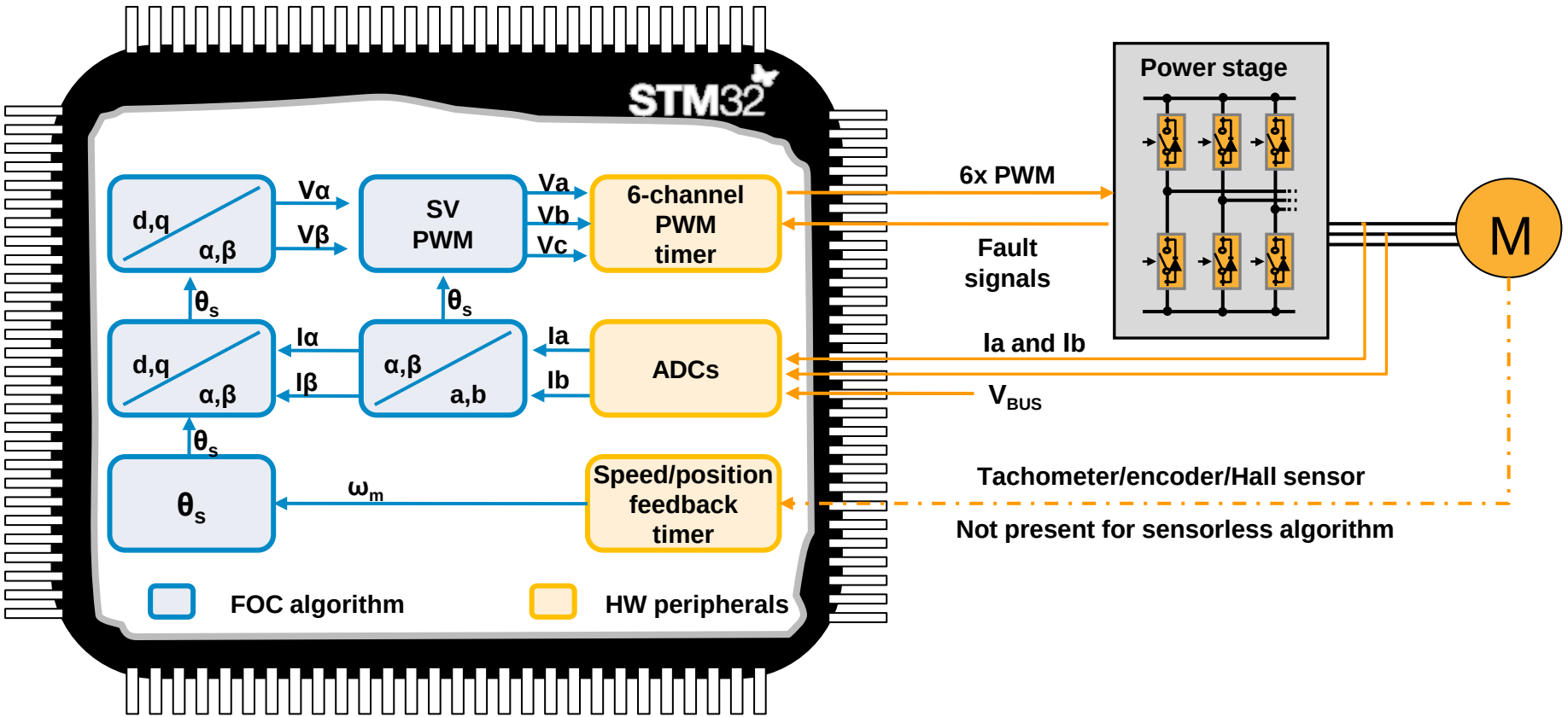
Block diagram of FOC algorithm example



Benefits of FOC

- Optimized efficiency even during transient operation
- Precise and responsive speed control to load variations
- Precise position control (through instantaneous torque control)
- Acoustical noise reduction due to precise control technique

FOC with STM32



STM32 FOC PMSM SDK v3.0 key features

Single/dual simultaneous vector control (FOC)
Any combination of current-reading topologies and speed or position sensors is supported

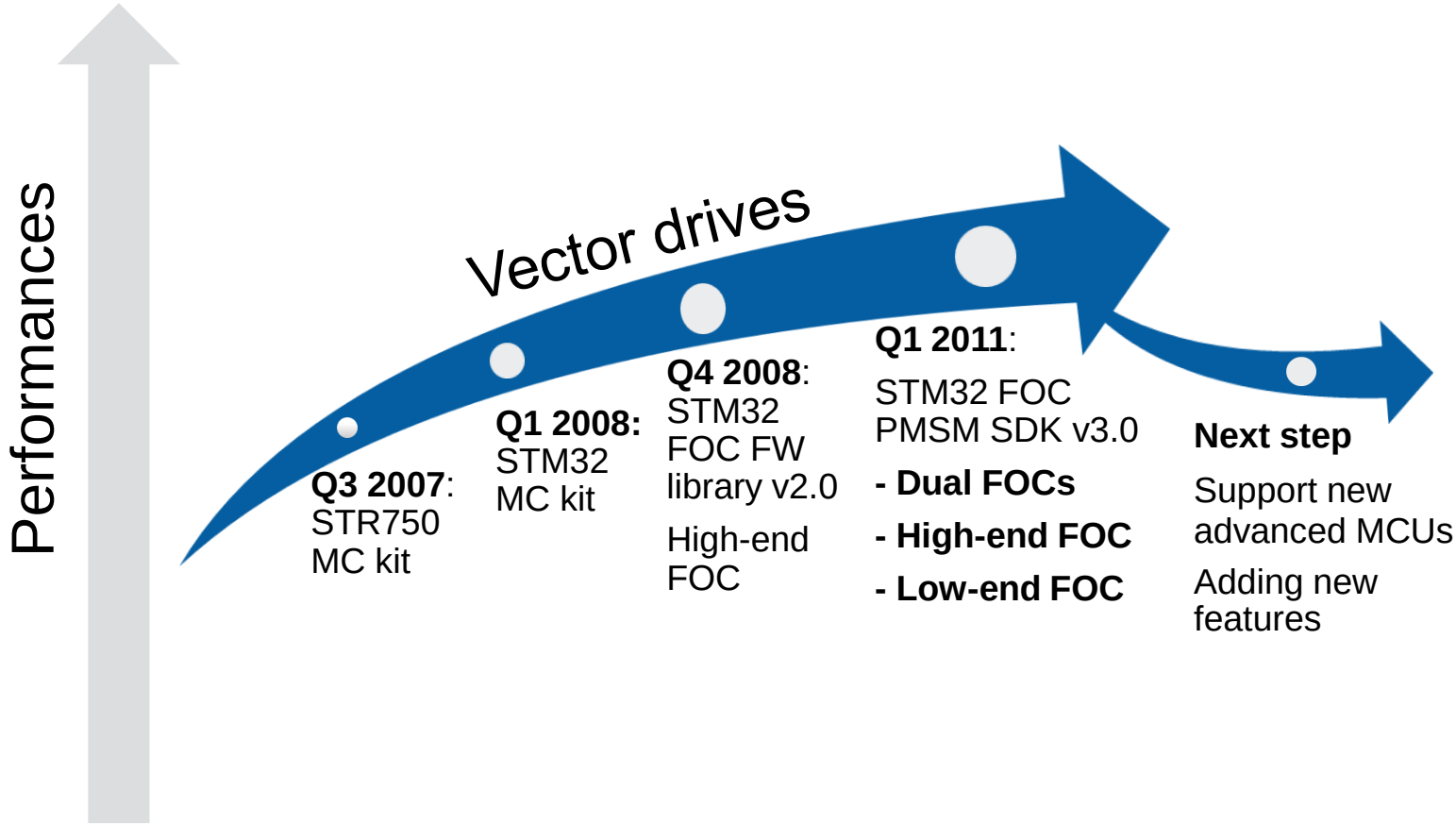
Supports both STM32F100x and STM32F103x families

Full customization through ST MC workbench (GUI)

Algorithm improvements compared to v2.0

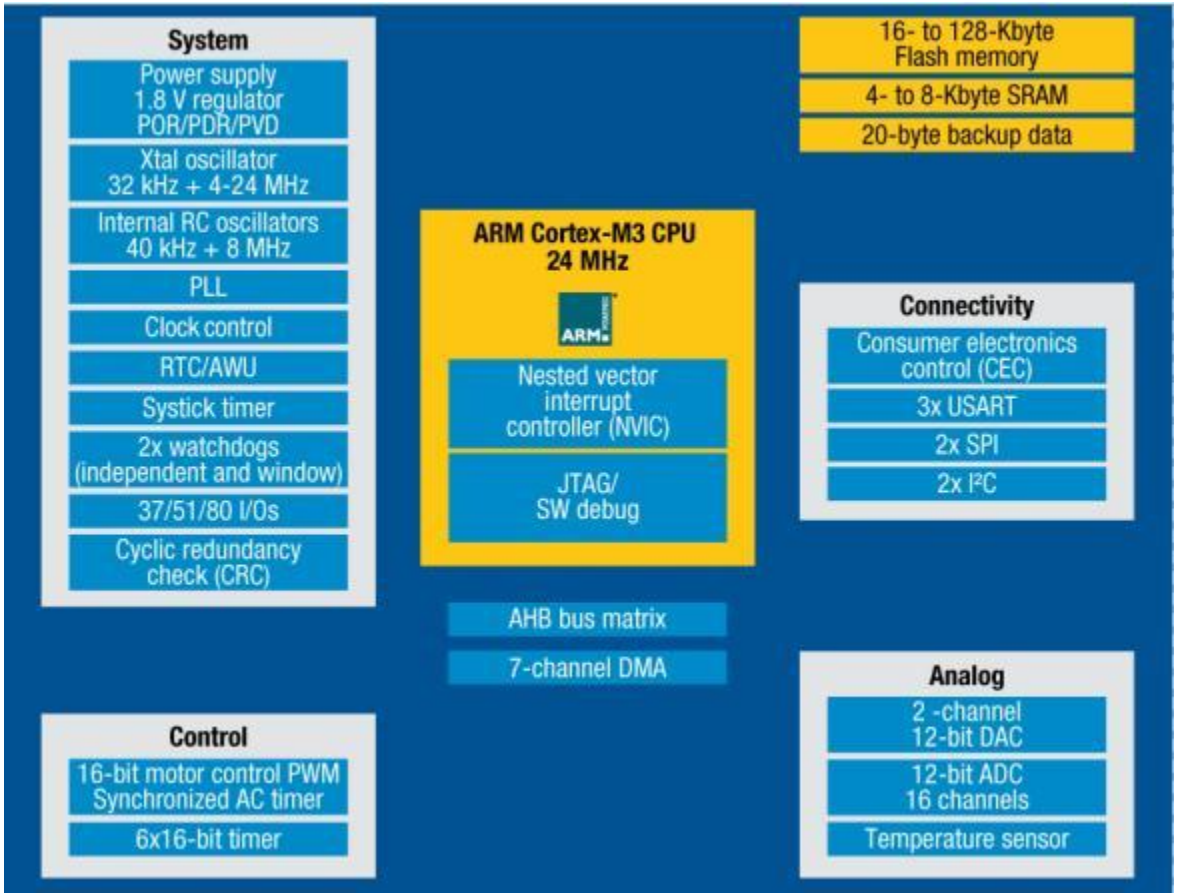
Application example based on FreeRTOS

3-phase brushless motor control evolution



STM32F100 Value line

- 32-bit ARM® Cortex™-M3 core
  - Up to 30 DMIPS at 24 MHz max
- 2.0 to 3.6 V operation
- -40 to +105 °C
- Enhanced control
  - 1x 16-bit advanced timer
  - 6x 16-bit PWM timers
- Advanced analog
  - 1x fast 12-bit 1.2 µs ADC
  - Dual-channel 12-bit DAC
- System integration
  - Internal 8 MHz RC oscillator
  - Built-in safe reset system
- Datasheets



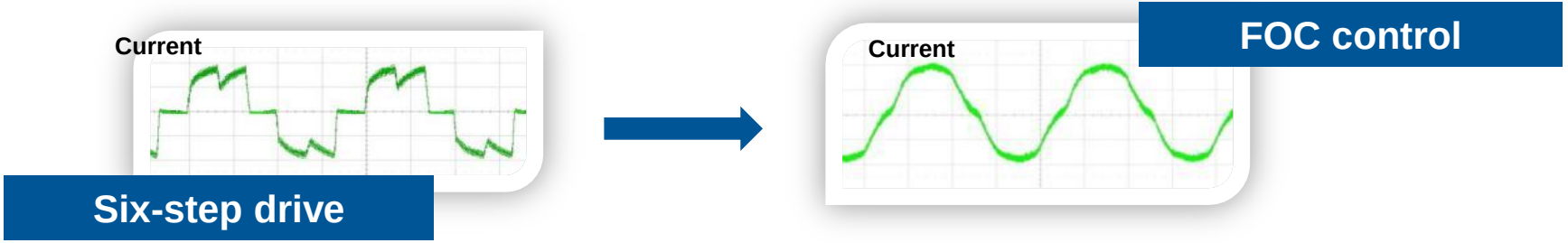
FOC single motor drive with STM32F100

Target application characteristics

- Requirements for dynamic performances are moderate
- Quietness of sinusoidal current control (versus 6-step drive) is valuable
- Extended speed range is required
- Particularly suitable for pumps, fans and compressors

Advantages

- Cost optimized
- More silent
- Lower torque ripple
- Extended speed range more easily achieved



Performances of FOC with STM32F100

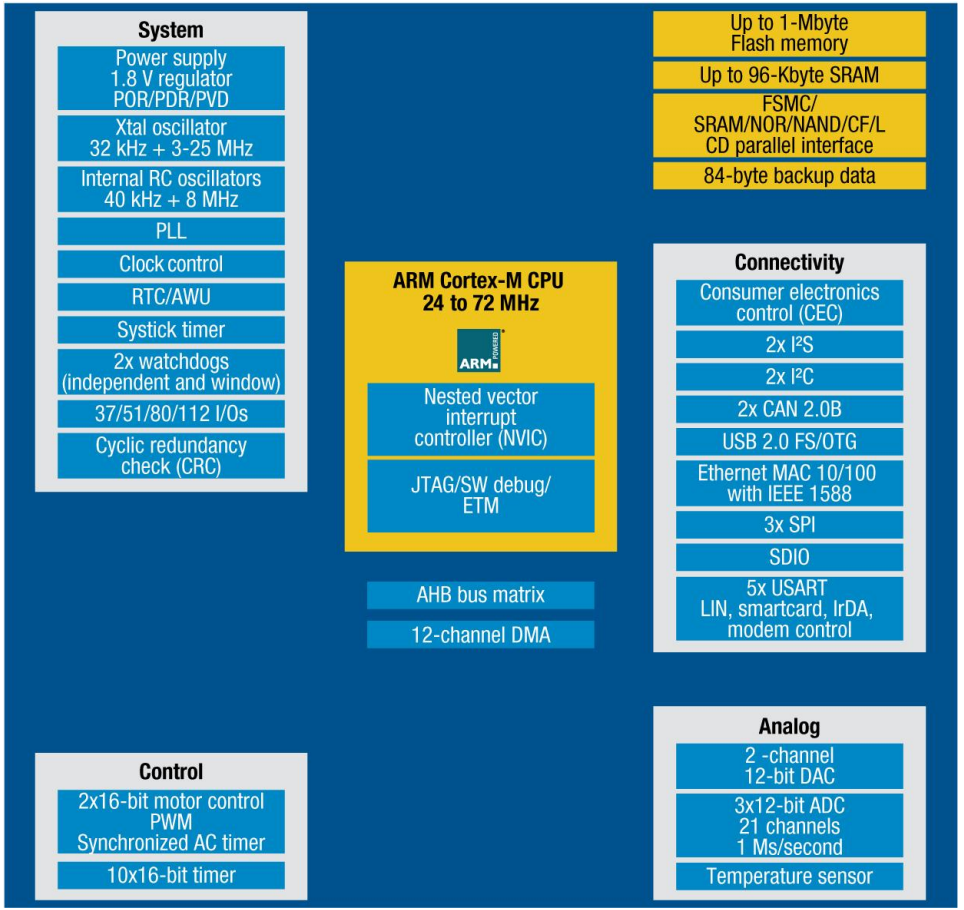
Configuration: 1 shunt/sensorless at 20 kHz PWM,10 kHz FOC

- Motor control code size is 15.82 Kbytes
- Motor control RAM usage is 2.77 Kbytes
- FOC total execution time is 65.22 µs (ADC ISR + TIM1 update ISR)
- FOC introduced CPU load is 65.2%
- Total CPU load is ~70% (~60% at 8 kHz FOC)

ISR: interrupt service routine

STM32F103 Performance line

- 32-bit ARM® Cortex™-M3 core
  - 1.25 DMIPS/MHz (Dhrystone 2.1)
- 2 to 3.6 V supply
- -40 to + 105°C
- From 16-Kbytes to 1-Mbyte Flash memory
- Enhanced control
  - Up to 2x 16-bit advanced timer
  - Up to 4x 16-bit PWM timers
- Advanced analog
  - Up to 3x fast 12-bit 1.2 µs ADC
- System integration
  - Internal 8 MHz RC oscillator
  - Built-in safe reset system
- Datasheets



FOC single motor drive with STM32F103

Target applications

- Wide application range from home appliances to robotics, where:
  - Accurate and quick regulation of motor speed and torque is required (such as in torque load transient or abrupt target speed variations)
  - CPU load granted to motor control must be low due to other duties

Home appliances

Industrial motor drives

Power tools

Games

Escalators and elevators

Fitness, wellness and healthcare

Performances of FOC with STM32F103

Configuration: 1 shunt/sensorless at 10 kHz FOC sampling time

- Motor control code size is 16.2 Kbytes
- Motor control RAM usage is <2.5 Kbytes
- FOC total execution time is 26.1 µs (ADC ISR + TIM1 update ISR)
- FOC introduced CPU load is 30%

ISR: interrupt service routine

FOC dual motor drive with STM32F103

Target applications

- Wide application range from home appliances to robotics, where:
  - Up to two FOC drives have to run at the same time
  - Accurate and quick regulation of motor speed and torque is required (such as in torque load transient or abrupt target speed variations)

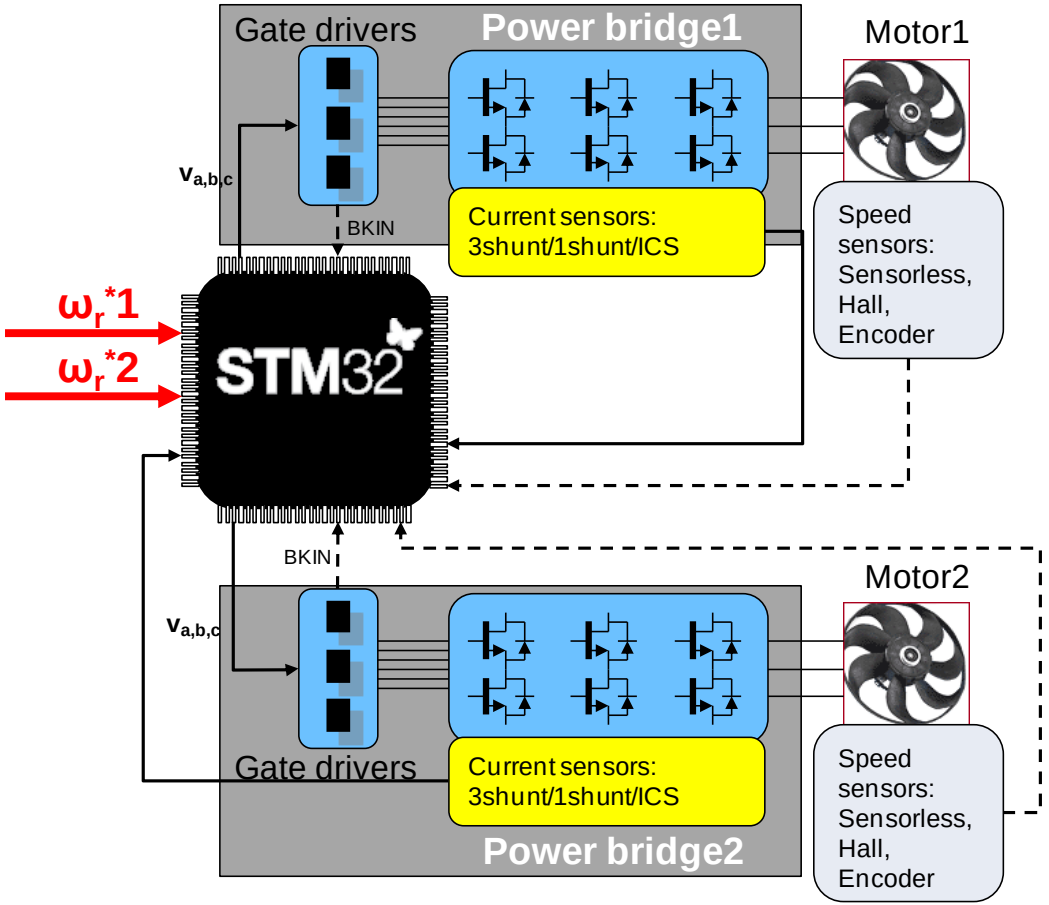
Dishwashers:
spray + drain pumps

Washing machines:
drum + drain pumps

Air conditioners:
compressors + outdoor fans

Industrial motor drives

Dual FOC PMSM – block diagram



With STM32 FOC PMSM SDK v3.0, STM32F103 high-density devices with their extended set of peripherals (2 advanced timers, 3 fast ADCs, and more) can drive 2 motors in diverse configurations

ICS: isolated current sensors

Performances of dual FOC with STM32F103

Example of configuration No. 1:

- Motor 1, 1 shunt/sensorless @ 8 kHz PWM/FOC – flux weakening enabled
- Motor 2, 1 shunt/sensorless @ 16 kHz PWM, 8 kHz FOC

- Motor control code size is 22.3 Kbytes (1.5 times below single motor case)
- Motor control RAM usage is 4.01 Kbytes
- FOC introduced CPU load (including TIMx update ISRs) is 44%
- Total CPU load ~50%

ISR: interrupt service routine

Performances of dual FOCs with STM32F103

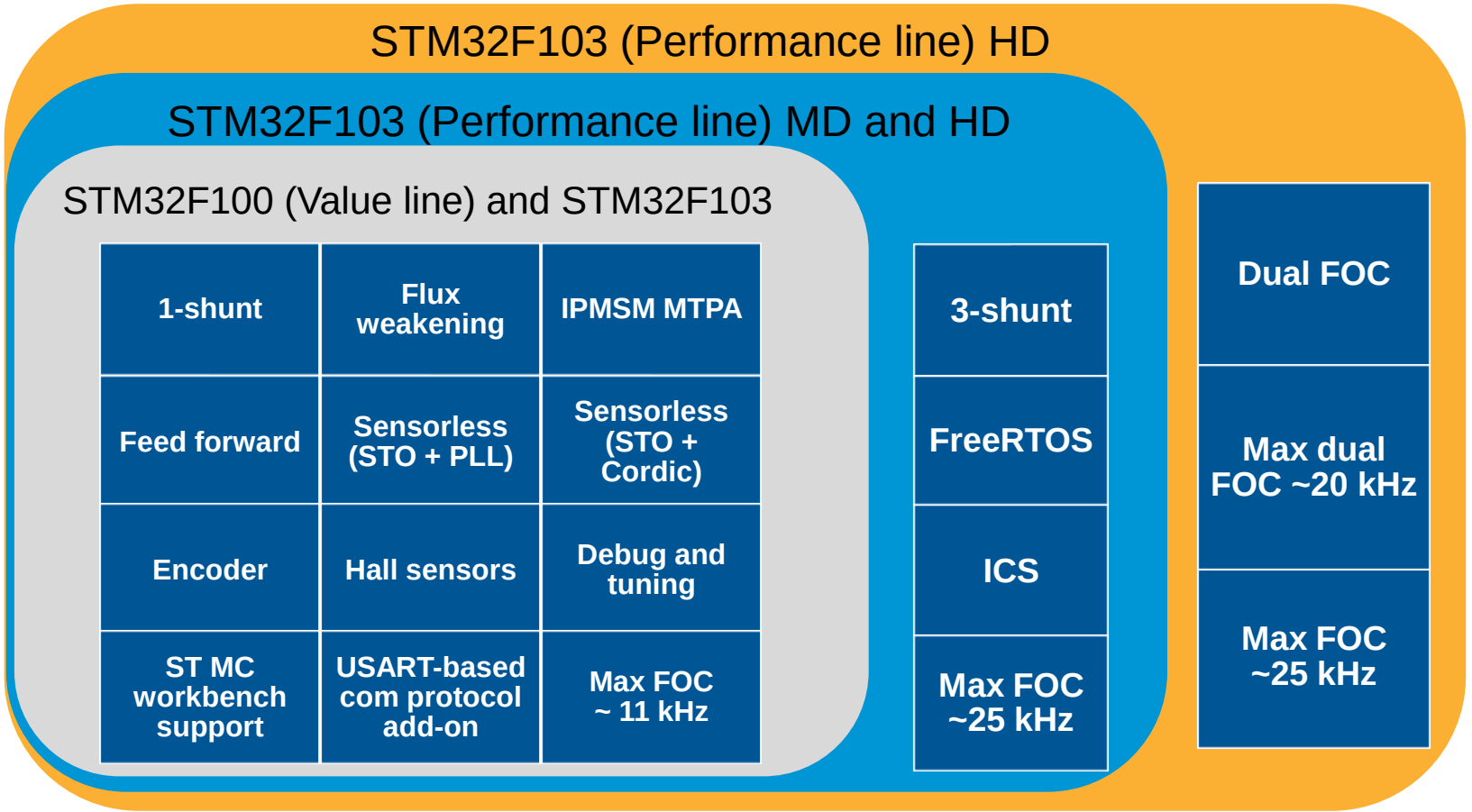
Example of configuration No. 2:

- Motor 1, 3 shunts/sensorless @ 16 kHz PWM/FOC – MTPA and flux weakening enabled
- Motor 2, 1 shunt/sensorless @ 16 kHz PWM, 8 kHz FOC

- Motor control code size is 25.5 Kbytes
- Motor control RAM usage is 4.14 Kbytes
- FOCs introduced CPU load (including TIMx update ISRs) is 62.6%
- Total CPU load <70%

ISR: interrupt service routine

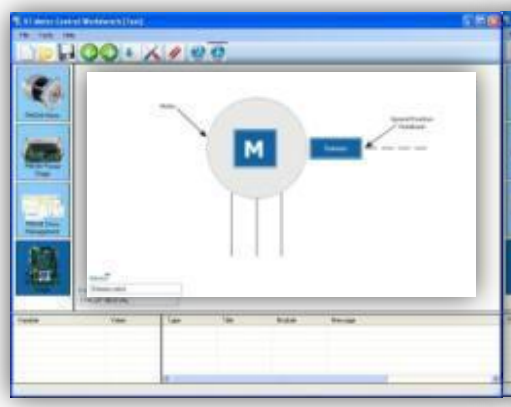
Summary table: features set – MCU support



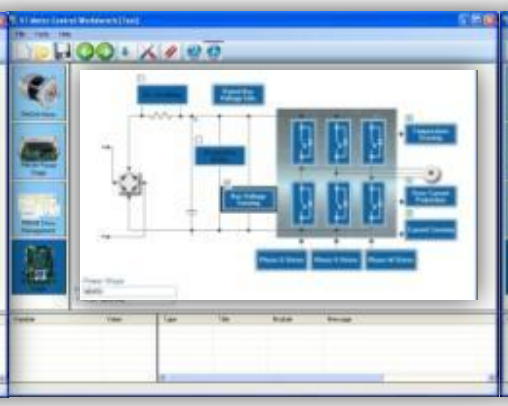
ICS: isolated current sensors

ST Motor Control Workbench v1.0.2 (STMCWB)

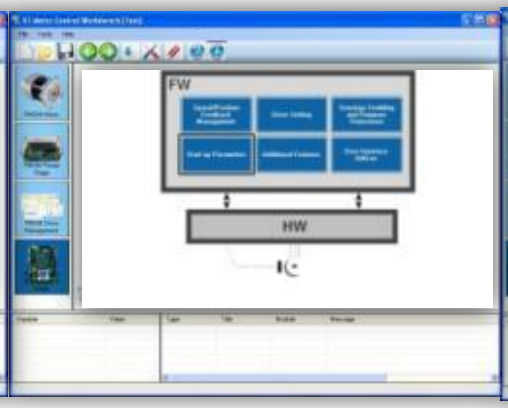
STMCWB is a PC code generator tool developed to reduce the firmware development time for STM32 FOC PMSM SDK v3.0. A graphical user interface (GUI) allows you to generate all parameter header files that configure the library, according to application needs.



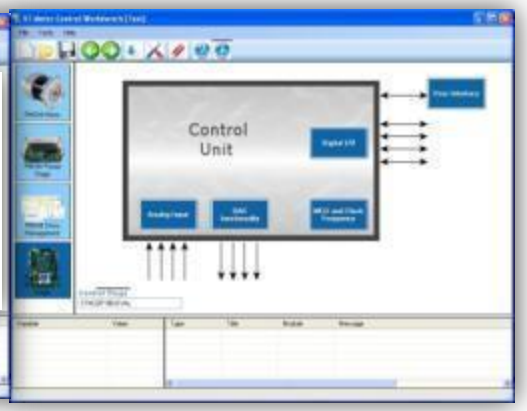
Motor



Power stage

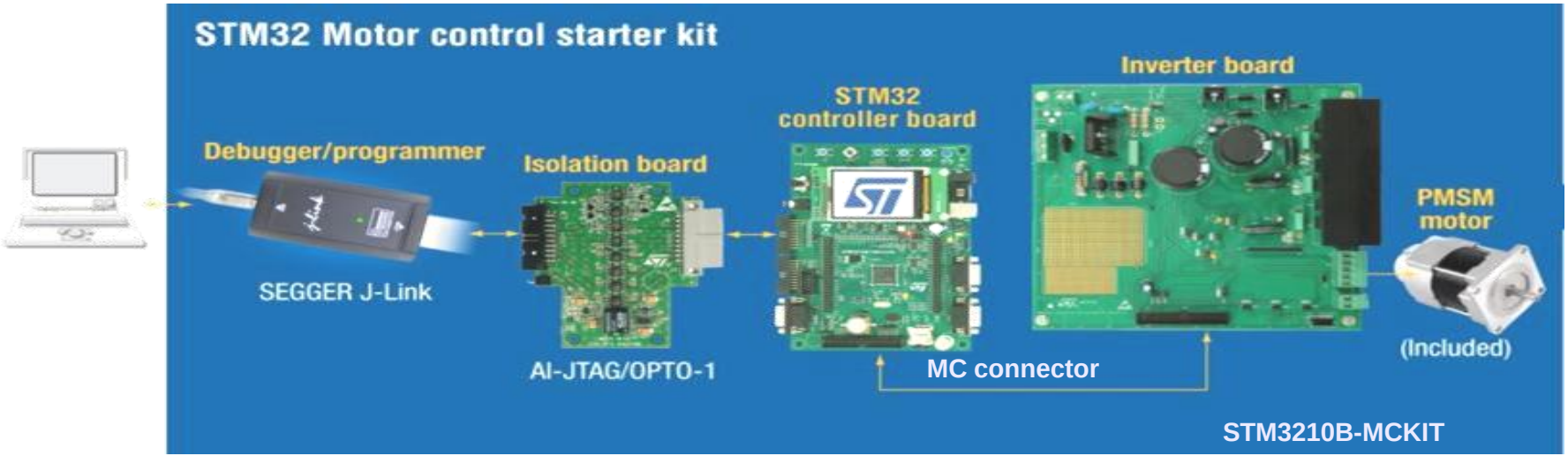


Drive management



Control stage

STM3210B-MCKIT starter kit



STM3210B-MCKIT starter kit

STM3210B-MCKIT starter kit

Main features

- Driving strategy: vector control
  - AC induction motors, sensored
  - PMSM motors, sensored and sensorless
- 34-pin dedicated motor control connector
- Encoder, Hall sensor, tachometer sensor inputs
- Current sensing mode:
  - 3 shunt resistors
  - Single shunt

ST complete offer

- STM32F103 (32-bit MCU with dedicated motor control timer)
- L6386DE (gate driver)
- VIPer12AS (power supply downconverter)
- L7815CP, L7805CP, LD1117S33TR (voltage regulators)
- STGF7NC60H (IGBT)
- TSV994, TS374ID, TS372ID (op-amps)
- M74HC09RM13TR, M74HCT7007RM13TR (logic)

STM32 evaluation boards (control board)

STM32 FOC PMSM SDK v3.0

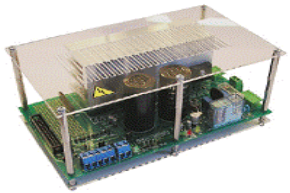
FOC	FOC	FOC	Dual FOC
Optimized for STM32F100x	High performance	High performance	

STM32100B-EVAL	STEVAL-IHM032V1	STM3210B-EVAL	STM3210E-EVAL	STEVAL-IHM022V1
				

http://www.st.com/evalboards

Complementary high-voltage power stages

SLLIMM™ (ST IPMs) based



STEVAL-IHM025V1

- 1000 W
- 1x IGBT SLLIMM™: **STGIPL14K60**
- 1x converter based on **VIPer16**
- 1x IGBT: **STGP10NC60KD**

STEVAL-IHM027V1

- 1000 W
- 1x IGBT SLLIMM™: **STGIPS10K60A**
- 1x converter based on **VIPer16**
- 1x IGBT: **STGP10NC60KD**

STEVAL-IHM028V1

- 2000 W
- 1x IGBT SLLIMM™: **STGIPS20K60**
- 1x PWM SMPS: **VIPer26LD**
- 1x IGBT: **STGW35NB60SD**

(*) Available in Q4/2011

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Gate-driver and power-transistor based

STEVAL-IHM023V2

- 1000 W
- 3x PWM smart drivers: **L6390**
- 1x converter based on **VIPer16**
- 7x IGBT power switches: **STGP10NC60KD**

STEVAL-IHM021V1

- 3x PWM smart drivers: **L6390**
- 1x converter based on **VIPer12**
- 6x MOSFET power switches: **STD5N52U**

STEVAL-IHM024V1

- 3x PWM smart drivers: **L6390**
- 1x converter based on **VIPer12**
- 6x IGBT power switches: **STGDL35NC60DI**

STEVAL-IHM032V1 (*)

- 150 W
- 3x PWM smart drivers: **2xL6392D** and **1x L6391D**
- 1x converter based on **VIPer12**
- 6x IGBT power switches: **STGD3HF60HD**

Low voltage power stages and drive solutions

Low-voltage power stages

STEVAL-IHM031V1

- 120 W
- 3x dual power MOSFETs: **STS8DNH3L**
- 2x PWM smart drivers: **L6387E**
- 1x step-down converter: **L4976D**

STEVAL-IEM003V1

- Power stage up to 48 V
- 2000 W
- 3x PWM smart drivers: **L6388**
- 6x LV power MOSFETs: **STV250N55F3**
- 1x step-down converter: **L4978D**

Complete motor drive solutions

STEVAL-IFN003V1 (*)

- FOC PMSM motor drive
- 80 W
- 1x 32-bit microcontroller: **STM32F103C**
- 1x motor drive IC: **L6230PD**

(*) Available in Q4/2011

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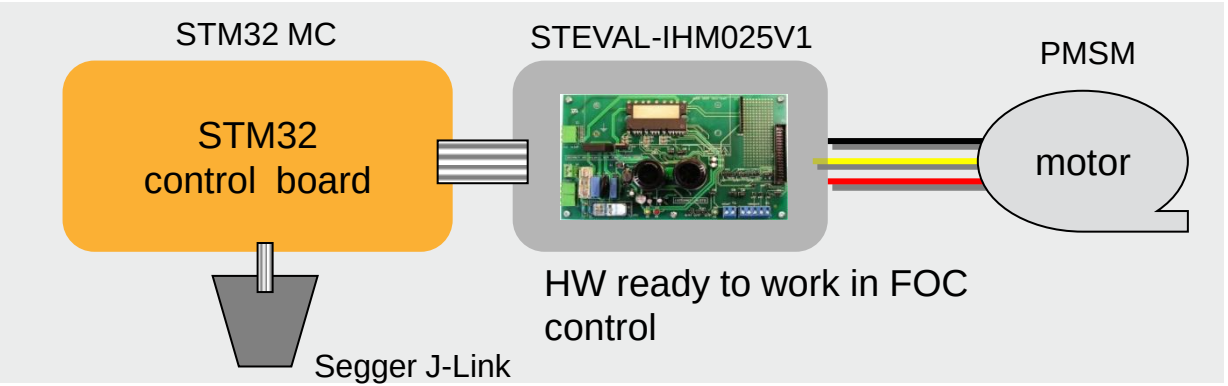
Example: STEVAL-IHM025V1 configurations

Field oriented control (FOC)

STM32 FOC PMSM SDK v3.0 configuration through the PC GUI: STMCWB v1.0.2



More information

Download:

STM32 FOC PMSM SDK v 3.0 firmware library zip file

ST MC Workbenchv1.0.2 zip file

Consult:

Technical note TN0516 Overview of the STM32F103/STM32F100 PMSM single/dual FOC SDK V3.0

User manual UM1052 STM32F103 or STM32F100 PMSM single/dual FOC SDK V3.0

User manual UM1053 Advanced dev. guide for STM32F103/STM32F100 PMSM single/dual FOC library

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Thank you