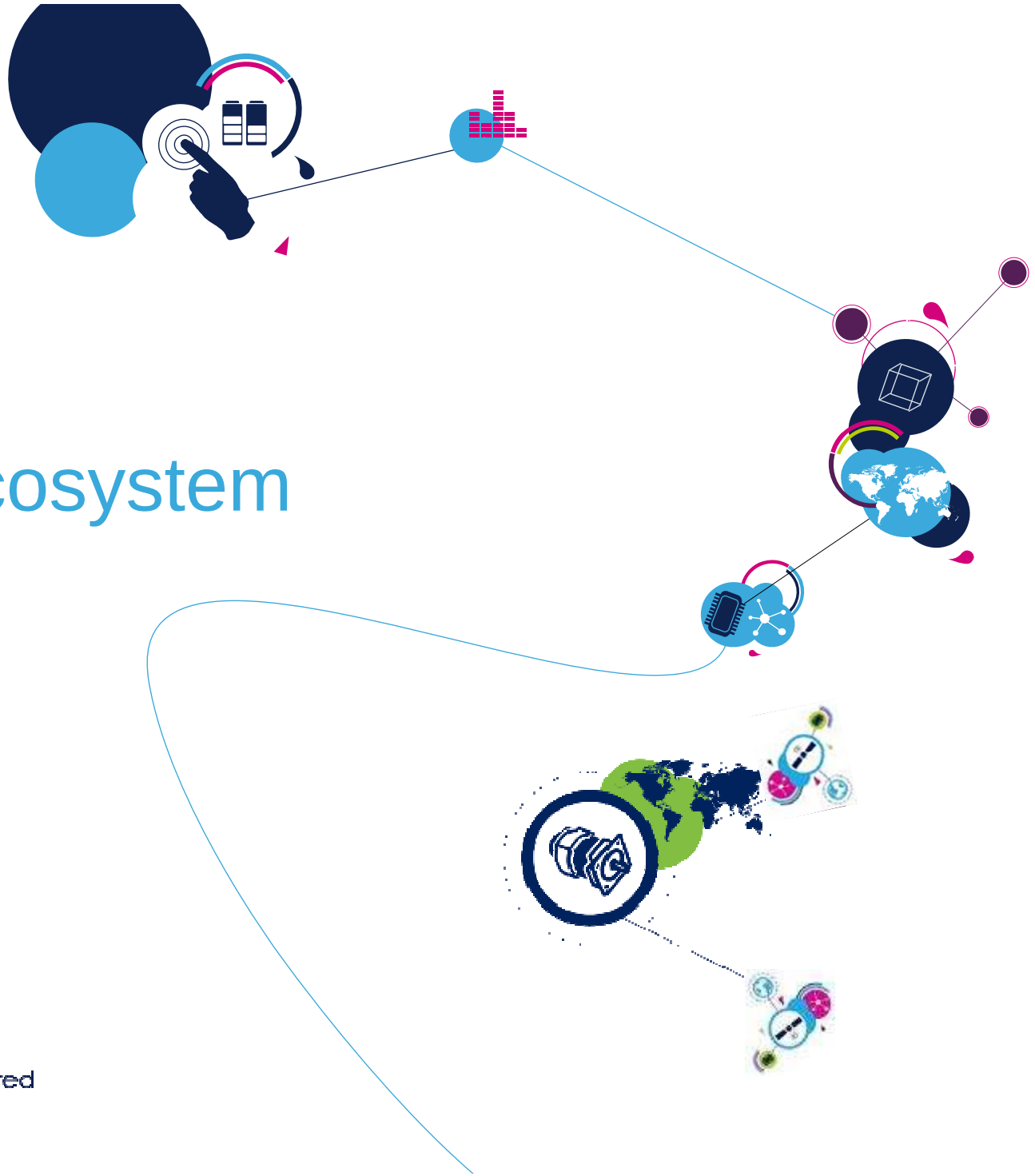
ST Motion Control Ecosystem
Easy Plug and Spin



ST MC Ecosystem

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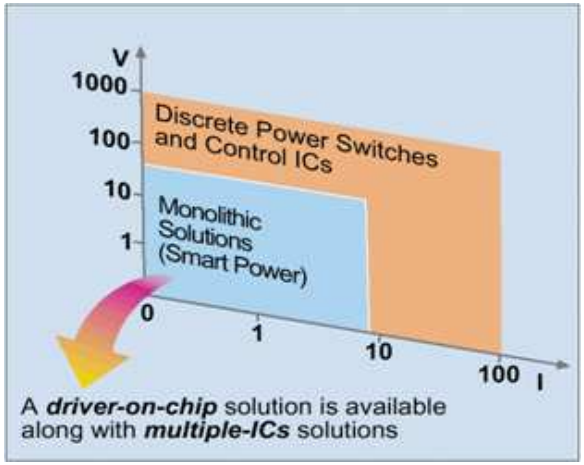
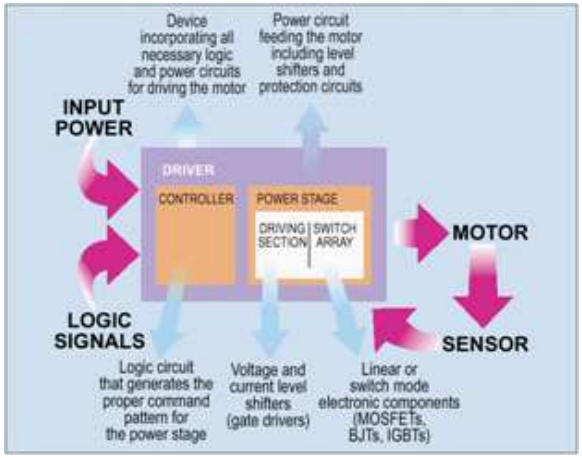
ST is committed to Motor Control

STMicroelectronics was among the first to recognize this trend and today offers a full range of component for optimizing motor control systems.

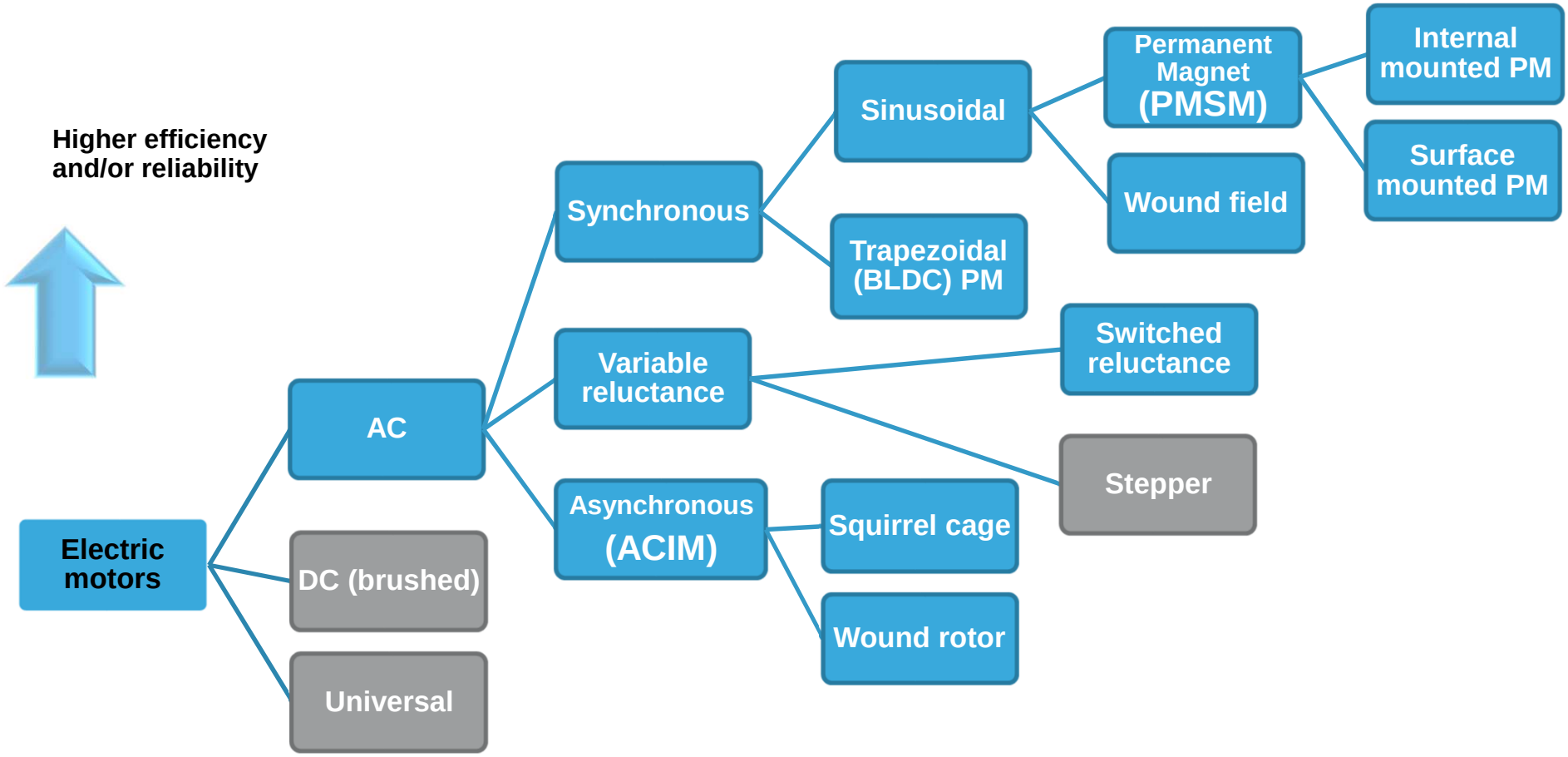
ST is universally acknowledged as the supplier with the most comprehensive semiconductor portfolio for such applications, including:

- Microcontrollers
- Power Discrete
- Smart Power and Dedicated ICs





Electric Motor: Classification

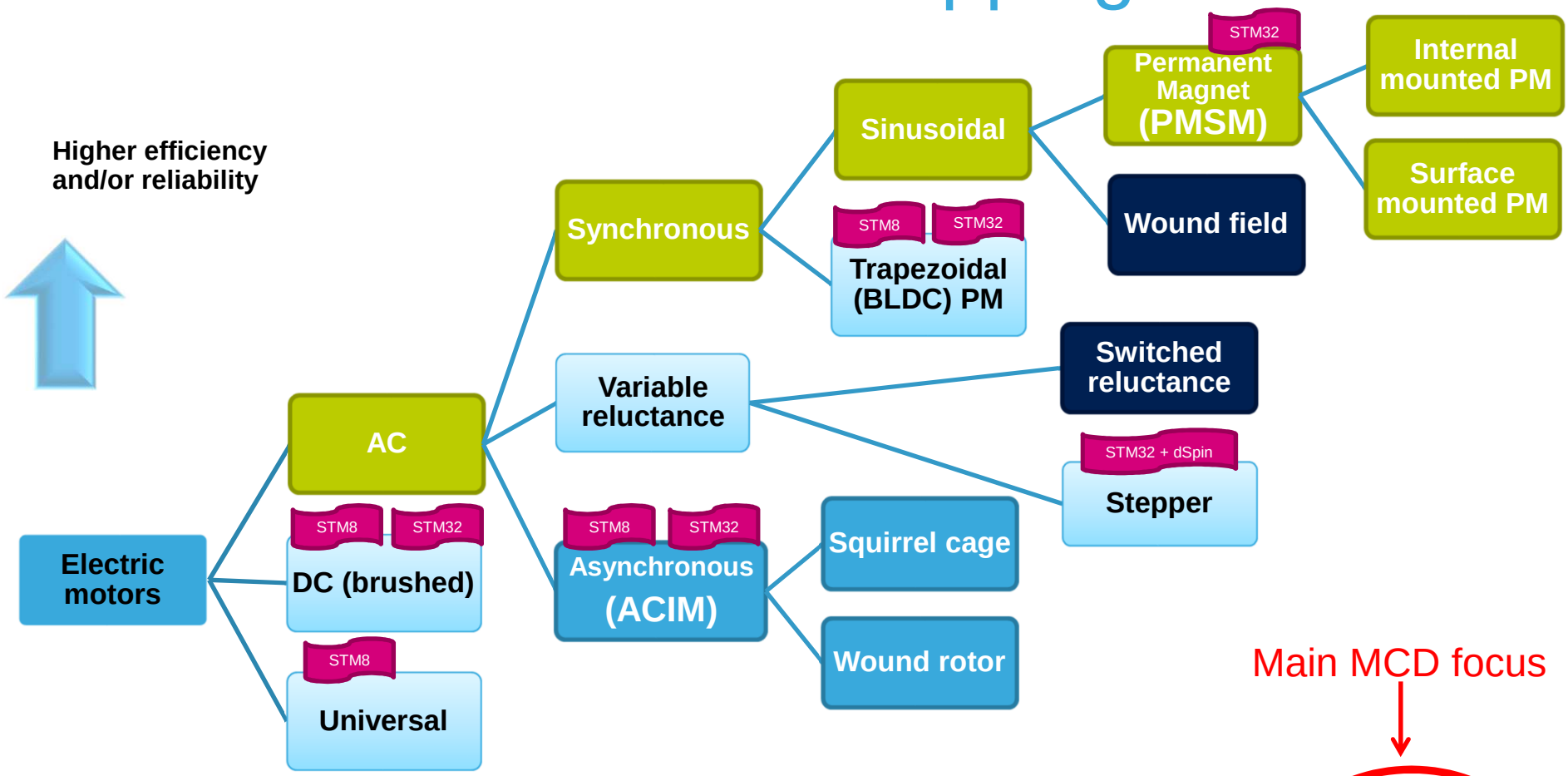


- **PMSM:** 3-phase permanent magnet synchronous motor
- **ACIM:** 3-phase induction motor

Limited computation needs
Driving method well-known, mastered by customer
Light ecosystem
Basic ADC/PWM requirement

Computation intensive
Complex driving, requires specific knowledge and/or support
Complete ecosystem necessary
Requires 3-phase timer + sync'd ADC

Electric Motor: MCU mapping



- **PMSM:** 3-phase permanent magnet synchronous motor
- **ACIM:** here 3-phase induction motor

Solution available today

Supported with ST products but no ecosystem

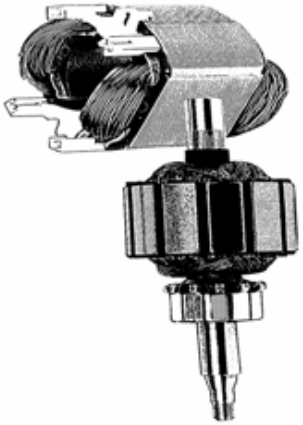
Solution available (HW & SW)

Complete Motor Control ecosystem (FW Library)

Complete Motor Control ecosystem (FW library)

Electric Motor Families:

WITH BRUSHES

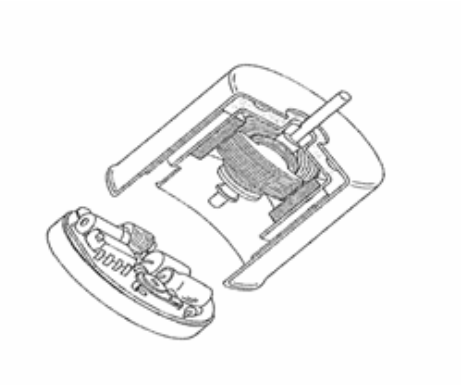


UNIVERSAL

BRUSHLESS

1 & 3 phase induction
Asynchronous

ELECTRONICALLY COMMUTATED

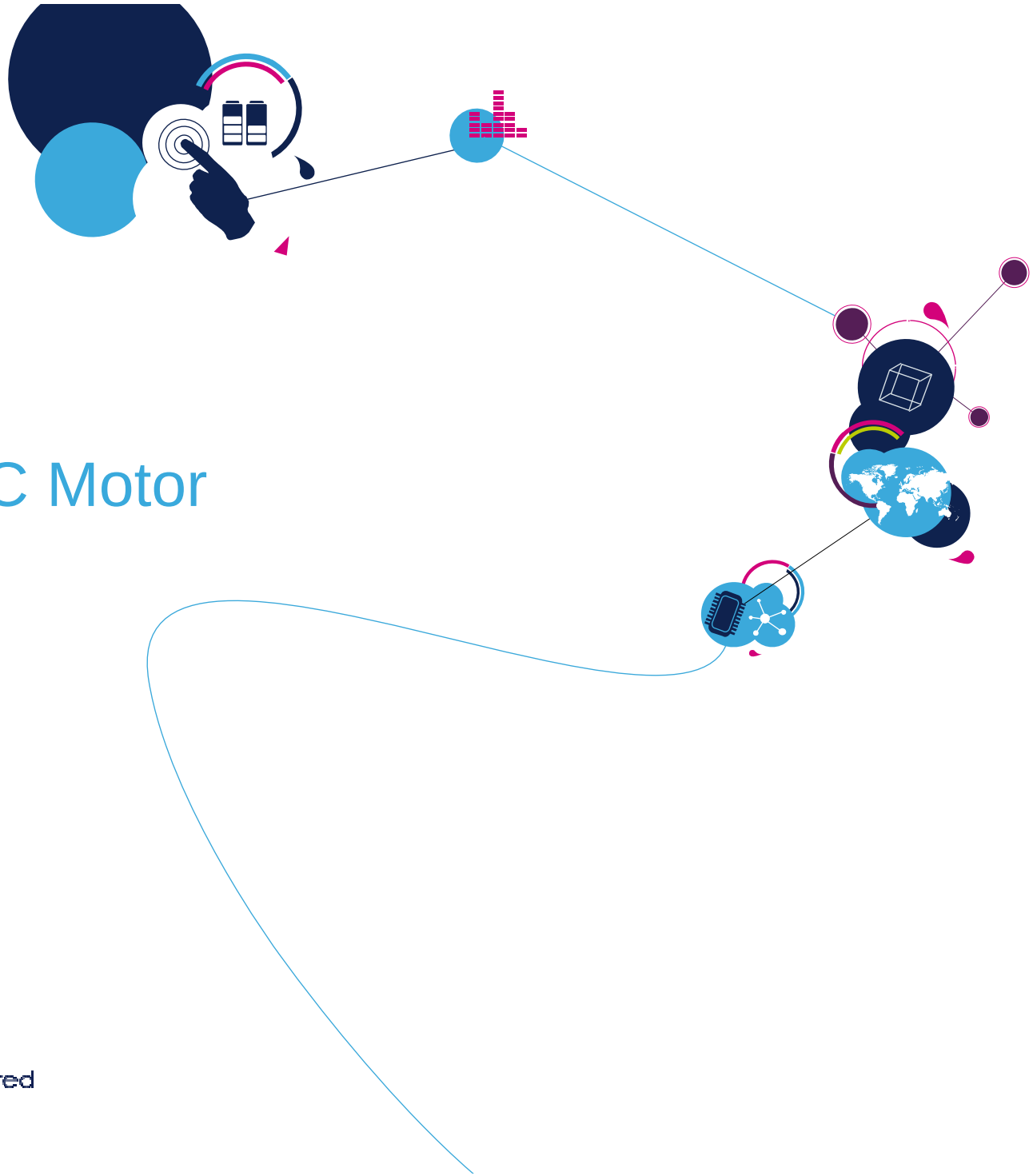


BLDC + SR
Synchronous

Standard MCU – Triac Control

Dedicated MCU – 3 phase Inverter Control

Note: SR is Switch Reluctance Motor



The Brush DC Motor

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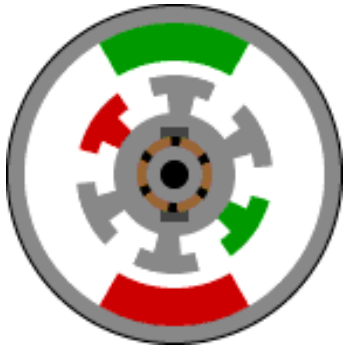
The Brush DC Motor



The rotor of the brush DC motor includes a winding which is fed by a DC voltage source through carbon brushes. The stator circuit comprises a permanent magnet structure or a winding. If the stator includes a winding, the latter can be connected to the rotor winding in series, or in parallel or can be excited separately.

Brush DC motors can be driven in voltage mode since the motor speed is proportional to the supply voltage.

However, to control the torque of the motor, a current control loop is usually added in higher performance systems.

For bi-directional operation, the rotor current must be inverted with respect to the stator magnetic field.

Major Applications:

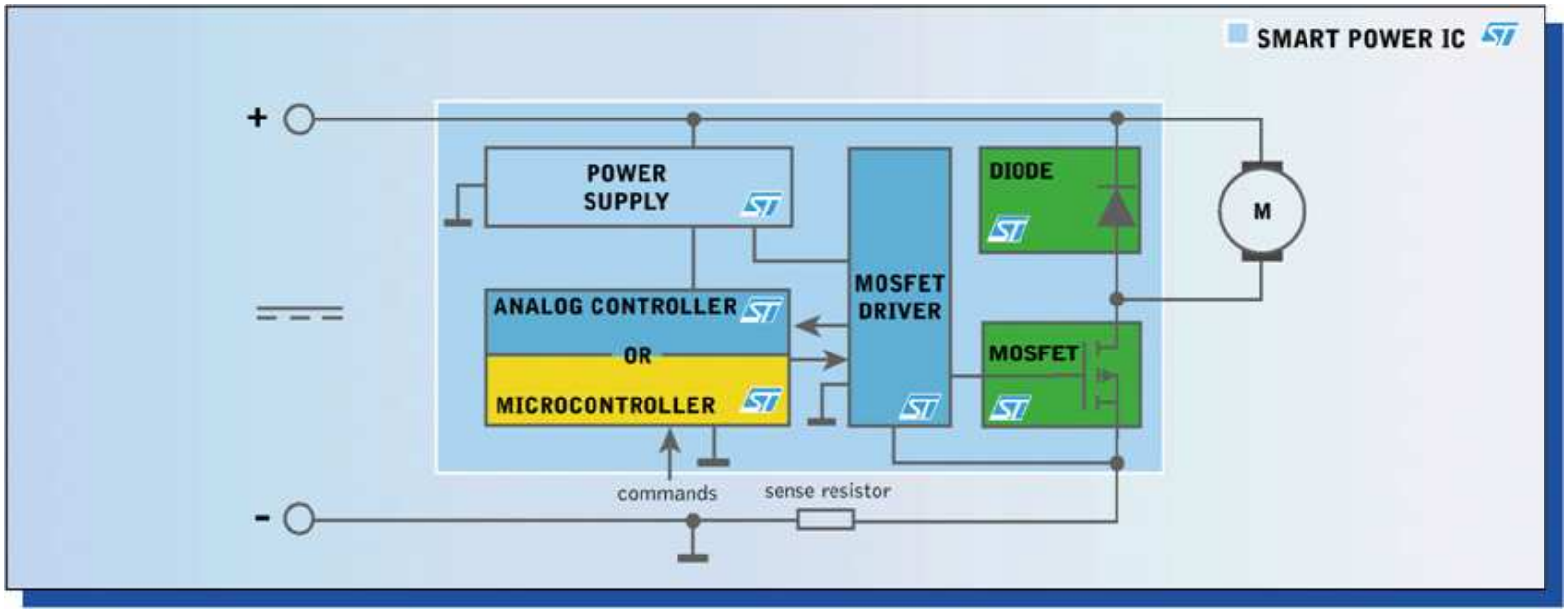
Consumer audio/video - Shavers - Toys - Cordless tools - Automotive body functions - Traction – Servomechanisms - Factory automation - Machine tools

Typical Application Parameters

•Supply Voltage: 6 to 320 Vdc
•Motor Power: up to 20,000W
•Speed Range: 0 to 30,000 RPM

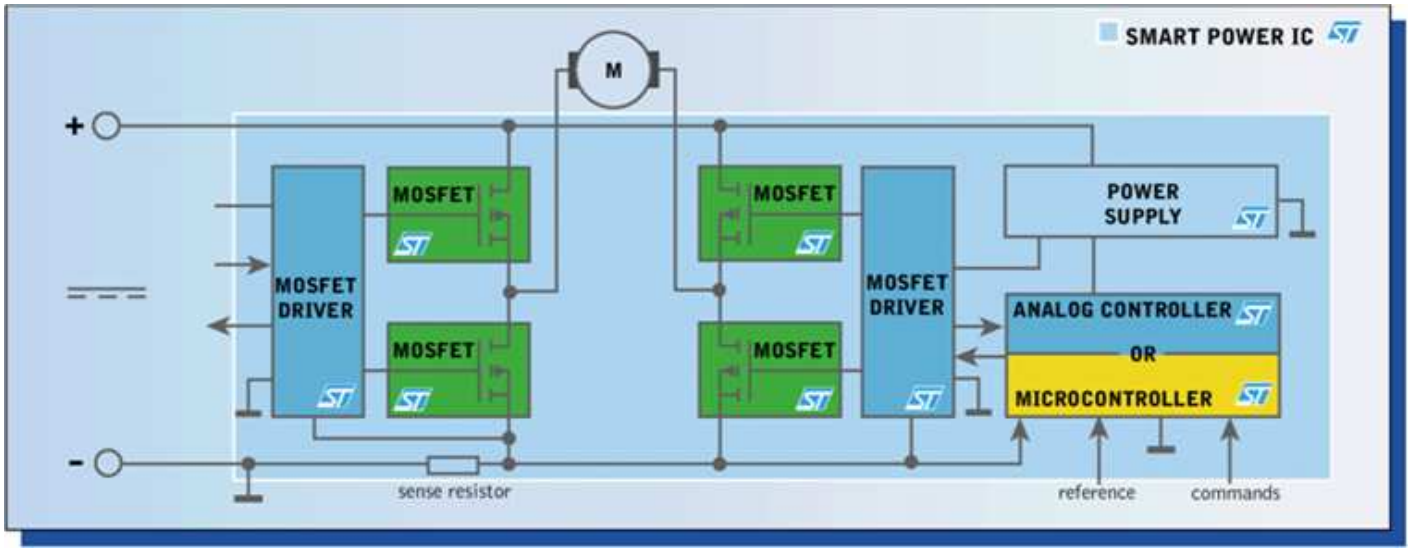
Single Switch Chopper

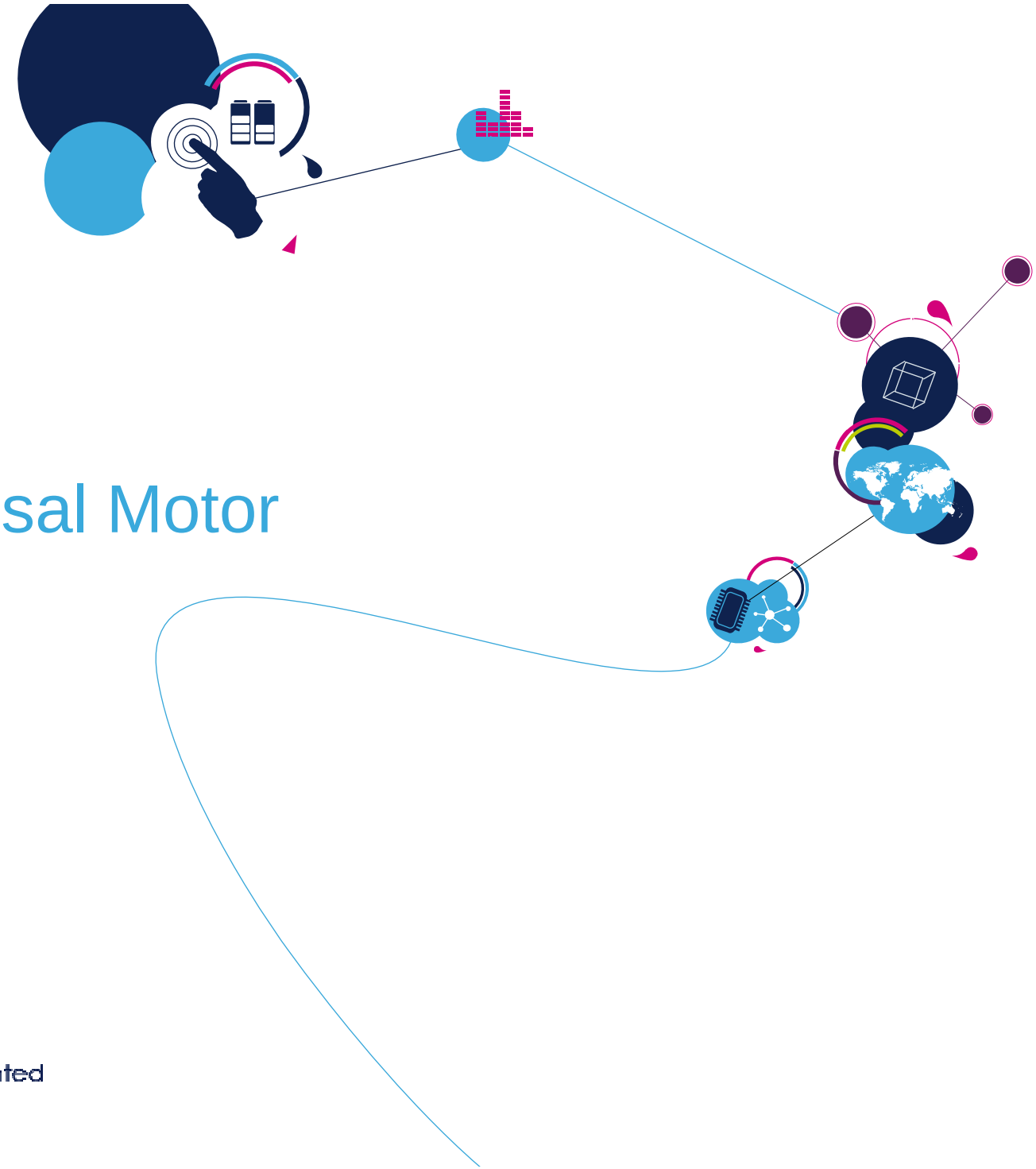
For the unidirectional operation of a brush DC motor, only one power switch is needed. In case of PWM control, a freewheeling diode is connected across the motor.



Full-Bridge Converter

This configuration enables the bi-directional operation of brush DC motors.





The Universal Motor

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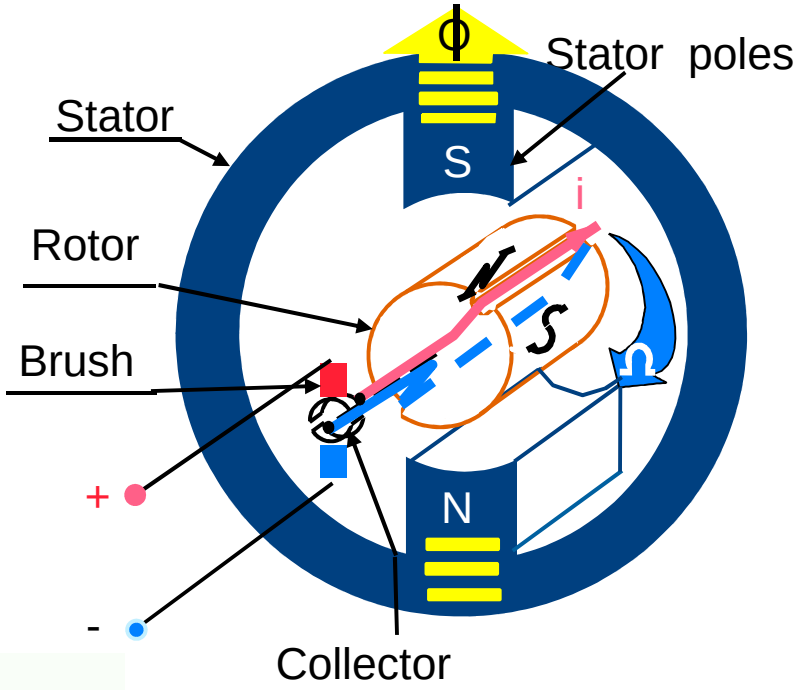
Universal Motor: Introduction

The Universal Motor is a **brush motor** with a series excitation. As its torque is insensitive to current direction, it can take AC or DC source supply. The speed is controlled by varying motor voltage.

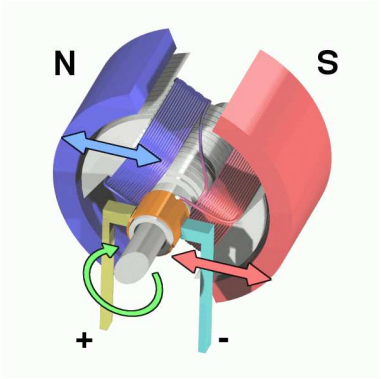


Major Advantages of Universal Motor

- ✓ Variable speed in a large range
- ✓ High torque at start-up
- ✓ Speed adjustment is easy to implement
- ✓ Low cost solution
- ✓ Directly on the mains

Major Drawbacks of Universal Motor

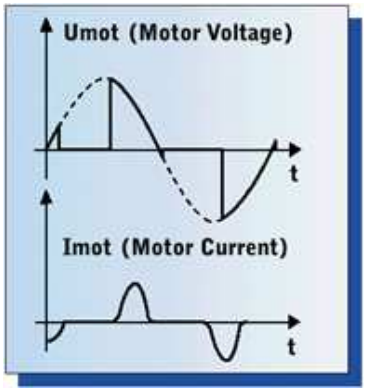
- x Low life time (3000hrs)
- x Sparkles, RFI perturbations
- x Brushes Noise
- x Low Efficiency

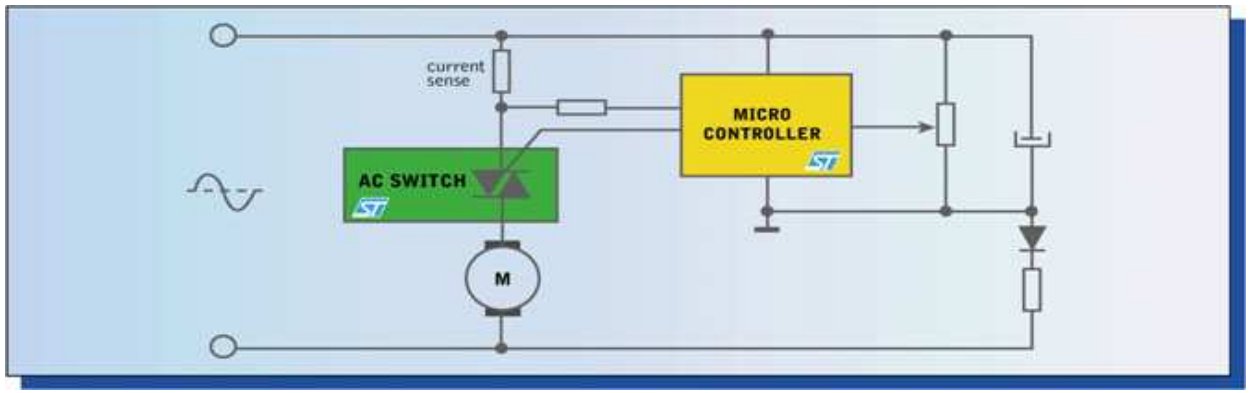


Universal Motor: AC Universal Motor Drive

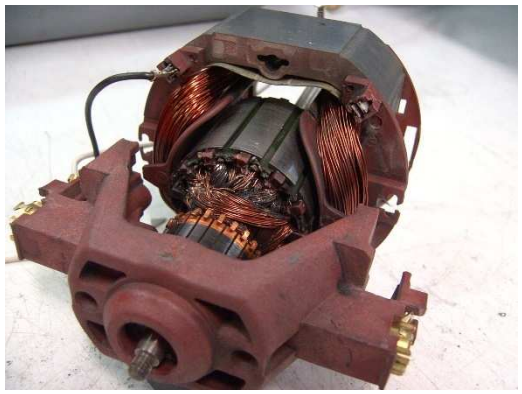
The motor is connected to the mains through an ACS device. AC Voltage across the motor varies in phase-control mode by means of a microcontroller which sets the TRIAC triggering time.

Phase Angle Principle





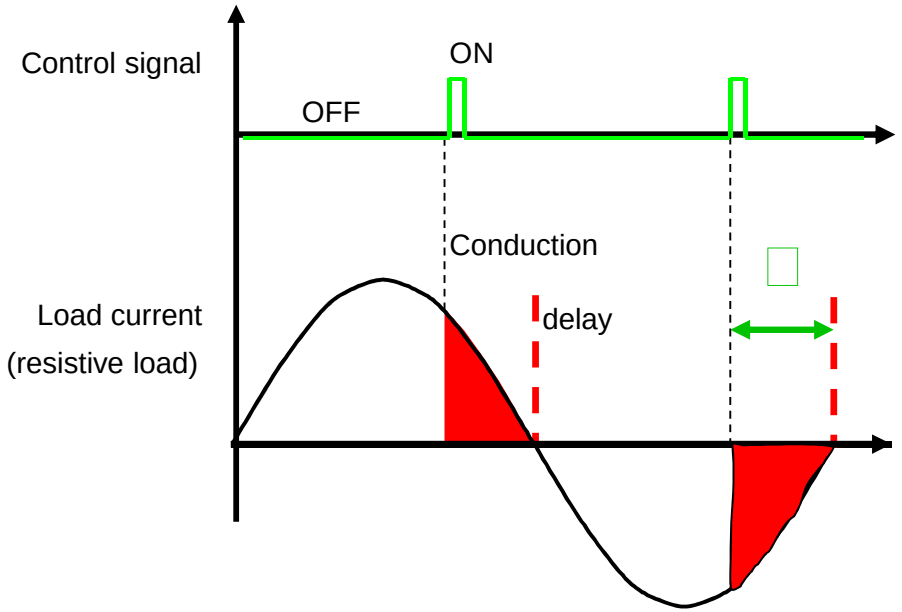
Torque = k. I^2



Phase Angle Control: Advantages and Drawback

Principle:

This method consist of change the RMS voltage applied in motor. In this case the voltage is a function of the firing angle of the TRIAC.
The Conduction angle (α) or firing angle, varies from 0° to 180°



ADVANTAGES :

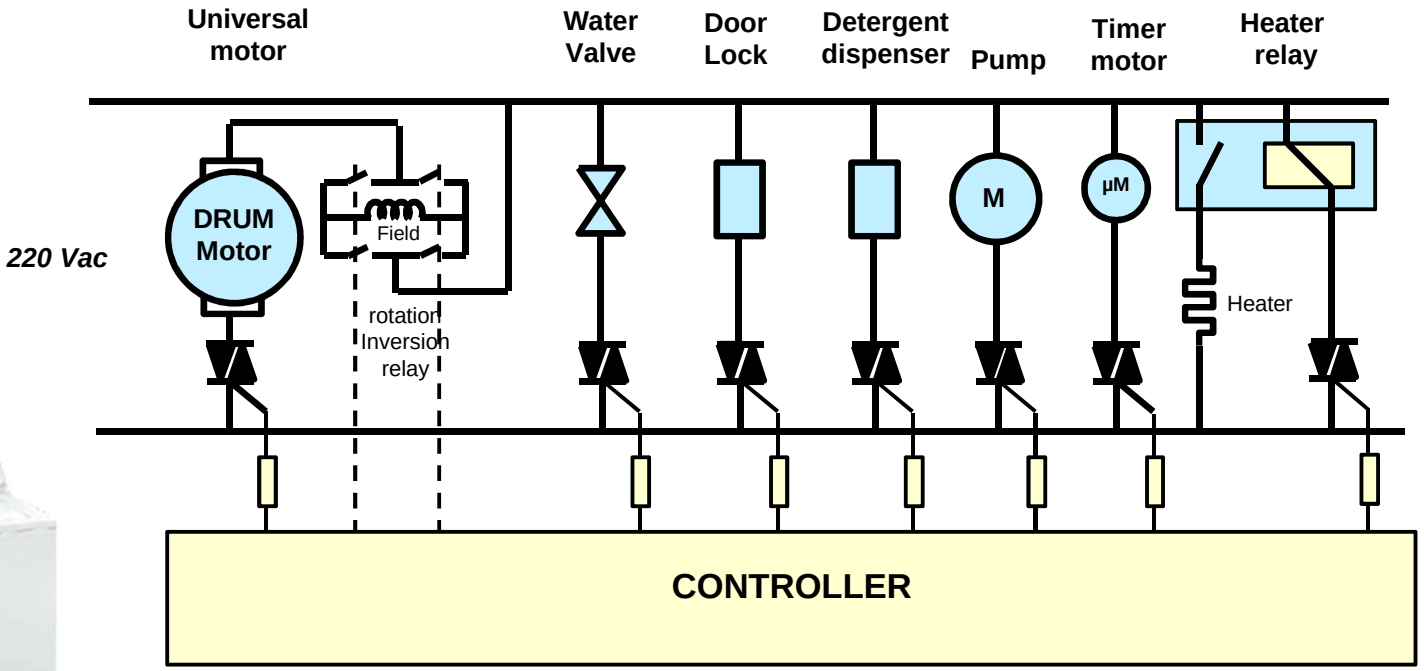
- **SIMPLE CONTROL CIRCUITS**
- **SOFT START (inrush current limitation)**
- **TORQUE COMPENSATION**

DRAWBACK :

- **Conducted HARMONICS**
- **Poor Efficiency**

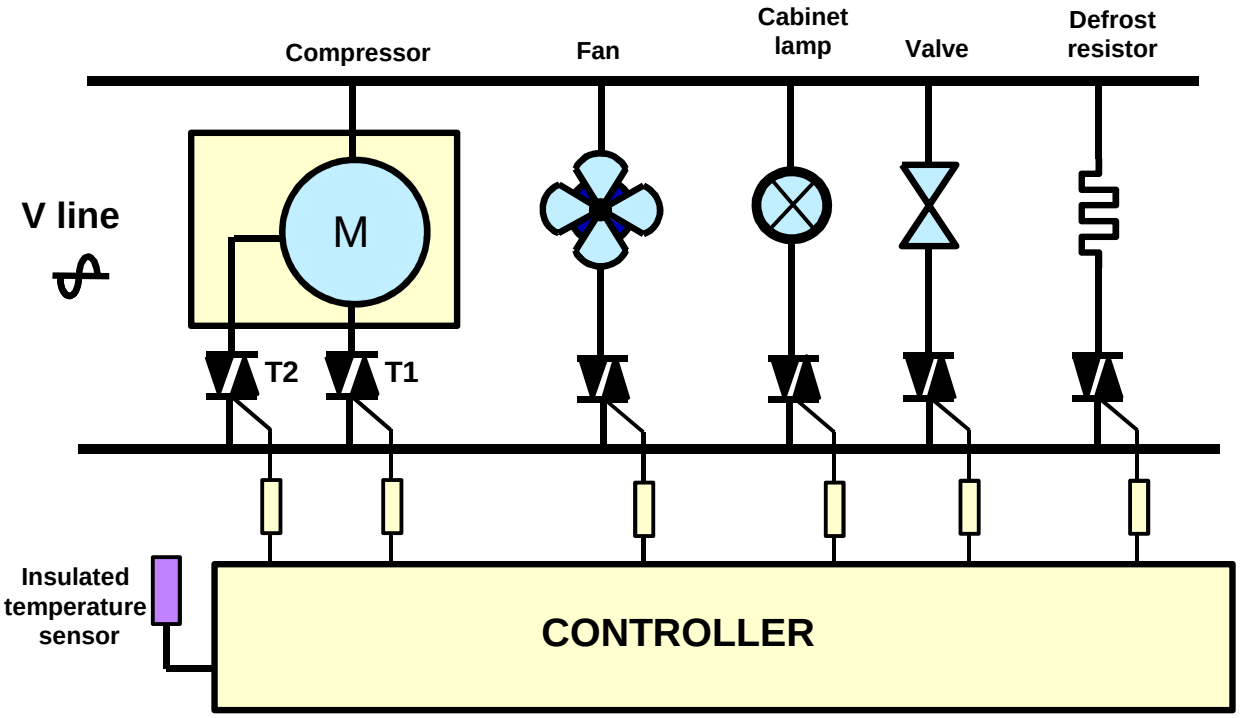
Typical Application : MCU+TRIAC

WASHING MACHINE



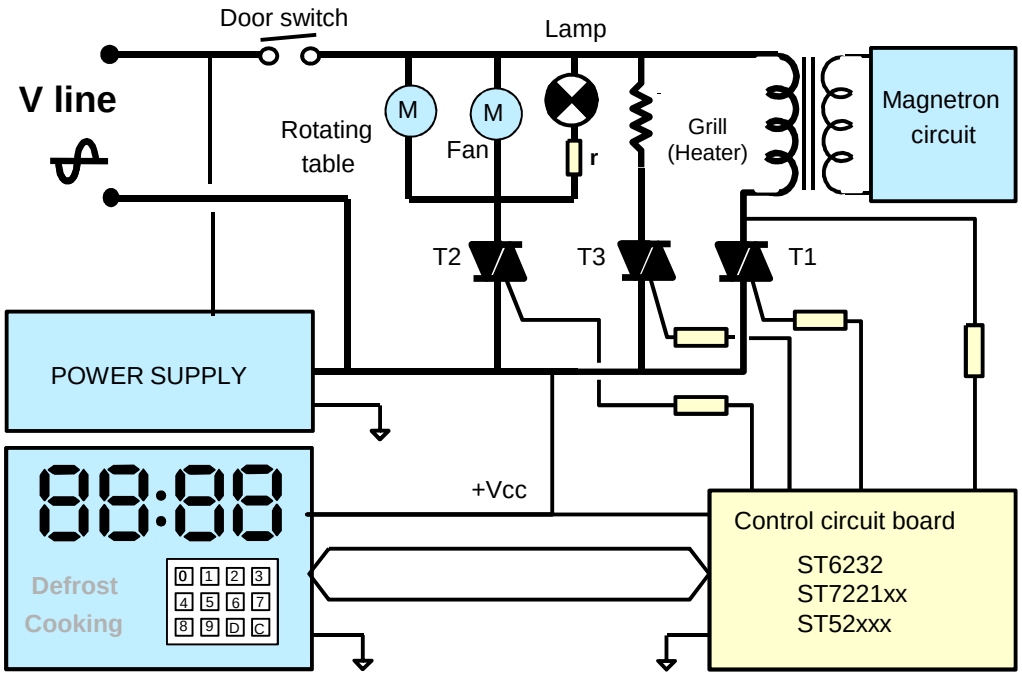
Typical Application: MCU+TRIAC

REFRIGERATOR



Typical Application: MCU+TRIAC

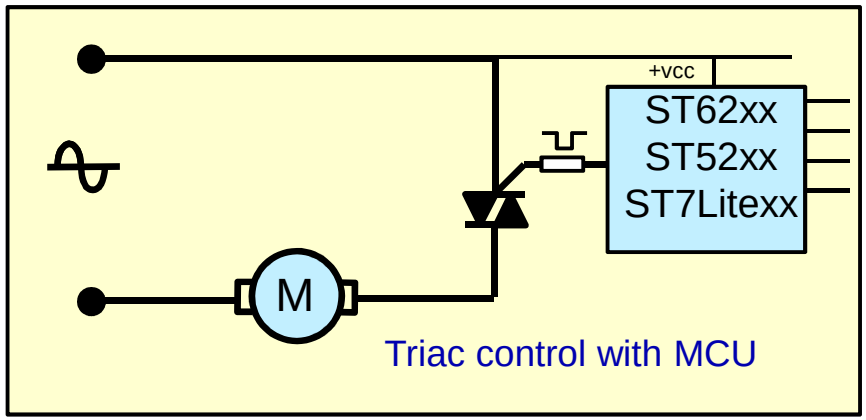
MICROWAVE OVEN

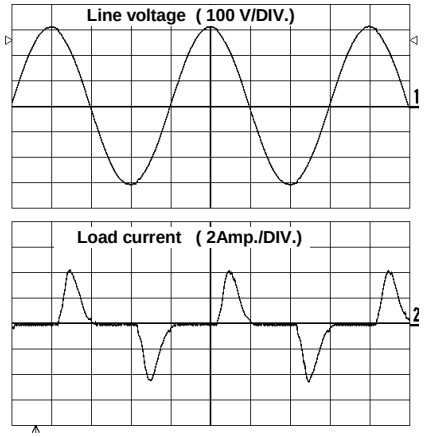


T1 : ***BTA12-600 CW***
T2: ***T410-600***
T3: ***BTB12-600 CW***

Typical Application: MCU+TRIAC

VACUUM CLEANER

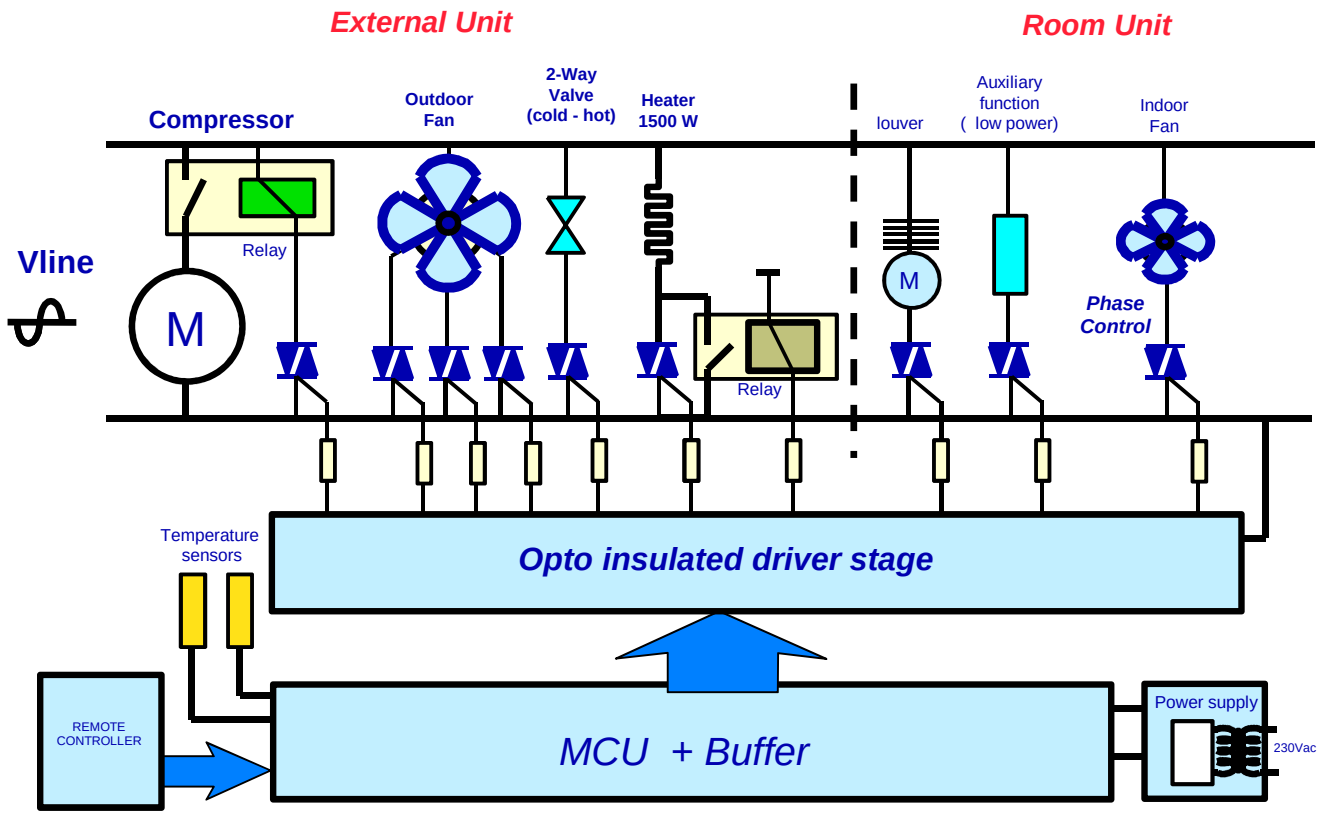




- *Speed variation*
- *Soft start*
- *Bag Status*
- *System Monitoring*

Typical Application: MCU+TRIAC

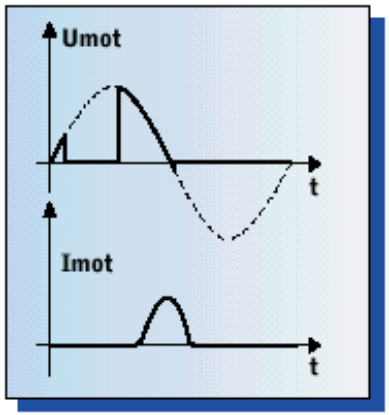
AIR CONDITIONING

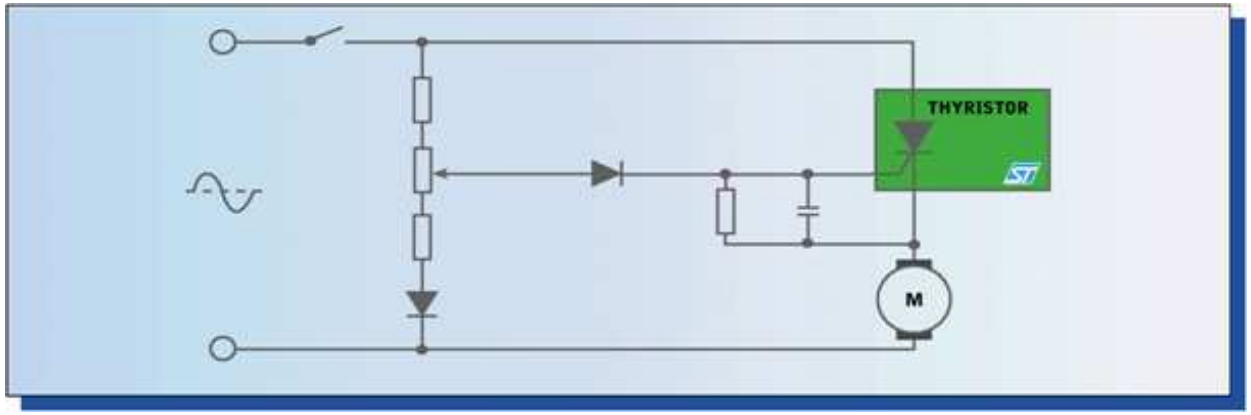


Universal Motor: DC Universal Motor Drive

A THYRISTOR supplies the motor during the positive mains half cycle.

Both the THYRISTOR and its control are connected in such a way that the motor back-EMF compensates the motor load variations to adjust the speed.



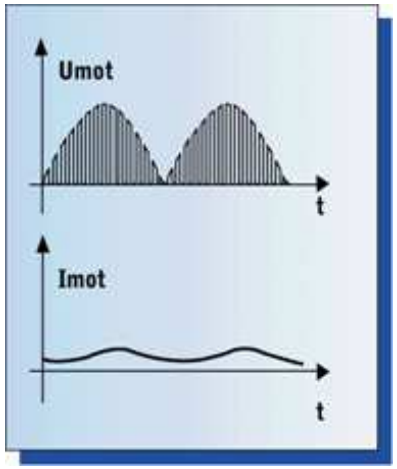


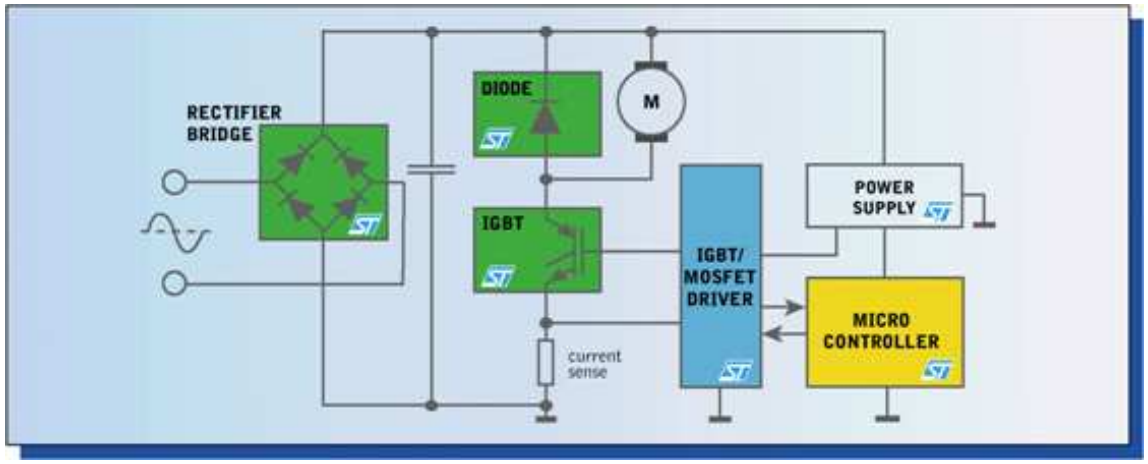
This low-cost circuit is popular for low power and intermittent use equipment.

High Frequency PWM Universal Motor Control

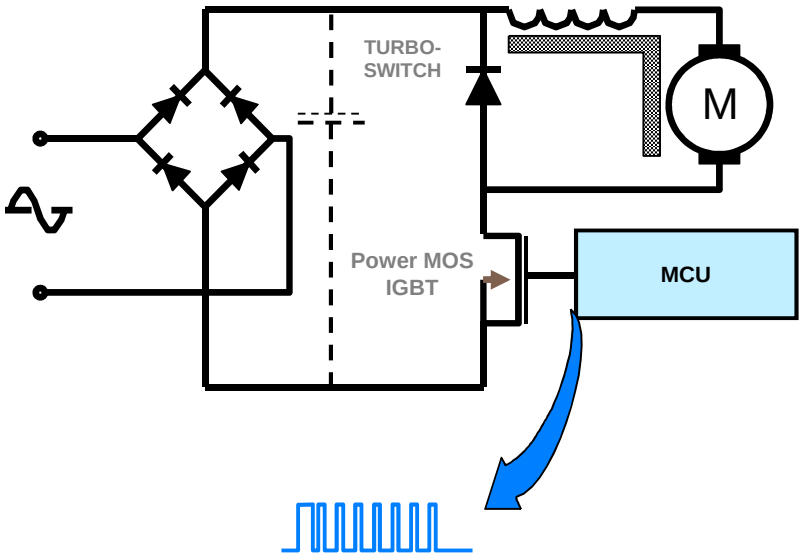
The rectified voltage across the motor varies in PWM mode at an inaudible switching frequency.

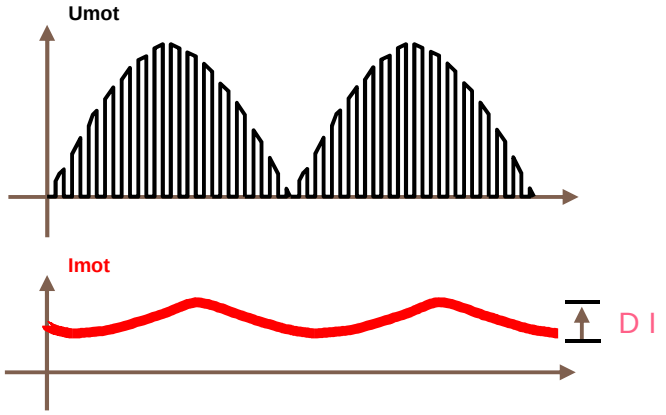
The DC supply provides a smooth current operation, reducing motor acoustic noise and improving motor efficiency.





DC PWM Control: Principle

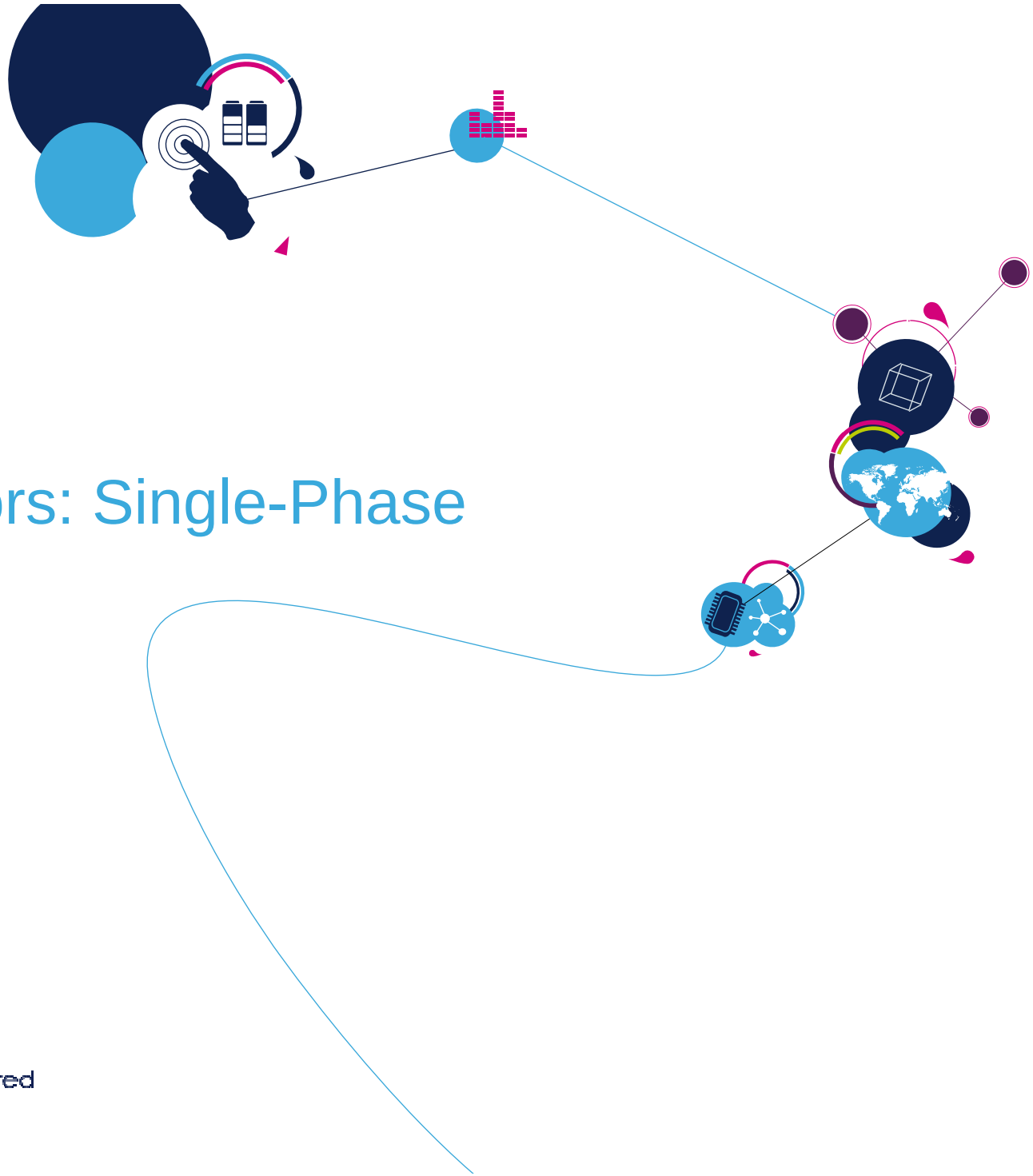




Flexible PWM generator within MCU to fix the speed:

1 register value for Frequency
1 register value for duty-cycle

- ➔ **Low current ripple**
- ➔ **Reduced acoustic noise**
- ➔ **Optimized efficiency**



Induction Motors: Single-Phase

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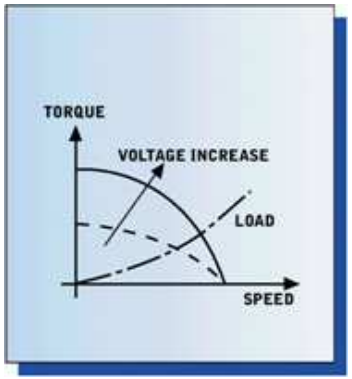
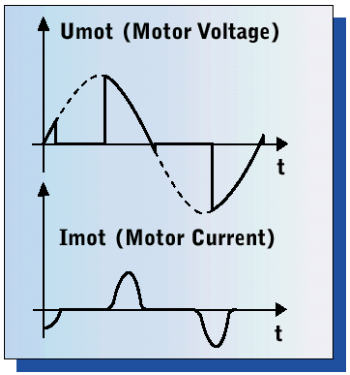
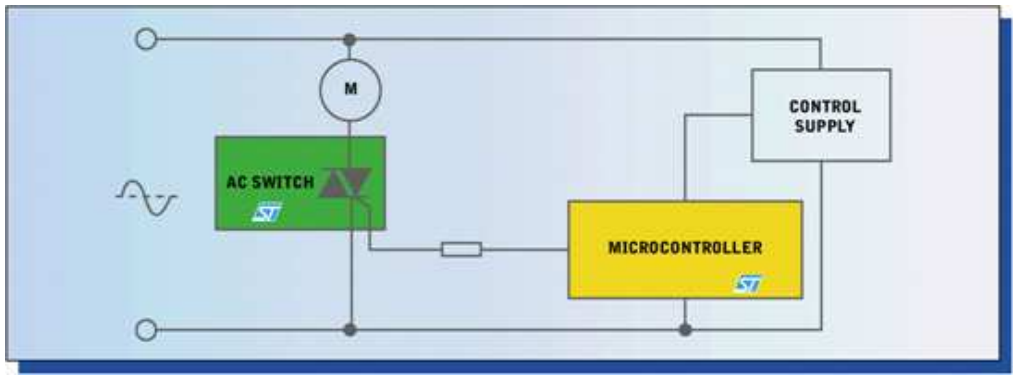
Phase-Controlled Induction Motor Drive

A silent and cost-effective variable speed drive can be achieved by an innovative topology whereby the speed is controlled. A simple phase-control switch can then vary the speed by adapting the motor torque profile. (See also the AC Universal Motor Drive)

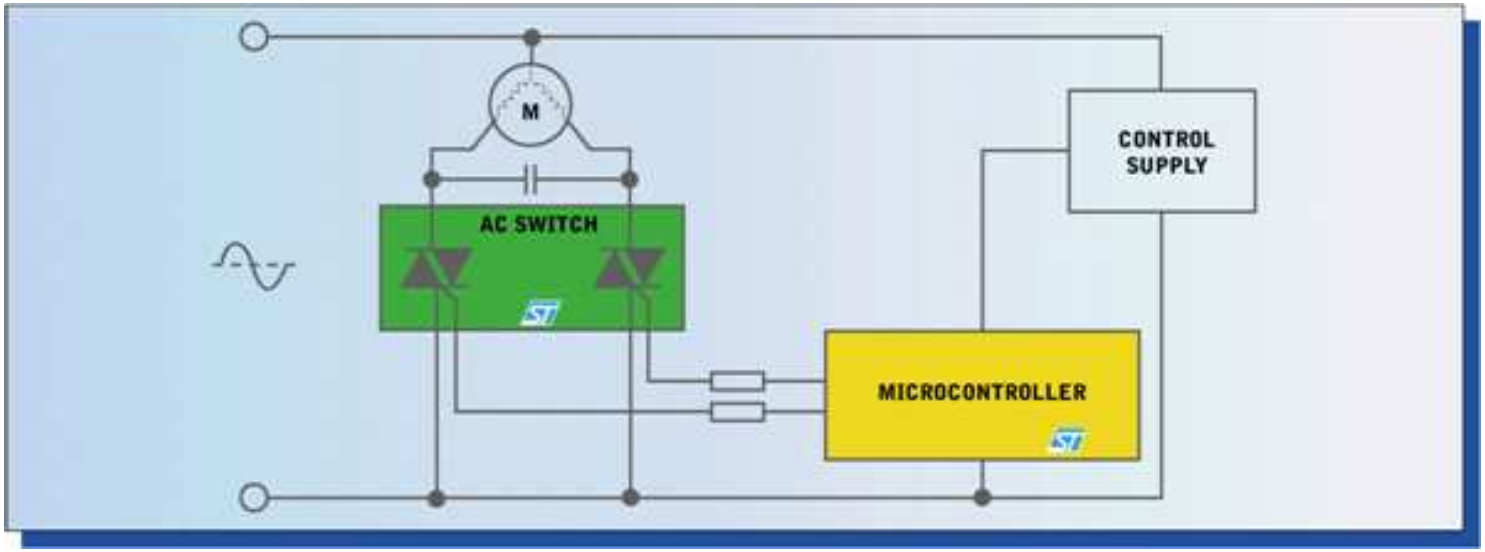






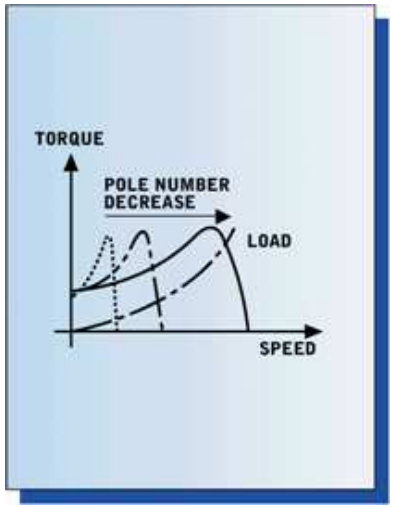
Bi-Directional Induction Motor Drive

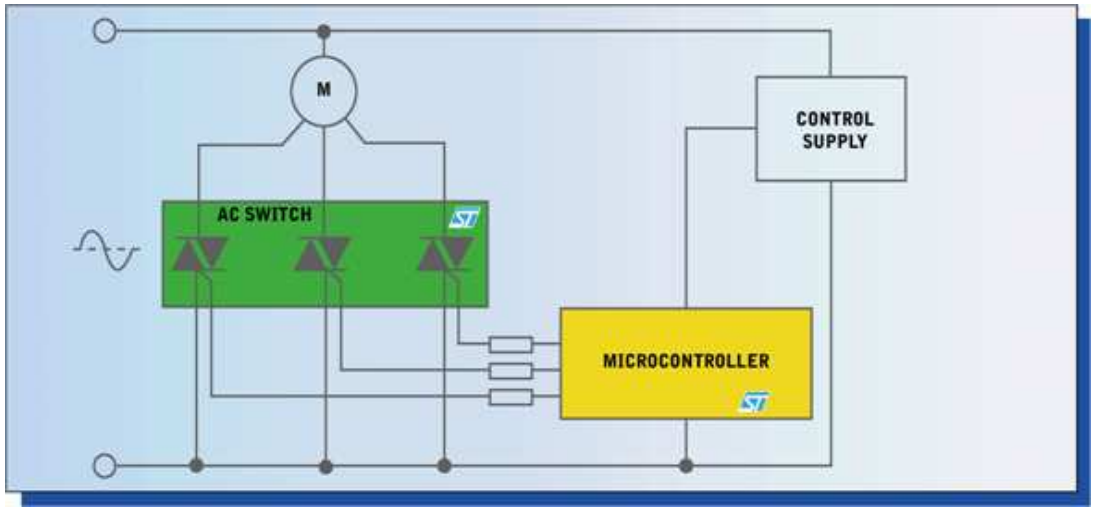
When a motor with a phase-shift capacitor is used, the direction of rotation can be reversed by means of two AC switches which connect the phase-shift capacitor in series with either of the two stator windings.



Multi-Winding On/Off Induction Motor Drive

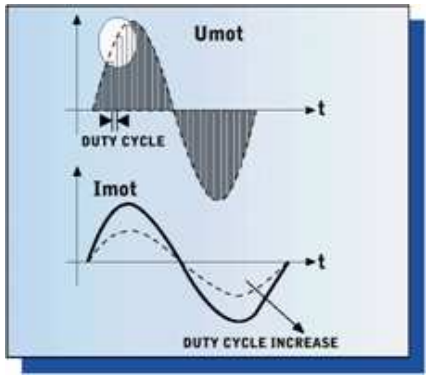
The stator coil is divided into 3 or 4 pairs of winding. The speed is adjusted stepwise by connecting different combinations of these windings to the mains through AC switches *in order to change the number of excited stator poles and the base speed.*

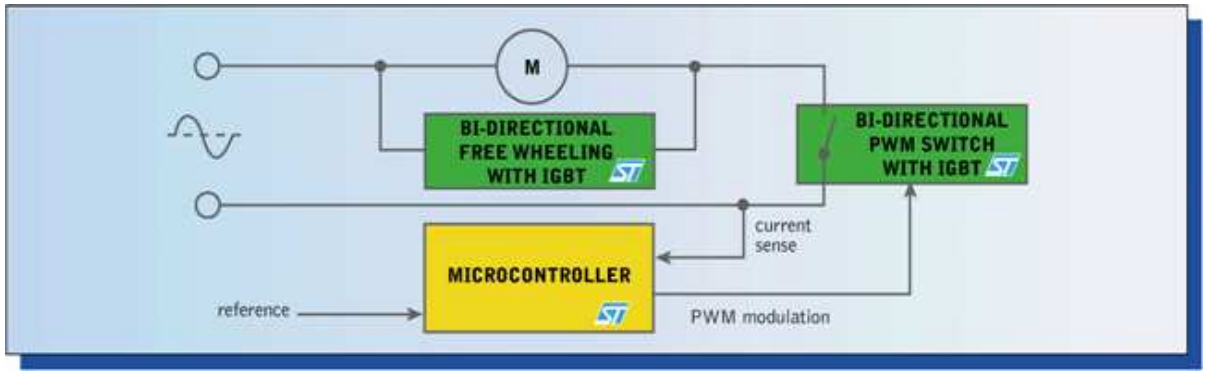




High Frequency AC Chopper Induction Motor Drive

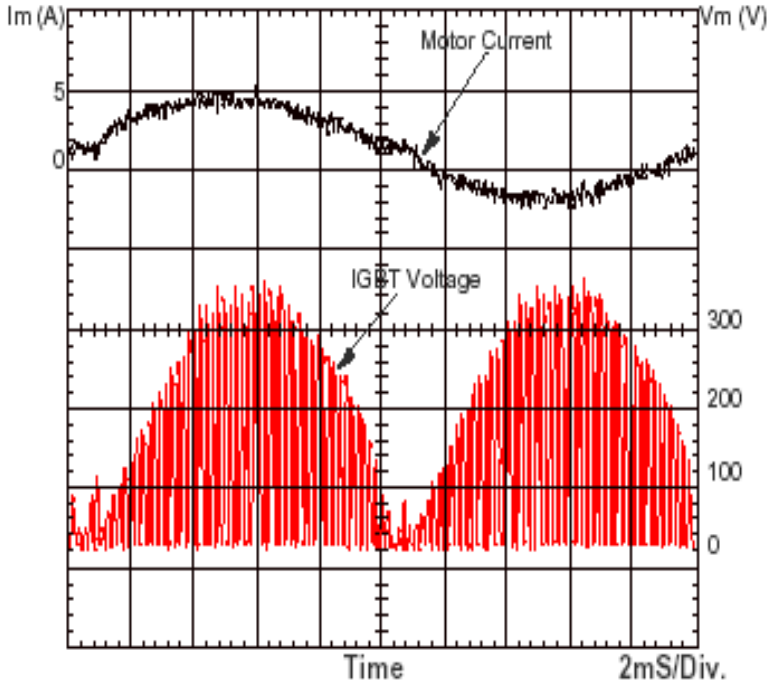
The induction motor is driven in high frequency mode by an innovative single switch topology, which delivers a silent and cost effective variable speed drive.

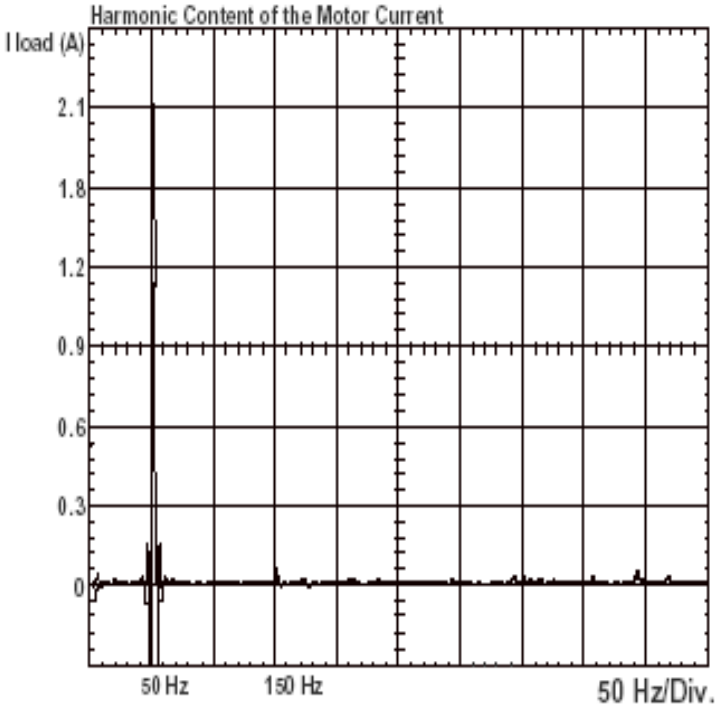




The speed is controlled by the motor voltage: the power switch runs in PWM mode and its duty cycle changes linearly to control the speed versus the torque.

High Frequency AC Chopper Induction Motor Drive Experimental Results



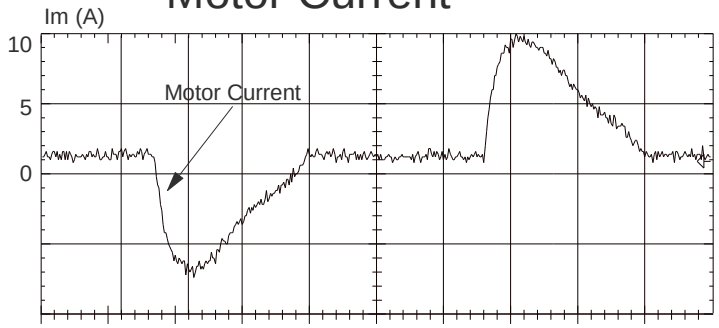


FFT of the Motor Current

High Frequency AC Chopper Induction Motor Drive Phase Angle Partialization driving comparison

with TRIAC driver and Phase Angle Partialization

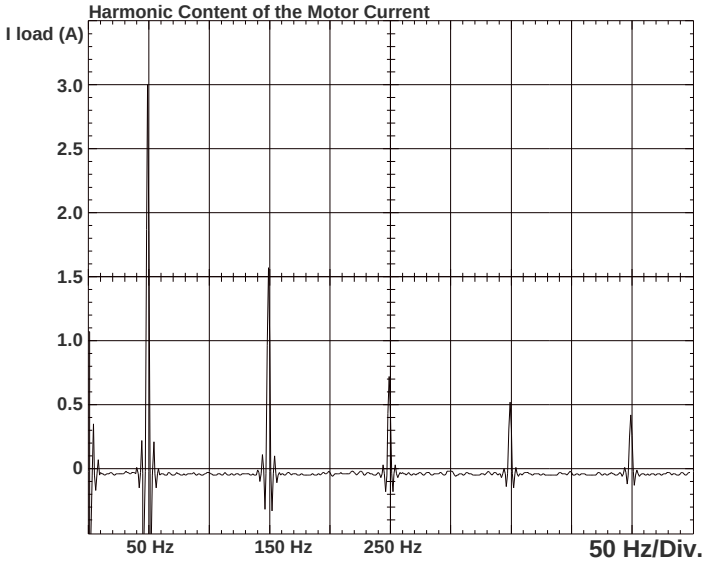
Motor Current



Comparing Harmonics Power Content between the two solutions

	1 st (Watt)	3 rd (Watt)	5 th (Watt)
Triac Solution	500	68	32
Proposed Solution	400	0.1	0.0

Current Harmonic Content



Induction Motor: The Three-Phase

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The Three-Phase motor

The three-phase induction motor is a brushless motor. Its stator is copper wound and the rotor is typically made of an aluminum squirrel cage. The motor is supplied with three sinusoidal voltage waveforms which produce a rotating stator field.

The speed is adjusted by the field frequency. The rotor follows this field with a lag called the slip.

Typical Application Parameters

- Voltage: 100 to 240 Vac
- Motor Power: 50 to 2200 W
- Speed Range: 0 to 20.000 RPM
- Features: Robust, silent and reliable

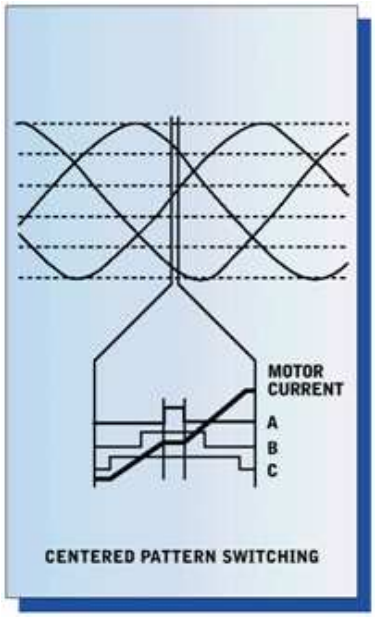
Major Applications

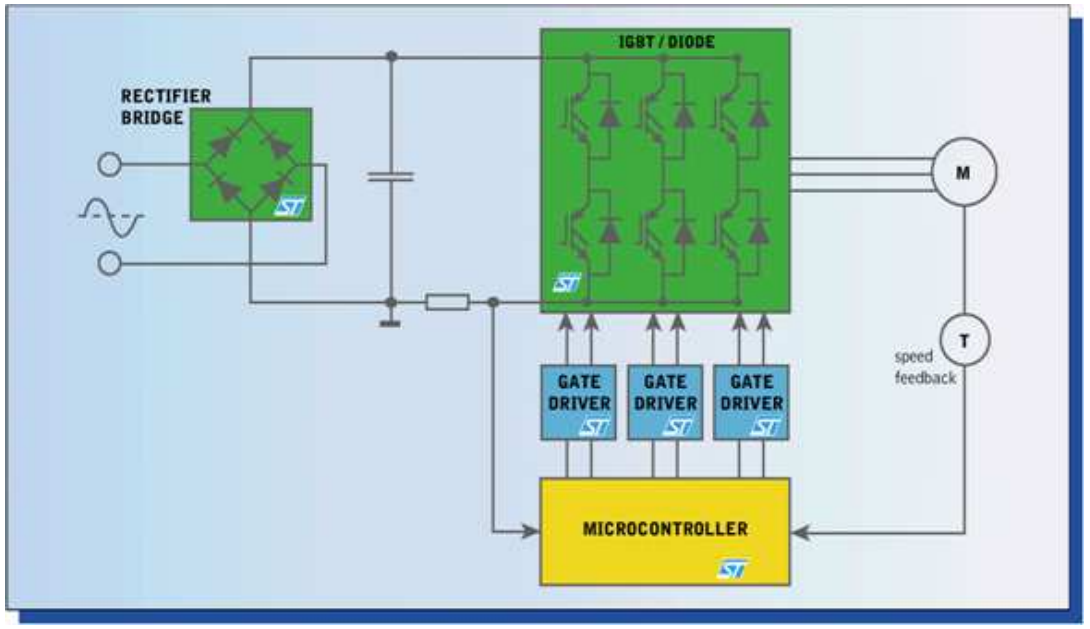
Washing Machine, Fans, Air Compressor, Heating, Ventilation and Air Conditioning, Industrial Control.

Note: Slip frequency is the difference between stator frequency f and rotor frequency

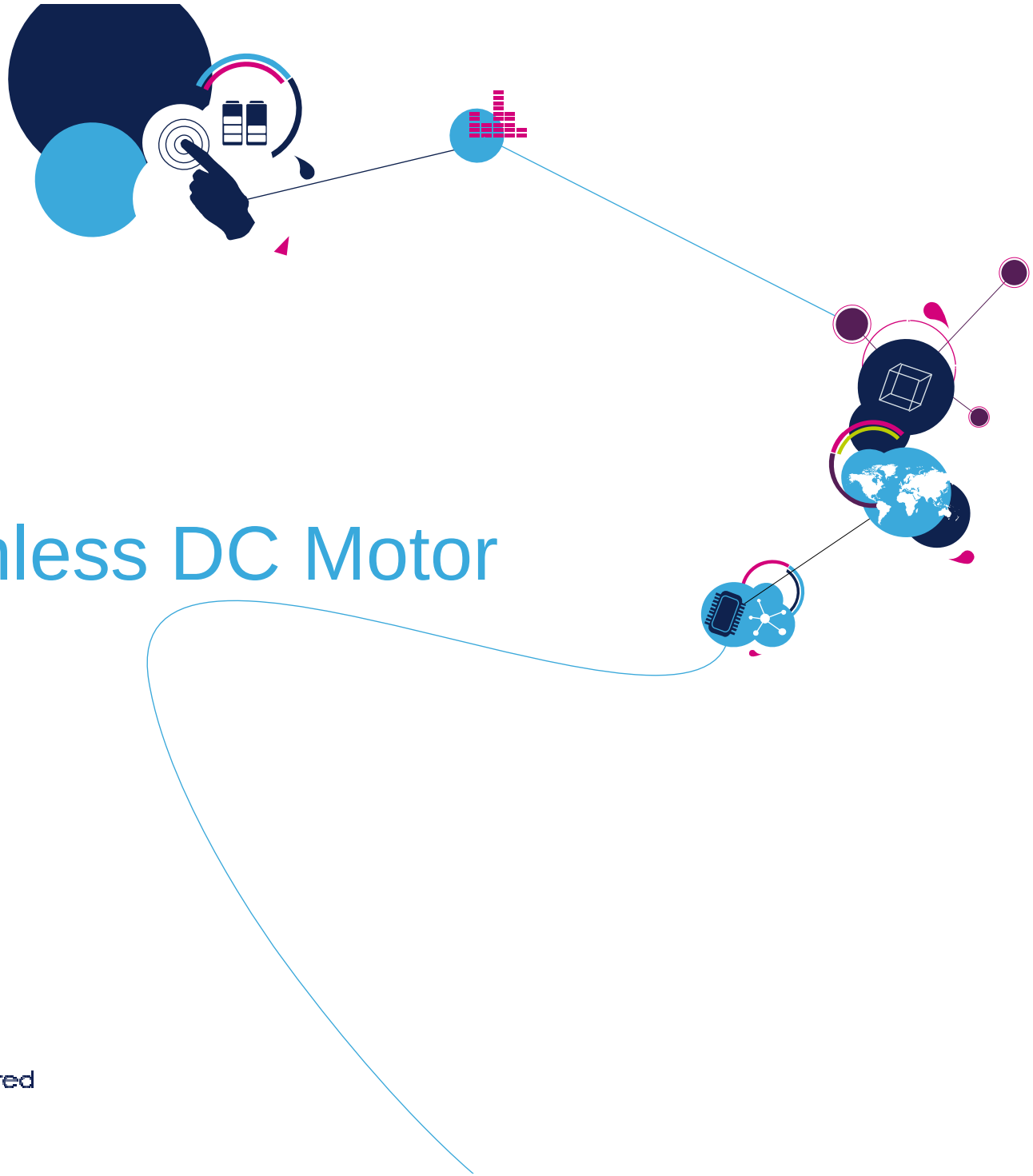
Three-Phase Induction Motor in Scalar Control Mode

Scalar control is typically achieved by controlling the voltage to frequency ratio (V/f) in an open or closed loop. Optimized motor efficiency can be achieved by implementing slip regulation.





Note: Slip frequency is the difference between stator frequency f and rotor frequency



The Brushless DC Motor

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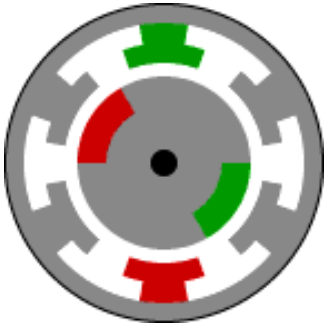
The Brushless DC Motor

The stator of the brushless DC Motor is copper wound and its rotor features a number of permanent magnets. The motor is supplied with three alternative waveforms which produce a rotating stator field. The rotor runs at the synchronous speed, and optimum motor efficiency occurs when the current in the motor and the back-EMF are in phase.



Typical Application Parameters

Voltage: up to 60Vdc; 100 to 240Vac
Motor Power: 5 to 2,200W
Speed Range: 0 to 30,000 RPM

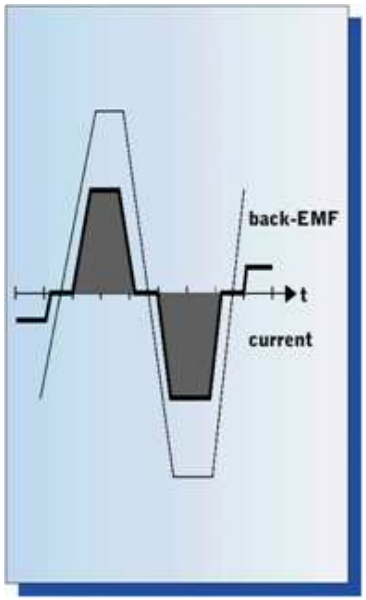
Features: High torque capability at start up and low speed, Highly efficient and compact

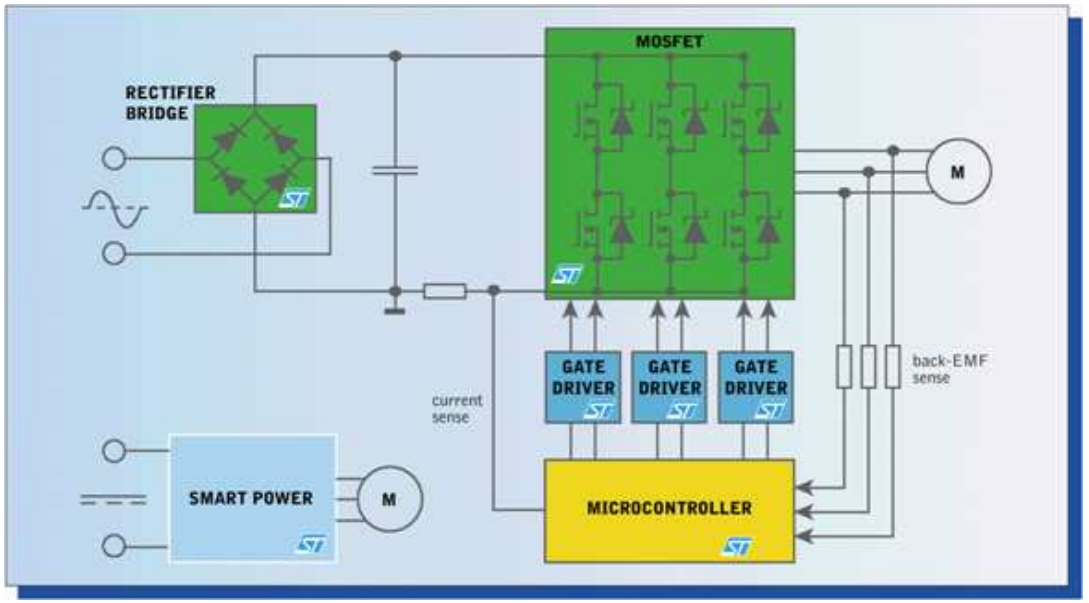
Major Applications

Heating, ventilation and air conditioning, Refrigerators, Medical equipment, Robotics, Fans, Pumps, Hard disk drives, CD/DVD drives.

Brushless DC Motor in six step mode

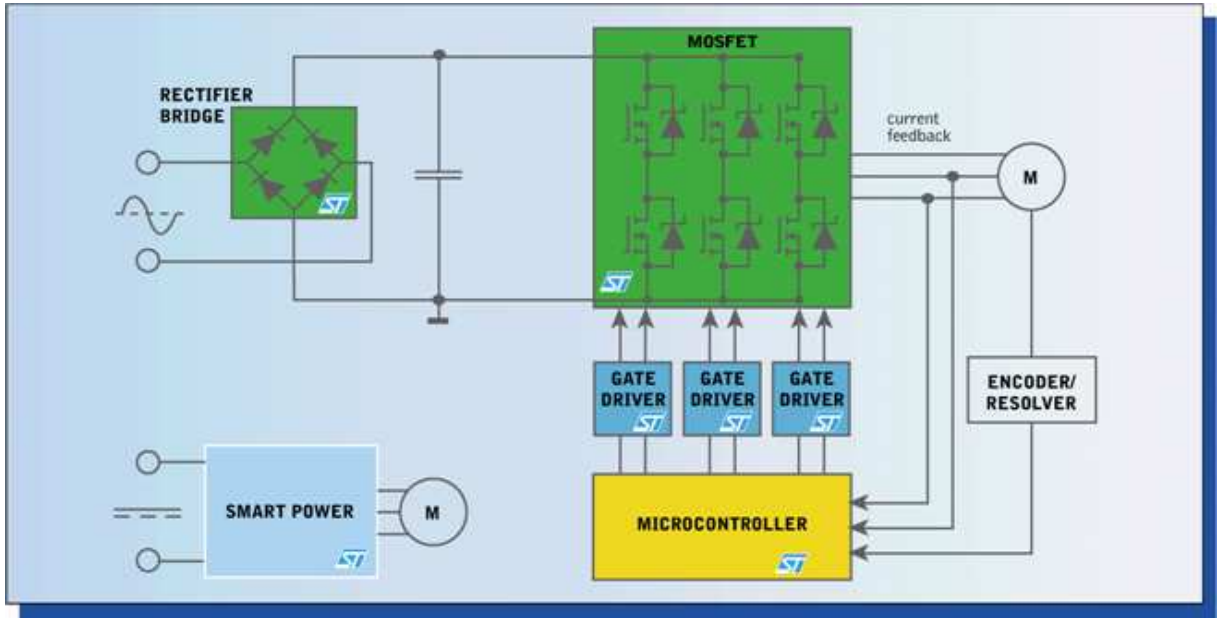
The motor is supplied by three trapezoidal 6-step waveforms. During each step, two phases are excited. In sensorless mode, the unexcited phase is monitored to read the back-EMF.

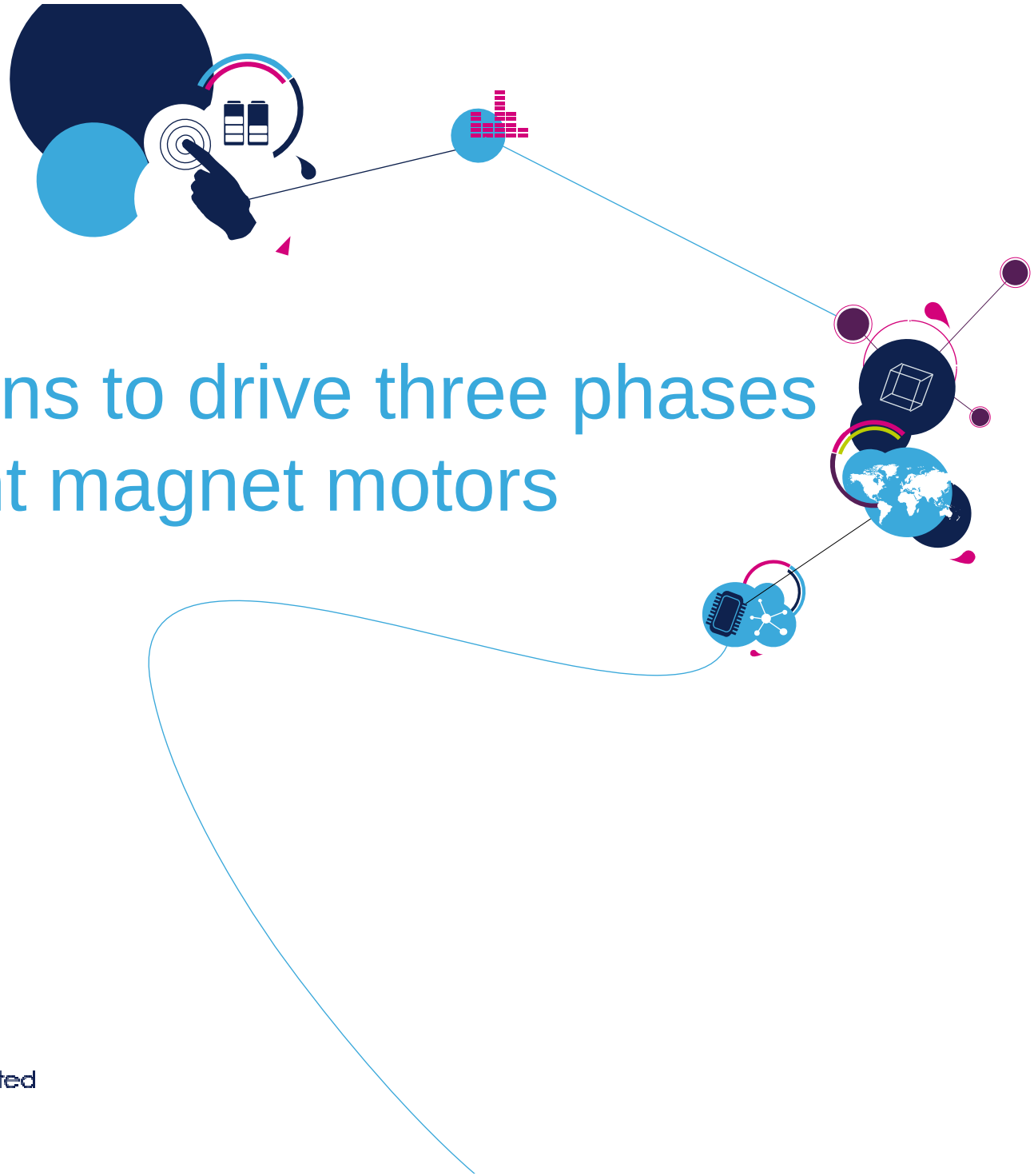




Brushless DC Motor in Sinusoidal Mode

The motor is supplied by three sinusoidal waveforms. This control mode delivers low levels of acoustic and electromagnetic noise. A resolver and current sensors are normally needed for high-performance operation.





ST solutions to drive three phases permanent magnet motors

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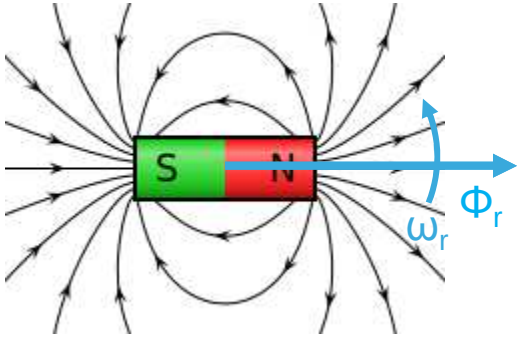
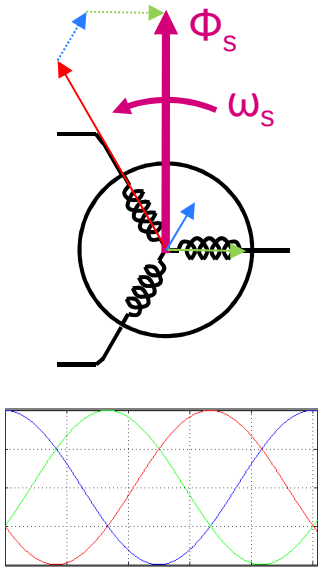
What is FOC?

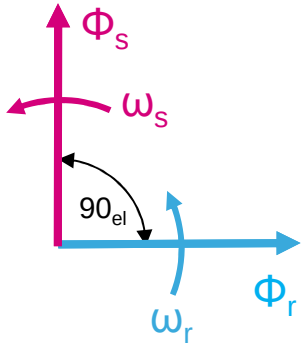
- FOC is the acronym of ***Field Oriented Control.***
- The purpose of the FOC is to maximize the electro-magnetic torque provided by the motor keeping the two magnetic fields (rotor and stator) always at 90 electrical degrees.

Rotor magnetic field



Stator magnetic field





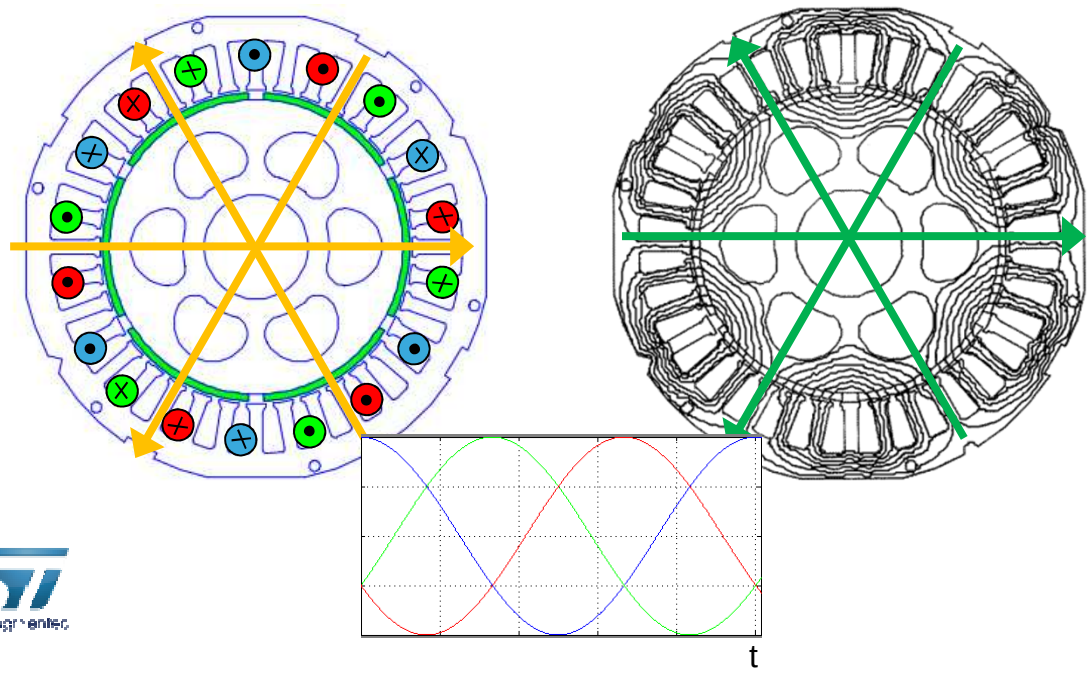
Torque T_e is maximized if the two field are kept at 90°

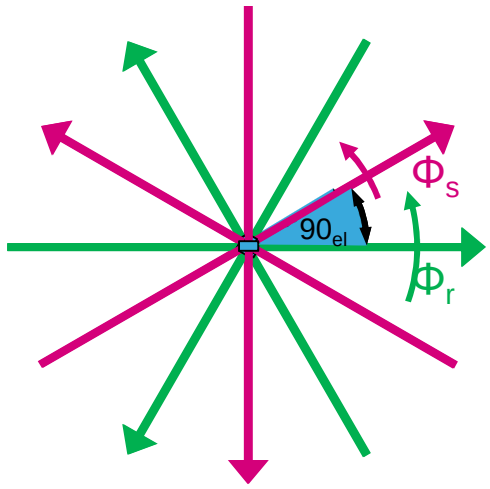
Benefits of FOC

- Best energy ***efficiency*** even during ***transient operation.***
- ***Responsive speed control*** to load variations.
- ***Decoupled control*** of both electromagnetic torque and flux.
- Acoustical ***noise reduction*** due to sinusoidal waveforms.
- Active ***electrical brake*** and ***energy reversal.***

PMSM FOC Basics

- Field Oriented Control: stator currents (Field) are controlled in amplitude and phase (Orientation) with respect to rotor flux
  - ➢current sensing is mandatory (3shunt/1shunt/ICS)
  - ➢speed / position sensing is mandatory (encoder/Hall/sensorless algorithm)
  - ➢current controllers needed (PI/D,FF)
    - ❖not easy… high frequency sinusoidal references + stiff amplitude modulation..
    - ❖reference frame transformation (Clarke / Park) allows to simplify the problem:



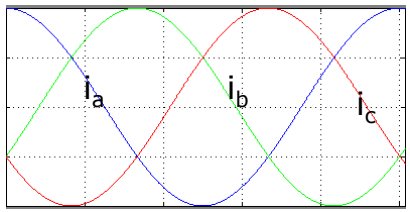


T_e maximized if…

PMSM FOC Basics:

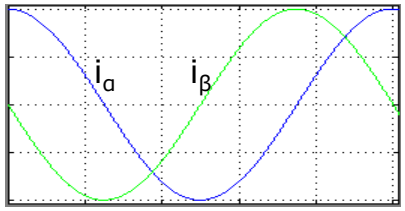
reference frame transformations

- Clarke: transforms i_a,i_b,i_c (120°) to i_α,i_β (90°); (consider that ia+ib+ic=0);

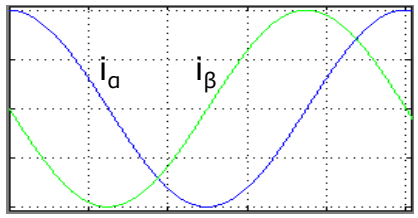


$$i_\alpha = i_{as}$$

$$i_\beta = -\frac{i_{as} + 2i_{bs}}{\sqrt{3}}$$

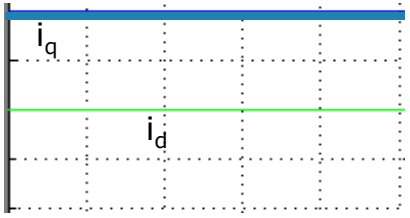


- Park: currents i_α,i_β , transformed on a reference frame rotating with their frequency, become DC currents i_q,i_d (90°)

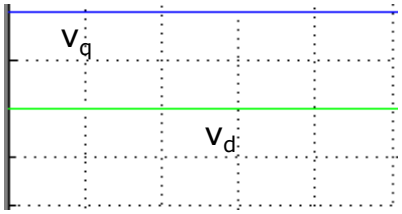


$$i_{qs} = i_\alpha \cos\theta_r - i_\beta \sin\theta_r$$

$$i_{ds} = i_a \sin\theta_r + i_\beta \cos\theta_r$$

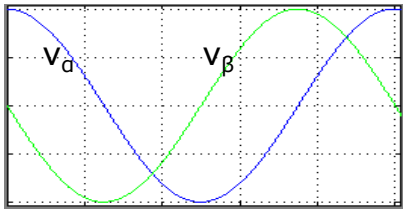


- PI regulators now work efficiently in a 'DC' domain; their DC outputs, voltage reference v_q, v_d are handled by the Reverse Park -> v_α,v_β AC domain

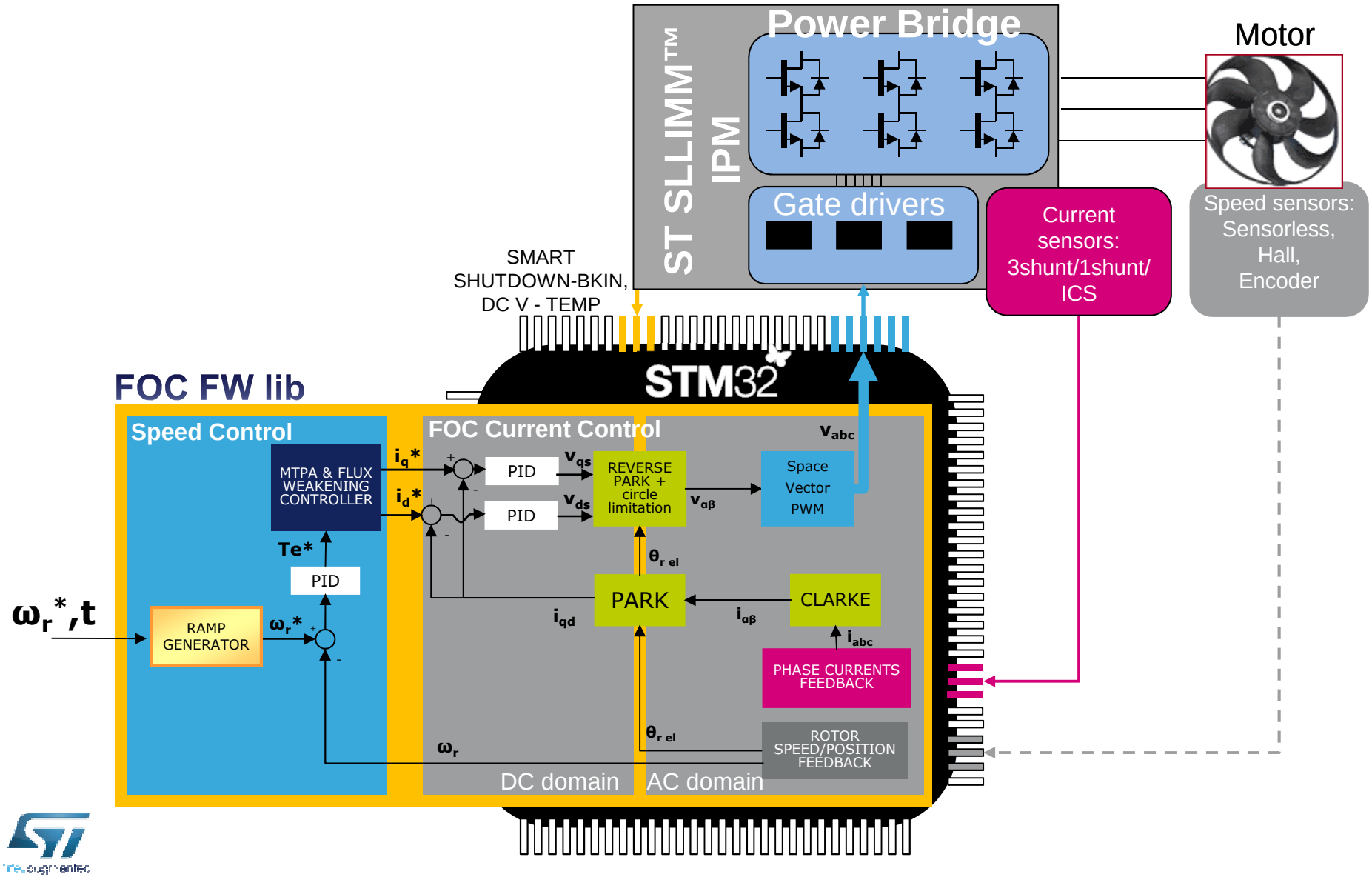


$$v_\alpha = v_{qs} \cos\theta_r + v_{ds} \sin\theta_r$$

$$v_\beta = -v_{qs} \sin\theta_r + v_{ds} \cos\theta_r$$



PMSM FOC – Block Diagram

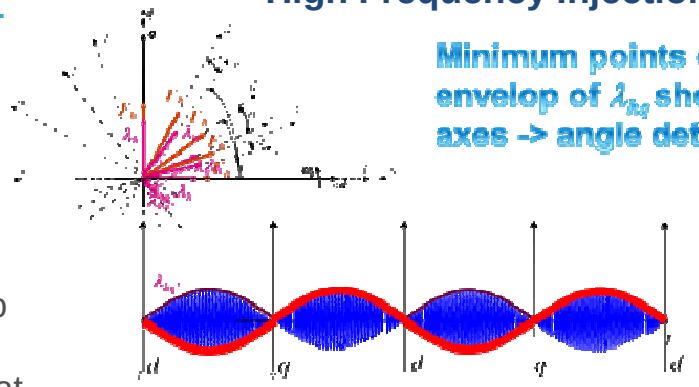


ST PMSM FOC library

Features

- Speed/position sensors supported:
  - Quadrature Encoder
    - Expensive sensor, usually only in robotics applications
  - Hall Sensors
    - Cheaper sensors, usually for application requiring full torque at zero speed
  - Sensor-less
    - High frequency injection (ST patent pending):
      - for anisotropic motors (IPMSM, Ld<Lq)
      - allows precise rotor angle detection; it enables advantages of FOC in torque/speed/position control mode at very low and zero speed
    - State observer + PLL
      - Use electrical quantities (mainly current feedback) to estimate rotor position
      - Used for many applications not requiring full torque at zero speed or very low speed operations (< 3-5% of nominal speed)
    - State Observer + CORDIC

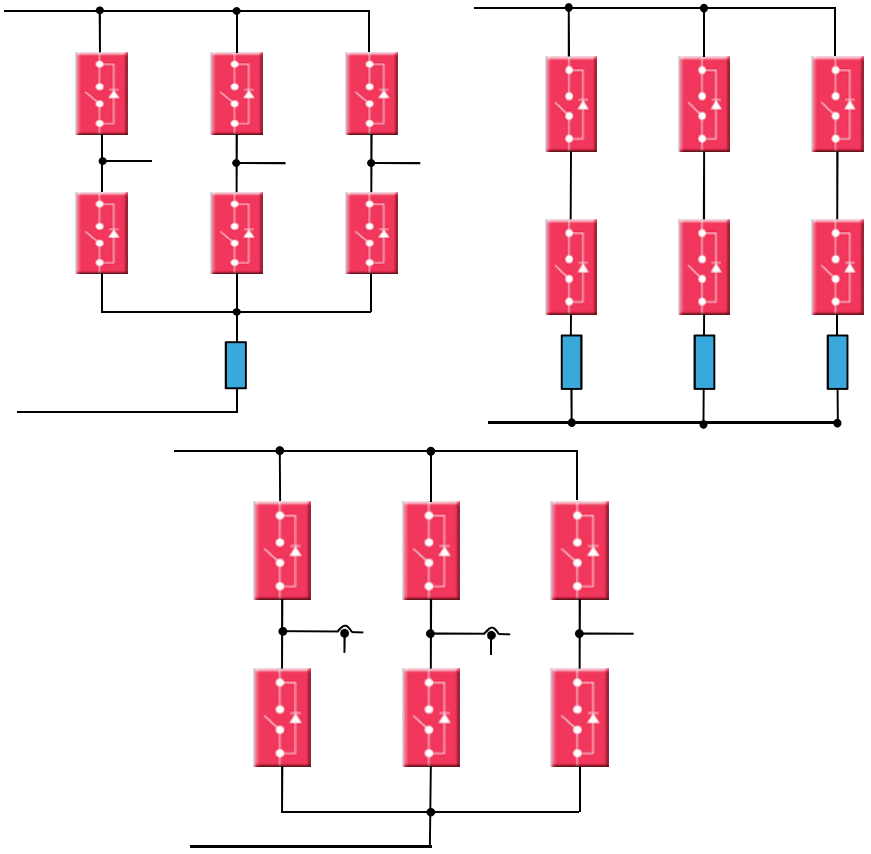
High Frequency Injection

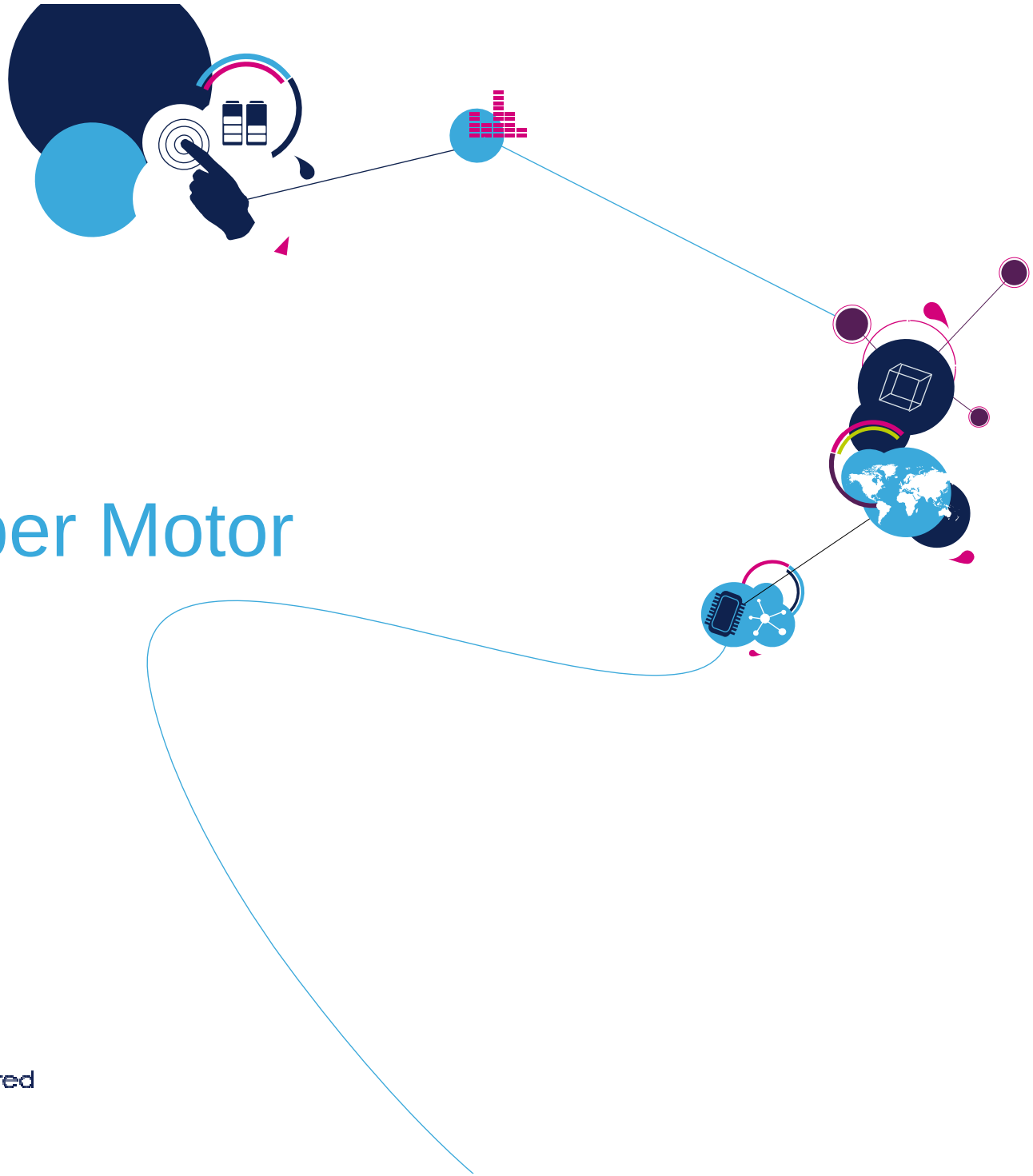


ST PMSM FOC library

Features

- Current sensing topologies:
  - 1 shunt resistor placed on the DC link
    - ST patented algorithm
    - Only one op-amp /shunt resistor is needed → lowest cost
    - Current reading algorithm may result in not accurate torque regulation
  - 3 shunt resistors placed in the three legs
    - Current reading accuracy: high
    - Best compromise cost / performances
  - 2 Isolated Current Sensors (ICS)
    - Not dissipative current sensing topology → mandatory when current exceed some tens Ampere
    - Expensive
  - Any possible configuration (2 motors x 3 current sensing x 3 speed sensors type) is supported by FW library





The Stepper Motor

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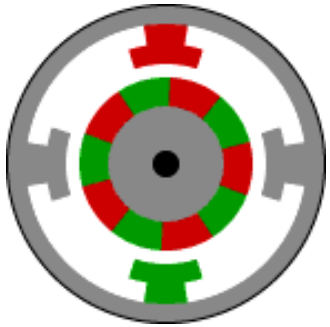
The Stepper Motor



The stepper motor carries windings on the stator only. The rotor usually features permanent magnets.

The stepper motor converts digital current pulses into fixed angular steps.

For this reason, they are normally used in an open loop configuration and they are the most cost-effective solution in many positioning applications.

Electrically speaking, there are two basic types of stepper motors:

- **Unipolar:** the current is allowed to flow only in one direction through the motor windings

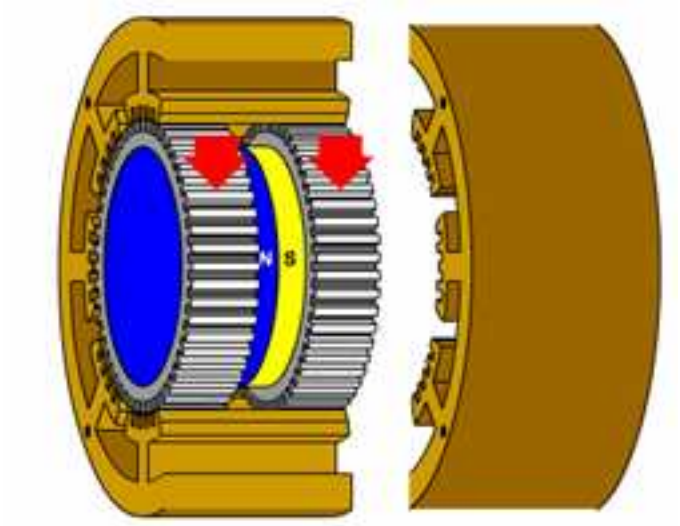
- **Bipolar:** the current will flow in both directions through the windings

The Stepper Motor: Control Methodologies

A stepper motor driver typically works in switch mode and includes a current control circuit whereby the current in the windings is usually controlled in such a way that it follows a predetermined profile.

In half and full step modes, the current profile is rectangular whilst in micro step mode it is nearly sinusoidal.

A power bridge is needed to drive bipolar stepper motors; but an array of switches is sufficient to drive unipolar stepper motors.



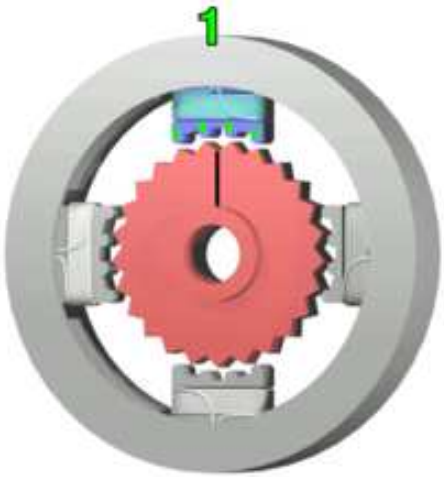
Typical Application Parameters

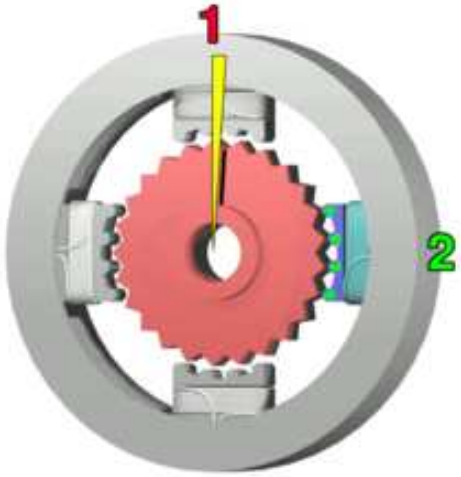
- Supply Voltage: 12 to 180Vdc
- Motor Power: up to 300W
- Speed Range: 0 to 1,000 RPM
- Angular Resolution: 0.1 up to 45 degrees
- Features: High torque, Position accuracy

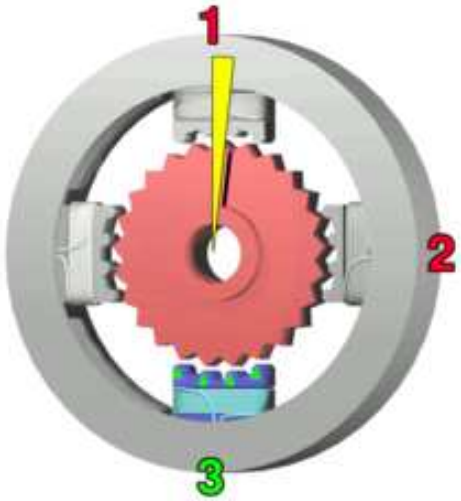
Major Application

Printers, Automotive, Air conditioning louver, Factory automation, Machine tools

PRINCIPLE

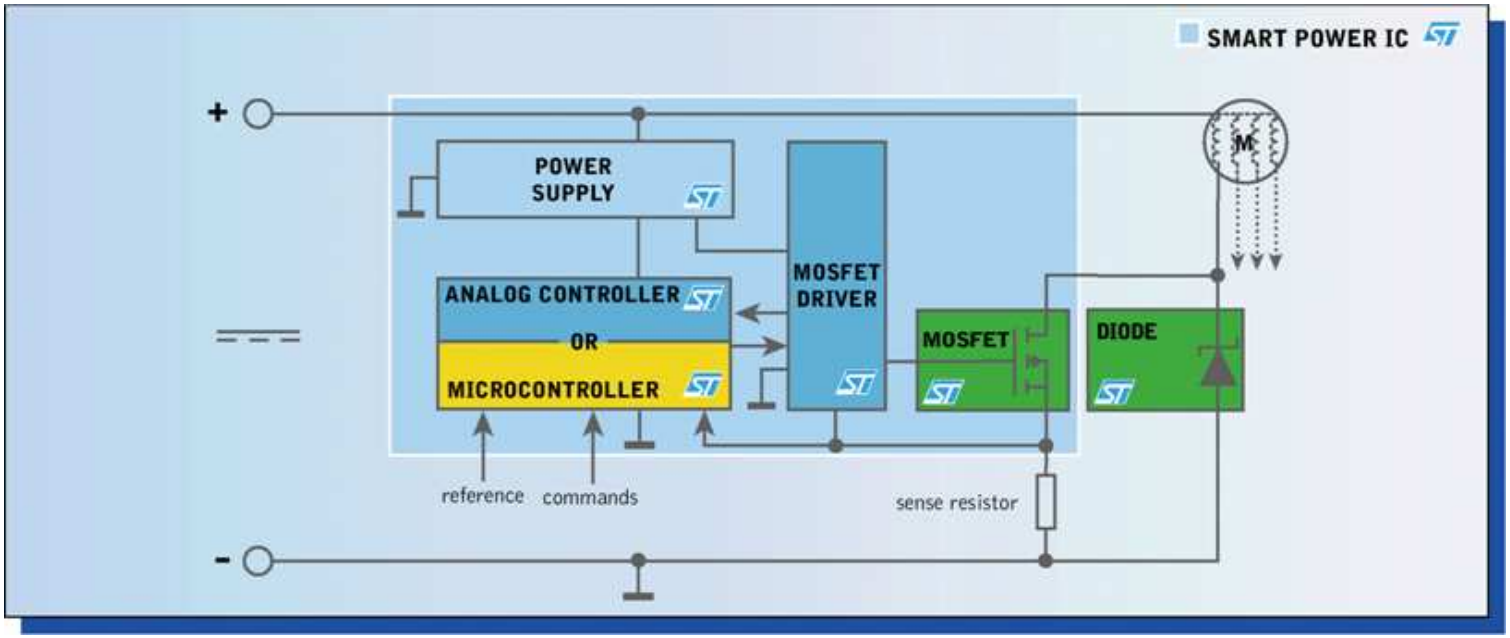






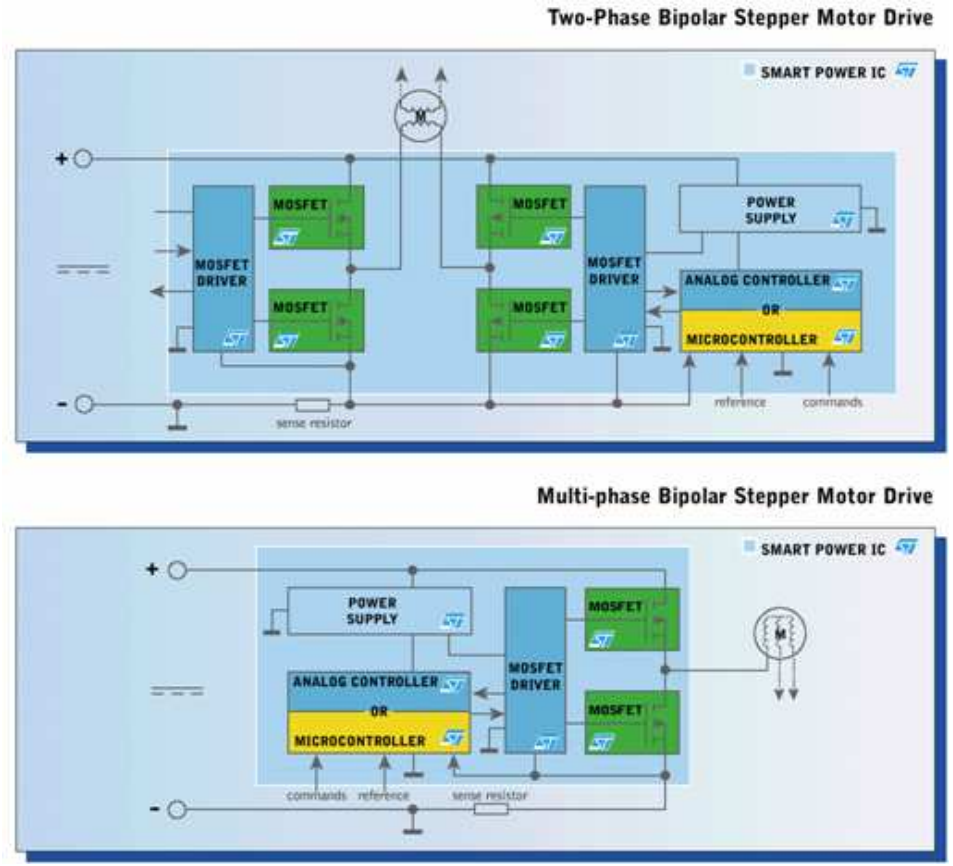
Driver for Unipolar Stepper Motor

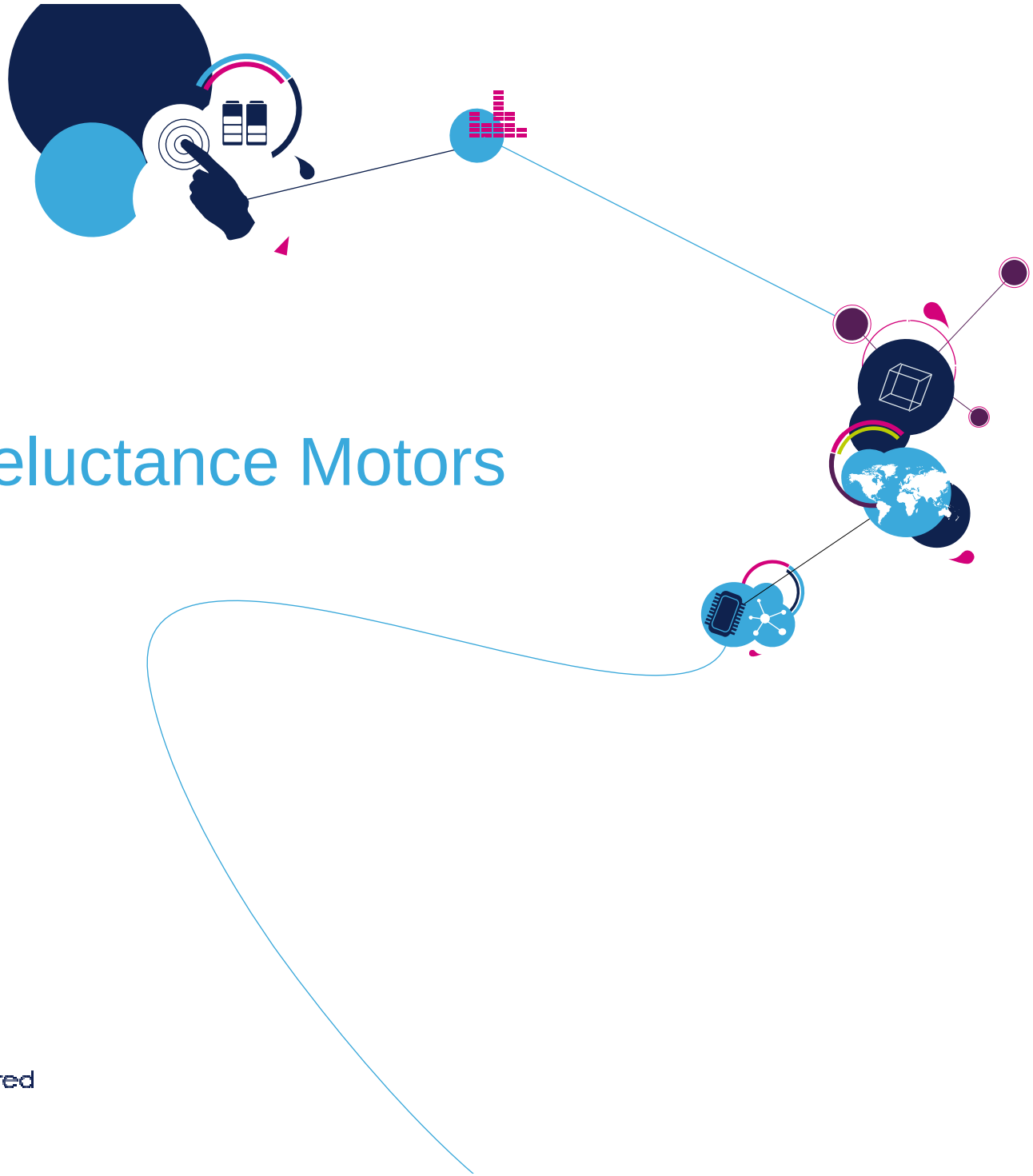
All stator windings share a common terminal. The free terminal of each winding is connected to a separate power switch. Diodes are used for clamping the voltage across the switches at turn-off.



Driver for Bipolar Stepper Motor

A full-bridge converter is required to drive each of the two windings of a two-phase motor, whereas a three-phase inverter is needed to drive a three-phase motor.





Switched Reluctance Motors

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Switched Reluctance Motors

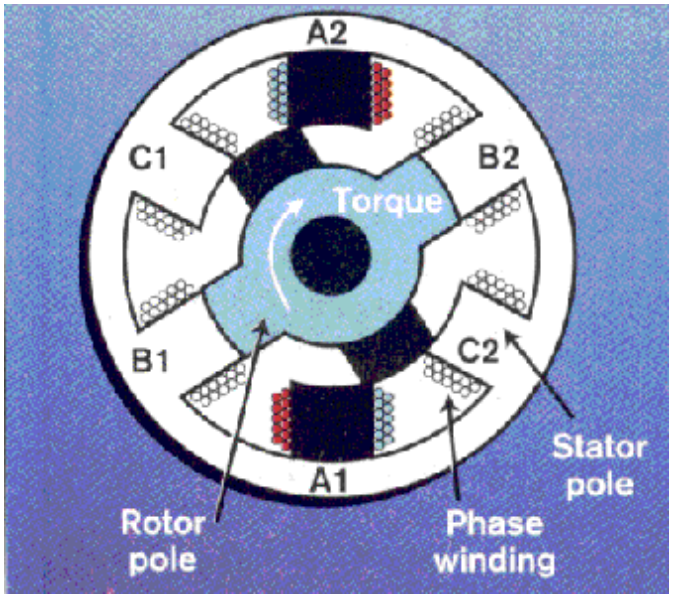
Switched Reluctance Motors (SRM) are step-motors where both stator and rotor have salient poles. No permanent magnets are used, therefore the magnetic flux is produced by means of the stator coils. The speed is controlled by varying the frequency of the voltage control signal as in a stepper motor.

Major Advantages of SR Motor

- Speed variable in a wide range
- Easy speed control implementation
- High torque at start-up
- Absence of brushes and magnetic parts
- Low manufacturing costs

Major Drawbacks of SR Motor

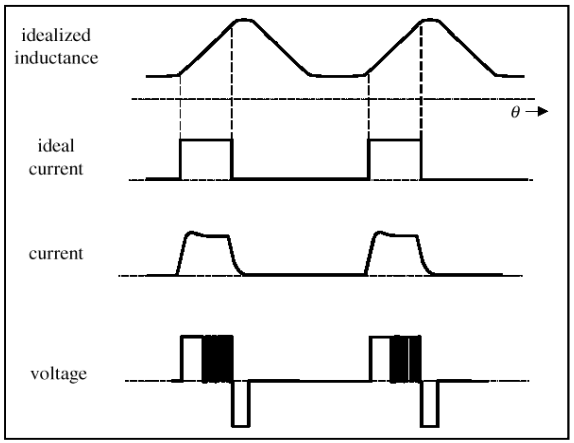
- Not directly on the mains
- Complex electronics for control
- High system costs

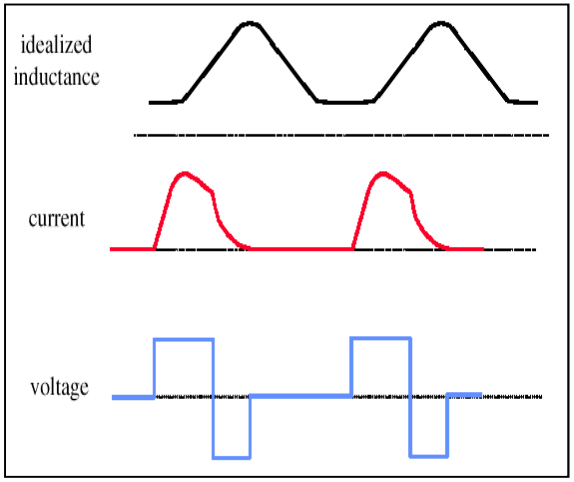


3-phase, 6/4 motor configuration

Typical Applications: Vacuum cleaners, Washing machines, Food processors

SRM drive with rotor position feedback



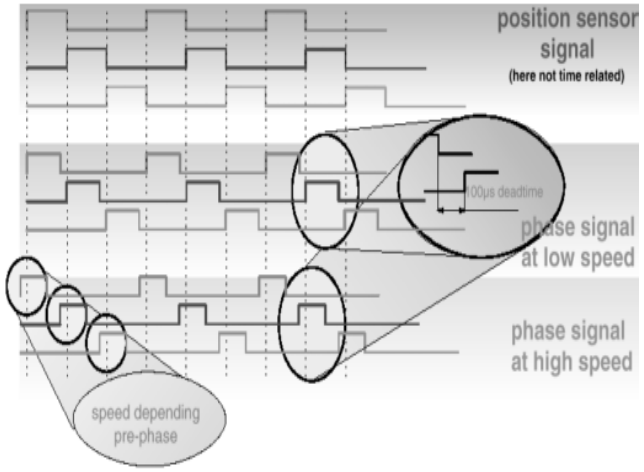


Since the relation linking the supplied torque T and the phase current *i* is

$$T = \frac{i^2}{2}\frac{dL}{d\theta}$$

current has to be supplied when the inductance L seen from each phase (and variable with rotor position with respect to stator phase) is rising in order to have positive torque.

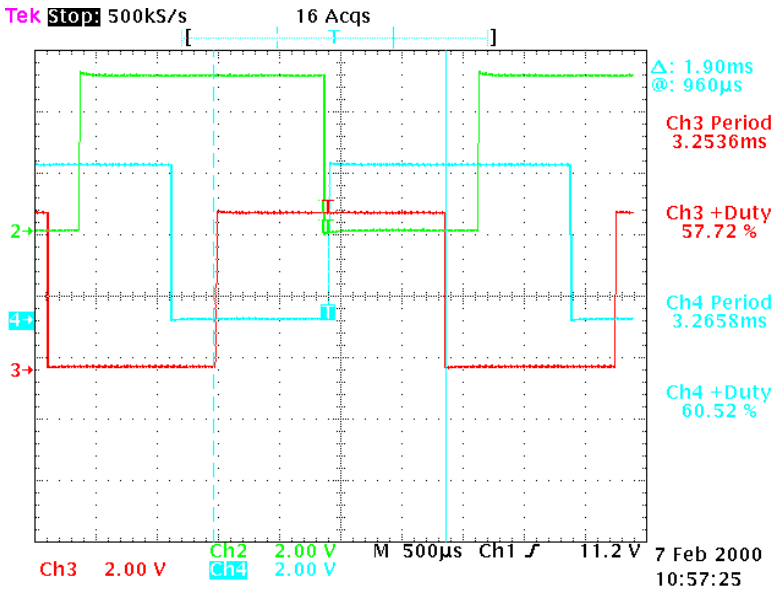
If current is supplied during L decreasing, a braking effect is obtained.



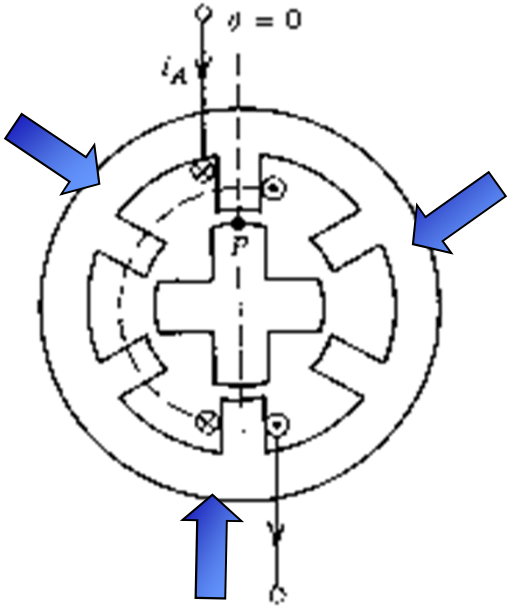
SRM Position Sensor Placement

Hall or photo-transistor sensors can be placed on the stator shaft to measure rotor position, therefore inductance variations.

Example of 3 photo-transistor sensors positioned at 120 degrees distance



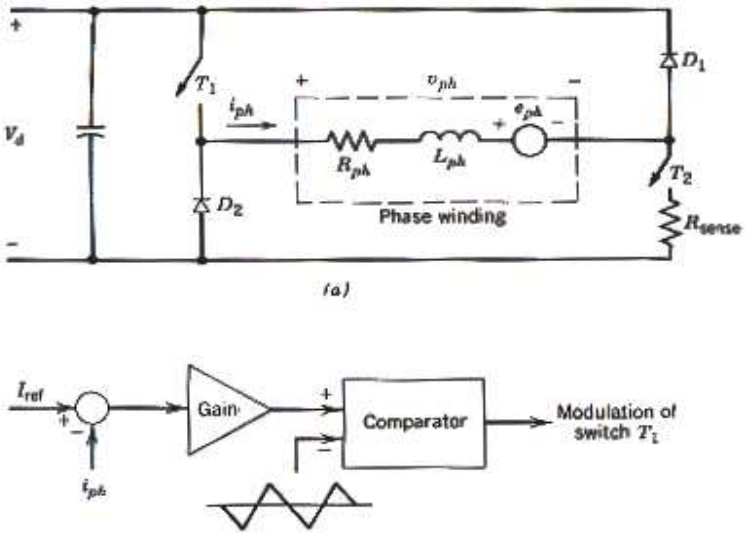
Sensors measures from oscilloscope



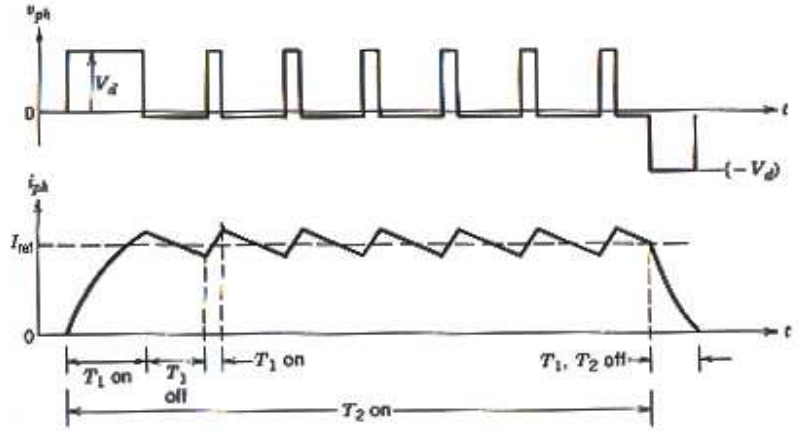
120 degree sensors position on a 6/4 SRM

Current Mode Modulation (2N Switches)

With this technique, the magnitude of the current flowing into the stator windings is controlled using a control loop on a current feedback.
The current winding in each phase is directly measured with a current/voltage converter or a current sense resistor connected in series with the phase. The current is compared with a desired value to calculate the error signal, that is compensated via a suitable control law.



Hardware topology of PWM Current Mode Control



V and I phase Waveform

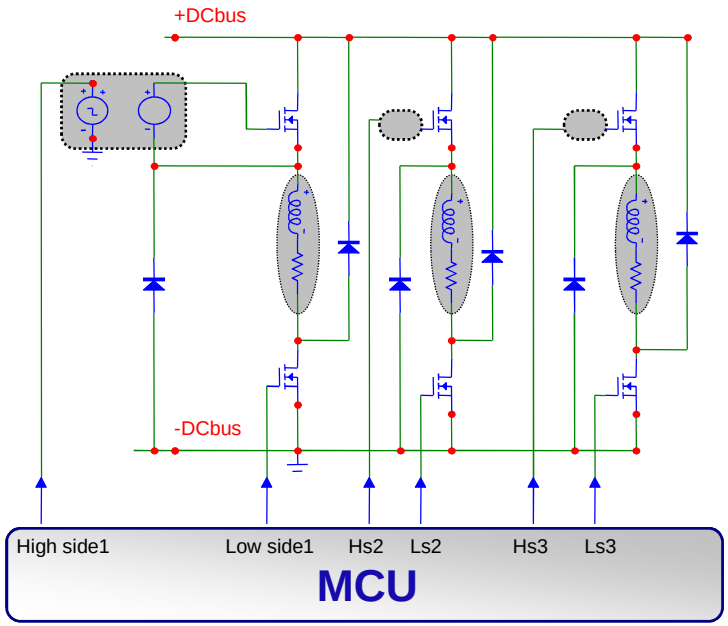
2n Switches Inverter Driver

Advantages

- Single phase current modulation (by using the pre-phase High-Side Switch)
- Fast phase turn-off
- Fastest phase de-energizing
- VBus fully exploitable

Drawbacks

- High cost (6 power switches + 3 drivers)
- High end microcontroller (6 independent control signals)



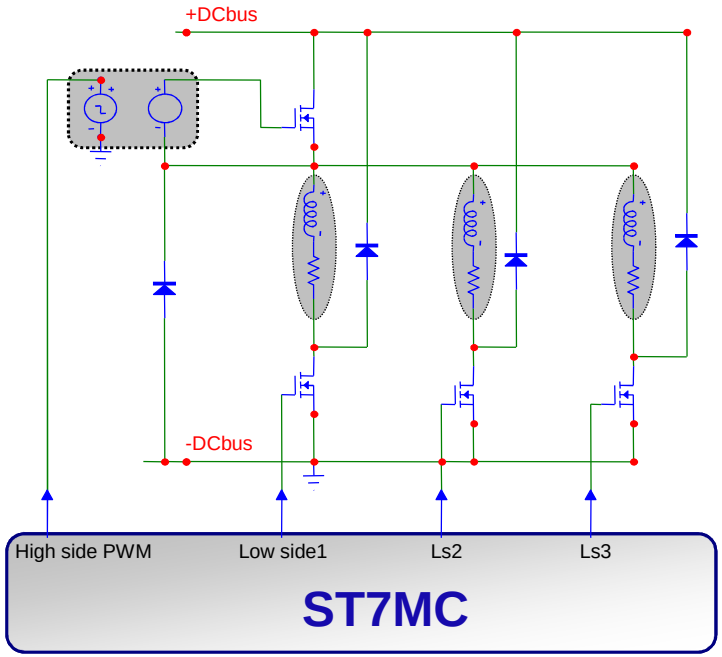
N+1 Switches Inverter Driver

Advantages

- Low cost (3 power switches + 2 drivers)
- Low end microcontroller (4 independent control signals + 1 PWM)
- Only 1 fast switch and 4 slow switch

Drawbacks

- Current 'tail' after phase turn-off
- Common current phase modulation
- Vbus higher than rated motor voltage (PWM duty cycle <<100%)
- Less Torque capacity due to no phase overlap energizing possibilities



Industrial Motion Control

Motor type	Applications addressed
3-phase motors	• Home appliances (washing machines, Fridge, etc..) • Industrial (pumps, fans, etc.) Servo drives, Robotics
Stepper motors	• Industrial • Security system • Building automation • Medical and Appliances
DC Brushed Motors	• Battery power application like Power tools and more .
Universal motor And AC Load	• Appliances like washing machines, vacuum cleaners, power tools etc.

ST Motion Control Ecosystem
3-Phase Motors ST PMSM FOC SDK

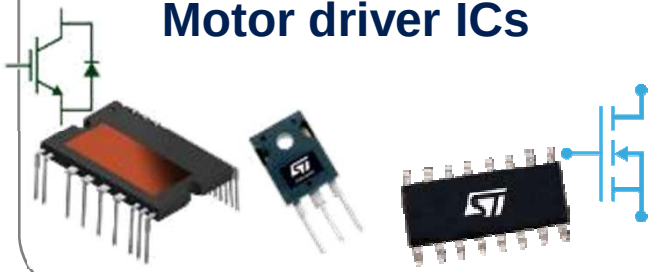
Ready-to-use ST Solution for Motion Control

MCUs for Motor Control (8-32 bit)

STM32 STM32 F3 STM32 F0 STM32 F1 STM32 F4

MC FW Library

IPM, Power transistors, Motor driver ICs

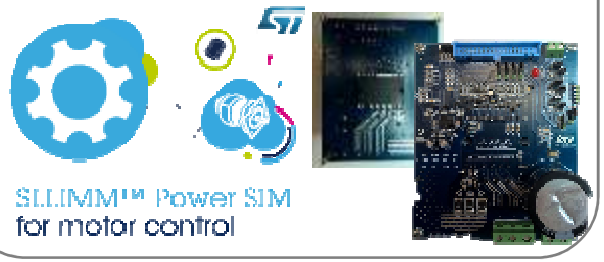


ST MC Workbench

PC SW GUI
Full customization and real time communication

Wide range of algorithms for specific applications (FOC – 6step)

HW tools



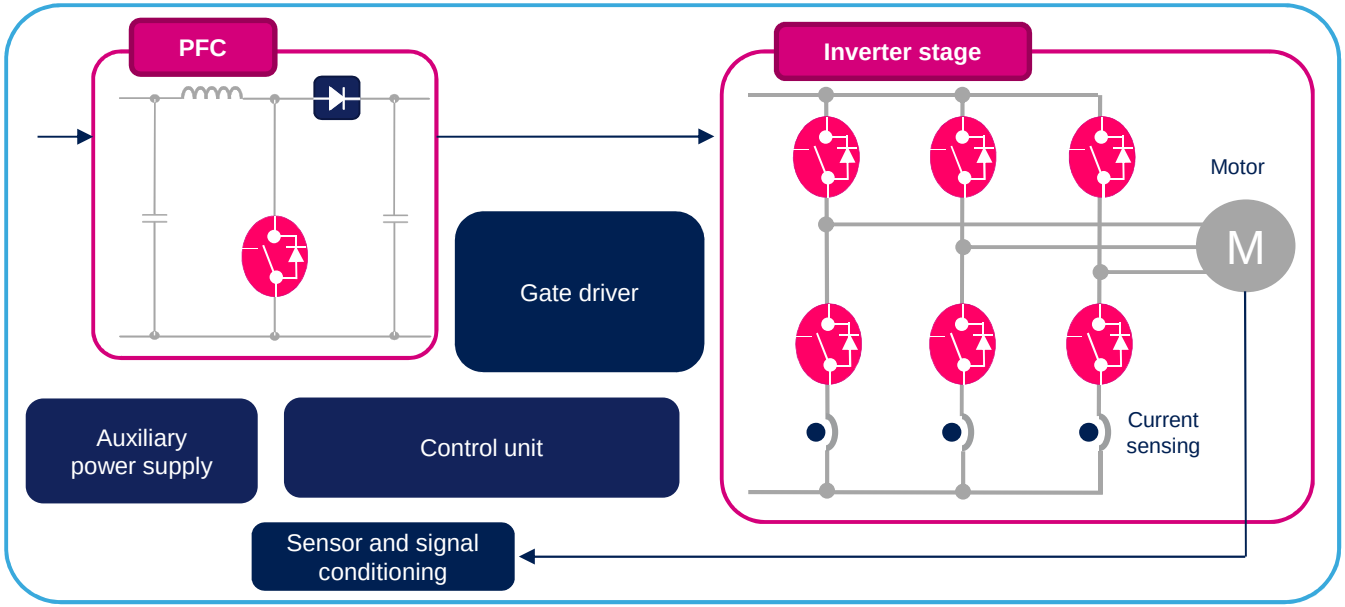
SLLIMM™ Power SIM for motor control

Technical Support (WW level)

3-ph Motors
High voltage

PFC Controllers (L49xx)
Rectifiers (STTHxx, STPSxx)
Power MOSFETs (MDmesh™ M2, M5 600V-650V)
IGBT (TFS V,HB 600-650V)

Power Transistors
IGBT (TFS 600V - 1200V)
IPM (SLLIMM™)
Power MOSFETs
(Mdmesh™ M2, M5 520V-650V, SiC 1200V**)**



Power Management
VIPERxx, LDO, DC-DC…

Op. Amp. and comparators (TSVxx, LMxx)

Microcontrollers 8-bit / 32-bit
STM32Fx (CORTEX M0, M3,M4), STM8S

Gate Drivers
L638x, L639x, L649x, STGAP1S; TD35x

Tools (HW & SW)

3-ph Motors Low Voltage

Gate Driver for MOSFET/IGBT

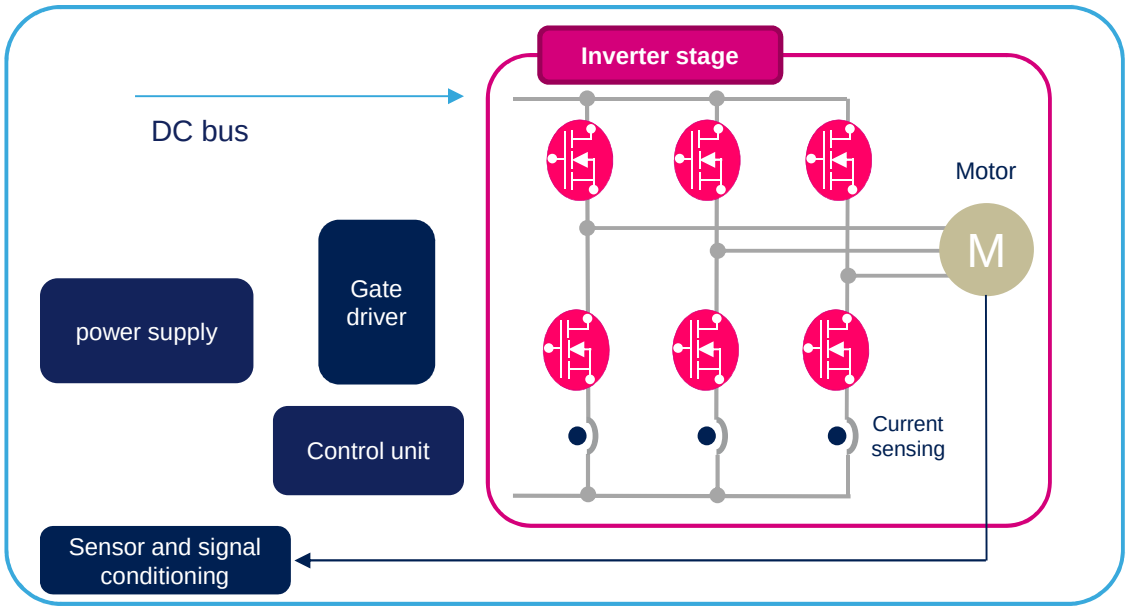
- L638x, L639x, L649x, TD35X

Motor driver ICs

- L6230, L6234, L6235; L6229
- STSPIN230
- STM32SPINF0

Power MOSFETs

- STripFET F6,F7 (20V÷350V)



Power Management
DCDC converter, LDO, …

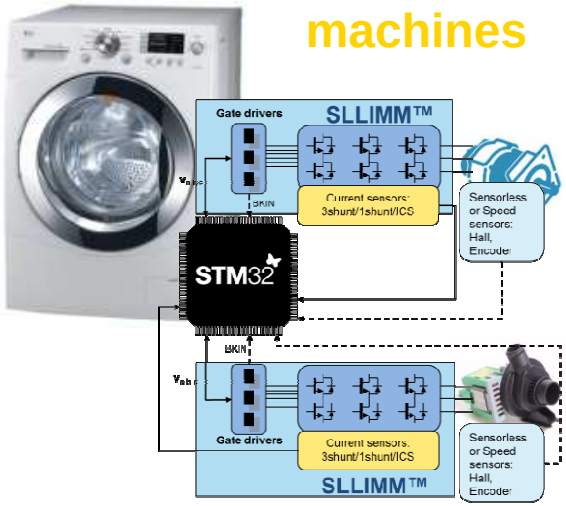
Microcontrollers 8-bit / 32-bit
STM32Fx (CORTEX M0, M3,M4), STM8S

Op. Amp. and comparators (TSVxx, LMxx)

Tools (HW & SW)

Dual motor in Home appliances User cases

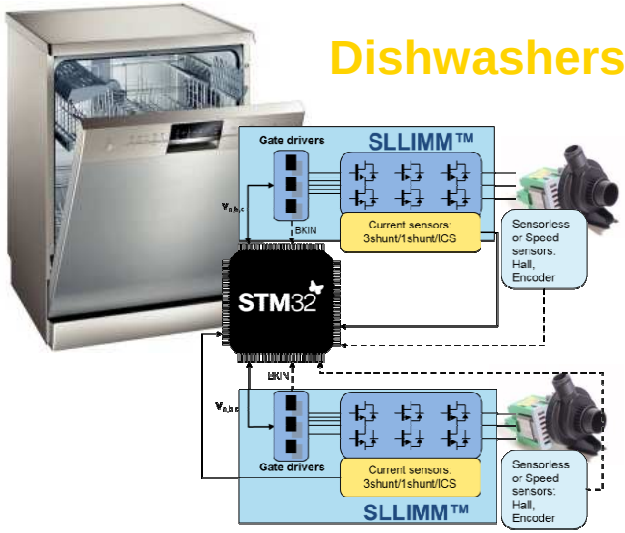
Washing machines



Drum

Drain pump

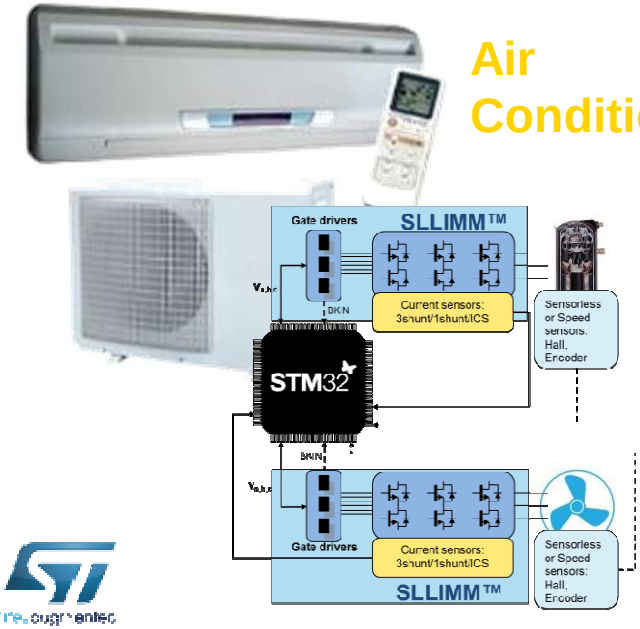
Dishwashers



Main pump

Drain pump

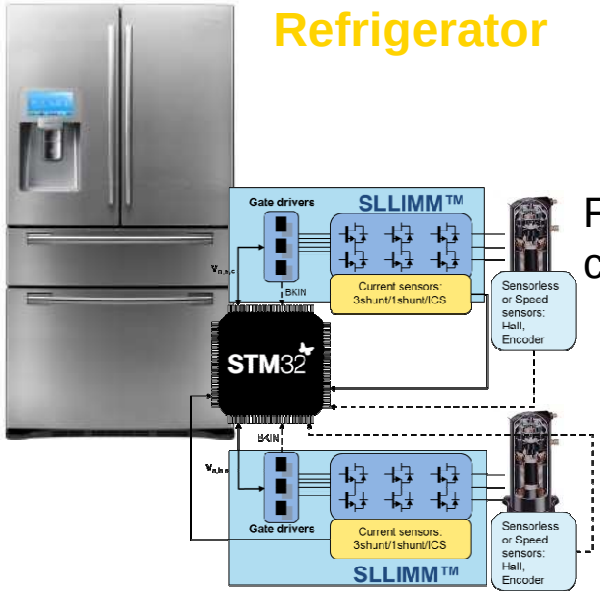
Air Conditioning



Main compressor

Fan

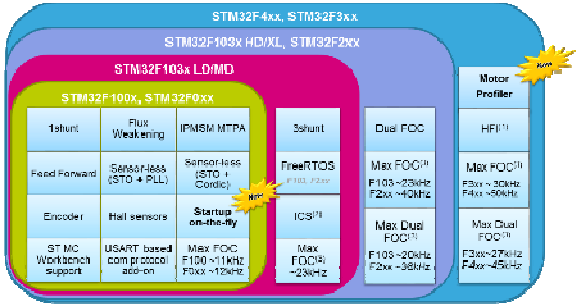
Refrigerator

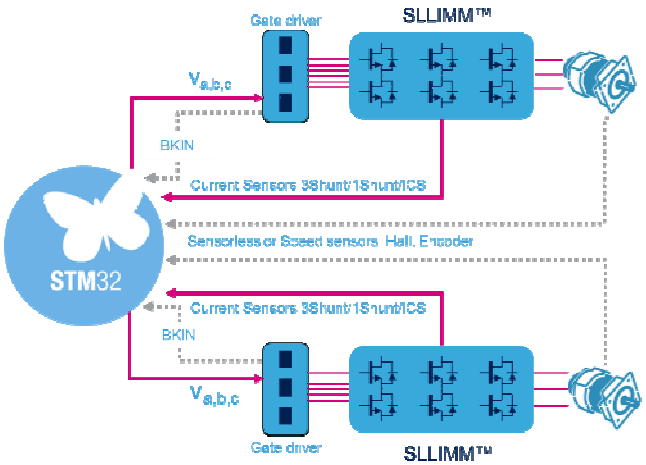


Fridge compressor

Freezer compressor

AirCon IPs





Dual Driving

High Frequency Injection (HFI)
Reliable and efficient start up, low speed operation

Flux Weakening
Expand the speed limits of a PMSM
→ reach compressor's maximum power capability

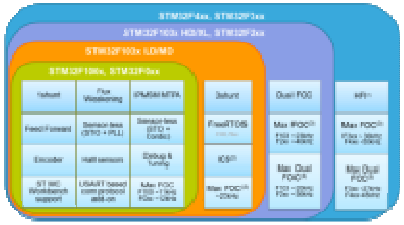
Maximum Torque Per Ampere (MTPA)
Optimize of the torque for each load
→ energy efficiency

On-the-fly startup (OTF)
Smooth drive insertion when the outdoor fan is moving due to the wind.

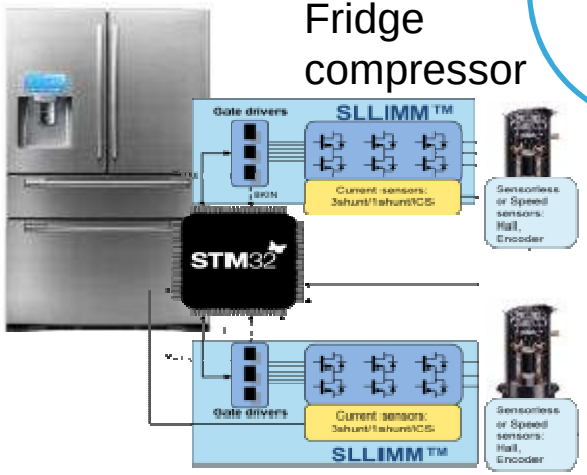
Reduction of the acoustic noise (ST patent)
Torque Ripple Compensation

Digital PFC single stage

Fridge IPs



Dual Driving



Fridge compressor

Freezer compressor

High Frequency Injection (HFI)

Reliable and efficient start up, Low speed operation

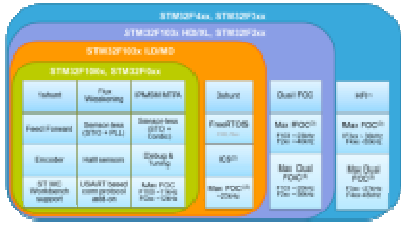
Flux Weakening

Expand the operating limits of a PMSM by reaching speeds higher than rated → to reach the maximum power capability of the compressor

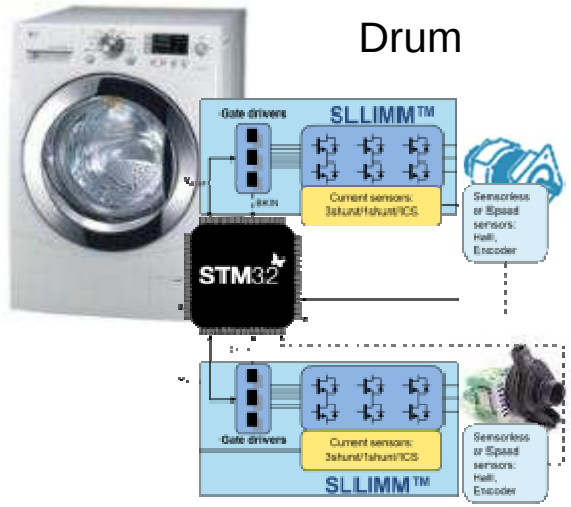
Maximum Torque Per Ampere (MTPA)

Optimization of the torque for each load (current) → increasing of efficiency

Washing Machines IPs



Dual Driving



High Frequency Injection (HFI)

Low speed operation, → high efficient at each start up during washing cycle

Flux Weakening

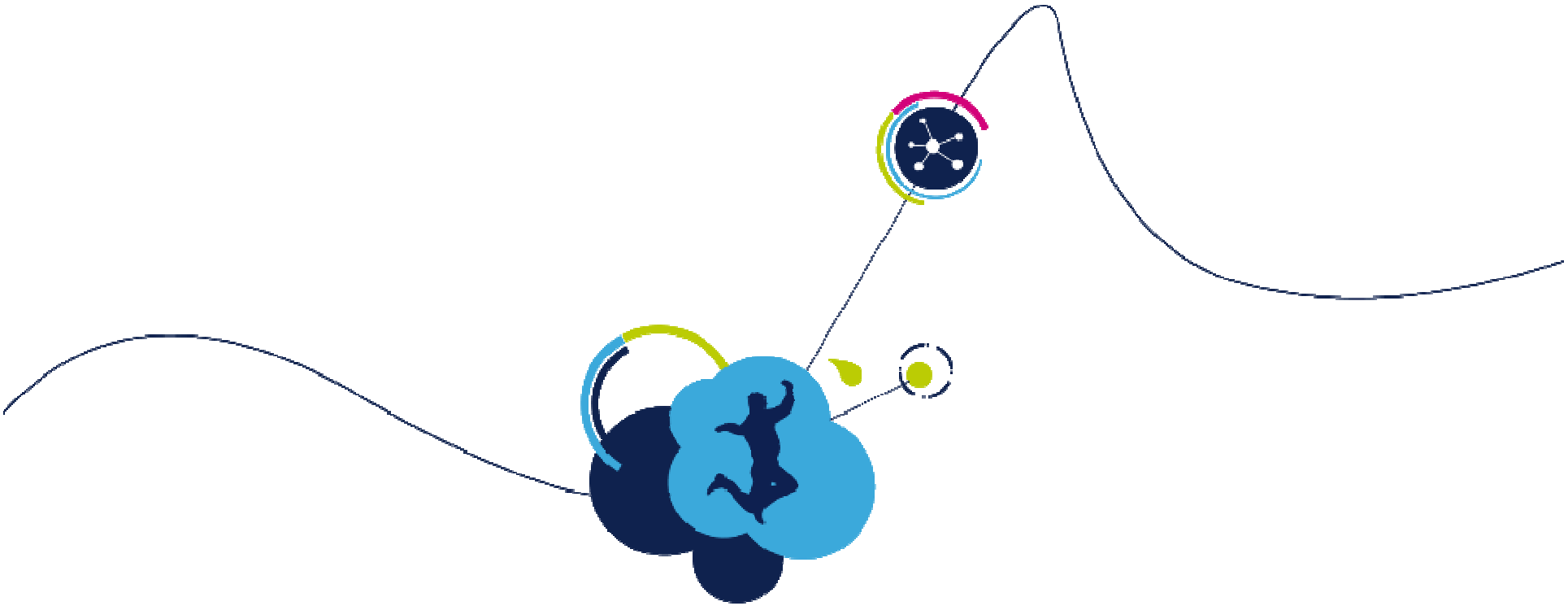
Expand the operating limits of a PMSM by reaching speeds higher than rated → to keep high speed during spin dryer phase (the load decrease)

Overvoltage Protection HW/S

Maximum Torque Per Ampere (MTPA)

Optimization of the torque for each load (current) → increasing of efficiency

Feed Forward Improve the control of the current at high speed → useful WM centrifugal.



ST Evaluation Board Offer

Flexible motor control platforms

STM32 PMSM FOC SDK
(Firmware library)

Flexible Motor Control platform	Complete Motor Control drives	STM32 ODE: Nucleo + X-NUCLEO	Motor Control Kit

based on
ST MC connector

Control stages

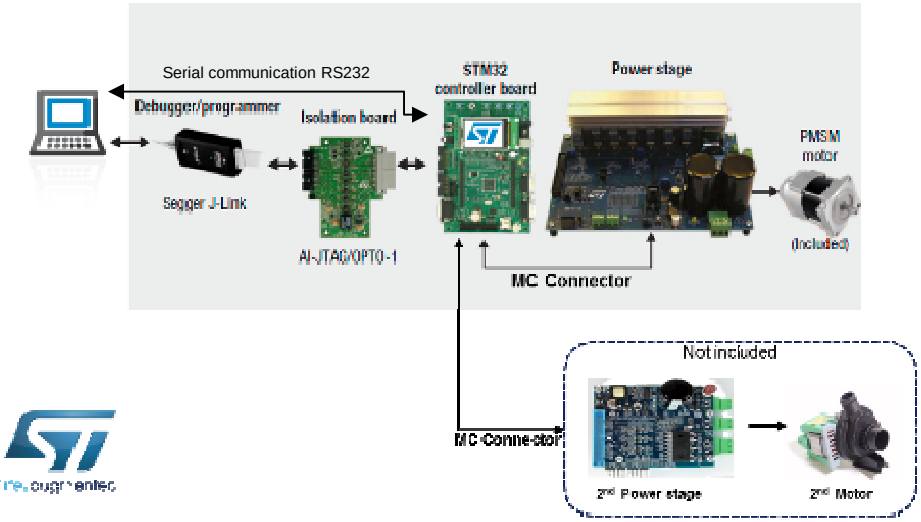
Power stages

Motor control kits

Part Number	Description	ST Link on-board	Type
P-NUCLEO-IHM001	STM32 Nucleo Pack FOC and 6-step control for Low voltage 3-ph motors	Yes (embedded)	Single drive
P-NUCLEO-IHM002	with DC Power supply		
STM32100B-MCKIT	Motor control starter kit for STM32F100 (128KB Flash) Value Line MCUs	Yes	Single drive
STM3210B-MCKIT	Motor control starter kit for STM32 (128KB flash) Performance and Access Line microcontrollers	No	Single drive

The motor control kit connections represented below can also be applied when combining STM32 control boards and evaluation power boards.

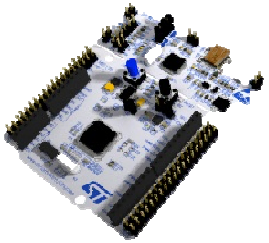
STM3210B-MCKIT STM32100B-MCKIT



- P-NUCLEO-IHM001
- P-NUCLEO-IHM002

P-NUCLEO-IHM01/P-NUCLEO-IHM02
Low Voltage MC kit for PMSM/BLDC motor

NUCLEO-F302



X-NUCLEO-IHM07M1*

LV BLDC Motor

ST MC SW Tools

Expansion Nucleo Board with STSPIN L6230

Main features

- 3-Phase motor control application (up to 50V,1.4 A)
- 6 Step modulation - FW library compatible with STM32Cube Mx (X-CUBE-SPN7)
- Vector drive control – ST PMSM FOC SDK (STSW-STM32100)

….allow the engineers to easily implement high end motion control algorithms (available with MC SDK).

High Voltage MC Kit Solution

- A kit designed to allow easy and effective evaluation of high voltage motor control devices offered by ST.
- Extend the NUCLEO range to include high power motor control

NUCLEO-F303

Nucleo Board with STM32 for Motor control

+

X-NUCLEO-IHM09M1

Expansion Nucleo Board with MC Connector

+

SLLIMM CARD STEVAL-IPM10B

Power Evaluation Board with SLLIMM gen. II IPM

Available in Q1

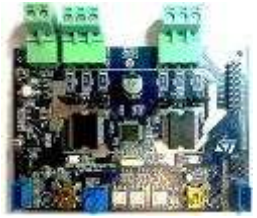
ST Complete Inverters

Part Number	Description	ST Link on-board	Type
STEVAL-IHM034V2	Dual-motor control and PFC demonstration board featuring the STM32F103 and STGIPS20C60	No	Single/Dual drive
STEVAL-IHM036V1	Low-power motor control board featuring the SLLIMM™ STGIPN3H60 and MCU STM32F100C6T6B	No	Single drive
STEVAL-IHM038V1	BLDC ceiling fan controller based on STM32 and SLLIMM-nano	No	Single drive
STEVAL-IHM040V1	BLDC/PMSM driver demonstration board based on STM32 and the SLLIMM-nano	No	Single drive
STEVAL-IHM042V1	Compact, low-voltage dual-motor control board based on the STM32F303 and L6230	Yes	Single/Dual drive
STEVAL-IHM043V1	6-Step BLDC sensorless driver board based on the STM32F051 and L6234	No	Single drive

STEVAL-IHM034V2

STEVAL-IHM036V1

STEVAL-IHM042V1



STEVAL-IHM043V1

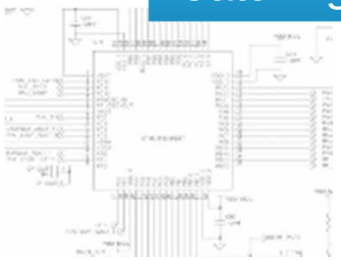
STEVAL-IHM038V1

STEVAL-IHM040V1

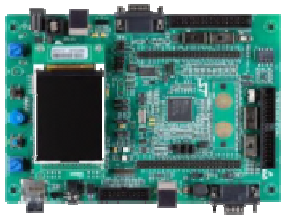
Flexible MC Platform
Building Your Evaluation Kit

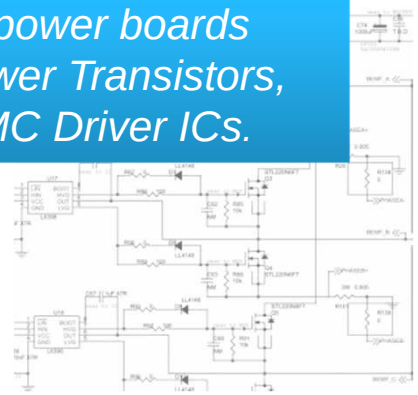
Full set of control boards featuring all ST MCUs

Full set of power boards featuring Power Transistors, IPM, and MC Driver ICs.



STM32XX-EVAL
Control board





STEVAL-XX
Power board

MC Connector

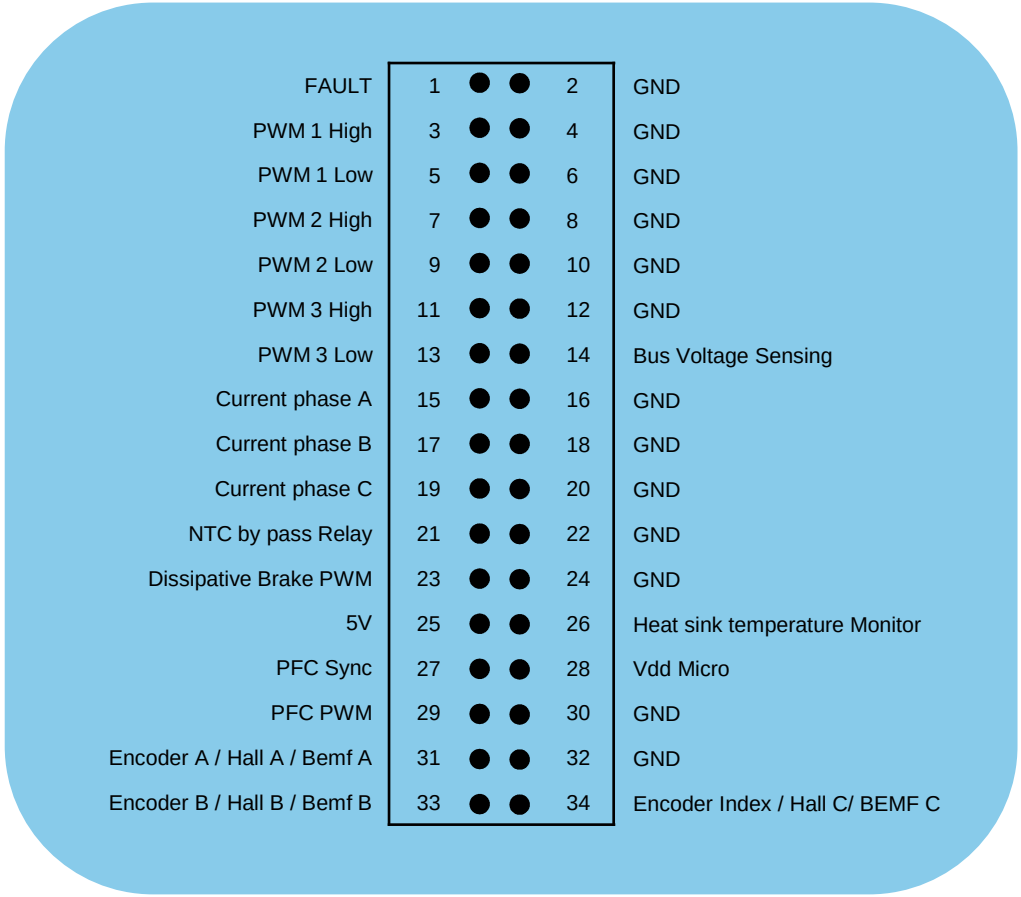
NUCLEO-XX
Control board

+

X-NUCLEO-IHM09M1
Connector Adapter

The MC connector

34-pin connector dedicated to motor control applications, it is a standard ST interface between MCU evaluation boards and power boards.



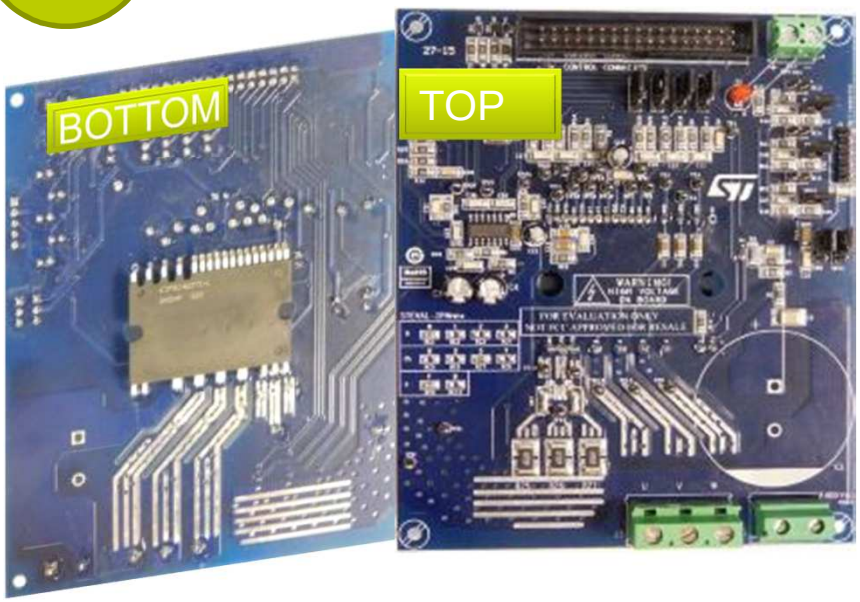
Key hardware features 1/3

Reference / bundle	Voltage	Power	Motor type / control type *	ST Parts	Application focus
STEVAL-IPM05F	125 – 400 V_{DC}	Up to 700 W	PMSM/BLDC FOC/6-step 3-shunt	• 1 x **STGIF5CH60TS-L** • 1x **TSV994**	Power board: water pumps, fans, dish washers and more
STEVAL-IPM07F	125 – 400 V_{DC}	Up to 800 W	PMSM/BLDC FOC/6-step Single/3-shunt	• 1 x **STGIF7CH60TS-L** • 1x **TSV994**	Power board: water pumps, fans and more
STEVAL-IPM10F	125 – 400 V_{DC}	Up to 1 kW	PMSM/BLDC FOC/6-step	• 1 x **STGIF10CH60TS-L** • 1x **TSV994**	Power board: pumps, compressors, washing machines and more
STEVAL-IPM10B	125 – 400 V_{DC}	Up to 1.2 kW	PMSM/BLDC FOC/6-step single/3-shunt	• 1 x **STGIB10CH60TS-L** • 1x **TSV994**	Power board: pumps, compressors, air conditioning and more
STEVAL-IPM15B	125 – 400 V_{DC}	Up to 1.5kW	PMSM/BLDC FOC/6-step single/3-shunt	• 1 x **STGIB15CH60TS-L** • 1x **TSV994**	Power board: pumps, compressors, fans, dish washers and more

STEVAL-IPMxxx

SLLIMM™ “Cards plan”

Power board



SLLIMM™ Cards plan

- STEVAL-IPM08B → STGIB8CH60TS-L Planned
- STEVAL-IPM20B → STGIB20M60TS-L Planned
- STEVAL-IPM30B → STGIB30M60TS-L Planned

SLLIMM™ nano Cards plan

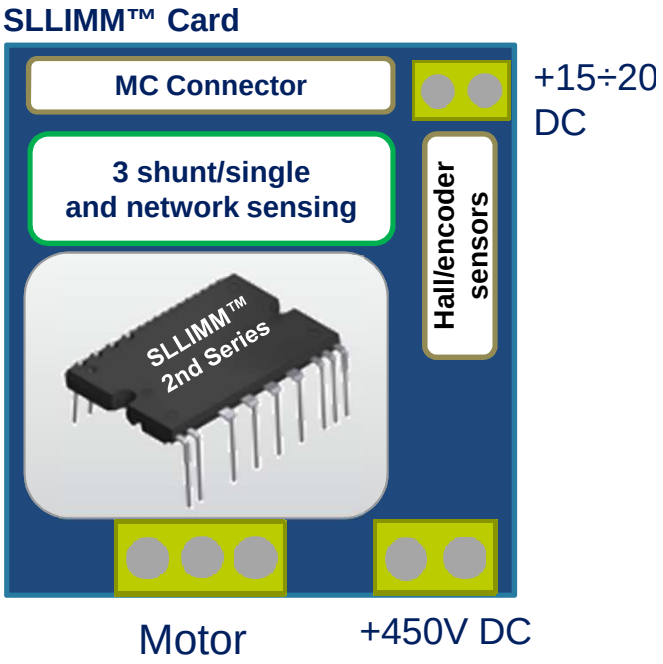
- STEVAL-IPMnG3Q →STGIPQ3H60T-Hxy in production
- STEVAL-IPMnM1N → STIPN1M50T-H Planned
- STEVAL-IPMnM2N → STIPN2M50T-H Planned
- STEVAL-IPMnG5Q → STIPQ5M60T-Hx Planned

Power board

STEVAL-IPMnG3Q Features and architecture

- **Inverter Evaluation Board based on 2nd series of ST's SLLIMM™ IPM Trench Gate Field Stop Technology IGBT**

- Input voltage: 125 ÷ 400 V_{DC}
- Nominal power: up to 300 W
- Input auxiliary voltage: up to 20V DC
- Single- or three- shunts resistors for current
- Three options for current sensing: external dedicated op-amps, internal SLLIMM-nano op-amp (single) or through MCU
- Overcurrent hardware protection
- IPM temperature monitoring and protection
- Hall sensor or encoder input
- 2nd series of SLLIMM-nano IPM (STGIPQ3H60T-H – Full Molded package)
- Motor control connector (32pins) interfacing with ST MCU boards



Key hardware features 2/3

Reference / bundle	Voltage	Power	Motor type / control type *	ST parts	Application focus
STEVAL-IHM021V2	120/230 V_{AC} nominal (60/50 Hz)	Up to 100 W	PMSM/BLDC FOC/6-step 3-shunt	• 3x **L6390** • 1x **Viper12** • 6x **STD5N52U**	Power board: water pumps, fans, dish washers, washing machines
STEVAL-IHM023V3	90 – 285 V_{AC} 125 – 400 V_{DC}	Up to 1 kW	PMSM/BLDC FOC/6-step Single/3-shunt	• 3x **L6390** • 1x **Viper16** • 7x **STGP10H60DF**	Power board: pumps, compressors, washing machines and more
STEVAL-IHM028V2	90 – 285 V_{AC} 125 – 400 V_{DC}	Up to 2 kW	PMSM/BLDC FOC/6-step Single/3-shunt	•1x **STGIPS20C60** • 1x **VIPer26LD** • 1x **STGW35NB60SD**	Power board: pumps, compressors, air conditioning and more
STEVAL-IHM032V1	230 V_{AC} nominal 86 to 260 V_{AC}	Up to 150 W	PMSM/BLDC FOC/6-step Single/3-shunt	• 2x **L6392D** • 1x **L6391D** • 1x **Viper12** • 6 x **STGD3HF60HD**	Power board: pumps, compressors, fans, dish washers and more
STEVAL-IHM035V2	120/230 V_{AC} nominal	Up to 100 W	PMSM/BLDC FOC/6-step single-shunt	• 1x **STGIPN3H60** • 1x **VIPer16L**	Power board: pumps, compressors, fans, dish washers and more
STEVAL-IHM045V1	30 – 270 V_{AC} 40 – 400 V_{DC}	Up to 100 W	PMSM FOC Single/3-shunt	• 1x **STGIPN3H60A** • 1x **VIPer06L** • 1x **TSV994**	Power board: pumps, compressors, fans, dish washers and more

STM32 evaluation boards with MC Connector

Part Number	Description	ST Link on-board	Type
STM32072B-EVAL	Evaluation board with STM32F072VB MCU	Yes	Single drive
STM3210E-EVAL	Evaluation board for STM32 F1 series - with STM32F103 MCU	No	Single drive
STM3220G-EVAL	Evaluation board for STM32 F2 series - with STM32F207IG MCU	Yes	Single drive
STM32303E-EVAL	Evaluation board for STM32F303xx microcontrollers	Yes	Single/Dual drive
STM32446E-EVAL	Evaluation board for STM32F407 line - with STM32F407IG MCU	Yes	Single drive
STEVAL-IHM039V1	Dual motor drive control stage based on the STM32F415ZG microcontroller	No	Single/Dual drive

STM32072B-EVAL

STM32446G-EVAL

STM32303E-EVAL

For the complete list visit st.com

In-circuit debugger/programmer..

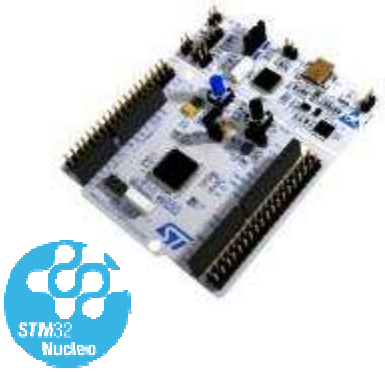
- ST-LINK/V2
- ST-LINK/V2-ISOL (2500 VRMS high isolation voltage)(1)

(1) for high-voltage applications if not implemented in the evaluation board

STM32 ODE
Hardware Components

STM32 Nucleo Development Boards

- Based on ST's 32-bit ARM Cortex-M based STM32 microprocessors
- Development boards for all STM32 families available or planned



STM32 Nucleo Expansion Boards

- Boards with additional functionality: **Motion control**, sensing, connectivity, power, analog
- Plugged on top of the STM32 Nucleo developer board or stacked on top of other expansion boards
- Leverage ST wide product portfolio

L6230 Expansion Board

Expansion board for 6 Step and FOC driving of BLDC motors (low Voltage)

Key Features

- Driver for Low voltage 3 phase Motors
- Stacked connection of multiple boards
- Suitable for Mass and Hobbistic market
- Input voltage: 8 - 48Vdc
- Max output current: 1.4 Arms
- NTC on board
- DAC connector for debug
- 3 shunt / 1 Shunt current sensing configuration
- Compatible with FOC Library: STSW-STM32F100

Key Products

- 6 STEP Motor control Library
- L6230PD
- BAT30KFILM
- TSV994IPT

Order Code: X-NUCLEO-IHM07M1

MOSFET F7 Expansion Board for NUCLEO

Expansion board for PMSM / BLDC motor control based on POWER MOSFET F7

Key Features

Driver for Low voltage 3 phase Motors with 60V F7 Power MOSFET

- **Input voltage: 10 – 48Vdc**
- **Max output current: ~15A**
- **NTC on board**
- **DAC connector for debug**
- **Compatible with FOC and 6 Step alghoritm**

Key Products

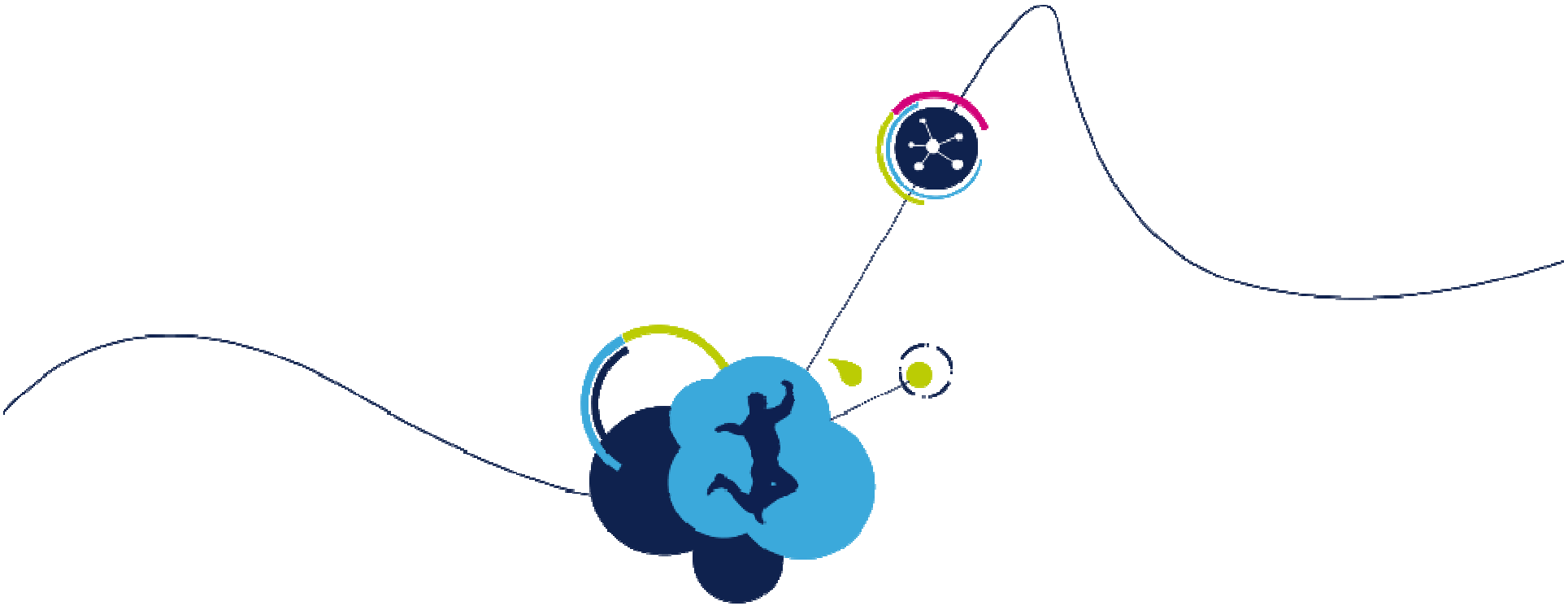
- **STL220N6F7**
- **L6398**
- **TSV994IPT**

Application Segments:	Motor control
Status, Estimated End Date	Available
Order Code:	**X-NUCLEO-IHM08M1**

End

Key hardware features 3/3

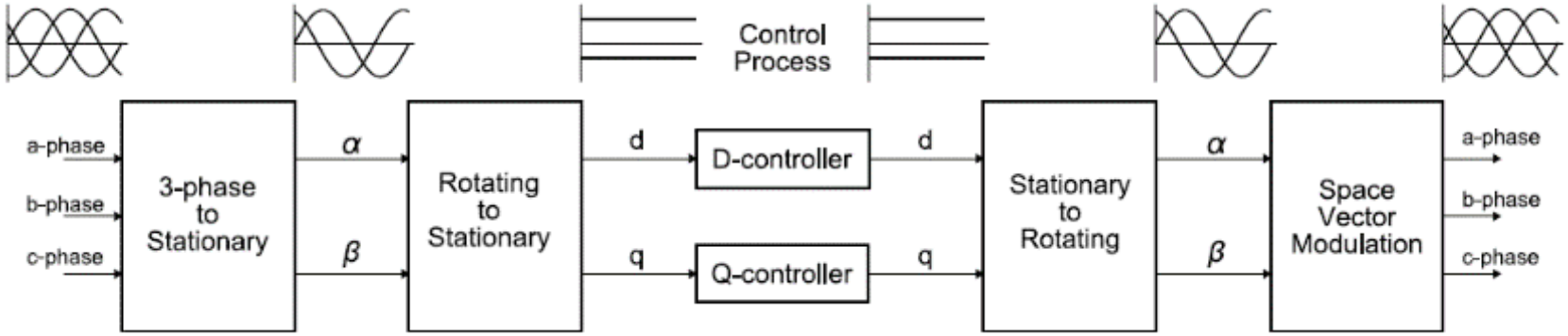
Reference / bundle	Voltage	Power / current	Motor type / control type *	ST Parts	Application focus
X-NUCLEO-IHM07M1	Up to 48V	Up to 2.5A	PMSM/BLDC FOC/6-step Single/3-shunt	• 1x **L6230** • 1x **BAT30KFILM** • 1x**TSV994IPT**	Sewing machines, pumps, drones,
X-NUCLEO-IHM08M1	10 – 48Vdc	Up to 15A	PMSM/BLDC FOC/6-step Single/3-shunt	• 6x**STL220N6F7** • 3x**L6398** • 1x**TSV994IPT**	Drones, e-bikes, drills, pumps, etc.
X-NUCLEO-IHM09M1	-	-	Motor control connector adapter	• **Not silicon devices**	Allow connection of STM32 NUCLEO boards with any ST motor control power boards
X-NUCLEO-IHM11M**1**	1.8 V to 10 Vdc	Up to 1.3	PMSM/BLDC 6-step	• 1xSTSPIN230, • 1xTSV991ILT • 1xBAT30KFILM	BLDC 3-phase Motor Driver



Motor control – SDK workflow

Benefits of FOC

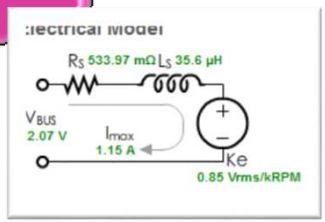
- **Best energy efficiency**
  even during transient operation, due to optimal current angle
- **Responsive speed control**
  to load variations, due to direct and decoupled control of electromagnetic torque and flux
- **Precise position control**
  due to direct and decoupled control of electromagnetic torque and flux;
- **Acoustical noise reduction**
  due to sinusoidal waveforms / optimized control



Motor control – SDK – Workflow

Set up the HW

Use motor specs or identify the motor using Motor Profiler



Finalize the project with Workbench

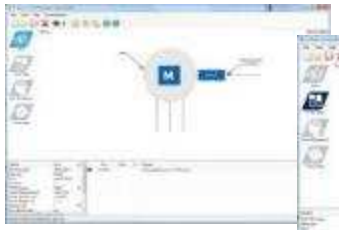
Send commands with serial communication

ST MC Workbench
PC GUI for FOC SDK v4.2

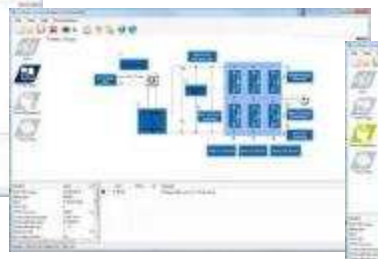
ST MC Workbench

Configure the MC FW lib Generatiing .h files

Motor



Power Stage

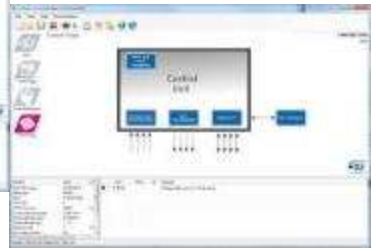


New Project

Drive Management

New Project

Control Stage



New Project

Toolchain

Build Your Project

+

MC SDK project

executable

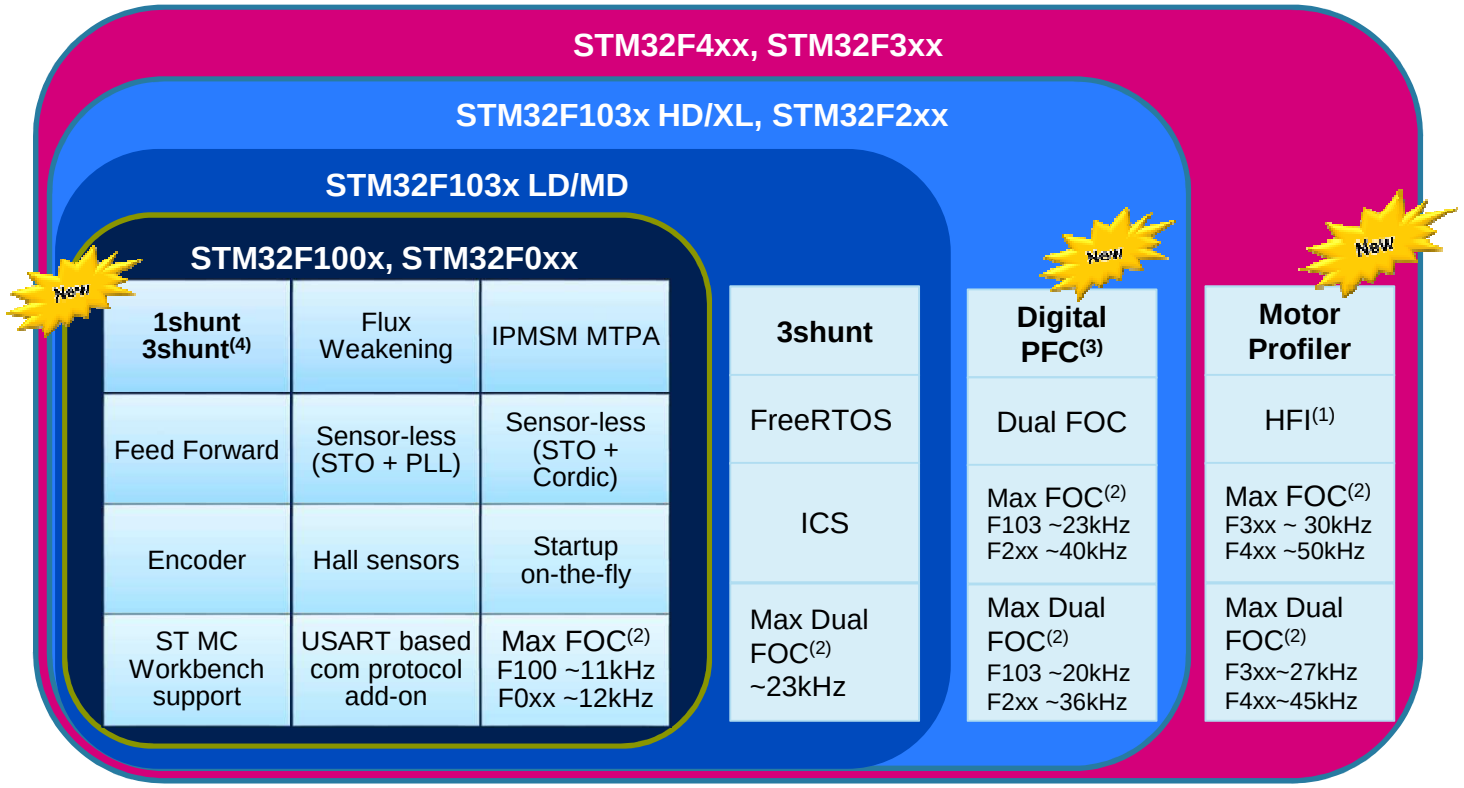
Application

Program the HW and RUN your motor

executable

Feature of STM32 FOC SDK

- In Drive settings, choose a correct PWM frequency and torque and flux execution rate in such a way that the $FOC\ rate = \frac{PWM\ freq}{Execution\ rate}$ is compatible with the maximum FOC rate according to the microcontroller used.



(1) High Frequency Injection

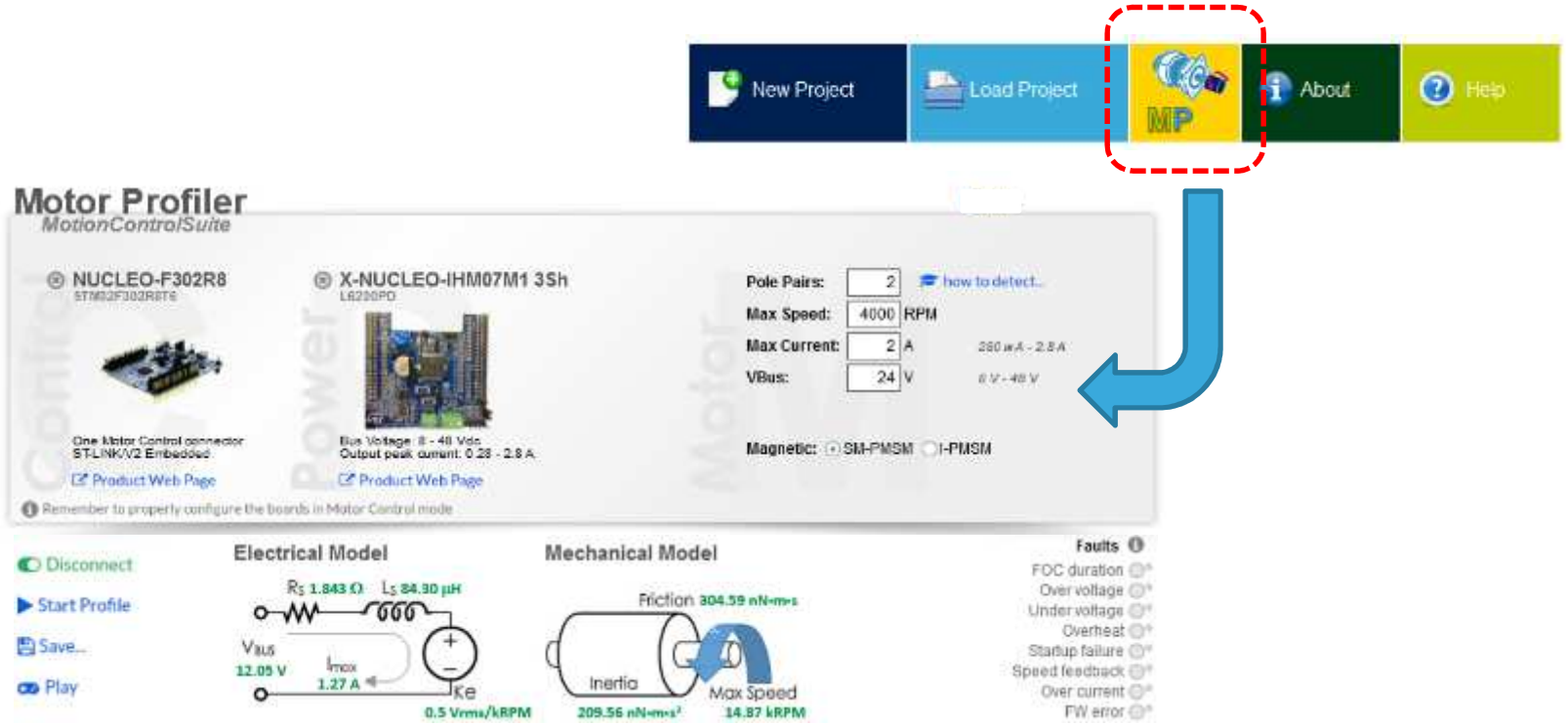
(2) Max FOC estimated in sensorless mode

(3) STM32F103xC/D/E/F/G and STM32F303xB/C

(4) Only for STM32F0xx

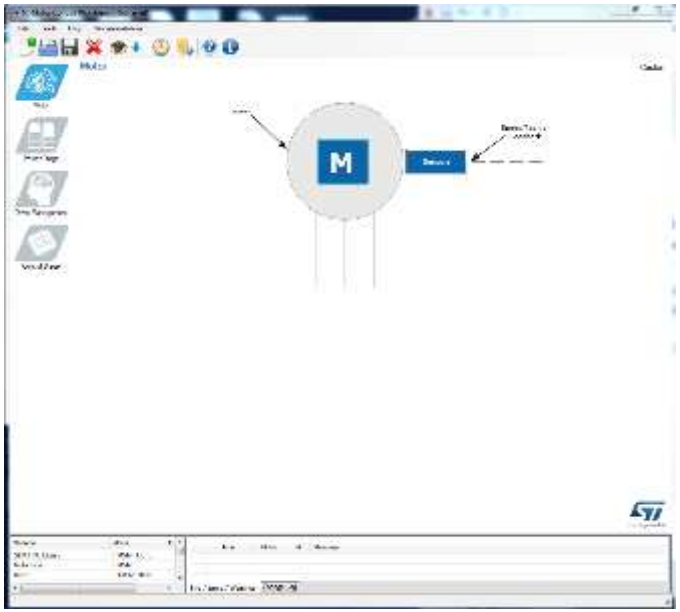
Motor control – SDK – Workflow 2/4

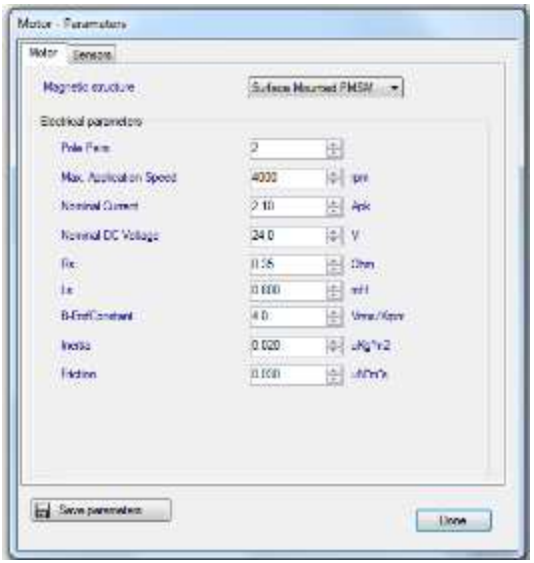
- When the hardware is ready, if the user does not know the motor parameters, he can identify the motor.
- How? Using the ***Motor Profiler***!!
  - Follow the instruction in Step 6.
- If want to measure the Motor parameter in the lab Step 8



Set up motor parameters

- ST MC Workbench – Motor section contains:
  - Motor parameters
  - Motor sensor parameters
- In this hands-on session, we will configure the system for sensor-less control using a motor with a surface-mounted magnet.
- For a custom project, the user can set all the parameters individually.

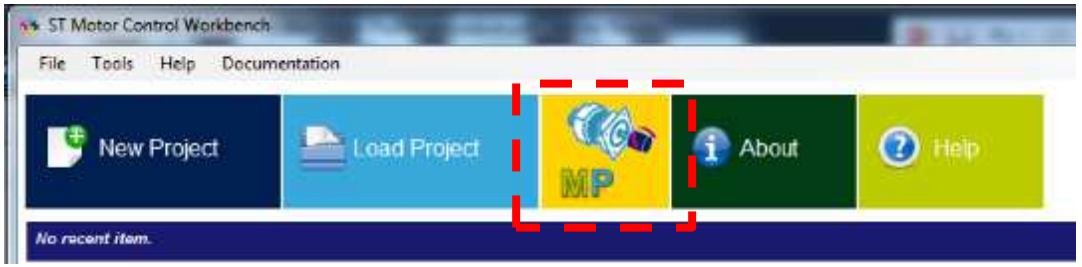




Set up motor parameters

- If motor parameters are unknown (or the instrumentation to measure them is missing), it is possible to use the new ***Motor Profiler*** feature with the supported ST hardware.

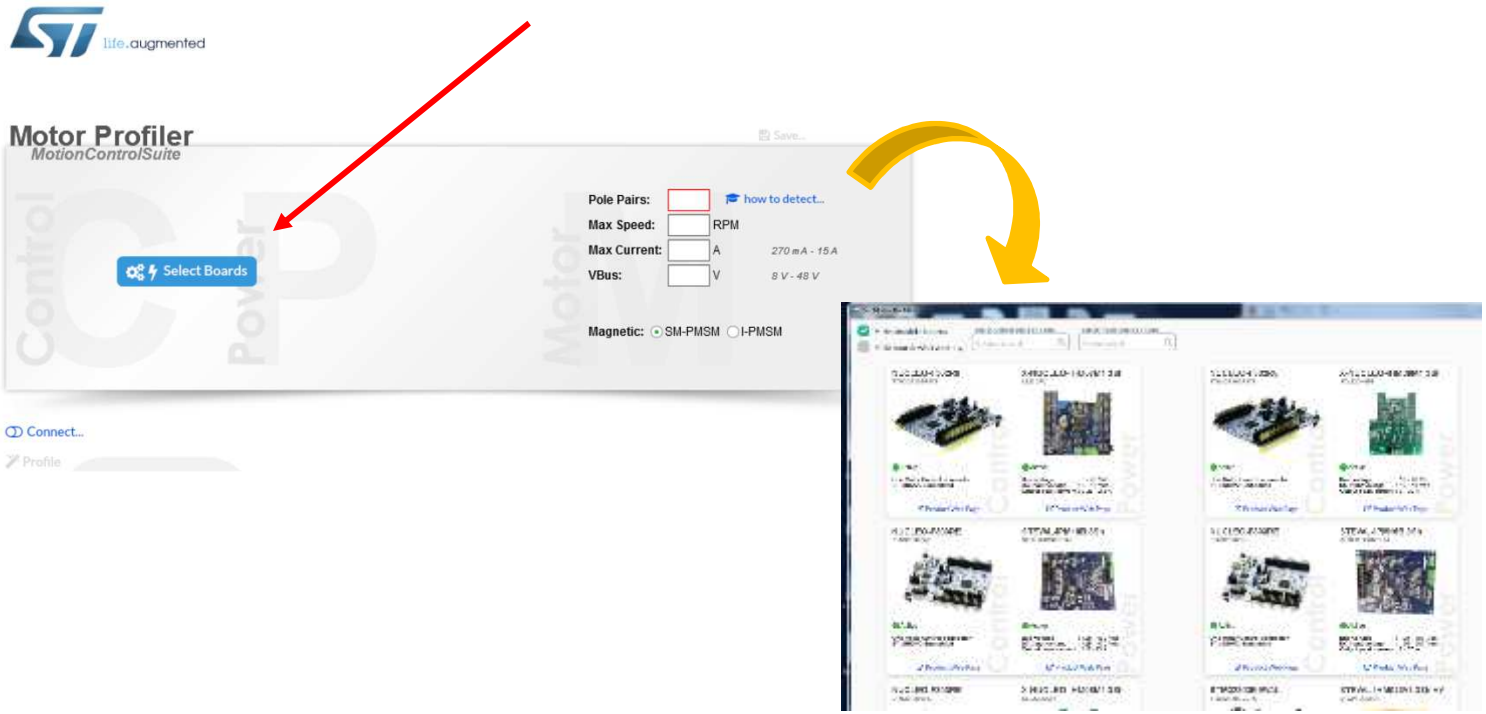
- Two ways to open the Motor Profiler:
  - From the Home page of the ST Motor Control Workbench



  - From the “STMotorProfiler” installation folder

Set up the Motor Profiler

- Click “Select Boards” to display a list of supported boards. The Motor Profiler feature can be used only in the systems listed.

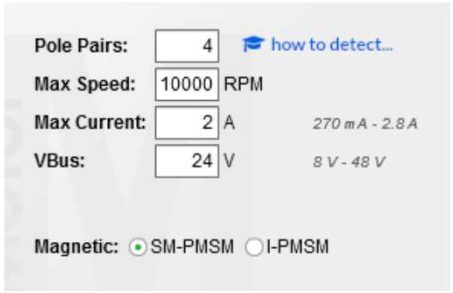


Set up the Motor Profiler

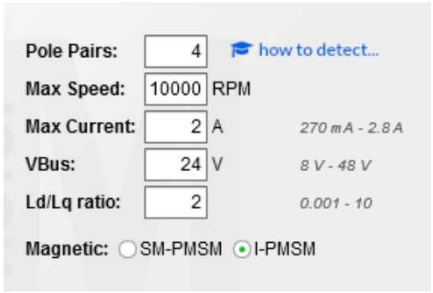
Parameters set by the user:

- Motor pole pairs (mandatory)
- Maximum application speed
  - Not mandatory. If not selected, the Motor Profiler will try to reach the maximum allowed speed.
- Maximum peak current
  - The maximum peak current delivered to the motor
- Expected bus voltage provided to the system.
- Type of motor
  - Surface-mounted permanent magnet synchronous motor (SM-PMSM)
  - Internal permanent magnet motor (I-PMSM). In this case, the Ld/Lq ratio as input is required.

SM-PMSM

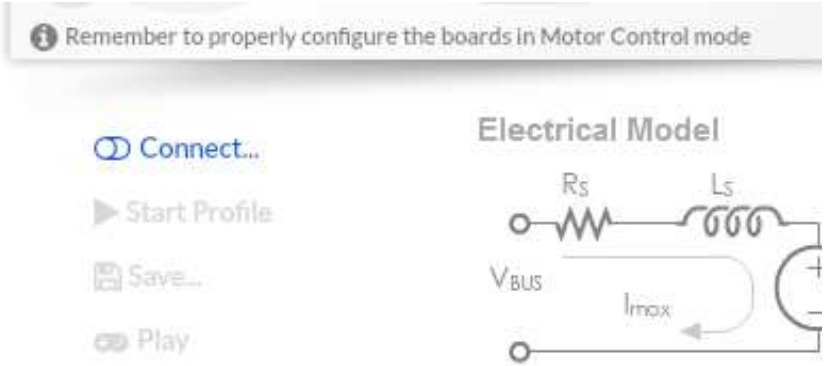


I-PMSM



Set up the Motor Profiler

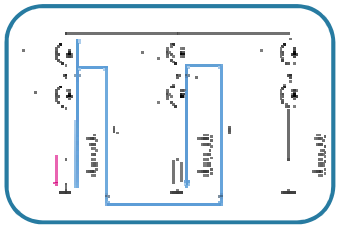
- Connect the selected hardware to the PC.
- Click the “Connect” button.
  - If communication with the board is successful.
- Click the “Profile” button.



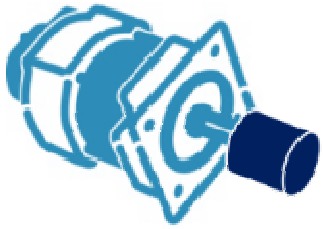
Run the Motor Profiler

- Procedure will end in about 60 seconds.

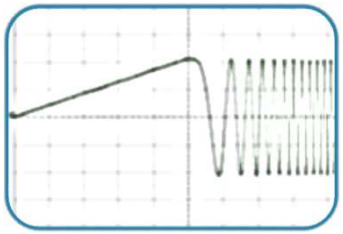
Motor stopped
- Rs measurement
- Ls measurement
- Current regulators set-up



10 sec

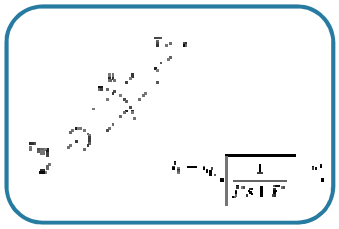


Open loop
- Ke measurement
- Sensorless state observer set-up
- Switch over



5 sec

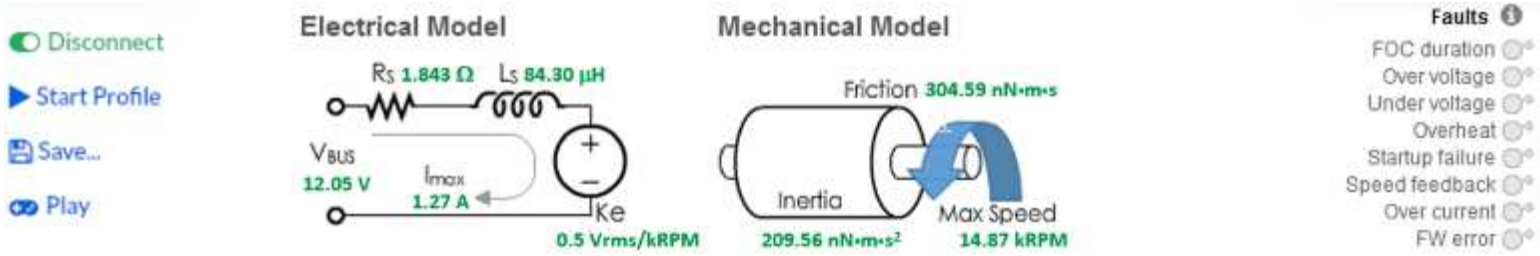
Closed loop
- Friction coefficient measurement
- Moment of inertia measurement
- Speed regulator set-up



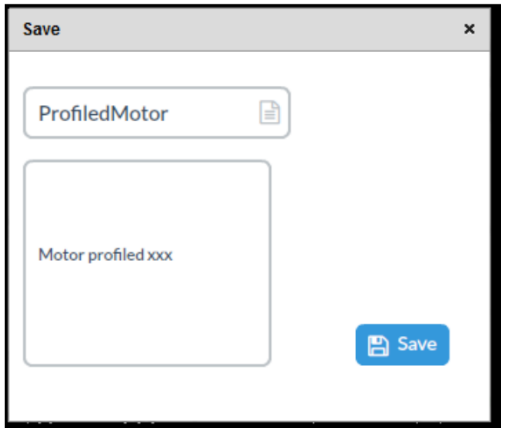
45 sec

Motor Profiler complete

- At the end of the procedure, the measured parameters will be displayed in a dedicated window.



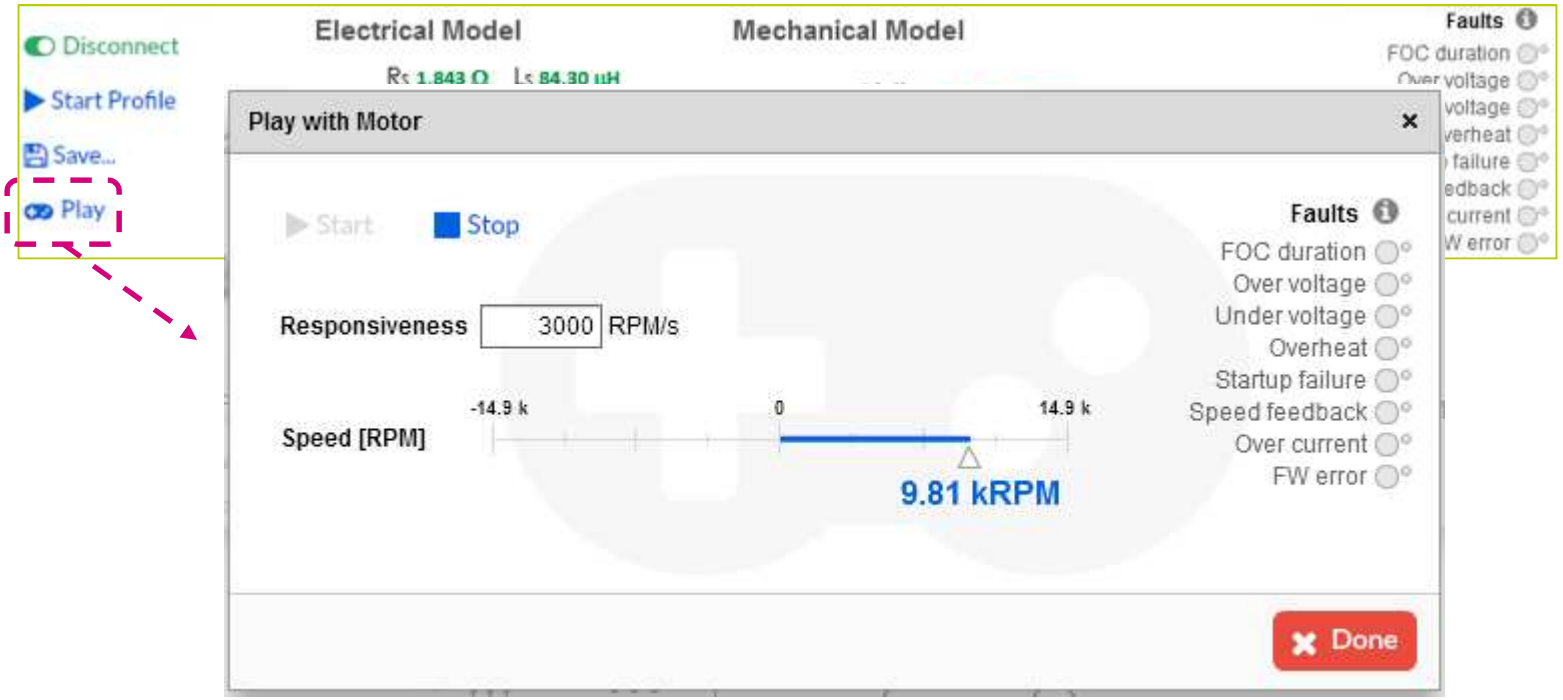
- It is possible to import them into the Workbench project and save them for later use.



Motor Profiler complete

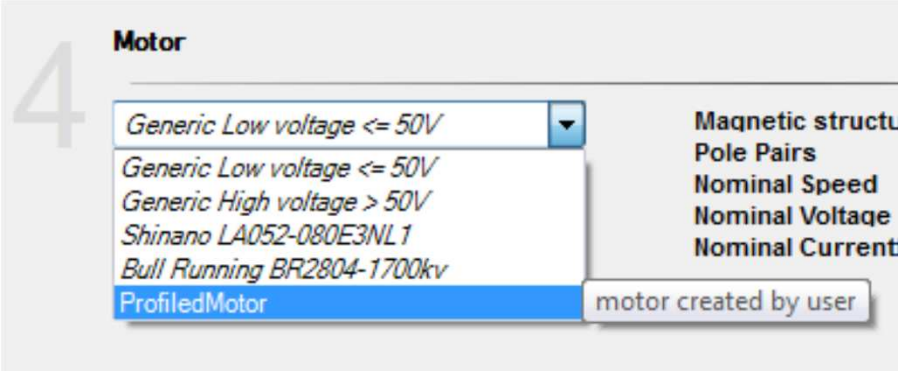
Play Mode

- At the end of the procedure, it is possible to run and control the motor's speed



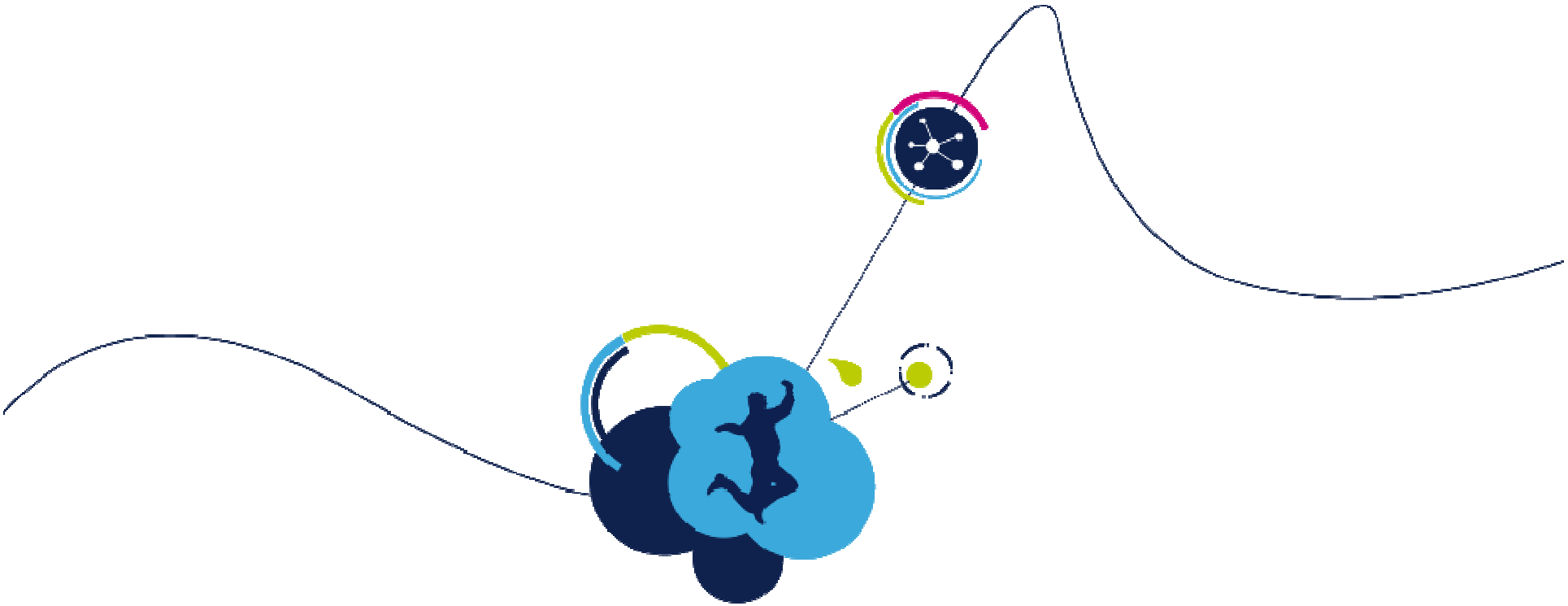
Motor Identified

- Motor Identified: users can switch the motor on or off using the “Start” and “Stop” buttons.
- It is possible to create a new ST MC Workbench project with the profiled motor by clicking “New Project” in the Motor section.



Motor Profiler Disclaimer

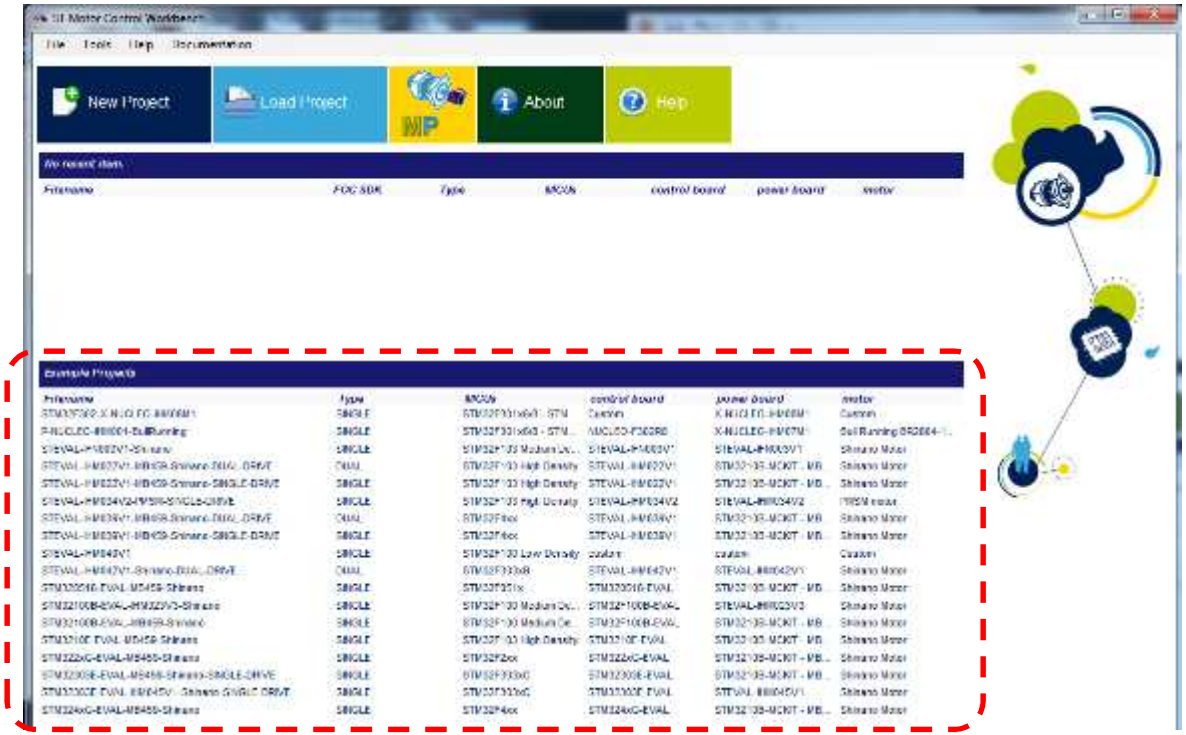
- The Motor Profiler algorithm is intended to quickly evaluate the ST 3-phase motor control solution (PMSM)
- The Motor Profiler can be used only when using compatible ST evaluation boards. Choose the best ST hardware according to the motor characteristics.
- The precision of the measurement is not like when using proper instrumentation.
- In certain cases, Motor Profiler measurements may not be reliable. Please see the limits reported in the software tool.



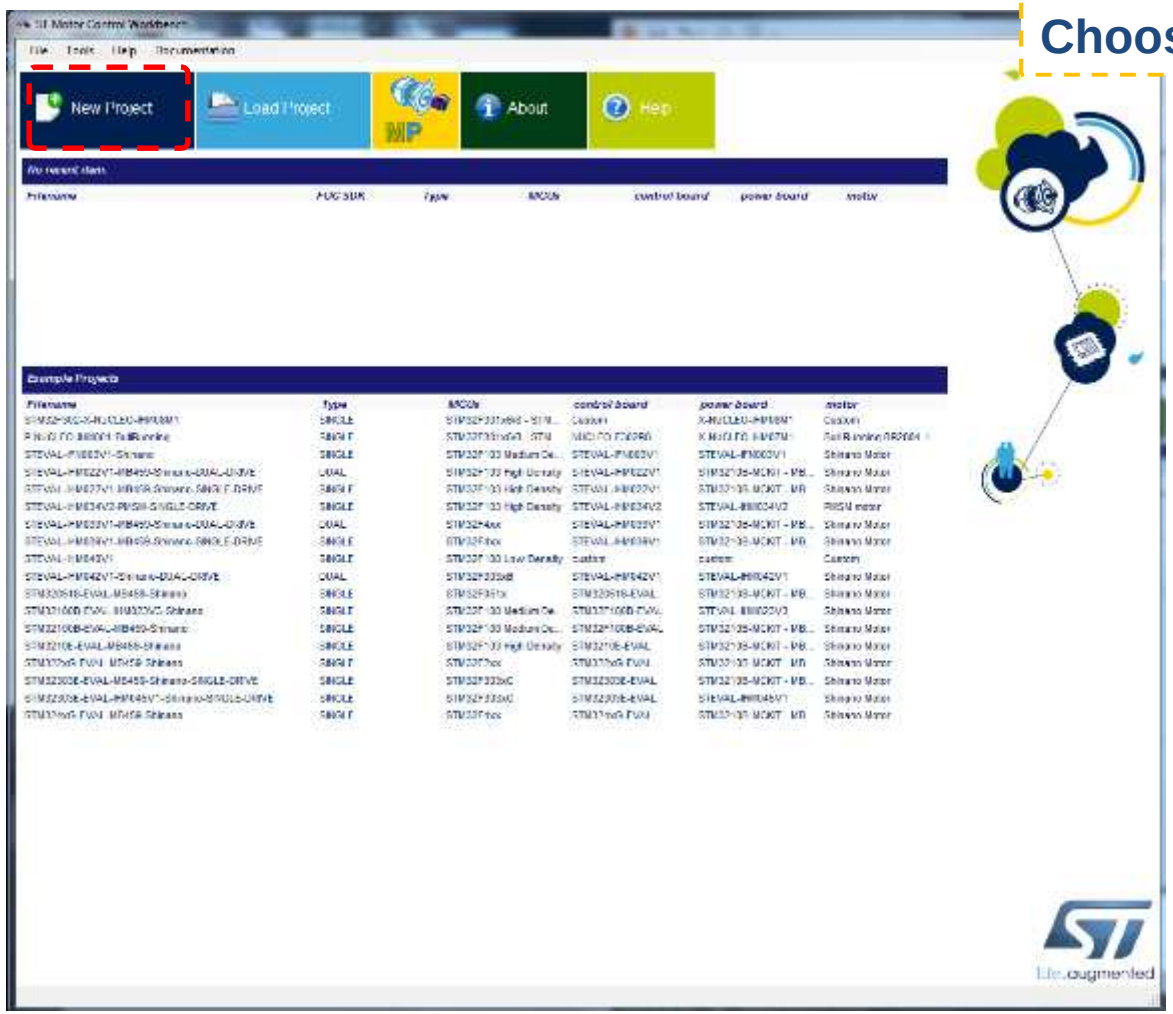
Set up workbench project

Create a new Workbench project based on the ST evaluation board

- Choose the example Workbench project that best fits your needs.
  - Choose the one with the same name of the ST evaluation board you are using, or
  - choose the one with the same microcontroller you are using.

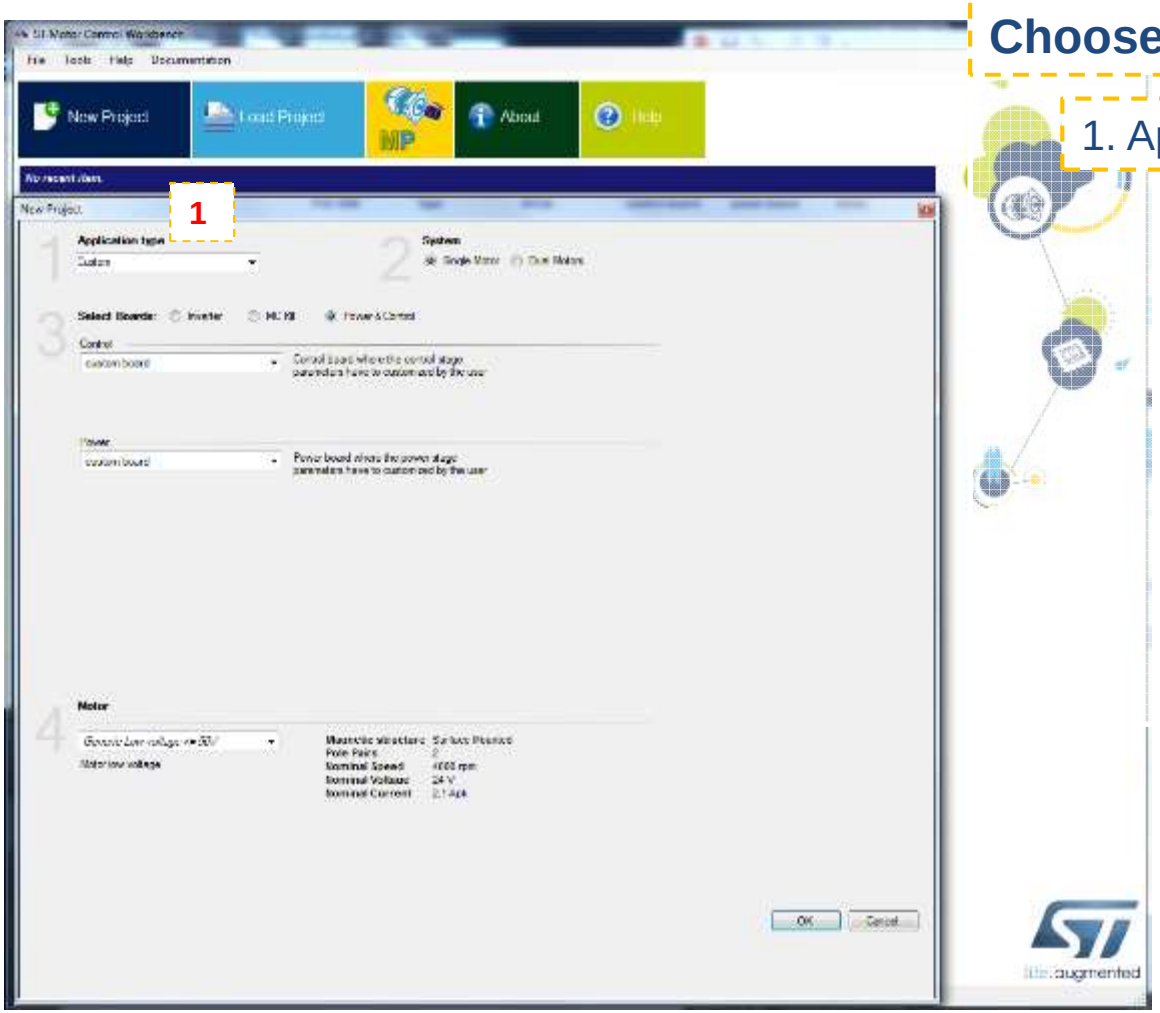


Create a new Workbench project based on the ST evaluation board



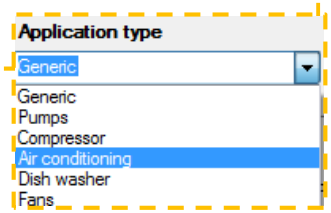
Choose: New Project

Create a new Workbench project based on the ST evaluation board

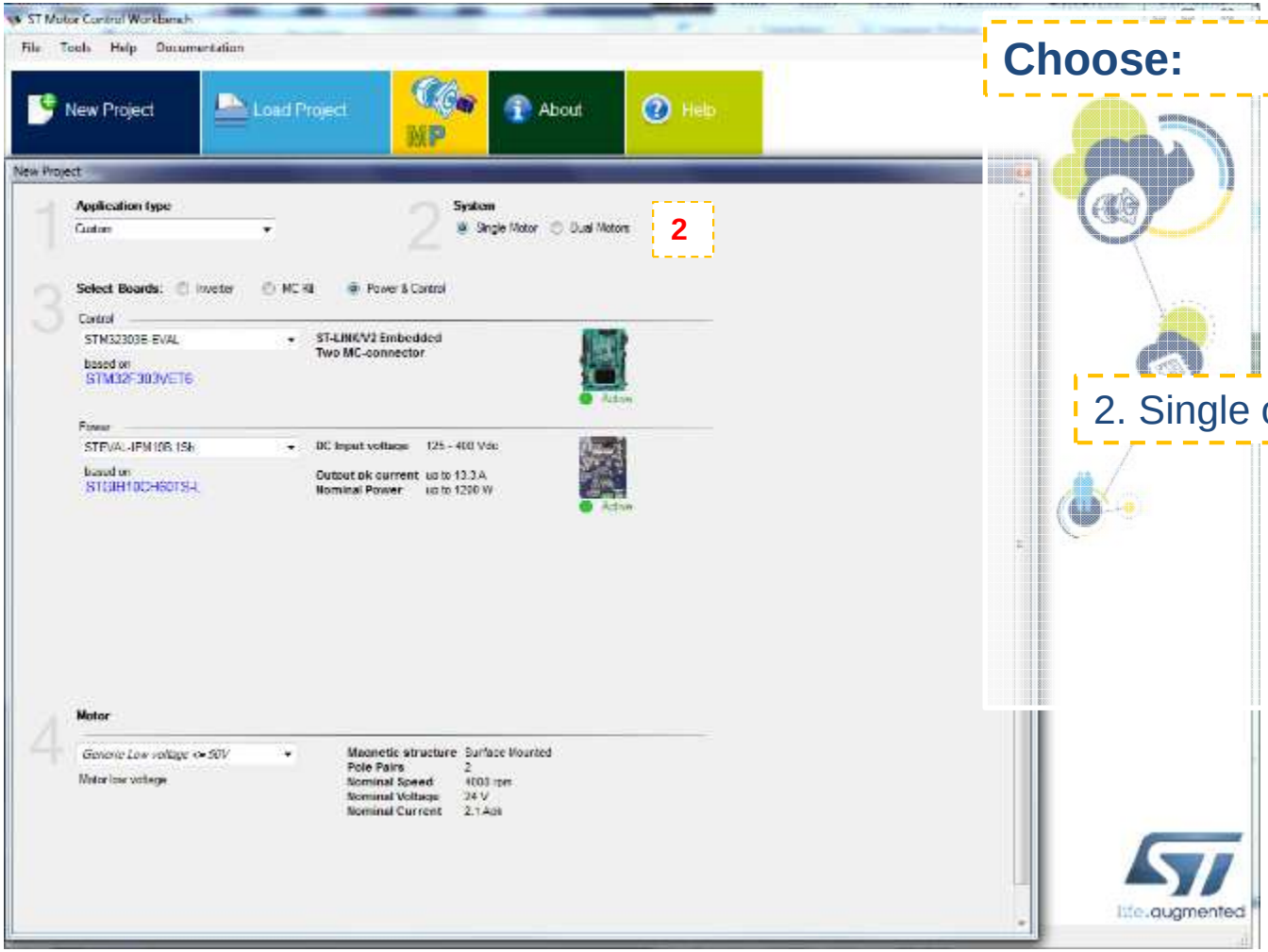


Choose:

1. Applications



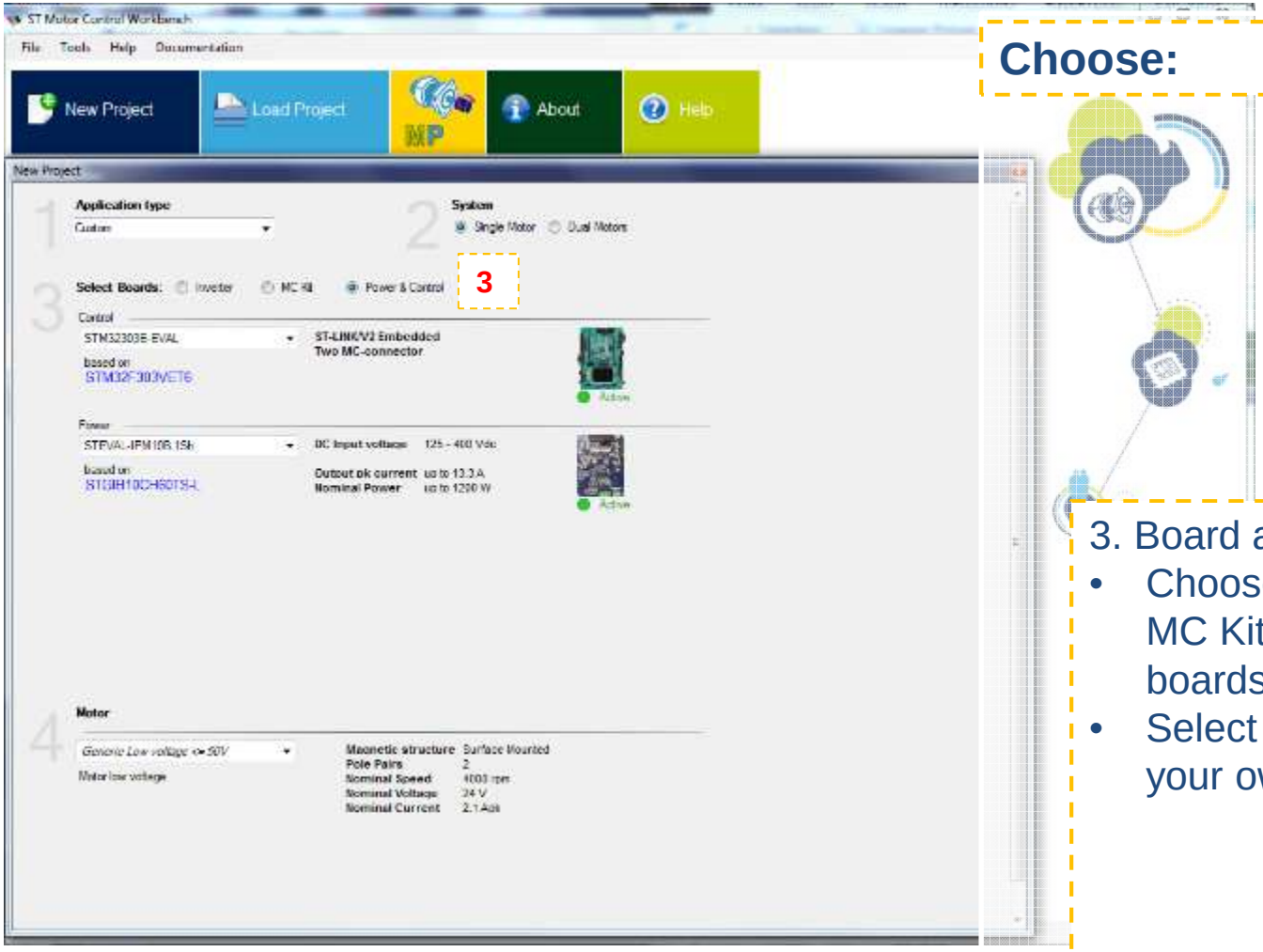
Create a new Workbench project based on the ST evaluation board



Choose:

2. Single or dual motor

Create a new Workbench project based on the ST evaluation board

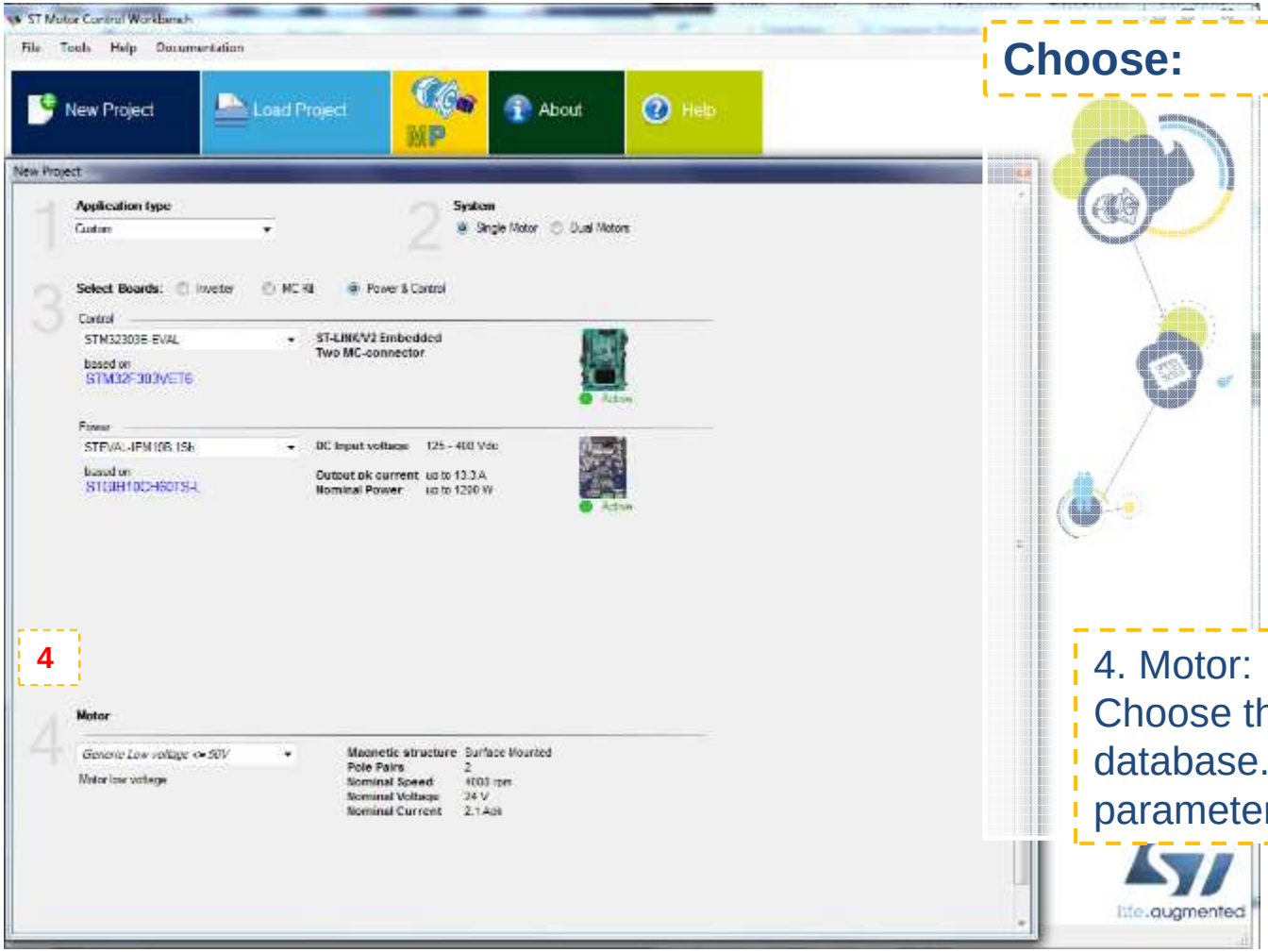


Choose:

3. Board approach:

- Choose if you are using Inverter, MC Kit or Power plus Control boards.
- Select the board used or create your own custom board.

Create a new Workbench project based on the ST evaluation board



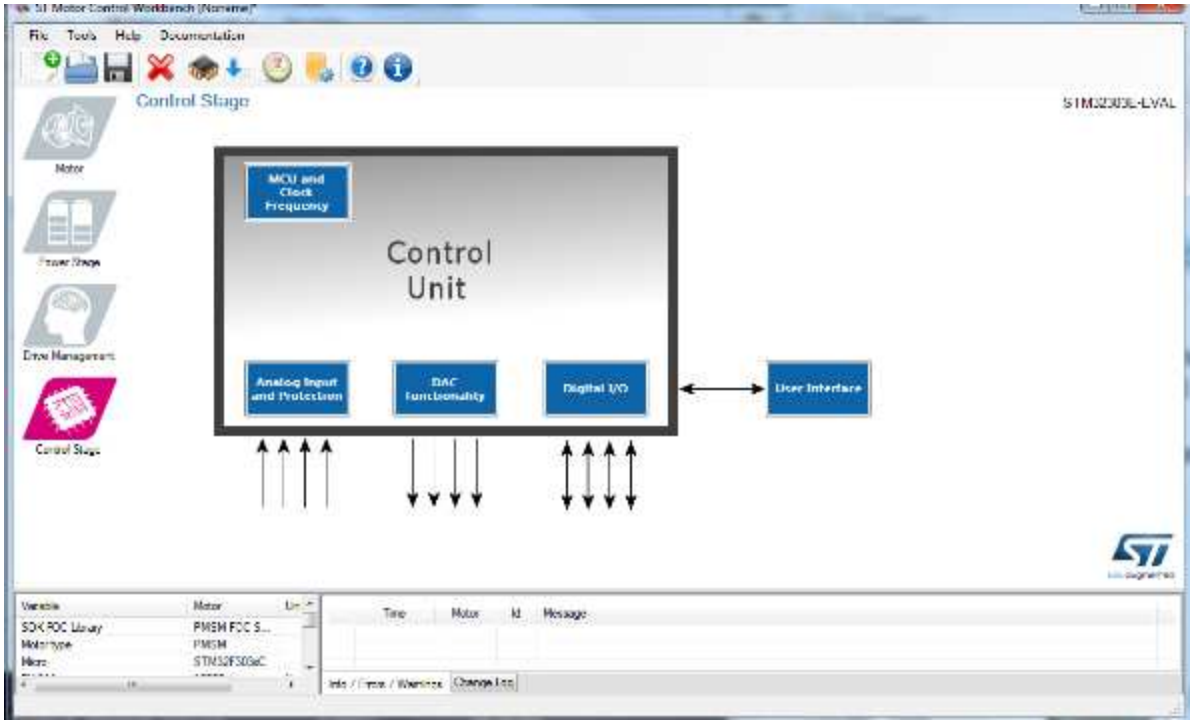
Choose:

4. Motor:
Choose the motor from a motor database. (You can save your motor parameters from your project.)

Create a new Workbench project

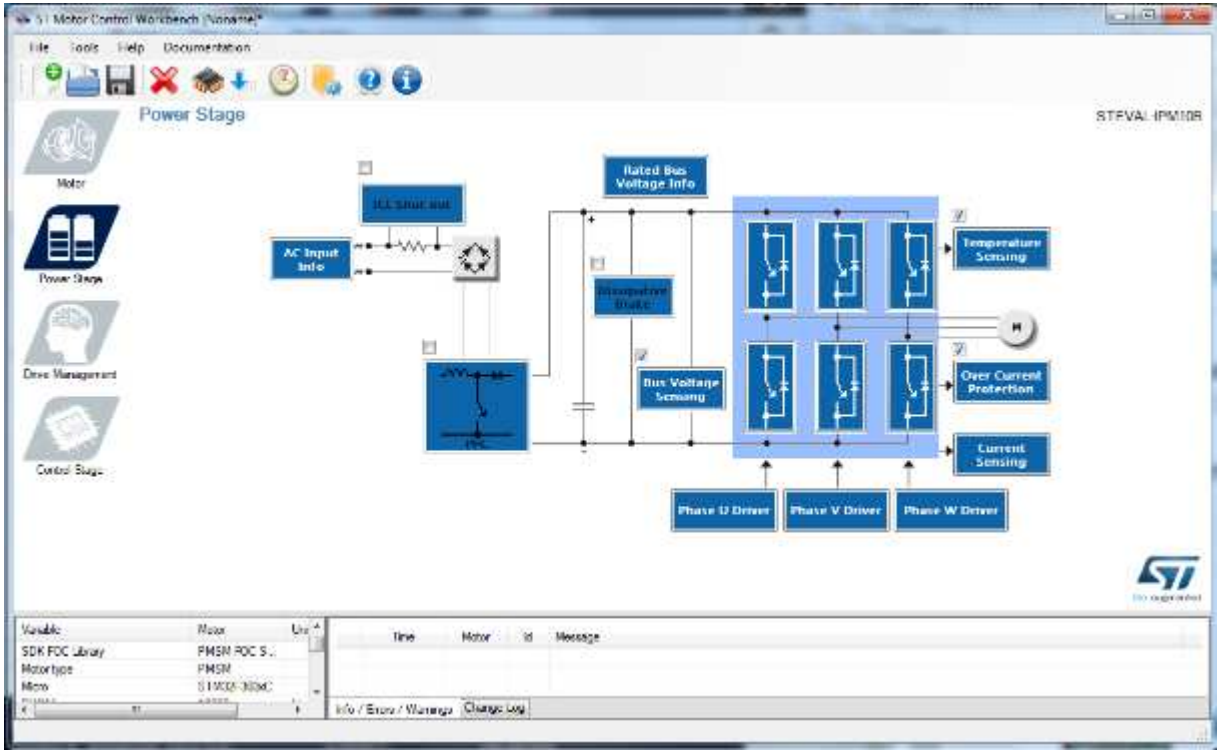
- Starting from the board selection or example project, the control stage parameters will be populated with the correct values.
- For a custom project, the user can set all the parameters.

STM32303E-EVAL



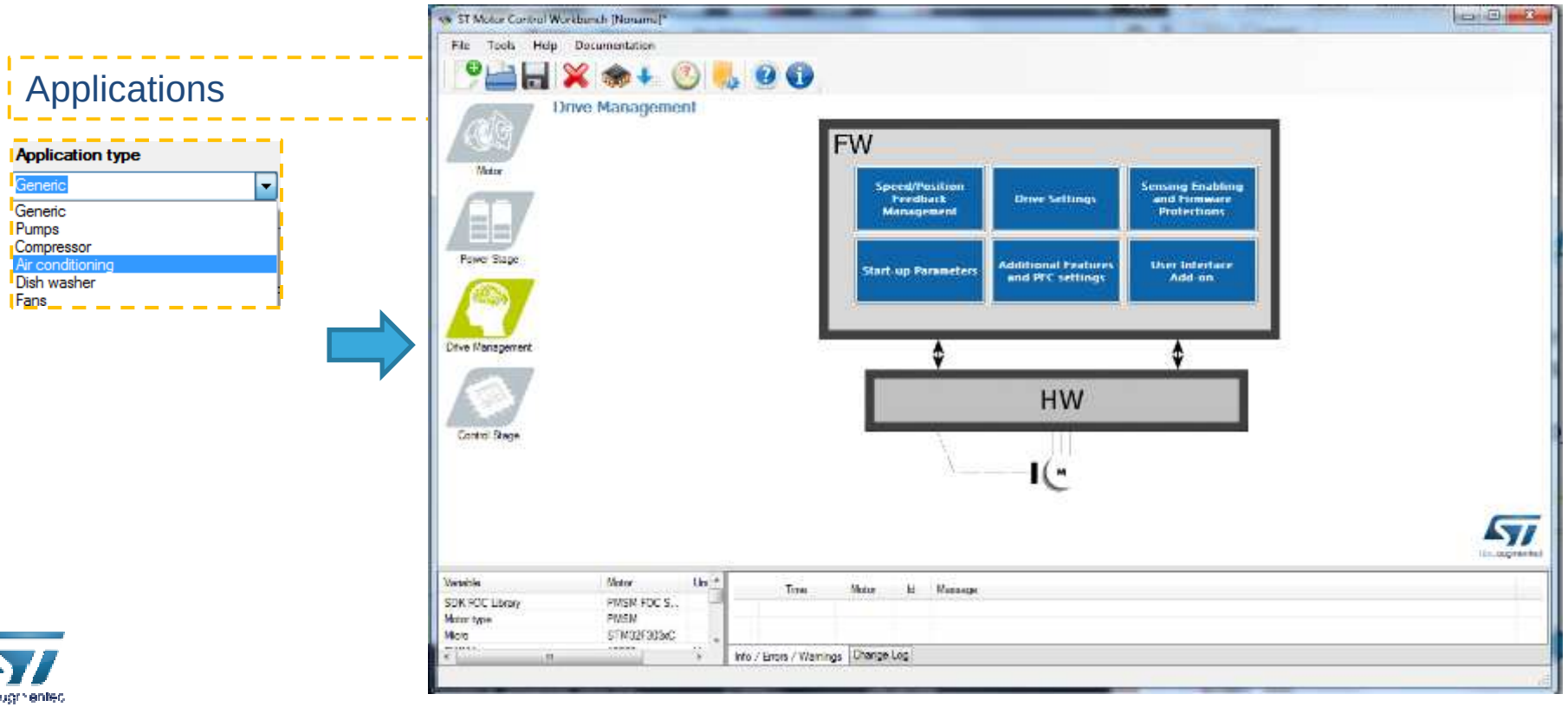
Set up power stage

- Starting from the board selection or example project, the power stage parameters will be populated with the correct values.
- For a custom project, the user can set all the parameters.



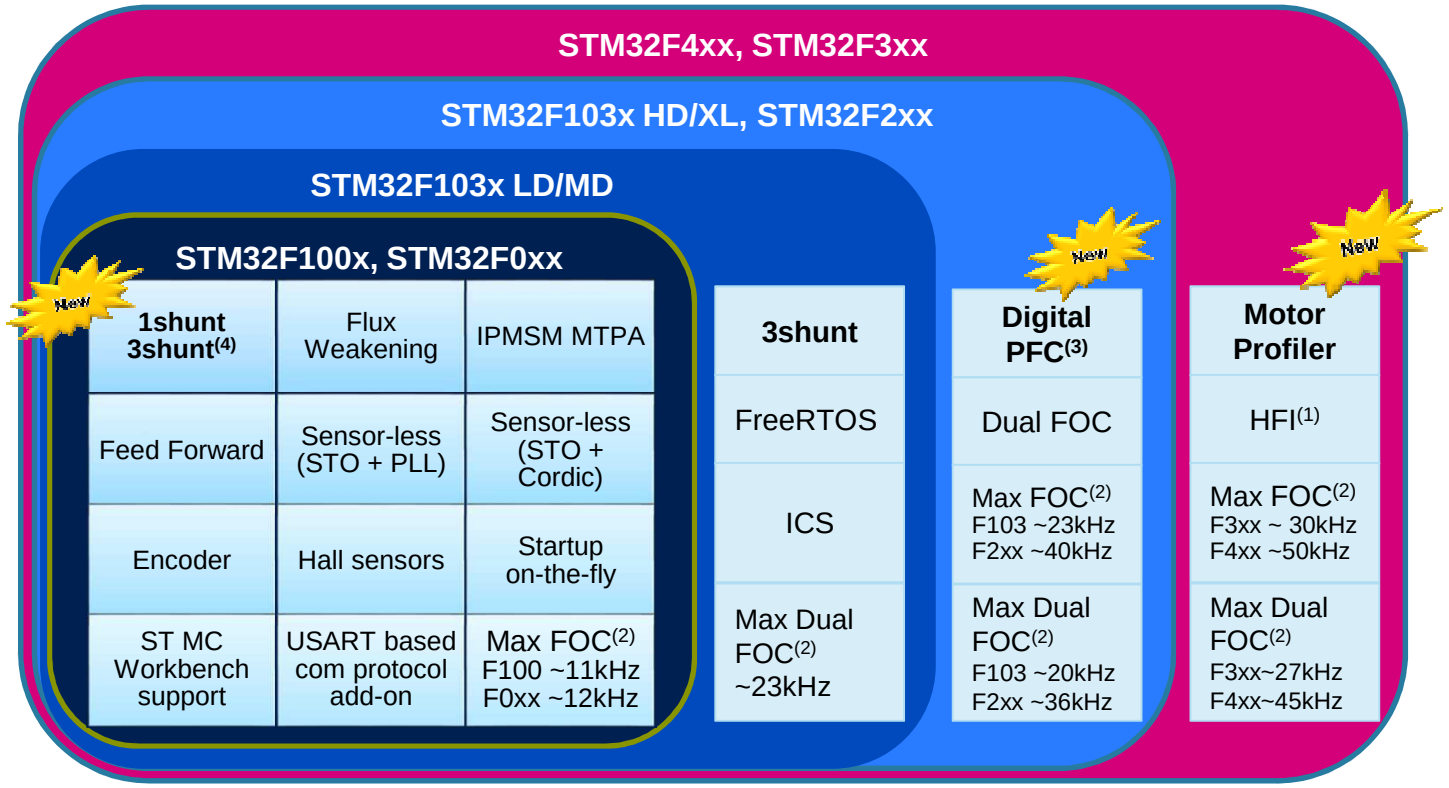
Set up drive parameters

- Starting from the board selection according to the chosen application, drive parameters will be populated with the correct values.
- For a custom project, the user can set all the parameters.



Drive Parameter

- In Drive settings, choose a correct PWM frequency and torque and flux execution rate in such a way that the $FOC\ rate = \frac{PWM\ freq}{Execution\ rate}$ is compatible with the maximum FOC rate according to the microcontroller used.



(1) High Frequency Injection

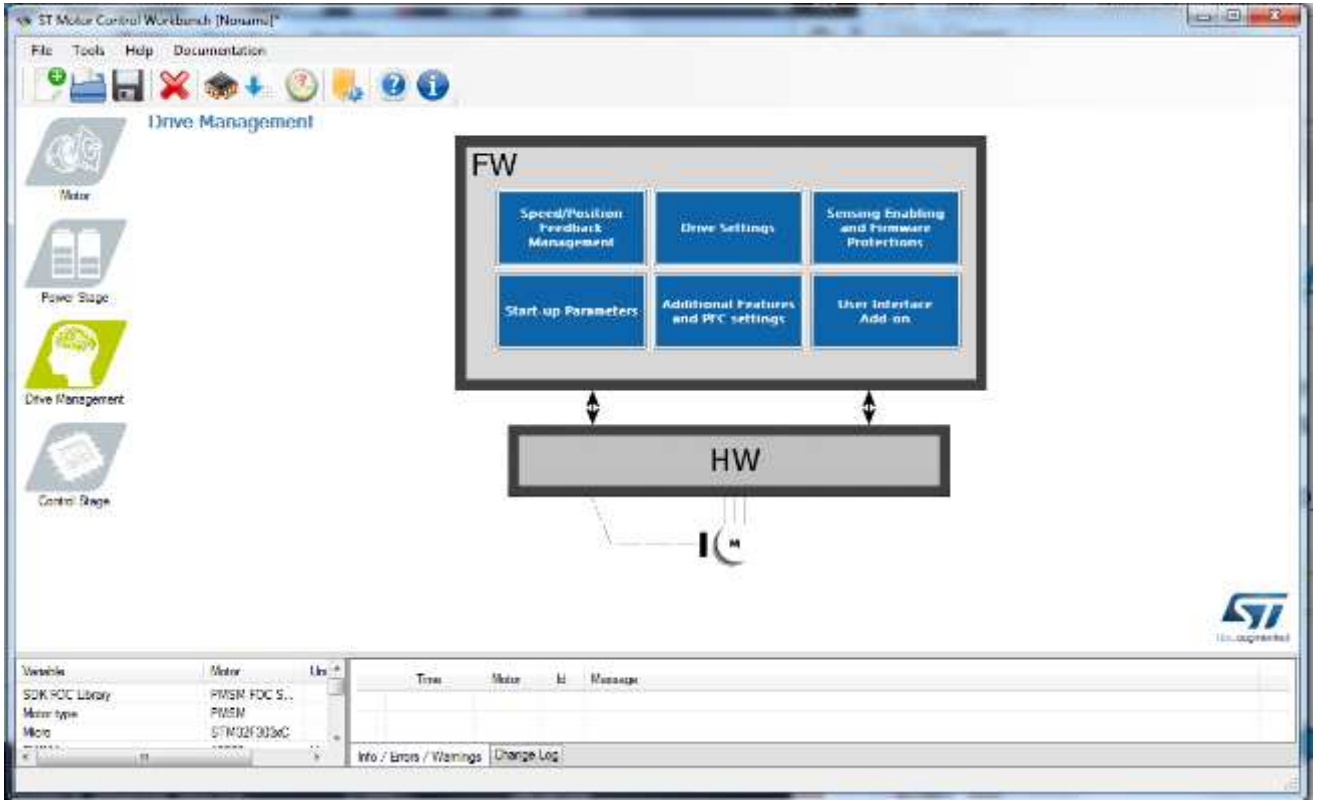
(2) Max FOC estimated in sensorless mode

(3) STM32F103xC/D/E/F/G and STM32F303xB/C

(4) Only for STM32F0xx

Drive parameter tricks

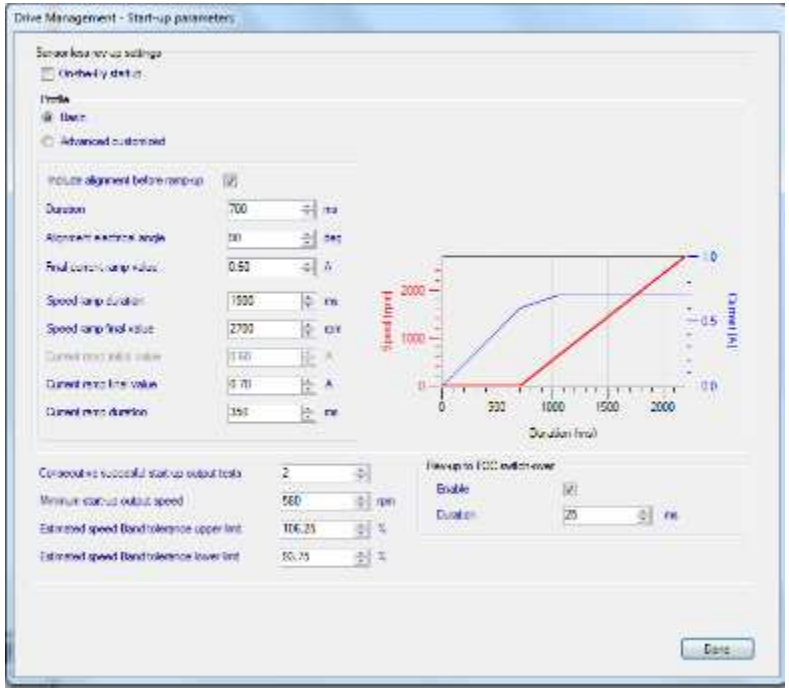
- In Drive settings, decrease cut-off frequency of torque and flux regulator down to 2000 rad/s if power stage → current reading topology is single shunt.
- In Sensing enabling and FW protections, uncheck the sensing options not supported by power stage and check any “Set intervention threshold to power stage xxx” buttons.
- In Drive settings, initially set default target speed to at least 20% of maximum application speed.
- In additional features, start without any additional method (possible to add them later).

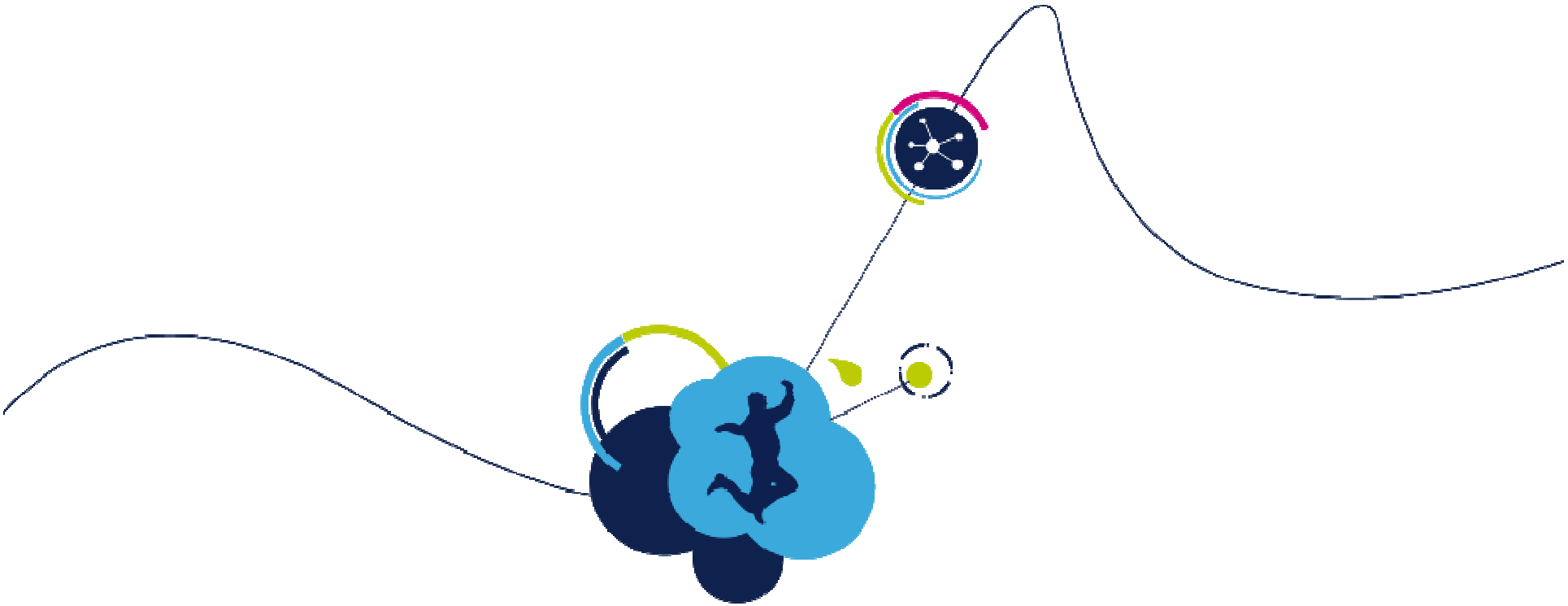


Drive parameter tricks

- ***If motor profiler is not used***, in Start-up parameters, select the *basic* profile.
- Set *current ramp initial and final values* equal to the motor nominal current value / 2 (if load is low at low speed, otherwise it can be set up to 0.8-1.0 times the nominal current value).
- Set *speed ramp final value* to approximately 30% of the maximum application speed.
- Depending on the motor inertia, it may be required to increase the *speed ramp duration*.
- Set *minimum start-up output speed* to 15% of the maximum application speed (if required, decrease it later).
- Set *estimated speed band tolerance lower limit* to 93.75%
- Enable the alignment at the beginning of your development (duration 2000 ms, final current ramp value from 0.5 to 1 times the motor nominal current depending on the load)

Basic





Digital PFC

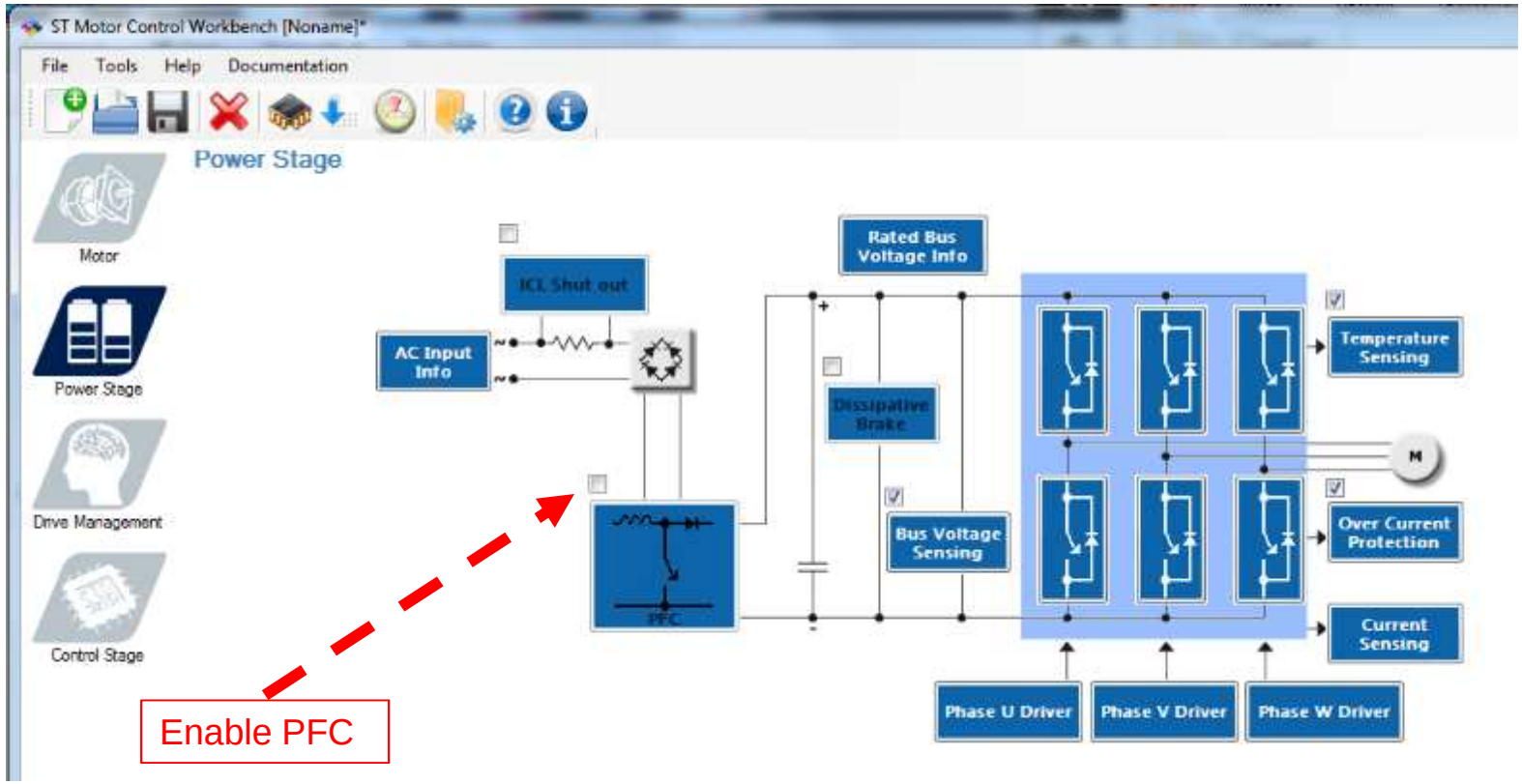
Digital PFC

Advantages of implementing active power-factor-correction (PFC) using the same microcontroller which is driving the motor with ST FOC algorithm:

- **Performance optimization** because the microcontroller knows information on the load (for instance the power requested by the motor) and can improve the performance of the PFC
- Cost saving (reduction of components count)

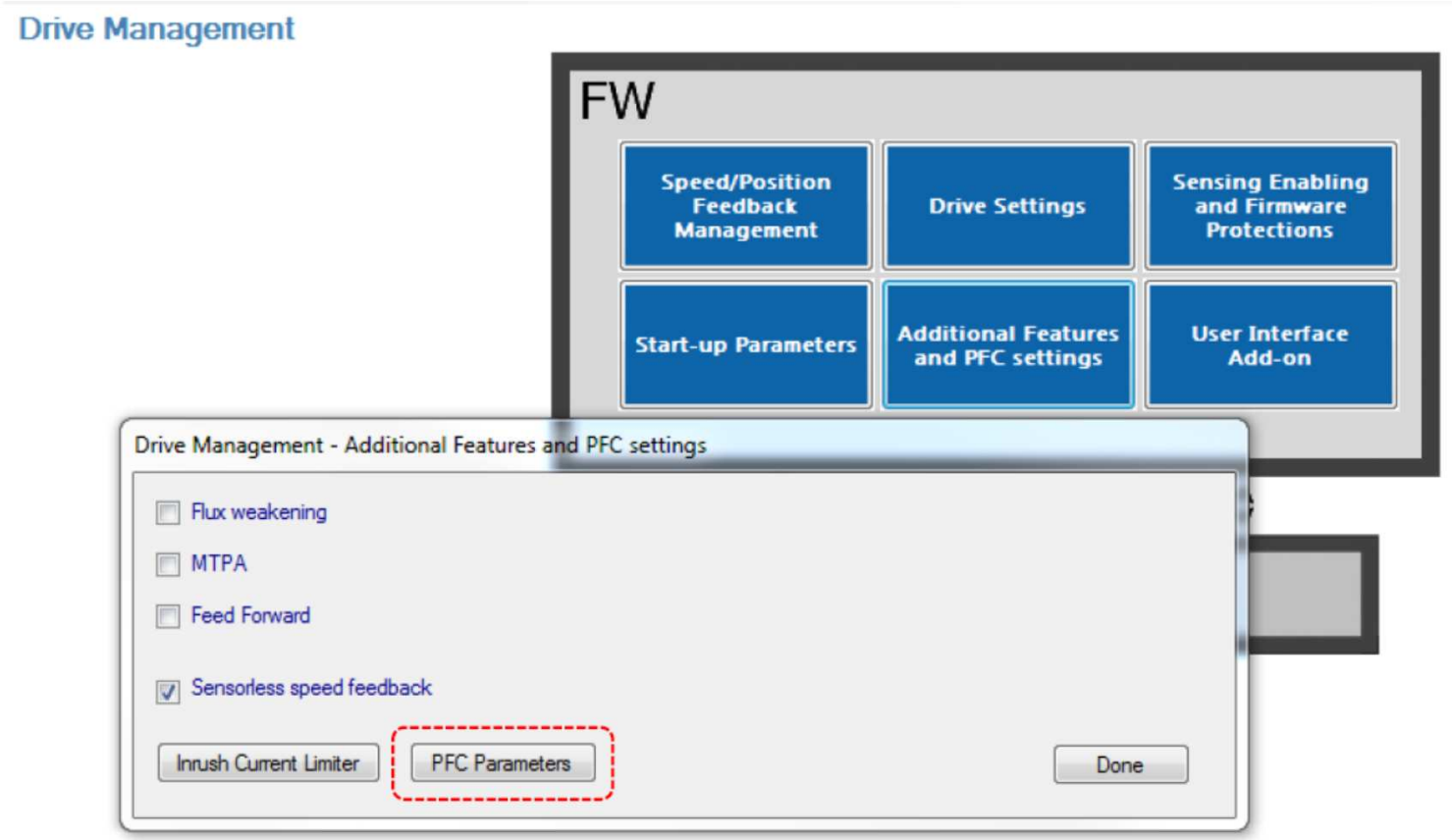
Digital PFC Enabling

- Digital “Power-factor-correction” algorithm working together with the ST motor control FOC firmware is included in the ST MC FOC SDK and can be enabled using the ST MC Workbench



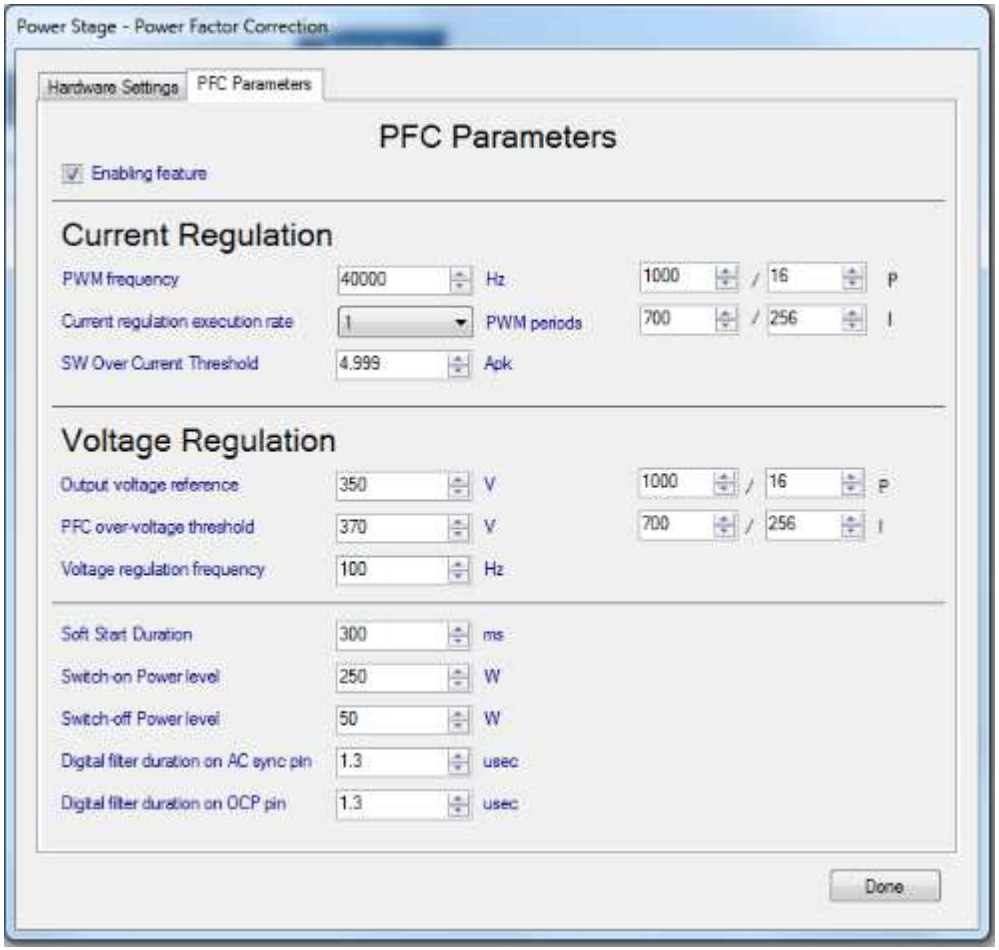
Digital PFC
where to set parameters

- To enable the digital PFC, go in the Drive Management -> Additional Features and PFC settings and click PFC Parameters



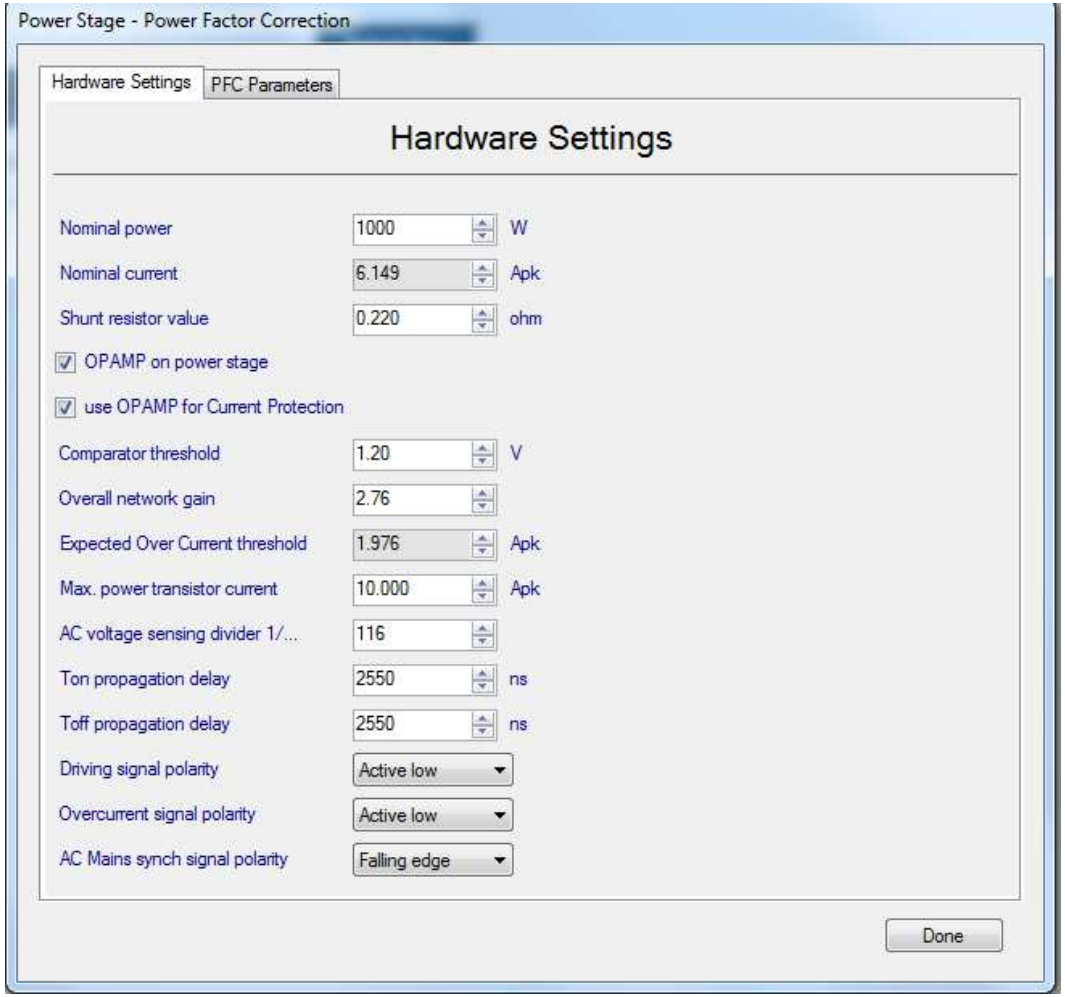
Digital PFC SW settings

- Select “Enabling feature” to enable the PFC in the firmware.



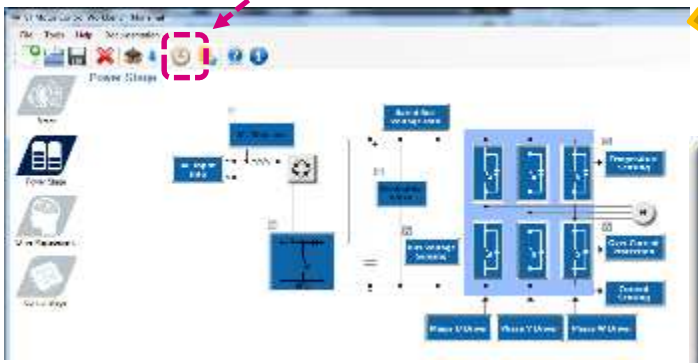
Digital PFC HW settings

Set the Physical hardware parameters according to the selected power stage.



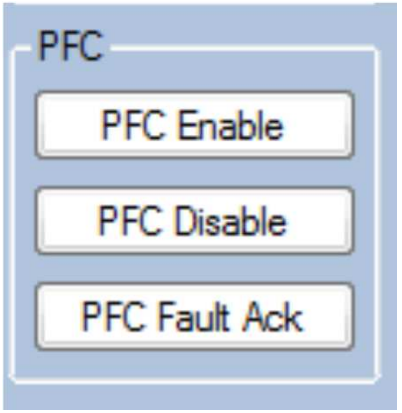
Digital PFC
Real Time monitoring

It is possible to enable, disable or make on-the-fly modifications on the PFC variable using the WB monitor feature.



Digital PFC
Real-time monitoring

- The PFC section must be enabled.
- To switch off the PFC, click “PFC Disable”.
- Click “PFC Fault Ack” to clear the PFC faults.

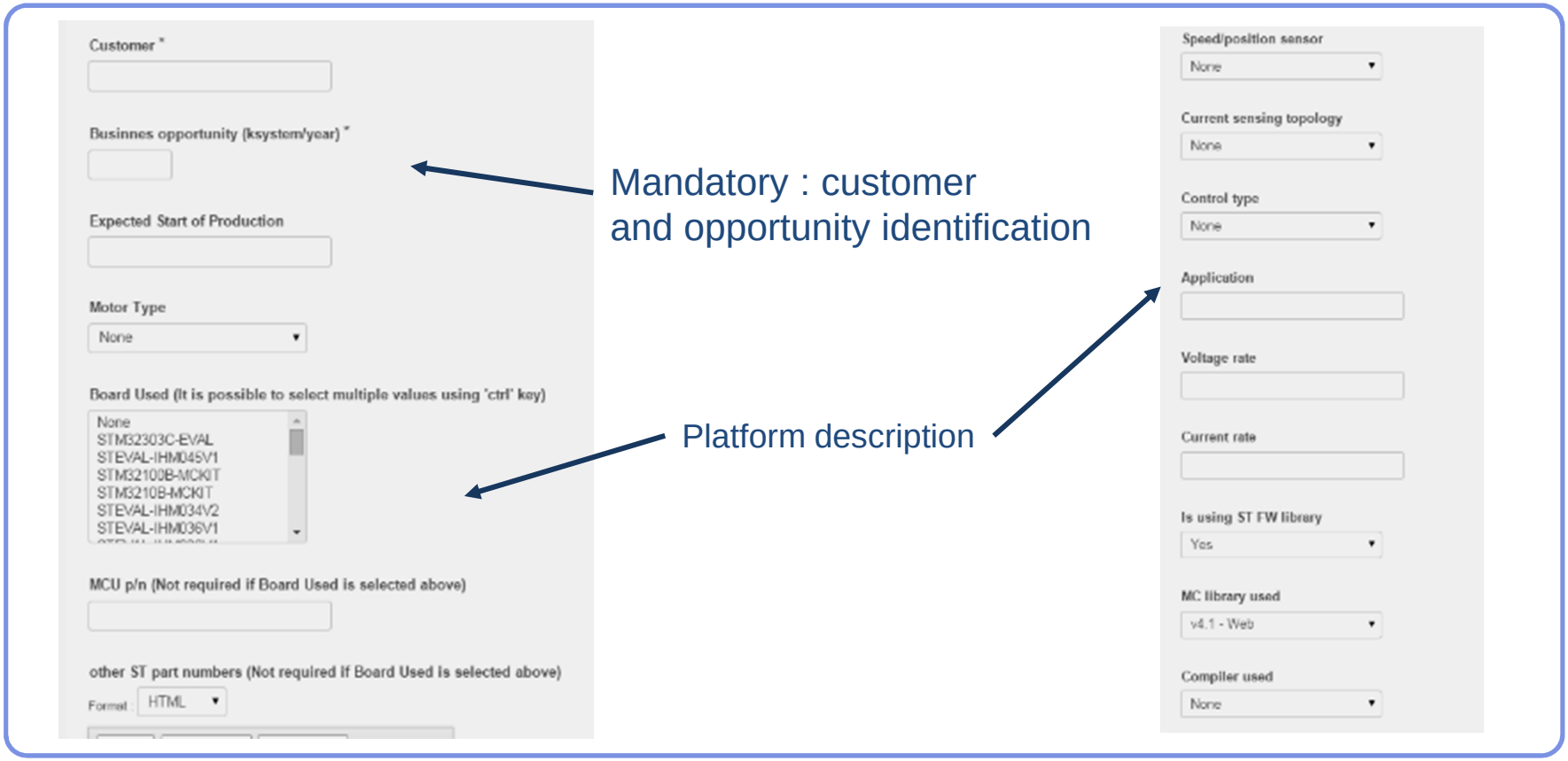


- The PFC status and register can be viewed and/or modified using the direct access in the “Register” tab.

0x4D	PFC Status		0
0x4E	PFC Flags		0
0x4F	PFC DC bus reference	Volt	0
0x50	PFC DC bus measured	Volt	0
0x51	AC Mains frequency	Hz	0
0x52	AC Mains voltage 0-to-pk	Volt	0
0x53	PFC Current loop Kp		0
0x54	PFC Current loop Ki		0
0x55	PFC Current loop Kd		0
0x56	PFC Voltage loop Kp		0
0x57	PFC Voltage loop Ki		0
0x58	PFC Voltage loop Kd		0
0x59	PFC startup duration	ms	0
0x5A	PFC abilitation status		0

System Lab - Motion Control - Support Requests

The tracker allow to easy technical support second level of request :
easy balance between support / development , avoinding direct request.
All ST employes have access to Codex:
https://codex.cro.st.com/plugins/tracker/?tracker=8650&func=new-artifact



This tool is used also to provide source code of Library

Stepper Motors

DC-DC converter

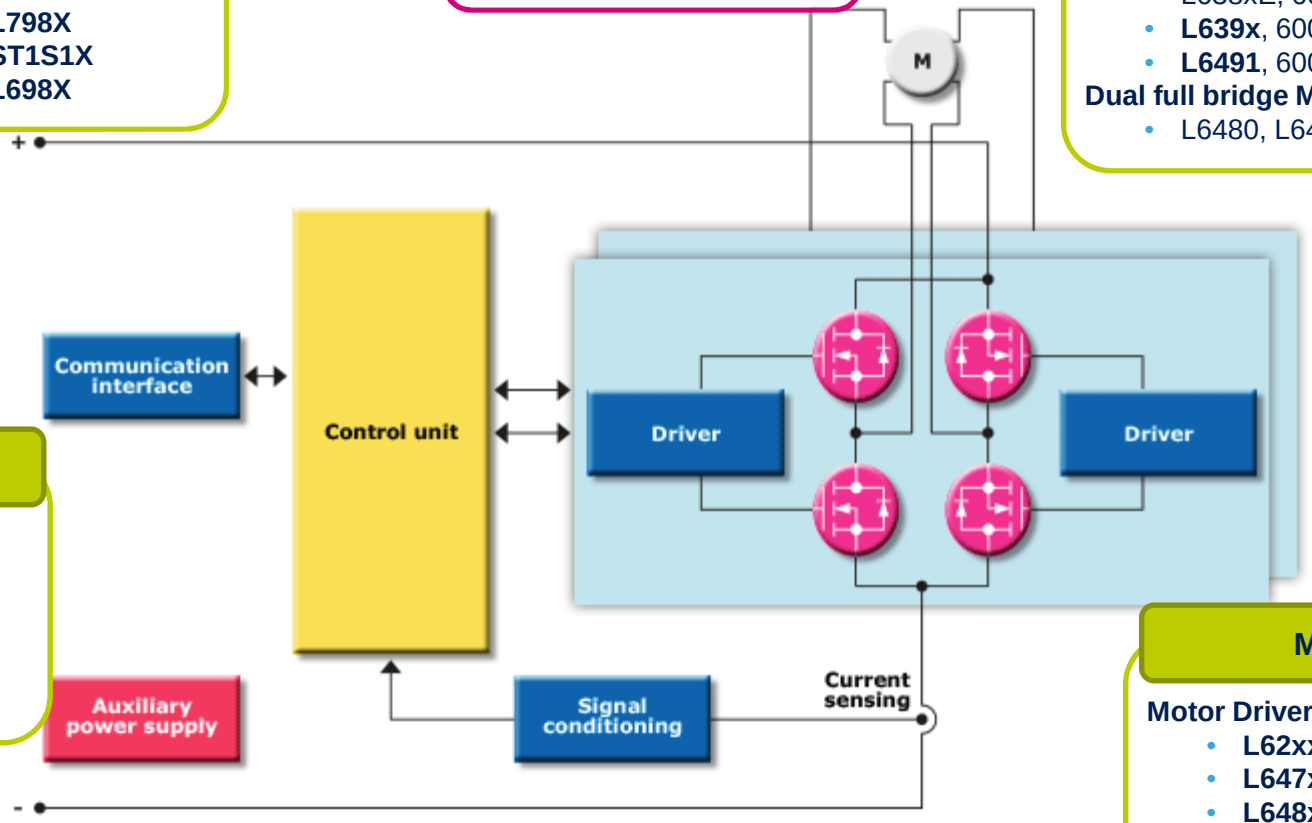
Buck regulators:
- **L597X**
- **L798X**
- **ST1S1X**
- **L698X**

Power Transistors
Power MOSFETs
(STripFET H7, F6, F7)

Gate Driver

Half Bridge MOS Gate Driver:
- L638xE, 600V, 0.65A
- **L639x**, 600V, 0.43A
- **L6491**, 600V, 4A

Dual full bridge MOS Gate Driver:
- L6480, L6482



Microcontroller

- 8-bit MCU:
  - STM8S
- 32-bit MCU
  - STM32F0
  - STM32F1
  - STM32F3

Motor Driver

Motor Driver ICs:
- **L62xx, L62xxQ**
- **L647x**
- **L648x**
- **POWERSTEP1**
- **STSPIN220(*)**

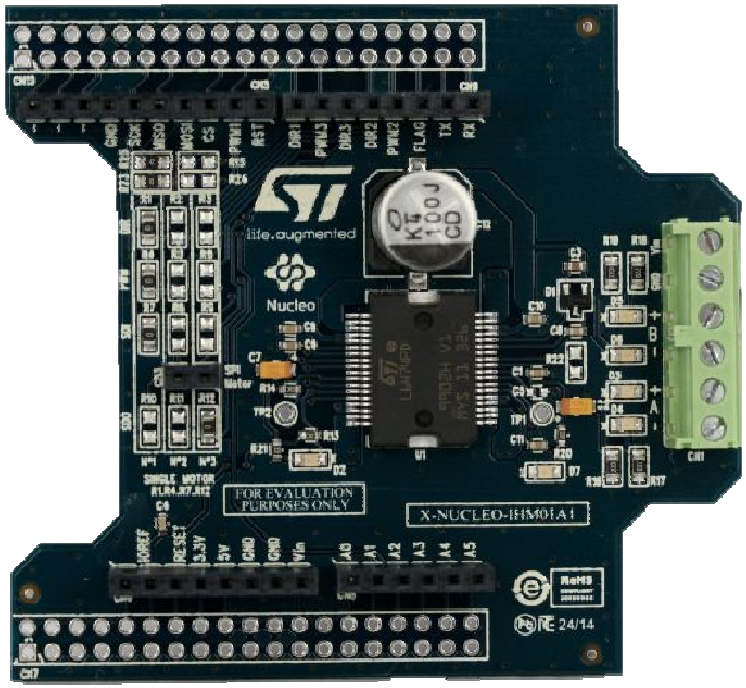
Op. Amp. and comparators (TSVxx, LMxx)

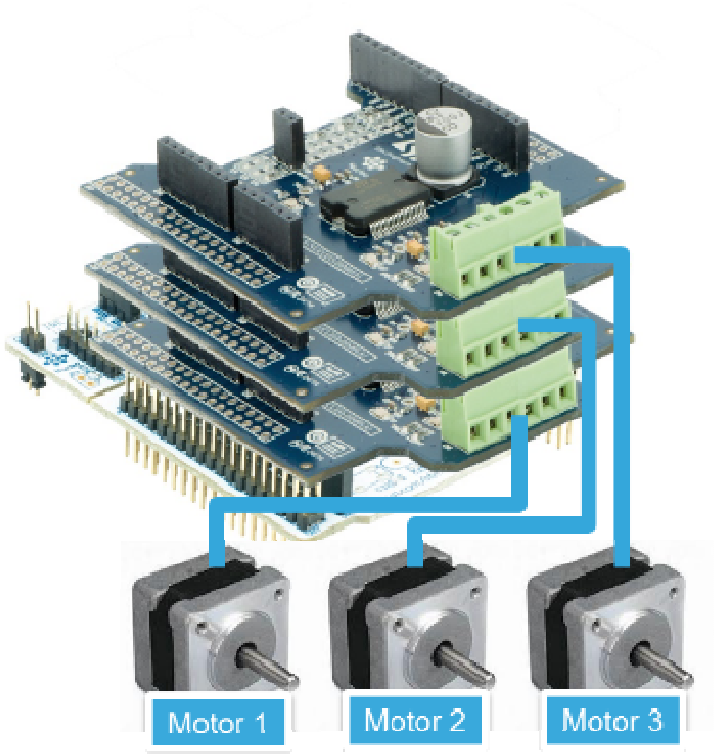
Tools (HW & SW)

X-NUCLEO-IHM01A1
Stepper motor driver board based on L6474

Multi motor solutions

The X-NUCLEO-IHM01A1 is compatible with the Arduino UNO R3 connector, and supports the addition of other boards which can be stacked to drive up to three stepper motors with a single STM32 Nucleo board.





Tools for Stepper and DC Brushed Motor

Low voltage stepper driver expansion board based on STSPIN220

- Supply voltage: 1.8V – 10V
- 2 A max output current
- Up to 1/256 microsteps
- Extremely low STBY consumption (~150nA)
- PWM current control with programmable off-time
- Step-clock / direction inputs
- Fully protected dual full-bridge
- Ultra compact QFN package

X-NUCLEO-IHM06A1

X-NUCLEO-IHM04A1

Dual brush DC motor driver expansion board based on L6206

- Supply voltage: 7V – 52V
- 5.6 A max output current
- RDS(ON)=0.3Ω
- Fully protected dual full-bridge
- Parallel outputs operation for higher current capability
- Operating frequency up to 100KHz
- Programmable non-dissipative OCP
- Diagnostic output

Evaluation Tools 1/2

Order code	Description	Core product
X-NUCLEO-IHM01A1	Stepper motor driver expansion board for STM32 Nucleo	L6474H/PD
X-NUCLEO-IHM02A1	Two axes stepper motor driver expansion board based on L6470 for STM32 Nucleo	L6470H
X-NUCLEO-IHM03A1	POWERSTEP01 System-in-Package motor driver expansion board for STM32 Nucleo	POWERSTEP01
X-NUCLEO-IHM04A1	Dual full-bridge motor driver expansion board based on L6206 for STM32 Nucleo	L6206PD
X-NUCLEO-IHM05A1	Dual full-bridge stepper motor driver expansion board based on L6208 for STM32 Nucleo	L6208PD
X-NUCLEO-IHM06A1	Low voltage microstepping motor driver expansion board based on STSPIN10D20 in QFN 3x3 package for STM32 Nucleo	STSPIN10D20
X-NUCLEO-IHM12A1	Low voltage dual brush DC motor driver expansion board based on STSPIN240 for STM32 NUCLEO	STSPIN240
EVLPOWERSTEP01	System-in-package integrating microstepping controller and 10 A power MOSFETs; evaluation board	POWERSTEP01
EVAL6470H	Fully integrated microstepping motor driver based on L6470 (Digtal Motion Engine and voltage mode control); evaluation board	L6470H
EVAL6470H-DISC	Discovery kit: development tool to easily explore L6470 microstepping motor driver	L6470H
STEVAL-IKM001V1	Evaluation kit based on the L6470H	L6470H
EVAL6470PD	Fully integrated microstepping motor driver based on L6470 in high power PowerSO package; evaluation board	L6470PD
EVAL6472H	Fully integrated microstepping motor driver based on L6472 (Predictive current control and adaptive decay); evaluation board	L6472H
EVAL6472H-DISC	Discovery kit: development tool to easily explore L6472 microstepping motor driver	L6472H
EVAL6472PD	Fully integrated microstepping motor driver based on L6472 in high power PowerSO package; evaluation board	L6472PD

Evaluation Tools 2/2

Order code	Description	Core product
EVAL6474H	Microstepping motor driver based on L6474 (current control and adaptive decay) ; evaluation board	L6474H
EVAL6474PD	Microstepping motor driver based on L6474 in high power PowerSO package; evaluation board	L6474PD
EVAL6480H	Fully integrated microstepping motor controller with Digital Motion Engine, SPI and voltage mode control; evaluation board	L6480H
EVAL6480H-DISC	Discovery kit: development tool to easily explore L6480 microstepping controller	L6480H
EVAL6482H	Fully integrated microstepping motor controller with Digital Motion Engine, SPI, predictive current control and adaptive decay; evaluation board	L6482H
EVAL6482H-DSIC	Discovery kit: development tool to easily explore L6482 microstepping controller	L6482H
EVAL6206PD	Dual full-bridge motor driver in high power PowerSO package (programmable overcurrent); evaluation board	L6206PD
EVAL6206Q	Dual full-bridge motor driver in QFN package (programmable overcurrent); evaluation board	L6206Q
EVAL6207N	Dual full-bridge motor driver in PowerDIP package (embedded PWM current control); evaluation board	L6207N
EVAL6207Q	Dual full-bridge motor driver in QFN package (embedded PWM current control); evaluation board	L6207Q
EVAL6208N	Dual full-bridge motor driver in PowerDIP package (embedded stepping sequence generator); evaluation board	L6208N
EVAL6208PD	Dual full-bridge stepper driver in high power PowerSO package (embedded stepping sequence generator); evaluation board	L6208PD
EVAL6208Q	Dual full-bridge stepper driver in QFN package (embedded stepping sequence generator); evaluation board	L6208Q

Industrial Motion Control

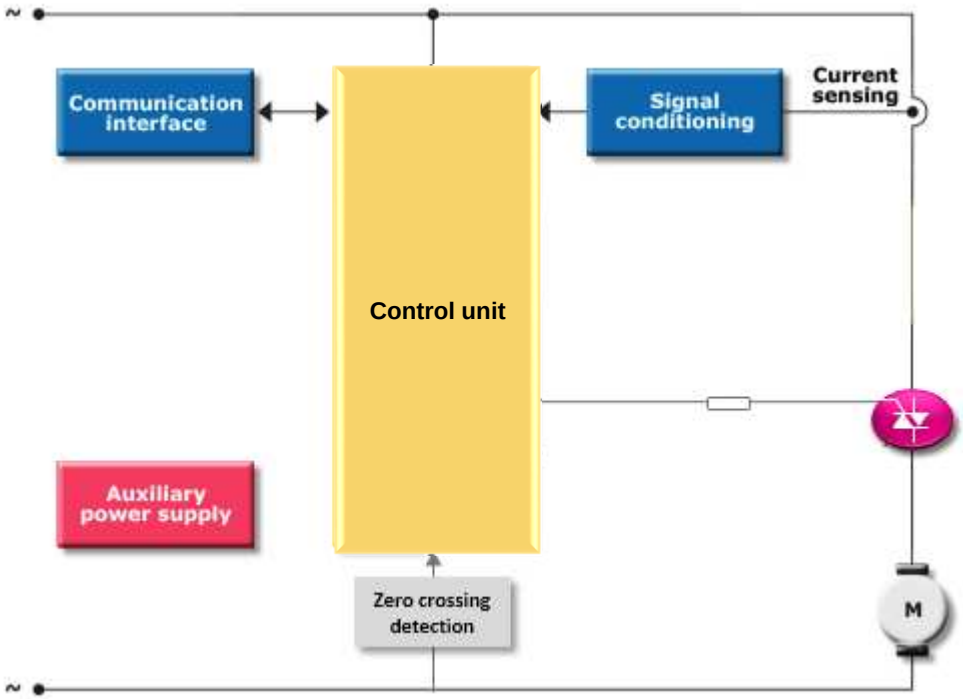
Motor type	Applications addressed
3-phase motors	• Home appliances (washing machines, Fridge, etc..) • Industrial (pumps, fans, etc.) Servo drives, Robotics
Stepper motors	• Industrial • Security system • Building automation • Medical and Appliances
DC Brushed Motors	• Battery power application like Power tools and more .
Universal motor And AC Load	• Appliances like washing machines, vacuum cleaners, power tools etc.

Universal and single phase AC induction Motors

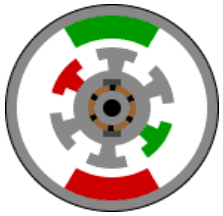
Auxiliary Power Supply

HV Converters, 4W to 20W
- VIPer Plus, **VIPer06, VIPer16,** (VIPerxx)

Triacs H,T series ACS™, ACST



Microcontroller
- 8-bit MCU:
  - STM8S
- 32-bit MCU
  - STM32F0



Op. Amp. and comparators (TSVxx, LMxx)

Tools (HW & SW)

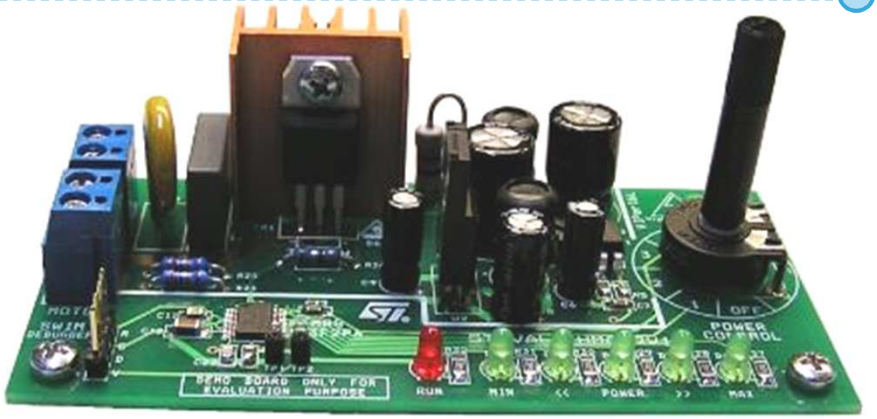
Vacuum Cleaner Control with STM8S and High Tj TRIACs
STEVAL-IHM029V2

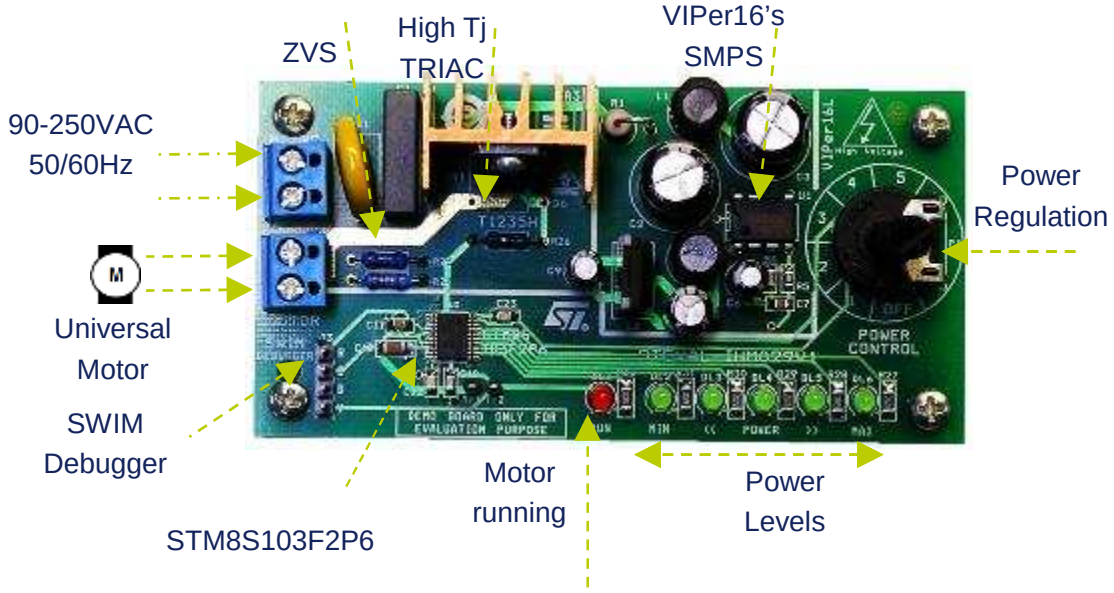
Key Features

- Wide range input voltage (90VAC-250VAC 50/60Hz)
- STM8S103F2P6 as Main Controller
- 1W SMPS based on VIPer16L
- Negative power supply
- Direct driving of TRIAC
- Soft-start and smooth power change function
- Stand-by total consumption <300mW @ 250VAC
- Robust design
- **IEC-61000-4-4, burst up to 8kV**
- **IEC-61000-4-5, 2kV surge**

Key Products

- STM8S103F2P6
- T1235T-8T
- VIPer16L
- L7905CP (Negative Voltage Regulator)
- STTH1R06





ACS/SCR/Triac power boards

Order code	Description
STEVAL-IHM029V2	Demonstrate High-Tj solution for 2000 W universal motor validate solution immunity to surges and EFT. **SCR/Triac Products:** T1235T-8T
STEVAL-IHM041V1	Universal motor speed control open loop or closed loop speed control modes demonstrate snubberless device operation. **SCR/Triac Products:** T1635T-8I
STEVAL-IHT001V2	Compressor / Light bulb / Defrost resistor / Fan control Demonstrate EFT immunity and fridge efficiency gains thanks to electronic control Adapt Triac control and fridge control by Graphic PC interface **SCR/Triac Products:** ACST610-8FP, ACS102-6TA, ACS110-7SN
STEVAL-IHT005V2	Demonstrate feasibility of Triac / ACS control with 3V3 MCU Validate solution immunity to surges and EFT. **SCR/Triac Products:** T1635H-8I, ACST1635-8FP, Z0109MA, ACS108-8SA
STEVAL-IHT006V1	Single-phase compressor control cabinet lighting by LEDs **SCR/Triac Products:** ACST830-8T
STEVAL-IHT007V1	Plug-in of the STM8S discovery kit opto-transistor Triac and ACS insulated control **SCR/Triac Products:** T1010H-6G, ACS108-6SUF

Thanks