STM32 Nucleo expansion boards Motor control selection guide

STM32 Open Development Environment

STM32 ODE ecosystem

FAST, AFFORDABLE PROTOTYPING AND DEVELOPMENT

The **STM32 Open Development Environment (ODE)** is an open, flexible, easy and affordable way to develop innovative devices and applications based on the STM32 32-bit microcontroller family combined with other state-of-the-art ST components connected via expansion boards. It enables fast prototyping with leading-edge components that can quickly be transformed into final designs.

The STM32 ODE includes the following five elements:

- STM32 Nucleo development boards. A comprehensive range of affordable development boards for all STM32 microcontroller series, with unlimited unified expansion capability, and with integrated debugger/programmer. STM32 MCUs are particularly suitable to develop Permanent Magnet Synchronous Motors (PMSM), Brushless DC motors (BLDC), AC induction motors (ACIM), and Stepper motors.
- STM32 Nucleo expansion boards. Boards with additional functionality to add sensing, control, connectivity, power, audio or other functions as needed. The expansion boards are plugged on top of the **STM32 Nucleo development boards**. More complex functionalities can be achieved by stacking additional expansion boards
- STM32Cube software. A set of free-of-charge tools and embedded software bricks to enable fast and easy development on the STM32, including a Hardware Abstraction Layer, middleware and the STM32CubeMX PC-based configurator and code generator
- STM32Cube expansion software. Expansion software provided free of charge for use with STM32 Nucleo expansion boards, and compatible with the STM32Cube software framework
- STM32Cube Function Packs. Set of function examples for some of the most common application cases built by leveraging the modularity and interoperability of STM32 Nucleo development boards and expansions, with STM32Cube software and expansions.

The STM32 Open Development Environment is compatible with a number of IDEs including **STM32CubeIDE**, IAR EWARM, Keil MDK-ARM and GCC/LLVM-based IDEs, with the possibility to integrate the various components such as **STM32CubeMX**, **STM32CubeProgrammer** or **STM32CubeMonitor**.
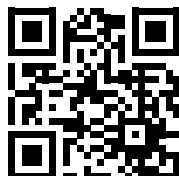
STM32 Nucleo development boards	**STM32 Open Development Environment**	STM32Cube development software
STM32 Nucleo expansion boards (X-NUCLEO)		STM32Cube expansion software (X-CUBE)
Function packs		

FIND OUT MORE
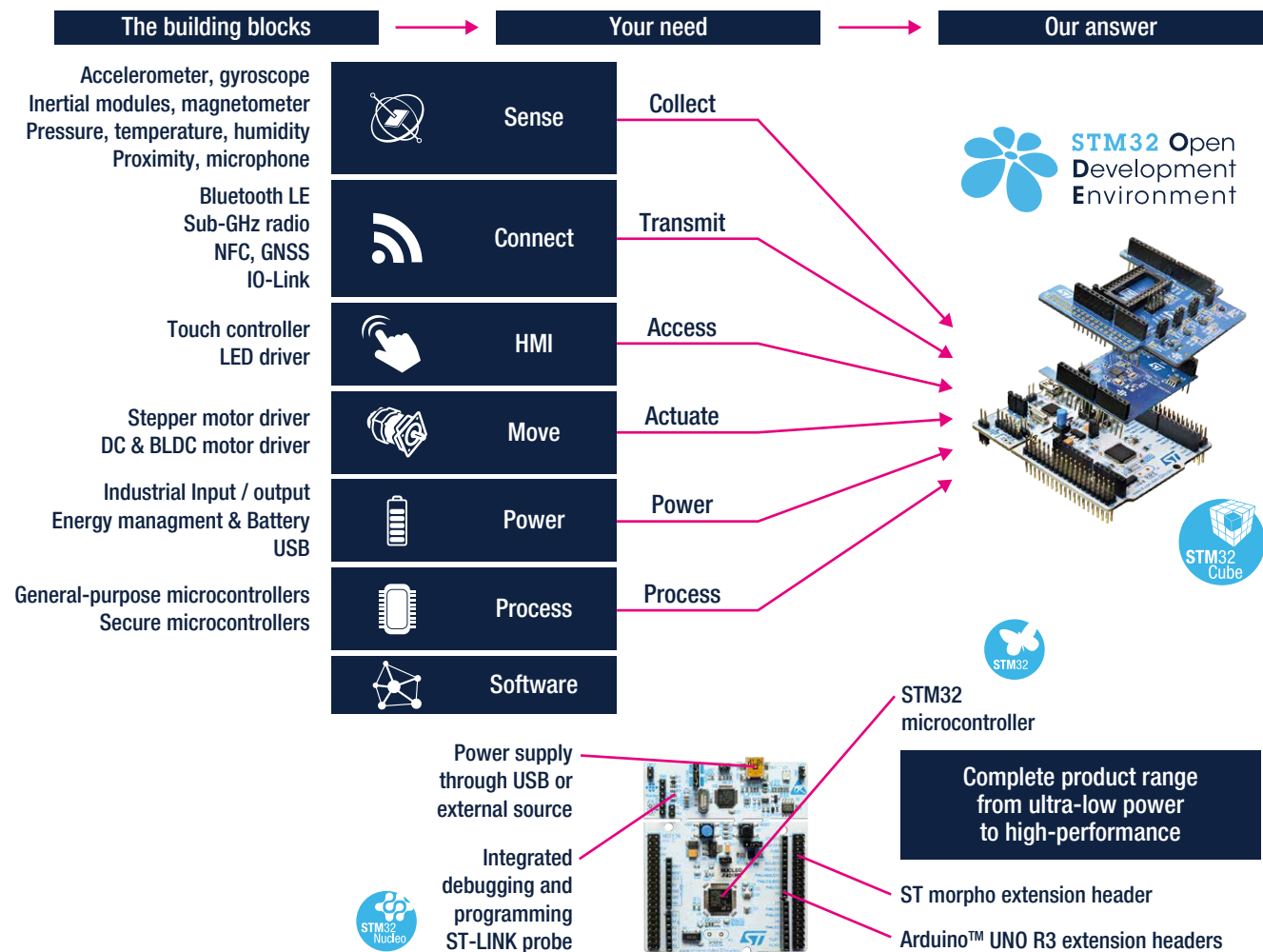
http://www.st.com/stm32ode

STM32 Open Development Environment: all that you need

The combination of a broad range of expandable boards based on leading-edge commercial products and modular software, from driver to application level, enables fast prototyping of ideas that can be smoothly transformed into final designs.

To start your design:

- Choose the appropriate STM32 Nucleo development board (MCU) and expansion (X-NUCLEO) boards (sensors, connectivity, audio, motor control etc.) for the functionality you need
- Select your development environment (IAR EWARM, Keil MDK, and GCC-based IDEs) and use the free STM32Cube tools and software such as **STM32CubeMX**, **STM32CubeProgrammer**, **STM32CubeMonitor** or **STM32CubeIDE**.
- Download all the necessary software to run the functionality on the selected STM32 Nucleo expansion boards.
- Compile your design and upload it to the STM32 Nucleo development board.
- Then start developing and testing your application.

Software developed on the STM32 Open Development Environment prototyping hardware can be directly used in an advanced prototyping board or in an end product design using the same commercial ST components, or components from the same family as those found on the STM32 Nucleo boards.

The building blocks	Your need	Our answer

The building blocks		Your need	Our answer
Accelerometer, gyroscope Inertial modules, magnetometer Pressure, temperature, humidity Proximity, microphone	Sense	Collect	
Bluetooth LE Sub-GHz radio NFC, GNSS IO-Link	Connect	Transmit	
Touch controller LED driver	HMI	Access	
Stepper motor driver DC & BLDC motor driver	Move	Actuate	
Industrial Input / output Energy managment & Battery USB	Power	Power	
General-purpose microcontrollers Secure microcontrollers	Process	Process	
	Software		

STM32 Open Development Environment

Power supply through USB or external source

Integrated debugging and programming ST-LINK probe

STM32 microcontroller

Complete product range from ultra-low power to high-performance

ST morpho extension header

Arduino™ UNO R3 extension headers

Motor control family

ST, a pioneer in the field of **motor and motion control**, offers a wide selection of ICs to best match an application spectrum covering a wide range of power ratings and motor types, as well as varied system partitioning.

STSPIN motor drivers embed all the functions needed to drive motors efficiently and with the highest accuracy and include an advanced motion profile generator to relieve the host microcontroller, while ensuring robustness and reliability thanks to a comprehensive set of protection and diagnostic features. Particularly noteworthy are the adaptive current decay control scheme used in many of the STSPIN motor driver ICs as well as the innovative voltage mode driving used in micro-stepping motor drivers that provides incredibly silent motion and enhanced torque control accuracy and thus motion smoothness.

Our line-up of STSPIN motor control ICs has been developed with the objectives of modularity, scalability and robustness to provide designers a wide choice of solutions to fit different requirements and system architectures.

The STSPIN32 series motor drivers integrate STM32 microcontrollers, power management, and gate drivers in a range of multiple intelligent driver variations to answer your 3-phase BLDC application requirements.

All products have comprehensive built-in protection and diagnostic schemes to help attain the level of long term reliability and robustness requested to cope with harsh factory automation environments.

Available in a wide selection of space-saving, thermally-optimized packages, you are sure to find a device in our STSPIN line-up that addresses your motor or motion control system requirements.

The benefit of our 10 and 15 years longevity program is available for our industrial grade STSPIN motor drivers.
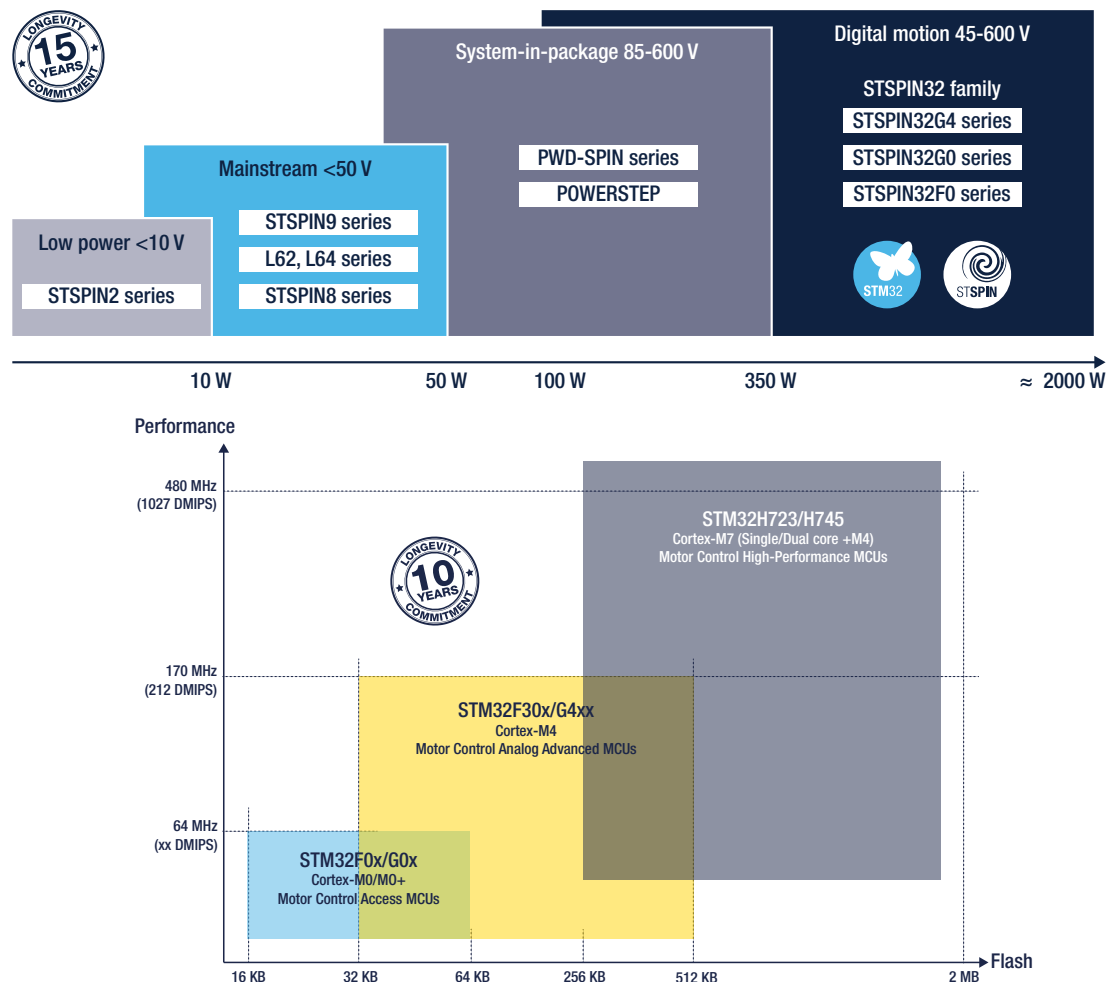
For more details on STSPIN motor drivers devices, please visit **www.st.com/stspin**

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Expansion boards for motor control

The STM32 Nucleo expansion boards for motor control cover all the main motor categories in a wide operating range of both current and voltage.

Stepper motor	Brushed DC	Brushless DC
X-NUCLEO-IHM01A1 X-NUCLEO-IHM02A1 X-NUCLEO-IHM03A1 X-NUCLEO-IHM05A1 X-NUCLEO-IHM06A1 X-NUCLEO-IHM14A1	X-NUCLEO-IHM04A1 X-NUCLEO-IHM12A1 X-NUCLEO-IHM13A1 X-NUCLEO-IHM15A1	X-NUCLEO-IHM07M1 X-NUCLEO-IHM08M1 X-NUCLEO-IHM09M2* X-NUCLEO-IHM11M1 X-NUCLEO-IHM16M1 X-NUCLEO-IHM17M1 * connector expansion board

For Brushless DC motors there is also the possibility to have an omni-comprehensive kit including STM32 Nucleo board, Motor Control expansion board and a dedicated motor.

Motor Control Nucleo Pack

KIT Name	Nucleo (included)	X-Nucleo (included)	Motor (included)	Power Supply
P-NUCLEO-IHM001	NUCLEO-F302R8	X-NUCLEO-IHM07M1	Bull-Running model BR2804-1700 kV	
P-NUCLEO-IHM002	NUCLEO-F302R8	X-NUCLEO-IHM07M1	Bull-Running model BR2804-1700 kV	•
P-NUCLEO-IHM03	NUCLEO-G431RB	X-NUCLEO-IHM16M1	Gimbal motor GBM2804H-100T	•

Stepper motor

Stepper motors are widely used in holding and positioning applications in the computer, security, industrial automation and automotive sectors. Depending on the number of phases, the winding arrangement and the required level of motion smoothness.

In bipolar stepper motors, current can flow in both directions; a full-bridge converter is required to drive each of the two windings of a two-phase motor. During motion, the type of electronic control (full step, half step, micro-stepping) and the resulting phase current waveform impact the vibration level, the acoustic noise, motion smoothness and sensitivity to resonances. ST's portfolio of STSPIN stepper motor drivers spans from relatively simple ICs with current control and phase generation to more complex solutions. They combine in a single chip all that is needed to autonomously drive a stepper motor using high-level motion commands coming from the motor or motion control system host – a microcontroller, DSP or FPGA.

Available in a large selection of space-saving, thermally-enhanced packages, STSPIN stepper motor drivers provide a ready-to-use, optimized solution for motor and motion control systems in a wide range of voltage and current ratings.
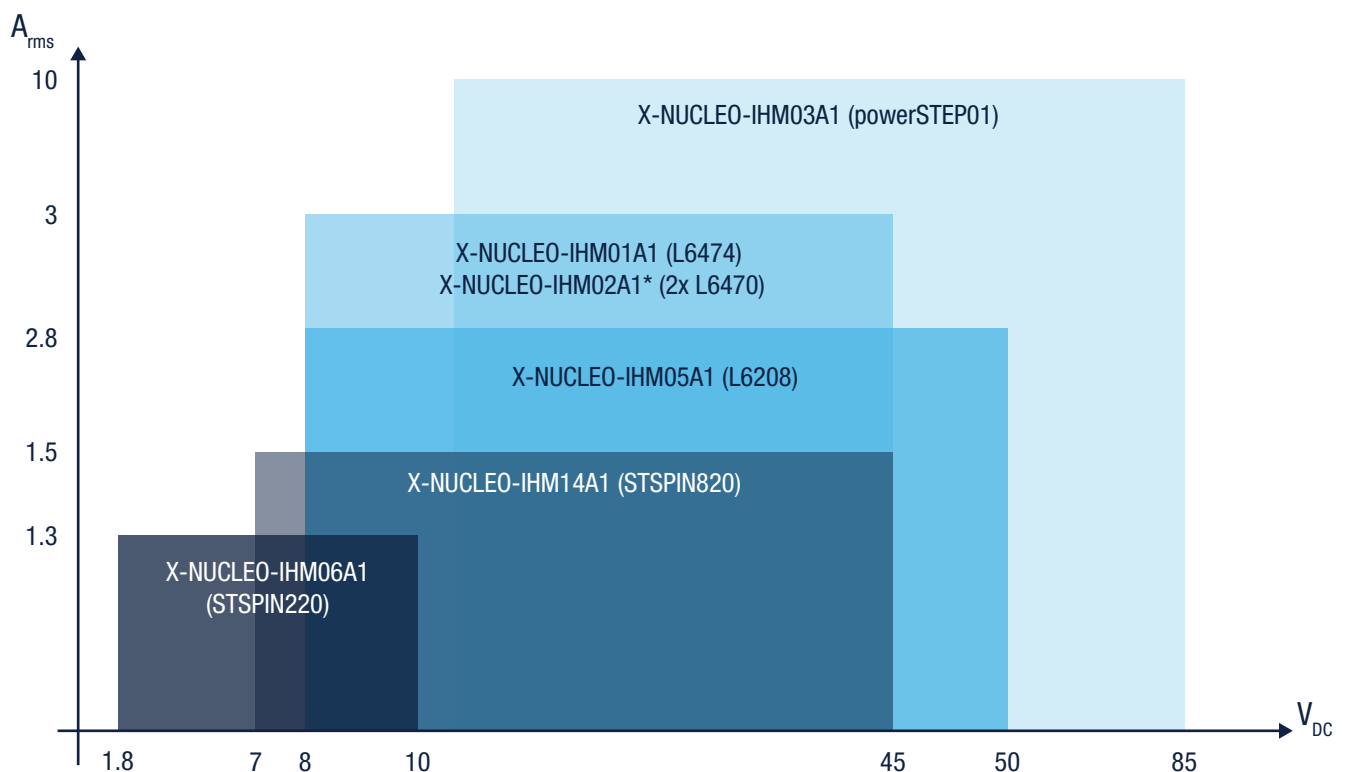
*IHM02A1 is dual stepper

Stepper motor control Nucleo expansion boards grouped by operative range and family. Use this graphical representation to select the best appropriate board based on the operative range of the motor to be used.

Expansion boards

Board	Voltage	Power/Max Current	ST parts	Stackable	Application focus
X-NUCLEO-IHM01A1	8 - 45 V_{DC}	Up to 3 A_{rms}	1x L6474	Up to 3 boards, 3 motors	Textile machines, factory automation, industrial and 3D printers. Up to 16 microsteps
X-NUCLEO-IHM02A1	8 - 45 V_{DC}	Up to 3 A_{rms} for each motor driver	2x L6470	Up to 4 boards (up to 8 motors)	Textile machines, factory automation, industrial and 3D printers. Up to 128 microsteps, Voltage mode driving
X-NUCLEO-IHM03A1	10.5 - 85 V_{DC}	Up to 10 A_{rms}	1x powerSTEP01	Up to 3 boards, 3 motors	Textile and sewing machines, pick and place machines, factory automation, industrial printers, industrial mixers. Up to 128 microsteps
X-NUCLEO-IHM05A1	8 - 50 V_{DC}	Up to 2.8 A_{rms}	1x L6208	No	Money handling machines, factory automation, valves, textile machines. For bipolar stepper motor. Microstepping managed by MCU.
X-NUCLEO-IHM06A1	1.8 - 10 V_{DC}	Up to 1.3 A_{rms}	1x STSPIN220	Up to 2 boards (*)	POS, cash registers, toys, camera control, IoT and haptic feedbacks 3D printers Up to 256 microsteps
X-NUCLEO-IHM14A1	7 - 45 V_{DC}	Up to 1.5 A_{rms}	1x STSPIN820	Up to 2 boards (*)	Label printers, surveillance and dome cameras, textile machines, 3D printers, antenna control. Up to 256 microsteps.

(*) Some limitations could be present when the boards are stacked.

	NUCLEO-F401RE	NUCLEO-F334R8	NUCLEO-F302R8	NUCLEO-F030R8	NUCLEO-F072RB	NUCLEO-L053R8
X-NUCLEO-IHM01A1 (X-CUBE-SPN1)	●	●		●		●
X-NUCLEO-IHM02A1 (X-CUBE-SPN2)	●		●		●	
X-NUCLEO-IHM03A1 (X-CUBE-SPN3)	●	●		●		●
X-NUCLEO-IHM05A1 (X-CUBE-SPN5)	●	●		●		●
X-NUCLEO-IHM06A1 (X-CUBE-SPN6)	●	●		●		●
X-NUCLEO-IHM14A1 (X-CUBE-SPN14)	●	●		●		●

Stepper motor control Nucleo expansion boards compatibility matrix.

The X-CUBE expansions are built on STM32Cube software technology to ease portability across different STM32 microcontrollers. The software comes with a sample implementation of the drivers running on the associated X-NUCLEO motor control expansion boards connected to a featured STM32 Nucleo development board.
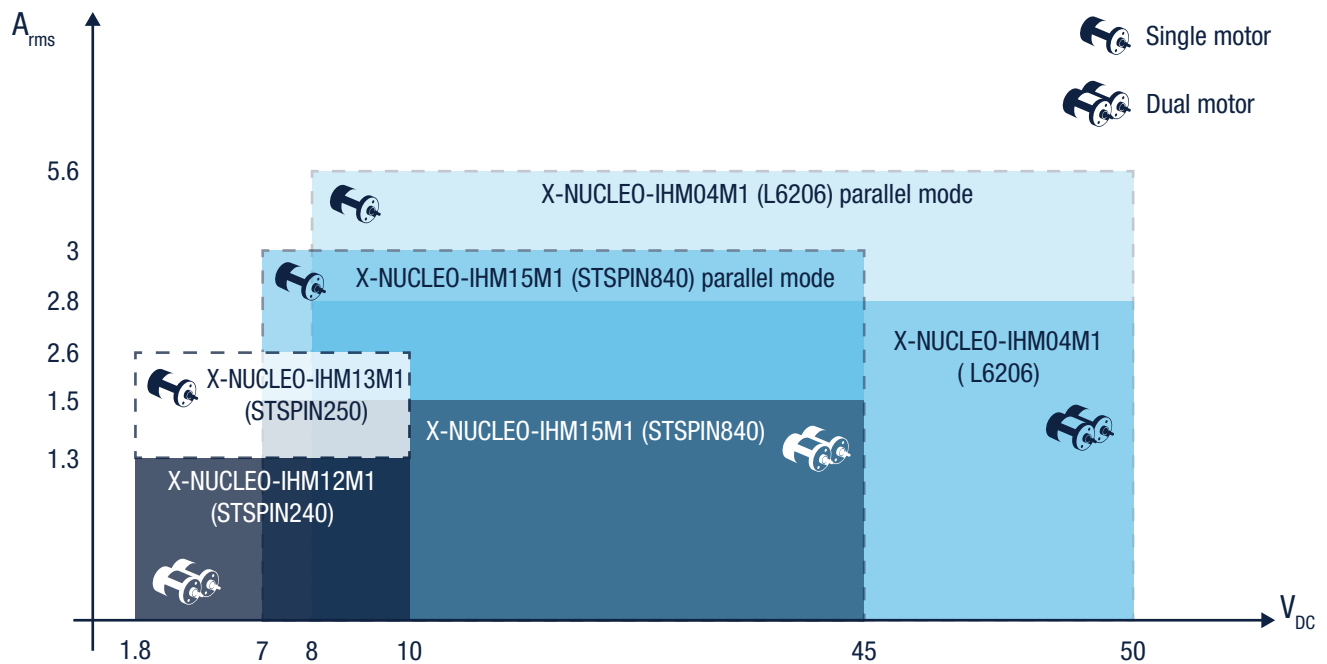
Brushed DC motors

A **brushed motor** is an easy-to-drive, low-cost DC motor often driven by batteries. The electric motor uses brushes to provide power to an armature coil sitting between permanent magnets that create the magnetic field. The current through the brush to the coil drives the rotor and is used for motors up to a horsepower. As the armature rotates, the stationary brushes come into contact with different sections of the rotating commutator and so wear out over time.

Brushed DC motor are commonly used in industrial applications such as robots, valves and healthcare equipment

ST's STSPIN motor drivers for brushed DC motors integrate a dual current control core and a dual full-bridge power stage to drive two brushed DC motors.

Available in a large selection of space-saving, thermally-enhanced packages, STSPIN brushed DC motor driver ICs provide a ready-to-use, optimized solution for motor and motion control systems in a wide range of voltage and current ratings.

Brushed DC motor control Nucleo expansion boards grouped by operative range and family. Use this graphical representation to select the best appropriate board based on the operative range of the motor to be used.

This parallel mode, if supported, converts some motor boards to a single brush DC driver doubling the output current capability.

Expansion boards

Board	Voltage	Power/Max Current	ST parts	Stackable	Application focus
X-NUCLEO-IHM04A1	8 - 50 V_{DC}	Up to 2.8 A_{rms} (5.6 A_{rms} in parallel mode)	1x L6206	No	Stage lighting, antenna control, vending machines, factory automation. Both bi-directional or uni-directional brush DC motors without current limiting. It drives dual bipolar DC or quad unipolar DC motors. Relays and other inductive loads. Outputs can be paralleled.
X-NUCLEO-IHM12A1	1.8 - 10 V_{DC}	Up to 1.3 A_{rms}	1x STSPIN240	No	eValves, IoT, edu/home robots, healthcare, toys, eLock, actuators. Ultra low voltage and portable equipment. Dual bi-directional brush DC motor with current limiter. Parallel operation is not allowed.
X-NUCLEO-IHM13A1	1.8 - 10 V_{DC}	Up to 2.6 A_{rms}	1x STSPIN250	No	eValves, IoT, edu/home robots, healthcare, toys, eLock, actuators. Ultra low voltage and portable equipment. Single high current bi-directional brush DC motor with current limiter.
X-NUCLEO-IHM15A1	7 - 45 V_{DC}	Up to 1.5 A_{rms} (3 A_{rms} in parallel mode)	1x STSPIN840	No	Stage lighting, Industrial automation, service robots, medical and health care, ATM, Vending machines. Dual bi-directional brush DC motor with current limiter. Parallel operation enabled through a dedicated pin.

	NUCLEO-F401RE	NUCLEO-F334R8	NUCLEO-F302R8	NUCLEO-F030R8	NUCLEO-F072RB	NUCLEO-L053R8
X-NUCLEO-IHM04A1 (X-CUBE-SPN4)	●	●				●
X-NUCLEO-IHM12A1 (X-CUBE-SPN12)	●	●		●		●
X-NUCLEO-IHM13A1 (X-CUBE-SPN13)	●	●		●		●
X-NUCLEO-IHM15A1 (X-CUBE-SPN15)	●	●		●		

Brushed DC motor control Nucleo expansion boards compatibility matrix.

The X-CUBE expansions are built on STM32Cube software technology to ease portability across different STM32 microcontrollers. The software comes with a sample implementation of the drivers running on the associated X-NUCLEO motor control expansion boards connected to a featured STM32 Nucleo development board.
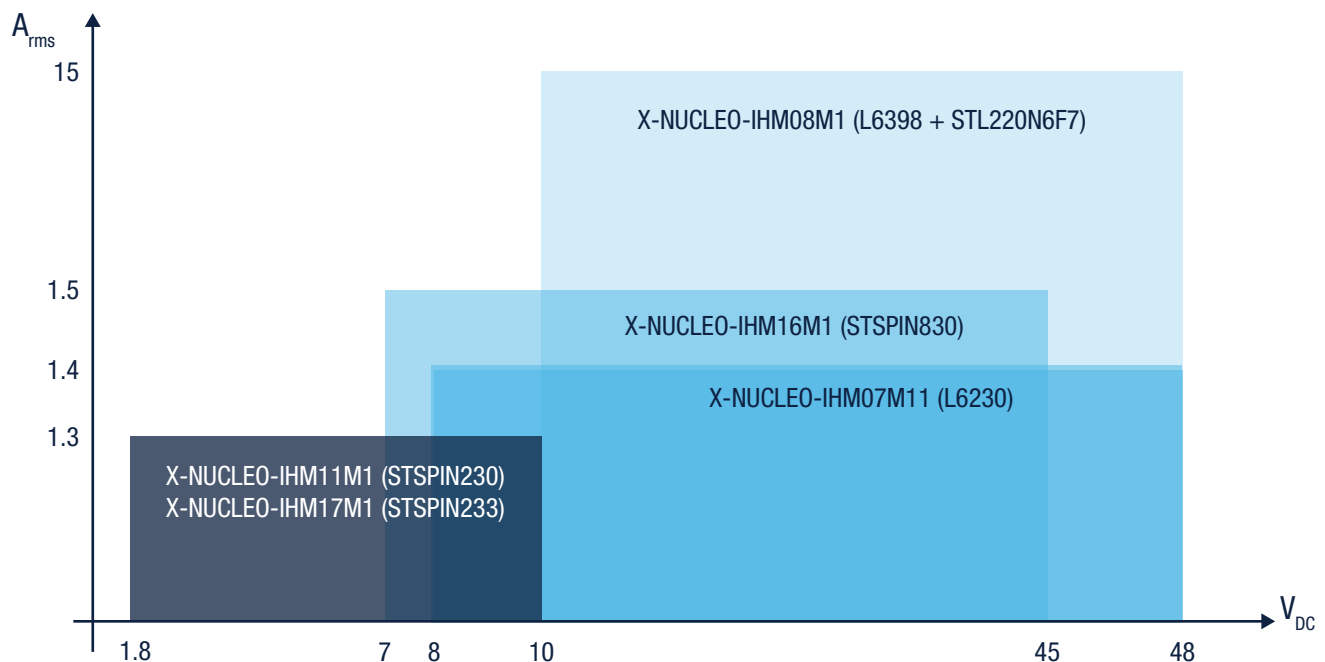
Brushless DC motors

Permanent Magnet synchronous motor and **Brushless DC motors (BLCD)** are replacing DC brush motors more and more in many applications due to advantages such as higher efficiency, quieter operation, low torque ripple and fast response time and better reliability. Despite their different structures, all three-phase permanent magnet motors (BLDC, permanent magnet synchronous motors, PMSM, or permanent magnet AC, PMAC) are driven by a pulse-width-modulated (PWM) three-phase bridge (three half bridges) so as to supply the motor with variable frequency and amplitude of voltages and currents. With the rapid evolution of Industry 4.0 and the Internet of Things (IoT), coupled with the push for higher efficiency in motor control, brushless direct current (BLDC) motors are being used increasingly in diverse application segments. Examples include:

• Industry and automation, blowers, cooling fans and industrial robotics
• Emerging high-tech, for drones, gimbal control, and collaborative warehouse robots
• Home applications, for power try and automation tools and vacuum cleaners

ST's STSPIN drivers for 3-phase brushless DC (BLDC) motors includes power drivers in a 3-phase bridge configuration and integrated solutions with built-in decoding logic for Hall-effect sensors. Our BLDC motor drivers also feature a PWM current controller to autonomously drive a BLDC motor through motion commands coming from the motor or motion control system host – a microcontroller, DSP or FPGA.

In addition to the integration of the power MOSFET and the associated driving circuitry, they include protection and diagnostic features for over-temperature, over-current and under-voltage conditions, resulting in robust and reliable designs. Available in a wide selection of space-saving, thermally-enhanced packages, STSPIN 3-phase BLDC motor driver ICs provide a ready-to-use and optimized solution for motor and motion control systems in a wide range of voltage and current ratings.

A_{rms}

15	X-NUCLEO-IHM08M1 (L6398 + STL220N6F7)
1.5	X-NUCLEO-IHM16M1 (STSPIN830)
1.4	X-NUCLEO-IHM07M11 (L6230)
1.3	X-NUCLEO-IHM11M1 (STSPIN230) X-NUCLEO-IHM17M1 (STSPIN233)

V_{DC}

1.8   7 8   10   45   48

Brushless DC motor control Nucleo expansion boards grouped by operative range and family. Use this graphical representation to select the best appropriate board based on the operative range of the motor to be used.

Expansion boards

Board	Voltage	Power/Max Current	ST parts	Stackable	Application focus
X-NUCLEO-IHM07M1	8 - 48 V_{DC}	Up to 1.4 A_{rms}	1x L6230	No	Fans, pumps, factory automation, money handling machines and medical equipment. Low power brushless motor driver in single shunt and 3 shunts topology.
X-NUCLEO-IHM08M1	10 - 48 V_{DC}	Up to 15 A_{rms}	3x L6398 6x STL220N6F7	No	Fans, propellers for drones. High power brushless motor driver in single shunt and 3 shunt topology.
X-NUCLEO-IHM09M2	N.A.	N.A.	Not Silicon Part	No	Motor control connector adapter
X-NUCLEO-IHM11M1	1.8 - 10 V_{DC}	Up to 1.3 A_{rms}	1x STSPIN230	No	Low voltage three-phase brushless DC motor driver. Ultra low voltage and portable equipment such as thermal printers, robotics and toys. Brushless motor driver in single shunt topology.
X-NUCLEO-IHM16M1	7 - 45 V_{DC}	Up to 1.5 A_{rms}	1x STSPIN830	No	Antenna control, fans, robots, factory automation, home appliances and medical equipment. Brushless motor driver in single shunt and 3 shunt topology.
X-NUCLEO-IHM17M1	1.8 - 10 V_{DC}	Up to 1.3 A_{rms}	1x STSPIN233	No	Healthcare and medical, IoT, gimbals, edu/home robots, toys, fans, small actuators. Ultra low voltage and portable equipment. Brushless motor driver in single shunt and three shunt topology.

All the brushless DC motor control X-NUCLEO expansion boards are natively supported by the **STM32 Motor Control Software Development Kit (X-CUBE-MCSDK)**. This lets you combine them with several STM32 Nucleo development boards and quickly begin evaluating with the support of optimized control libraries (6STEP and field-oriented control) and easy-to-use configuration and control tools provided by the **X-CUBE-MCSDK**.

STM32 ODE ecosystem

STM32ODE MOTOR CONTROL ECOSYSTEM

ST proposes a wide range of evaluation boards for comprehensive evaluation of ST's products and solutions while reducing your development time. In particular, all of ST's microcontroller evaluation boards have ST's standard MC connector on-board allowing the use of the board in conjunction with any of the power stage evaluation boards.

The **X-NUCLEO-IHM09M2** motor control connector expansion board allows to evaluate motor control solutions for three-phase motors with an external ST motor control power board, thanks to ST morpho and 34-pin motor control connector, allowing to extend the STM32ODE motor control support to high voltage STEVAL and EVAL Brushless Motors boards.

STM32 MC SDK (motor control software development kit) firmware (**X-CUBE-MCSDK**) includes the permanent-magnet synchronous motor (PMSM) firmware library and the STM32 Motor Control Workbench to configure the firmware library parameters through its graphical user interface. All the brushless DC motor control X-Nucleo expansion boards are supported.

STM32 Motor Control Workbench is PC software that reduces the design effort and time needed for the firmware configuration. The user generates a project file through the GUI, and initializes the library according to the application needs. Some algorithm variables can be monitored and changed in real time.
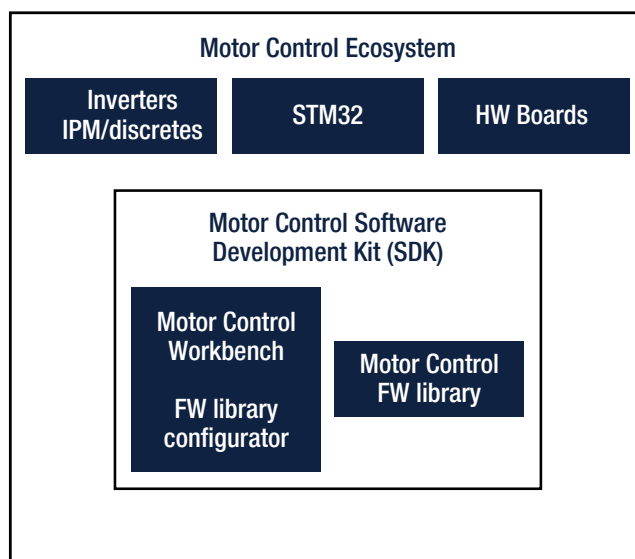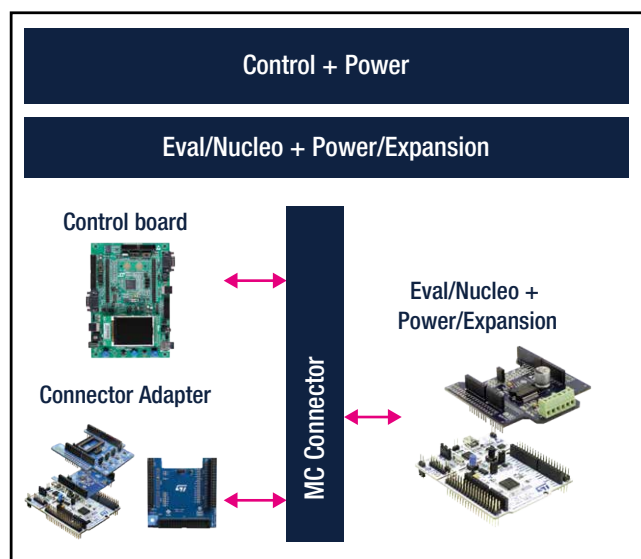
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www.st.com/stm32-motor-control

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