



life.augmented

# 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 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 Nucleo  
expansion boards (X-NUCLEO)



STM32 Open  
Development  
Environment



STM32Cube  
development software

STM32Cube  
expansion software (X-CUBE)

Function packs



FIND OUT MORE

<http://www.st.com/stm32ode>

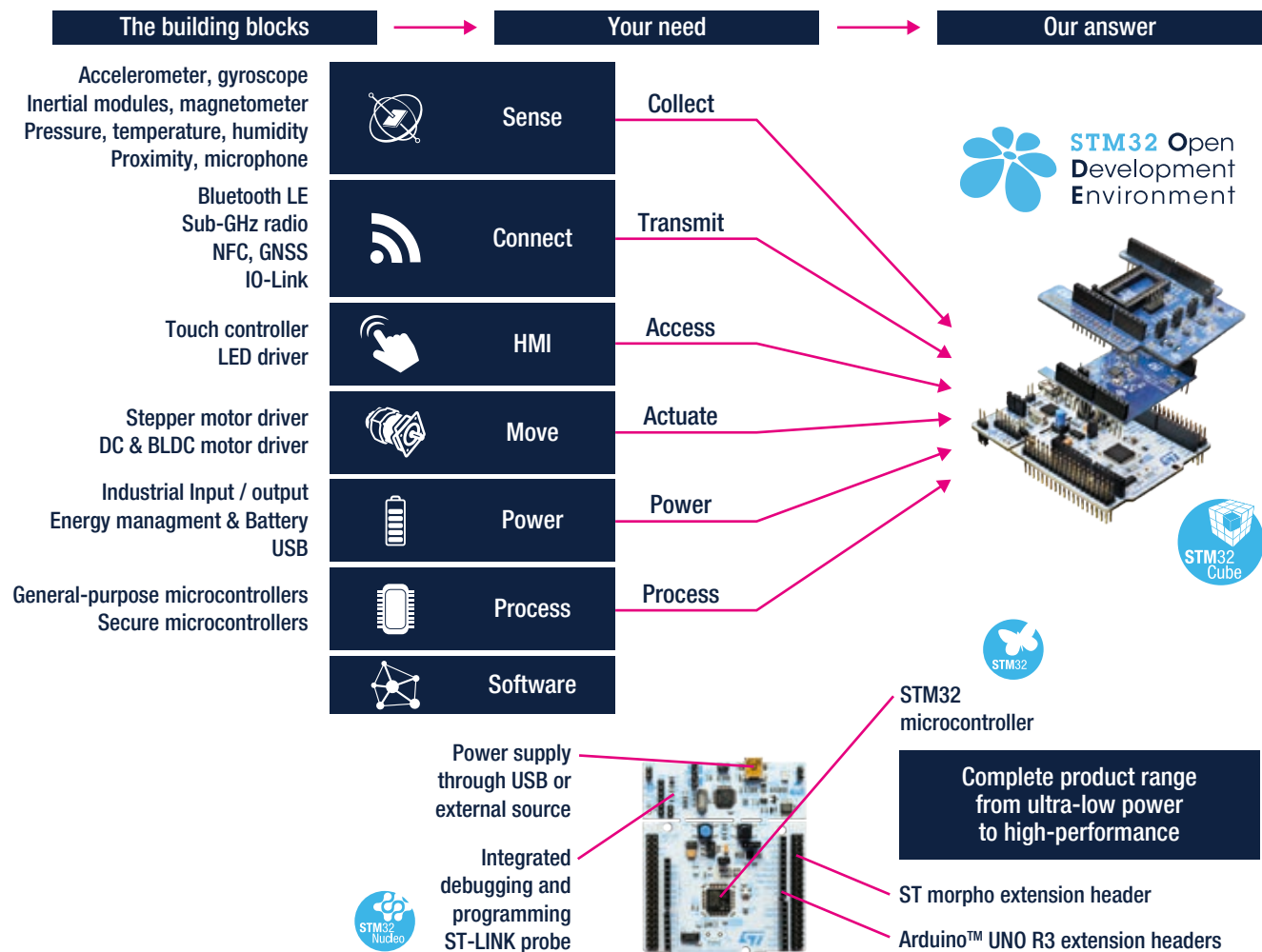
# STM32 Open Development Environment: all that you need

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.



# Motor control family

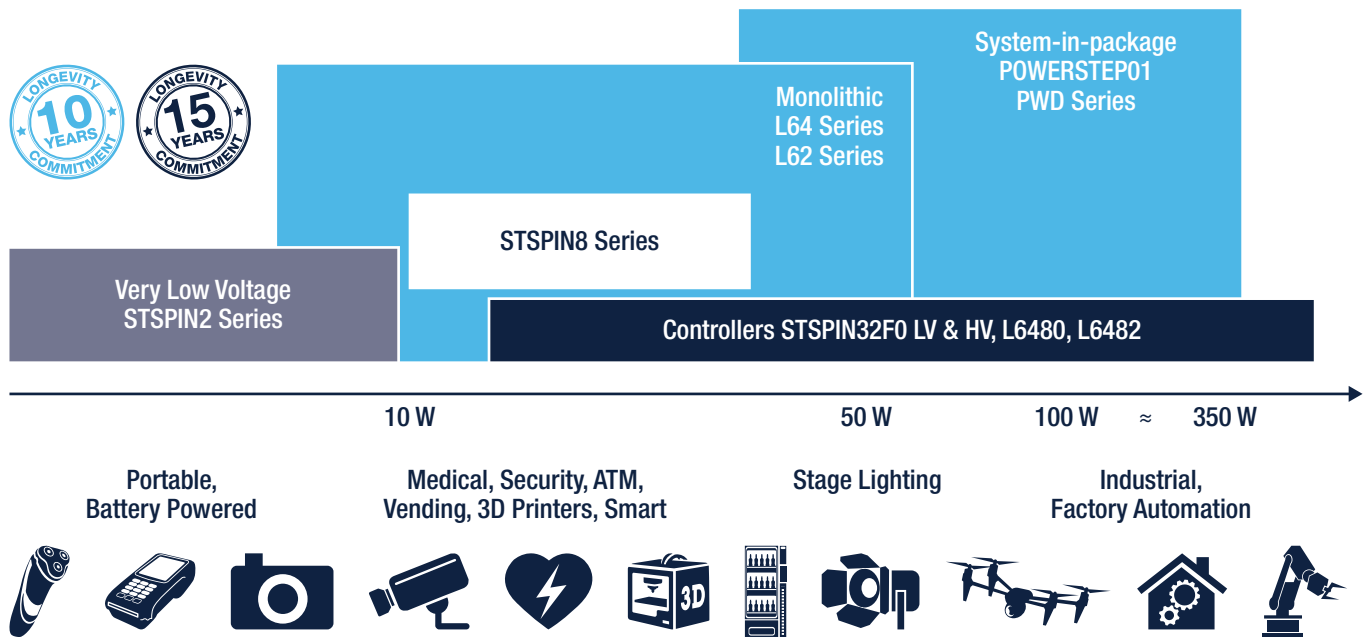
ST, a pioneer in the field of motor and motion control, offers a wide selection of ICs to best match an application spectrum covering a wide range of power ratings and motor types, as well as varied system partitioning.

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.

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](http://www.st.com/stspin)

# 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  |
|--|
| X-NUCLEO-IHM01A1<br>X-NUCLEO-IHM02A1<br>X-NUCLEO-IHM03A1<br>X-NUCLEO-IHM05A1<br>X-NUCLEO-IHM06A1<br>X-NUCLEO-IHM14A1 |

| Brushed DC   |
|--|
| X-NUCLEO-IHM04A1<br>X-NUCLEO-IHM12A1<br>X-NUCLEO-IHM13A1<br>X-NUCLEO-IHM15A1 |

| Brushless DC  |
|---|
| X-NUCLEO-IHM07M1<br>X-NUCLEO-IHM08M1<br>X-NUCLEO-IHM09M1*<br>X-NUCLEO-IHM11M1<br>X-NUCLEO-IHM16M1<br>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

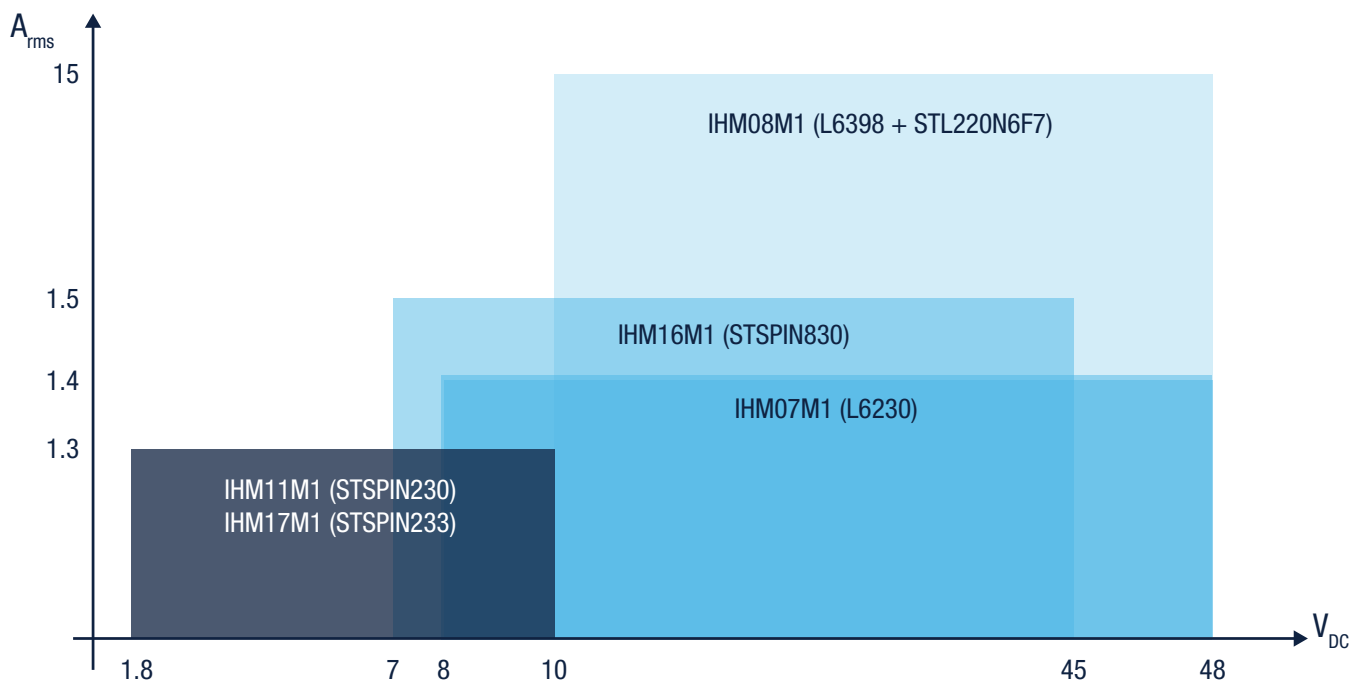
| KIT Name        | Nucleo (included) | X-Nucleo (included) | Motor (included)                  | Power Supply |
|-----------------|-------------------|---------------------|-----------------------------------|--------------|
| P-NUCLEO-IHM001 | NUCLEO-F302R8     | X-NUCLEO-IHM07M1    | Bull-Running model BR2804-1700 kV |              |
| P-NUCLEO-IHM002 | NUCLEO-F302R8     | X-NUCLEO-IHM07M1    | Bull-Running model BR2804-1700 kV | •            |
| P-NUCLEO-IHM003 | 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.



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   |
|-------------------------|---------------------------|--|----------------|---------------------------------|---|
| <b>X-NUCLEO-IHM01A1</b> | 8 - 45 V <sub>DC</sub>    | Up to 3 A <sub>rms</sub>                       | 1x L6474       | Up to 3 boards, 3 motors        | Textile machines, factory automation, industrial and 3D printers.<br>Up to 16 microsteps  |
| <b>X-NUCLEO-IHM02A1</b> | 8 - 45 V <sub>DC</sub>    | Up to 3 A <sub>rms</sub> for each motor driver | 2x L6470       | Up to 4 boards (up to 8 motors) | Textile machines, factory automation, industrial and 3D printers.<br>Up to 128 microsteps, Voltage mode driving                           |
| <b>X-NUCLEO-IHM03A1</b> | 10.5 - 85 V <sub>DC</sub> | Up to 10 A <sub>rms</sub>                      | 1x powerSTEP01 | Up to 3 boards, 3 motors        | Textile and sewing machines, pick and place machines, factory automation, industrial printers, industrial mixers.<br>Up to 128 microsteps |
| <b>X-NUCLEO-IHM05A1</b> | 8 - 50 V <sub>DC</sub>    | Up to 2.8 A <sub>rms</sub>                     | 1x L6208       | No                              | Money handling machines, factory automation, valves, textile machines.<br>For bipolar stepper motor.<br>Microstepping managed by MCU.     |
| <b>X-NUCLEO-IHM06A1</b> | 1.8 - 10 V <sub>DC</sub>  | Up to 1.3 A <sub>rms</sub>                     | 1x STSPIN220   | Up to 2 boards (*)              | POS, cash registers, toys, camera control, IoT and haptic feedbacks 3D printers<br>Up to 256 microsteps                                   |
| <b>X-NUCLEO-IHM14A1</b> | 7 - 45 V <sub>DC</sub>    | Up to 1.5 A <sub>rms</sub>                     | 1x STSPIN820   | Up to 2 boards (*)              | Label printers, surveillance and dome cameras, textile machines, 3D printers, antenna control.<br>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 |
|---|---------------|---------------|---------------|---------------|---------------|---------------|
| <b>X-NUCLEO-IHM01A1</b><br>(X-CUBE-SPN1)  | ●             | ●             |               | ●             |               | ●             |
| <b>X-NUCLEO-IHM02A1</b><br>(X-CUBE-SPN2)  | ●             |               | ●             |               | ●             |               |
| <b>X-NUCLEO-IHM03A1</b><br>(X-CUBE-SPN3)  | ●             | ●             |               | ●             |               | ●             |
| <b>X-NUCLEO-IHM05A1</b><br>(X-CUBE-SPN5)  | ●             | ●             |               | ●             |               | ●             |
| <b>X-NUCLEO-IHM06A1</b><br>(X-CUBE-SPN6)  | ●             | ●             |               | ●             |               | ●             |
| <b>X-NUCLEO-IHM14A1</b><br>(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.

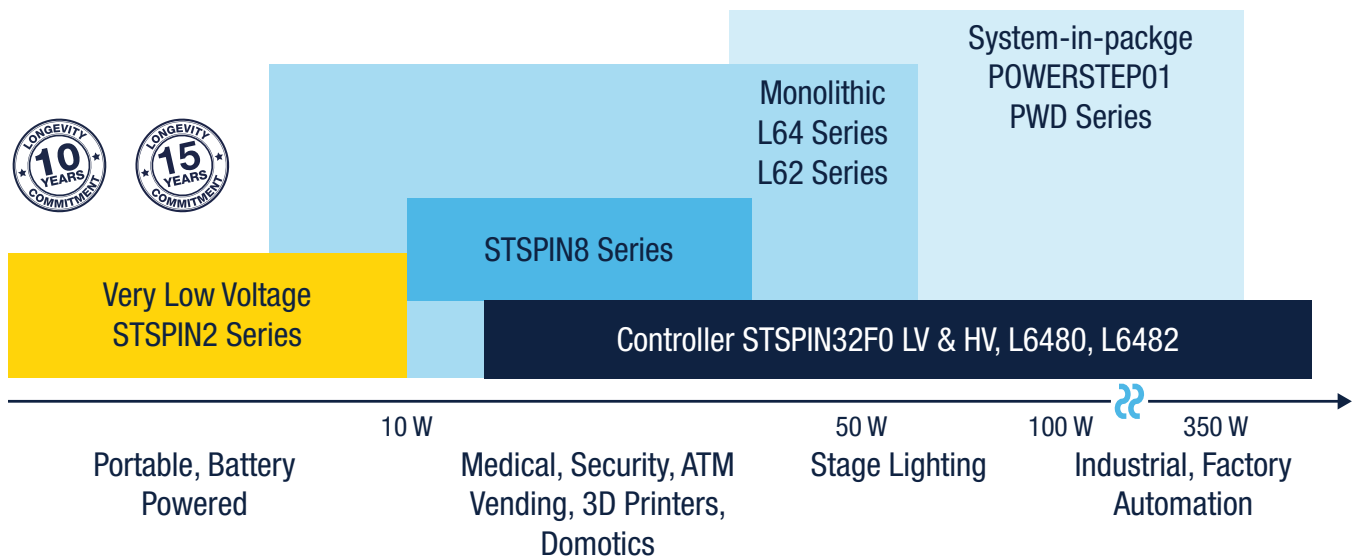
# Brushed DC motors

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  |
|-------------------------|--------------------------|---|--------------|-----------|--|
| <b>X-NUCLEO-IHM04A1</b> | 8 - 50 V <sub>DC</sub>   | Up to 2.8 A <sub>rms</sub><br>(5.6 A <sub>rms</sub> 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. |
| <b>X-NUCLEO-IHM12A1</b> | 1.8 - 10 V <sub>DC</sub> | Up to 1.3 A <sub>rms</sub>  | 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.   |
| <b>X-NUCLEO-IHM13A1</b> | 1.8 - 10 V <sub>DC</sub> | Up to 2.6 A <sub>rms</sub>  | 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.   |
| <b>X-NUCLEO-IHM15A1</b> | 7 - 45 V <sub>DC</sub>   | Up to 1.5 A <sub>rms</sub><br>(3 A <sub>rms</sub> 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-F072R8 | NUCLEO-L053R8 |
|---|---------------|---------------|---------------|---------------|---------------|---------------|
| <b>X-NUCLEO-IHM04A1</b><br>(X-CUBE-SPN4)  | ●             | ●             |               |               |               | ●             |
| <b>X-NUCLEO-IHM12A1</b><br>(X-CUBE-SPN12) | ●             | ●             |               | ●             |               | ●             |
| <b>X-NUCLEO-IHM13A1</b><br>(X-CUBE-SPN13) | ●             | ●             |               | ●             |               | ●             |
| <b>X-NUCLEO-IHM15A1</b><br>(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.

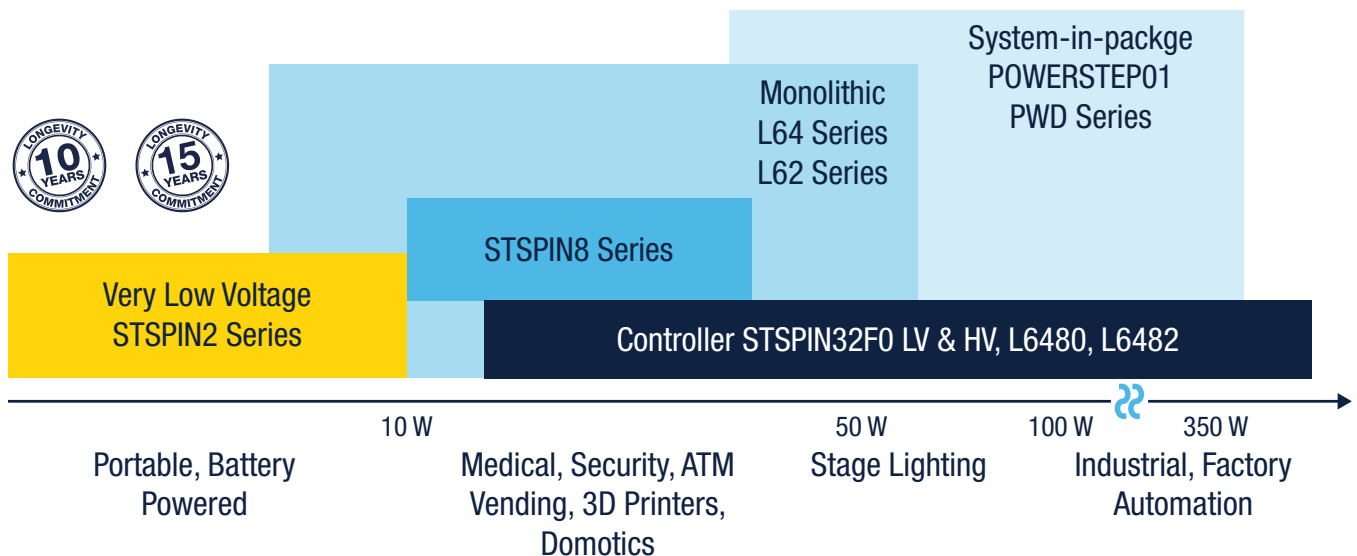
# Brushless DC motors

Permanent Magnet synchronous motor and Brushless DC motors (BLDC) 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.



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 <sub>DC</sub>   | Up to 1.4 A <sub>rms</sub> | 1x L6230                  | No        | Fans, pumps, factory automation, money handling machines and medical equipment.<br>Low power brushless motor driver in single shunt and 3 shunts topology.   |
| X-NUCLEO-IHM08M1 | 10 - 48 V <sub>DC</sub>  | Up to 15 A <sub>rms</sub>  | 3x L6398<br>6x STL220N6F7 | No        | Fans, propellers for drones.<br>High power brushless motor driver in single shunt and 3 shunt topology.  |
| X-NUCLEO-IHM09M1 | N.A.                     | N.A.                       | Not Silicon Part          | No        | Motor control connector adapter  |
| X-NUCLEO-IHM11M1 | 1.8 - 10 V <sub>DC</sub> | Up to 1.3 A <sub>rms</sub> | 1x STSPIN230              | No        | Low voltage three-phase brushless DC motor driver.<br>Ultra low voltage and portable equipment such as thermal printers, robotics and toys.<br>Brushless motor driver in single shunt topology.      |
| X-NUCLEO-IHM16M1 | 7 - 45 V <sub>DC</sub>   | Up to 1.5 A <sub>rms</sub> | 1x STSPIN830              | No        | Antenna control, fans, robots, factory automation, home appliances and medical equipment.<br>Brushless motor driver in single shunt and 3 shunt topology.  |
| X-NUCLEO-IHM17M1 | 1.8 - 10 V <sub>DC</sub> | Up to 1.3 A <sub>rms</sub> | 1x STSPIN233              | No        | Healthcare and medical, IoT, gimbals, edu/home robots, toys, fans, small actuators.<br>Ultra low voltage and portable equipment.<br>Brushless motor driver in single shunt and three shunt topology. |

|                                    | NUCLEO-F401RE | NUCLEO-F334R8 | NUCLEO-F302R8 | NUCLEO-F103RB | NUCLEO-F030R8 |
|------------------------------------|---------------|---------------|---------------|---------------|---------------|
| X-NUCLEO-IHM07M1<br>(X-CUBE-SPN7)  | ●             |               | ●             | ●             | ●             |
| X-NUCLEO-IHM08M1<br>(X-CUBE-SPN8)  | ●             |               | ●             |               |               |
| X-NUCLEO-IHM11M1<br>(X-CUBE-SPN11) | ●             |               |               |               |               |
| X-NUCLEO-IHM16M1<br>(X-CUBE-SPN16) | ●             |               | ●             |               | ●             |
| X-NUCLEO-IHM06A1<br>(X-CUBE-SPN6)  | ●             | ●             | ●             |               | ●             |
| X-NUCLEO-IHM17M1<br>(X-CUBE-SPN17) | ●             |               | ●             | ●             | ●             |

Brushless 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.

# STM32ODE

## Motor Control Ecosystem

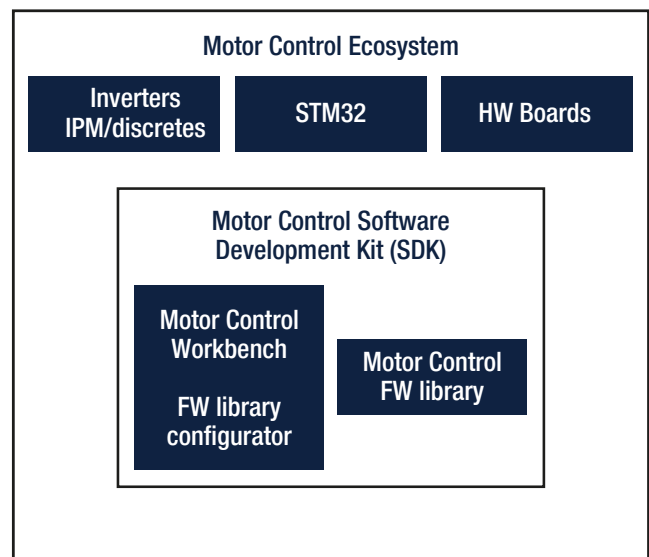
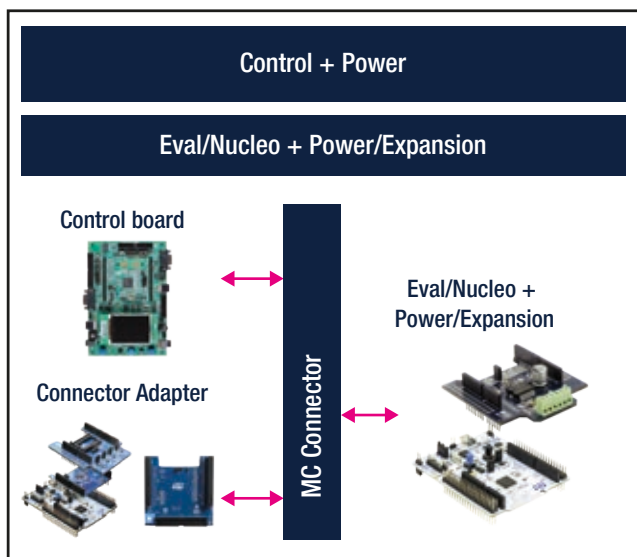
### STM32ODE MOTOR CONTROL ECOSYSTEM

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-IHM09M1 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.

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 of the variables of the algorithm being used can be monitored and changed in real time.



**FIND OUT MORE**

[https://www.st.com/content/st\\_com/en/stm32-motor-control-ecosystem.html](https://www.st.com/content/st_com/en/stm32-motor-control-ecosystem.html)



For more information on ST products and solutions, visit [www.st.com](http://www.st.com)

© STMicroelectronics - June 2020 - Printed in the United Kingdom - All rights reserved  
ST and the ST logo are registered and/or unregistered trademarks of STMicroelectronics International NV or its affiliates in the EU and/or elsewhere. In particular, ST and the ST logo are Registered in the US Patent and Trademark Office. For additional information about ST trademarks, please refer to [www.st.com/trademarks](http://www.st.com/trademarks).  
All other product or service names are the property of their respective owners.

