life.augmented

# Motor control Reference Guide

# Contents

# ST Motor Control Ecosystem

## ST's commitment to motor control reinforces the environmental revolution

In line with the environmental revolution, electric motor control is moving very quickly in the direction of higher efficiency for motors and drives. Moreover, an increased level of integration at the lowest cost is required to support market penetration of new technologies, as well as increased safety and reliability. Committed to electric motor control for more than 20 years, ST was among the first to recognize these trends.

ST is riding the winds of change with innovations in integrated intelligent power modules and systems-in-package, monolithic motor drivers, fast and efficient power switches, voltage-transient protected Triacs, powerful and secure microcontrollers. Whichever motor technology you use, from traditional and rugged to the most modern and efficient, ST is able to supply the right electronic devices and a complete ecosystem with a range of evaluation boards, reference designs, firmware and development tools to simplify and accelerate design cycles.

**STAY UP-TO-DATE**

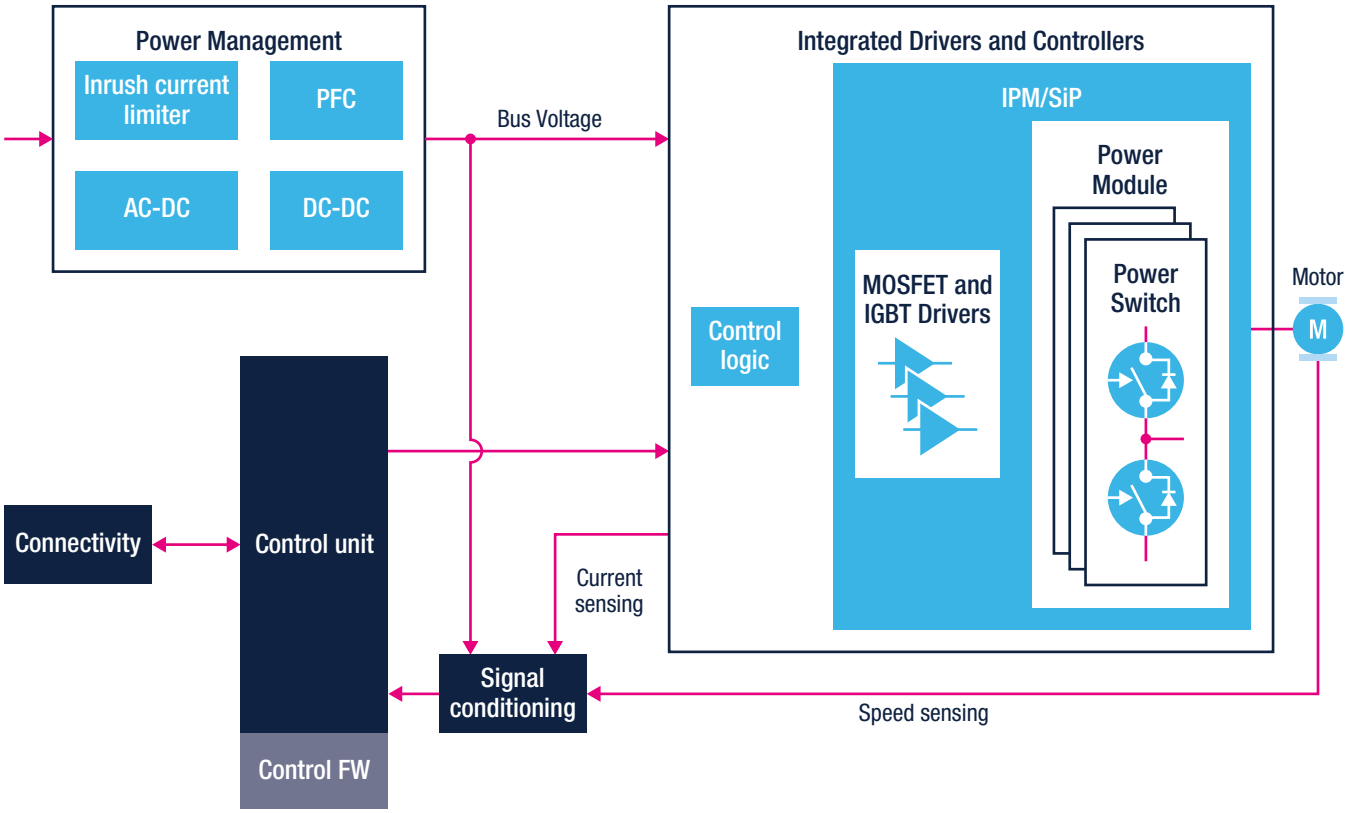
For more information and up-to- date material, visit motor control application page on ST's website at **http://www.st.com/motorcontrol**

# PMSM & BLDC Motors

Permanent Magnet synchronous motor and Brushless DC motors are replacing DC brush motors more and more in many applications due to advantages such as higher efficiency, quieter operation and better reliability.

Despite their different structures, all three-phase permanent magnet motors (BLDC, PMSM or 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.

To provide the highest level of design flexibility, ST's product portfolio includes specific products for both high- and low-voltage applications like monolithic drivers ICs, power MOSFETs, IGBTs, gate drivers, power modules and dedicated microcontrollers to address a broad range of applications.



## Key Products

| | Product family | Description with key Features | Key products |
|---|---|---|---|
| **Integrated Drivers and Controllers** | • STSPIN2 Series<br>• STSPIN8 Series<br>• STSPIN32F0 Series<br>• L62 Series | Wide range of efficient and accurate motor drivers able to drive PMSM and BLDC motors, ranging from several watts to few kilo watts | • STSPIN23*<br>• STSPIN830<br>• STSPIN32F0*<br>• L623* |
| **Control unit** | • STM32 Series<br>• STM8s Series | General-purpose product lines ranging from a basic, cost-efficient peripheral set, up to more performance and analog functions able to manage FOC motor control | • STM32G0*<br>• STM32G4*<br>• STM32F0*<br>• STM32F103*<br>• STM32F30*<br>• STM32F4*<br>• STM32F7*<br>• STM32L4*<br>• STM8S* |
| **Intelligent power Module (IPM/SiP)** | • SLLIMM 2nd series<br>• SLLIMM-nano<br>• SLLIMM-nano 2nd series<br>• SLLIMM-nano SMD | 3-phase inverter, IGBT and MOSFET based | • STGI*<br>• STI* |
| **MOSFET and IGBT Drivers** | • L649 series<br>• L639 series<br>• STGAP series<br>• STDRIVE series<br>• L638 series<br>• TD35 series | STDRIVE Mosfet and IGBT Gate drivers | • L649*<br>• L639*<br>• STGAP*<br>• STDRIVE*<br>• L638*<br>• TD35* |
| **SiC and GaN Drivers** | • STGAP2SiC series<br>• STDRIVEG series | STDRIVE SiC and GaN gate drivers | • STGAP2SiC*<br>• STDRIVEG* |
| **Power Module** | ACEPACK | Six pack and CIB topology, MOSFET SiC trench gate field-stop IGBT | • A1PyyMwwWz<br>• AxPyySwwMz<br>• AxCyySwwMz |
| **Power Switch** | • F6 & F7 Low Voltage MOSFET<br>• IGBT M series<br>• IGBT S series<br>• IGBT H series<br>• DM2 MOSFET<br>• DM6 MOSFET | Low Voltage MOSFET<br>High voltage IGBT and MOSFET | • STxyN4F7<br>• STxyN6F7<br>• STxyN8F7<br>• STxyN10F7<br>• STGxyyM65DF2<br>• STGxyyM120DF3<br>• STGxyyS120DF3<br>• STGxyyH60DF<br>• STxyN60DM6<br>• STxyN60DM2 |
| **Inrush Current Limiter** | 600 V, 800 V and 1200 V<br>High Tj SCR | High Tj SCRs. Strong noise immunity trade-off<br>(Up to dV/dt = 1000 V/us at high temperature 150 °C,<br>High turn-on capability dI/dt = 100 A/us) | • TN6050HP-12WY<br>• TN5015H-6G<br>• TM8050H-8W |
| **Signal conditioning** | • TSV9 series<br>• TSC2 series | High speed up to 20 MHz low voltage opamp<br>for low side current sensing.<br>Bi-directional current sense monitor<br>for low side and high side up to 70 V | • TSV99x<br>• TSV91x<br>• TSC201x |
| | • TSV TSX TSB series - operational amplifiers<br>• TSZ series - zero drift amplifiers<br>• TS series - comparators<br>• TSC series - current sense amplifiers | High accuracy and high gain bandwidth product<br>for low-side current measurement.<br>Fast response time for fault detection.<br>High voltage capability for accurate high side current measurement | • TSV732 TSX712 TSB712<br>• TSZ122 TSZ182<br>• TS3022<br>• TSC2010, 2011, 2012 TSC210, 213<br>• TSC2011 TSC210 |

## Main Evaluation Boards

| Reference/bundle | Voltage | Power/Max Current | ST parts | Application focus |
|---|---|---|---|---|
| **STEVAL-HKI001V2** | 50 – 650 $V_{DC}$ | Up to 35 $A_{RMS}$ to the motor | • 1x A2C35S12M3-F<br>• 7x STGAP1AS<br>• 1x STM32F303RBT7 | Motor drive: pumps, Motion/Servo Control, Industrial motor drives and more |
| **STEVAL-STDRIVE601** | Up to 600 V | Up to 1000 kW | • 1xSTDRIVE601<br>• 6xSTGD6M65DF2 | Motor Drive: 3-phase motor drivers, Power board: pumps, fans, Industrial inverters, home appliances |
| **STEVAL-AP1PF50M**[1] | 125 – 400 $V_{DC}$ | Up to 10 kW | • A1P50S65M2<br>• STGAP2S<br>• STGWA50M65DF2 | HVAC, pumps, industrial drives |
| **STEVAL-CTM009V1** | 48 $V_{DC}$ | Up to 5 kW | • 36x STH310N10F7-6 or STH315N10F7-6<br>• 3x L6491DTR<br>• 1x A7986ATR<br>• 1x TSZ121IYLT<br>• 4x STTH102AY<br>• 7x STPS5L60SY<br>• 6x SM15T12CAY<br>• 1x SM4T28AY<br>• 1x ESDA14V2LY, ESDA6V2LY, ESDA5V2LY | Power board: forklifts, golf carts professional power tools, E-rickshaws and more |
| **STEVAL-CTM010V1** | 230 $V_{AC}$ 50 Hz/ 60 Hz | Up to 2 kW | • STGIB10CH60TS-L<br>• STGIPQ3H60T-HZ<br>• STGWT20H65FB<br>• STTH30AC06CPF<br>• PM8841D<br>• T1235T-8FP<br>• TS391RILT<br>• STM32F303RBT6<br>• VIPER26LD | Room air conditioning |
| **STEVAL-IPM05F** | 125 – 400 $V_{DC}$ | Up to 500 W | • 1x STGIF5CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM07F** | 125 – 400 $V_{DC}$ | Up to 700 W | • 1x STGIF7CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM08B** | 125 – 400 $V_{DC}$ | Up to 800 W | • 1x STGIB8CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM10B** | 125 – 400 $V_{DC}$ | Up to 1200 W | • 1x STGIB10CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPMM10B** | 125 – 400 $V_{DC}$ | Up to 1200 W | • 1xSTIB1060DM2T-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM10F** | 125 – 400 $V_{DC}$ | Up to 1000 W | • 1x STGIF10CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPMM15B** | 125 – 400 $V_{DC}$ | Up to 1500 W | • 1xSTIB1560DM2T-L | Power board: pumps, compressors, fans, home appliance |
| **STEVAL-IPM15B** | 125 – 400 $V_{DC}$ | Up to 1500 W | • 1x STGIB15CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM20B** | 125 – 400 $V_{DC}$ | Up to 2000 W | • 1xSTGIB20M60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM30B** | 125 – 400 $V_{DC}$ | Up to 2500 W | • 1xSTGIB30M60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPMNM1S** | 125 – 400 $V_{DC}$ | Up to 60 W | • 1x STIPNS1M50T-H | Power board: pumps, fans, small appliances |
| **STEVAL-IPMNM2S** | 125 – 400 $V_{DC}$ | Up to 100 W | • 1x STIPNS2M50T-H | Power board: pumps, fans, small appliances |
| **STEVAL-IPMnM3Q** | 125 – 400 $V_{DC}$ | Up to 300 W | • 1xSTIPQ3M60T-HZ | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPMnM5Q** | 125 – 400 $V_{DC}$ | Up to 450 W | • 1xSTIPQ5M60T-HZ | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPMNG3S** | 125 – 400 $V_{DC}$ | Up to 300 W | • 1x STGIPNS3H60T-H | Power board: pumps, compressors, fans, high-end power tools |
| **STEVAL-IPMNM1N** | 125 – 400 $V_{DC}$ | Up to 60 W | • 1x STIPN1M50T-H | Power board: pumps, fans, small appliances |
| **STEVAL-IPMNM2N** | 125 – 400 $V_{DC}$ | Up to 100 W | • 1x STIPN2M50T-H | Power board: pumps, fans, small appliances |
| **STEVAL-IPMNG3Q** | 125 – 400 $V_{DC}$ | Up to 300 W | • 1x STGIPQ3H60T-HZ | Power board: pumps, compressors, fans, high-end power tools |
| **STEVAL-IPMNG5Q** | 125 – 400 $V_{DC}$ | Up to 450 W | • 1x STGIPQ5C60T-HZ | Power board: pumps, compressors, fans, high-end power tools |
| **STEVAL-IPMNG8Q** | 125 – 400 $V_{DC}$ | Up to 600 W | • 1x STGIPQ8C60T-HZ | Power board: pumps, compressors, fans, high-end power tools |
| **STEVAL-IHM023V3** | 90 – 285 $V_{AC}$<br>125 – 400 $V_{DC}$ | Up to 1 kW | • 3x L6390<br>• 1x Viper16<br>• 7x STGP10H60DF | Power board: pumps, compressors, washing machines and more |
| **STEVAL-IHM028V2** | 90 – 285 $V_{AC}$<br>125 – 400 $V_{DC}$ | Up to 2 kW | • 1x STGIPS20C60<br>• 1x VIPer26LD<br>• 1x STGW35NB60SD | Power board: pumps, compressors, air conditioning and more |
| **STEVAL-IHM032V1** | 86 to 260 $V_{AC}$ | Up to 150 W | • 2x L6392D<br>• 1x L6391D<br>• 1x Viper12<br>• 6 x STGD3HF60HD | Power board: pumps, compressors, fans, home appliances and more |

Note: 1. Available in Q3

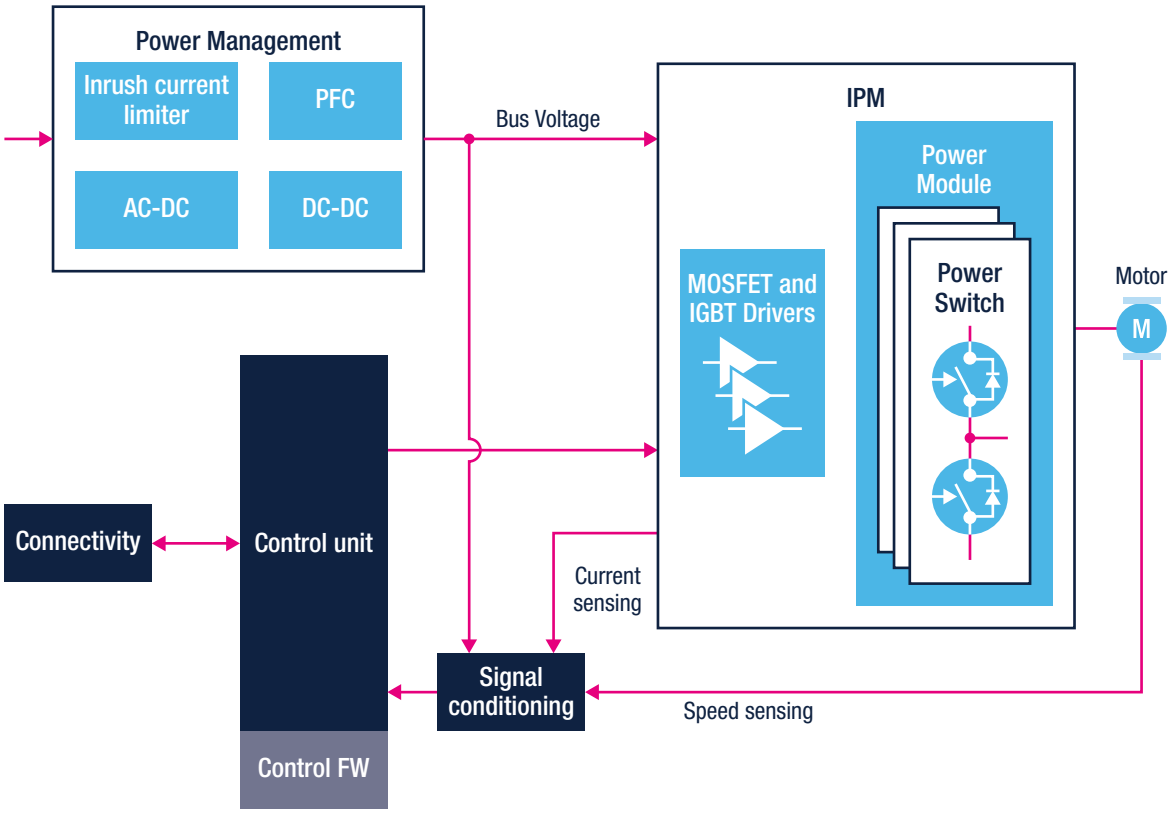
| Reference/bundle | Voltage | Power/Max Current | ST parts | Application focus |
|---|---|---|---|---|
| **STEVAL-IHM034V2** | 230 $V_{AC}$ | Up to 1700 W | • 1x STGIPS20C60<br>• 1xSTM32F103RC<br>• 1x L6391<br>• 1x Viper16LD<br>• 1x TSV914ID<br>• 3x STTH1L06A | Motor drive with digital PFC: room air conditioning, compressor and more |
| **STEVAL-IHM035V2** | 120/230 $V_{AC}$ | Up to 100 W | • 1x STGIPN3H60<br>• 1x VIPer16L | Power board: pumps, compressors, fans, home appliances and more |
| **STEVAL-ISF003V1** | 230 $V_{AC}$ (or 120 $V_{AC}$) | Up to 7.4 kW | • 1x TN5050H-12WY<br>• 1x STTH60L10WY<br>• 1x STM8S103K3T3 | Inrush current limiter in front-end bridge for motor power board |
| **STEVAL-IHT008V1** | 230 VAC or 120 $V_{AC}$ | Up to 800 W | • 1x T1635T-8FP<br>• 1x ACST210-8FP<br>• 1x ACS108-8SN<br>• 1x Z0109MUF<br>• 1x ViPER 26LD<br>• 1x STM8S103K3T3C | Inrush current limiter for inverter-based home appliances |
| **STEVAL-SCR001V1** | 90 - 265 $V_{AC}$ | Up to 800 W | • 2x TN5015H-6G | Inrush current limiter for small appliances with BLDC motor |
| **STEVAL-ESC001V1** | 11.1 up to 22.2 $V_{DC}$ | Up to 20 Arms | • 6x STL160N4F7<br>• 3x L6398DTR<br>• STM32F303CBT7<br>• 3x TSV991ILT<br>• 1x STPS1L40M, 3x STPS0560Z, 7x BAT30KFILM<br>• 1x L7986TR | Motor drive: Electronics speed controllers for drones (E.S.C.), RC vehicles (electric cars, helicopter, trucks, etc) |
| **STEVAL-ESC002V1** | 6.7 - 45 $V_{DC}$ | Up to 20 Arms | • 1x STSPIN32F0A<br>• 1x STL140N6F7<br>• 1x STPS0560Z<br>• 1x LMV321LILT | Power tools, fans, pumps, drones ESC, air purifiers, coffee machines, edu/home robots |
| **STEVAL-SPIN3201** | 8 - 45 $V_{DC}$ | Up to 15 Arms | • 1x STSPIN32F0<br>• 6x STD140N6F7<br>• 1x STPS1L60A<br>• 7x BAT30KFILM<br>• 1x LD3985M33R<br>• 1x USBLC6-2SC6 | Power tools, fans, pumps, drones ESC, home appliances, factory automation, edu/home robots |
| **STEVAL-SPIN3202** | 7 - 45 $V_{DC}$ | Up to 15 Arms | • STSPIN32F0A<br>• 6x STD140N6F7<br>• 1x STPS1L60A<br>• 7x BAT30KFILM<br>• 1x LD3985M33R<br>• 1x USBLC6-2SC6 | Power tools, fans, pumps, drones ESC, home appliances, factory automation, edu/home robots |
| **STEVAL-SPIN3204** | 7 - 45 $V_{DC}$ | Up to 15 Arms | • 1x STSPIN32F0B<br>• 6x STD140N6F7<br>• 1x STPS1L60A<br>• 7x BAT30KFILM<br>• 1x LD3985M33R<br>• 1x USBLC6-2SC6 | Power tools, fans, pumps, drones ESC, home appliances, factory automation, edu/home robots |
| **STEVAL-GMBL02V1** | 6 - 8.4 $V_{DC}$ | Up to 1.3 Arms | • 3x STSPIN233;<br>• 1x STM32F303RE<br>• 1x LSM6DSLTR<br>• 1x M24C02-RMN6TP<br>• 1x USBLC6-4SC6 | Handheld applications and drone 3 axis gimbals |
| **X-NUCLEO-IHM07M1** | 8 - 48 $V_{DC}$ | Up to 1.4 Arms | • 1x L6230PD<br>• 1x TSV994IPT | Fans, pumps, factory automation, money handling machines and medical equipment |
| **X-NUCLEO-IHM08M1** | 10 - 48 $V_{DC}$ | Up to 15 Arms | • 6x STL220N6F7<br>• 3x L6398D<br>• 1x TSV994IPT<br>• 1x ST1S14PHR<br>• 1x LMV331ILT | Power tools, fans, pumps, drones ESC, home appliances, factory automation, edu/home robots |
| **X-NUCLEO-IHM09M1** | N.A. | N.A. | • Not Silicon Part | Motor control connector adapter |
| **X-NUCLEO-IHM16M1** | 7 - 45 $V_{DC}$ | Up to 1.5 Arms | • 1x STSPIN830<br>• 1x TSV994IPT | Antenna control, fans, robots, factory automation, home appliances and medical equipment |
| **X-NUCLEO-IHM17M1** | 1.8 - 10 $V_{DC}$ | Up to 1.3 Arms | • 1x STSPIN233<br>• 1x TSV994IPT | Healthcare and medical, IoT, gimbals, edu/home robots, toys, fans, small actuators |
| **P-NUCLEO-IHM001** | 8 - 48 $V_{DC}$ | Up to 1.4 Arms | • 1x L6230<br>• 1x STM32F3 | Fans, pumps, factory automation, money handling machines and medical equipment |
| **P-NUCLEO-IHM003** | 7 - 45 $V_{DC}$ | Up to 1.5 Arms | • 1x STSPIN830<br>• 1x STM32G4 | Fans, pumps, factory automation, money handling machines and medical equipment |
| **STEVAL-ISQ014V1** | N.A. | N.A. | | Low-side current sensing based on TSZ121 UM1737 |
| **STEVAL-AETKT1V1** | N.A. | N.A. | | High-side current-sense amplifier demonstration board based on TSC2011 |
| **STEVAL-AETKT1V2**[1] | N.A. | N.A. | | High-side current-sense amplifier demonstration board based on TSC2010, 2011, 2012 |

Note: 1. Available in Q3

# 3-phase Induction Motor (ACIM)

## Overview

Three-phase induction motors are brushless motors. The stator is copper-wound and the rotor is typically an aluminum squirrel cage. The typical drive configuration is a three-phase bridge (3 half-bridges) modulated to provide three sine wave voltages to the stator. Typically used in higher power applications, the driving portion can be composed of power MOSFETs or IGBTs with high-voltage gate drivers, or power modules integrating three half-bridges and related gate driving stage. Field oriented-control or scalar (volts/hertz) control algorithms are implemented in the microcontroller that controls the inverter.



## Key Products

| | Product family | Description with key Features | Key products |
|---|---|---|---|
| **Control unit** | • STM32 Series | General-purpose product lines ranging from a basic, cost-efficient peripheral set, up to more performance and analog functions able to manage FOC motor control | • STM32F7*<br>• STM32F4*<br>• STM32F30*<br>• STM32F0*<br>• STM32G0*<br>• STM32L4 |
| **Intelligent power Module (IPM)** | • SLLIMM 2nd series<br>• SLLIMM-nano<br>• SLLIMM-nano 2nd series | 3-phase inverter, IGBT and MOSFET based | • STGIxxyyzz<br>• STIxxyyzz |
| **MOSFET and IGBT Drivers** | • L649 series<br>• L639 series<br>• STGAP series<br>• STDRIVE601<br>• L638 series<br>• TD35 series | STDRIVE Mosfet and IGBT Gate drivers | • L649*<br>• L639*<br>• STGAP*<br>• STDRIVE*<br>• L638*<br>• TD35* |
| **Power Module** | • ACEPACK | Sixpack and CIB topology, trench gate field-stop IGBT | • AxPyySwwMz<br>• AxCyySwwMz |
| **Power Switch** | • IGBT M series<br>• IGBT S series<br>• IGBT H series<br>• DM2 MOSFET | IGBT and High Voltage Power MOSFET | • STGxyyM65DF2<br>• STGxyyM120DF3<br>• STGxyyS120DF3<br>• STGxyyH60DF<br>• STxyN60DM2 |
| **Inrush Current Limiter** | • High Temperature SCR | From 12 A to 80 A and 600 V to 1200 V SCR.<br>Junction $T_j$ = 150 °C<br>Strong noise immunity trade-off<br>(dV/dt = 500 V/us, $I_{GT}$ = 15 mA or 1000 V/µs/50 mA) | • TN1205H-6G<br>• TN2015H-6FP<br>• TN3015H-6G<br>• TN5015H-6G<br>• TN3050H-12GY<br>• TM8050H-8D3<br>• TN4050-12PI<br>• TN6050HP-12WY<br>• TN6050-12PI |
| **Signal conditioning** | • TSV9 series<br>• TSC2 series | High speed up to 20 MHz low voltage opamp<br>for low side current sensing.<br>Bi-directional current sense monitor<br>for low side and high side up to 70 V | • TSV99x<br>• TSV91x<br>• TSC201x |
| | • TSV TSX TSB series - operational amplifiers<br>• TSZ series - zero drift amplifiers<br>• TS series - comparators<br>• TSC series - current sense amplifiers | High accuracy and high gain bandwidth product<br>for low-side current measurement.<br>Fast response time for fault detection.<br>High voltage capability for accurate high side current measurement | • TSV732 TSX712 TSB712<br>• TSZ122 TSZ182<br>• TS3022<br>• TSC2010, 2011, 2012 TSC210, 213<br>• TSC2011 TSC210 |

## Main Evaluation Boards

| Reference/bundle | Voltage | Power/Max Current | ST parts | Application focus |
|---|---|---|---|---|
| **STEVAL-HKI001V2** | 50 – 650 $V_{DC}$ | Up to 35 $A_{RMS}$ | • 1x A2C35S12M3-F<br>• 7x STGAP1AS<br>• 1x STM32F303RBT7 | Motor drive: pumps, Motion/Servo Control, Industrial motor drives and more |
| **STEVAL-STDRIVE601** | Up to 600 V | Up to 1000 W | • 1xSTDRIVE601<br>• 6xSTGD6M65DF2 | Motor Drive: 3-phase motor drivers, Power board: pumps, fans, Industrial inverters, home appliances |
| **STEVAL-AP1PF50M**[1] | 125 – 400 $V_{DC}$ | Up to 10 kW | • A1P50S65M2<br>• STGAP2S<br>• STGWA50M65DF2 | HVAC, pumps, industrial drives |
| **STEVAL-CTM010V1** | 230 $V_{AC}$<br>50 Hz/ 60 Hz | Up to 2 kW | • STGIB10CH60TS-L<br>• STGIPQ3H60T-HZ<br>• STGWT20H65FB<br>• STTH30AC06CPF<br>• PM8841D<br>• T1235T-8FP<br>• TS391RILT<br>• STM32F303RBT6<br>• VIPER26LD | Room air conditioning |
| **STEVAL-IPM05F** | 125 – 400 $V_{DC}$ | Up to 500 W | • 1x STGIF5CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM07F** | 125 – 400 $V_{DC}$ | Up to 700 W | • 1x STGIF7CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM08B** | 125 – 400 $V_{DC}$ | Up to 800 W | • 1x STGIB8CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM10B** | 125 – 400 $V_{DC}$ | Up to 1200 W | • 1x STGIB10CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPMM10B** | 125 – 400 $V_{DC}$ | Up to 1200 W | • 1xSTIB1060DM2T-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM10F** | 125 – 400 $V_{DC}$ | Up to 1000 W | • 1x STGIF10CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPMM15B** | 125 – 400 $V_{DC}$ | Up to 1500 W | • 1xSTIB1560DM2T-L | Power board: pumps, compressors, fans, home appliance |
| **STEVAL-IPM15B** | 125 – 400 $V_{DC}$ | Up to 1500 W | • 1x STGIB15CH60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM20B** | 125 – 400 $V_{DC}$ | Up to 2000 W | • 1xSTGIB20M60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPM30B** | 125 – 400 $V_{DC}$ | Up to 2500 W | • 1xSTGIB30M60TS-L | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPMNM1S** | 125 – 400 $V_{DC}$ | Up to 60 W | • 1x STIPNS1M50T-H | Power board: pumps, fans, small appliances |
| **STEVAL-IPMNM2S** | 125 – 400 $V_{DC}$ | Up to 100 W | • 1x STIPNS2M50T-H | Power board: pumps, fans, small appliances |
| **STEVAL-IPMNG3S** | 125 – 400 $V_{DC}$ | Up to 300 W | • 1x STGIPNS3H60T-H | Power board: pumps, compressors, fans, high-end power tools |
| **STEVAL-IPMNM1N** | 125 – 400 $V_{DC}$ | Up to 60 W | • 1x STIPN1M50T-H | Power board: pumps, fans, small appliances |
| **STEVAL-IPMnM3Q** | 125 – 400 $V_{DC}$ | Up to 300 W | • 1xSTIPQ3M60T-HZ | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPMNM2N** | 125 – 400 $V_{DC}$ | Up to 100 W | • 1x STIPN2M50T-H | Power board: pumps, fans, small appliances |

Note: 1. Available in Q3

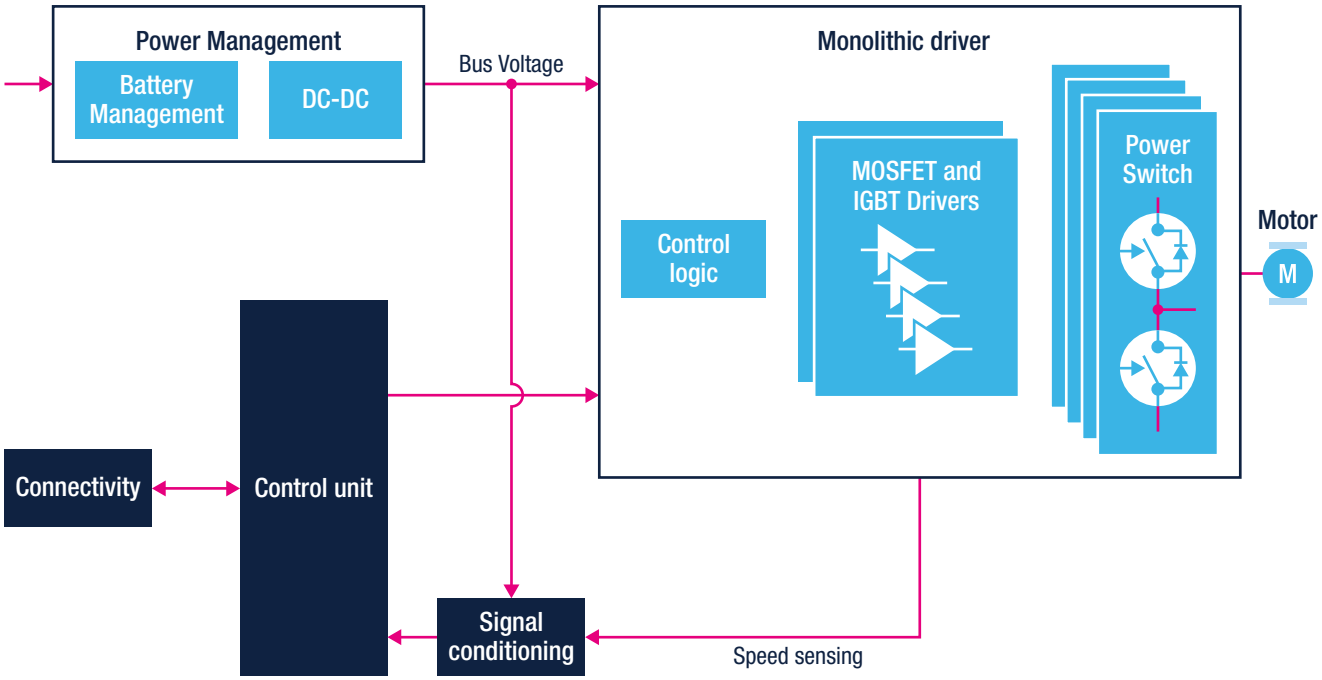
| Reference/bundle | Voltage | Power/Max Current | ST parts | Application focus |
|---|---|---|---|---|
| **STEVAL-IPMNG3Q** | 125 – 400 $V_{DC}$ | Up to 300 W | • 1x STGIPQ3H60T-HZ | Power board: pumps, compressors, fans, high-end power tools |
| **STEVAL-IPMnM5Q** | 125 – 400 $V_{DC}$ | Up to 450 W | • 1xSTIPQ5M60T-HZ | Power board: pumps, compressors, fans, home appliances |
| **STEVAL-IPMNG5Q** | 125 – 400 $V_{DC}$ | Up to 450 W | • 1x STGIPQ5C60T-HZ | Power board: pumps, compressors, fans, high-end power tools |
| **STEVAL-IPMNG8Q** | 125 – 400 $V_{DC}$ | Up to 600 W | • 1x STGIPQ8C60T-HZ | Power board: pumps, compressors, fans, high-end power tools |
| **STEVAL-IHM023V3** | 90 – 285 $V_{AC}$<br>125 – 400 $V_{DC}$ | Up to 1 kW | • 3x L6390<br>• 1x Viper16<br>• 7x STGP10H60DF | Power board: pumps, compressors, washing machines and more |
| **STEVAL-IHM028V2** | 90 – 285 $V_{AC}$<br>125 – 400 $V_{DC}$ | Up to 2 kW | • 1x STGIPS20C60<br>• 1x VIPer26LD<br>• 1x STGW35NB60SD | Power board: pumps, compressors, air conditioning and more |
| **STEVAL-IHM032V1** | 86 to 260 $V_{AC}$ | Up to 150 W | • 2x L6392D<br>• 1x L6391D<br>• 1x Viper12<br>• 6x STGD3HF60HD | Power board: pumps, compressors, fans, home appliances and more |
| **STEVAL-IHM034V2** | 230 $V_{AC}$ | Up to 1700 W | • 1x STGIPS20C60<br>• 1x L6391<br>• 1x Viper16LD<br>• 1x TSV914ID<br>• 3x STTH1L06A | Motor drive with digital PFC: room air conditioning, compressor and more |
| **STEVAL-IHM035V2** | 120/230 $V_{A}$ | Up to 100 W | • 1x STGIPN3H60<br>• 1x VIPer16L | Power board: pumps, compressors, fans, home appliances and more |
| **STEVAL-ISF003V1** | 230 $V_{AC}$<br>(or 120 $V_{AC}$) | Up to 7.4 kW | • 1x TN5050H-12WY<br>• 1x STTH60L10WY<br>• 1x STM8S103K3T3 | Inrush current limiter board |
| **STEVAL-IHT008V1** | 230 $V_{AC}$<br>or 120 $V_{AC}$ | Up to 800 W | • 1x T1635T-8FP<br>• 1x ACST210-8FP<br>• 1x ACS108-8SN<br>• 1x Z0109MUF<br>• 1x ViPER 26LD<br>• 1x STM8S103K3T3C | Low standby loss front-end with inrush current limitation and insulated AC switch control |
| **STEVAL-SCR001V1** | 90-265 $V_{AC}$ | Up to 800 W | • 2x TN5015H-6G | Inrush current solution with bypass SCR |
| **STEVAL-ISQ014V1** | N.A | N.A | | Low-side current sensing based on TSZ121 UM1737 |
| **STEVAL-SCR001V1** | N.A | N.A | | High-side current-sense amplifier demonstration board based on TSC2011 |
| **STEVAL-AETKT1V2** | N.A | N.A | | High-side current-sense amplifier demonstration board based on TSC2010, 2011, 2012 |

Note: 1. Available in Q3

# Stepper motors

## Overview

Stepper motors are widely used in holding and positioning applications in the computer, security, industrial automation sectors. Depending on the number of phases, the winding arrangement and the required level of motion smoothness, ST offers several types of bipolar stepper motor drivers to ensure the best performance for your application. 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, microstepping) and the resulting phase current waveform impact the vibration level, the acoustic noise, motion smoothness and sensitivity to resonances. ST fully supports all of these configurations with monolithic motor driver ICs (embedding digital controllers, power devices and protection functions), and for higher power, with a controller + MOSFET combination approach.



## Key Products

| | Product family | Description with key Features | Key products |
|---|---|---|---|
| **Control unit** | • STM32 Series | | • STM32F0 Series<br>• STM32F1 Series<br>• STM32F3 Series<br>• STM32G0 Series<br>• STM32G4 Series |
| **Monolithic driver** | • STSPIN2 Series<br>• STSPIN8 Series<br>• PowerSTEP01<br>• L64 Series | Efficient and accurate stepper drivers able to reach high motion resolution, up to 256 microsteps and to fit in a wide range of applications, spanning from portable to high current industrial ones | • STSPIN220<br>• STSPIN820<br>• PowerSTEP01<br>• L64* |
| **Power switch** | • F7 Low Voltage | Low Voltage MOSFET | • STxyN4F7<br>• STxyN6F7 |
| **Signal conditioning** | • TSV TSX TSB series - operational amplifiers<br>• TSZ series - zero drift amplifiers<br>• TS series - comparators<br>• TSC series - current sense amplifiers | High accuracy and high gain bandwidth product for low-side current measurement.<br>Fast response time for fault detection.<br>High voltage capability for accurate high side current measurement | • TSV732 TSX712 TSB712<br>• TSZ122 TSZ182<br>• TS3022<br>• TSC2010, 2011, 2012 TSC210, 213<br>• TSC2011 TSC210 |

## Main Evaluation Boards

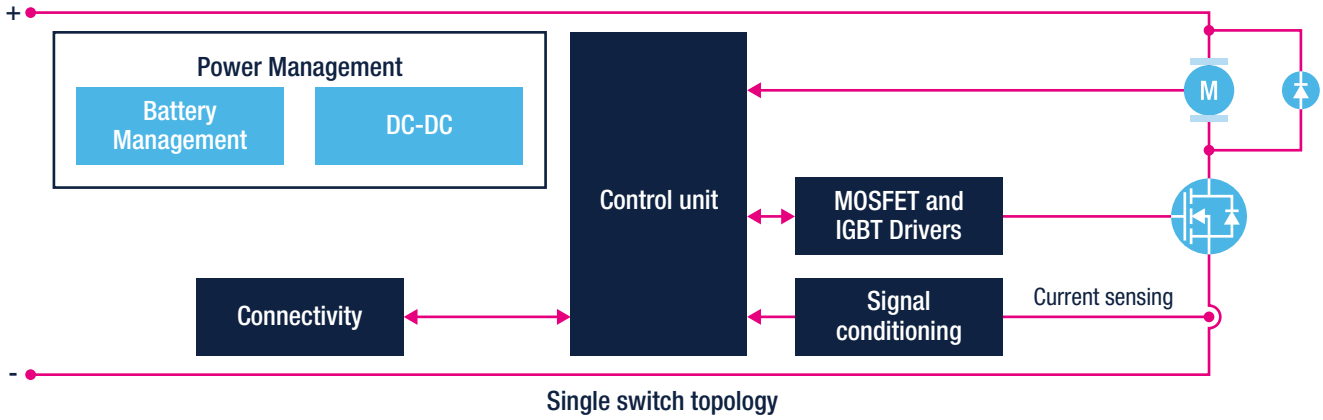
| Reference/bundle | Voltage | Power/Max Current | ST parts | Application focus |
|---|---|---|---|---|
| **X-NUCLEO-IHM14A1** | 7 -45 $V_{DC}$ | Up to 1.5 $A_{rms}$ | • 1x STSPIN820 | Label printers, surveillance and dome cameras, textile machines, 3D printers, antenna control |
| **X-NUCLEO-IHM06A1** | 1.8 - 10 $V_{DC}$ | Up to 1.3 $A_{rms}$ | • 1x STSPIN220 | POS, cash registers, toys, camera control, IoT and haptic feedbacks 3D printers |
| **X-NUCLEO-IHM05A1** | 8 - 50 $V_{DC}$ | Up to 2.8 $A_{rms}$ | • 1x L6208PD | Money handling machines, factory automation, valves, textile machines |
| **X-NUCLEO-IHM03A1** | 10.5 - 85 $V_{DC}$ | Up to 10 $A_{rms}$ | • 1x powerSTEP01 | Textile and sewing machines, pick and place machines, factory automation, industrial printers, industrial mixers |
| **X-NUCLEO-IHM01A1** | 8 - 45 $V_{DC}$ | Up to 3 $A_{rms}$ | • 1x L6474PD | Textile machines, factory automation, industrial and 3D printers |
| **STEVAL-3DP001V1** | 8 - 45 $V_{DC}$ | Up to 3 $A_{rms}$ | • 6x L6474H<br>• 1x STM32F401VET6<br>• 1x ST1S40IPHR<br>• 3x STL8N10F7<br>• 3x STT6N3LLH6 | Fused Filament Fabrication 3D printers |
| **STEVAL-ISQ014V1** | N.A. | N.A. | | Low-side current sensing based on TSZ121 UM1737 |
| **STEVAL-AETKT1V1** | N.A. | N.A. | | High-side current-sense amplifier demonstration board based on TSC2011 |
| **STEVAL-AETKT1V2**[1] | N.A. | N.A. | | High-side current-sense amplifier demonstration board based on TSC2010, 2011, 2012 |

Note: 1. Available in Q3

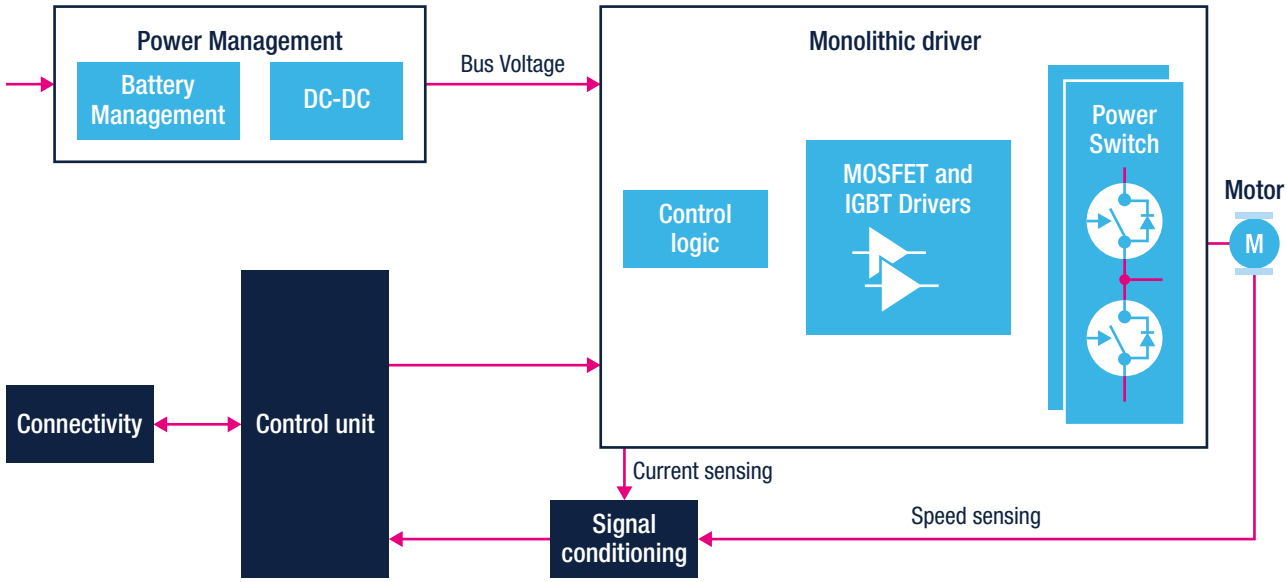
# Brushed DC motors

## Overview

Brushed DC motor are commonly used in industrial applications such as robots, valves and healthcare equipment. When only one direction of rotation is required, a single switch topology with PWM modulation can be used to vary the voltage applied to the motor, and thus to control its speed. When positioning is required or when both directions of rotation are needed (e.g. car windows) a full H-bridge with PWM control is used. At lower power levels, ST offers a full set of integrated motor drivers with a progressive selection of integrated features, embedded gate drivers, power transistors, protection functions, current sensing and even DC-DC converters. For higher power needs, ST's portfolio also includes discrete low voltage power MOSFETs and gate driver ICs to implement the required H-bridge. A general-purpose 8-bit microcontroller or a cost-optimized 32-bit microcontroller can be used to implement these drives.




Single switch topology




Full Bridge topology

## Key Products

| | Product family | Description with key Features | Key products |
|---|---|---|---|
| **Control unit** | • STM32 Series<br>• STM8S Series | | • STM32F0 Series<br>• STM32F1 Series<br>• STM32G0 Series |
| **Monolithic driver** | • STSPIN2 Series<br>• STSPIN8 Series<br>• PWD Series<br>• L62 Series | A complete set of versatile and scalable monolithic motor drivers addressing a wide range of applications, spanning from portable to high current and high voltage industrial ones | • STSPIN2*<br>• STSPIN840<br>• PWD*F60<br>• L62* |
| **MOSFET and IGBT Drivers** | • L649 series<br>• L639 series<br>• L638 series<br>• TD35 series<br>• STDRIVE101<br>• STDRIVE601 | STDRIVE Mosfet and IGBT Gate drivers | • L649*<br>• L639*<br>• L638*<br>• TD35* |
| **Power Switch** | • F6 & F7 Low Voltage | Low voltage MOSFET | • STxyN4F7<br>• STxyN6F7<br>• STxyN8F7<br>• STxyN10F7 |
| **Power Schottky** | • STPSx45/60/80/100 | ST's power Schottky diodes combine low voltage-drop characteristics with negligible or zero recovery. They range from 15 to 200 V and from 1 to 240 A, so covering all application needs from OR-ing and 48 V converters, to battery chargers and welding equipment. They are avalanche specified for improved ruggedness | • STPS3045<br>• STPS41H100 |
| **FERD Diodes** | • FERDx45/60/100 | ST field-effect rectifier diodes (FERD) help improve designs with new versions focusing on trade-off upgrades. The design of the FERDs has allowed both a decrease in the voltage drop and a decrease in the leakage current temperature coefficient. As a result, the runaway safety margin is improved and maybe beyond the typical safety margin of Schottky barrier diodes | • FERD2045S<br>• FERD20U60DJF<br>• FERD30SM100DJF |
| **Signal conditioning** | • TSV TSX TSB series - operational amplifiers<br>• TSZ series - zero drift amplifiers<br>• TS series - comparators<br>• TSC series - current sense amplifiers | High accuracy and high gain bandwidth product for low-side current measurement.<br>Fast response time for fault detection.<br>High voltage capability for accurate high side current measurement | • TSV732 TSX712 TSB712<br>• TSZ122 TSZ182<br>• TS3022<br>• TSC2010, 2011, 2012 TSC210, 213<br>• TSC2011 TSC210 |

## Main Evaluation Boards

| Reference/bundle | Voltage | Power/Max Current | ST parts | Application focus |
|---|---|---|---|---|
| **X-NUCLEO-IHM15A1** | 7 - 45 $V_{DC}$ | Up to 1.3 $A_{rms}$ | • 1x STSPIN840 | Stage lighting, Industrial automation, service robots, medical and health care, ATM, Vending machines |
| **X-NUCLEO-IHM13A1** | 1.8 - 10 $V_{DC}$ | Up to 2.6 $A_{rms}$ | • 1x STSPIN250 | eValves, IoT, edu/home robots, healthcare, toys, eLock, actuators |
| **X-NUCLEO-IHM12A1** | 1.8 - 10 $V_{DC}$ | Up to 1.3 $A_{rms}$ | • 1x STSPIN240 | eValves, IoT, edu/home robots, healthcare, toys, eLock, actuators |
| **X-NUCLEO-IHM04A1** | 8 - 50 $V_{DC}$ | Up to 2.8 $A_{rms}$ | • 1x L6206PD | Stage lighting, antenna control, vending machines, factory automation |
| **STEVAL-ISQ014V1** | N.A. | N.A. | | Low-side current sensing based on TSZ121 UM1737 |
| **STEVAL-AETKT1V1** | N.A. | N.A. | | High-side current-sense amplifier demonstration board based on TSC2011 |
| **STEVAL-AETKT1V2**[1] | N.A. | N.A. | | High-side current-sense amplifier demonstration board based on TSC2010, 2011, 2012 |

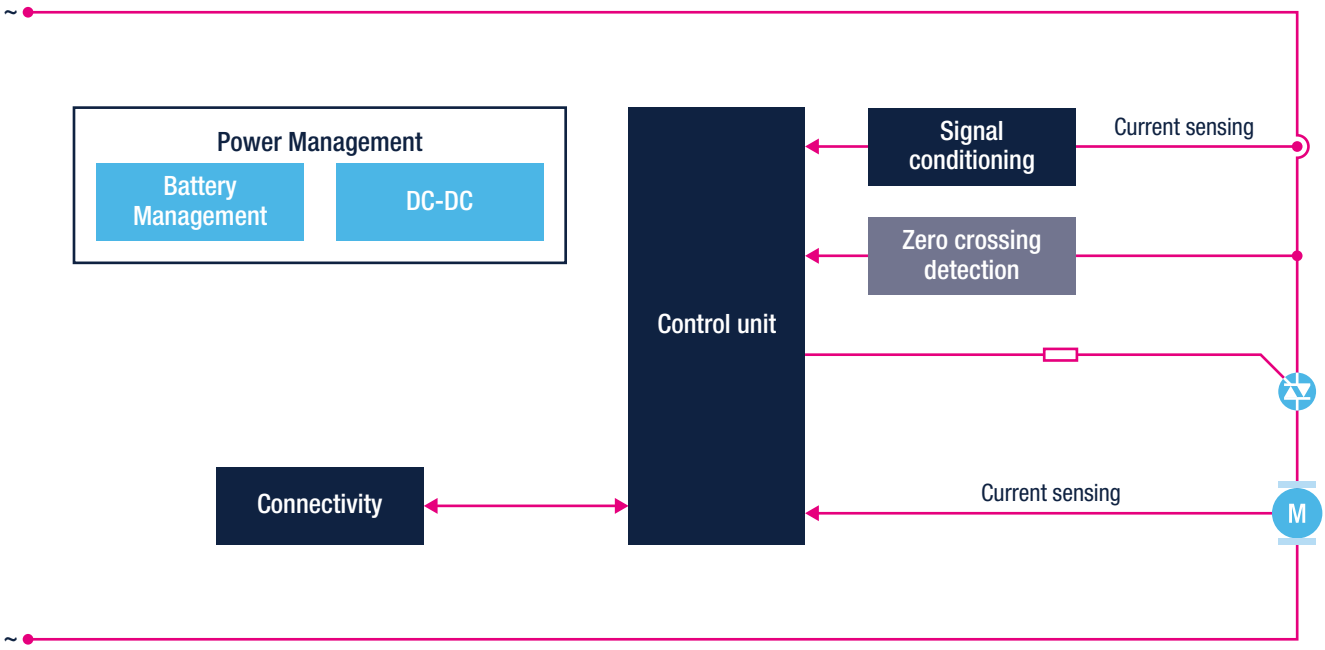
Note: 1. Available in Q3

# Universal motors

Universal motors can be used with AC or DC supplies and are commonly used in consumer appliances such as mixers, fans and vacuum cleaners.

Most universal motors are unidirectional. Bidirectional motors using two coils on the stator can be driven by applying a voltage to only one of them for the respective direction. The advantages of universal motors are high starting torque, very compact design and high speed.

A simple controller with an AC supply can be implemented using a low-end microcontroller and a single Triac or an AC switch.




Universal Motor AC Drive (Phase control drive)

| | Product family | Description with key Features | Key products |
|---|---|---|---|
| **Control unit** | • STM32 Series<br>• STM8S Series | | • STM32F0 Series<br>• STM32F1 Series<br>• STM32G0 Series |
| **AC Switches** | T-Series | High Tj Triac with strong dynamic behavior (dv/dt & di/dtc) | T1235T-8, T1635T-8 |
| | H-Series | 800 V High Tj Triac: 150 °C, High turn-off commutation | T1235H-8, T1635H-8, T2035H-8, T3035H-8 |
| | ACST-Series | Overvoltage protected ACSwitch, High static dv/dt, for IEC61000-4-5 voltage surge application compliance | ACST830-8, ACST1235-8FP, ACST1635-8FP |
| **Signal conditioning** | • TSV TSX TSB series - operational amplifiers<br>• TSZ series - zero drift amplifiers<br>• TS series - comparators<br>• TSC series - current sense amplifiers | High accuracy and high gain bandwidth product for low-side current measurement.<br>Fast response time for fault detection.<br>High voltage capability for accurate high side current measurement | • TSV732 TSX712 TSB712<br>• TSZ122 TSZ182<br>• TS3022<br>• TSC2010, 2011, 2012 TSC210, 213<br>• TSC2011 TSC210 |

## Main Evaluation Boards

| Reference/bundle | Voltage | Power/Max Current | ST parts | Application focus |
|---|---|---|---|---|
| **STEVAL-GLA001V1** | 90 - 265 $V_{AC}$ (50/60 Hz) | Up to 1 kW | • 1x T1635T-8FP<br>• 1x ACST310-8B<br>• 1x ACS108-8TN<br>• 1x Viper16HD<br>• 1x TSV631ILT | AC Load drives: up to 3 loads like lamp; Defrost resistor; door locks |
| **STEVAL-IHT001V2** | 100 - 240 $V_{AC}$ (50/60 Hz) | Up to 1.5 Arms | • 1x ACST610-8FP<br>• 1x ACS110-7SN<br>• 1x ACS102-6TA<br>• 1x STM8S003F3P6<br>• 1x USBUF02W6 | Compressor; Lamps; Defrost resistor; Fans |
| **STEVAL-IHT003V2** | 100 - 240 $V_{AC}$ (50/60 Hz) | Up to 10 Arms | • ACST610-8T<br>• X0202NN 5BA4 | Starter for Compressor |
| **STEVAL-IHT005V2** | 90 - 265 $V_{AC}$ (50/60 Hz) | Up to 2830 W | • 1x T1635H-6T<br>• 1x ACST1635-8FP<br>• 1x Z0109MA<br>• 3x ACS108-8SA<br>• 1x VIPER16L<br>• 1x STM32F100C4T6B | AC Load drives like valves, pumps, door locks, drum motors and heating resistors |
| **STEVAL-IHM029V2** | 90 - 265 $V_{AC}$ (50/60 Hz) | Up to 900 W | • T1635T-8FP<br>• VIPER16<br>• STTH1R06<br>• STM8S103 | Vacuum cleaners; food processors and power tools |
| **STEVAL-ISQ014V1** | N.A. | N.A. | | Low-side current sensing based on TSZ121 UM1737 |
| **STEVAL-AETKT1V1** | N.A. | N.A. | | High-side current-sense amplifier demonstration board based on TSC2011 |
| **STEVAL-AETKT1V2**[1] | N.A. | N.A. | | High-side current-sense amplifier demonstration board based on TSC2010, 2011, 2012 |

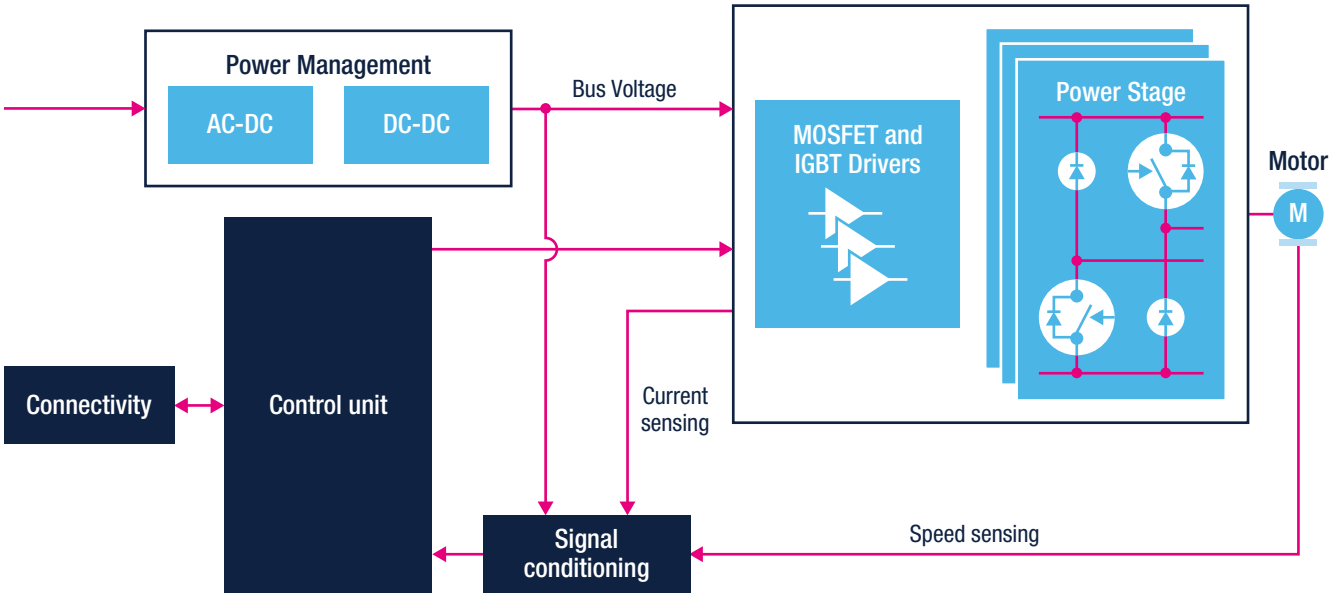
Note: 1. Available in Q3

# Switched reluctance motors

## Overview

Switched reluctance motors are mainly used in traction, industrial pumps and home appliances (vacuum cleaners and certain washing machines). Their structure is similar to that of stepper motors, but switched reluctance motors have fewer magnetic poles. Despite their simple structure, external electronic commutation is needed.

The asymmetrical half-bridge PWM drive leverages the motor's best features. An independent current loop is implemented for each motor phase so that some phase current overlap is possible to attain higher speeds. For the drive, 2 x n power switches are required (with n being the number of motor phases).




| | Product family | Description with key Features | Key products |
|---|---|---|---|
| **Control unit** | • STM32 Series | | • STM32F0<br>• STM32G0<br>• STM32F301<br>• STM32G4x1 |
| **Diode & Rectifier** | • STPSx45/60/80/100<br>• STTHxR03/04/06<br>• STTHxRQ06 | Power Schottky<br>Ultrafast diodes | • STPS3045, STPS41H100C<br>• STTH30R03<br>• STTH8R06<br>• STTH15RQ06 |
| **MOSFET and IGBT Drivers** | | | |
| **Power Switch** | • IGBT M series<br>• IGBT S series<br>• IGBT H series | High voltage IGBT | • STGxyyM65DF2<br>• STGxyyM120DF3<br>• STGxyyS120DF3<br>• STGxyyH60DF |
| **Signal conditioning** | • TSV TSX TSB series - operational amplifiers<br>• TSZ series - zero drift amplifiers<br>• TS series - comparators<br>• TSC series - current sense amplifiers | High accuracy and high gain bandwidth product for low-side current measurement.<br>Fast response time for fault detection.<br>High voltage capability for accurate high side current measurement | • TSV732 TSX712 TSB712<br>• TSZ122 TSZ182<br>• TS3022<br>• TSC2010, 2011, 2012 TSC210, 213<br>• TSC2011 TSC210 |

# Microcontrollers

## Microcontrollers portfolio

ST's product portfolio contains a comprehensive range of microcontrollers, from robust, low-cost 8-bit MCUs, the STM8 family, up to 32-bit Arm®-based Cortex®-M0/M0+, Cortex®-M3, Cortex®-M33; Cortex®-M4, Cortex®-M7 Flash microcontrollers with a rich choice of peripherals, the STM32 family.


| | 8-bit MCUs | 32-bit MCUs and MPUs | | |
|---|---|---|---|---|
| | STM8 | STM32 | | SPC5 |
| | Discover STM32 32-bit MCUs | Discover STM32 32-bit MCUs | Discover STM32 32-bit MCUs | Discover STM32 32-bit MCUs |
| MPU | | STM32**MP1** | | |
| High Performance MCUs | | | **MPU**<br>STM32**H7**<br>STM32**F7**<br>STM32**F4**<br>STM32**F2** | |
| Mainstream MCUs | STM8**S** | | STM32**G4**<br>STM32**F3**<br>STM32**G0**<br>STM32**F0**<br>STM32**F1** | |
| Ultra-low-power MCUs | STM8**L** | | STM32**L0**<br>STM32**L1**<br>STM32**L4**<br>STM32**L4+**<br>STM32**L5** | |
| Wireless MCUs | | | STM32**WB**<br>STM32**WL** | |
| Automotive MCUs | STM8**AF**<br>STM8**AL** | | | STC**56**<br>STC**57**<br>STC**58** |

## Key MCU Selection Guide for Motor control

| Motor | STM8S | STM32G0<br>STM32F0<br>STM32F1 | STM32G4<br>STM32F41x<br>STM32F3<br>STM32L4 | MPU<br>STM32H7<br>STM32F7<br>STM32F4 |
|---|---|---|---|---|
| Brushed DC Motors | x | | | |
| Single Phase AC Induction Motors | x | x | x | |
| Stepper Motors | x | x | | |
| Switched Reluctance Motors | x | x | x | |
| 3-phase PMSM/FOC - vector control | x | x | x | |
| 3-phase BLDC/6-step | x | x | x | x |
| Universal Motors | x | x | | |
| PFC | | x | x | x |
| 3-phase Induction motor control | | | | |

STM8S:
Brushed DC motors
Single-phase AC induction motors
Universal Motors

STM32:
Stepper motors
Switched reluctance motors
3-phase brushless motors

## STM8 8-BIT MICROCONTROLLERS


The STM8 MCU is part of a platform of technologies, IPs and tools which forms the basis of ST's comprehensive family of 8-bit microcontrollers. These cover, among others, many applications where there is an electric motor, from consumer electronics, including home appliances and factory automation, to automotive segments. The platform provides outstanding levels of digital and analog performance combined with a high level of cost effectiveness.

Implemented around a high-performance 8-bit core and a state-of-the-art set of peripherals and IPs, the microcontrollers in the STM8 family are manufactured using an ST-proprietary 130 nm embedded non-volatile memory technology.

### One series for every need

**Mainstream**

STM8

Data EEPROM,
3 and 5 V families,
precise RC

Industrial, consumer and mass market

Robust and reliable
Up to 125 °C

www.st.com/stm8s

**Automotive**

STM8

ASIL Ready

| STM8AF | STM8AL |
|---|---|
| Data EEPROM,<br>3 and 5 V families,<br>precise RC, LIN,<br>CAN, grade 0 | Data EEPROM,<br>1.65 and 3.6 V families,<br>precise RC, LIN,<br>grade 1 |
| Long-term guarantee | Long-term guarantee |
| AEC-Q100<br>Up to 150 °C | AEC-Q100<br>Up to 125 °C |
| www.st.com/stm8af | www.st.com/stm8al |

**Ultra-low-power**

STM8

Data EEPROM,
1.65 and 3 V families,
strong analog, LCD
drivers, low-leakage
technology

Ideal combination of low-power performance and features

High-end analog IPs
Active Halt < 1 A

www.st.com/stm8l

## Using STM8's peripherals for motor control

The STM8 comes with a set of peripherals that are suitable for many motor control topologies and applications.

The advanced timer available on the STM8S, STM8L and STM8A is a 16-bit timer capable of both centered or edge-aligned PWM pattern generation and, thanks to the availability of complimentary output on 3 of its channels, is specifically designed to address 3-phase and full-bridge topologies (for 3-phase AC IM, 3-phase PMSM/BLDC, bidirectional DC motors, stepper motor drives). The timer is also equipped with a synchronization circuit allowing the ADC to be triggered on specific events and an asynchronous emergency input.

The 12-bit ADC of the STM8L (10-bit on the STM8S and STM8A) allows motor current and voltage to be precisely sensed while its comparator could be used for hysteresis peak current control.

General-purpose 16-bit timers with their input capture capabilities are very well suited for motor speed feedback processing. In particular, the STM8L also features three input XOR gates combining the data coming from three Hall sensors to simplify speed measurement in 3-phase permanent magnet motors.

### KEY FEATURES

- Advanced timer for 3-phase inverters and full-bridge converter drivers
- Fast and precise ADC can be triggered by timer events
- 5 V power supply
- Input capture on general-purpose timers for easier speed feedback processing
- Encorder operating mode only for DC motors

## STM8S evaluation tools for motor control

| Order code | Description | Motors covered | Documentation |
|---|---|---|---|
| **STM8/128-EVAL** | STM8S MCU evaluation board; any motor control power stage featuring ST's standard MC connector can be connected (see 3-phase brushless motor evaluation tools section) | Depends on power stage connected through MC connector[1] | UM0482 |
| **STEVAL-IHM029V2** | Universal motor control evaluation board based on high-temperature junction Triac and STM8S microcontroller | Universal, single-phase Induction motors | UM0922 |
| **STEVAL-IHM041V1** | Universal motor driver with speed control based on the STM8 microcontroller and Triac (US version) | Universal, single-phase induction motors | UM1559 |
| **STEVAL-IHT001V2** | Cold digital thermostat kit | Single-phase induction motors | UM1542 |

Note: 1. A daughter board may be required to be plugged on STM8/128-EVAL depending on the type of the control and power stage to be connected

### BRUSHLESS MOTOR CONTROL WITH STM8S IN 3 STEPS:

1. Visit www.st.com to download STM8S FW library for 3-phase motor control
2. Configure the FW library through the STM8 MC Builder PC software
3. Develop your own applications in conjunction with a third-party IDE and C compiler


## STM32 32-bit microcontrollers

The STM32 family of 32-bit Flash microcontrollers based on the ARM Cortex-M processor is designed to offer new degrees of freedom to MCU users. By bringing a complete
32-bit product range that combines high-performance, real-time, low-power and low-voltage operation, while maintaining full integration and ease of development, the STM32 family helps you create new applications and design in the innovations you have long been dreaming about.

Most of the STM32 products lines embed Advanced Motor Control timer and are supported by the STM32 full feature Motor Control ecosystem.

### KEY FEATURES

- Advanced Motor Control timer for 3-phase inverters and full-bridge converter drivers
- Fast 12-bit and 16-bit -ADC- can be triggered by timer events
- ART Accelerator™, Control loop booster
- Safety ready: SIL, Class B
- STM32Trust: multi-level security
- Integrated analog (Op-Amp, DAC, Comparator…)
- Connectivity (Ethernet, CAN, UART, SPI, I²C, CAN-FD, FW Com stack…)
- Temperature range from -40 °C up to 125 °C
- Precise internal oscillator (1%)

**STM32F0, G0, F1, F3, G4**
**Mainstream**

- Rich advanced analog (F3, G4)
- Control loop optimized
- Advanced PWM Motor Control and High resolution timers
- Mathematical accelerators

**From cost optimized to full featured SoC solution for Motor Control**

**STM32F2, F4, F7, H7, MPU**
**High-performance**

- MCU (single or dual core), MPU
- Advanced Connectivity (Ethernet…)
- Graphic Accelerator
- Large embedded SRAM

**Motor Control and much more…**

**STM32L5, L4, (L1, L0)**
**Ultra-low-power**

- EEPROM
- LCD interface
- Graphic accelerator
- The lowest power consumption ideal for battery operated application

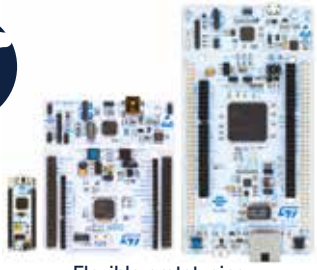
**Low power performance and features**

# STM32 ECOSYSTEM

## Hardware tools

**www.st.com/stm32hardwaretools**

### STM32 Nucleo board



Flexible prototyping

The highly affordable STM32 Nucleo boards allow anyone to try out new ideas and to quickly create prototypes with any STM32 MCU.

Sharing the same connectors, STM32 Nucleo boards can easily be extended with a large number of specialized application hardware add-ons (Nucleo-64 include Arduino Uno rev3 & ST morpho connectors, Nucleo-32 include Arduino Nano connectors).

### Discovery kit

Creative demos

STM32 Discovery kits are a cheap and complete solution for the evaluation of the outstanding capabilities of STM32 MCUs. They carry the necessary infrastructure for demonstration of specific device characteristics,
a HAL library and comprehensive software examples allow to fully benefit from the devices features and added values.

Extension connectors give access to most of the device's I/Os and make the connection of add-on hardware possible.

### Evaluation board

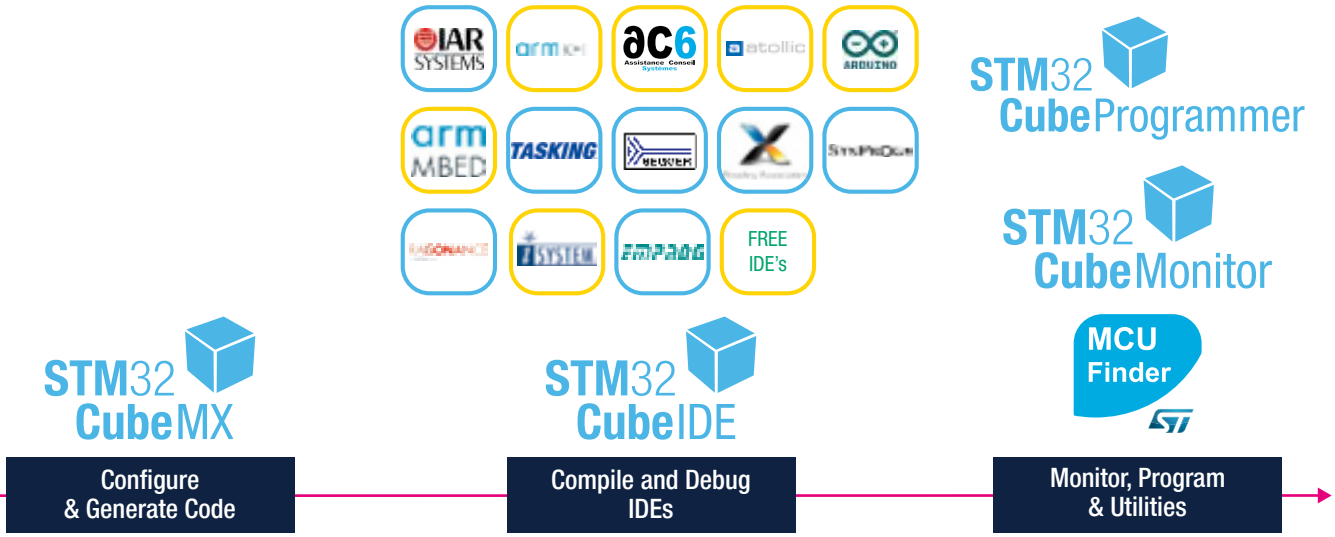
Full-feature evaluation

The STM32 eval boards have been designed as a complete demonstration and development platform for the Arm® Cortex STM32 MCUs.

They carry external circuitry, such as transceivers, sensors, memory interfaces, displays and many more. The evaluation boards
can be considered as a reference design for application development.

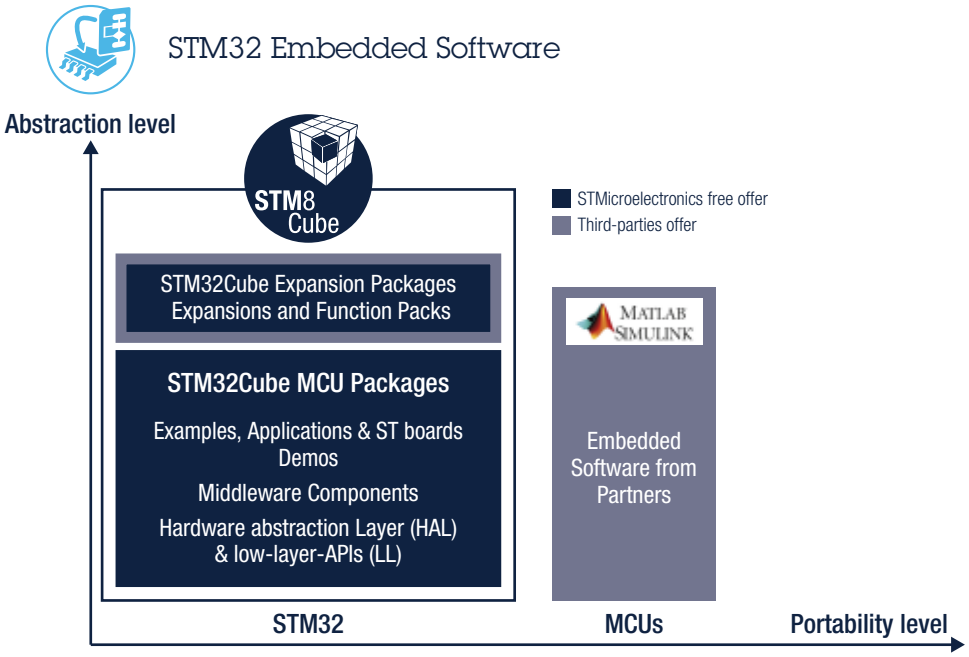
## Software tools

**www.st.com/stm32softwaretools**



## Embedded software

**www.st.com/stm32embeddedsoftware**




**ST COMMUNITY**

Ask, learn, share, discuss, become famous and engage with the community of STM32 enthusiasts on **community.st.com/stm32**

**STM32 EDUCATION**

Bring your STM32 project to life with the free educational and training resources on **st.com/stm32education**

## ST-MC-SUITE

The STM32/STM8 Motor Control Suite is the entry point for easy access to all resources for motor-control application development with STM32 and STM8 microcontrollers. The tool lets users gather tutorials, documentation and videos, store project setups including appropriate software and a choice of applicable evaluation boards (control and power), motor-control kits, and inverters that can be purchased online.

Thereby, users can select all the resources required and include it in a bundle. At the end of the process, they can download their bundle as a zip file that will centralize everything they requested.

ST-MC-SUITE will thus become the birthplace of many projects by offering knowledge, training, documentation, and a structure that can help engineers focus on what they want to do rather than lose time hunting for software, components, and information.

**KEY FEATURES**

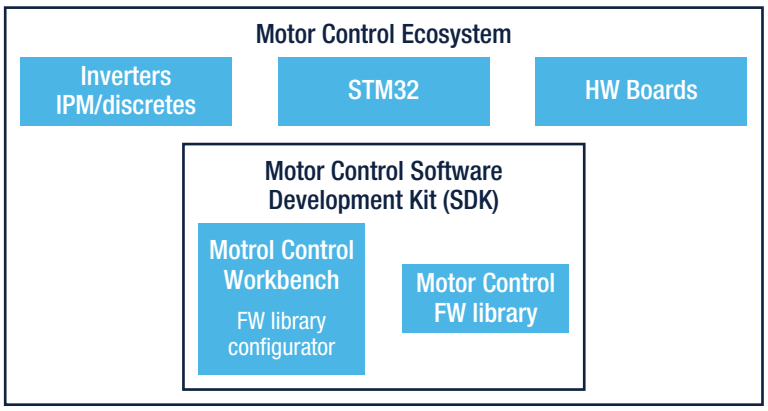
- Browse St's MCU to find the one which fit the best with your motor control application
- Select motor control materials needed and download all of them as a .zip file
- Save your setups for future reference
- Focus on PMSM (Permanent Magnet Synchronous Motors) controlled in FOC
- (Field Oriented Control) mode and BLDC (Brushless DC) motors controlled in 6-Step
- Extra motor types and control techniques will be added soon

# STM32 Motor Control Ecosystem

STM32 microcontrollers offer the performance of the industry-standard Arm® Cortex®-M cores running Field Oriented Control (FOC) modes, widely used in high-performance drives for air conditioning, home appliances, drones, building and industrial automation, medical and e-bike applications.

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.



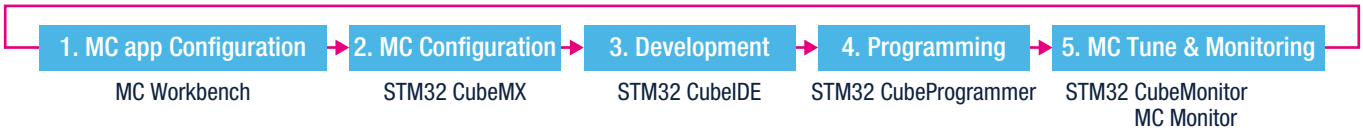

## KEY FIRMWARE FEATURES

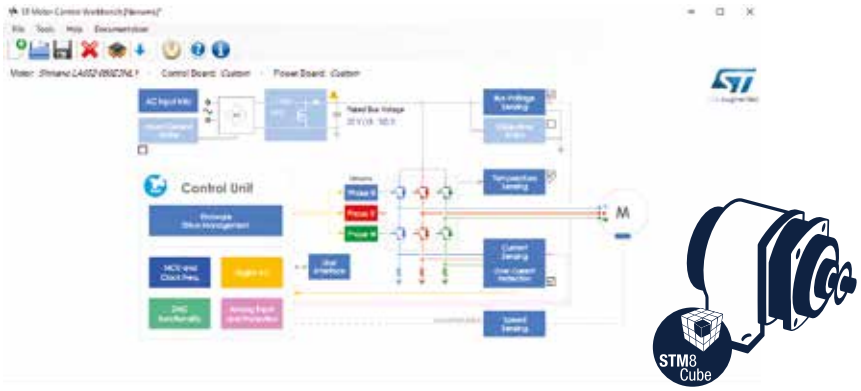
- Single/Dual simultaneous field-oriented control (FOC)
- Motor profiler for a fast startup of unknown motors
- Simplified firmware architecture based on the STM32Cube HAL/LL libraries
- Current reading topologies supported:
  - 1 shunt resistor
  - 3 shunt resistors
  - 2 ICS (Isolated Current Sensor)
- Speed/position sensors (Encoder and Hall) as well as sensor-less operation (state observer) supported
- On-the-fly startup for fans
- Speed and torque control
- Motor control algorithms implemented for specific applications, among them MTPA (maximum torque per ampere), Flux weakening, Feed forward and Start-on-the-fly
- Full customization and real time communication through STM32 Motor Control Workbench PC software
  - New project creation starting from the board
  - Workflow supporting the STM32CubeMX GUI configurator
  - Wide range of STM32 microcontrollers supported
- Position Control for configurations using a Quadrature Encoder as speed and position feedback
- FreeRTOS support
- Six- step examples available for STM32G4, STM32F4 and STSPINF0
- PFC FW example on STM32F1 and F3

STM32 Motor Control ecosystem web page:
**https://www.st.com/content/st_com/en/stm32-motor-control-ecosystem.html**

## MC WORKBENCH

Motor Control Workbench (available in the X-CUBE-MCSDK) is linked with STM32CubeMX. Developers can open STM32CubeMX thru Motor Control Workbench during their Motor Control development to change STM32 configuration.




## Full Integration/configuration in MC Workbench tools

| STM32 series | | F0 | F1 | F3 | F4 | F7 | L4 | G0 | G4 | STSpin32F0 |
|---|---|---|---|---|---|---|---|---|---|---|
| Current Sensing and over current protection OCP | Current 1-shunt or 3-shunt | • | • | • | • | • | • | • | • | • |
| | Insulated Current Sensing | | • | • | • | • | | | • | |
| | Embedded Comparators OCP, OPAMPs | | | • | | | | | • | |
| Speed/Position sensing | Sensor (Hall, Encoder sensors)/ Sensor-less | • | • | • | • | • | • | • | • | • |
| Bus Voltage sensing/ protection UVP/OVP | Vbus reading, Over and Under voltage protection | • | • | • | • | • | • | • | • | • |
| Temperature sensing/ protection OTP | Temperature measurement, Over temperature protection | • | • | • | • | • | • | • | • | • |
| FOC | Single | • | • | • | • | • | • | • | • | • |
| | Dual (Couple ADCs per motor) | | | • | • | | | | • | |
| | Dual (Sharing ADC resources for both motors) | | | • | • | | | | | |
| Control Mode | Torque/Speed/Position control | • | • | • | • | • | • | • | • | • |
| Other features | MTPA, Flux weakening, Feed Forward | • | • | • | • | • | • | • | • | • |
| | PFC - FW support | | • | • | | | | | | |

## FW Examples/No configuration possible in MC Workbench tools

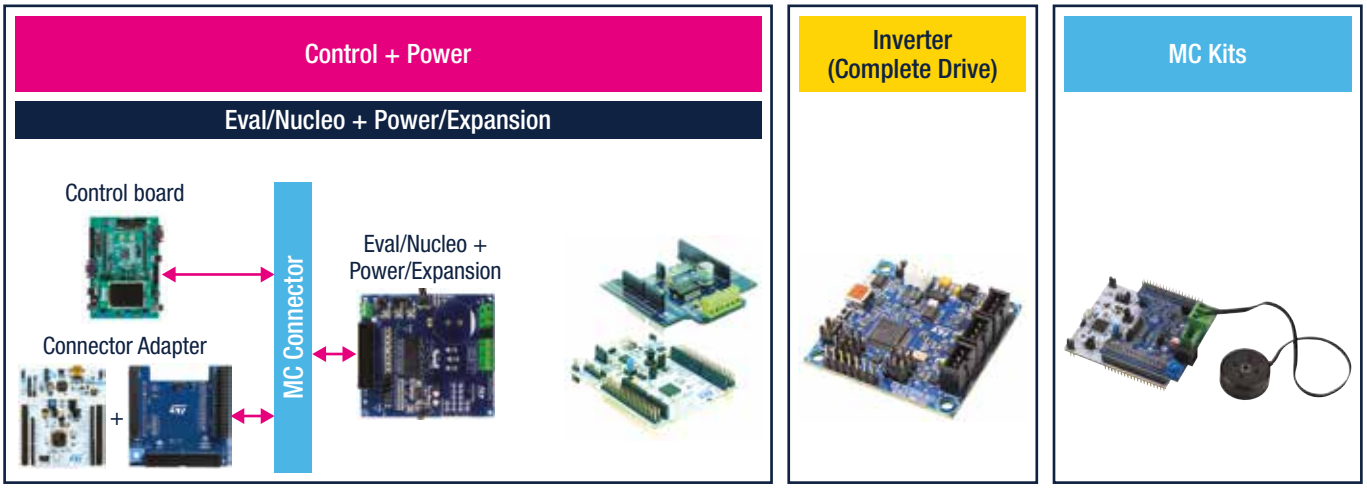
| STM32 series | | F0 | F1 | F3 | F4 | F7 | L4 | G0 | G4 | H7 CM4 | STSpin32F0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 Step | FW Examples (No configuration possible in MC Workbench tools) | | | | • | | | | • | | • |
| Dual Core | FW Examples | | | | | | | | | • | |
| PFC | FW Examples | | | • | | | | | | | |

## STM32 MOTOR PROFILER

- Automatic detection of key parameters of a PMSM
- Zero equipment required
- Spin motor within less than 1 min
- Best accuracy when Rs ≥ 1 Ω and Ls ≥ 1 mH


## STM32 EVALUATION BOARDS FOR MOTOR CONTROL

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.




### READY TO USE MOTOR CONTROL EVALUATION KITS:

- STM32 Nucleo Pack for motor control
- Complete evaluation kit -FOC, 6-step FW example based- for evaluation, fast prototyping, makers and education
  - Based on STM32 G4: P-NUCLEO-IHM03
  - Based on STM32 F3: P-NUCLEO-IHM001 and P-NUCLEO-IHM002
- Complete evaluation kit -FOC, 6-step FW example based- for evaluation, fast prototyping, makers and education

## STM32 MC SDK Control Boards

| Family | MCU | Board | Description |
|---|---|---|---|
| G0 | G081B | STM32G081B-EVAL | G0 Evaluation Board |
| F0 | F030R8 | NUCLEO-F030R8 | F0 Nucleo Board |
| F0 | F072RB | NUCLEO-F072RB | F0 Nucleo Board |
| F0 | F072VB | STM32072B-EVAL | F0 Evaluation Board |
| F1 | F103RB | NUCLEO-F103RB | F1 Nucleo Board (MD) |
| F1 | STM32F103ZET6 | STM3210E-EVAL | F1 Evaluation Board |
| F3 | F302R8 | NUCLEO-F302R8 | F3 Nucleo Board |
| F3 | F303RE | NUCLEO-F303RE | F3 Nucleo Board |
| F3 | F303VE | STM32303E-EVAL | F3 Evaluation Board |
| F4 | F446RE | NUCLEO-F446RE | F4 Nucleo Board |
| F4 | F407IG | STM3240G-EVAL | F4 Evaluation Board |
| F4 | F417IG | STM3241G-EVAL | F4 Evaluation Board |
| F4 | F446ZET | STM32446E-EVAL | F4 Evaluation Board |
| F4 | F415ZGT8 | STEVAL-IHM039V1 | F4 Evaluation Board |
| F4 | F401RE | NUCLEO-F401RE | F4 Nucleo Board |
| F7 | F746ZG | NUCLEO-F746ZG | F7 Nucleo Board |
| F7 | F769I | STM32F769I-EVAL | F7 Evaluation Board |
| L4 | L452RE | NUCLEO-L452RE | L4 Nucleo Board |
| L4 | L476G | STM32L476G-EVAL | L4 Evaluation Board |
| G4 | G474Q | STM32G474E-EVA | G4 Evaluation Board |
| G4 | G431R | NUCLEO-G431RB | G4 Nucleo board |
| H7 | H745ZI | NUCLEO-H745ZI | H7 Nucleo board |

## STM32 MC SDK Power Boards

| Board | Description |
|---|---|
| STEVAL-IHM023V3 | 1 kW 3-phase motor control evaluation board featuring L6390 drivers and STGP10H60DF IGBT |
| STEVAL-IHM028V2 | 2 kW 3-phase motor control evaluation board featuring the STGIPS20C60 IGBT intelligent power module |
| STEVAL-IHM045V1 | 3-phase high voltage inverter power board for FOC based on the STGIPN3H60A (SLLIMM™;-nano) |
| X-NUCLEO-IHM07M1 | Three-phase brushless DC motor driver expansion board based on L6230 for STM32 Nucleo |
| X-NUCLEO-IHM08M1 | Low-Voltage BLDC motor driver expansion board based on STL220N6F7 for STM32 Nucleo |
| X-NUCLEO-IHM11M1 | Low voltage three-phase brushless DC motor driver expansion board based on STSPIN230 for STM32 Nucleo |
| STEVAL-IPM05F | 500 W motor control power board based on STGIF5CH60TS-L SLLIMM™ 2nd series IPM |
| STEVAL-IPM07F | 700 W motor control power board based on STGIF7CH60TS-L SLLIMM™ 2nd series IPM |
| STEVAL-IPM10B | 1200 W motor control power board based on STGIB10CH60TS-L SLLIMM™ 2nd series IPM |
| STEVAL-IPM08B | 800 W motor control power board based on STGIB8CH60TS-L SLLIMM™ 2nd series IPM |
| STEVAL-IPM10F | 1000 W motor control power board based on STGIF10CH60TS-L SLLIMM™ 2nd series IPM |
| STEVAL-IPM15B | 1500 W motor control power board based on STGIB15CH60TS-L SLLIMM™ 2nd series IPM |
| STEVAL-IPMNG3Q | 300 W motor control power board based on STGIPQ3H60T-H SLLIMM™-nano IPM |
| STEVAL-IPMNG5Q | 450 W motor control power board based on STGIPQ5C60T-HZ SLLIMM™-nano IPM |
| STEVAL-IPMNG8Q | 600 W motor control power board based on STGIPQ8C60T-HZ SLLIMM™-nano IPM |
| STEVAL-IPMNM1N | 60 W motor control power board based on STIPNS1M50T-H SLLIMM™-nano SMD IPM MOSFET |
| STEVAL-IPMNM2N | 100 W motor control power board based on STIPN2M50T-H SLLIMM™nano IPM MOSFET |
| STEVAL-CTM010V1 | 450 W motor control power board based on STGIPQ5C60T-HZ SLLIMM™-nano IPM |
| STEVAL-CTM009V1 | 600 W motor control power board based on STGIPQ8C60T-HZ SLLIMM™-nano IPM |
| STEVAL-IPMnM1S | 60 W motor control power board based on STIPNS1M50T-H SLLIMM™-nano SMD IPM MOSFET |
| STEVAL-IPMnG3S | 100 W motor control power board based on STIPN2M50T-H SLLIMM™nano IPM MOSFET |

## STM32 MC SDK inverters

| Family | MCU | Board | Description |
|---|---|---|---|
| F0 | F031 | STEVAL_SPIN3201 | STSPIN32F0 3-shunt |
| F0 | F031 | STEVAL_SPIN3202 | STSPIN32F0A 1-shunt |
| F1 | F103RC | STEVAL_IHM034V2 | MC and digital PFC |
| F3 | F303RE | X-Nucleo_IHM16 + Nucleo-F303RE | Bundle |
| F3 | F303 | STEVAL-ESC001V1 | Electronic speed controller |
| F3 | F303 | STEVAL-IHM042V2 | Dual Drive only |
| G4 | G431 | B-G431B-ESC1 | G4 ESC board |
| F0 | F0251 | EVSPIN32F0251S1 | STSPIN32F0251 1-shunt |
| F0 | F0601 | EVSPIN32F0601S1 | STSPIN32F0601 1-shunt |
| F0 | F0601 | EVSPIN32F0601S3 | STSPIN32F0601 3-shunt |
| F0 | F0602 | EVSPIN32F0602S1 | STSPIN32F0602 3-shunt |
| F3 | F303 | STEVAL-HKI001V2 | STGAP1AS |

## AND MORE TO STAY TUNED

STM32 and STM8 Motor Control Ecosystem web page available at: https://www.st.com/content/st_com/en/stm32-motor-control-ecosystem.html

STM32 Motor Control Wiki available at: https://wiki.st.com/stm32mcu/wiki/Motor_control_overview

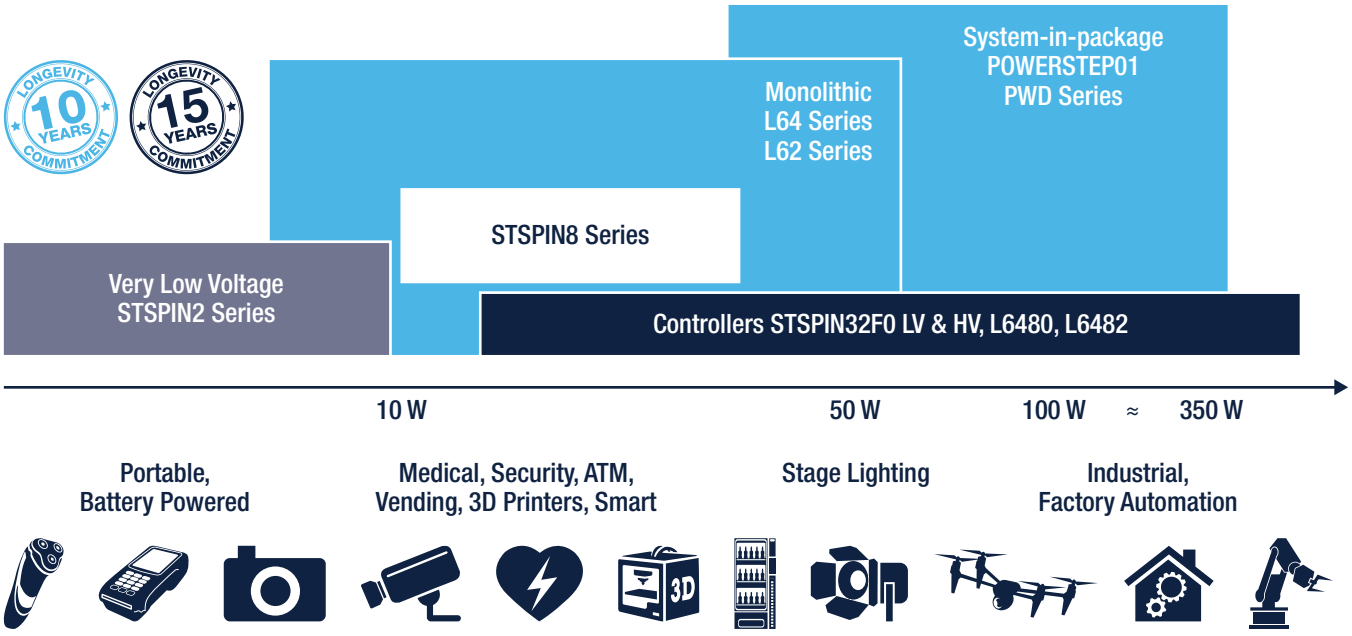
STM32 Motor Control Forum available at: **https://community.st.com/s/topic/0TO0X000000BoYJWA0/stm32-motor-control**

# Motor Driver ICs

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 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.



## L62 SERIES


The **L62** series includes a broad range of motor drivers which can drive any type of motor and fit a very wide range of applications. Designed for small and medium sized motors, they feature scalable offer of power stages. L6208 and L6228 are designed to drive stepper motors thanks to the embedded stepping sequence generator. L6205/06/07 and L6225/26/27 are general purpose brushed DC motor drivers having scalable power architecture and programmable overcurrent protection. L6229, L6230, L6234 and L6235 are ideal for both sensored and sensorless driving of 3-phase BLDC motors, also thanks to the embedded PWM current control and hall sensors decoding logic.

L62 Series offers around 30 devices allowing to select the right one from a wide range of packages and to meet all kinds of soldering and thermal needs.

L62X8
Stepper

L6229/L623X
3phase BLDC

L62X5/6/7
Dual/Single DC

| Part number | Desription | Vin min (V) | Vin max (V) | Rdson (Ohm) | I out max (Arms) |
|---|---|---|---|---|---|
| L6205 | Dmos Dual Full Bridge driver | 8 | 52 | 0.3 (0.15*) | 2.8 (5.6*) |
| L6206 / Q | | | | | |
| L6207 / Q | | | | | |
| L6208 / Q | Bipolar stepper motor | | | | |
| L6235 | 3-phase brushless DC motor driver | | | | |
| L6234 | | 7 | | | |
| L6225 | Dmos Dual Full Bridge driver | 8 | 52 | 0.7 (0.35*) | 1.4 (2.8*) |
| L6226 / Q | | | | | |
| L6227 / Q | | | | | |
| L6228 / Q | Bipolar stepper motor | | | | |
| L6229 | 3-phase brushless DC motor driver | | | | |
| L6230 | | | | | |

Note: * Features allowed in parallel mode driving for L62x5/6

### MAIN APPLICATIONS

- Stage lighting
- Vending and textile machines
- ATM and money handling machines
- Medical equipment
- Factory automation end-points
- Small home appliances
- Antenna control

## STSPIN2 SERIES


**STSPIN2** series is a perfect fit for portable 2 Li-Po cells powered solutions, offering a complete set of ICs able to drive brushed DC, stepper or three-phase BLDC motors. Thanks to the extremely compact package (QFN 3x3) and the lowest standby current available on the market (max 80 nA), STSPIN2 series represents the best performance-cost trade-off.

Devices are equipped with control logic and fully protected power stage. **STSPIN220** embeds advanced microstepping circuitry able to control a stepper motor with a high resolution of up to 256 µsteps, while **STSPIN230/3** are field oriented control compliant allowing an easy implementation of 1 or 2or 3 shunts topologies.

STSPIN220
Stepper

STSPIN230/233
3phase BLDC

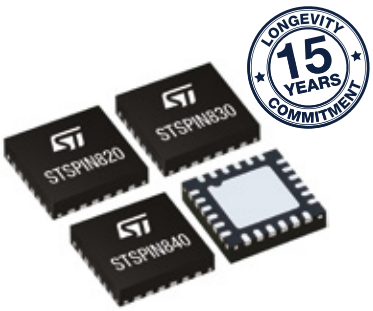
STSPIN240/250
Dual DC

| Part number | Desription | Vin min (V) | Vin max (V) | Rdson (Ohm) | I out max (Arms) |
|---|---|---|---|---|---|
| STSPIN220 | Microstepping driver up to 256 microsteps | 1.8 | 10 | 0.2 | 1.3 |
| STSPIN230/3 | 3-phase BLDC driver | | | | |
| STSPIN240 | Dual DC motor driver | | | | |
| STSPIN250 | Single DC motor driver | | | 0.1 | 2.6 |

### MAIN APPLICATIONS

- Portable health care
- e-valves, meters and e-lockers
- POS or label printers
- IoT and Gimbals
- Educational robots

## STSPIN8 SERIES




**STSPIN8** series represents an extension of STSPIN2 series, able to operate at a higher supply voltage. It consists of 3 fully integrated motor drivers packaged in a 4x4mm QFN package, integrating both the control logic and a fully protected low RDSon power stage making them a bullet proof solution for the new wave of demanding industrial applications. **STSPIN820** allows you to control stepper motors with a high resolution of up to 256 µsteps, **STSPIN830** is field oriented control compliant and enables 3 shunt resistors implementation while **STSPIN840** can be used in parallel mode in order to drive a brushed DC motor at a higher equivalent current.

STSPIN820
Stepper

STSPIN830
3phase BLDC

STSPIN840
Dual DC

| Part number | Desription | Vin min (V) | Vin max (V) | Rdson (Ohm) | I out max (Arms) |
|---|---|---|---|---|---|
| **STSPIN820** | Microstepping driver up to 256 microsteps | 7 | 45 | 0.5 | 1.5 |
| **STSPIN830** | 3-phase 3-shunts BLDC motor driver | | | | |
| **STSPIN840** | Dual brushed DC motor driver | | | 0.5 (0.25*) | 1.5 (3*) |

Note * Features allowed in parallel mode driving

### MAIN APPLICATIONS

- Stage lighting and antenna control
- 3D printers
- Vending and textile machines
- ATM and money handling machines
- Factory automation end-points
- Medical and healthcare equipment
- Video surveillance and dome cameras

## STSPIN32F0 SERIES


**STSPIN32F0** series is a family of self-supplied Systems-In-Package integrating a Cortex-M0™ microcontroller and an advanced 3-phase gate driver. The embedded MCU gives the freedom to configure the device with the motion control algorithm which best fits the end application targets. ST offers a set of the customers can choose among a set of pre-defined FW algorithms, spanning from more classical 6-step to the advanced sensorless field oriented control.

Internal 3.3 V DC/DC buck converter and 12 V LDO linear regulator supply the MCU, external components and gate drivers. Operational amplifiers are available and they can be used for signal conditioning of analog Hall-effect sensors or shunt resistor signals. Programmable threshold over current protection is guaranteed by the embedded comparator.

For Smart Industry and High-End Consumer


- Highly integrated system-in-package 7x7 mm
- Complete ST ecosystem comprising tools and SWs including motor-control algorithms

| Part number | Desription | Vin min (V) | Vin max (V) |
|---|---|---|---|
| **STSPIN32F0** | Advanced BLDC controller with embedded STM32 MCU | 8 | 45 |
| **STSPIN32F0A** | | 6.7 | 45 |
| **STPIN32F0B** | | 6.7 | 45 |

### MAIN APPLICATIONS

- Power tools
- Fans
- Vacuum cleaners, other HA
- Industrial automation and control
- Robotic arms
- Drones (gimbal and ESC control)

## STSPIN32F0 HV SERIES

**STSPIN32F0 HV** family extends the flexibility and all the features of STM32-based motor controllers to high voltage applications. Four pin-to-pin Systems-in-Package integrating an STM32 Cortex-M0 MCU and high-voltage 3-phase gate drivers, with embedded smartShutDown™. Advanced and fully protected 3-phase BLDC controllers are available for applications running up to 250 V and 600 V, at respectively two different gate currents of 0.35 A and 1 A. Thanks to the motor controllers' high scalability in home appliances and industrial applications, designers can easily design and reuse their current hardware and firmware in all applications fitting main voltage supplies (110 VAC & 220 VAC), without having to change PCB.

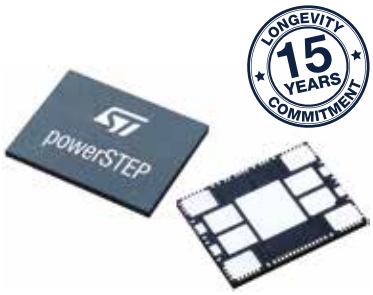
| Part number | Desription | Vin min (V) | Vin max (V) | Vout max (V) |
|---|---|---|---|---|
| **STSPIN32F0251** | 250 V 3-phase driver with STM32 | 9 | 20 | 250 |
| **STSPIN32F0252** | | | | |
| **STSPIN32F0601** | 600 V 3-phase driver with STM32 | 9 | 20 | 600 |
| **STSPIN32F0602** | | | | |

## POWERSTEP01

The **POWERSTEP01** is a highly configurable high current stepper motor driver able to operate up to 85 V. It integrates an advanced microstepping controller and 8 power MOSFETs, featuring a 16 mΩ $R_{DS(ON)}$.

Thanks to proprietary and patented technologies, the device can be configured to drive the motors in voltage or in current mode. The voltage mode allows to obtain very smooth and silent motion performance, while the current driving guarantees the full control of the motor current. Many other advanced features are available such as the full customization of the motion profile (acceleration, deceleration, speed, etc.), positioning calculations, sensorless stall detection, real-time diagnostics and user-configurable failure protections.

A very rich set of protections make the POWERSTEP01 bullet proof, as required by the most demanding motor control applications.




| Part number | Desription | Vin min (V) | Vin max (V) | Rdson (Ohm) | I out max (Arms) |
|---|---|---|---|---|---|
| **powerSTEP01** | System-in-package integrating microstepping controller and 10 A power MOSFETs | 7.5 | 85 | 0.016 | 10 |

### MAIN APPLICATIONS

- Textile Machines
- Sewing Machines
- Robot Welders
- Industrial label printers
- Industrial dozers and mixer

## L64 SERIES


The **L64** series includes ST's most advanced microstepping motor drivers and controllers. Both **L6470** and **L6480** feature advanced voltage control mode thus obtaining very smooth and silent motion and reaching high positioning precision (up to 128usteps). **L6472** and **L6482** instead drive the motors through an advanced current control algorithm with self-adapting decay and guaranteeing the target current is always supplied to the motor, with no loss of steps or control.

Many other advanced features are available such as the full customization of the motion profile (acceleration, deceleration, speed, etc.), positioning calculations, sensorless stall detection, real-time diagnostics and user-configurable failure protections.

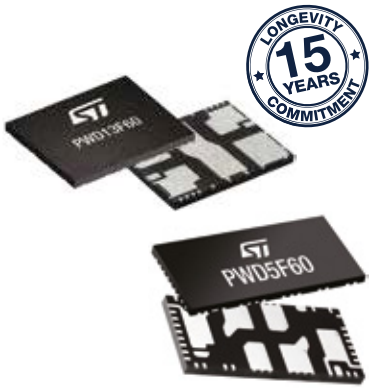
The **L648x** controllers allow higher voltage and current through external power MOSFETs.

| Part number | Product | Desription | Vin min (V) | Vin max (V) | Rdson (Ohm) | I out max (Arms) |
|---|---|---|---|---|---|---|
| Motor Drivers | L6470 | Voltage mode driving algorithm (1/128 µstep) | 8 | 45 | 0.3 | 3 |
| | L6472 | Predictive current control Adaptive decay (1/16 µstep) | | | | |
| | L6474 | Adaptive decay(1/16 µstep) | | | | |
| Controllers | L6480 | Voltage mode driving algorithm (1/128 µstep) | 8 | 85 | not applicable | |
| | L6482 | Predictive current control Adaptive decay (1/16 µstep) | | | | |

### MAIN APPLICATIONS

- ATM and money handling machines
- Medical equipment
- Video conferencing
- Antenna control
- Pick and place machines
- Home and factory appliances

## PWD SERIES – POWER DRIVERS




**PWD Series** are advanced power systems-in-package integrating smart gate drivers and four N-channel power MOSFETs in dual half-bridge configuration. These full-bridge power drivers represent a uniquely efficient alternative for brushed DC or single-phase BLDC motors.

The actual offer is related to two 600V rated devices, capable of delivering 3.5 A and 8 A of continuous current per MOSFET, respectively. Embedded gate drivers integrate bootstrap diodes allowing BOM space and cost saving. Both devices are offered in highly thermally efficient tiny QFN packages.

**PWD5F60** embeds also the peak-current control comparators that, in conjunction with positioning Hall-effect sensors, allow to achieve a stand-alone motor driver for single-phase BLDC motors (no need of a dedicated MCU), and thus significantly reducing the cost of such a driving system.

| Part number | Desription | Vin min (V) | Vin max (V) | Rdson (Ohm) | I out max (Arms) |
|---|---|---|---|---|---|
| PWD13F60 | High-density power driver - high voltage full bridge with integrated gate driver | 6.5 | 17 | 0.32 | 8 |
| PWD5F60 | | 10 | 20 | 1.38 | 3.5 |

### MAIN APPLICATIONS

- Industrial/Home appliances
- Factory automation
- Fans and pumps
- HID, ballasts
- Power supply units
- DC-DC and DC-AC converters
- Cooking hoods and gas heaters
- Blowers
- Power supply units

## Stepper motor drivers

| Part number | Package | General description | $R_{DS(on)}$ (Ω) | Supply voltage (V) | | Output Current-Max (A) RMS | Operating temperature | |
|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Max. | | Min. (°C) | Max. (°C) |
| **powerSTEP01** | VFQFPN 11x14x1 | System-in-package integrating microstepping controller and 10 A power MOSFETs | 0.016 | 7.5 | 85 | 10 | -40 | 150 |
| **STSPIN220** | VFQFPN 16 3x3x1.0 | Low Voltage Motor driver with up to 256 microsteps and embedded PWM current control | 0.2 | 1.8 | 10 | 1.3 | | |
| **L6474** | HTSSOP28; PowerSO 36 | Motor driver up to 16 microsteps with SPI and advanced current control | 0.3 | 8 | 45 | 3 | | |
| **L6472** | HTSSOP28; PowerSO 36 | Full features motor driver up to 128 microsteps with SPI, motion engine and advanced current control | | | | | | |
| **L6470** | | | | | | | | |
| **L6208** | PowerSO 36, SO24 | Stepper motor driver with embedded current control | | | 52 | 2.8 | | |
| **L6208Q** | VFQFPN 48 7x7x1.0 | | | | | | | |
| **STSPIN820** | TFQFPN 4x4x1.05 - 24L | Compact advanced 256 microsteps motor driver with step-clock and direction interface | 0.5 | 7 | 45 | 1.5 | | |
| **L6258** | PowerSO36 | PWM controlled high current DMOS universal motor driver | 0.6 | 12 | 40* | 1.5* | -40* | |
| **L6228** | PowerSO 36, SO24 | Stepper motor driver with embedded current control | 0.7 | 8 | 52 | 1.4 | -40 | |
| **L6228Q** | VFQFPN 32 5x5x1.0 | | | | | | | |
| **L6219** | SO24 | Stepper motor driver | - | 4.5* | 46* | 0.75* | -40* | 125* |
| **L6482** | HTSSOP38 | Stepper controller with SPI, motion engine, gate drivers and advanced current control featuring 128 microsteps | - | 7.5 | 85 | - | -40 | 150 |
| **L6480** | | | - | | | - | | |
| **L297** | PDIP 20; SO-20 | Stepper motor controller | - | 4.75 | 7 | - | | |

Note * The value may vary depending on the part number

## Brushed DC motor drivers

| Part number | Package | General description | $R_{DS(on)}$ (Ω) | Supply voltage (V) | | Output Current-Max (A) RMS | Output Current-Max (A) peak | Operating temperature | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Max. | | | Min. (°C) | Max. (°C) |
| **PWD5F60** | VFQFPN 15x7x1 mm. | High voltage full bridge with integrated comparators | 1.4 | 10 | 600 | 5 | 14 | -40 | 125 |
| **PWD13F60** | VFQFPN 10x13x1.0 | High voltage full bridge with integrated smart driver | 0.3 | 6.5 | 600 | 8 | 32 | | |
| **STSPIN240** | VFQFPN 16 3x3x1.0 | Low voltage dual brushed DC motor driver | 0.2 | 1.8 | 10 | 1.3 | 2 | -40 | 150 |
| **STSPIN250** | | Low voltage brushed DC motor driver | 0.1 | 1.8 | 10 | 2.6 | 4 | | |
| **L6205** | PDIP20; PowerSO-20; SO20 | Versatile DMOS dual full bridge motor drivers with embedded PWM current control | 0.3 | 8 | 52 | 2.8 | 7.1 | | |
| **L6206** | PowerSO 36; SO24 | | | | | | | | |
| **L6206Q** | VFQFPN 48 7x7x1.0 | | | | | | | | |
| **L6207** | PowerSO 36; SO24 | | | | | | | | |
| **L6207Q** | VFQFPN 48 7x7x1.0 | | | | | | | | |
| **STSPIN840** | TFQFPN 4x4x1.05 - 24L | Compact dual brushed DC motor driver with embedded PWM current control | 0.5 | 7 | 45 | 1.5 | 2.5 | | |
| **L6225** | PDIP20; PowerSO-20; SO20 | Versatile DMOS dual full bridge motor drivers with embedded PWM current control | 0.7 | 8 | 52 | 1.4 | 3.55 | | |
| **L6226** | PowerSO 36; SO24 | | | | | | | | |
| **L6226Q** | VFQFPN 32 5x5x1.0 | | | | | | | | |
| **L6227** | PowerSO 36; SO24 | | | | | | | | |
| **L6227Q** | VFQFPN 32 5x5x1.0 | | | | | | | | |
| **L6201** | PowerSO-20; SO-20 | DMOS full bridge motor driver | 0.3 | 12 | 48 | 1 | 5 | | |
| **L6202** | PDIP 18 | | | | | | 10 | | |
| **L6203** | MW 11L | | | | | | | | |
| **L2293Q** | VFQFPN 32 5x5x1.0 | Push-pull four channels motor driver with diodes | - | 4.5 | 36 | 0.6 | 1.2 | | |
| **L293D** | PDIP 16; SO-20 | | | | | | | | |
| **L293B** | PDIP 16 | | | | | 1 | 2 | | |
| **L293E** | PDIP 20 | | | | | | | | |
| **L298** | MW 15L; PowerSO-20 | Dual full bridge motor driver | | | | 2 | - | | |

## 3-phase Brushless DC motor drivers

| Part number | Package | General description | $R_{DS(on)}$ (Ω) | Supply voltage (V) | | Output Current-Max (A) RMS | Output Current-Max (A) peak | Operating temperature | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min. | Max. | | | Min. (°C) | Max. (°C) |
| **STSPIN32F0** | VFQFPN 48 7x7x1 | Advanced BLDC controller with embedded STM32, DC-DC; optimized for FOC | - | 8 | 45 | - | 0.6 | -40 | 125 |
| **STSPIN32F0A** | VFQFPN 48 7x7x1 | Advanced BLDC controller with embedded STM32, DC-DC, extended V Range and optimized for 6-step control | - | 6.7 | 45 | - | 0.6 | | |
| **STSPIN32F0B** | VFQFPN 48 7x7x1 | Advanced BLDC with embedded STM32, DC-DC, extended V Range and extra GPIOs | - | 6.7 | 45 | - | 0.35 | | |
| **STSPIN32F0251** | TQFP 64 10x10x1 | 250 V Advanced BLDC with embedded STM32 | - | 9 | 20 | - | 0.35 | | |
| **STSPIN32F0252** | TQFP 64 10x10x1 | 250 V Advanced BLDC with embedded STM32 and extra current capability, DCDC, extended V Range and extra GPIOs | - | 9 | 20 | - | 1 | | |
| **STSPIN32F0601** | TQFP 64 10x10x1 | 600 V Advanced BLDC with embedded STM32 | - | 9 | 20 | - | 0.35 | | |
| **STSPIN32F0602** | TQFP 64 10x10x1 | 600 V Advanced BLDC with embedded STM32 and extra current capability | - | 9 | 20 | - | -1 | | |
| **STSPIN830** | TFQFPN 4x4x1 - 24L | Compact 3-phase integrated motor driver optimized for 3 shunts configuration | 0.5 | 7 | 45 | 1.5 | 2.5 | -40 | 150 |
| **STSPIN230** | VFQFPN 16 3x3x1 | Low voltage 3-phase integrated motor driver | 0.2 | 1.8 | 10 | 1.3 | 2 | | |
| **STSPIN233** | VFQFPN 16 3x3x1 | Low voltage 3-phase integrated motor driver optimized for 3 shunts control | 0.2 | 1.8 | 10 | 1.3 | 2 | | |
| **L6229** | PowerSO 36; SO-24 | 3-phase 6-step integrated motor drivers with embedded Hall sensors decoding logic | 0.7 | 8 | 52 | 1.4 | 3.55 | | |
| **L6229Q** | VFQFPN 32 5x5x1 | | 0.7 | 8 | 52 | 1.4 | 3.55 | | |
| **L6235** | PowerSO 36; SO-24 | | 0.3 | 8 | 52 | 2.8 | 7.1 | | |
| **L6235Q** | VFQFPN 48 7x7x1 | | 0.3 | 8 | 52 | 2.5 | 7.1 | | |
| **L6230** | PowerSO 36; VFQFPN 32 5x5x1 | Triple half-bridge integrated motor drivers | 0.7 | 8 | 52 | 1.4 | 3.55 | | |
| **L6234** | PDIP 20; PowerSO-20 | | 0.3 | 7 | 52 | 2.8 | 5 | | |

## STSPIN PACKAGE OPTIONS EXAMPLES

QFN 11x14

VFQFPN 10x13

QFN 7x7 48L

QFN 3x3

POWERSO36

HTSSOP38

Dip20

SO24

## A COMPLETE ECOSYSTEM IS PROVIDED TO SUPPORT DESIGN-IN AND SHORTEN TIME-TO-MARKET

Designing motor control applications becomes much easier with the outstanding performance, features and full support of STSPIN motor driver ICs that make brushed DC, stepper and brushless motor control designs more efficient in a variety of applications.

A wide range of evaluation boards is provided, together with low-cost plug-and-play discovery kits: an ideal development tool for both beginners and experienced users that is autonomous and can be used with a software interface or with a custom firmware thanks to the embedded microcontroller.

Schematics, BOMs and gerber files are available to give you a headstart with your hardware design together with comprehensive technical documentation.

Software suites are also provided to enable quick and easy development of motor driving solutions.

In addition, STSPIN motor drivers can be easily evaluated in combination with an STM32 32-bit microcontroller in an open, flexible and affordable development environment to enable fast prototyping that can quickly be transformed into final designs.

The comprehensive development environment includes:

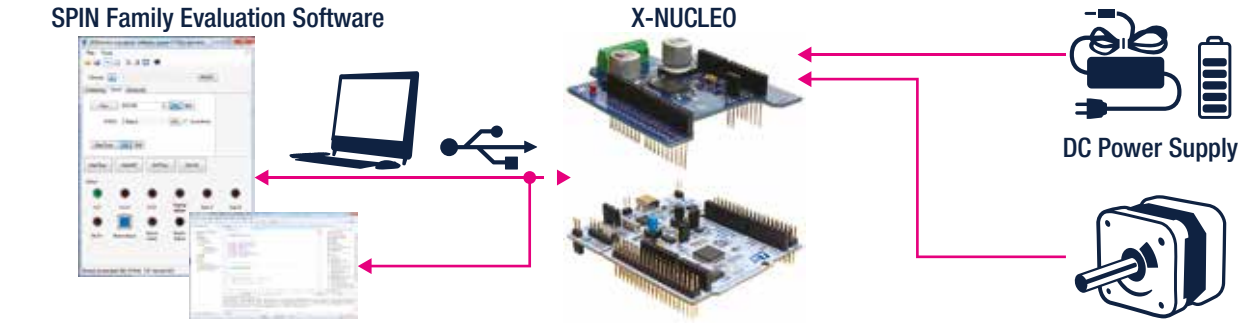
STM32 Nucleo development boards: a comprehensive range of affordable development boards for all STM32 microcontroller series.

STM32 Nucleo expansion boards: based on STSPIN motor drivers, the expansion boards can be plugged on top of the STM32 Nucleo development boards. More complex functionalities can be achieved by stacking additional expansion boards.

The expansion boards are equipped with standardized interconnections such as an Arduino Uno R3 connector or a morpho connector for a higher level of connectivity.

Each expansion board is supported by STM32-based software modules.

## SPEED-UP YOUR DESIGN WITH X-NUCLEO!

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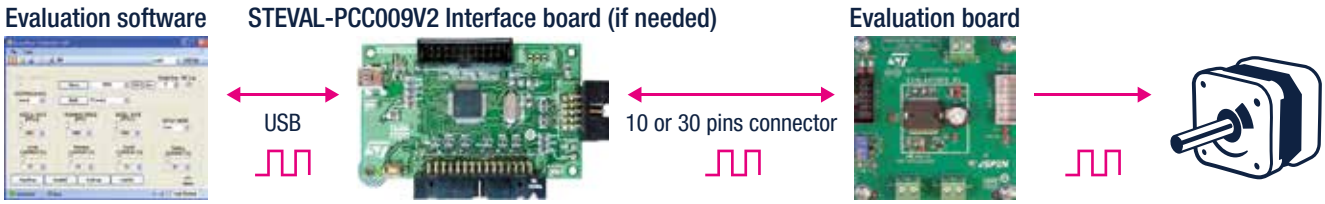
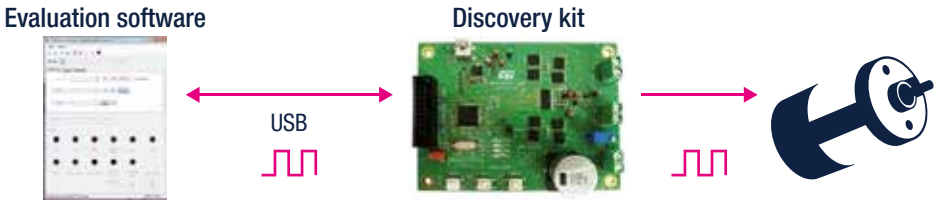
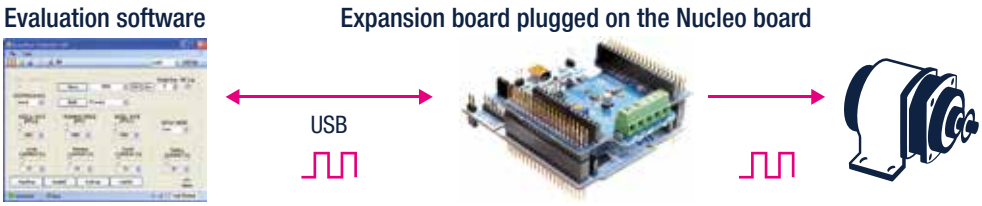
## EVALUATION BOARD SETUP



## DISCOVERY KIT SETUP




## NUCLEO BOARD SETUP




## Ecosystem for stepper motor drivers and controllers

| Part number | Tool type | Core product | Evaluation software | Firmware | Companion board |
|---|---|---|---|---|---|
| **X-NUCLEO-IHM14A1** | Expansion board for STM32 nucleo board | STSPIN820 | - | X-CUBE-SPN14 | STM32 Nucleo board F4, F0 or L0 series |
| **X-NUCLEO-IHM06A1** | Expansion board for STM32 nucleo board | STSPIN220 | STSW-SPIN002 | X-CUBE-SPN6 | STM32 Nucleo board F4, F0 or L0 series |
| **EVLPOWERSTEP01** | Evaluation board | POWERSTEP01 | STSW-SPIN002 | X-CUBE-SPN3 | STEVAL-PCC009V2 interface board |
| **X-NUCLEO-IHM03A1** | Expansion board for STM32 nucleo board | POWERSTEP01 | STSW-SPIN002 | X-CUBE-SPN3 | STM32 Nucleo board F4, F0 or L0 series |
| **EVAL6482H-DISC** | Discovery kit | L6482 | STSW-SPIN002 | STSW-SPIN005, STSW-SPINDISC01 | - |
| **EVAL6482H** | Evaluation board | L6482 | STSW-SPIN002 | STSW-SPIN005 | STEVAL-PCC009V2 interface board |
| **EVAL6480H-DISC** | Discovery kit | L6480 | STSW-SPIN002 | STSW-SPIN005, STSW-SPINDISC01 | - |
| **EVAL6480H** | Evaluation board | L6480 | STSW-SPIN002 | STSW-SPIN005 | STEVAL-PCC009V2 interface board |
| **STEVAL-3DP001V1** | Reference design | L6474 | STSW-3DP001 | - | - |
| **EVAL6474H** | Evaluation board | L6474 | STSW-SPIN002 | X-CUBE-SPN1 | STEVAL-PCC009V2 interface board |
| **EVAL6474PD** | Evaluation board | L6474 | STSW-SPIN002 | X-CUBE-SPN1 | STEVAL-PCC009V2 interface board |
| **X-NUCLEO-IHM01A1** | Expansion board for STM32 nucleo board | L6474 | STSW-SPIN002 | X-CUBE-SPN1 | STM32 Nucleo board F4, F0 or L0 series |
| **EVAL6472H-DISC** | Discovery kit | L6472 | STSW-SPIN002 | STSW-SPIN004, STSW-SPINDISC01 | - |
| **EVAL6472H** | Evaluation board | L6472 | STSW-SPIN002 | STSW-SPIN004 | STEVAL-PCC009V2 interface board |
| **EVAL6472PD** | Evaluation board | L6472 | STSW-SPIN002 | STSW-SPIN004 | STEVAL-PCC009V2 interface board |
| **EVAL6470H-DISC** | Discovery kit | L6470 | STSW-SPIN002 | STSW-SPIN004, STSW-SPINDISC01 | - |
| **EVAL6470H** | Evaluation board | L6470 | STSW-SPIN002 | STSW-SPIN004 | STEVAL-PCC009V2 interface board |
| **EVAL6470PD** | Evaluation board | L6470 | STSW-SPIN002 | STSW-SPIN004 | STEVAL-PCC009V2 interface board |
| **X-NUCLEO-IHM02A1** | Expansion board for STM32 nucleo board | L6470 | - | X-CUBE-SPN2 | STM32 Nucleo board F4, F0 or L0 series |
| **STEVAL-IKM001V1** | Evaluation kit EVAL6470H and STEVAL-PCC009V2 | L6470 | STSW-IKM001V1S | STSW-IKM001V1 | - |
| **X-NUCLEO-IHM05A1** | Expansion board for STM32 nucleo board | L6208 | STSW-SPIN002 | STSW-SPIN005 | STM32 Nucleo board F4, F0 or L0 series |
| **EVAL6208Q** | Evaluation board | L6208Q | STSW-SPIN003 | - | STEVAL-PCC009V2 interface board |
| **EVAL6228QR** | Evaluation board | L6228Q | - | - | - |
| **EVALSP820-XS** | Evaluation board | STSPIN820 | - | - | - |
| **STSPIN220 Click Board** | 3rd party expansion board | STSPIN220 | - | - | - |
| **STSPIN820 Click Board** | 3rd party expansion board | STSPIN820 | - | - | - |

## Ecosystem for brushed DC motor drivers and controllers

| Part number | Tool type | Core product | Evaluation software | Firmware | Companion board |
|---|---|---|---|---|---|
| **X-NUCLEO-IHM12A1** | Expansion board for STM32 nucleo board | STSPIN240 | STSW-SPIN002 | X-CUBE-SPN12 | STM32 Nucleo board F4, F0 or L0 series |
| **X-NUCLEO-IHM13A1** | Expansion board for STM32 nucleo board | STSPIN250 | STSW-SPIN002 | X-CUBE-SPN13 | STM32 Nucleo board F4, F0 or L0 series |
| **X-NUCLEO-IHM15A1** | Expansion board for STM32 nucleo board | STSPIN840 | - | X-CUBE-SPN14 | STM32 Nucleo board F4, F0 or L0 series |
| **EVALPWD5F60** | Evaluation Board | PWD5F60 | - | - | - |
| **EVALPWD13F60** | Evaluation board | PWD13F60 | - | - | - |
| **EVAL6227QR** | Evaluation board | L6227Q | - | - | - |
| **EVAL6227PD** | Evaluation board | L6227 | - | - | - |
| **EVAL6225PD** | Evaluation board | L6225 | - | - | - |
| **EVAL6207Q** | Evaluation board | L6207Q | STSW-SPIN003 | - | STEVAL-PCC009V2 interface board |
| **X-NUCLEO-IHM04A1** | Expansion board for STM32 nucleo board | L6206 | STSW-SPIN002 | X-CUBE-SPN4 | STM32 Nucleo board F4, F0 or L0 series |
| **EVAL6206Q** | Evaluation board | L6206Q | STSW-SPIN003 | - | STEVAL-PCC009V2 interface board |
| **EVAL6205N** | Evaluation board | L6205 | - | - | - |
| **EVAL2293Q** | Evaluation Board | L2293Q | - | - | - |
| **STSPIN250 Click Board** | 3rd party expansion board | STSPIN250 | - | - | - |

## Ecosystem for brushless DC motor drivers and controllers

| Part number | Tool type | Core product | Evaluation software | Firmware | Companion board |
|---|---|---|---|---|---|
| **STEVAL-SPIN3201** | Evaluation board | STSPIN32F0 | - | STSW-SPIN3201 | - |
| **X-NUCLEO-IHM11M1** | Expansion board for STM32 nucleo board | STSPIN230 | - | X-CUBE-SPN11 | STM32 Nucleo board F4, F0 or L0 series |
| **STEVAL-SPIN3202** | Evaluation Board | STSPIN32F0A | STSW-SPIN3202 | - | NUCLEO-F030R8, NUCLEO-F103RB, NUCLEO-F302R8 |
| **X-NUCLEO-IHM16M1** | Expansion board for STM32 nucleo board | STSPIN830 | - | X-CUBE-SPIN16 | - |
| **X-NUCLEO-IHM17M1** | Expansion board for STM32 nucleo board | STSPIN233 | - | X-CUBE-SPIN17 | NUCLEO-F030R8, NUCLEO-F103RB, NUCLEO-F302R8 |
| **P-NUCLEO-IHM001** | Nucleo Pack with NUCLEO-F302R8 and X-NUCLEO-IHM07M1 | L6230 | - | X-CUBE-SPN7, STSW-STM32100 | - |
| **X-NUCLEO-IHM07M1** | Expansion board for STM32 nucleo board | L6230 | - | X-CUBE-SPN7, STSW-STM32100 | STM32 Nucleo board F4, F0 or L0 series |
| **STEVAL-IHM042V1** | Evaluation board | L6230 | - | STSW-STM32100 | - |
| **STEVAL-IHM043V1** | Evaluation board | L6234 | - | STSW-STM32100 | - |
| **EVAL6230QR** | Evaluation board | L6230 | - | - | - |
| **EVAL6235Q** | Evaluation board | L6235Q | STSW-SPIN003 | - | STEVAL-PCC009V2 |
| **EVAL6229PD** | Evaluation board | L6229 | - | - | - |

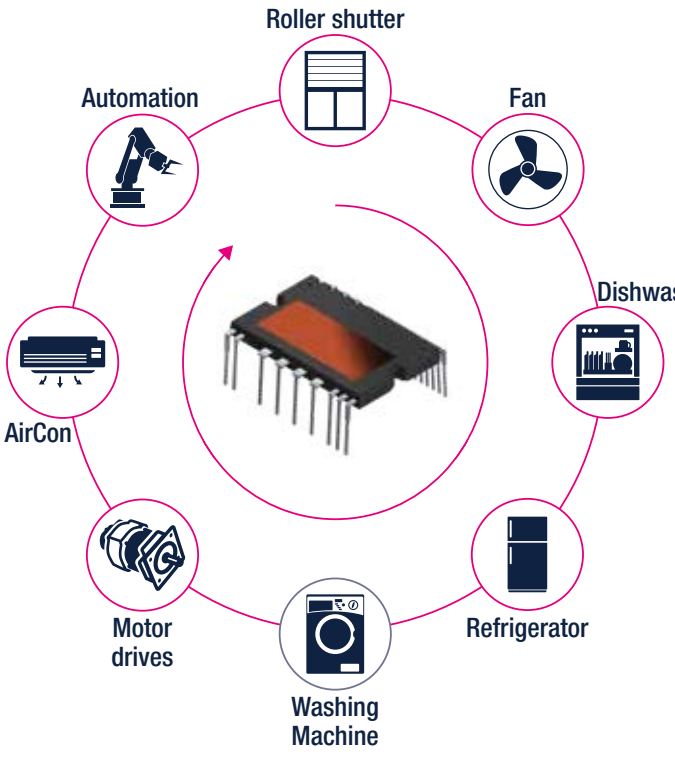
## Ecosystem for reference design

| Part number | Tool type | Description | Core product | Firmware |
|---|---|---|---|---|
| **STEVAL-ESC002V1** | Evaluation kit | Electronic Speed Controller reference design based on STSPIN32F0A | STSPIN32F0A | STSW-ESC002V1 |
| **STEVAL-GMBL02V1** | Evaluation kit | Reference design kit for Gimbal controller for drones and handheld applications | STSPIN233 | STSW-GMBL02V1 |

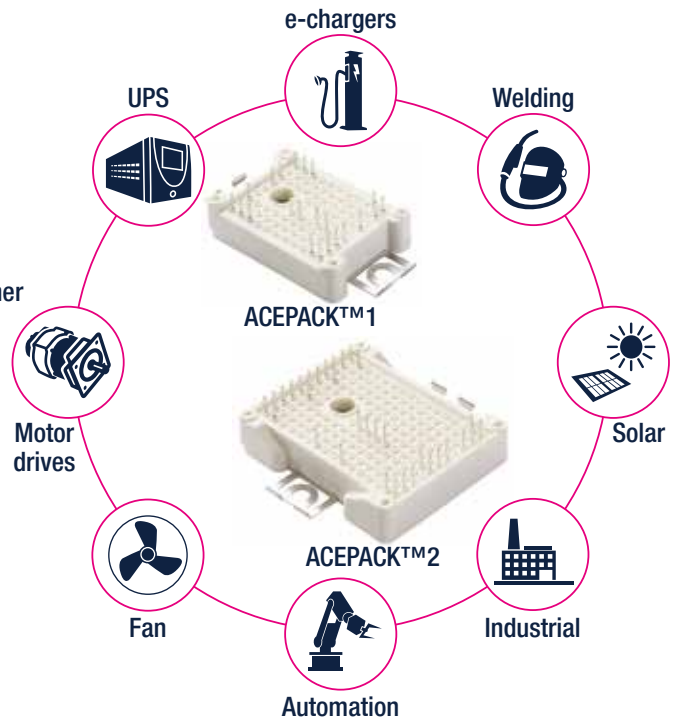
# Power Modules

Reduce your design time and efforts with ST's portfolio of highly-integrated, high-efficiency power modules for flexible and robust designs ranging from tens of watts up to 30 kW. Available in a wide selection of current capability, break down voltage and space-saving packages, you are sure to find a device in our Power Module product portfolio that addresses your motor or motion control system requirements.
ST's power module portfolio includes both SLLIMM™ families of Intelligent Power Modules (IPM) as well as ACEPACK™ Power Modules for all types of power switching applications.

**SLLIMM**
**Intelligent Power Modules**




**ACEPACK**
**Power Modules**



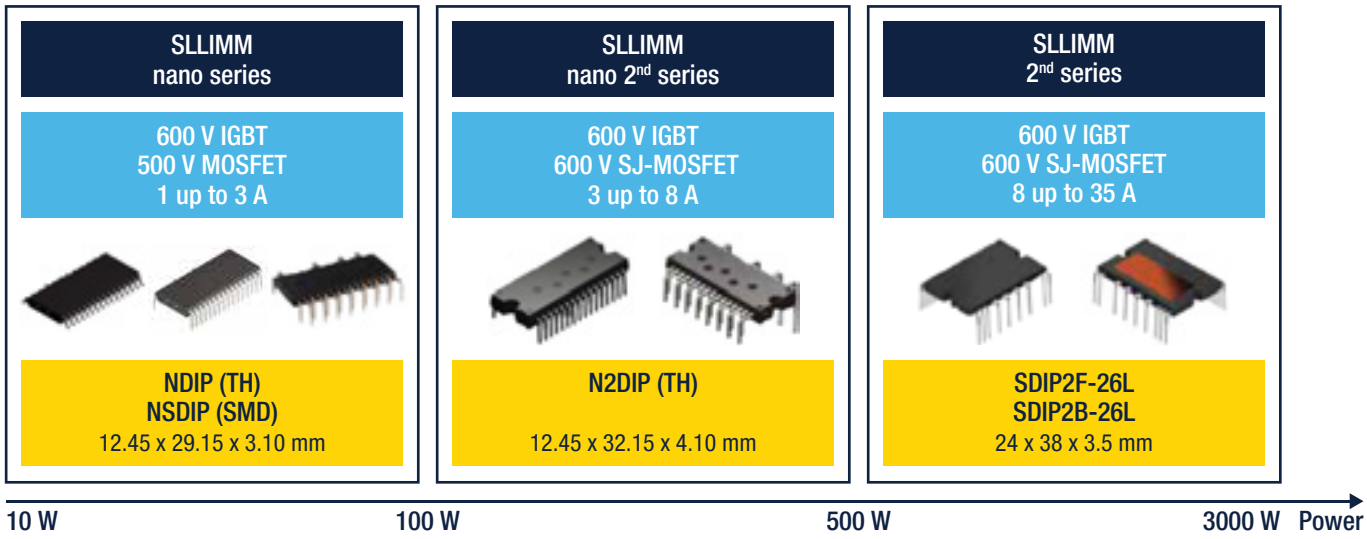
## SLLIMM™ INTELLIGENT POWER MODULES

Nowadays, the market requires high performance solutions able to satisfy the increasing energy saving requirements, compactness, reliability, and system costs in home appliances and in low power industrial applications.

To address these market needs, STMicroelectronics has developed the SLLIMM (small low-loss intelligent molded module) families of compact, high efficiency, dual-in-line Intelligent Power Modules, with optional extra features.

It provides a high integrated level that means simplified circuit design, reduced BOM, smaller weight, and high reliability.

Available in different options, both packages (fully molded and DBC) and leads (through-hole and SMD), SLLIMM series can combine six power switches (IGBT, MOSFET and SJ-MOSFET) and drivers in an inverter configuration assuring the best compromise between conduction and switching energy with an outstanding robustness and EMI behavior, making the new product ideal to enhance the efficiency of 3 phases inverter and any motor drives working up to from the field: 25 kHZ for MOSFET technology in hard-switching circuitries and for an application power range from 10 W to 3 KW.

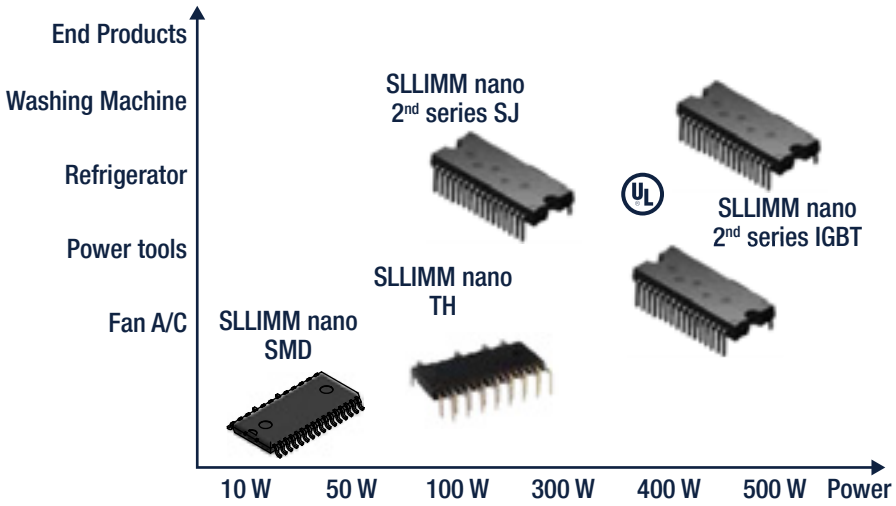



## SLLIMM™ NANO SERIES

Combining six switches driven by three high-voltage gate drivers in a compact DIP package, the ST's nano IPM family has been designed to cover different motor control applications from very low to medium power range.

The fully isolated SLLIMM-nano package is the ideal solution to satisfy the customer request to reduce assembly PCB/system space, without sacrificing thermal performance and reliability.

ST offers three package solutions: SLLIMM-nano SMD (Surface Mounting Device), SLLIMM-nano and SLLIMM–nano 2nd series TH (Through hole).




### KEY FEATURES

- Optimized voltage drop in conduction
- IGBT (planar, TFS) and MOSFET (planar, SJ) based
- 600 V and 500 V breakdown voltage
- Current availability up to 8 A at 25 °C
- Comparator for fault protection
- OpAmp for advanced current sensing
- Open emitter configuration for individual phase current sensing
- Internal bootstrap diodes
- Interlocking function and UVLO
- Mounted slots package options
- In line and zig-zag leads options (w/wo stand-off)

| Product PN | Lead type | Switch type | BV | $I_{CN}$ | Vcesat typ/Max $R_{DS(on)}$ | $t_{dead}$ min |
|---|---|---|---|---|---|---|
| STGIPN3H60(A)(T)-(H) | TH | IGBT | 600 V | 3 A | 2.15 V | 1.5 µs |
| STGIPN3HD60-H | | | | 3 A | 2.15 V | 1 µs |
| STIPN2M50T-H/L | | MOSFET | 500 V | 2 A | 1.7 Ω | 1 µs |
| STIPN1M50T-H | | | | 1 A | 3.6 Ω | 1 µs |
| STGIPNS3H60T-H | SMD | IGBT | 600 V | 3 A | 2.15 V | 1.5 µs |
| STGIPNS3HD60-H | | | | 3 A | 2.15 V | 1 µs |
| STIPNS2M50(T)-H | | MOSFET | 500 V | 2 A | 1.7 Ω | 1 µs |
| STIPNS1M50T-H | | | | 1 A | 3.6 Ω | 1 µs |
| STIPNS1M50SDT-H | | | | | | |
| STGIPQ3H60T-HZ/L(S) | TH | IGBT | 600 V | 3 A | 2.15 V | 1.5 µs |
| STGIPQ3HD60-HZ/L | | | | 3 A | 2.15 V | 1.0 µs |
| STGIPQ5C60T-HZ/L(S) | | | | 5 A | 1.65 V | 1.5 µs |
| STGIPQ8C60T-HZ | | | | 8 A | 2.0 V | 1.0 µs |
| STIPQ3M60T-HZ/L | | SJ-MOSFET | | 3 A | 1.6 Ω | 1.0 µs |
| STIPQ5M60T-HZ/L | | | | 5 A | 1.0 Ω | 1.0 µs |

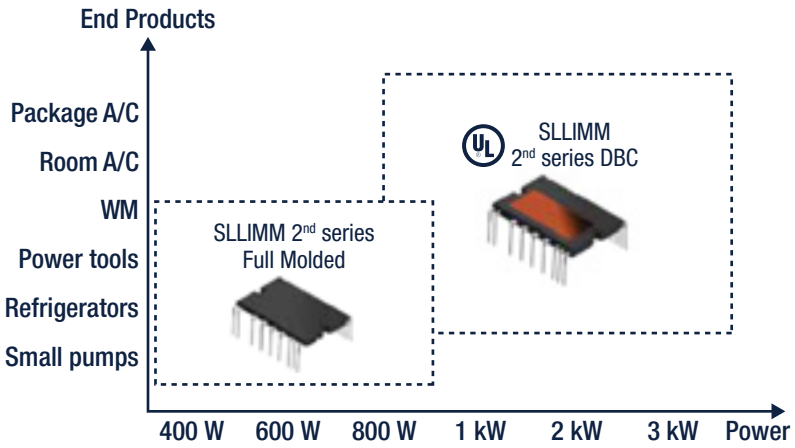
## SLLIMM™ 2ND SERIES

The SLLIMM 2nd series is the last ST's family of compact, high efficiency, dual-in-line intelligent power modules, with optional extra features.

This family has been designed using a new internal configuration with two drivers, one high-side driver and one low-side driver, and with the improved trench gate field-stop IGBT or SJ-MOSFETs.

The best compromise between conduction and switching energy with an outstanding robustness and EMI behavior make the new product ideal to enhance the efficiency of compressor, pumps, fans and any motor drives working up to 20 kHz in hard-switching circuitries and for an application power range from 300 W to 3 KW.

This series will complement and overcome the already available SLLIMM series in term of power and features, package' types and flexibility and it takes over the main functions of previous one, adding some more features and enlarging the technology package option.




### KEY FEATURES

- 600 V, from 8 A to 35 A DC rating at 25 °C
- Low $V_{CEsat}/R_{DSon}$
- Optimize driver and silicon for low EMI
- Lowest Rth value on the market for the DBC package versions
- Internal bootstrap diode
- Maximum operating junction temperature
  - 175 °C for IGBT based
  - 150 °C for SJ MOSFET based
- Separate open emitter outputs;
- NTC on board
- Integrated temperature sensor on Low side driver
- Comparator for fault protection
- Shutdown input/fault output
- Isolation rating of 1500 Vrms/min

| Part Number | Switch technology | $I_c$ @ 25 °C (@ 80 °C) | $V_{ce(sat)}/R_{DSon\ (typ)}$ @ $I_c$ 25 °C (@ $I_c$ 80 °C) | Max $R_{th(j-c)}$ | $t_{scw}$ |
|---|---|---|---|---|---|
| STGIF5CH60TS-L(E)(X) | IGBT | 8 A (5 A) | 1.7 V (1.5 V) | 5.0 °C/W | 5 µs |
| STGIF7CH60TS-L(E)(X) | | 10 A (7 A) | | 4.80 °C/W | |
| STGIF10CH60TS-L(E) | | 15 A (10 A) | | 4.60 °C/W | |
| STGIB8CH60TS-L(E) | | 12 A (8 A) | 1.7 V (1.5 V) | 3.0 °C/W | 5 µs |
| STGIB10CH60TS-L(E)(X) | | 15 A (10 A) | | 2.26 °C/W | |
| STGIB15CH60TS-L(E)(X) | | 20 A (15 A) | | 1.85 °C/W | |
| STGIB20M60TS-L(E) | | 25A (20 A) | | 1.40 °C/W | 8 µs |
| STGIB30M60TS-L(E) | | 35 A (30 A) | | 1.20 °C/W | |
| STIB1060DM2T-L | SJ-MOSFET | 10 | 180 mΩ | 1.59 °C/W | 12 µs |
| STIB1560DM2T-L | | 15 | 150 mΩ | 1.10 °C/W | 12 µs |

Note F = Full Molded package B = DBC package T = NTC on board S = Temperature sensing E = Short leads and emitter forward L = Long leads X = Medium leads

## ACEPACK™

The latest ST power module family offers new ACEPACK 1 and ACEPACK 2 Power Modules on Sixpack and Converter Inverter Brake (CIB) topologies.

With an embedded NTC thermistor, these highly reliable power modules offer the best compromise between conduction and switching loss, maximizing the efficiency of any converter system up to 20 kHz in hard-switching circuitries for an application range from 3 to 30 kW.

Offering PressFIT and solder pin options for flexible and stable mounting, these robust power modules, which are part of ST's M series Trench Gate Field- Stop IGBTs, ensure a compact design and cost-effective system.

The flexibility and characteristics of ACEPACK packages bring additional power and design features to ensure the best possible solution for your applications.

### KEY FEATURES

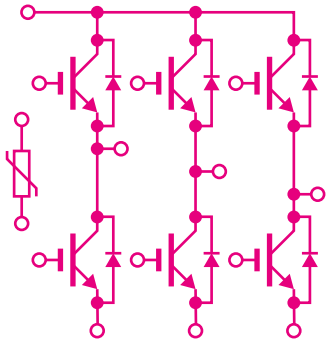
- 15 to 75 A current rating at 25 °C
- 650 to 1200 V Breakdown voltage
- Integrated 5 kΩ NTC temperature monitoring
- Soft and fast recovery diode
- PressFIT and solder contact pin options
- Reliable and easy mounting system
- Low stray inductance module design

### KEY BENEFITS

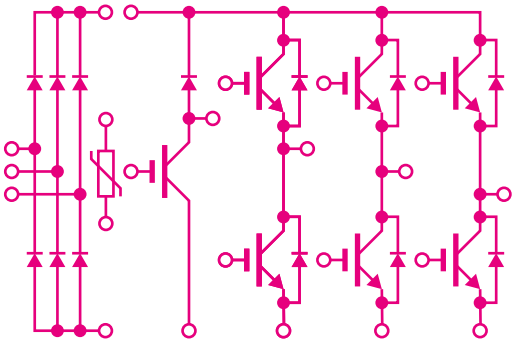
- High power density
- High reliability and quality
- 175 °C maximum junction temperature for increased robustness

ACEPACK™1

ACEPACK™2



Six-Pack + NTC



CIB + NTC

| Product PN | Package | Topology | $BV_{CES}$ | $I_C$ rating | Max isolation voltage |
|---|---|---|---|---|---|
| A1P25S12M3/-F | A1 | Six-Pack | 1200 V | 25 A | 2500 Vrms/min |
| A1P35S12M3/-F | | | | 35 A | |
| A1C15S12M3/-F | | CIB | 1200 V | 15 A | |
| A1P50S65M2/-F | | Six-Pack | 650 V | 50 A | |
| A1P18M65W2-1* | | Six-Pack | 1200 V | $R_{DS(on)}$ = 18 mOhm | |
| A1P25M12W2-1* | | Six-Pack | 650 V | $R_{DS(on)}$ = 25 mOhm | |
| A2C25S12M3/-F | A2 | CIB | 1200 V | 25 A | |
| A2C35S12M3/-F | | | | 35 A | |
| A2P75S12M3/-F | | Six-Pack | 1200 V | 75 A | |
| A2C50S65M2/-F | | CIB | 650 V | 50 A | |

Note Blank = Solder pin  F = Press Fit  * Samples available in Q4 2020

## Evaluation Tools

| Reference/bundle | Voltage | Power | Motor type/ control type * | ST parts | Application focus |
|---|---|---|---|---|---|
| STEVAL-HKI001V1 | 50 - 650 $V_{DC}$ | Up to 35 $A_{RMS}$ to the motor | PMSM<br>FOC<br>3-shunt | • 1x A2C35S12M3-F<br>• 7x STGAP1AS<br>• 1x STM32F303RBT7 | Power board: pumps, Motion/Servo Control, Industrial motor drives and more |
| STEVAL-AP1PF50M[1] | 125 - 400 $V_{DC}$ | Up to 10 kW | | • A1P50S65M2<br>• STGAP2S<br>• STGWA50M65DF2 | HVAC, pumps, industrial drives |

Note: 1. Available in Q3

# ST PowerStudio - THE DYNAMIC ELECTRO-THERMAL SIMULATION SOFTWARE FOR POWER DEVICES

ST PowerStudio is a powerful and flexible simulation software for SLLIMM™ intelligent power modules and ACEPACK™ power modules.

The tool features a one-click comprehensive power and thermal analysis, avoiding long, complex and expensive application testing.

It provides a very accurate estimation of power loss, junction and case temperatures, and even explores non-testable parameters and helps in sizing a suitable heatsink.

Finally, the software helps developers select the proper device fitting the application mission profile, saving design time and resources.

ST PowerStudio (STSW-POWERSTUDIO) is based on a very precise built-in electrical and thermal model for each device and thanks to an iterative calculation taking into account the self-heating effects, it provides a very accurate estimation of the power loss as well as junction and case temperatures.

The software simulates mission profiles with a static load (single set of input conditions) or a dynamic load, changing the input conditions over time

and performing very long simulation profiles.

Several thermal set-up input conditions can be simulated, such as:

- devices without heatsink, estimating the case and the junction temperatures;
- fixed case temperature (with heatsink), estimating the junction temperature and the heatsink;
- fixed heatsink thermal resistance, estimating the case and junction temperatures;
- fixed heatsink thermal impedance, estimating the case and junction temperatures and considering the thermal inertia of the system.

Simulation results are shown on tables and on dedicated scope views, in function of time, load current and switching frequency.

An output report is provided with the summary of all the information and results for an easy comparison or archiving.

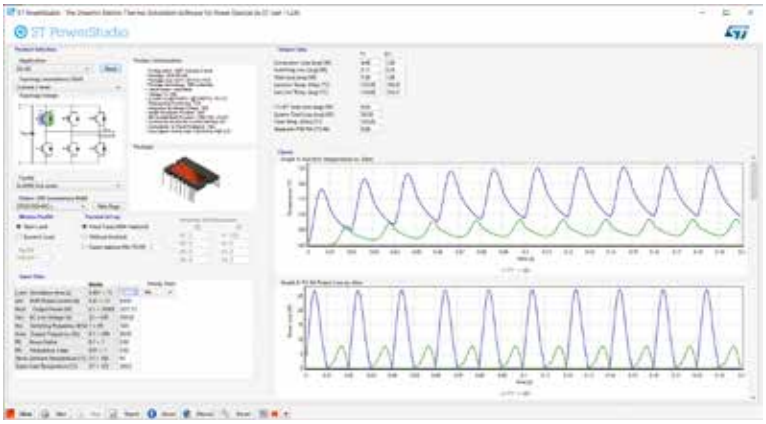
## KEY FEATURES

- Comprehensive power and thermal analysis
- User-friendly interface
- Static and dynamic mission profile
- Multi thermal set-up
- Simulation with or without heatsink
- Internal self-heating model
- Output data, tables and charts, for each power device
- Quick link to the device documentation
- Output PDF report
- Online forum
- Portable software
- Multi-language (English, Chinese and Japanese)

## KEY BENEFITS

- Selection of proper device fitting the application mission profile
- Easier, faster and cheaper solution design
- Deep analysis of power loss and device temperatures
- Exploration of non-testable parameters
- Very accurate temperature-dependent output results
- Complex and long mission profile simulation
- Heatsink size estimation
- Internet connection not required for simulation

## USER INTERFACE



# Power MOSFETs

**ST's power MOSFET portfolio offers a broad range of breakdown voltages from -100 V to 1700 V, with low gate charge and low on-resistance, combined with state-of-the art packaging. ST's process technology for both high-voltage power MOSFETs (MDmesh™) and low-voltage power MOSFETs (STripFET) has enhanced power handling capability, resulting in high-efficiency solutions.**

## LOW VOLTAGE MOSFETs- STripFET F7 MOSFETs

ST's new STripFET F7 MOSFETs deliver among the best on resistance currently available at 40 V, 60 V, 80 V and 100 V devices to minimize conduction losses, coupled with minimal capacitances and gate charge. STripFET F7 shows furthermore Optimized intrinsic capacitances ratio (Crss/Ciss) to minimize EMI effects, high current capability and extremely low thermal resistance to improve power dissipation

The resulting devices help to simplify final designs and reduce equipment size and cost by allowing system power and efficiency targets to be met using fewer devices in small package sizes.

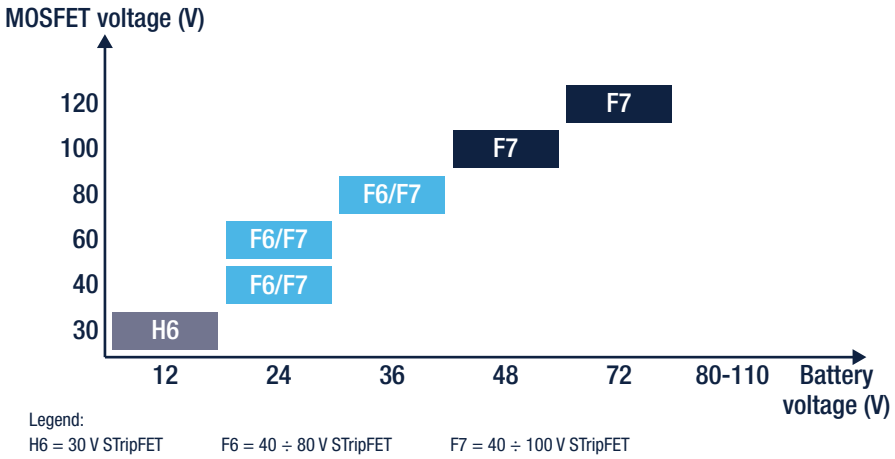
The F7 product offer is complemented with the cost effective H/F6 series, available in both, N and P-Channel polarity.

| VDSS | Part number | Marketing status | Package | $R_{DS(on)}$ (@VGS = 10 V) max (Ω) | Qg typ (nC) |
|---|---|---|---|---|---|
| 100 | STX310N10F7 | Active | TO-220/H²PAK-2/H²PAK-6 | 0.0023 | 180 |
| | STX150N10F7 | Active | TO-220/TO-220FP/H²PAK-2/I²PAK | 0.0039 | 117 |
| | STL110N10F7 | Active | PowerFLAT™ 5x6 | 0.006 | 72 |
| | STX100N10F7 | Active | TO220/D²PAK/DPAK/TO-220FP | 0.008 | 61 |
| | STL90N10F7 | Active | PowerFLAT™ 5x6 | 0.008 | 45 |
| | STX80N10F7 | Active | DPAK/TO-220FP | 0.0095 | 45 |
| | STL8N10F7 | Active | PowerFLAT™ 3.3x3.3 | 0.02 | 25 |
| 80 | STX270N8F7 | Active | TO-220/H²PAK-2/H²PAK-6 | 0.021 | 193 |
| | STX170N8F7 | Active | TO-220/H²PAK-2 | 0.0037 | 120 |
| | STX140N8F7 | Active | TO-220/TO-220FP/H²PAK-2 | 0.004 | 96 |
| | STL130N8F7 | Active | PowerFLAT™ 5x6 | 0.0036 | 96 |
| 60 | STL220N6F7 | Active | PowerFLAT™ 5x6 | 0.0014 | 100 |
| | STP220N6F7 | Active | TO-220 | 0.0023 | 100 |
| | STL140N6F7 | Active | PowerFLAT™ 5x6 | 0.0028 | 55 |
| | STX140N6F7 | Active | TO-220/H²PAK | 0.0032 | 55 |
| | STL130N6F7 | Active | PowerFLAT™ 5x6 | 0.0035 | 42 |
| | STX130N6F7 | Active | TO-220/D²PAK/DPAK | 0.005 | 42 |

| VDSS | Part number | Marketing status | Package | $R_{DS(on)}$ max @ 10 V | Qg (nC) 4.5 V |
|---|---|---|---|---|---|
| -60 V | STx10P6F6 | Active | TO-220/DPAK | 0.16 | 6.4* |
| 40 | STL260N4LF7 | Active | PowerFLAT 5x6 | 0.0011 | 53 |
| | STL260N4F7 | Active | PowerFLAT 5x6 | 0.0011 | 67* |
| | STH320N4F6-6 | Active | H²PAK | 0.0013 | 240* |
| | STP260N4F7 | Active | TO-220 | 0.0022 | 67* |
| | STL160N4F7 | Active | PowerFLAT 5x6 | 0.0025 | 29* |

Note * value @ 10 V

## STripFET POSITIONING VS VOLTAGE BATTERY IN MC




Legend:
H6 = 30 V STripFET F6 = 40 ÷ 80 V STripFET F7 = 40 ÷ 100 V STripFET

### TECHNOLOGY FEATURES

- Best in class ON-resistance
- High current capability
- Extremely low thermal resistance
- High quality & reliability
- Wide packaging options

### BENEFITS

- High efficiency and system miniaturization
- Lower battery consumption
- Reliable system operation

## High Voltage MOSFETs

| $BV_{DSS}$ (V) | Max $R_{DS}$ (Ω) | Max $I_D$ (A) | Qg (nC) | Trr (typ) (ns) | Sales Type | Main application | Packages | Eng. Samples | Production |
|---|---|---|---|---|---|---|---|---|---|
| 600 | 1.55 | 3.5 | 9 | 70 | STx5N60DM2 | Motor Control | D1 dice sales/DPAK | Available | Production |
| | 1.1 | 5 | 9 | 73 | STx6N60DM2 | Motor Control | DPAK/TO-220/IPAK | Available | Production |
| | 0.9 | 6 | 10 | 75 | STx7N60DM2 | Motor Control | DPAK/TO-220/IPAK | Available | Production |
| | 0.600 | 8 | 13.5 | 80 | STx8N60DM2 | SMPS, HID, Motor Control | TO-220FP/DPAK | Available | Production |
| | 0.338/0.372 | 12/8.5 | 15.3 | 85 | STx15N60DM6 | SMPS, Motor Control | DPAK/ PowerFLAT 5x6 HV | Available | Production |

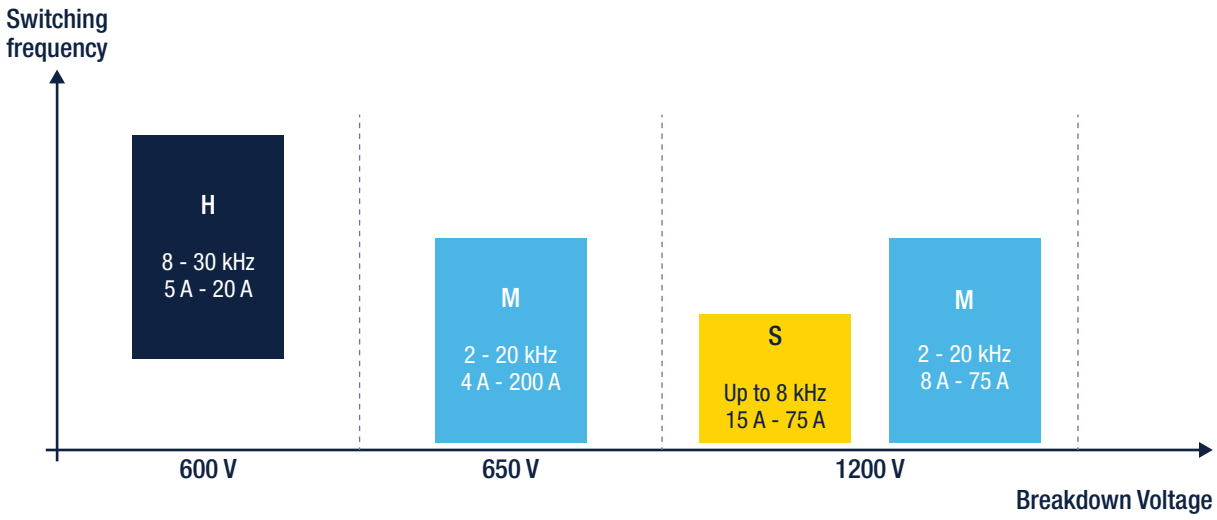
# IGBT

The ST offers a very wide portfolio of IGBTs, tailored to motor control application, developed using an advanced proprietary trench-gate field stop structure, with voltage classes of 600 V, 650 V and 1200 V available both in bare die and discrete packages as well as IPMs and power modules.

Some of the highlights of our IGBT portfolio are as follows:

- Low $V_{CE(SAT)}$ for reduced conduction power losses
- Improved switch-off energy spread versus increasing temperature resulting in enhanced efficiency
- Tight parameter distribution for design simplification and easy paralleling
- Co-packaged anti-parallel diode specifically designed for improved EMC compatibility

Reported below the IGBTs series to motor control, which are: “H”, “M” and “S” series.
These series combine a very low saturation voltage with a maximum operating junction temperature of 175 °C and the short circuit capability.



# 600-650 V IGBT series

## 600 V H SERIES

The 600 V “H” series, with current capability going from 5 A up to 20 A and short-circuit rated, represents an optimum compromise between conduction and switching power losses to maximize the efficiency of medium to high switching frequency inverters.

| | | | | | | Packages | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| IGBT P/N | $BV_{CES}$ (V) | $I_{CN}$ [1] (A) | $V_{CE(sat)}$ [2] (V) | $t_{sc}$ [3] (µs) | Switching frequency range | DPAK | D²PAK | TO-220 | TO-220FP | TO-247 | TO-3P |
| STG*5H60DF | 600 | 5 | 1.5 | 3 | 8 - 30 kHz | D | B | P | F | | |
| STG*7H60DF | | 7 | 1.5 | | | | B | P | F | | |
| STG*10H60DF | | 10 | 1.5 | | | | B | P | F | | |
| STG*15H60DF | | 15 | 1.6 | | | | B | P | F | | |
| STG*20H60DF | | 20 | 1.6 | | | | B | P | F | W | WT |

Note 1) $I_{CN}$: IGBT nominal collector current @ $T_C$ = 100 °C
2) $V_{CE(sat)}$: typical conduction losses @ $I_{CN}$, $T_C$ = 25 °C
3) $t_{sc}$: min short circuit withstanding time @ $V_{CC}$ ≤360 V, $V_{GE}$ = 15 V, $T_{jstart}$ =150 °C

## 650 V M SERIES

The 650 V “M” series, with current capability from 4 A to 120 A (available also in die form in 200 A), represent the best GPI technology on the market, optimized in EMI thanks to soft waveforms and thanks to an outstanding short-circuit withstand time of 6 µs, it is an optimum compromise in performance to maximize the efficiency of three phase industrial drive systems where low-loss and short-circuit capability are mandatory.

| | | | | | | Packages | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| IGBT P/N | $BV_{CES}$ (V) | $I_{CN}$ [1] (A) | $V_{CE(sat)}$ [2] (V) | $t_{sc}$ [4] (µs) | Switching frequency range | DPAK | D²PAK | TO-220 | TO-220FP | TO-247 | TO-247 long leads | Max247 long leads |
| STGx4M65DF2 | 650 | 4 | 1.6 | 6 | Up to 20 kHz | D | B | P | F | | | |
| STGx6M65DF2 | | 6 | 1.55 | | | D | B | P | F | | | |
| STGx10M65DF2 | | 10 | 1.55 | | | | B | P | F | W | | |
| STGx15M65DF2 | | 15 | 1.55 | | | | B | P | F | | | |
| STGx20M65DF2 | | 20 | 1.55 | | | | B | P | F | | WA | |
| STGx30M65DF2 | | 30 | 1.55 | | | | B | P | F | W | WA | |
| STGx50M65DF2 | | 50 | 1.65 | | | | | | | | WA | |
| STGx75M65DF2 | | 75 | 1.65 | | | | | | | W | WA | |
| STGx120M65DF2 | | 120 | 1.65 | | | | | | | | | YA |

Note 1) $I_{CN}$: IGBT nominal collector current @ $T_C$ = 100 °C
2) $V_{CE(sat)}$: typical conduction losses @ $I_{CN}$, $T_C$ = 25 °C
4) $t_{sc}$: min short circuit withstanding time @ $V_{CC}$ ≤400 V, $V_{GE}$ = 15 V, $T_{jstart}$ = 150 °C

# 1200 V IGBT series

## 1200 V M SERIES

1200 V “M” series, with current capability from 8 A to 40 A (available in die form also in 35 A and 75 A dice), optimized in EMI and showing a minimum short-circuit withstand time of 10 µs at 150 °C, address the Motor and compressor drives offering the best trade-off performances according to the working operating frequency up to 20 kHz.

| | | | | | | Packages | | |
|---|---|---|---|---|---|---|---|---|
| IGBT P/N | $BV_{CES}$ (V) | $I_{CN}$ [1] (A) | $V_{CE(sat)}$ [2] (V) | $t_{sc}$ [3] (µs) | Switching frequency range | TO-247 | TO-247 long leads | TO-220 |
| **STGx8M120DF3** | 1200 | 8 | 1.85 | 10 | Up to 20 kHz | W | WA | P |
| **STGx15M120DF3** | | 15 | | | | W | WA | |
| **STGx25M120DF3** | | 25 | | | | W | WA | |
| **STGx40M120DF3** | | 40 | | | | W | WA | |

Note 1) $I_{CN}$: : Nominal collector current @ $T_J$ = 100 °C
2) $V_{CE(sat)}$: Typical conduction losses @ $I_{CN}$, $T_J$ = 25 °C
3) $t_{sc}$: min short circuit whitstand time @ $T_{J\text{-start}}$ ≤150 °C, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V

## 1200 V S SERIES

The 1200 V “S” series, with current capability from 15 A up to 40 A (available in die form up to 75 A ) and short-cicuit withstand time of 10 µs, is tailored to get the best trade-off between conduction and switching-off energy losses to improve significantly the overall performance of three phase industrial drive systems at low switching frequency (<8 kHz).

| | | | | | | Packages | | |
|---|---|---|---|---|---|---|---|---|
| IGBT P/N | $BV_{CES}$ (V) | $I_{CN}$ [1] (A) | $V_{CE(sat)}$ [2] (V) | $t_{sc}$ [3] (µs) | Switching frequency range | TO-247 | TO-247 long leads | TO-220 |
| **STGx15S120DF3** | 1200 | 15 | 1.55 | 10 | Up to 8 kHz | W | WA | |
| **STGx25S120DF3** | | 25 | 1.60 | | | W | WA | |
| **STGx40S120DF3** | | 40 | 1.65 | | | W | WA | |

Note 1) $I_{CN}$: : Nominal collector current @ $T_J$ = 100 °C
2) $V_{CE(sat)}$: Typical conduction losses @ $I_{CN}$, $T_J$ = 25 °C
3) $t_{sc}$: min short circuit whitstand time @ $T_{J\text{-start}}$ ≤150 °C, $V_{CC}$ = 600 V, $V_{GE}$ = 15 V

# Diode & Rectifier

ST's ultrafast diodes range from 300 V to 1200 V with various Vf/Trr and Qrr/S factor trade-offs so as to achieve the best performance for any application. The «R» trade-off stands for «Rapid», and are the ones proposed in the below metric.These «R» diodes have been developped to have reduced switching time and associated reverse recovery charges, making them ideal for use in the PFC circuit of the motor control board.

The new «RQ» series, that stands for «Rapid & Quiet», achieve low reverse recovery time, combined with a soft behaviour. This will be particularly appreciated in higher power applications, where switching current are more important,. In that envrionment, a reduction of the noise generated by the commutation of the diode enable to improve the system EMI performances.

All ST products are rated up to 175 °C operating junction temperature, as a result of the reduced leakage currents.

**KEY FEATURES**

- Wide voltage range from 300 V to 1200 V
- Up to 200 A current range
- Low-profile PowerFLAT™ packages
- Different $V_F/T_{rr}$ trade-offs available in different packages
- 175 °C operating junction temperature

| | Part number | $I_{FAV}$ (A) | $V_F$ max (V)/25 °C | Qrr typ (nC)/125 °C | Sfactor Typical | Package |
|---|---|---|---|---|---|---|
| 300 V ultrafast rectifiers | STTH8R03 | 8 | 1.8 | 60 | 0.4 | TO-220AC |
| | STTH8R03DJF | 8 | 1 | 120 | 0.3 | PowerFLAT™ 5 x 6 |
| | STTH30R03 | 30 | 1.4 | 63 | 0.4 | D²PAK, TO-247 |
| 400 V ultrafast rectifiers | STTH8R04 | 8 | 1.5 | 148 | 0.4 | D²PAK, TO-220AC, TO-220AC Ins |
| | STTH20R04 | 20 | 1.7 | 225 | 0.3 | D²PAK, TO-220AC, DO-247, TO-220FPAC |
| | STTH30R04 | 30 | 1.45 | 525 | 0.4 | D²PAK, TO-220AC, DO-247, DOP3 Ins |
| 600 V ultrafast rectifiers | STTH1R06 | 1 | 1.9 | 120 | | DO-41, SMA, SMB |
| | STTH5R06 | 5 | 2.9 | 110 | 0.35 | D²PAK, TO-220AC, DPAK, TO-220FPAC |
| | STTH5R06DJF | 5 | 1.2 | 180 | 0.5 | PowerFLAT™ 5 x 6 |
| | STTH8R06 | 8 | 2.9 | 150 | 0.3 | D²PAK, TO-220AC, TO-220AC Ins, I²PAK, TO-220FPAC |
| | STTH12R06 | 12 | 2.9 | 180 | 0.2 | D²PAK, TO-220AC |
| | STTH15RQ06 | 15 | 2.95 | 250 | 1 | TO-220AC, D²PAK, DO-247, DO-247LL |
| | STTH25M06 | 25 | 1.6 | 250 | 0.5 | TO220FPAC, DPAK |
| | STTH30RQ06 | 30 | 2.95 | 485 | 1 | TO-220AC, D²PAK, DO-247, DO-247LL |
| | STTH30RQ06C | 2 x 30 | 1.45 | 485 | 0.9 | TO-247 LL |
| | STTH60RQ06 | 60 | 2.95 | 660 | 1 | DO-247 |
| 800 V/1000 V/1200 V Ultrafast rectifiers | STTH108A | 1 | 1.65 | | | SMA |
| | STTH208A | 2 | 1.65 | | | SMA |
| | STTH110A | 1 | 1.7 | | | SMA |
| | STTH310S | 3 | 1.7 | | | SMC |
| | STTH810G | 8 | 2 | 1100 | 2 | D²PAK |
| | STTH212 | 2 | 1.75 | 680 | | SMB, SMC |
| | STTH1512G | 15 | 2.1 | 2600 | 1.5 | D²PAK |
| | STTH15S12W | 15 | 3.1 typ | 1300 | 2 | DO-247 |
| | STTH6012W | 60 | 2.05 | 6400 | 1 | DO-247, D²PAK |
| 800 V Bridge | STBR3008-Y | 30 | 1.1 | - | - | DO-247 |
| | STB6008-Y | 60 | 1.1 | - | - | DO-247 |
| 1200 V Bridge | STBR3012 | 30 | 1.3 | - | - | DO-247, D²PAK HV |
| | STBR6012 | 60 | 1.3 | - | - | DO-247 |

# Thyristors (SCRs and Triacs) and AC Switches

ST offers a complete range of thyristors and AC switches with voltage ratings up to 1200 V, current ratings up to 100 A and a set of packages from miniature surface-mounted packages to high power dissipation isolated and non-isolated packages.

To address control motor applications, T-Series Triacs are offering a complete range of current ratings, up to 20 Ampere. The T-Series Snubberless Triac is able to drive high inductive load thanks to its strong turn-off capabilities (dI/dt)c. The H-Series family is featuring a strong thermal performances, fully rated at 150 °C, suitable for high power loads and devices (600 V and new 800 V) in hot environments. ACST™ and ACST AC Switches are overvoltage self-protected devices, improving the application safety and reliability.

High temperature 150 °C SCRs are perfectly fitting requirements to build a solid-state relay for motor starter or for inrush current limitation in AC/DC stage.

## TRIACS

ST's portfolio of Triacs includes devices with voltage ratings up to 800 V and RMS on-currents up to 40 A in general-purpose standard configurations, a new high commutation T series in Snubberless™ technology, and 3-quadrant high-temperature Triacs (H series) for use in harsh environments. They are the reference for universal and induction motor drivers in appliance applications where, due to their ability to manage the stringent inrush conditions when driving inductive loads, they can switch off three times their rating current.

### KEY FEATURES

- Robustness and reliability
- Wide voltage and current ranges
- Extended portfolio:
  - T-Series Snubberless™ Triacs with enhanced switch-off capability, suitable for inductive loads
  - High-temperature H series for high power loads and hot environments

| | Part number | Packages | Current rating ($A_{RMS}$) | Non repetitive surge peak on-state current (A) | Repetitive off-state voltage (V) | Operating Tj max (°C) | $I_{GT}$ (mA) |
|---|---|---|---|---|---|---|---|
| T series | T405T-6FP | T0220FPAB | 4 | 30 | 600 | 125 | 5 |
| | T435T-600FP | | 4 | 30 | 600 | 125 | 35 |
| | T635T-8 | T0220FPAB<br>TO-220AB<br>$D^2PAK$ | 6 | 45 | 800 | 150 | |
| | T835T-8 | | 8 | 60 | 800 | 150 | |
| | T1235T-8 | | 12 | 90 | 800 | 150 | |
| | T1635T-8 | | 16 | 120 | 800 | 150 | |
| | T2035T-8 | $D^2PAK$ | 20 | 160 | 800 | 150 | |

| | Part number | Packages | Current rating ($A_{RMS}$) | Non repetitive surge peak on-state current (A) | $V_{DRM}$ - $V_{RRM}$ (V) | Operating Tj max (°C) | $I_{GT}$ (mA) |
|---|---|---|---|---|---|---|---|
| High-temperature Triacs | T410H | TO-220 | 4 | 40 | 600 | 150 | 10 |
| | T610H | TO-220 | 6 | 60 | | | 10 |
| | T835H-6 | TO-220, $D^2PAK$, TO-220I | 8 | 80 | | | 35 |
| | T1035H-6 | | 10 | 100 | | | |
| | T1235H-6 | | 12 | 120 | | | |
| | T1635H-6 | | 16 | 160 | | | |
| | T2035H-6 | | 20 | 200 | | | |
| | T3035H-6 | TO-220, TO-220I | 30 | 270 | | | |
| | T3035H-8 | T0220, TO-220I, $D^2PAK$ | 30 | 270 | 800 | | |
| | T2035H-8 | | 20 | 200 | | | |
| | T1635H-8 | | 16 | 160 | | | |
| | T1235H-8 | | 12 | 120 | | | |
| | T835H-8 | | 8 | 80 | | | |

## ACS™ AND ACST

Using innovative ASD application-specific device technology, ST's ACS™ and ACST devices are specific switches developed for home appliances and industrial control applications.

While maintaining very high switch-off capability, logic-level devices allow direct drive by a microcontroller. With integrated overvoltage protection against random transients, no external MOV protection is needed, providing system safety and transient and surge voltage immunity as defined in the IEC 61000-4-4 and -4-5 standards. The ACST series now extends from 2 A to 16 A, housed in TO-220AB and TO-220FP packages, and the ACS series is also extended to 800 V with a lower gate triggering sensitivity of 5 mA.

### KEY FEATURES

- High switch off capability
- Low gate current for direct connection to MCU
- Internally protected, no need of external circuitry to meet IEC 61000-4-4 and -4-5 standards

| Part number | Current rating ($A_{RMS}$) | Non repetitive surge peak on-state current (A) | Repetitive off-state voltage (V) | Operating Tj max (°C) | $I_{GATE}$ (mA) | Packages |
|---|---|---|---|---|---|---|
| **ACS108** | 0.8 | 13.7 | 800 | 125 | 10 | SOT223, TO92 |
| **ACS120** | 2 | 20 | 700 | 125 | 10 | DPAK, TO-220AB, TO-220FPAB |
| **ACST2** | 2 | 8 | 800 | 125 | 10 | DPAK, TO-220FPAB |
| **ACST3** | 3 | 20 | | | 10 | TO-220FPAB, DPAK |
| **ACST4** | 4 | 30 | | | 10, 35 | DPAK, TO-220FPAB |
| **ACST8** | 8 | 80 | | | 30 | $D^2$PAK, TO-220AB, TO-220FPAB |
| **ACST1035-8FP** | 10 | 90 | 800 | 150 | 35 | TO-220FPAB |
| **ACST1235-8FP** | 12 | 100 | 800 | 150 | 35 | TO-220FPAB |
| **ACST1635-8FP** | 16 | 140 | 800 | 150 | 35 | TO-220FPAB |

## HIGH TEMPERATURE SCR

High-temperature silicon-controlled rectifiers (SCRs), are designed to improve the reliability of applications such as overvoltage crowbar protection and motor control circuits in power tools and kitchen aids, inrush current-limiters and voltage regulators. Perfectly suited for automotive stationary battery chargers, motorbike voltage regulators and motor drive applications, they help reduce costs by using smaller heatsinks.Their voltage robustness up to 1200 V, high noise immunity and power dissipation performance at 150 °C junction temperature (Tj) are key features for functions such as AC switches, AC phasing inverters, and AC-DC controlled rectifier bridges.

Available in SMD as well as through-hole-isolated and non-isolated packages, ST's high-Tj SCRs feature:

- A very low gate-triggering current (600 V SCRs only)
- A peak off-state voltage (blocking voltage) from 600 V up to 1200 V
- A maximum on-state current from 12 A to 80 A
- A maximum junction temperature of 150 °C

| Part number | $I_{TRMS}$ (A) | $I_{GT}$ (mA) | dV/dt @ 150 °C (V/µs) | tq (µs) | $I_{TSM}$ (A) | TO-220AB | TO-220FPAB | $D^2$PAK | TO-220AB ins | TO-247 | $D^3$PAK |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Industrial High Temperature 600 V SCR** | | | | | | | | | | | |
| **TN1205H-6** | 12 | 2 to 5 | 100 | 65 typ | 120 | • | | • | | | |
| **TN1605H-6** | 16 | 6 | 200 | 70 typ | 140 | • | • | • | • | | |
| **TN1610H-6** | 16 | 10 | 1000 | 70 typ | 140 | • | • | | • | | |
| **TN2010H-6** | 20 | 10 | 400 | 70 typ | 180 | • | • | • | • | | |
| **TN2015H-6** | 20 | 15 | 750 | 70 typ | 180 | • | • | | | | |
| **TN3015H-6** | 30 | 15 | 1000 | 80 typ | 270 | • | | • | • | | |
| **TN4015H-8** | 40 | 15 | 500 | 35 typ | 360 | • | | • | • | | |
| **TN5015H-8** | 50 | 15 | 500 | 50 typ | 450 | • | | • | • | | |
| **Automotive and Industrial High Temperature and High Voltage SCR** | | | | | | | | | | | |
| **TN3050H-12** | 30 | 50 | 1000 | 150 typ | 300 | | | • | | • | |
| **TN5050H-12** | 50/80 | 50 | 1000 | 150 typ | 580 | | | | | • | |
| **TN6050HP-12WY** | 50/80 | 50 | 1000 | 150 typ | 580 | | | | | • | |
| **TM8050H-8** | 80 | 50 | 1000 | 150 max | 600 | | | | | • | • |

• Available

# MOSFET and IGBT Gate Drivers

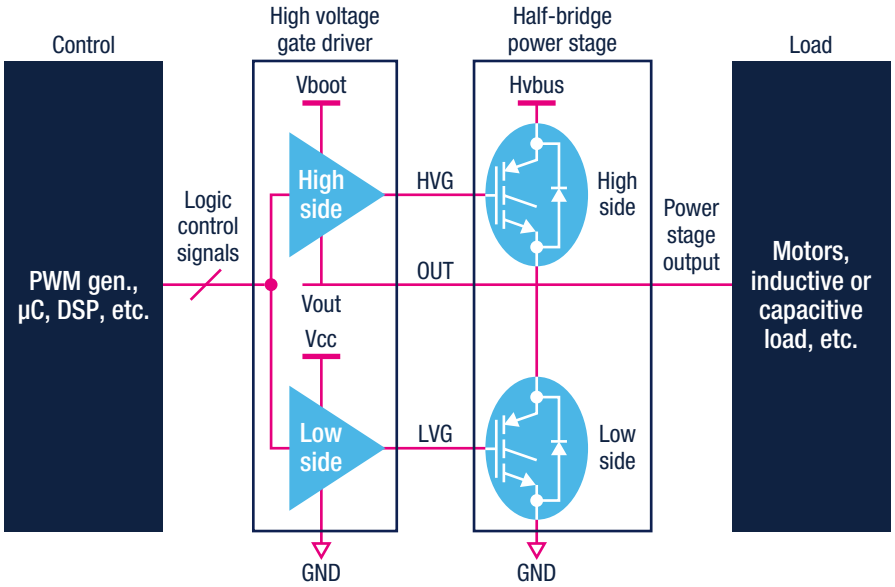
A necessary companion for discrete power MOSFETs and IGBTs as well as digital – microcontrollers, DSPs and FPGAs – or analog controllers in any switched-mode power converter, STDRIVE gate drivers generate the necessary voltage and current level required to accurately and efficiently activate the power stage in industrial, consumer, computer and automotive applications.

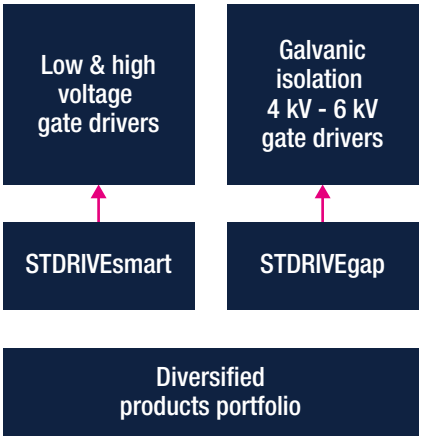
With a range spanning from single- to half-bridge and multiple-channel drivers rated for either low- or high-voltage (up to 1700 V) applications, ST also offers galvanically-isolated gate driver ICs for safety and functional requirements, System-in-Package (SiP) solutions integrating high- and low-side gate drivers and MOSFET-based power stages, responding to the industrial market trend towards higher levels of integration and lower development costs.

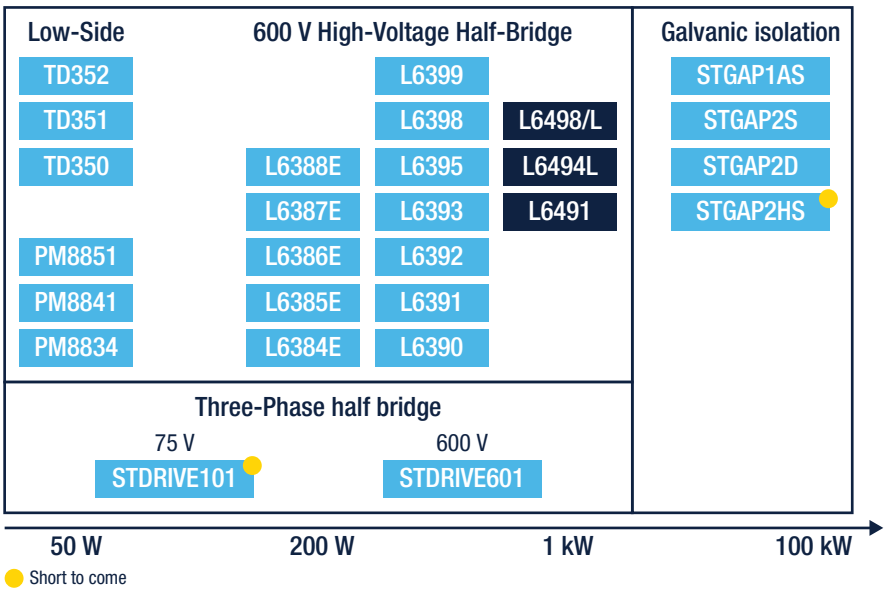
In many cases, there is an STDRIVE perfectly designed to fit your switched-mode power converter or motor driver design.

STDRIVE comes with extensive evaluation hardware and software as well as a technical documentation toolbox to help minimize time-to-market.

The benefit of our 15 years longevity program is available for our STDRIVE Mosfet and IGBT drivers.





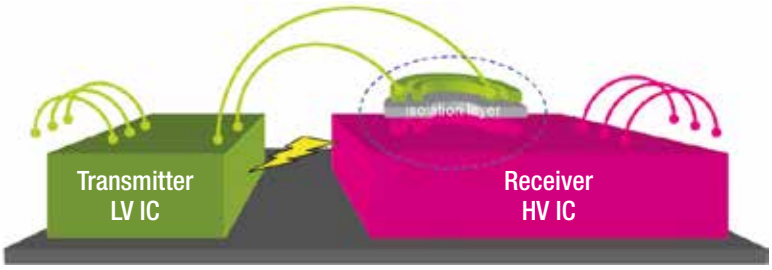

**KEY FEATURES**

- Half-bridge, single-channel and multichannel gate drivers
- State-of-the-art integration thanks to:
  - HV bootstrap diode
  - Op amp
  - Comparator
  - Smart shutdown
  - Undervoltage lock out (UVLO)
  - Interlocking
  - Programmable deadtime

## STGAP

**STGAP1AS** is an IGBT/Mosfet driver with 4 kV galvanic isolation which provides robustness and noise immunity. A thick oxide isolation layer is grown on-chip to build a miniature transformer which is used to transfer signals between input and output.

Protection features are embedded, and high configurability level is possible through the SPI interface.




Package frame

| General description | Supply voltage (VDD) min (V) max (V) | Input configuration | Output current-Max nom (A) | Undervoltage lockout (V) (VH ON) & (VH OFF) nom (V) | Supply voltage (VH) min, max (V) | Negative gate drive ability | Miller Clamp, DESAT detection, SENSE comparator | Pin Count nom () |
|---|---|---|---|---|---|---|---|---|
| **STGAP1AS** | 3 V, 5.5 V | SD, IN+, IN- | 5 | programmable | 4.5, 36 V | yes | yes | 24 |

**STGAP2S and STGAP2D** are drivers which offer a functional galvanic isolation with isolation voltage up to 1.7 kV.

**STGAP2HS** is driver which include a 6 kV galvanic isolation between the gate driving channel and the low voltage control and interface circuitry.

Their 4 A current output capability and rail-to-rail outputs make the devices also suitable for high power inverter applications such as motor drives in industrial applications.

| Part Number | Channel # | Configuration | Voltage max (V) | Output current max (A) | Common-mode transient immunity (V/ns) | Supply voltage c (V) max | TTL/CMOS logic inputs (V) | Propagation delay (ns) | Additional features | Package |
|---|---|---|---|---|---|---|---|---|---|---|
| **STGAP2SCM** | 1 | Miller Clamp | 1700 | 4 | ±100 | 26 | 3.3, 5 | 80 | UVLO and thermal shutdown Adjustable deadtime and HW interlocking function | SO-8 |
| **STGAP2SM** | | Sepatared outputs | | | | | | | | |
| **STGAP2D** | 2 | | | | | | | | | SO-16 |
| **STGAP2HSCM*** | 1 | Miller Clamp | 1200 | 4 | ±100 | 26 | 3.3, 5 | 80 | 6 kV galvanic isolation UVLO and thermal shutdown | SO-8W |
| **STGAP2HSM*** | | Sepatared outputs | | | | | | | | |

Note * Short to come

## STDRIVE THREE-PHASE BRIDGE GATE DRIVERS

ST's three-phase STDRIVE are designed to integrate in a single component all the required gate drivers for three-phase motor applications. That responds to the industrial market trend towards higher levels of integration and lower development costs. High level of integration, moreover, can offer a better matching of critical parameter in power applications, as propagation delays.

| Part Number | Channel # | Voltage max (V) | Output current max (A) | Common-mode transient immunity (V/ns) | Supply voltage c (V) max | TTL/CMOS logic inputs (V) | Propagation delay (ns) | Additional features | Package |
|---|---|---|---|---|---|---|---|---|---|
| **STDRIVE101*** | 6 | 75 | 0.6 | ±50 | 20 | 3.3, 5 | 120 | Two input strategies: HIN, LIN or EN, PWM driving | QFN4x4 24 Leads |
| **STDRIVE601** | | 600 | 0.35 | ±100 | 20 | 3.3, 5 | 80 | UVLO and thermal shutdown and HW interlocking function | SO-28 |

Note * Short to come

## STDRIVE HIGH VOLTAGE HALF-BRIDGE GATE DRIVERS

ST's high-voltage drivers are designed to optimize Field Oriented Control motor drive systems and feature excellent performance at high switching frequency. The smart shutdown function helps to effectively protect the final application.

STDRIVE MOSFET and IGBT gate drivers can integrate a comparator for protection, an operational amplifier for current sensing and an integrated bootstrap diode, thus reducing the number of external components required at system level.

ST's new STDRIVE family of half-bridge MOSFET and IGBT gate drivers is designed to operate in harsh industrial environments withstanding high voltages up to 600 V, while maintaining good noise immunity and low switching losses.

**L6491**, **L6494**, and **L6498** high-voltage half-bridge gate drivers are particularly suited for medium- and high-capacity power switches thanks to their sink/source current capability up to 4 A.

| Part Number | Supply Voltage (V) max | Protection Option Type | Key features | Output Current-Max (A) | Input configuration | Grade | Undervoltage lockout (V) | | | | Operating Temperature (°C) | | EVALBoard | Board description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (On VCC ON) nom | (On VCC OFF) nom | (On VBOOT ON) nom | (On VBOOT OFF) nom | min | max | | |
| **A6387** | 17 | Interlocking function | Bootstrap diode | 0.65 | HIN, LIN | Automotive | 6 | 5.5 | - | - | -40 | 125 | | |
| **L6384E** | 17 | Undervoltage lockout | Adjustable deadtime, Bootstrap diode | 0.65 | SD, Single IN | Industrial | 12 | 10 | - | - | -40 | 125 | EVALSTDRV600HB8 | Demonstration board kit for L638xE and L639x high-voltage gate drivers |
| **L6385E** | 17 | Undervoltage lockout | Bootstrap diode | 0.65 | HIN, LIN | Industrial | 9.6 | 8.3 | 9.5 | 8.2 | -40 | 125 | EVALSTDRV600HB8 | Demonstration board kit for L638xE and L639x high-voltage gate drivers |
| **L6386AD** | 17 | Undervoltage lockout, Comparator | Bootstrap diode | 0.65 | HIN, LIN, SD | Industrial | 9.6 | 8.3 | - | 8.2 | -40 | 125 | | |
| **L6386E** | 17 | Undervoltage lockout, Comparator | Bootstrap diode | 0.65 | HIN, LIN, SD | Industrial | 12 | 10 | 11.9 | 9.9 | -40 | 125 | | |

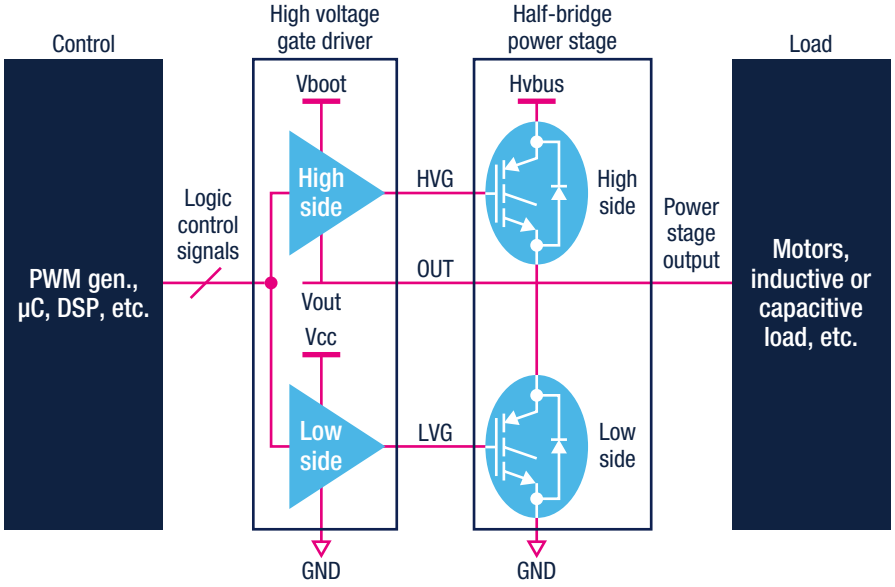
| Part Number | Supply Voltage (V) max | Protection Option Type | Key features | Output Current-Max (A) | Input configuration | Grade | Undervoltage lockout (V) | | | | Operating Temperature (°C) | | EVALBoard | Board description |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | (On VCC ON) nom | (On VCC OFF) nom | (On VBOOT ON) nom | (On VBOOT OFF) nom | min | max | | |
| **L6387E** | 17 | Undervoltage lockout, Interlocking function | Bootstrap diode | 0.65 | HIN, LIN | Industrial | 6 | 5.5 | - | - | -40 | 125 | EVALSTDRV600HB8 | Demonstration board kit for L638xE and L639x high-voltage gate drivers |
| **L6388E** | 17 | Undervoltage lockout, Interlocking function | Adjustable deadtime, Bootstrap diode | 0.65 | HIN, LIN | Industrial | 9.6 | 8.3 | 9.5 | 8.2 | -40 | 125 | EVALSTDRV600HB8 | Demonstration board kit for L638xE and L639x high-voltage gate drivers |
| **L6389E** | 17 | Undervoltage lockout, Interlocking function | Adjustable deadtime, Bootstrap diode | 0.65 | HIN, LIN | Industrial | 9.6 | 8.3 | 9.5 | 8.2 | -40 | 125 | EVALSTDRV600HB9 | Demonstration board kit for L638xE and L639x high-voltage gate drivers |
| **L6390** | 20 | Undervoltage lockout, Interlocking function, Comparator, Smart shutdown | Adjustable deadtime, Bootstrap diode, Operational amplifier | 0.43 | HIN, LIN, SD | Industrial | 12 | 10.5 | 11.5 | 10 | -40 | 125 | | |
| **L6391** | 20 | Undervoltage lockout, Interlocking function, Comparator, Smart shutdown | Adjustable deadtime, Bootstrap diode | 0.43 | HIN, LIN, SD | Industrial | 12 | 10.5 | 11.5 | 10 | -40 | 125 | | |
| **L6392** | 20 | Interlocking function | Adjustable deadtime, Bootstrap diode, Operational amplifier | 0.43 | HIN, LIN, SD | Industrial | 12 | 10.5 | 11.5 | 10 | -40 | 125 | | |
| **L6393** | 20 | Comparator | Adjustable deadtime, Bootstrap diode | 0.43 | SD | Industrial | 9.5 | 8 | 9 | 8 | -40 | 125 | EVAL6393FB | Low voltage full bridge reference design board featuring L6393 advanced high-voltage gate driver |
| **L6395** | 20 | - | Bootstrap diode | 0.43 | HIN, LIN | Industrial | 9.5 | 8.8 | 8.6 | 8 | -40 | 125 | EVALSTDRV600HB8 | Demonstration board kit for L638xE and L639x high-voltage gate drivers |
| **L6398** | 20 | Interlocking function | Bootstrap diode | 0.43 | HIN, LIN | Industrial | 9.5 | 8.8 | 9 | 8 | -40 | 125 | EVALSTDRV600HB8 | Demonstration board kit for L638xE and L639x high-voltage gate drivers |
| **L6399** | 20 | Interlocking function | Bootstrap diode | 0.43 | HIN, LIN | Industrial | 9.5 | 8 | 9 | 9 | -40 | 125 | EVALSTDRV600HB8 | Demonstration board kit for L638xE and L639x high-voltage gate drivers |
| **L6491** | 20 | Interlocking function, Comparator, Smart shutdown | Adjustable deadtime, Bootstrap diode | 4 | HIN, LIN, SD | Industrial | 9.3 | 8.7 | 8.6 | 8 | -40 | 125 | EVAL6491HB | Demonstration board for L6491 gate driver with smart shut down feature |
| **L6494** | 20 | Undervoltage lockout, | Adjustable deadtime, Bootstrap diode | 2 | HIN, LIN, SD | Industrial | 9.3 | 8.7 | 8.6 | 8 | -40 | 125 | EVAL6494L | Demonstration board for L6494L gate driver |
| **L6498** | 20 | Undervoltage lockout, Interlocking function | Bootstrap diode | 2 | HIN, LIN, SD | Industrial | 9.3 | 8.7 | 8.6 | 8 | -40 | 125 | EVAL6498L | Evaluation board for the L6498L gate driver |
| **TD350E** | 26 | Undervoltage lockout, Active Miller clamp, 2-level turn-off, Desaturation detection | - | 2.3 | - | Industrial | - | - | - | - | -40 | 125 | | |
| **TD351** | 26 | Undervoltage lockout, Active Miller clamp, 2-level turn-off | - | 1.7 | - | Industrial | - | - | - | - | -40 | 125 | | |
| **TD352** | 26 | Undervoltage lockout, Active Miller clamp, Desaturation detection | Adjustable deadtime | 1.7 | - | Industrial | - | - | - | - | -40 | 125 | | |
| **STGAP2D** | 26 | Shudown protection | Thermal Shutdown | 4 | IN+, IN-, SD, BRAKE | Industrial | 9.1 | 8.4 | - | - | -40 | 125 | EVALSTGAP2DM | Demonstration board for STGAP2DM isolated half-bridge gate driver |
| **STGAP1AS** | 36 | Active Miller clamp, Desaturation detection, Overcurrent detection, 2-level turn-off, VCE overvoltage protection, Temperature warning, shutdown protection, Undervoltage lockout, Overvoltage lockout | Adjustable deadtime, Thermal Shutdown | 5 | IN+, SD | Automotive | 4.1 | 3.8 | - | - | -40 | 125 | EVALSTGAP1AS | STGAP1AS evaluation board |
| **STGAP2SM** | 26 | Active Miller clamp, Shutdown protection, Undervoltage lockout | Thermal Shutdown | 4 | IN+, IN- | Industrial | 9.1 | 8.4 | - | - | -40 | 125 | EVALSTGAP2SM | Demonstration board for STGAP2SM isolated 4 A single gate driver |
| **STGAP2SCM** | 26 | Separated Outputs, Shutdown protection | Thermal Shutdown | 4 | IN+, IN- | Industrial | 9.1 | 8.4 | - | - | -40 | 125 | EVALSTGAP2SCM | Demonstration board for STGAP2SCM isolated 4 A single gate driver |
| **STDRIVE601** | 21 | Undervoltage lockout, Interlocking function, Smart shutdown, Comparator | Bootstrap diodes | 0.35 | HIN, LIN, SD | Industrial | 8.5 | 8 | 8 | 7.5 | -40 | 125 | EVALSTDRIVE601 | Demonstration board for STDRIVE601 triple gate driver |

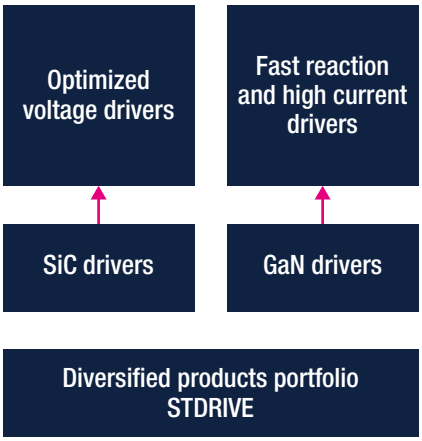
# Silicon Carbide and Gallium Nitride Gate Drivers

Silicon carbide (SiC) MOSFETs combine excellent switching performance and allow more efficient and compact systems. Gallium Nitride (GaN) FETs are very fast switching elements and an accurate design allows to drive them taking all the advantages brought by these switches.

ST's companion for discrete power SiC and GaN FETs as well as digital – microcontrollers, DSPs and FPGs – or analog controllers in any switched-mode power converter or motor drive, STDRIVE gate drivers generate the necessary voltage and current level required to accurately and efficiently activate the power stage in industrial, consumer, computer and automotive applications.

STDRIVE perfectly fits your switched-mode power converter or motor design based on SiC or GaN FETs.



## GALVANIC ISOLATION

**STGAP2SiCS** and **STGAP2SiCD** are SiC drivers with 6 kV galvanic isolation which provides robustness and noise immunity. A thick oxide isolation layer is grown on-chip to build a miniature transformer which is used to transfer signals between input and output.

Their 4 A current output capability and rail-to-rail outputs make the devices a perfect fit for SiC and GaN inverter applications in industrial.

## HIGH VOLTAGE GAN DRIVER

**STDRIVEG600** driver is designed in order to optimize speed and output current for GaN FET. Some useful features are embedded in the product for reducing the number of external components required at system level.

| Part Number | Voltage max (V) | Output current max (A) | Common-mode transient immunity (V/ns) | Supply voltage c (V) max | TTL/CMOS logic inputs (V) | Propagation delay (ns) | Additional features | Package |
|---|---|---|---|---|---|---|---|---|
| **STGAP2SiCSCM*** | 1200 | 4 | ±100 | 28 | 3.3, 5 | 100 | 6 kV galvanic isolation Miller Clamp | SO-8W |
| **STGAP2SiCSM*** | | | | | | | 6 kV galvanic isolation Separated outputs | |
| **STDRIVEG600*** | 800 | Up to 5.5 | ±200 | 21 | 3.3, 5 | 45 | UVLO and thermal shutdown and HW interlocking function | SO-16 |

Note * Short to come

## SiC MOSFET GEN2 1200 V

The best RdsOn vs Gate charge trade off, suitable for industrial motor driver application.

| Part Number | $V_{DS}$ (V) | $R_{DS(on)}$ typ @25 °C (Ω) | Id (A) | Package | | | |
|---|---|---|---|---|---|---|---|
| | | | | HiP247 | HiP247-LL | HiP247-4LL | H²PAK-7L |
| | | | | Tj max = 200 °C | | | |
| **1200 Gen2 (Vgs = 18 V) series** | | | | | | | |
| **SCTW70N120G2V** | 1200 | 0.025 | 80 | x | | | |
| **SCTWA70N120G2V-4** | | | | | | x | |
| **SCTH70N120G2V-7** | | | | | | | x |
| **SCTW40N120G2V** | | 0.070 | 45 | x | | | |
| **SCTWA40N120G2** | | | | | x | | |
| **SCTWA40N120G2V-4** | | | | | | x | |
| **SCTH40N120G2V-7** | | | | | | | x |

# Signal conditioning

## Operational amplifier

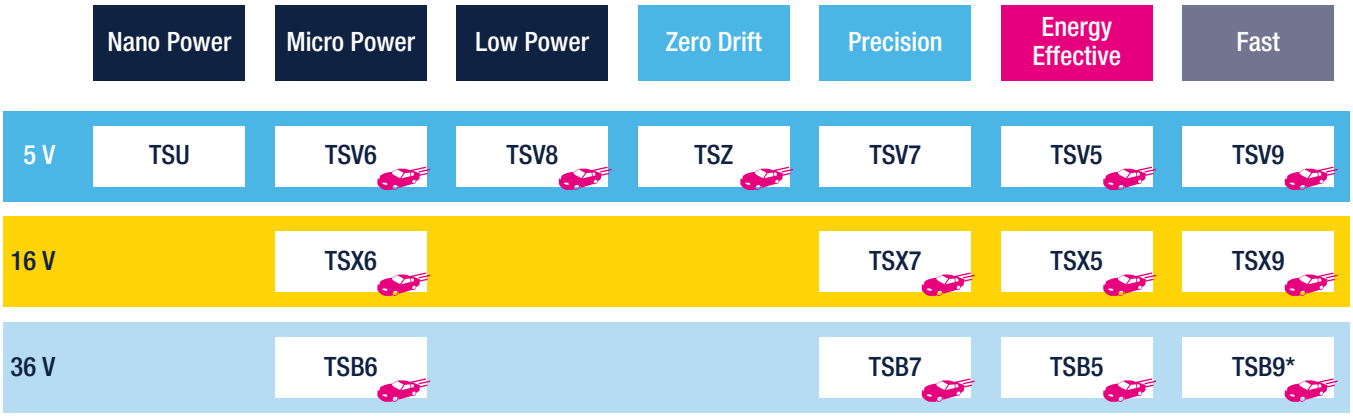
ST has a wide range of Op-Amps, including both industry-standard and high-performance Op-Amps. Our strengths include:

- Growing portfolio of Zero-drift amplifiers
- Reliable high-volume supplier of both standard and high-performance Op-Amps
- Space-saving packages, such as DFN, QFN, SOT-23 and SC-70

Our JFET, bipolar, CMOS and BiCMOS technologies allow our products to support:

- A wide supply range, from 1.5 V to 36 V
- High ratios of performance-to-power consumption

Our automotive-grade products are AEC-Q100 qualified and tested with certified high-reliability flow, to meet the very specific, rigorous demands of the automotive market.




**HIGHLIGHT: TSB712**

- Dual amplifier
- Rail-to-rail input and output
- 6 MHz bandwidth
- 2.7 V to 36 V supply voltage
- Excellent precision
- Guaranteed input offset voltage of 300 µV max at 25 °C
- Perfectly suited for a wide variety of applications such as: active filters, motor control, actuator driving, hall effect sensors and resistive transducers

| Applications | Features | Products |
|---|---|---|
| Low side current sensing | Precision, low Vio as good as 5 µV | TSZ121, TSZ181, TSV731, TSX711 |
| Temperature sensing | Low power consumption as low as 580 nA | TSU101, TS941, TSV631, TSU111 |
| Vibration sensing | High Bandwidth up to 20 Mhz | TSX9291, TSH22, TSV991 |
| Angle measurement DC brushless motor | High output Current, > 100 mA | TSX561, TS982, TS507 |
| High side current sensing | High Common-mode Voltage up to 70 V | TSC101, TSC102, TSC103, TSC2011, TSC213, TSC2010, TSC2012, TSC210 |
| Data acquisition and instrumentation, Test and measurement equipments, Motor control, Industrial process control, Strain gauge | 36 V Signal conditioning | TSB572, TSB611, TSB712, TSB7192, TSB571, TSB711, TSB7191 |

## HIGH-SIDE CURRENT SENSING (TSC SERIES)

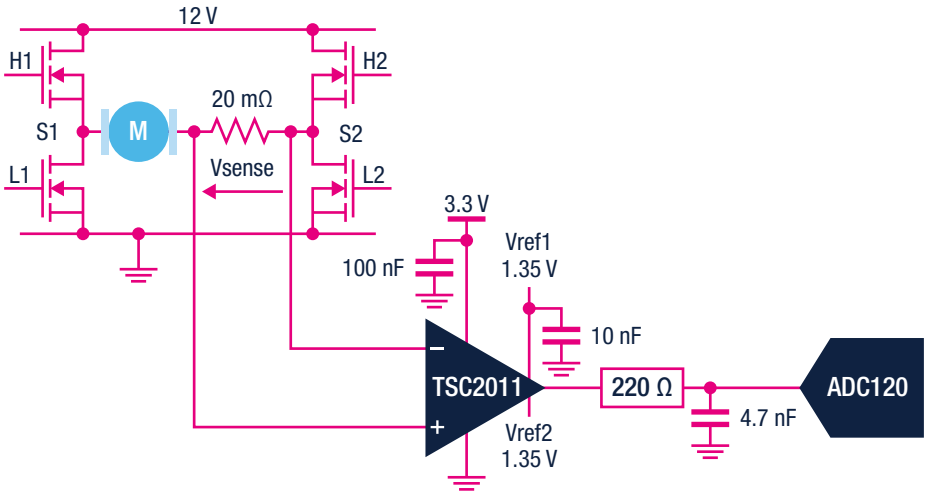
Accurate sensing of currents is central to enhancing application safety. Controlling the current within set boundaries avoids overheating and short circuits. Current measurement is also an essential part of energy metering.

The main features of our growing high-side current-sense amplifier portfolio are:

- Up to 70 V line monitoring
- Integrated solutions (for example, inclusion of EMI filtering on output) for faster design times and a reduced BOM
- Robust devices that do not require external protection
- Automotive-grade qualified current-sense amplifiers

### HIGHLIGHT: TSC2011

- Wide common mode voltage: -20 to 70 V
- Offset voltage: ±200 µV max.
- 2.7 to 5.5 V supply voltage
- 60 V/V gain
- Gain error: 0.3% max.
- Offset drift: 5 µV/°C max.
- Quiescent current: 20 µA in shutdown mode
- SO8 and MiniSO8 package




| Order code | Description | Reference |
|---|---|---|
| **STEVAL-ISQ007V1** | High-side current-sense amplifier demonstration board based on TSC101 | AN2727 |
| **STEVAL-ISQ010V1** | High-side current-sense amplifier demonstration board based on TSC102 | DB0982 |
| **STEVAL-ISQ013V1** | Low-side current sensing based on TS507 | AN3222 |
| **STEVAL-ISQ014V1** | Low-side current sensing based on TSZ121 | UM1737 |
| **STEVAL-AETKT1V1** | High-side current-sense amplifier demonstration board based on TSC2011 | |
| **STEVAL-AKI001V1** | 8 multiplexed channels conversion 50 ksps to 1 Msps based on ADC120 | UM2691 |
| **STEVAL-AETKT1V2** | High-side current-sense amplifier demonstration board based on TSC2010, 2011, 2012 | |

## ANALOG-TO-DIGITAL CONVERTER

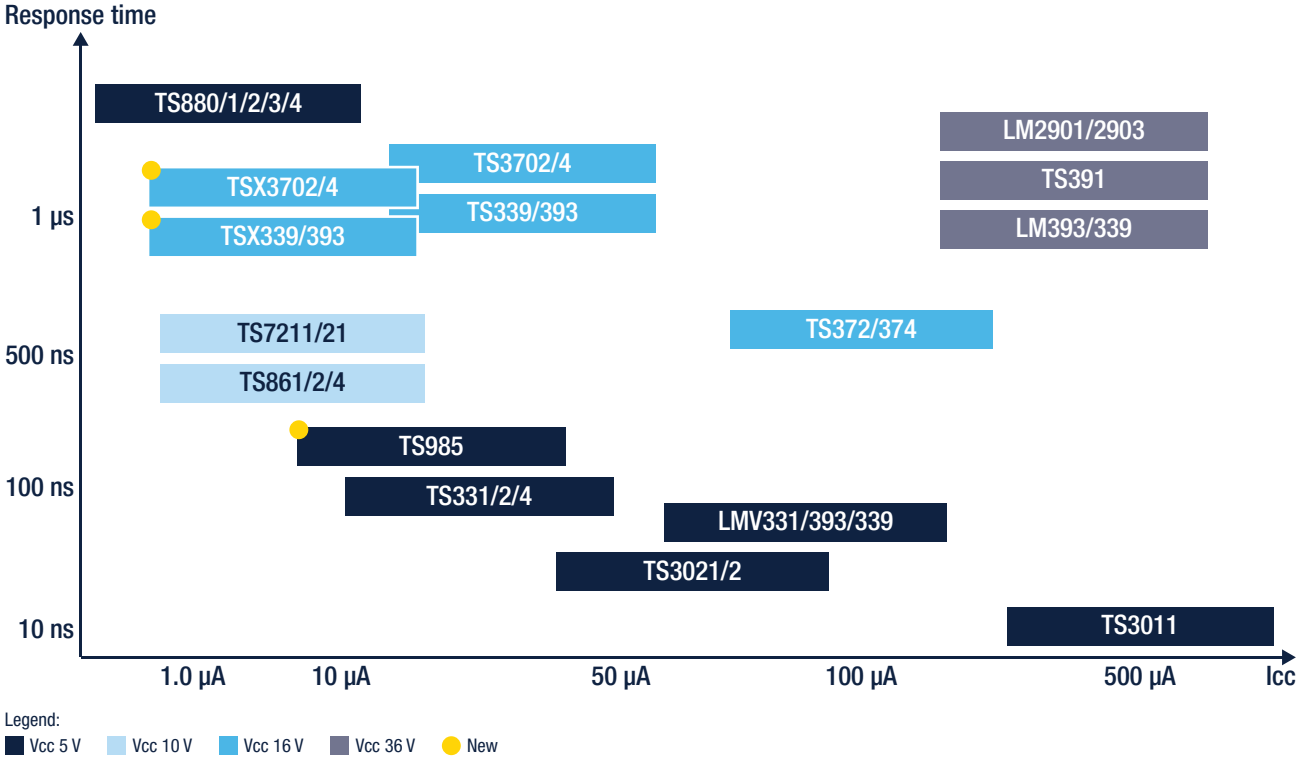
ST proposes the ADC120, a robust and flexible 8-channel,12-bit,  50 ksps to 1Msps ADC, for industrial environments, guaranteed up to 125 °C. The ADC120 offers the best linear performances over the largest sampling frequency range. It is interfaced through a 4-wire SPI bus.

## COMPARATORS

ST is a leading supplier of comparators, and our portfolio offers:

- High-speed comparators, with response times as fast as 8 ns
- Micropower comparators with operating currents as low as 210 nA
- High-temperature (150 °C) qualified devices
- Guaranteed specified min/max electrical performances

Our automotive-grade products are AEC-Q100 qualified and tested with certified high-reliability flow, to meet the very specific, rigorous demands of the automotive market.

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