Products and solutions for Smart Industry

Contents

Introduction

This document summarizes ST's portfolio, providing a reference for today's main applications that will enable you to better focus on your design solutions.

Our devices are intended to make applications easier to develop: the solutions that we showcase in this document are an important link between our devices and your applications.

Our reference designs, evaluation boards, software or development tools, are always linked to at least one of our products. To make it easier for developers to use our ICs, at least one development tool is associated to each of our products. This guide first lists the type of application, followed by the related solutions and products.

Main applications addressed:

- Programmable logic controllers (PLC) and industrial IOs
- Industrial connectivity
- Condition monitoring and Predictive maintenance
- Industrial safety
- Artificial intelligence

For instance, someone looking to design a typical industrial sensor application (i.e. pressure or temperature monitoring solution) will find their target application mentioned many times as the industrial sensor itself, or with IO-Link communication or in the wider perspective of a predictive maintenance implementation. This redundancy gives more information to the reader, but for a focused search, dedicated product paragraphs are also helpful.

The following sections focus on these applications and often include an example solution to help you get started.

Developers will also find information on the best ICs to be used regardless of the smart industry sub application, as well as a description of related solutions.

Applications

PLC AND INDUSTRIAL I/Os

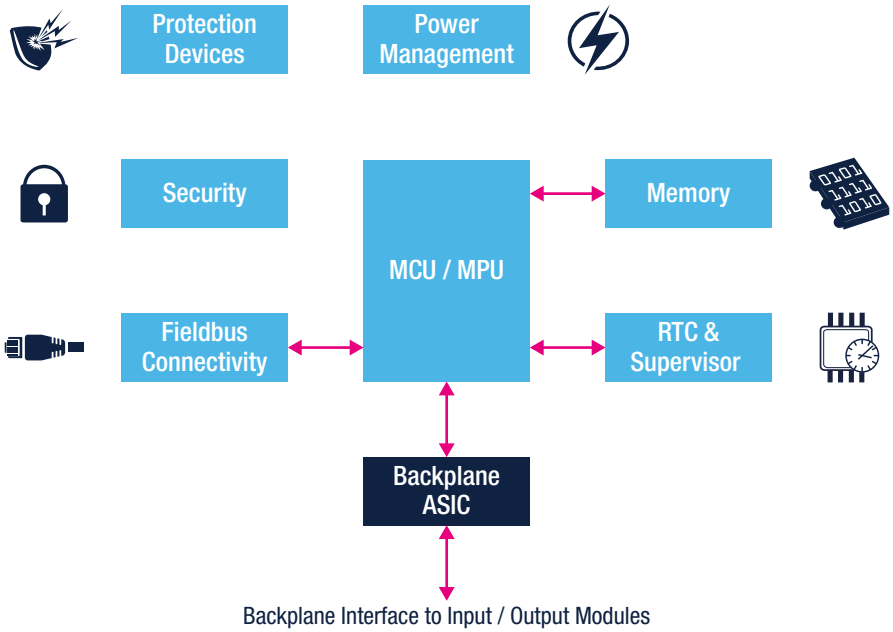
The PLC (Programmable Logic Controller) is the most representative device in the factory floor and as such the best indicator of the technological evolution in the field.

When looking at a PLC, we can identify a number of sub-blocks which can be part of the main system or can be connected as a peripheral, the market in this case is highly fragmented but well standardized at the same time.

The main sub-blocks representing the current PLCs are:

- Control unit
- I/Os modules
- HMI (Human Machine Interface)
- Fieldbus and industrial Ethernet
- Safety
- IO-Link
- Wireless communication module

Based on the above assumptions, a PLC could be represented in a variety of forms, here below you see what can be considered as the system core.

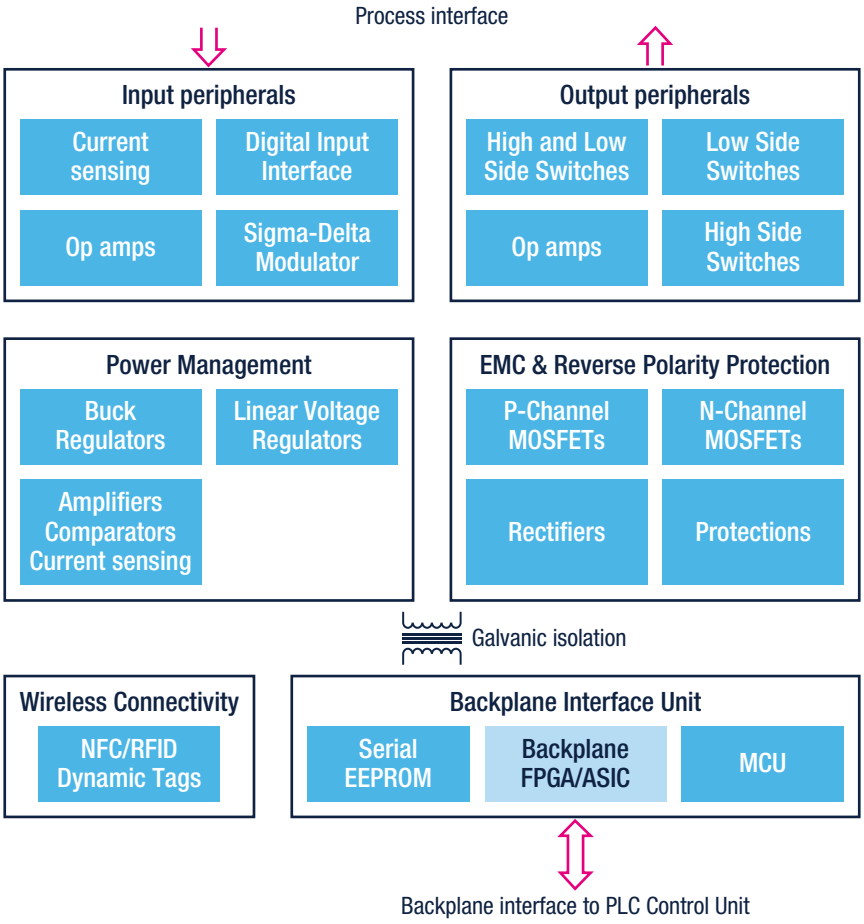


The table below lists a selection of ST's products for PLCs. For a complete list and smart search engine, visit **www.st.com**. In some cases (i.e. certain Serial EEPROM part numbers), the "*" indicates a family of products where it is possible to find ICs for the Automotive segment.

	Buck Regulators	Linear Voltage regulators	Amplifiers, Comparators, Current sensing	Multi-Output Controllers and Regulators
Power Management	L3751, L49*, L59*, L69*, L79*, L7987*, ST1S*	LD*9, LDK*, LDL*, L78*, LD1*, LM2*, LM3*	LM*, LMV*, TSV*, TSX*, TSZ*, TS3*, TS922*, TS98*, TSC201*	PM6641, STPMIC1 Series, STPMIC02
	P-Channel MOSFETs	**N-Channel MOSFETs**	**Rectifiers**	**Protections**
EMC & Reverse Polarity Protection	STD10P*, STL*, STN3P*	STB*, STD1*, STD2*, STD3*, STD6*, STL*, STN*, STP*, STS*, ST*N*F*	STPS*, FERD*	STEF01, SMB15*, SM15*, SM6T*, SMA6F*, SMB6F*, SMC30J*, SMCJ*, ESDA*, SPT01-335DEE, STIEC45*
	MCU/MPU	**RTC & Supervisors**	**Secure Element**	**Serial EEPROM**
Control Unit	STM32MP1 Series STM32H7 Series	M41ST*, M48T*, M41T*, STM6*, STM7*, STM8*, STWD100	STSAFE-J, STSAFE-TPM	M24*, M93* M95*
	Intelligent Power Switches	**Signal isolator**	**Sigma-Delta modulator**	
Galvanic Isolation	ISO8200AQ, ISO8200B, ISO8200BQ	STISO620, STISO621	ISOSD61/ISOSD61L	
	Ethernet Protection	**CAN Transceiver**	**CAN Protection**	**RS-232, RS-485/422**
Wired Connectivity	HSP051-4*10, HSP061-4M10, SLVU2.8	L9615	ESDCAN*	ST202*, ST232*, ST324*, ST3485*, ST485*, ST4E1240[1]
	Bluetooth®	**NFC/RFID reader**	**NFC/RFID Dynamic Tags**	**RF Filter Balun**
Wireless Connectivity	BlueNRG*, STM32WB*M, STM32WBA*	ST25R*	ST25DV	BAL-*, BALF-*, BALF-NR*

Note: 1. Coming soon

The figure below is a typical block diagram of a remote industrial IO module.



The table below lists a selection of ST's products for Industrial IOs.

	Current Sensing	**Digital Input Interface**	**Op amps**	
Input peripherals	TSC201*	CLT01-38S*, CLT03-2Q3, CLT3-4B, PCLT-2A, SCLT3-8B*	TSV7 36 V series TSB719*, TSB182	
	High- and Low-Side Switches	**Low-Side**	**High-Side**	**Op amps**
Output peripherals	TDE170*	IPS4260L	VNI2140J, VNI4140K*, VNI8200XP*	TSX63*, TSX92*, TSB582
	Buck Regulators	**Linear Voltage regulators**	**Amplifiers, Comparators, Current sensing**	
Power Management	L3751, L597*, L598*, L698*, L798*	LD108*, LD29*, LD390*, LM21*, LM31*	LM2*, TS91*, TS92*, TS72*, TS88*, TSC201*	
	P-Channel MOSFETs	**N-Channel MOSFETs**	**Rectifiers**	**Protections**
EMC & Reverse Polarity Protection	STD10P*, STL*, STN3P*	ST*N4F*,ST*N6F* ,ST*N8F*, ST*N10F*	STPS*, FERD*	STEF01, SMB15*, SM15*, SM6T*, SMB6F*, SMC30J*, SMCJ*, ESDA*, SPT01-335DEE, STIEC45*
	NFC/RFID Dynamic Tags	**NFC/RFID reader**		
Wireless Connectivity	ST25DV	ST25R*		
	Serial EEPROM	**MCU**		
Backplane Interface Unit	M24C*, M95*	STM32F0*, STM32F1*, STM32F2*, STM32F4*, STM32G0*, STM32G4* STM32H5, STM32H7, STM32L4, STM32L4+, STM32U5, STM32WL, STM32WB, STM32WBA		

Main evaluation boards and reference designs

When it comes to PLCs and industrial I/Os' modules, we can offer many reference designs, from the low cost product boards (often expansion boards for our STM32 microcontrollers) to the system boards that provide features and capabilities at a broad level. It is the case of the **STEVAL-PLC001V1**, a reference design exploiting HMI features, as it is powered by the STM32F746 with the TouchGFX library, and an heterogeneous mixout of I/Os respondig to safety features (i.e. 60 V rated inputs or 4 kV galvanically isolated outputs), with a companion software package offering application examples, including some Ladder logic diagrams.

X-NUCLEO-PLC01A1
Industrial input/output expansion board based on VNI8200XP and CLT01-38SQ7 for STM32 Nucleo

X-NUCLEO-OUT01A2
Industrial digital output expansion board based on ISO8200BQ for STM32 Nucleo

X-NUCLEO-OUT03A1
Industrial digital output expansion board based on IPS2050H for STM32 Nucleo

X-NUCLEO-OUT06A1
Industrial digital output expansion board based on IPS1025H-32 for STM32 Nucleo

X-NUCLEO-OUT15A1
Industrial digital output expansion board based on IPS1025HF for STM32 Nucleo

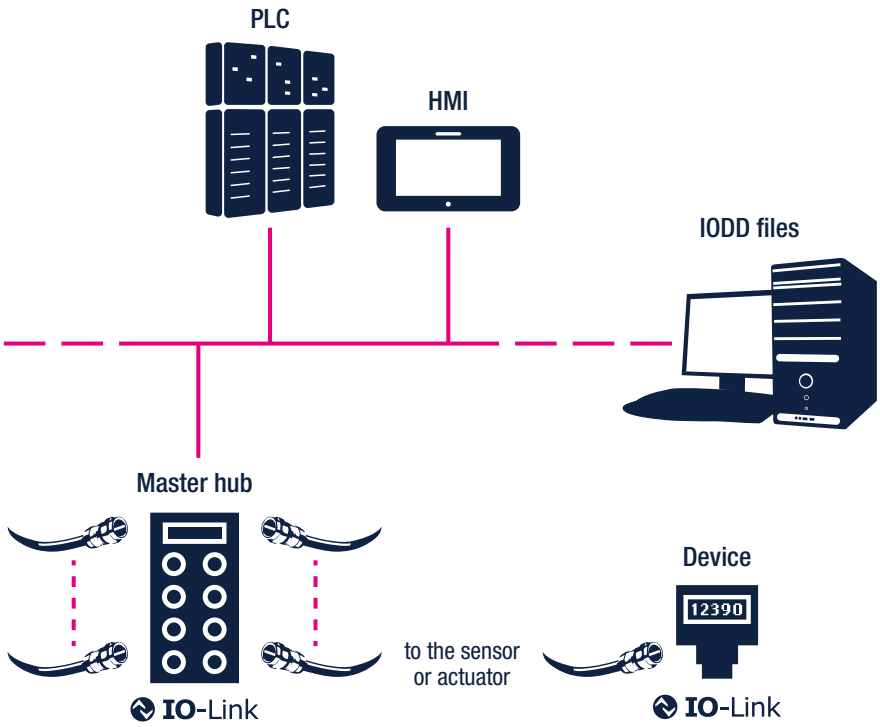
IO-Link TECHNOLOGY

IO-Link communication networks (IEC 61131-9) enable bi-directional, **point-to-point data connectivity down to the actuator and sensor level**, managing data pre-processing, sensor parameter tuning and advanced diagnostics.

IO-Link offers several key advantages including:

- Reduced commissioning and set-up time by storing key parameters
- Compatibility with existing cabling and connectors
- Interoperability across different manufacturers based on a common standard

We offer a range of ICs including IO-Link transceivers, STM32 microcontrollers, environmental and motion sensors, interfaces as well as protection devices to help meet IEC 61000 requirements for electro-static discharge (ESD), burst and surge immunity together with a set of hardware and software evaluation tools to help implement efficient IO-Link solutions.



This table lists ST's products for IO-Link solutions. In some cases (i.e. certain Serial EEPROM part numbers), the "*" indicates a family of products where it is possible to find ICs for the Automotive segment.

	IO-Link transceivers				**High-side switches**
Wired connectivity	L6360 , L6362A, L6364				VNI2140J, VNI4140K*, VNI8200XP*
		NFC/RFID Dynamic Tags	**NFC/RFID reader**		
Wireless connectivity		ST25DV	ST25R*		
	MCUs		**Serial EEPROM**		
Backplane interface unit	STM32F0 Series, STM32F1 Series, STM32F2 Series, STM32F4 Series, STM32G0 Series, STM32G4 Series STM32H5, STM32H7, STM32L4, STM32L4+, STM32U5, STM32WL, STM32WB, STM32WBA		M24*, M93*, M95*		
		Linear Voltage Regulators	**Buck Regulators**		
Power management		LD*9, LDK*, LDL*, L78*, LD1*, LM2*, LM3*	L3751, L49*, L59*, L69*, L79*, L7987*, ST1S*		
	P-Channel MOSFETs	**N-Channel MOSFETs**	**Rectifiers**	**Protections**	
EMC & Reverse Polarity Protection	STD10P*, STL*, STN3P*	STB*, STD1*, STD2*, STD3*, STD6*, STL*, STN*, ST*N8F*, ST*N10F*, STS*	STPS*, FERD*	STEF01, SMB15*, SM15*, SM6T*, SMA6F*, SMB6F*, SMC30J*, SMCJ*, ESDA*, SPT01-335DEE, STIEC45*	

STEVAL-IDP004V2

IO-Link master multi-port evaluation board based on L6360

P-NUCLEO-IOM01M1

STM32 Nucleo pack for IO-Link master with IO-Link v1.1 PHY and stack

STEVAL-IOD04KT1

Industrial smart sensor kit based on L6364W dual IO-Link device transceiver

X-NUCLEO-IOD02A1

Dual channel IO-Link device expansion board based on L6364Q for STM32 Nucleo

P-NUCLEO-IOD01A1

STM32 Nucleo pack for IO-Link device fully compatible with IO-Link v1.1 (PHY and stack)

STEVAL-IDP003V1

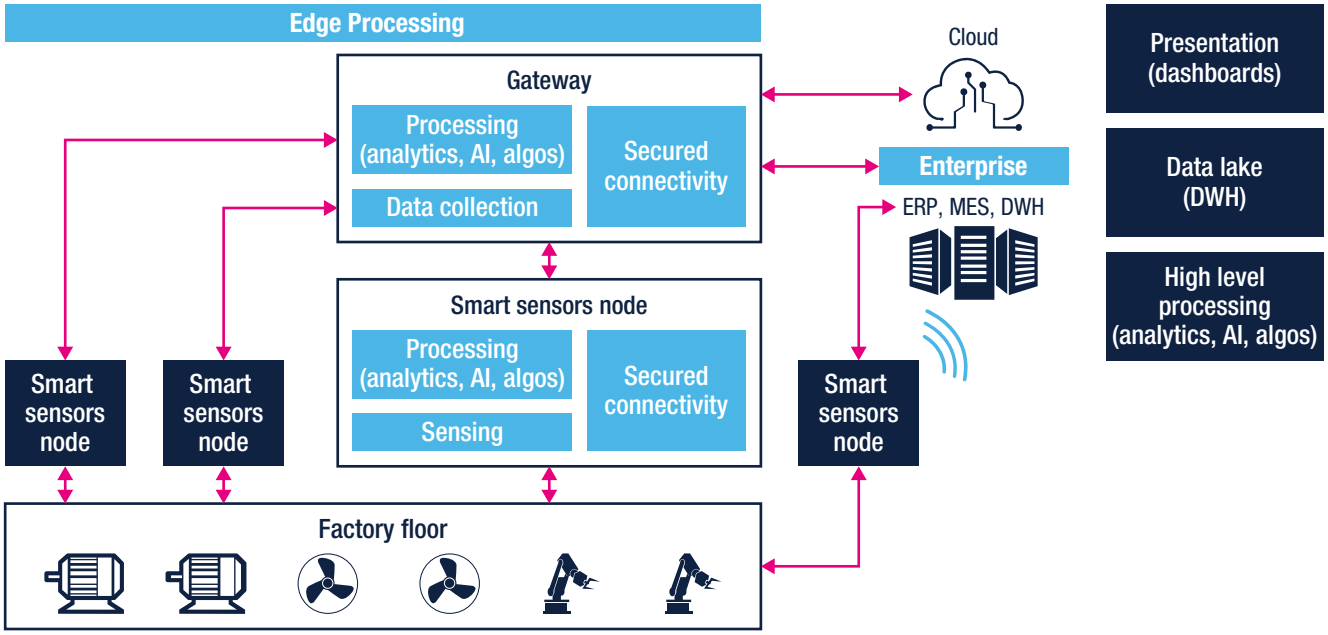
IO-Link industrial modular sensor board based on L6362A

PREDICTIVE MAINTENANCE AND SMART SENSORS

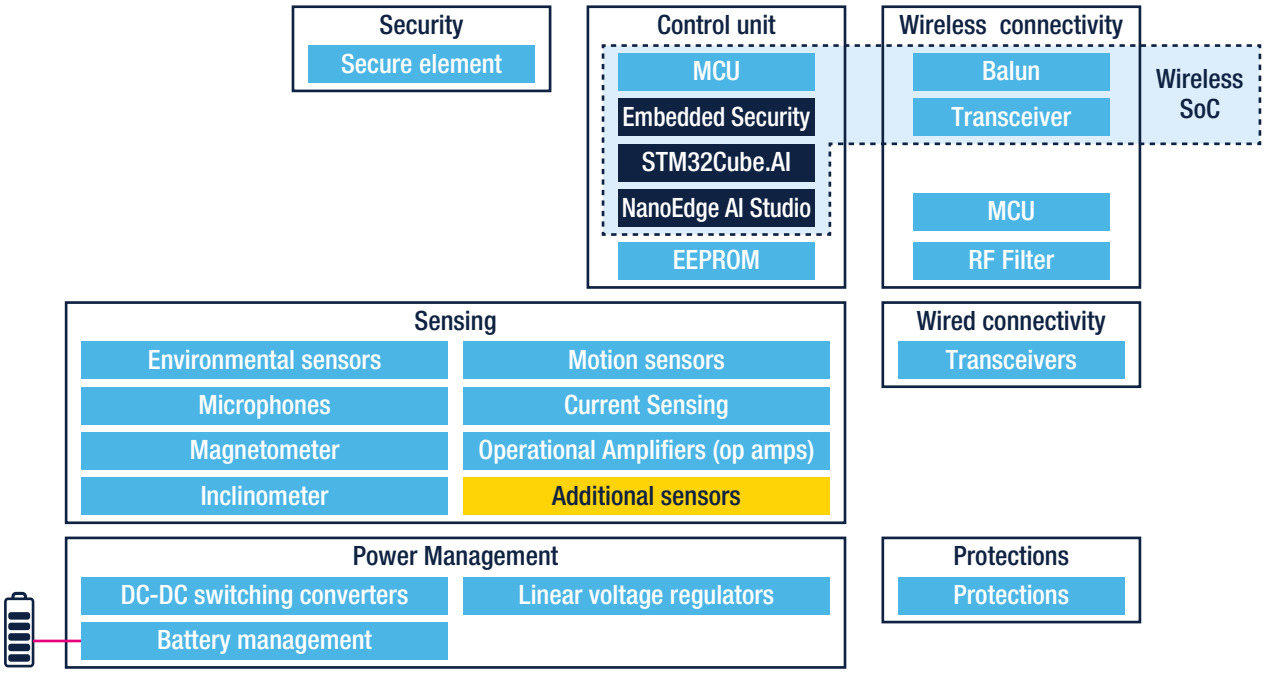
There is a clear evolution regarding the industrial sensors and the related terminology: from simple end-nodes with no other capability except detecting variations in what they are committed to measure, to intelligent nodes capable of local processing (edge processing), with artificial intelligence and connectivity features.

As such, today we are talking of smart sensor nodes and at ST, we are offering ICs (our latest generation of MEMS sensors is called ISPU, intelligent sensor processing unit) and solutions (field-ready reference designs, battery operated in order to leave your smart sensor running autonomously on the equipment to be monitored).

Anomaly detection, condition based monitoring and predictive maintenance all of these disciplines have their foundations on smart sensors and AI: here we see a continuity among our latest MEMS and the ecosystem around, such as our advanced software libraries developed for our STM32 (NanoEdge AI Studio and STM32Cube.AI) and the solutions we are going to introduce such as our STWIN.box (STEVAL-STWINBX1) and Proteus (STEVAL-PROTEUS1).



The smart sensor node and the gateway are the two main blocks used in this solution.



The following table summarizes the products in the smart sensor node.

	Transceivers				
Wired connectivity	IO-Link Device: L6362A, L6364 RS-232 RS-485/422: ST202*, ST232*, ST324*, ST3485*, ST485*, ST4E1240[1]				
	Balun	**Transceiver**	**RF Filter**	**Wireless SoC**	**NFC**
Wireless connectivity	BAL-*, BALF-*, BALF-NR*	BlueNRG-*, S2-LP	MLPF-WB55-0*	STM32WB3*, STM32WB5*, STM32WLE*	ST25DV
	MCU	**EEPROM**	**Security Secure element**		
Control Unit	STM32L Series, STM32F0 Series, STM32F4 Series, STM32F7 Series, STM32H7 Series, STM32G0 Series, STM32H5, STM32H7, STM32L4, STM32L4+, STM32U5, STM32WL, STM32WB, STM32WBA	M24*, M93*, M95*	STSAFE-A1*		
	Environmental sensors	**Motion sensors**	**Microphones**	**e-Compass**	**Signal conditioning**
Sensing	Pressure: LPS2*, LPS3* T-Plus: LIS2DTW12 Temperature: STLM*, STTS* Humidity: HTS221	Accelerometers: IIS2D*, IIS2ICLX, IIS3DHHC, IIS3DWB Gyroscopes: I3G4250D i-NEMO: ISM330*	IMP23ABSU, IMP34DT05	IIS2MDC, ISM303DAC	Amplifiers and Comparators: LM2*, TS91*, TS92*, TS72*, TS88* Voltage References: TS3*, TL43*, TS82*
	DC-DC switching converters	**Linear Voltag Regulators**	**Battery management**	**Protections**	
Power management	STL*, ST*N*F*, L6986I, L6983I, STBB1A	STB*, STD1*, STD2*, STD3*, STD6*, STL*, ST*N*F*, STP*, STS*	STPS*, FERD*	ESDA*, ESDALC*, ESDZ*, USBLC6-*	

Note: 1. Coming soon

	Balun	**Transceiver**	**RF Filter**	**Wireless SoC**	
Wireless connectivity	BALF-NRG-0*, BALF-SPI-0*	BlueNRG-*, S2-LP	MLPF-WB55-0*	STM32WB3*, STM32WB5*	
	MCU	**EEPROM**	**TPM Secure element**		
Control Unit	STM32F7 Series, STM32H7 Series, STM32MP1 Series, STM32H5, STM32H7, STM32L4, STM32L4+, STM32U5, STM32WL, STM32WB, STM32WBA	M24*, M93*, M95*	STSAFE-J100, ST33GTPMI*		
	DC-DC switching converters	**Linear Voltag Regulators**	**Power over Ethernet**	**E-Fuse**	**Protections**
Power management	L49*, L59*, L69*, L79*, L7987*, ST1S*, ST1PS01, ST1PS02, ST1PS03 Multi-Output Controllers and Regulators STPMIC1	LD39*, ST73*, LDLN0*, STLQ*	PM880*	STEF*, STPMIC02	SMB15*, SM15*, SM6T*, SMB6F*, SMC30J*, SMCJ*, ESDA*, SPT01-335DEE, STIEC45*

Main application boards and reference designs for condition monitoring and predictive maintenance are listed below with their order code. This is followed by an example of these solutions along with a few screenshots of our dashboard.

The **STEVAL-PROTEUS1** is an evaluation kit designed for temperature and vibration monitoring over a 2.4 GHz multiprotocol wireless SoC (our STM32WB) to address condition monitoring of industrial equipment. To make it easier the deployment on the field, the kit comes with a LiPo battery and a plastic case and on the main board all components are mounted exclusively on the top side of the PCB. The included comprehensive software and the firmware libraries with time and frequency domain vibration analysis ease your software customization and can reliably improve your time-to-market.

The main board includes the STM32WB5MMG ultra-low-power and small form factor wireless radio module compliant with the Bluetooth® Low Energy SIG specification v5.2, ZigBee 3.0, and IEEE 802.15.4-2011.

The powerful Arm®-based Cortex-M4 with FPU and large memory allows running the embedded algorithm at node level, ensuring the development of applications with different types of connectivity with a unique hardware. Moreover, the main board integrates the STSAFE-A110 secure element that provides authentication and secure data management.

The IIS3DWB high bandwidth (up to 6 kHz) accelerometer, the IIS2DLPC ultra-low power, and the ISM330DHCX inertial module (accelerometer and gyroscope) with MLC make the hardware ideal for a customized vibration monitoring development.

The STWIN.box (**STEVAL-STWINBX1**) is an evolution of the original STWIN kit (**STEVAL-STWINKT1B**) which had a great success in the last years in the domain of smart industrial sensors for predictive maintenance.

Respect to its predecessor it features a higher mechanical accuracy in the measurement of vibrations, an improved robustness, an updated BoM to reflect the latest and best-in-class MCU and industrial sensors, and an easy-to-use interface for external add-ons.

The STWIN.box kit consists of an STWIN.box core system, a 480 mAh LiPo battery, an adapter for the ST-LINK debugger, a plastic case, an adapter board for DIL 24 sensors and a flexible cable.

The many on-board industrial-grade sensors are featuring: ultra-low power, 9 DoF motion sensing, wide-bandwidth vibration analysis, audio and ultrasound acoustic inspection, very precise local temperature, and environmental monitoring.

A rich set of software packages is available in source code. Optimized firmware libraries and a complete companion cloud application help to speed up the design cycle to develop end-to-end solutions.

STWIN.box supports a range of connectivity options, such as the built-in RS485 transceiver, BLE, Wi-Fi, and NFC.

A 34-pin expansion connector allows the association of small form factor daughter boards such as the new STEVAL-C34KAT2, iNemo inertial module with embedded ISPU and temperature sensor expansion kit.

The STWIN.box is suitable for field trials, demonstrations, and PoC for industrial IoT applications that use ST software and third-party software.

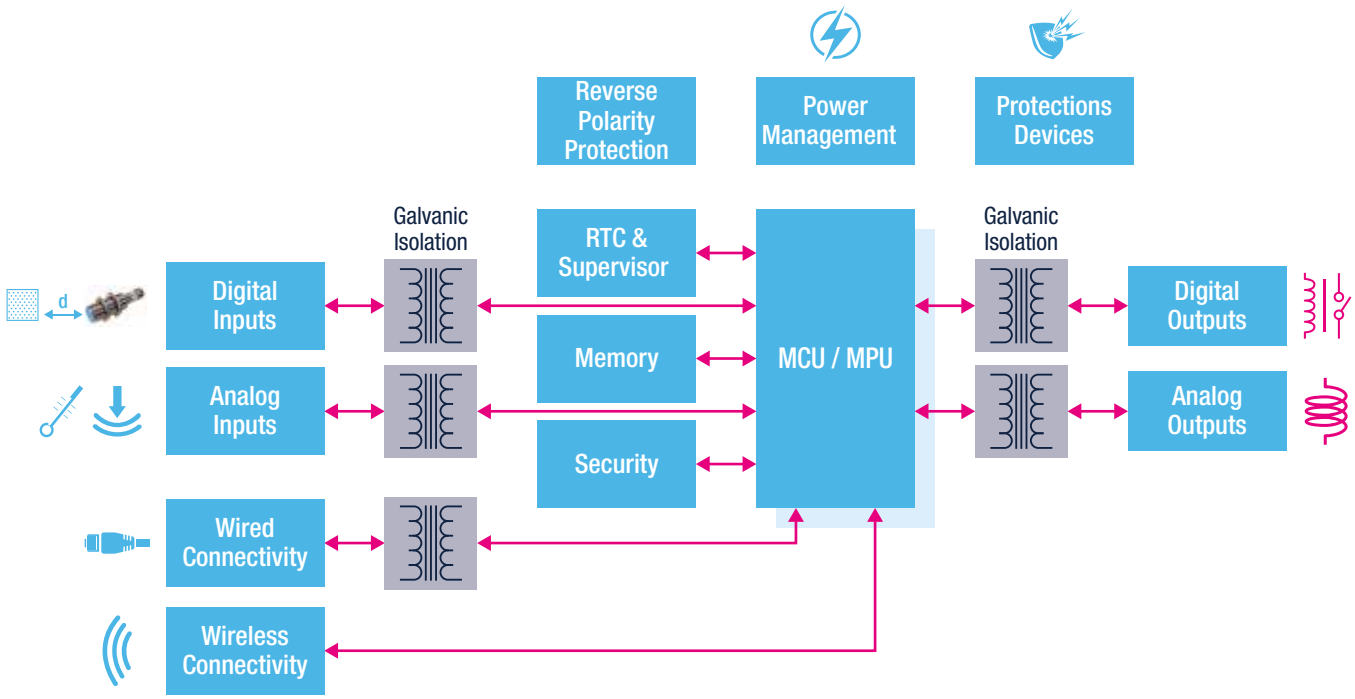
INDUSTRIAL SAFETY

To facilitate the development and certification process of **safety-critical services and functions**, ST offers a range of hardware and software solutions. This includes a comprehensive set of certified software libraries and documentation to help manufacturers design products that meet functional safety standards. ST's **X-CUBE-STL** software package for STM32 MCUs and MPUs supports the design of **IEC 61508-certified solutions**, reaching **Safety Integrity Level (SIL2/SIL3)**.

Not only the Self-Test library for our MCUs but also smart power ICs for safe automation:

- Intelligent Power Switches including galvanic isolated ICs for driving actuators
- Current Limited Terminations to implement efficient and supply-free digital inputs for smart sensors
- DC/DC converters providing power supply for various circuits in safe applications

Our selected products for safe automation are certified by authorities like TÜV, UL and VDE.



ICs offering for Industrial Safety:

	IO-Link	RS-232, RS-485/422	CAN Transceiver	CAN Protection	Ethernet Protection
Wired connectivity	L6360, L6362A, L6364	ST202*, ST232*, ST324*, ST3485*, ST485*	L9615	ESDCAN*	HSP051-4*10, HSP061-4M10, SLVU2.8
	NFC/RFID Dynamic Tags	**Bluetooth®**	**RF Filter Balun**	**NFC/RFID reader**	
Wireless connectivity	ST25DV	BlueNRG*, STM32WB3*, STM32WB5*	BAL-*, BALF-*, BALF-NR*	ST25R*	
	MCU	**Serial EEPROM**	**RTC & Supervisors**	**Secure Element**	
Control Unit	STM32F0*, STM32F1*, STM32F2*, STM32F4*, STM32F7*, STM32H7*, STM32G0*, STM32G4*, STM32L0*, STM32L4*, STM32L4+*, STM32H5, STM32H7, STM32L4, STM32L4+, STM32U5, STM32WL, STM32WB, STM32WBA	M24*, M93*, M95*	M48T*, M41T*, M41ST*, STM6*, STM7*, STWD100	STSAFE-A1*	
	Digital Input Interface	**Current sensing**	**Op amps**	**Galvanic Isolation Signal isolator**	**Sigma-Delta Modulator**
Input Peripherals	CLT03-2Q3	TSC201*	TSB182, TSB7*, TSX63*, TSX92*, TSV7*	STISO620, STISO621	ISOSD61, ISOSD61L
	High and Low Side Switches	**High-Side Switches**	**Low-Side Switches**	**Op amps**	**Galvanic Isolation Signal Isolator**
Output Peripherals	TDE170*	IPS160H, IPS161H, IPS160HF, IPS161HF, ISO8200*	IPS4260L	TSB582, TSX63*, TSX92*	STISO621, STISO620
	Multi-Output Controllers and Regulators	**Linear Voltage Regulators**	**Buck Regulators**		
Power management	STPMIC1 Series	LD*9, LDK*, LDL*, L78*, LD1*, LM2*, LM3*	L3751, L49*, L59*, L69*, L79*, L7987*, ST1S*		
	P-Channel MOSFETs	**N-Channel MOSFETs**	**Rectifiers**	**Protections**	
EMC & Reverse Polarity Protection	STD10P*, STL*, STN3P*	ST*N6F*, ST*N8F*, ST*N10F*	STPS*, FERD*	STEF01, SMB15*, SM15*, SM6T*, SMA6F*, SMB6F*, SMC30J*, SMCJ*, ESDA*, SPT01-335DEE, STIEC45*	

Our latest reference designs for industrial safety

A couple of key reference designs have been introduced lately on industrial safety.

The **STEVAL-SILPC01** is a PLC solution with a 1oo2 architecture, featuring the CLT03-2Q3 dual channel digital input and the IPS160HF single channel digital output.

The system is built around the **STM32H723VG** microcontroller to meet the SIL level. It has been officially assessed by TÜV Italia (TÜV SUD Group) in compliance with SIL 2 / PL d requirements: random failure rates, systematic capability (for the hardware), architectural constraints in accordance with IEC 61508, EN 62061, EN ISO 13849-1, and EN ISO 13849-2 standards.

The **STEVAL-FSM01M1** is a safe dual channel digital I/O expansion board compatible with the STM32 Nucleo. Its system architecture reflects our long-term experience with designing digital I/O applications to reach the highest-grade robustness and to meet the requirements on reliability of operation in the most challenging industrial environments such as factory automation and functional safety.

The X-CUBE-STL software library dedicated to industrial safety applications for the STM32 family, has been integrated in the software packages coming with both the STEVAL-SILPLC01 and STEVAL-FSM01M1 (STSW-SILPLC and STSW-FSM01 respectively).

Suggested application boards and related ICs for fail-safe applications

X-NUCLEO-OUT08A1

Industrial digital output expansion board based on IPS160HF for STM32 Nucleo

X-NUCLEO-OUT10A1

Industrial digital output expansion board based on IPS161HF for STM32 Nucleo

ARTIFICIAL INTELLIGENCE

Use the power of Machine Learning (ML) and Neural Networks to enhance signal processing performance, increase productivity and add new capabilities to your STM32 application.

STMicroelectronics offers a comprehensive development ecosystem that helps you embed Machine Learning and Deep Learning algorithms into your STM32-based solutions and leverage the benefits of Artificial Intelligence to imagine new user experiences.

Run AI algorithms locally on your MCU without necessarily relying on cloud capabilities.

Better user experience

Real time, no latency

Reliable

Privacy by design

Optimized cloud usage

Sustainable

Computer vision at the edge

The momentum around computer vision applications keep rising with today's strong demand for data-driven insights for smart devices. ST offers hardware and software tools as well as a complete ecosystem for developers to run computer vision applications based on STM32.

These resources help them find the best solutions for a wide range of applications including room occupancy, face recognition, smart city management, meter reading and many more.

ST offers several small and low-power STM32 boards to help developers rapidly prototype computer vision applications:

Discovery kit with high-performance STM32H7 series microcontroller with DSP and DP-FPU (STM32H747I-DISCO)

Flash and operate in real time the Convolutional Neural Network optimized using STM32Cube.AI to extend your project with machine vision.

OpenMV Cam H7 machine vision board with embedded STM32H743VI MCU

Wide set of OpenMV computer vision libraries and simple run time configuration via microPython.

NanoEdge AI Studio: automated machine learning tool for smarter products

With NanoEdge AI Studio, ST makes AI more accessible: software developers can now create optimized ML libraries from the tool's user-friendly environment, without needing advanced data science skills or expertise in Artificial Intelligence (AI).

NanoEdge AI Studio is a PC-based push-button development studio that embeds an automatic search engine for AI libraries. It enables developers to easily generate an optimized ML library for their project, based on a minimal amount of data and in a matter of minutes. Input signals can come from a wide variety of vibration, pressure, sound, magnetic, and time-of-flight sensors, just to name a few, or even a combination of signals from several different sources. Multiple sensors can be combined, either in a single library, or using multiple libraries concurrently.

Once the library is created, it can be easily loaded into a microcontroller to train and infer directly at the edge for improved security and reduced latency.

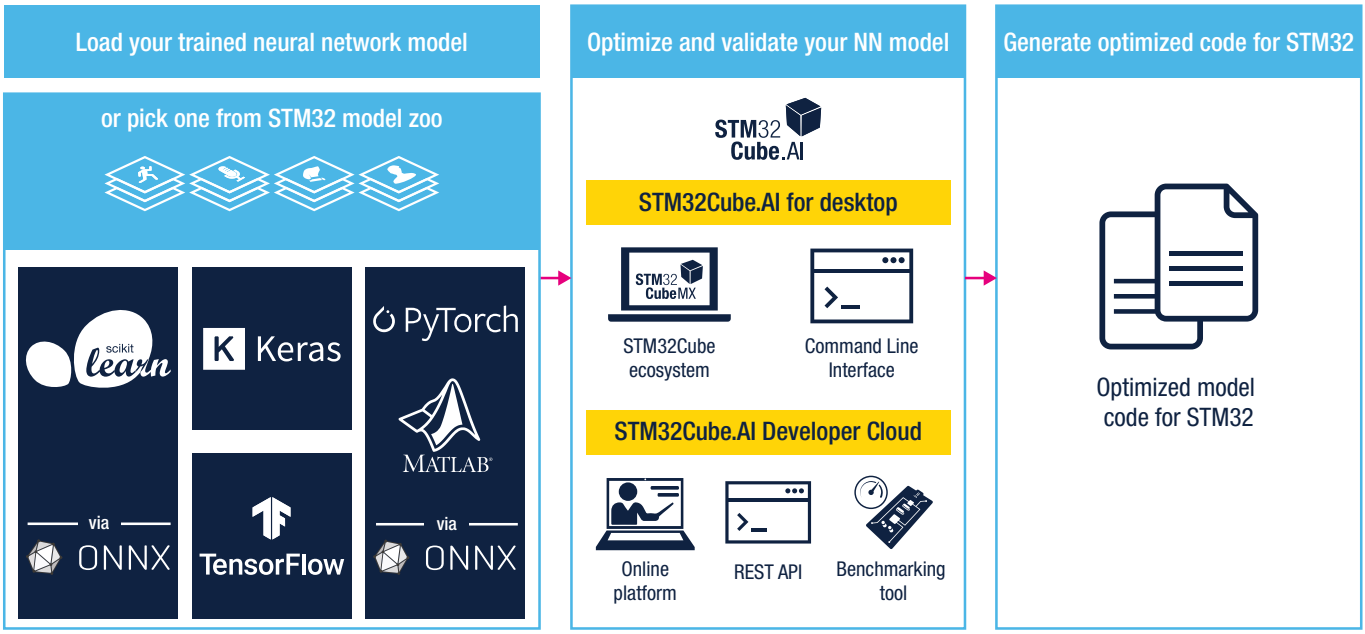
On-device learning allows to refine the ML model for any specific product/environment without having to re-develop the entire algorithm on a PC or gateway. This way, it becomes easy to improve a solution for a specific system/environment or usage.

STM32CUBE.AI: free tool for edge ai developers

STM32Cube.AI allows to optimize and deploy trained Neural Network models from the most popular AI frameworks on any STM32 microcontroller. The tool is available via a graphical interface in the STM32CubeMX environment as well as in command line. For a pure digital experience, this tool is now available online through STM32Cube.AI Developer Cloud.

STM32Cube.AI offers options for large network to store weights and activation buffers in external memories while supporting 8-bit quantization of ONNX networks and TensorFlow™ Lite quantized networks. In addition, to further accelerate application prototyping, we offer access to STM32 Model zoo on Github. It includes a repository of models, training scripts and application code examples to make the work of data scientists easier.

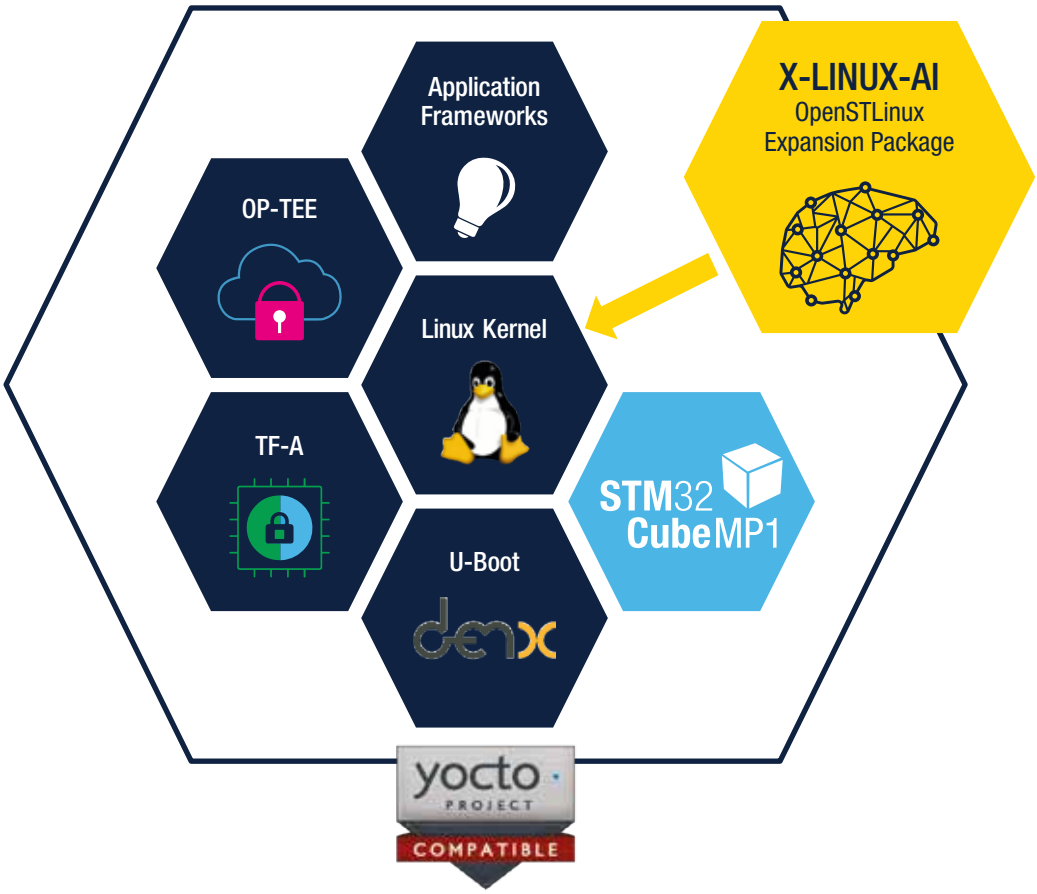
From ideation to production, it boosts AI performance with highly optimized code on STM32.



AI on MPUs: libraries and runtimes for OpenSTLinux

To take full advantage of the many capabilities of the feature-rich STM32MP1 microprocessor, developers can use our STM32Cube Expansion Package (X-CUBE-AI) for the embedded Arm Cortex-M4 core. You can also run various AI frameworks on the Cortex-A7 core thanks to our mainlined open-source Linux distribution, X-LINUX-AI.

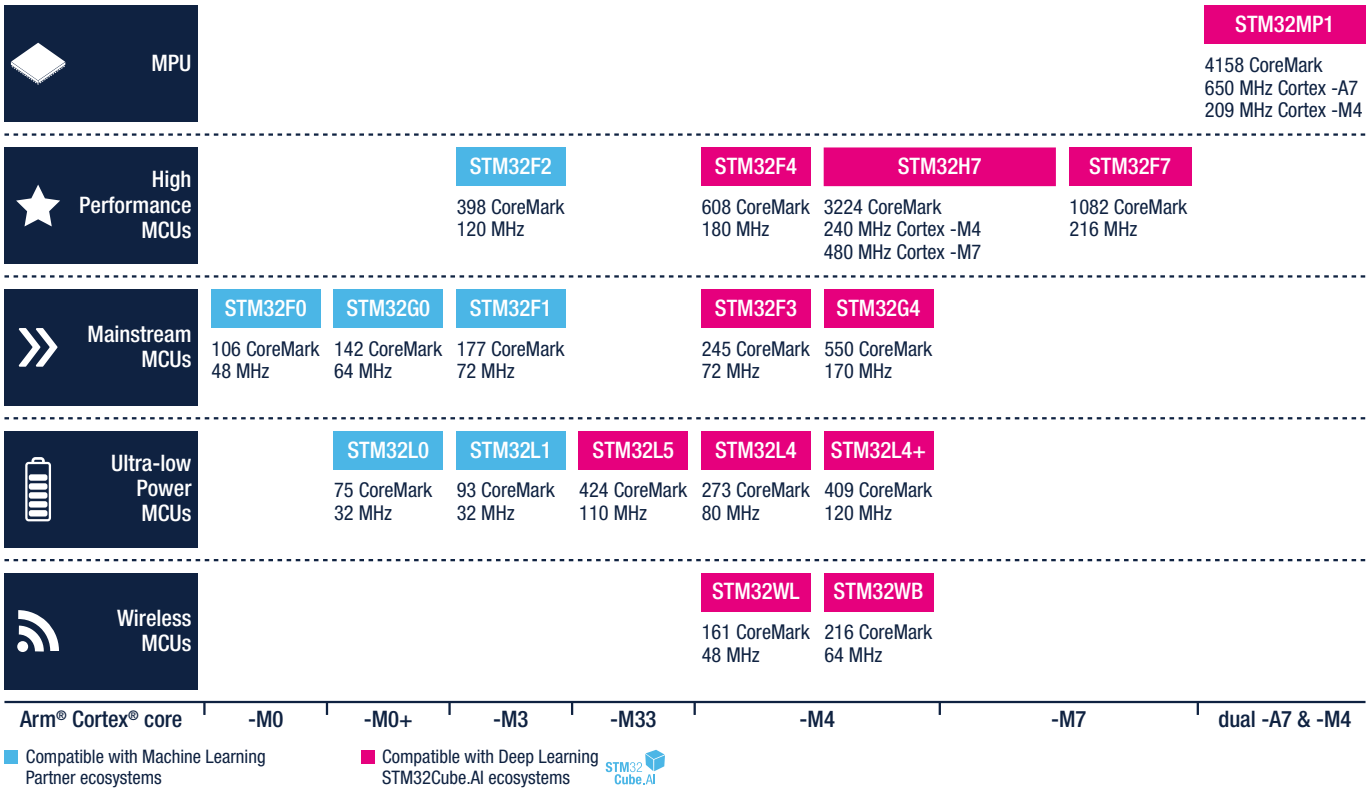
This STM32 MPU OpenSTLinux expansion package targets Artificial Intelligence applications and contains Linux® AI frameworks as well as application examples to get started with typical use cases such as computer vision.



Learn more on
www.st.com/STM32AI

MAKING AI ACCESSIBLE NOW

Leader in Arm® Cortex®-M 32-bit General Purpose MCU



Learn more at **st.com/STM32AI**

Products

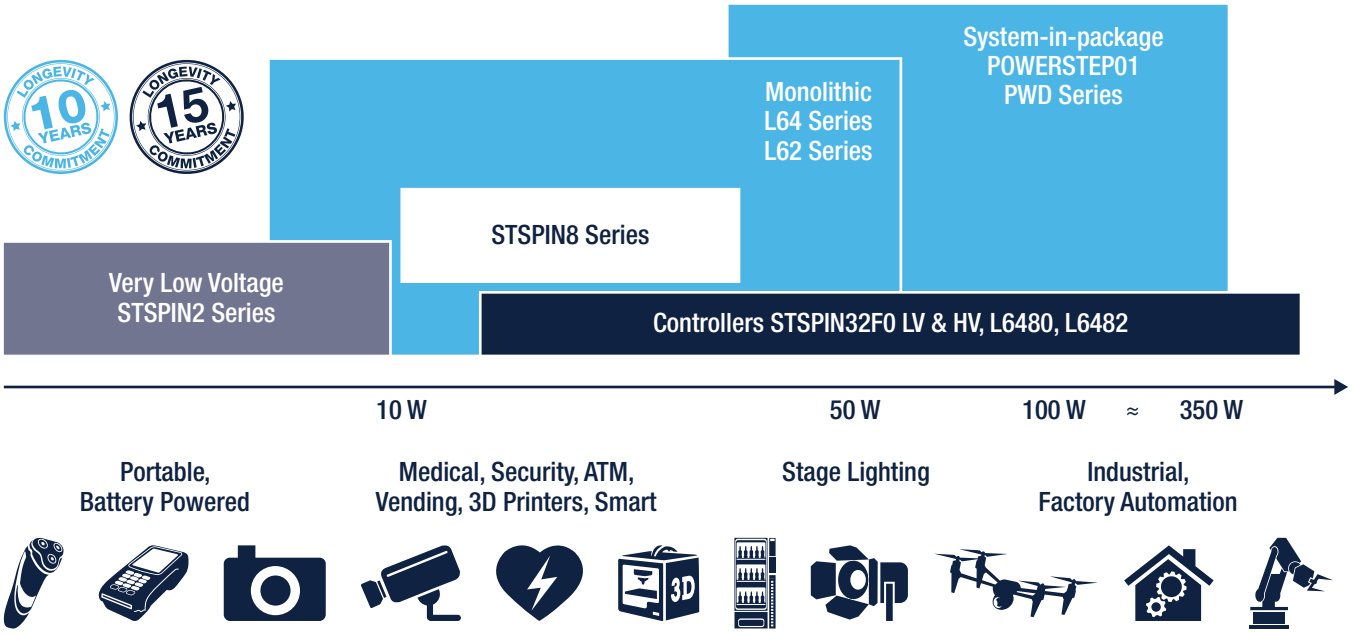
Motor drivers and Gate drivers

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 to drive motors.

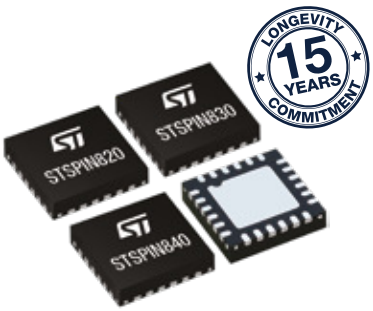
All products have comprehensive built-in protection and diagnostic schemes to help attain the level of long-term reliability and robustness requested to cope with harsh factory automation environments.

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.

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.



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 R_{DSon} 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/single 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

STSPIN9 SERIES

Available in a compact QFN package, the **STSPIN9** high-current monolithic motor driver series integrates both the control logic and a fully protected low RDS(on) power stage making them ideal to meet the stringent requirements of demanding industrial applications. The STSPIN9 series is the best choice to drive motor at high current saving space on the PCB.

With a selectable 7-method input strategy, the controller embeds two analog operational amplifiers that can be used for the signal conditioning of analog Hall-effect sensors or shunt resistor signals. Thanks to its flexibility, STSPIN9 series can cover the needs of driving multple different types of motors, including BDC, BLDC and stepper. The adjustable slew rate ensures the best ratio between performances and EMI.

Product	Desription	Vin min (V)	Vin max (V)	RDS(on) (Ohm)	IOUT max (Arms)
STSPIN948	Dual full bridge driver	5	58	0.4	4.5
STSPIN958	Full bridge driver				5

MAIN APPLICATIONS

- Home appliances
- Robotics
- Stage lighting
- Antenna control
- Textile machines
- Vending machines
- Factory automation

STSPIN32F0 SERIES OF LOW-VOLTAGE BLDC CONTROLLERS WITH EMBEDDED STM32 MCU

The **low-voltage STSPIN32F0 series** of self-supplied system-in-package integrate 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 application targets.

ST offers a set of pre-defined firmware algorithms, spanning from classical 6-step to the advanced sensorless field-oriented control. An 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 for signal conditioning of analog Hall-effect sensors or shunt resistor signals. Programmable threshold over current protection is guaranteed by the embedded comparator.

Product	Desription	V_{IN} min (V)	V_{IN} max (V)	I_{GATE} (A)	Op amps	#GPIOs
STSPIN32F0	• FOC and 6-step gate drivers • 3.3 V/12 V regulators • 13 and 3 shunt architectures • Bootloader for FW on-the-field upgrade	8	45	0.6	4	15
STSPIN32F0A		6.6			3	16
STSPIN32F0B					1	20

MAIN APPLICATIONS

- Power tools
- Battery powered home appliances
- Fans and pumps
- Drones and aeromodelling
- Robotics
- E-bikes

STSPIN32F0 SERIES OF HIGH-VOLTAGE BLDC CONTROLLERS WITH EMBEDDED STM32 MCU

The **high-voltage STSPIN32F0 series** extends the flexibility and all features of STM32-based motor controllers to high-voltage applications. Four pin-to-pin system-in-package integrating an STM32 Cortex-M0 MCU and high voltage 3-phase gate drivers, with an embedded smartShutDown feature.

These advanced, 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 controller's high scalability in home appliances and industrial applications, designers can easily develop and reuse their current hardware and firmware in all applications fitting main voltage supplies (100 and 220 V_{AC}), without having to change PCBs.

Product	Desription	V_{IN} min (V)	V_{IN} max (V)	V_{OUT} max (V)	I_{GATE} (A)
STSPIN32F09251	250 V 3-phase driver with STM32	9	20	250 V	0.35
STSPIN32F0252					1
STSPIN32F0601	600 V 3-phase driver with STM32	9	20	600 V	0.35
STSPIN32F0602					1

MAIN APPLICATIONS

- Compressors, pumps and fans
- Home appliances
- Industrial automation and control
- Power and garden tools
- Air conditioning

STSPIN32G4 SERIES OF LOW-VOLTAGE 3-PHASE MOTOR CONTROLLERS WITH EMBEDDED STM32G4 MCU

The low-voltage **STSPIN32G4** series of extremely integrated and flexible motor controller for driving 3-phase brushless motors, helps designers choose the most suitable driving mode and reduce PCB area and overall BoM costs. It embeds a triple half-bridge gate driver able to drive power MOSFETs with a current capability of 1 A (sink and source). Three bootstrap diodes are also embedded.

The high- and low-side switches of the same half-bridge cannot be simultaneously kdriven high, thanks to an integrated interlocking function. An additional protection feature is represented by hardware VDS monitoring circuitry that constantly check each of the six external MOSFETs and in case an overvoltage is detected across one of them, switches off all gate drivers outputs. The overvoltage threshold is set through a dedicated short-circuit protection threshold (SCREF) pin.

An internal high-precision low-drop linear regulator (LDO) is used to generate the 3.3 V supply (VREG3V3) starting from the regulator input voltage. The 3.3 V output voltage supplies both the gate driver logic and the MCU. It is protected against short-circuit, overload and undervoltage conditions.

The integrated MCU (STM32G431VBx3) is based on the high-performance 32-bit Arm Cortex-M4 core, operating at a frequency up to 170 MHz and featuring a single-precision floating-point unit (FPU), full set of DSP (digital signal processing) instructions and a memory protection unit (MPU) which enhances the security.

Finally, with an additional external 3-phase driver (i.e. the STDRIVE101) two independent 3-phase BLDC motors can be efficiently driven from the STSPIN32G4, offering an unprecedent BoM saving and overall optimization.

Product	Desription	V_{IN} min (V)	V_{IN} max (V)	I_{GATE} (A)
STSPIN32G4	Advanced BLDC controller with embedded STM32 MCU	5.5	75	1

MAIN APPLICATIONS

- E-bikes
- Industrial automation
- Power tools
- Robotics and drones
- Battery powered home appliances
- Pumps and fans

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 ideal for 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
- Stage lighting

Stepper motor drivers

Part number	Package	General description	$R_{DS(on)}$ (Ω)	Supply voltage (V)		Output Current-Max (A) RMS
				Min.	Max.	
STSPIN948	VFQFPN 7x7x1	58 V stepper motor driver 200 mΩ	0.2	5	58	-
powerSTEP01	VFQFPN 11x14x1	System-in-package integrating microstepping controller and 10 A power MOSFETs	0.016	7.5	85	10
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
L6228	PowerSO 36, SO24	Stepper motor driver with embedded current control	0.7	8	52	1.4
L6228Q	VFQFPN 32 5x5x1.0					
L6219	SO24	Stepper motor driver	-	10	46	0.75
L6482	HTSSOP38	Stepper controller with SPI, motion engine, gate drivers and advanced current control featuring 128 microsteps	-	7.5	85	-
L6480			-			-
L6258EX	PowerSO36	PWM controlled high current DMOS universal motor drive	0.6	12	40	1.5
L297	PDIP 20; SO-20	Stepper motor controller	-	4.75	7	-

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
				Min.	Max.		
STSPIN948	VFQFPN 7x7x1	58 V dual DC motor driver 200 mΩ (single 100 mΩ)	0,2	5	58	4.5	7
STSPIN958	VFQFPN 5x5x1 mm.	58 V single DC motor driver 200 mΩ					
PWD5F60	VFQFPN 15x7x1 mm.	High voltage full bridge with integrated comparators	1.4	10	600	5	14
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
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
				Min.	Max.		
STSPIN32G4	VFQFPN 64 9x9x1	High performance 3-phase motor controller with embedded STM32G4, DC-DC, dual motor control	-	5.5	75	-	1
STSPIN32F0	VFQFPN 48 7x7x1	Advanced BLDC controller with embedded STM32, DC-DC; optimized for FOC	-	8	45	-	0.6
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
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 TOOL'S 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 custom firmware thanks to the embedded microcontroller.

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

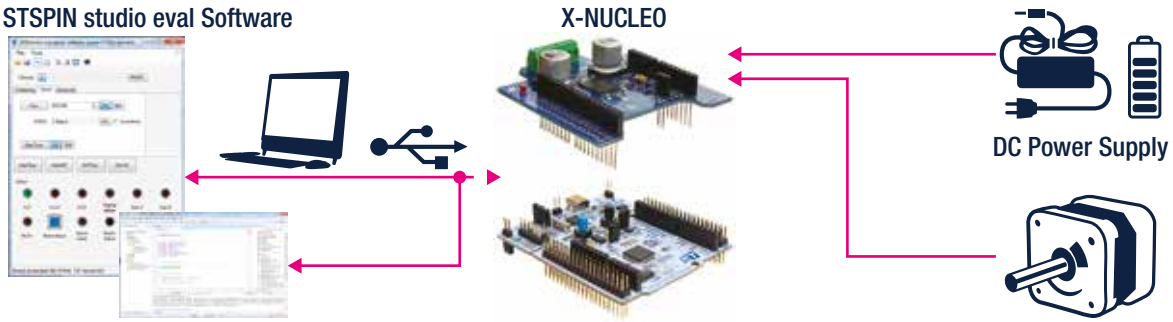
Software suites are also provided to enable quick and easy development of motor driving solutions.

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

STM32 expansion boards (X-Nucleo) 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.



Find your X-Nucleo now on st.com/x-nucleo

STSPIN STUDIO SOFTWARE

STSPIN Studio – part number **STSW-STSPIN01** – is an easy-to-use software for the evaluation of brushed DC and stepper motors with the STSPIN family devices.

It allows the proper command for several evaluation boards of stepper and brush DC motor drivers while three-phase brushless DC motors can be configured with the STM32 ecosystem previously detailed in this document.

STSPIN STUDIO software platform allows to investigate a wide range of final applications through an intuitive GUI where the user can control and monitor motor operation.

Its main purpose is to set parameters to apply the proper control of the motor and optimize the performance of the final application.

STSPIN Studio can also manage the on-line updating, allowing the user to easily download the last version of firmware for each device, ensuring the best performances.

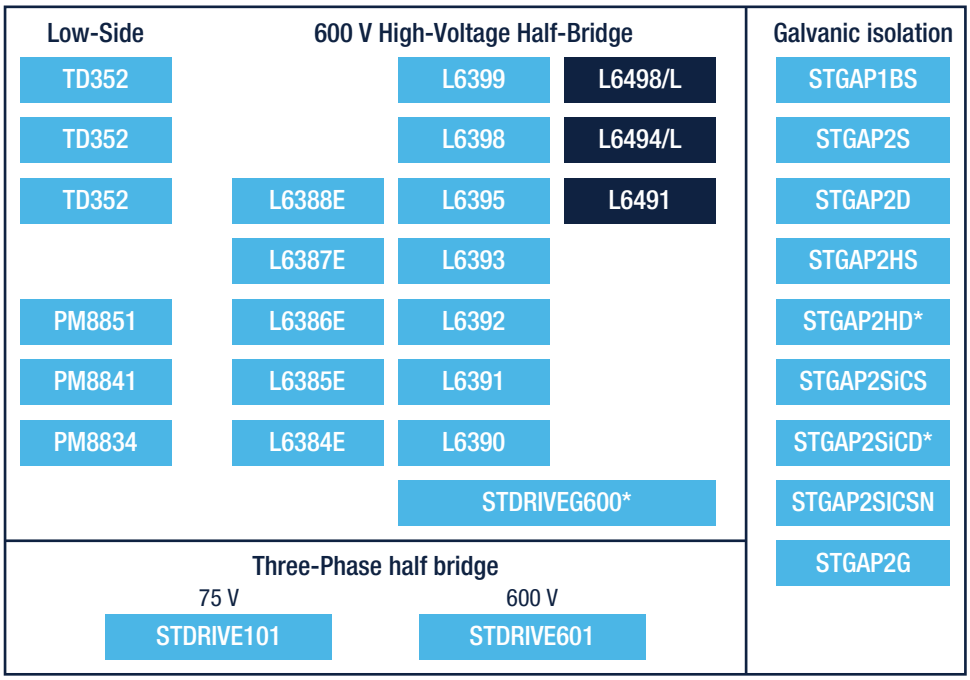
STSPIN Studio can be used with STM32 Nucleo board development platform, to quickly evaluate and start a development with the expansion board of STSPIN device family.

Additionally, a brand-new platform of interchangeable plug-in boards has been released to make the evaluation even easier. Evaluation main board are designed to hold plug-in boards for the STSPIN2, STSPIN8, STSPIN9, L62 and L64 families creating a single hardware platform to be used in combination with STSPIN STUDIO.

STSPIN STUDIO works also in combination with general-purpose evaluation boards of those families.

GATE DRIVERS

The **STDRIVE** and STGAP families cover devices with higher ratings for motion control systems. Available in a wide selection of current output drive capabilities and configurations – independently driven high and low side or with on-chip dead time – the STDRIVE high voltage drivers include on-chip op amps and comparators to help design converter protection circuits.



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

Note: * Short to come

STDRIVE high voltage half-bridge gate drivers

Our 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) (all nominal values)				Operating temperature (°C)		Package
							on V_{CC} ON	on V_{CC} OFF	on V_{Boot} ON	on V_{Boot} OFF	Min	Max	
A6387	18	Interlocking function	Bootstrap diode	0.65	HIN, LIN	Automotive	6.0	5.5	-	-	-40	125	SO-8
L6384E	17	UVLO	Adjustable deadtime, Bootstrap diode	0.65	SD, Single IN	Industrial	12	10	-	-	-40	125	DIP-8 SO-8
L6385E	17	UVLO	Bootstrap diode	0.65	HIN, LIN	Industrial	9.6	8.3	9.5	8.2	-40	125	DIP-8 SO-8
L6386AD	17	UVLO, Comparator	Bootstrap diode	0.65	HIN, LIN, SD	Industrial	9.6	8.3	-	8.2	-40	125	SO-14
L6386E	17	UVLO, Comparator	Bootstrap diode	0.65	HIN, LIN, SD	Industrial	12	10	11.9	9.9	-40	125	SO-14
L6387E	17	UVLO, Interlocking function	Bootstrap diode	0.65	HIN, LIN	Industrial	6	5.5	-	-	-40	125	DIP-8 SO-8

Part number	Supply Voltage (V) max	Protection Option Type	Key features	Output current max (A)	Input configuration	Grade	Undervoltage lockout (V) (all nominal values)				Operating temperature (°C)		Package
							on V_{CC} ON	on V_{CC} OFF	on V_{Boot} ON	on V_{Boot} OFF	Min	Max	
L6388E	17	UVLO, Interlocking function	Adjustable deadtime, Bootstrap diode	0.65	HIN, LIN	Industrial	9.6	8.3	9.5	8.2	-40	125	DIP-8 SO-8
L6389E	17	UVLO, Interlocking function	Adjustable deadtime, Bootstrap diode	0.65	HIN, LIN	Industrial	9.6	8.3	9.5	8.2	-40	125	DIP-8 SO-8
L6390	20	UVLO, Comparator, Interlocking function, Smart shutdown	Adjustable deadtime, Bootstrap diode, Operational Amplifier	0.43	HIN, LIN, SD	Industrial	12	10.5	11.5	10	-40	125	SO-16
L6391	20	UVLO, Comparator, Interlocking function, Smart shutdown	Adjustable deadtime, Bootstrap diode	0.43	HIN, LIN, SD	Industrial	12	10.5	11.5	10	-40	125	SO-14
L6392	20	Interlocking function	Adjustable deadtime, Bootstrap diode, Operational Amplifier	0.43	HIN, LIN, SD	Industrial	12	10.5	11.5	10	-40	125	SO-14
L6393	20	Comparator	Adjustable deadtime, Bootstrap diode	0.43	SD	Industrial	9.5	8	9	8	-40	125	SO-14
L6395	20	-	Bootstrap diode	0.43	HIN, LIN	Industrial	9.5	8.8	8.6	8	-40	125	SO-8
L6398	20	Interlocking function	Bootstrap diode	0.43	HIN, LIN	Industrial	9.5	8.8	9	8	-40	125	DIP-8 SO-8
L6399	20	Interlocking function	Bootstrap diode	0.43	HIN, LIN	Industrial	9.5	8	9	9	-40	125	SO-8
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	SO-14
L6494	20	UVLO	Adjustable deadtime, Bootstrap diode	2	HIN, LIN, SD	Industrial	9.3	8.7	8.6	8	-40	125	SO-14
L6498	20	UVLO, Interlocking function	Bootstrap diode	2	HIN, LIN, SD	Industrial	9.3	8.7	8.6	8	-40	125	SO-8 SO-14
TD350E	26	UVLO, Miller Clamp, 2 level turn off, DESAT	-	2.3	-	Industrial	-	-	-	-	-40	125	SO-14
TD351	26	UVLO, Miller Clamp, 2 level turn off	-	1.7	-	Industrial	-	-	-	-	-40	125	SO-8
TD352	26	UVLO, Miller Clamp, DESAT	Adjustable deadtime	1.7	-	Industrial	-	-	-	-	-40	125	SO-8

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	Supply Voltage (V) max	Protection Option Type	Key features	Output current max (A)	Input configuration	Grade	Undervoltage lockout (V) (all nominal values)				Operating temperature (°C)		Package
							on V_{CC} ON	on V_{CC} OFF	on V_{Boot} ON	on V_{Boot} OFF	Min	Max	
STDRIVE101	36	UVLO, Comparator, VDS monitoring	Bootstrap diode	0.6	INH, INL IN, EN	Industrial	5.5	5.4	5	4.9	-40	125	VFQFN-24
STDRIVE601	21	UVLO, Comparator, Interlocking function, Smart shutdown	Bootstrap diode	0.35	HIN, LIN, SD	Industrial	8.5	8	8	7.5	-40	125	SO-28

STGAP family

STGAP is a platform of isolated gate drivers with embedded isolation which provides robustness and noise immunity. A silicon isolation is used to transfer effectively signals between input and output. STGAP includes dedicated products able to drive properly IGBT, MOSFET, SiC or GaN.

Part number	Supply Voltage (V) max	Max GND to GND_ISO Voltage (V)	Protection Option Type	Key features	Output current max (A)	Input configuration	Grade	UVLO (V)		Operating temperature (°C)		Package
								(on V_{CC} ON) nom	(on V_{CC} OFF) nom	Min	Max	
STGAP1BS	36	1500	Miller Clamp, DESAT, Overcurrent detection, 2 level turn off, VCE overvoltage protection, Temperature warning, Shutdown protection, UVLO, OVLO	4 kV galvanic isolation, Adjustable deadtime, Thermal shutdown	5	IN+, IN-	Automotive	4.1	3.8	-40	125	SO-24
STGAP2SM	26	1700	UVLO, Miller Clamp, Shutdown protection	1.7 kV functional isolation, Thermal shutdown	4	IN+, IN-	Industrial	9.1	8.4	-40	125	SO-8
STGAP2SCM	26	1700	UVLO, Separated outputs, Shutdown protection	1.7 kV functional isolation, Thermal shutdown	4	IN+, IN-	Industrial	9.1	8.4	-40	125	SO-8
STGAP2HSM	26	1200	UVLO, Miller Clamp, Shutdown protection	6 kV galvanic isolation, Thermal shutdown	4	IN+, IN-	Industrial	9.1	8.4	-40	125	SO-8W
STGAP2HSCM	26	1200	UVLO, Separated outputs, Shutdown protection	6 kV galvanic isolation, Thermal shutdown	4	IN+, IN-	Industrial	9.1	8.4	-40	125	SO-8W
STGAP2DM	26	1200	UVLO, Shutdown protection	6 kV galvanic isolation, Thermal shutdown	4	IN+, IN- SD, BRAKE	Industrial	9.1	8.4	-40	125	SO-16
STGAP2HDM*	26	1200	UVLO, Separated outputs, Miller Clamp, Shutdown protection	6 kV galvanic isolation, Thermal shutdown	4	IN+, IN- SD, BRAKE	Industrial	9.1	8.4	-40	125	SO-36 4 pin left

Note: * Short to come

SIC and GaN gate drivers

SiC and GaN power switches are addressed by some products with dedicated performances.

Part number	Supply Voltage (V) max	Protection Option Type	Key features	Output current max (A)	Input configuration	Grade	Undervoltage lockout (V) (all nominal values)				Operating temperature (°C)		Package
							on V_{CC} ON	on V_{CC} OFF	on V_{Boot} ON	on V_{Boot} OFF	Min	Max	
STGAP2SiCS	26	UVLO, Miller Clamp, Shutdown protection	Thermal shutdown	4	IN+, IN-	Industrial	9.1	8.4	-	-	-40	125	SO-8
STGAP2SiCSC													
STGAP2SiCD	26	UVLO, Separated outputs, Miller Clamp, Shutdown protection	Thermal shutdown	4	IN+, IN- SD, BRAKE	Industrial	9.1	8.4	-	-	-40	125	SO-36 4 pin left
STDRIVEG600	21	UVLO, Separated outputs, Interlocking function	Bootstrap diode	5.5	HIN, LIN, SD	Industrial	4.5	4.2	-	-	-40	125	SO-16
STGAP2SICSN	26	UVLO, Separate Output, Shutdown protection	Thermal shutdown	4	IN+, IN-	Industrial	9.1	8.4	-	-	-40	125	SO-8N
STGAP2SICSNC	26	UVLO, Miller Clamp, Shutdown protection	Thermal shutdown	4	IN+, IN-	Industrial	9.1	8.4	-	-	-40	125	SO-8N
STGAP2GS	26	UVLO, Separate Output, Shutdown protection	Thermal shutdown	4	IN+, IN-	Industrial	4.5	4.4	-	-	-40	125	SO-8
STGAP2GSN													

Evaluation Boards

Here is a list of the most commonly used evaluation boards. For a full list of available boards and tools, please visit **www.st.com**.

Order code	Supply Voltage (V) max	Package
EVAL6393	L6393D	600 V full-bridge reference design featuring L6393; suitable for FANs and DC motors control
EVAL6491HB	L6491D	Evaluation board for L6491 gate driver
EVALSTGAP1S	STGAP1BS	Evaluation board for STGAP1BS galvanically isolated 1.5 kV gate driver
STEVAL-IHM021V2	L6390D	100 W 3-phase inverter reference design for FOC controlled PMSM, based on L6390 advanced half bridge gate driver and MOSFET
STEVAL-IHM023V3	L6390D	1 kW 3-phase reference design for single shunt FOC controlled PMSM, based on L6390 advanced half bridge gate driver and IGBT
STEVAL-IHM032V1	L6391D, L6392D	150 W 3-phase inverter reference design for FOC and trapezoidal control: based on L6391 and L6392 advanced half-bridge gate drivers and IGBT
EVALSTGAP2HS	STGAP2HSM STGAP2HSCM	Half-bridge configuration to evaluate 2 sample of STGAP2HSM or STGAP2HSCM
EVALSTGAP2SICS	STGAP2SiCS STGAP2SiCSC	Half-bridge configuration to evaluate 2 sample of STGAP2SiCSM or STGAP2SiCSCM
EVALSTDRIVE601	STDRIVE601	Demonstration board for STDRIVE601 triple gate driver
EVALSTDRIVE101	STDRIVE101	Demonstration board for STDRIVE101 triple gate driver up to 20 A load

STEVAL-IHM032V1

EVALSTGAP2HS

EVAL6491HB

In many cases, several evaluation tools are associated to one single part number. This is the case of our STDRIVE101 triple half-bridge gate driver, where the EVALSTDRIVE101 evaluation board is connected in a multiple configuration.

Evaluation software

USB

NUCLEO-F303RE

EVALSTDRIVE101

Galvanic Isolated Sigma-Delta Modulators

Galvanic isolated analog to digital converters play a fundamental role in the industrial market where power and digital worlds must live together.

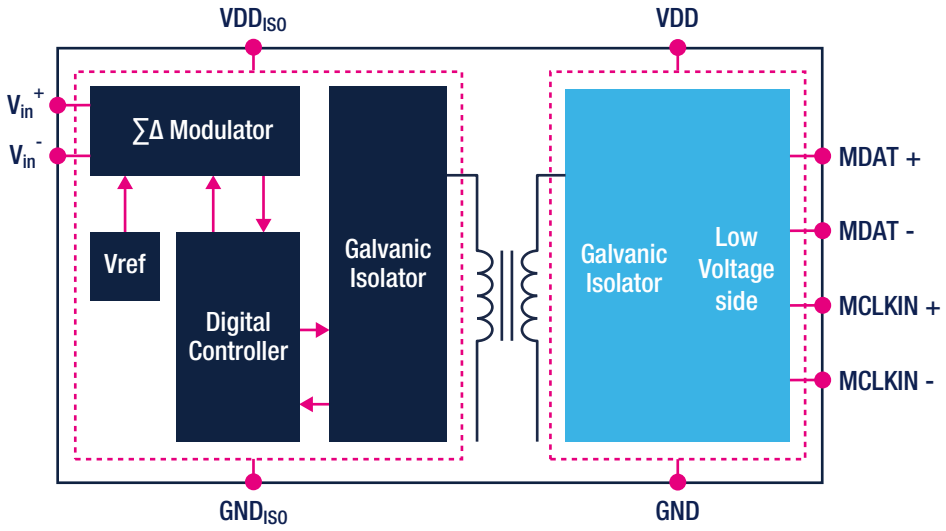
In servo drive applications, stand-alone analog to digital modulator is typically used to sense and convert in digital 1-bit streaming the phase currents, the phase-to-phase voltages and the DC Bus voltage of the motor processable by the host controller.

Hence ∑Δ AD converters must be very accurate, immune to noise and ensure reliability in harsh environment, with the goal of prolonging as much as possible system lifetime.

Combining the afore-mentioned functionalities with thick oxide silicon-based isolation it is possible to guarantee the needed application safety against human shocks, prevent ground potential difference or ground loop (by eliminating stray currents flowing between power system and digital system that cause data communication errors), and keep high rejection against fast noise transients.

Thanks to the very accurate and robust galvanically isolated ∑Δ modulators such as the ISOSD61, the host controller can drive the motor in real time and in a very precise way in terms of position, speed and torque.

At application level typical combination of ∑Δ 1-bit modulator and shunt are the perfect choice to achieve the best compromise for high precision, low cost, and low form factor solution in place of Hall Effect sensors.



KEY PRODUCT FEATURES

- 16-bit Resolution
- ±320mV Input Range
- ±250mV Input Linear Range
- Up to 25 MHz external clock
- 50kHz Bandwidth
- 86 dB typical SNR
- - 83 dB typical THD
- 30 kV/µs typical CMTI
- 6kV PEAK Isolation (VIOTM)
- 1.2kV PEAK Working Voltage (VIORM)
- LVDS and TTL options
- SO16 wide package

Development tools

A variety of evaluation boards and reference designs are available to help you develop applications based on ST's portfolio of galvanically isolated modulators.

Part Number	Version	Linear Imput Range	Max. clock frequency	Resolution	SNR	Isolation	CMTI	Package & Packaging
ISOSD61	TTL/CMOS	±250 mV	25 MHz	16-bit	86 dB	6 kV	30 kV/us	SO16W Tray
ISOSD61TR	TTL/CMOS							SO16W Tape & Reel
ISOSD61L	LVDS							SO16W Tray
ISOSD61LTR	LVDS							SO16W Tape & Reel

Based on the ISOSD61 galvanically isolated sigma-delta modulator with low-voltage differential signaling (LVDS) and single-ended (TTL/CMOS) options, the EVALST-ISOSD61T board comes with all the necessary documentation and resources to reduce evaluation and design phases.

The EVALST-3PHISOSD evaluation board implements a complete 3-phase current sensing platform based on low-cost shunt sensors. The input analog signal is oversampled by ISOSD61 and converted into an output bitstreams, thanks to the embedded firmware which exploits the DFSDM filters of the STM32F413 micro to convert the three bitstreams into 24-bit current data at a selectable sampling rate.
The firmware also implements a virtual COM port communication to easily access the internal parameters to read data and to calibrate the board.

A complete library of technical documentation including datasheets, application notes, user manuals, gerber files, and schematics is available for developers.

EVALST-3PHISOSD

EVALST-ISOSD61T

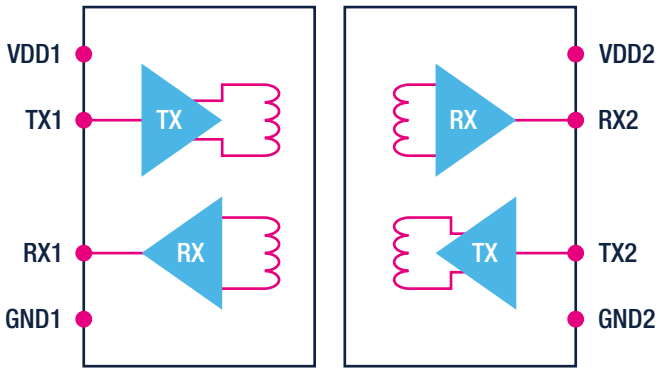
DIGITAL ISOLATORS

Galvanic isolation is a fundamental function in motor control applications. ST offers galvanic isolation integrated in key products targeting motor control applications, such as drivers and current sensors, nevertheless, depending on selected application architectures or for specific sections in the system, standard digital isolators transferring digital signal between two different voltage domains, which must be isolated galvanically for functional or safety reasons, could be selected by application designers.

Leveraging on ST's 6 kV thick-oxide galvanic-isolation technology, STISO62x are dual-channel digital isolators which are equipped with Schmitt trigger input, providing robustness to noise and very high speed (100 Mbps) input/output switching time with an exceptional low pulse distortion (<3ns).

STISO620 has 2 both channels with the same directionality, while STISO621 and STISO621W have isolated digital channels in the opposite directionality.

STISO620 and STISO621 are offered in SO8 narrow body package option with 4 mm creepage and clearance values, 4 kVpk impulse withstand voltage (VIOTM) and 2830 Vrms isolation voltage (VISO). STISO621W features SO8 wide package with 8 mm creepage and clearance and up 6 kVpk impulse withstand voltage (VIOTM) and 3536 Vrms isolation voltage (VISO). The part numbers support a high rate of maximum working isolation voltage (VIOWM=849 Vrms). Isolation key parameters have been tested in accordance with VDE0884-10 and UL 1577 standards and the products have been certified by UL.



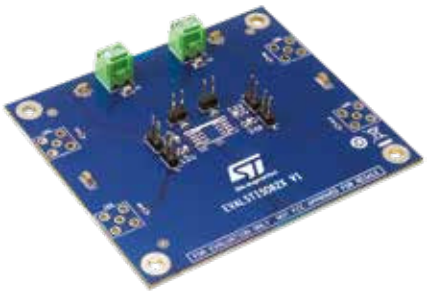
STISO621/STISO621W/STISO620 KEY FEATURES

- Dual channel, digital isolators with 1 – 1 and 2 - 0 channel direction
- Up to 6 kV peak isolation (VIOTM)
- 1.2 kV peak working voltage (VIORM)
- High common-mode transient immunity: >50 kV/µs
- Data rate up to 100 Mbps
- Pulse width distortion: < 3ns
- 3 to 5.5 V supplies
- 3.3 V and 5V level translation
- –40 to +125°C extended industrial temperature range
- SO8 narrow-body and wide package options (STISO621W)
- UL1577 Certified (File Number: E362869)

Part Number	Viotm	Viso	Creepage/Clearance	Data Rate	CMTI min	Package & packing
STISO620	4k Vpk	2828 Vrms	4 mm	100 Mbps	50 kV/us	SO8 Narrow Tube
STISO620TR						SO8 Narrow Tape & Real
STISO621						SO8 Narrow Tube
STISO621TR						SO8 Narrow Tape & Real
STISO621W	6k Vpk	3536 Vrms	8 mm			SO8 Wide Tube
STISO621WTR						SO8 Wide Tape & Real

Development tools

The ST dual-channel digital platform can be evaluated by EVALSTISO62XV1 product evaluation board.



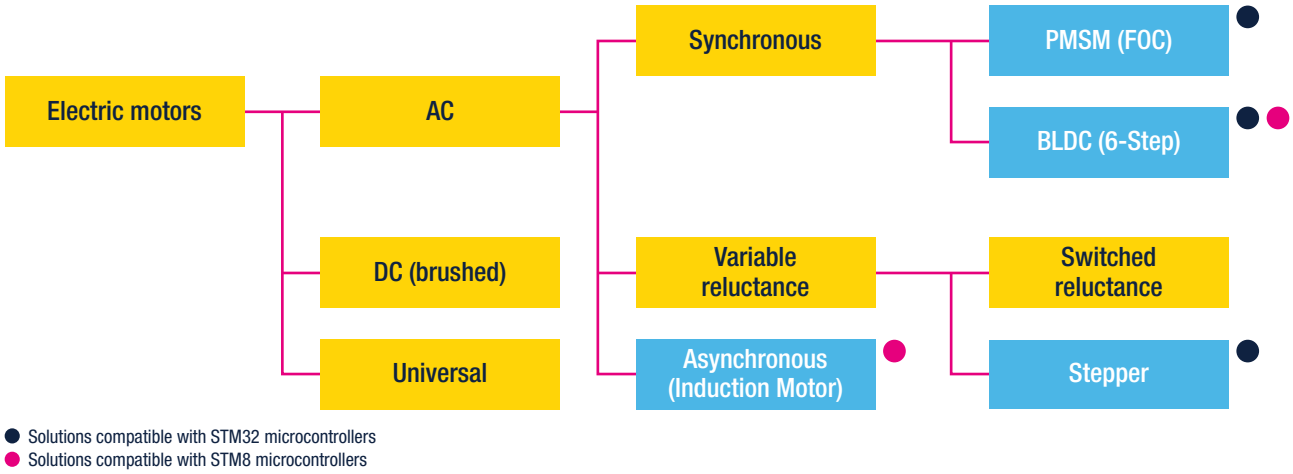
STM32 ECOSYSTEM FOR MOTOR CONTROL

From HW boards, SW tools and embedded SW to training resources and documentations, the STM32 ecosystem offers many materials to ease the development of motor control applications.

- Large STM32/STM8 (32bit/8bit) MCU portfolio, industrial grade, supporting Motor Control requirements
- Tailored digital and analog peripherals
- Large set of embedded features (present in the MC-SDK) to cope with different application needs

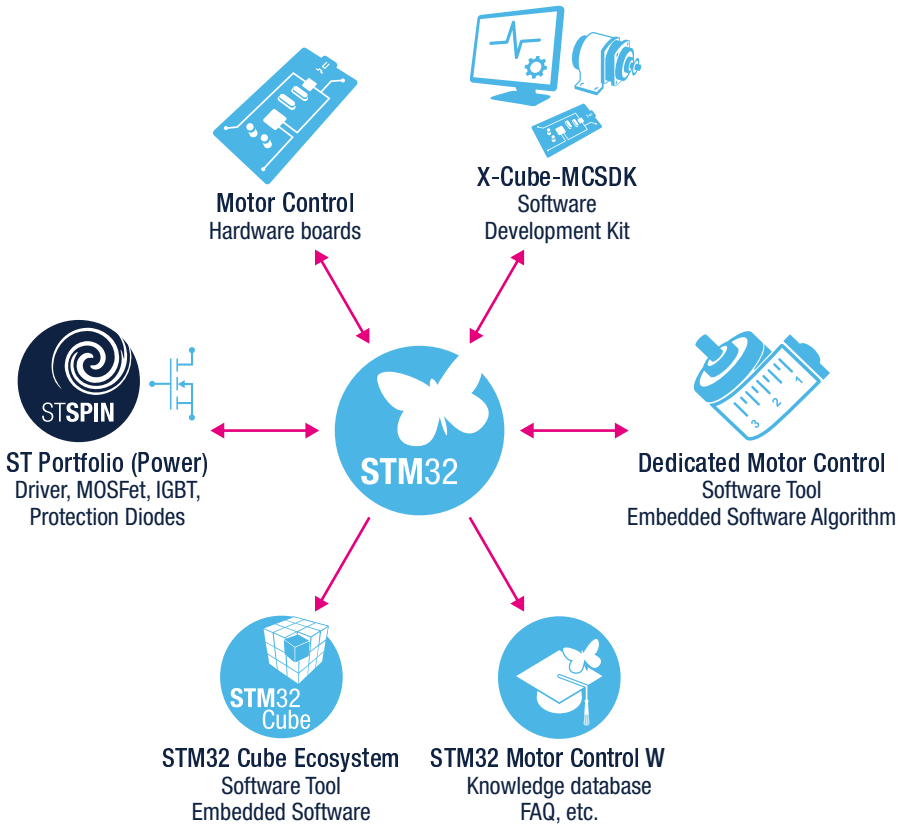
STM32 MCUs are particularly suitable to develop Permanent Magnet Synchronous Motors (**PMSM**), Brushless DC motors (BLDC), AC induction motors (ACIM), and Stepper motors.

Motor control type supported by the STM32 and STM8 Motor control ecosystem

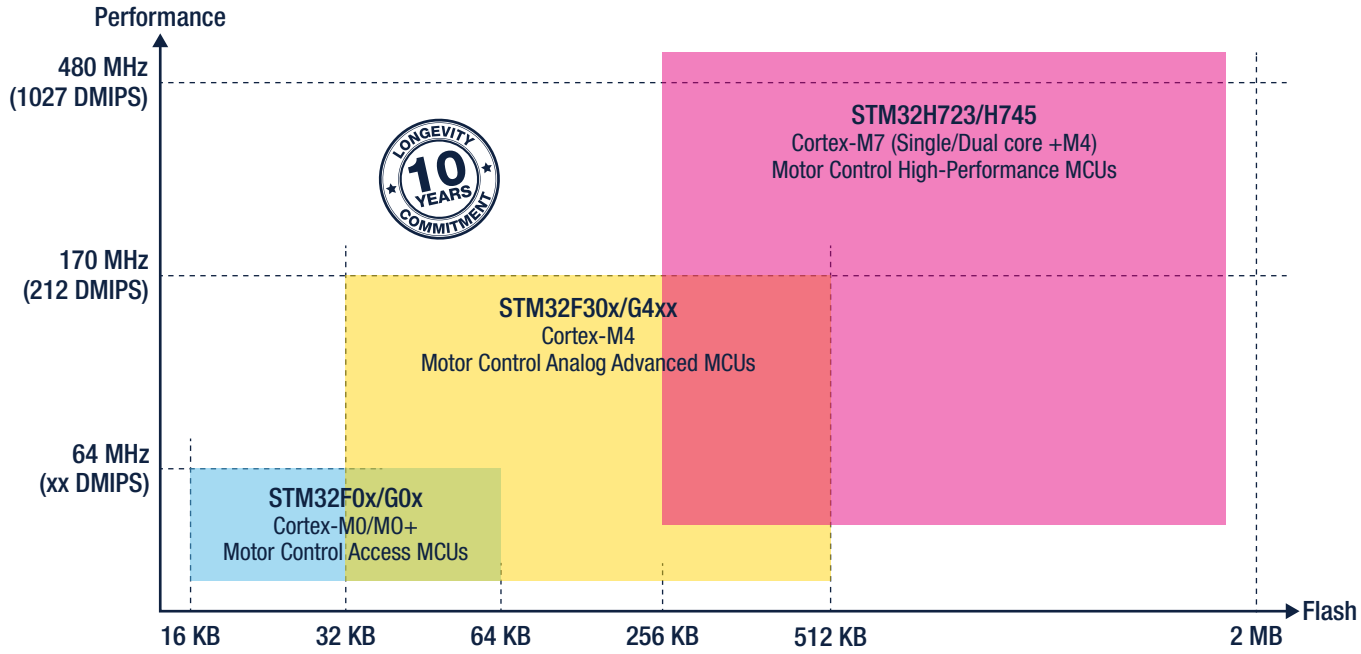


Motor control Ecosystem

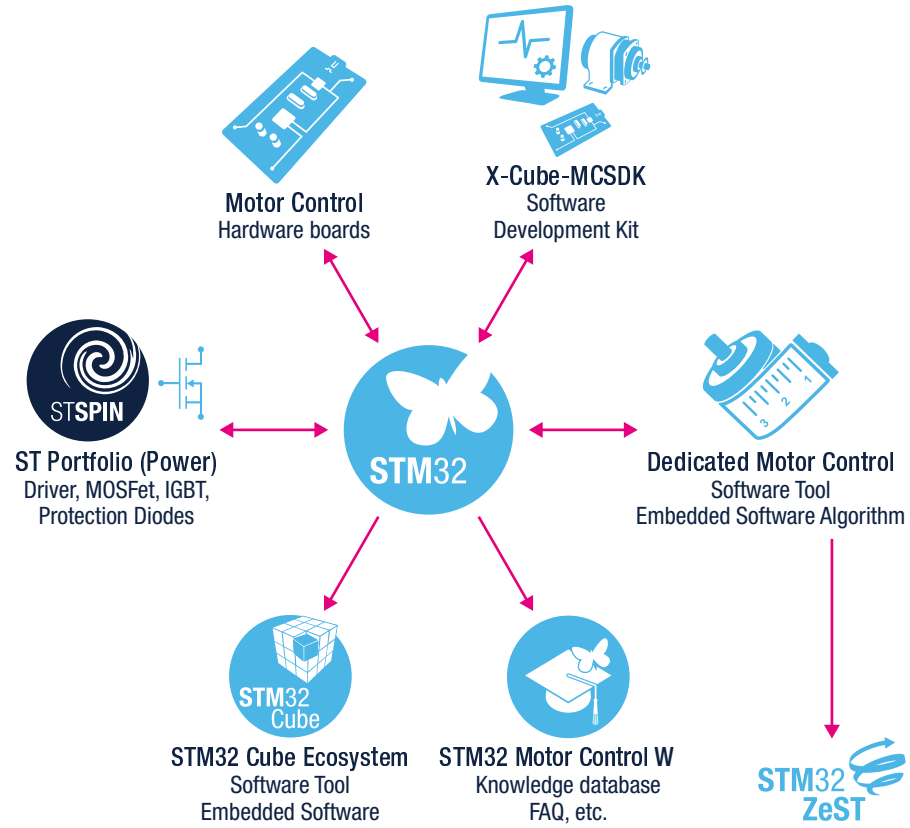
STM32 tools and software provide an integrated development environment to ease and support the design of motor control solutions. Learn more on **st.com/stm32-motor-control**



STM32 MCU flagships for Motor Control applications



Development Flow



Software tools

STM32Cube & X-CUBE-MCSDK (including MC-WorkBench)

STM32Cube is a free set of tools and embedded software bricks for STM32 microcontrollers and microprocessors addressing all the needs of a complete project development cycle. It includes the STM32CubeMX configuration tool which enables the generation of C initialization code for Cortex-M cores.

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

The X-CUBE-MCSDK is a software development kit for 6-step BLDC motors/PMSM (FOC) solutions including a Motor Control firmware library, software tools and graphical user interface.

The Motor Control Workbench, embedded in the X-CUBE-MCSDK, is a graphical user interface used to configure the Motor Control library. The Motor Profiler, embedded in the X-CUBE-MCSDK, is a software tool that automatically measures the electrical parameters of PMSM and BLDC motors. It can be used to run an unknown motor from scratch in only few minutes.

The Motor Pilot, embedded in the X-CUBE-MCSDK, is a software tool, with a customizable user interface, that allows to do real time monitoring, and tuning of motor-control applications.

Embedded Software

The Motor Control library, embedded in the X-CUBE-MCSDK, is based on HAL and/or LL driver from STM32Cube. It is configured through its GUI: Motor Control Workbench.

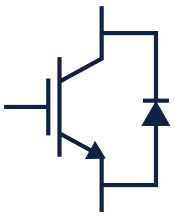
Features/SW algorithms available in the Motor Control FW library on different STM32 MCUs

STM32 series		F0	F1	F3	F4	F7	L4	G0	G4	H7	C0	H5	STSpin32F0/G4	High bandwidth 1.84 mbd
Current sensing and over current protection OCP	Current 1-shunt or 3-shunt	•	•	•	•	•	•	•	•				•	
	Insulated Current Sensing		•	•	•	•			•					
	Embedded comparators OCP, Op Amps			•					•					
Speed/Position sensing	Sensor (Hall, Encoder)/Sensor-less	•	•	•	•	•	•	•	•				•	
Bus Voltage sensing/ protection UVP/OVP	V_{bus} 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)			•	•									
Six Step	Full support	•						•	•		•		•	
ACIM	Configured through WB, Example only								•					
Sensor-less Mode	STO/PLL, STO/Cordic (Luenberger)	•		•	•	•	•	•	•	•	•	•	•	
	HSO (High Speed Observer)								•					
Control mode	Torque/Speed/Position control	•	•	•	•	•	•	•	•				•	
Other features	MTPA, Flux weakening, Feed Forward	•	•	•	•	•	•	•	•				•	
	PFC – FW support		•	•										
	Discontinuous PWM	•		•	•	•	•	•	•	•	•	•	•	
	Over Modulation and Single shunt phase shift	•		•	•	•	•	•	•	•	•	•	•	
	Monitor control pilot - MC Protocol V2													•
	IOC reading capability	•		•	•	•	•	•	•	•	•	•	•	

Hardware Tools

Hardware tools to evaluate STM32 MCUs in different Motor Control environments (in terms of power range) are available.

IGBTs, POWER MOSFETs AND SiC MOSFETs



IGBTs AND POWER MOSFETs

ST's portfolio of Insulated Gate Bipolar Transistors (IGBT) contains a comprehensive range of devices based on various process technologies with breakdown voltages from 300 to 1250 V and higher, offered as bare dice and/or as discrete components. Our technology portfolio:

- Planar punch-through (PT) IGBTs
- Automotive-grade IGBTs (AEC-Q101)
- Trench-gate field-stop (TFS) IGBTs

ST's IGBTs feature the best trade-off between conduction and switch-off energy loss tailored for different applications:

- General-purpose inverters
- UPS
- Automotive
- Motor control
- Welding and induction heating
- Home appliances
- Solar inverters

Naming convention for trench-gate field-stop (TFS) products:

STG	WA	50	M	65	D	F	2	AG

Available package

B	D²PAK
D	DPAK
H...-2	H2PAK
F	TO-220FP
FW	TO-3PF
P	TO-220
W	TO-247
WA	TO-247 long Leads
WT	TO-247-4
YA	Max247 Long Leads

Nominal Device Current

IGBT series

H	600 V, Medium speed (8 ÷ 30 kHz)
H...B(2)	High speed (16 ÷ 60 kHz)
HP...B(2)	H...B(2) with protection diode
V	Very high speed (50 ÷ 100 kHz)
M	Low loss (2 ÷ 20 kHz)
S	Low drop (up to 8 kHz)
H	1200 V, High speed (20 ÷ 100 kHz)
IH	Soft switching (16 ÷ 60 kHz)

Breakdown voltage ÷ 10

Technology Generation

F	Trench gate field stop technology

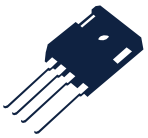
Diode Options

D	Very fast recovery
DH	Half-rated diode
DL	Low forward voltage for soft-switching applications only

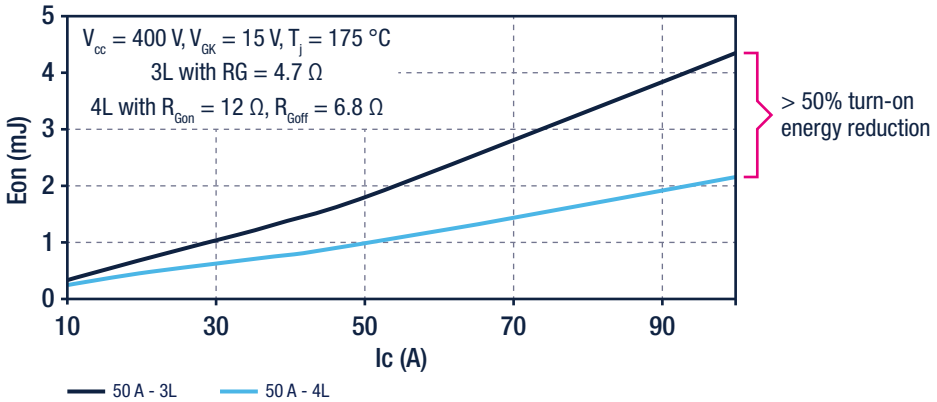
Qualification

AG	Automotive grade
Blank	Industrial grade

Improve your application efficiency with TO247-4 package: separating emitter pin into driving emitter (kelvin) and power emitter, this new package will reduce parasitic stray inductance contribution, with a great benefit in turn on switching losses, as shown in the diagram below (**STGW50H65DFB2-4**, turn-on switching comparison, 3 vs 4 leads configuration).



E_{ON} vs I_C between 3 Leads and 4 Leads in 50 A device



TO247-4 products:

IGBT P/N	BV_{CES}	I_{CN}	$V_{CE(sat)}$ @ I_{Cnom}	E_{off} @ I_{Cnom}	E_{on} @ I_{Cnom}	R_{th}	FRD Option
	(V)	(A)	(V)	(mJ)	(mJ)	°C/W	
STGW50H65DFB2-4	650	50	1.55	0.48	0.63	0.55	Very Fast
STGW75H65DFB2-4		75	1.55	0.77	0.99	0.42	Very Fast
STGW100H65FB2-4		100	1.55	1.14	1	0.34	-

For further information about our IGBT product portfolio, visit www.st.com/IGBT or download our IGBT Finder smartphone app:

Download on the App Store

GET IT ON Google Play

ST's offering of power MOSFETs includes hundreds of devices. The naming convention below highlights the diversity of our portfolio with its different packages and our latest silicon technologies.

ST	x	20	N	95	y	K5

Package

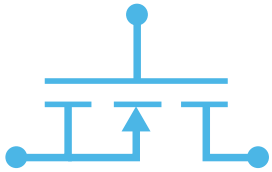
R	SOT-23
T	SOT-23-6L
N	SOT-223
S	SO-8
D	DPAK ("D..T4" for older P/N)
L	PowerFLAT 2x2; 3.3x3.3; 5x5; 5x6; 8x8
LD	PowerFLAT dual side cooling
B	D^2PAK ("B..T4" for older P/N)
E	ISOTOP
F	TO-220FP
FH	TO-220FP wide creepage
FI	I^2PAKFP
FU	TO-220FP narrow leads
FW	TO-3PF
H	H^2PAK-2 H^2PAK-6
I	I^2PAK
K	LFPAK
O	TO-LL
P	TO-220
Q	TO-92
U	IPAK (-S for short leads)
V	PowerSO-10
W	TO-247 (-4 for 4 leads)
WA	TO-247 long leads
Y	Max247®

Indicative current range

Breakdown voltage ÷ 10 (with the exception of non 10 multiples)

Channel polarity

N	N-channel
P	P-channel
N...N	Two different N-channel dice
N...P	Complementary pair
DN or DP	Dual N-Ch or dual P-Ch



Technology

H5	STripFET H5 (12 V, 30 V)
H6	STripFET H6 (-30 V, 30 V)
F3	STripFET F3 (40 V to 100 V)
F5	STripFET F5 (40 V)
F6	STripFET F6 (-100 V to 80 V)
F7	STripFET F7 (40 V to 100 V)
M2	MDmesh M2 (400 V to 650 V)
DM2	MDmesh DM2 Series ≥ 400 up to 650 V
M2-EP	MDmesh M2 EP (650 V)
M6	MDmesh M6 (≥ 650 V up to 700 V
M5	MDmesh M5 (550 V, 650 V)
K3	SuperMESH K3 ≥ 400 V
K5	MDmesh K5 (800 V to 1500 V)
DK5	MDmesh DK5 (≥ 950 V up to 1050 V)

Special features

C	Current sensing
D	Fast recovery diode
L/LL	Logic level 4.5 V drive optimized
T	Temperature sensing
V	Super logic level (2.5 V - 2.7 V drive)
Z	Clamped by Zener diode (33 V)

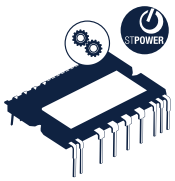
Based on the advanced and innovative properties of wide bandgap materials, ST's silicon carbide (SiC) MOSFETs feature very low $R_{DS(on)}$* area for the 1200 V rating combined with excellent switching performance, translating into more efficient and compact systems. Compared with silicon MOSFETs, SiC MOSFETs exhibit low on-state resistance* area and excellent switching performances in all temperature ranges, simplifying the thermal design of power electronic systems.

The main features and benefits of our SiC MOSFETs include:

- Very high temperature handling capability (T_{jmax} = 200 °C) leading to reduced PCB form factors (simplified thermal management) as well as improved system reliability
- Significantly reduced switching losses (minimal variation versus temperature) resulting in more compact designs (with smaller passive components)
- Low on-state resistance resulting in higher system efficiency (reduced cooling requirements)
- Simple to drive (cost-effective network driving)
- Very fast and robust intrinsic body diode (no need for external freewheeling diode, thus more compact systems)

Part number	V_{DSS} (V)	I_{Dmax} (A) (@ 25 °C)	$R_{DS(on)}$ (max (Ω) (@ V_{GS} = 20 V)	Total gate charge Qg typ (nC)	T_{jmax} (°C)	Package
SCTW90N65G2V	650	119	0.018	157	200	HiP247™
SCTWA90N65G2V	650	119	0.018	157	200	HiP247™ Long Leads
SCTH90N65G2V-7	650	119	0.018	157	175	H2PAK-7
SCTW35N65G2V	650	45	0.055	73	200	HiP247™
SCTWA35N65G2V	650	45	0.055	73	200	HiP247™ Long Leads
SCTH35N65G2V-7	650	45	0.055	73	175	H2PAK-7
SCTW70N120G2V	1200	80	0.025	150	200	HiP247™
SCTH70N120G2V-7	1200	80	0.025	150	175	H2PAK-7
SCTW40N120G2V	1200	45	0.07	61	200	HiP247™
SCTWA40N120G2	1200	45	0.07	61	200	HiP247™ Long Leads
SCTH40N120G2V-7	1200	45	0.07	61	175	H2PAK-7
SCTW60N120G2	1200	60	0.04	101	200	HiP247™
SCTH60N120G2-7	1200	60	0.04	101	175	H2PAK-7
SCT1000N170	1700	6	1	11	200	HiP247™
SCTWA1000N170	1700	6	1	11	200	HiP247™ Long Leads
SCT20N170	1700	25	0.064	101	200	HiP247™
SCTWA20N170	1700	25	0.064	101	200	HiP247™ Long Leads

POWER MODULES



Intelligent Power Modules

The SLLIMM (small low-loss intelligent molded module) families of compact, high efficiency, dual-in-line Intelligent Power Modules (IPM), ensure optional extra features. They provide a high-integrated level that means simplified circuit design, reduced BOM, smaller weight, and high reliability. 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 energies with an outstanding robustness and EMI behavior, thus enhancing the efficiency of 3-phase inverter and any motor drives working up to 20 kHz in hard-switching circuitries and for an application power range from 10 W to 7 kW.

SLLIMM nano SMD	SLLIMM nano	SLLIMM nano 2nd series	SLLIMM 2nd series	SLLIMM HP*
600 V IGBT 500 V MOSFET 1 up to 3 A	600 V IGBT 500 V MOSFET 1 up to 3 A	600 V IGBT 600 V SJ-MOSFET 3 up to 8 A	600 V IGBT 600 V SJ-MOSFET 8 up to 35 A	IGBT 650 V, 50 A 1200 V, 10 A
				
NSDIP-26L (SMD) 12.45 x 29.15 x 3.10 mm	NDIP-26L (TH) 12.45 x 29.15 x 3.10 mm	N2DIP-26L (TH) 12.45 x 32.15 x 4.10 mm	SDIP2F-26L SDIP2B-26L 24 x 38 x 3.5 mm	SDIPHP-30L 31x 52 x 5.6 mm
Power rating: 10 W ÷ 70 W	Power rating: 70 W ÷ 100 W	Power rating: 100 W ÷ 500 W	Power rating: 500 W ÷ 3 kW	Power rating: 2.5 kW ÷ 5 kW

Note: * In development

ACEPACK™ Power Modules

ACEPACK™ (Adaptable Compact Easier package) product portfolio including ACEPACK 1 and ACEPACK 2 based on IGBT or SiC MOSFET is conceived to address industrial applications such as industrial motor drives, solar panels, charging stations, welding and power management solutions (DC-DC, AC-DC converters for UPS, charger, etc.).

The 2 Power Modules, ACEPACK 1 and ACEPACK 2, IGBT based are available in Six pack and converter inverter brake (CIB) topologies.

Two packages, ACEPACK™ 1 and ACEPACK™ 2 have been introduced, both with Six-pack and converter inverter brake (CIB) topologies.

The new SiC-based power modules are available in several topologies such as fourpack, half-bridge, sixpack and converter inverter brake (CIB) topologies ensuring a compact design and costeffective system.

A new evaluation board, 25 kW Dual active bridge reference design, for battery charging application, is going to be released. The board using the new SiC-based power modules offer very high efficiency while providing a modular approach for high flexibility in system development.

ACEPACK™1

ACEPACK™2

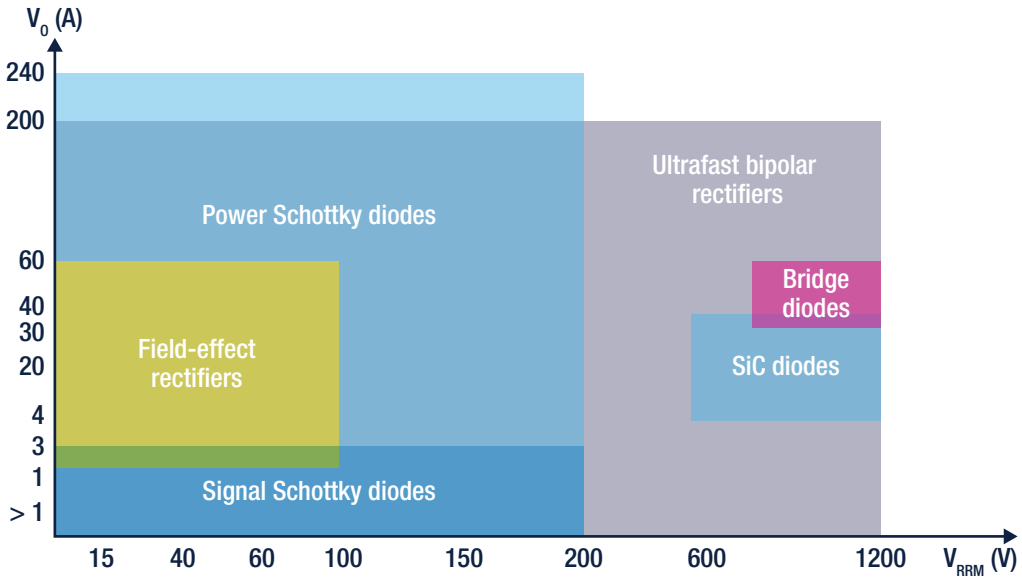
DIODES AND SiC RECTIFIERS

ST offers Schottky and ultrafast rectifier solutions for all market requirements. ST's latest developments include our M series, based on Schottky technology, with improved avalanche rating and the integration of higher currents in 1 mm thick packages, such as SOD-123F, SOD-128F, PSMC, SMA Flat, and SMB Flat.

Our range of small signal Schottky diodes with flip-chip packages helps meet the most stringent space saving requirements, especially for portable communication equipment. For high-efficiency rectification or freewheeling functions, our new field-effect rectifier diodes, the FERD family improve the power density capability of converters.

For power converter applications where silicon diodes reach the limits of their operating temperature and power density, ST offers the low VF and high surge series of silicon carbide rectifiers.

AEC-Q101 automotive-grade qualified diodes and rectifiers >



ST's silicon-carbide diodes take advantage of SiC's superior physical characteristics over silicon, with 4 times better dynamic characteristics and 15% less forward voltage (VF).

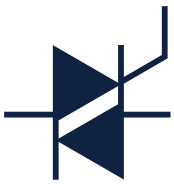
Their low reverse recovery characteristics make ST's SiC diodes a key contributor to energy savings in SMPS applications and in emerging domains such as solar energy conversion, EV or HEV charging stations, and other applications such as welding equipment and air conditioners.

ST's SiC product portfolio is now up to 40 A at 650 V and in the range from 6 to 20 A at 1200 V, housed in DPAK HV and TO-220AC packages.

SiC

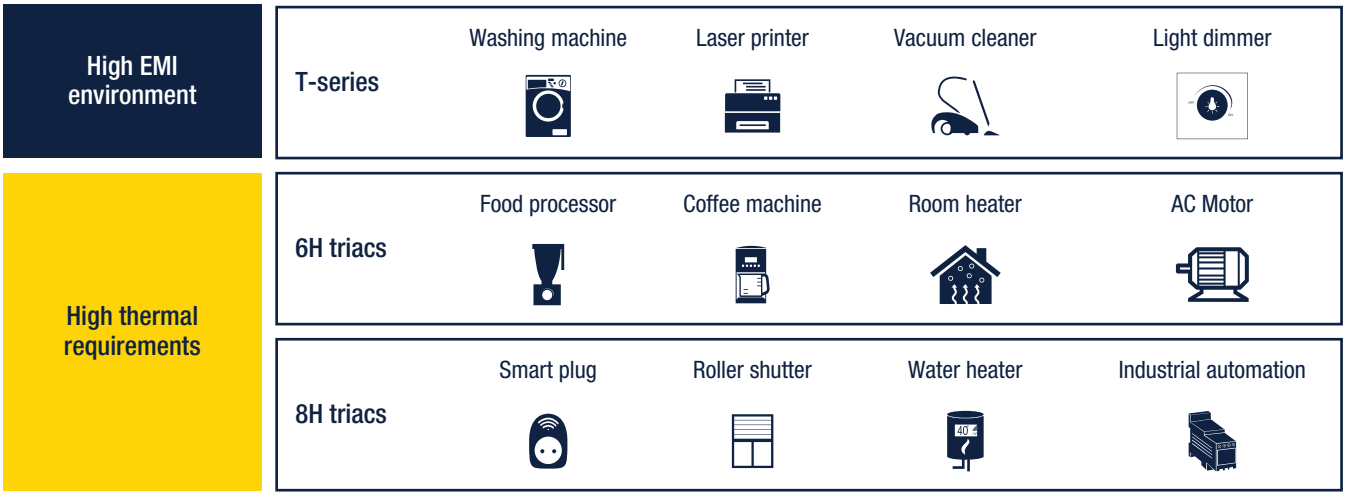
ST introduces Trench Schottky Diodes to provide more power integration in compact packages. It enables space saving on board and efficient operation at high switching frequencies.

THYRISTORS AND AC SWITCHES



For low-power industrial applications (current rating < 25 A), ST has developed overvoltage-protected AC switches, high-temperature H series TRIACs and high-voltage operation TRIACs and alternistors.

Every application needs the right TRIAC or AC switch. The following table provides ST's recommended series for industrial applications and not only:



ACST AC switch: Overvoltage protection and high application robustness

The ACST series, with integrated overvoltage crowbar protection and snubberless™ operations, eliminates the need for additional external protection to support IEC 61000-4-4 and IEC 61000-4-5 standards (Control Board Compliance). It makes for easier design, smaller boards and therefore more cost-effective projects.

The ACST AC switches can handle surges of 2000 V with a clamping voltage (V_{CL}) of 850 V.

Part number	Package					$I_{T(RMS)}$	V_{DRM}/V_{RRM}	I_{GT}	I_{TSM}	dV/dt	(dI/dt)c	Max. T_J
						Max (A)	Max (V)	Max (mA)	Max (A)	Min (V/µs)	Min (A/ms)	Max (°C)
	DPAK	D2PAK	TO-220AB	TO-220AB	Full Pack	RMS on-state current	Repetitive peak off-state voltage	Triggering gate current	Non repetitive surge peak on-state current	Rising Ratio Of Off Voltage	Rate of decrease of on-state current	Junction Temperature
Logic level (Direct MCU drive)												
ACST210-8	B				FP	2	800	10	8	500	0.5	125
ACST310-8	B					3			20	500	1	
ACST410-8	B				FP	4			30	500	2	
ACST610-8		G	T		FP	6			45	500	3.5	
ACST1010-7		G				10	700		100	200	4	
ACST1210-7		G				12			120	200	5	
Snubberless (I_{GT} > 20 mA)												
ACST435-8	B					4	800	35	30	1000	5	125
ACST830-8		G	T		FP	8		30	80	2000	8	
ACST1035-7		G				10	700	35	100	2000	12	
ACST1220		G				12						
ACST1235-7		G				12			120	2000	14	
High-temperature Snubberless												
ACST1235-8					FP	12	800	35	120	2000	6	150
ACST1635-8					FP	16			140	300	4	

ACST SERIES YOUR DESIGN, SIMPLIFIED

- Auto-protected against AC line overvoltage surges
- Enables compliance with IEC 61000-4-4 and -4-5 disturbances
- No need for additional components (RC network, MOV)
- Easy control board design

H Series TRIACs: High Temperature and High Application Robustness

The H Series TRIACs are specified for a maximum junction temperature of 150 °C. They are particularly suited to hot environments and to PCB designs requiring high power density, with a current rating up to 30 A. They are available in D²PAK and TO-220 packages.

These “No Compromise, no nonsense” devices offer high thermal cycling performance and high turn-off commutation capability, making them the most rugged range of TRIACs in the industry.

All the part numbers listed in the following table operate at T_{jmax} = 150 °C.

	Part number	Package: TO-220AB	Package: TO-220AB Insulated	Package: D²PAK	$I_{T(RMS)}$ A Max	T_J °C Max	V_{DRM}/V_{RRM} V Max	I_{GT} mA Max	I_{TSM} A Max	dV/dt V/µs @150 °C Min	(dI/dt)c A/ms @10 V/µs, @150 °C Min
	600 V, 10 mA Gate, Logic-Level Triacs										
6H-Series	T610H-6	T			6	150	600	10	60	75	2.3
	T810H-6	T		G	8				80	75	3
	T1010H-6	T		G	10				100	75	3.8
	T1610H-6	T			16				160	100	3
	600 V, 35 mA Gate, Snubberless Triacs										
6H-Series	T835H-6	T	I	G	8	150	600	35	80	1000	11
	T1035H-6	T	I	G	10				100		13
	T1235H-6	T	I	G	12				120		16
	T1635H-6	T	I	G	16				160		21
	T2035H-6	T	I	G	20				200		27
	T3035H-6	T	I	G	30				270		33
	600 V, 50 mA Gate, Snubberless Triacs										
6H-Series	T850H-6	T	I	G	8	150	600	50	80	1500	14
	T1050H-6	T	I	G	10				100		18
	T1250H-6	T	I	G	12				120		21
	T1650H-6	T	I	G	16				160		28
	T2050H-6	T		G	20				200		36
	T3050H-6	T	I	G	30				270		44
	800 V, 35 mA Gate, Snubberless Triacs										
6H-Series	T835H-8	T	I	G	8	150	800	35	80	1500	8
	T1235H-8	T	I	G	12				120		12
	T1635H-8	T	I	G	16				160		16
	T2035H-8	T	I	G	20				200		20
	T3035H-8	T	I	G	30				270		25

H SERIES
NO COMPROMISE, NO NONSENSE

- High reliability
- High turn-off performance
- High noise immunity
- High current density
- High current surge performance
- Heatsink reduction
- Surface Mount Design compatible D²PAK

Triac

- Controlled bridges
- AC switching
- Motor starters

IE3 Motor Starter

Heating

HVAC

Solid State Relay

SCR

- Controlled bridges
- AC switching
- Motor starters

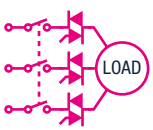
Critical Power UPS

Charging Station

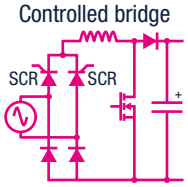
Renewable

Energy management

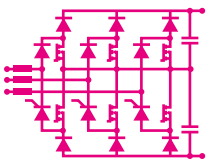
Motor soft starter



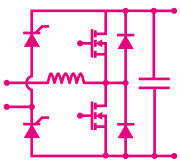
Controlled bridge



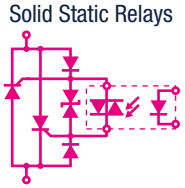
3-Phase Vienna



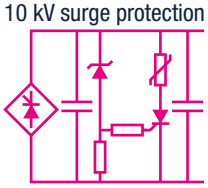
Totem Pole PFC Boost



Solid Static Relays



10 kV surge protection



High-voltage TRIACs: 1200 V capability and high application robustness

The new T2550-12 TRIAC has been designed for industrial applications such as 3-phase motor soft-starters, contactors and protectors, with the market's first 25 A, 50 mA, 1200 V TRIAC. Thanks to its high current robustness (withstands 6 million cycles of repetitive inrush current at 50 A), the T2550-12 prolongs the lifetime and extends the current rating of 3-phase motor starters and controllers. In its D²PAK package variant, it allows a more compact design compared to mechanical contactors.

Part number	Package	$I_{T(RMS)}$ A Max	V_{DRM}/V_{RRM} V Max	I_{TSM} A Max	I_{GT} mA Max	dV/dt V/µs Min	(dI/dt)c A/ms Min	T_J °C Max
12 A, 1200 V, 125 °C Triac								
TXDV1212	TO-220AB Ins.	12	1200	120	100	2000	30	125
25 A, 1200 V, 125 °C Triac								
T2550-12T	TO-220AB	25	1200	240	50	2500	20	125
T2550-12I	TO-220AB Ins.							
T2550-12G	D²PAK							
TPDV1225	TOP-3 Ins.			230	150	2000	88	
40 A, 1200 V, 125 °C Triac								
TPDV1240	TOP-3 Ins.	40	1200	350	200	500	142	125

T1225-12G SMD TRIAC FOR 1200 V APPLICATIONS

- Compact D²PAK package
- Robust turn-off commutation
- Outstanding immunity performance

SCR thyristors

ST is proud to offer the most innovative silicon-controlled rectifier (SCR) portfolio for industrial applications. Indeed, ST is the first to offer a sensitive SCR with 1250 V surge capability (TS110) as well as fully qualified automotive-grade SCR for medium power (**TN6050HP-12WY**).

	Part number	Package	RMS Current (A)	Triggering (mA)	Surge current (A)	dV/dt (V/µs)
Industrial Grade	**1200 V, 125 °C**					
	TYN1212RG	TO-220AB	12	15	120	200
	TN2540-12G	D²PAK	25	40	300	1500
	TYN1225RG	TO-220AB	25	40	300	1500
	BTW68-1200RG	TOP3-I	30	80	400	250
	TN4050-12PI	TOP3-I	40	50	400	500
	TN4050-12WL	TO-247 LL	40	50	400	500
	BTW69-1200N	TOP3	50	50	700	1000
	BTW69-1200RG	TOP3-I	50	80	580	1000
	TN6050-12PI	TOP3-I	60	50	700	2000
	TN6050-12WL	TO-247 LL	60	50	700	2000
	TN5050H-12PI	TOP3-I	50	50	450	1500
	TN8050H-12PI	TOP3-I	80	50	680	1500
Automotive Grade	**1200 V, 150 °C**					
	TN3050H-12GY	D²PAK	30	50	300	1000
	TN3050H-12WY	TO-247	30	50	300	1000
	TN6050HP-12WY	TO-247	60	50	600	1000

High surge capability SCR TS110

The TS110 is a unique offering for industrial automation. Thanks to highly sensitive triggering levels, it is suitable for circuit breaker applications where the available gate current is limited. Such applications include GFCI (ground fault circuit interrupter), AFCI (arc fault circuit interrupter), RCD (residual current device), and RCBO (residual current circuit breaker with overload protection).

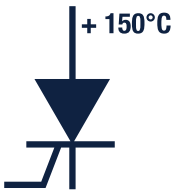
The 1250 V surge voltage capability of the TS110 enables high robustness of the whole circuit breaker. The low leakage current of the TS110 reduces power consumption over the entire lifetime of the circuit breaker.

	I_T	V			Sensitivity					Packages							
	Amp	600 V	800 V	1250 V	5 µA	50 µA	100 µA	150 µA	200 µA	TO-92	SMBFLAT-3L	SOT-223	SOT23	IPAK	DPAK	TO-220	TO-220FP
X and P01 Families																	
X006/P01	0.8	•			•	•			•	•		•					
X01	1	•						•			•		•				
X02	1.25	•	•			•			•	•	•	•					
X04	4	•	•			•			•					•	•		
TS Family																	
TS420	4	•							•					•	•	•	
TS820	8	•							•					•	•		•
TS1220	12	•							•					•	•		•
TS Family Overvoltage Protected																	
TS110	1.25			•			•			•	•						

TS110 ULTIMATE CIRCUIT BREAKER SCR

- Resists to applicative 5 kV surge & 4 kV burst tests
- Directly driven by RCD – AFCI circuit
- Low losses of the circuit breaker
- High surge current: 25 A – 10 ms

High-temperature SCR thyristors



Our high-temperature SCR series work at T_{jmax} = 150 °C. It is ideal, whether for mixed bridges in motor drive boards or for AC switch operations above 35 A (I_T (RMS)). The high-temperature SCR thyristor series is available in through-hole (for legacy designs) and SMD (for modern, compact designs) packages.

TN3050H-12GY, TN3050H-12WY and TN6050HP-12WY are fully qualified automotive-grade devices at T_j = 150 °C (AGAC).

	Part number	$I_{T(RMS)}$ A	I_{GT} mA	dV/dt @150 °C (V/µs)	T_q (µs)	I_{TSM} A	Package									Grade
							TO-220AB	TO-220FPAB	TO-220AB ins	TO-247	DPAK	D2PAK	D3PAK	H2PAK	HU3PAK	
600 V	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-6	40	15	500	85 typ	360	•		•			•				
	TN5015H-6	50	15	500	85 typ	450	•		•			•				
800 V	TN1605H-8	16	5 to 8	500	85 typ	160	•	•	•		•	•				
	TM8050H-8	80	50	1000	150 max	670				•			•			
	TN4035HA-8GY	40	35	2000	85 typ	300						•				Automotive
1200 V	TN3050H-12Y	30	50	1000	150 typ	300				•		•				Automotive
	TN3050HP-12L2Y	30	50	1000	150 typ	300									•	Automotive
	TN4050HP-12x2Y	40	50	1000	150 typ	300								•	•	Automotive
	TN4050HA-12GY	40	50	1000	150 typ	400						•				Automotive
	TN6050HP-12Y	60	50	1000	150 typ	600				•						Automotive

TN3050H-12GY: FIRST MEDIUM-POWER D²PAK AUTOMOTIVE SCR

- AGAC certified
- 150°C operating junction temperature
- 1200 V (direct, reverse)
- Reduced stand-by losses, lower leakage
- Compact cooling system

POWER MANAGEMENT ICs

Focus on AC/DC converters

ST's high-voltage AC-DC converters combine an advanced pulse width modulation (PWM) controller with a high-voltage power MOSFET in a single package. This makes them ideally suited for offline switch mode power supplies (SMPS) with output power spanning from a few to a few tens of watts.

The VIPerGaN series (VIPerGaN50, VIPerGaN65, VIPerGaN100) features a 650 V HEMT GaN and a Quasi Resonant PWM controller, designed to maximize efficiency and minimize losses. It comes in a tiny 5x5 QFN package pin to pin compatible and fully scalable among the three part numbers. The series is optimized for QR flyback controllers SSR.

The VIPerPlus series (VIPer0P, VIPer122, VIPer222 and VIPer*1, VIPer*5, VIPer*6, VIPer*7, VIPer*8 families) features an 800 V avalanche-rugged power MOSFET and leading-edge PWM controller and consumes less than 4 mW for VIPer0P, 10 mW for VIPer*1 and 30 mW in standby for the others. It also comes with the largest choice of protection schemes and supports different topologies.

The VIPer26K belongs to VIPer*6 family and integrates a 1050 V avalanche-rugged power MOSFET, suitable for cost effective 1-phase/3-phases smart meters, industrial systems and lighting power supplies.

The Altair series has a built-in 800/900 V avalanche-rugged power MOSFET and a PWM controller specifically designed to work in constant-current/constant-voltage primary-side regulation (PSR-CC/CV). It means opto-less implementation, thus significantly reducing component count.

VIPer

SUPPORTED TOPOLOGIES

- Isolated
  - Regulation with optocouplerusing all ICs
  - PSR-CV (VIPer0P, VIPer*1, VIPer*6)
  - PSR-CC/CV with high accuracy (ALTAIR)
- Non isolated MOSFET for high robustness
  - Flyback with direct feedback, buck, buck-boost (VIPer0P, VIPer*1, VIPer*6)

VIPERPLUS & ALTAIR

PWM controller + HV power MOSFET in the same package

- Up to 1050V AR MOSFET for high robustness
- Extreme-low consumption
- High integration level for minimal BoM
- Flexible and easy to use

Differentiators - Find the plus for your application

Quasi-resonant (up to 240 kHz)			VIPer series 5					VIPerGaN
Jittered frequency (30, 60 or 115/120 kHz)	VIPer0P	VIPer series 1		VIPer series 6	VIPer series 7	VIPer series 8	VIPer series x22	
Brown-out protection (settable)			VIPer series 5		VIPer series 7			VIPerGaN
Low input voltage (18 VDC)		VIPer series 1						
Extra power timer (peak power)						VIPer series 8		
Double-level OCP			VIPer series 5		VIPer series 7	VIPer series 8		
Feed forward compensation			VIPer series 5					VIPerGaN
Embedded E/A 3.3 V, 1.2 V (V*1 & V0P)	VIPer0P	VIPer series 1		VIPer series 6			VIPer series x22	
Floating E/A ground (for easy negative output setting)	VIPer0P							
Self-supply option (remove auxiliary winding)	VIPer0P	VIPer series 1		VIPer series 6			VIPer series x22	
Wide range V_{cc} (4.5 to 30 V)	VIPer0P	VIPer series 1					VIPer series x22	
V_{cc} protection	VIPer0P	VIPer series 1		VIPer series 6			VIPer series x22	VIPerGaN
Flux runaway protection (for low start up peak current)	VIPer0P	VIPer series 1						
Zero power mode (ZPM)	VIPer0P							
Input OVP (Overvoltage protection)		VIPer series 1						VIPerGaN
Output OVP (Overvoltage protection)		VIPer series 1	VIPer series 5		VIPer series 7	VIPer series 8		VIPerGaN
Input UVP		VIPer series 1						
PWM current mode using optocoupler VIPer series 1Cycle-by-cycle OCP Light load management (Burst mode/PFM) Soft start up Thermal shutdown Short-circuit protection Automatic restart after fault	VIPer0P 10 mW 4 mW (ZPM)	VIPer series 1 10 mW	VIPer series 5 30 mW	VIPer series 6 30 mW	VIPer series 7 30 mW	VIPer series 8 30 mW	VIPer series x22 40 mW	VIPerGaN 30 mW

Topologies - The best fit for the most common architectures

Isolated flyback	Primary Side Regulation (PSR)	VIPer0P	VIPer series 1		VIPer series 6			VIPer series x22	
	Secondary Side Regulation (SSR)	VIPer0P	VIPer series 1	VIPer series 5	VIPer series 6	VIPer series 7	VIPer series 8	VIPer series x22	VIPerGaN
Non-isolated	Flyback/buck/ buck boost	VIPer0P	VIPer series 1		VIPer series 6			VIPer series x22	

Focus on DC/DC converters

DC-DC converters for industrial buses offer a wide choice of input voltage ranges and features.

Our broad portfolio of ICs is composed of highly-specialized products to meet every market requirement and power management needs: high voltage technology, together with high reliability and robustness for industrial applications.

L6983 – 38 V 3 A

With a wide input-voltage range from 3.5 V to 38 V, L6983 converter is an efficient and flexible solution for 12 V and 24 V industrial bus-powered systems. This new synchronous DC/DC converter maintain high efficiency at all loads with a maximum value of 95% and have extremely low quiescent current of just 17 µA.

Low current consumption (L6983C) and low-noise (L6983N) variants are available in QFN 16L package.

ST has also released the **STEVAL-ISA208V1** (for the L6983C) and the **STEVAL-ISA209V1** (for the L6983N).

L7983 – 60 V 300 mA

The L7983 is the ideal solution for industrial bus-powered systems. This new synchronous DC/DC with an input-voltage range from 3.5 V to 60 V allows addressing specifications for 12 V, 24 V and 48 V bus standards. “Low Noise Mode” selection (LNM) allows to meet low noise application standard specification, while “Low Consumption Mode” selection (LCM) maximizes the efficiency at light load (10 µA Quiescient Current) with controlled output voltage ripple

Adjustable, 3.3 V and 5 V Output Voltage variants are available in DFN 10L package

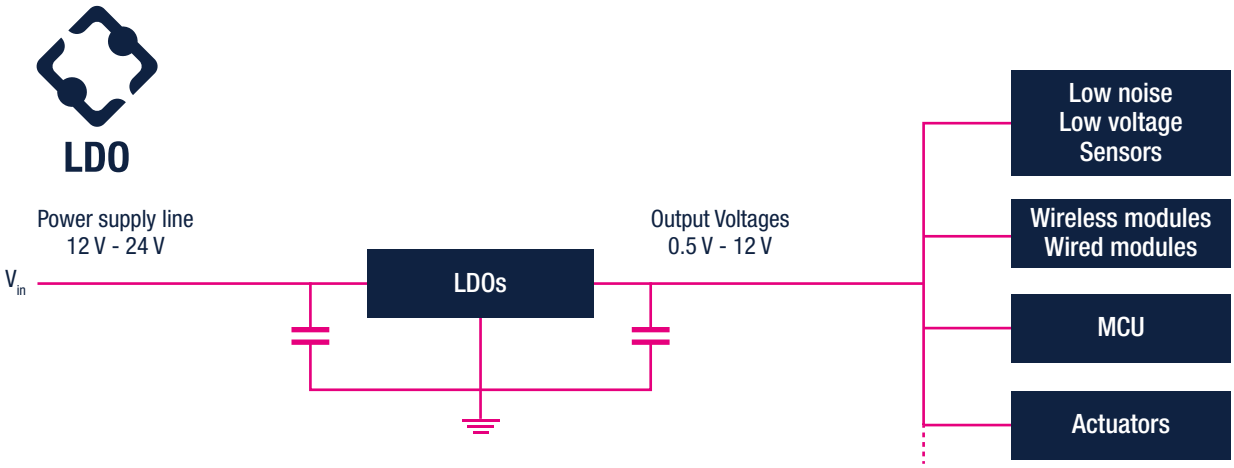
Part number	Package	Input Voltage (V) min	Input Voltage (V) max	Output Current-Max (A) nom	Rectification	Quiescent current (mA)	Switching frequency (kHz)
L6986I	HTSSOP16	4	38	1.9	Synchronous	1.5	225-1100
L6983I	QFPN	3.5	38	4.5	Synchronous	2.3	200-1000
L3751	QFN20 3.5 x 4.5	6	75	1.8	Synchronous	-	100-1000
ST1PS01	CSP P 0.4 mm	1.8	5.5	0.4	Synchronous	0.4	2000 max
ST1PS02	TQFN12	1.8	5.5	0.4	Synchronous	0.5	2000 max
ST1PS03	TQFN12	1.8	5.5	0.4	Synchronous	0.5	2000 max
STBB1A	DFN10 3 x 3	2	5.5	0.4	Synchronous	0.2	1500 max
L6983	QFPN 3 x 3 x 0.80 16L PITCH 0.50	3.5	38	3	Synchronous	0.017	200-2300
L6986	HTSSOP16	4	38	2	Synchronous	0.03	250-2000
L6986F	HTSSOP16	4	38	1.5	Synchronous	0.03	250-2000
L6986H	HTSSOP16	4	38	2	Synchronous	0.03	250-2000
L7980	DFN8 3 x 3, PowerSO-8	4.5	28	2	Asynchronous	2.4	250-1000
L7981	DFN8 3 x 3, PowerSO-8	4.5	28	3	Asynchronous	2.4	250-1000
L7985	DFN10 3 x 3, PowerSO-8	4.5	38	2	Asynchronous	2.4	250-1000
L7986	DFN10 3 x 3, PowerSO-8	4.5	38	3	Asynchronous	2.4	250-1000
L7986TA	PowerSO-8	4.5	38	3	Asynchronous	2.4	250-1000
L7983	DFN10 3 x 3	3.5	60	0.3	Synchronous	0.01	200 -2200
L7987	HTSSOP16	4.5	61	3	Asynchronous	1	250-1500
L7987L	HTSSOP16	4.5	61	2	Asynchronous	1	250-1500
L6902	SO-8	8	36	1	Asynchronous	2.5	250
ST1S03	DFN6 3 x 3	2.7	16	1.5	Asynchronous	2.5	1500
ST1S06	DFN6 3 x 3	2.7	5.5	1.5	Synchronous	1.5	1200-1800
ST1S09	DFN6 3 x 3	4.5	5.5	2	Synchronous	2.5	1200-1800
ST1S10	DFN8 4x4, PowerSO-8	2.7	18	3	Synchronous	1.5	400-1400
ST1S14	PowerSO-8	5.5	48	3	Asynchronous	2	1400
ST1S30	DFN8 4 x 4	2.7	6	3	Synchronous	2.5	1500
ST1S31	VFDFPN 8 3 x 3 x 1.0	2.8	5.5	3	Synchronous	0.63	1200-1900
ST1S32	DFN8 4 x 4	2.8	5.5	4	Synchronous	0.63	1200-1900
ST1S40	DFN8 4 x 4, PowerSO-8, SO-8	4	18	3	Synchronous	2.5	850
ST1S41	DFN8 4 x 4, PowerSO-8	4	18	4	Synchronous	1.5	850
ST1S50	DFN10 3 x 3	4	18	4	Synchronous	0.38	400-600
ST2S08B	QFN12 4 x 4	3	5.5	1.5	Synchronous	1.5	1200-1800

To fit critical requirements in sensing networks for factory automation, ST offers specific DC-DC converters such as the **SPV1040** (outdoor solar harvester with proprietary MPPT for loads up to about 3 W) and the **SPV1050** (indoor ultra-low power solar and TEG energy-harvester for any battery type and supercapacitor with embedded MPPT and LDOs for loads up to about 350 mW). The working principle of both devices is designed to extract the maximum energy from the source, while ensuring a fast and safe battery charge without shortening its lifetime

	Architecture	Harvesting Source	Target Battery	Other features	Evaluation tool
SPV1040	Boost	PV	Any type*	Over-current and Over-temperature protection, Input reverse polarity protection	STEVAL-ISV006V2, STEVAL-ISV012V1
SPV1050	Boost/Buck-Boost	PV and TEG	Any type (including supercap)	Over-voltage and under-voltage battery protection, 2 embedded LDOs (1.8 and 3.3 V)	STDES-IDS002V1, STDES-IDS003V1

Note: * CC-CV battery charger is needed to apply a lithium battery charging profile

Part Number	Maximum current (mA)	Quiscent current (µA)	Typ V_{drop} at max load (mV)	Input Voltage range (V)	PSRR typ @ 1 kHz	Noise (μV_{RMS})	Package	Feature
STLQ50	50	3.5	400	2.3-12	30	560	SOT323-5L	Ultra low Iq
LDK715	85	5	500	4.3-24	45	95	SOT23-5L, DFN8 3 x 3	Ultra low Iq, High Vin
ST715	85	3.8	500	2.5-24	45	95	SOT23-5L, DFN8 3 x 3	Ultra low Iq, High Vin
LD39015	150	18	80	1.5-5.5	65	29	SOT23-5L, Flip Chip 4	High PSRR, Tiny Package
LD39115	150	20	80	1.5-5.5	74	30	Flip Chip 4	High PSRR, Tiny Package
LD59015	150	31	150	2.3-5.5	76	20	SOT323-5L	High PSRR, Low noise
LDCL015	150	120	50	1.8-5.5	52	40	SOT23-5L	Capless
LDLN015	150	35	86	2.1-5.5	92	6.3	DFN6 2 x 2	High PSRR, Ultra Low noise
STLQ015	150	1	115	1.5-5.5	40	75	SOT23-5L	Ultra low Iq
LD39020	200	20	200	1.5-5.5	80	45	SOT23-5L, DFN4 1 x 1	High PSRR, Tiny Package
LD56020	200	18	190	1.1-5.5	95	8.8	Flip-chip4, SOT23-5L	Low input voltage, ultra low noise
LDK120	200	30	150	1.9-5.5	60	51	SOT23-5L, SOT323-5L, DFN6 1.2 x 1.3	Cost effective, Tiny Package
LDBL20	200	20	200	1.5-5.5	80	45	STSTAMPTM	High PSRR, Tiny Package
LDK220	200	55	200	2.5-13.2	55	20	SOT23-5L, SOT323-5L, SOT-89, DFN6 1.2 x 1.3	Cost effective, Tiny Package
LDK320	200	60	200	2.5-18	65	60	SOT23-5L, SOT-89	Cost effective, High PSRR
LDLN030	300	16	150	1.5-5.5	65	7.5	TSOT23-5L	High PSRR, Low noise
STLQ020	200	0.3	160	2-5.5	40	135	DFN6 2 x 2, Flip Chip 4	Ultra Low Iq, Tiny Package
LDLN025	250	12	120	1.5-5.5	65	6.5	DFN4 1x1, Flip Chip 4	High PSRR, Ultra Low noise
LD39030	300	20	300	1.5-5.5	80	45	DFN4 1 x 1	High PSRR, Tiny Package
ST730/32	300	5	600	2.5-28	75	70	SOT23-5L	Low Iq, High PSRR
LD39030SJ	300	20	200	1.5-5.5	62	30	Flip Chip 4	High PSRR, Tiny Package
LD39130S	300	1	300	1.4-5.5	70	38	DFN4 1.2 x 1.3, Flip Chip 4	Ultra Low Iq, Tiny Package
LDK130	300	30	200	1.9-5.5	60	51	SOT23-5L, SOT323-5L, DFN6 1.2 x 1.3	Cost effective, Tiny Package
LDFM	500	150	125	2.5-16	62	45	DFN6 2 x 2, DFN6 3 x 3, DPAK, PPAK	High Vin
ST1L08	800	35	70	1-5.5	80	45	DFN8 2 x 3	Ultra LDO, High PSRR
LDF	1000	150	200	2.6-16	62	45	DFN6 2 x 2, DFN6 3 x 3, DPAK, PPAK	High Vin
LD57100	1000	35	40	$V_{out}+V_{drop}$ to 5.5	86	27	Flip Chip 6b	Ultra low drop with bias
LD39100	1000	20	200	1.5-5.5	65	30	DFN6 3 x 3	Low noise, Low Iq
LDL112	1200	35	350	1.6-5.5	57	135	DFN6 2 x 2, DFN6 3 x 3, SO-8, PPAK	Low Iq, Reverse Current protection
LDL212	1200	250	350	2.5-18	70	75	DFN6 2 x 2, DFN6 3 x 3, SO-8	Cost Effective, High PSRR
LD39200	2000	100	110	1.25-6	70	45	DFN6 3 x 3, DFN8 4 x 4	Ultra LDO, High PSRR, Reverse Current protection



ST voltage regulators app

The ST Vreg app (ST-VREG-FINDER) is a free all-in-one smart selector for smartphones and tablets. You can select the products that fit your application needs from among our Linear and switching voltage regulators and Voltage reference portfolios.

The app includes a parametric search engine and a browser by product family, for easy sorting and filtering. Once you have made your selection, share the relevant documentation by mail or social media, check the availability of samples and order them in few clicks!

Download from the App Store or Google Play

Download on the App Store

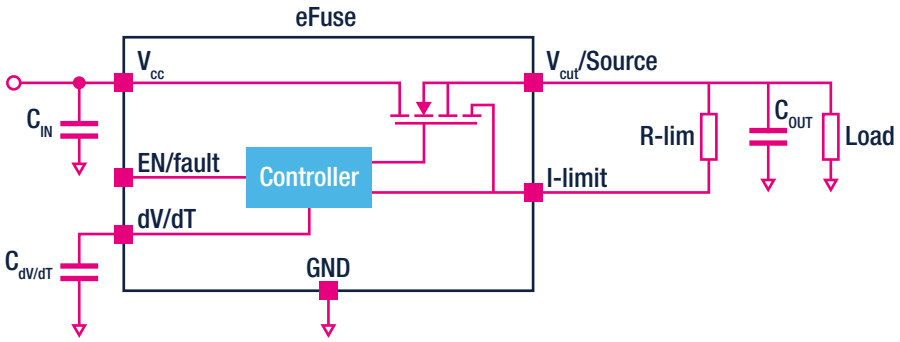
GET IT ON Google Play

The ST Vreg Finder is available on Google Play and App Store
www.st.com/vreg-finder

ST offers a very broad portfolio of power management ICs.

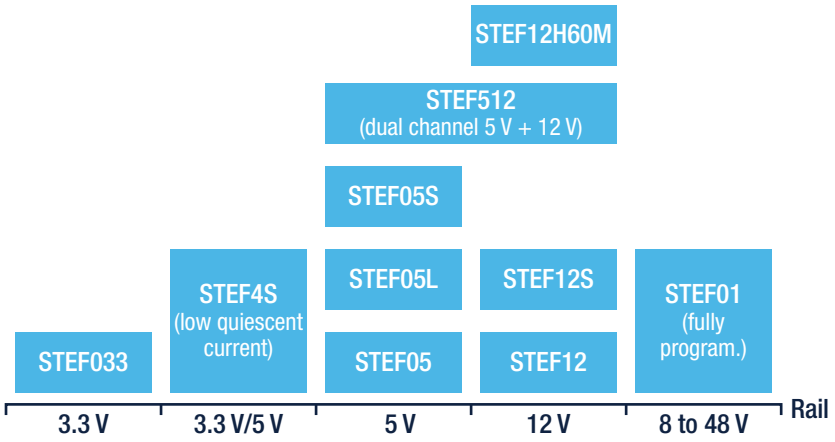
For fault management, the **eFuses** replace larger conventional fuses, offering complete and flexible management of the fault (overcurrent/overvoltage), without replacement after actuation.

eFuse



eFuses, a smart offer for a lots applications

The industrial power rail range is fully covered with the STEF01, which is usable throughout the 8 to 48 V range thanks to its programmability options.

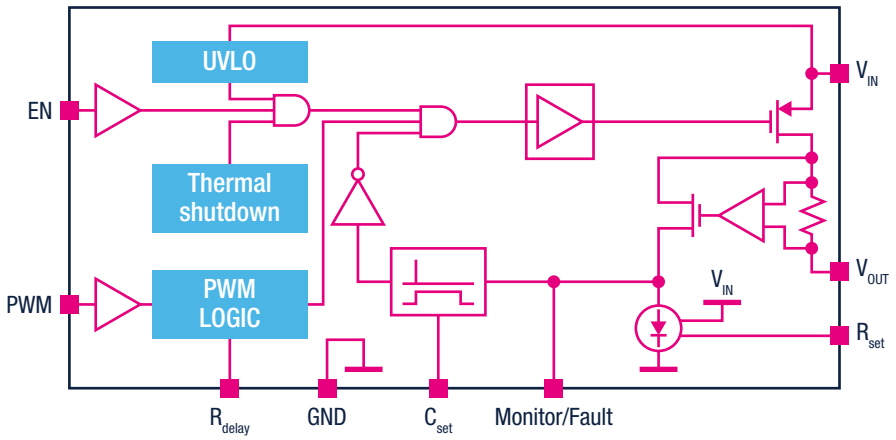


Connected in series to the power rail, ST's Power Breakers disconnect the load if power consumption exceeds a programmed limit: the integrated power switch is automatically opened and notifies the remote monitoring feature.

This approach helps optimize the design of power distribution systems, by defining and protecting with high accuracy all the low power circuits (LPC). Eventually, the power breaker enables cost savings in terms of isolation material, cable sizing and easier qualification and certification flow.

The STPW12 (12 V rails), exhibit features like:

- Auto-retry function with programmable delay
- Adj precise power limitation from 11 to 16 W
- Integrated N-channel power MOSFET
- PWM function



ESD AND EMI PROTECTIONS

In harsh factory automation environments, protection devices are the key to system reliability.

ST offers a wide range of protection devices dedicated to power and data lines.
More at **www.st.com/protection**

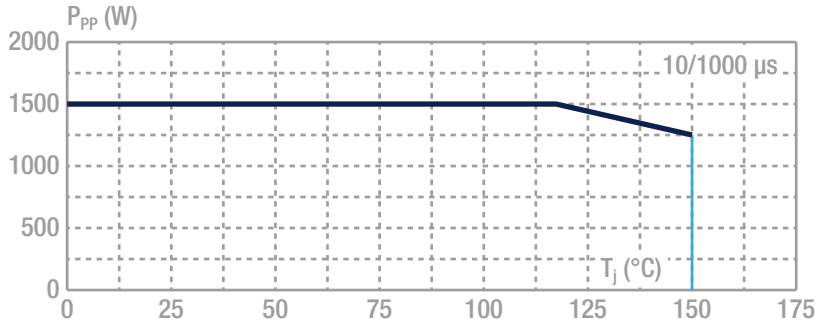
Power lines

Overvoltages and glitches appearing on power mains are modeled by the IEC 61000-4-5 international standard, also known as an 8/20 µs current waveform. Able to protect up to 500 A (8/20 µs), the STIEC45 series is the ideal surge suppressor solution for factory automation power lines.

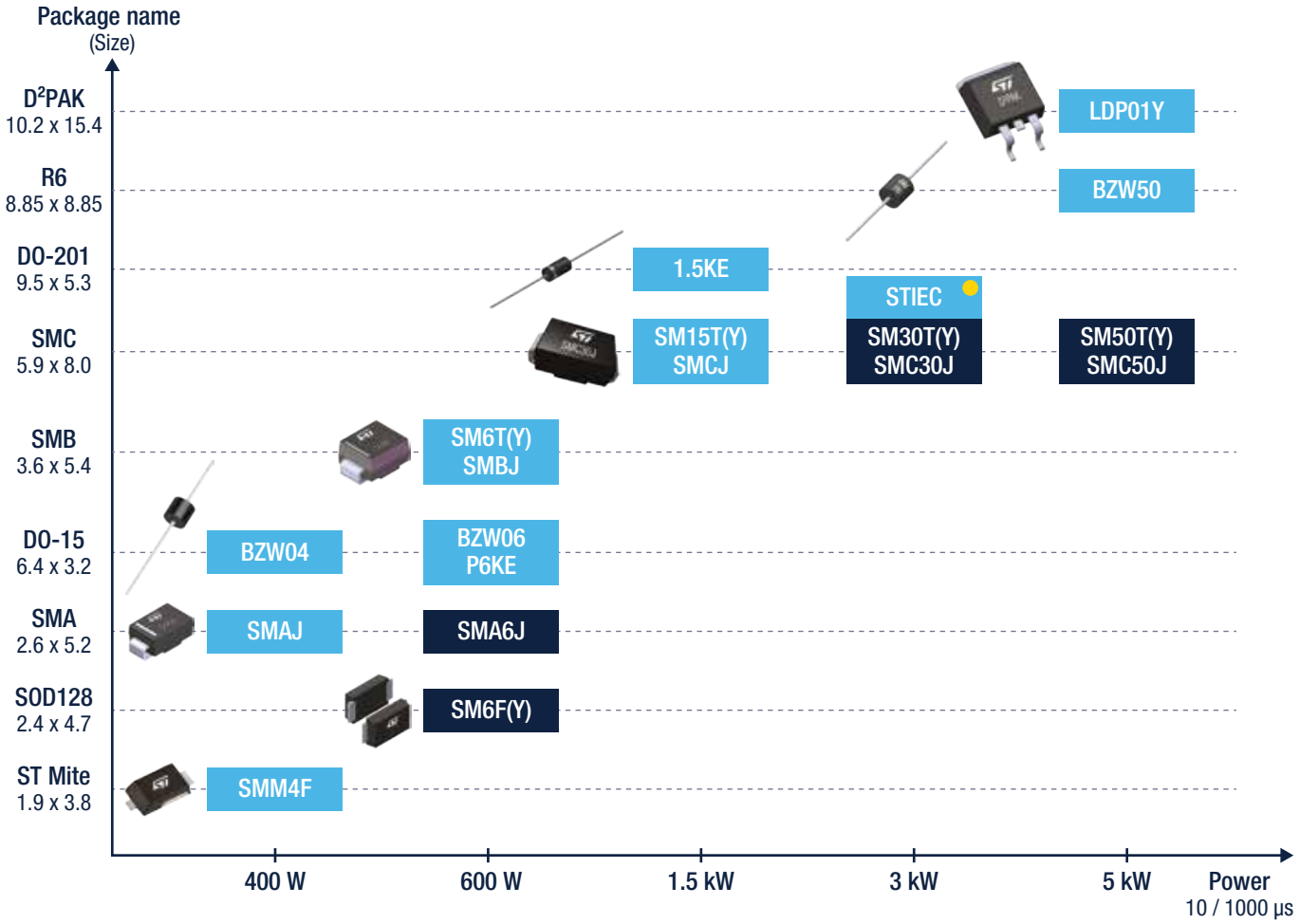
Order code	V_{BR} @ I_R				V_{CL} @ I_{PP} 8/20 µs, 1.2/50 µs	
	Min.	Typ.	Max.		Max.	
	V			mA	V	A
STIEC45-24AS	26.7	28.2	29.5	1	42	500
STIEC45-26AS	28.9	30.3	31.9	1	45	
STIEC45-27AS	30	31.6	33.2	1	47	
STIEC45-28AS	31.1	32.6	34.3	1	49	
STIEC45-30AS	33.3	35	36.8	1	55	
STIEC45-33AS	36.7	38.6	40.6	1	59	

As well as robust and reliable performance during voltage surges, ST's discrete TVS (transient voltage suppressor) devices exhibit excellent power derating versus temperature. As an example, ST's SM15T series (1500 W, 10/1000 µs) operates at full performance up to 115 °C

Peak pulse power dissipation versus initial junction temperature (printed circuit board)



A large choice of package is available to meet application requirements.

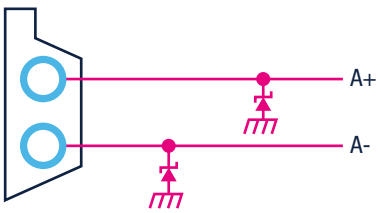


● 500 A 8/20µs (IEC 61000-4-5)

Data lines

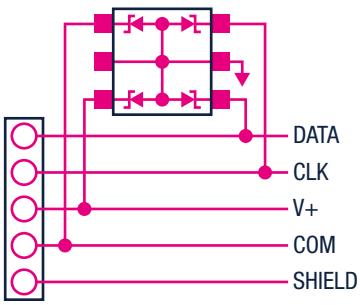
Communication buses, with long wires lengths, are particularly sensitive to electrostatic discharge (ESD). ST proposes multiline solutions in a single package, with various parasitic capacitance and voltage compromises, to address a wide range of industrial communication interfaces as shown below.

ASI interface
Actuator and sensor Interface



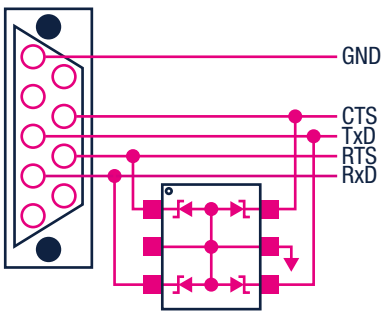
SMA4F33A
ESD with ± 30 kV contact

Seriplex interface



ESDA14/25xx
ESD protection in SOT666/323/23

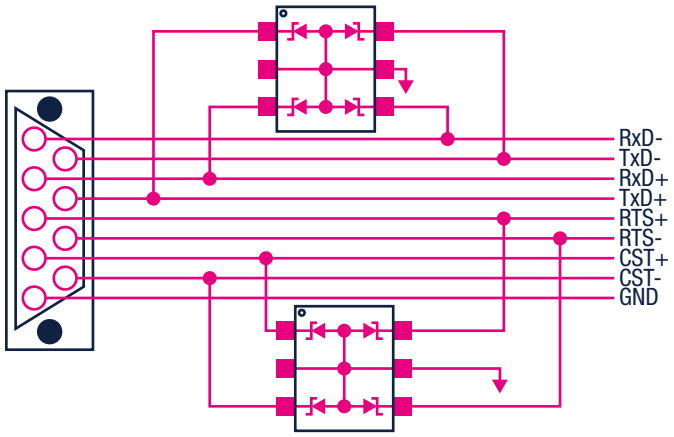
RS-232 interface
Modbus®



ESDA6V1/14/25xx
ESD protection in SOT666/323/23

RS-422 and RS-485 interface

Modbus®, Modbus Plus™, PROFIBUS®

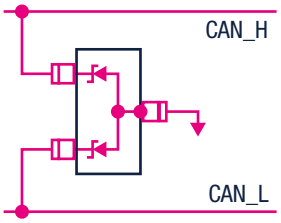


ESDA6V1/14/25xx

ESD protection in SOT666/323/23

CAN interface

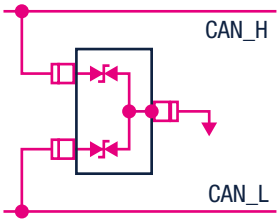
CANopen, DeviceNet™



ESDA6V1L/ESDALC6V1

ESD protection in SOT666/23

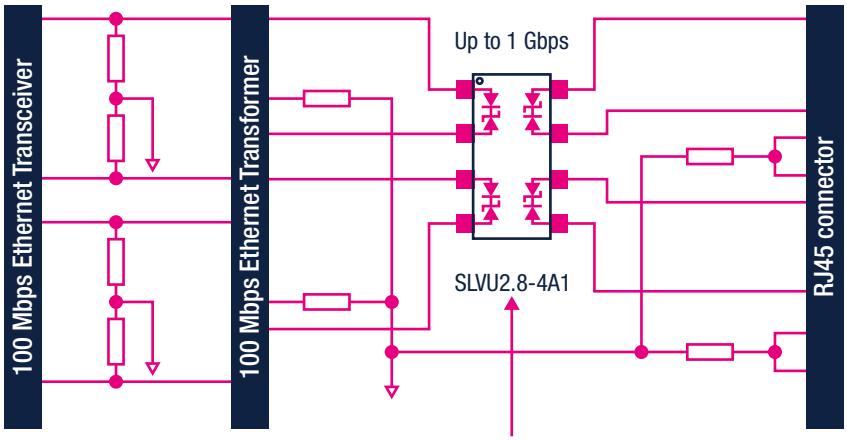
Dual-line TVS on 24 V field side (PLC, IO module)



ESDCAN06-2Bxx

ESD protection in SOT23/SOT323

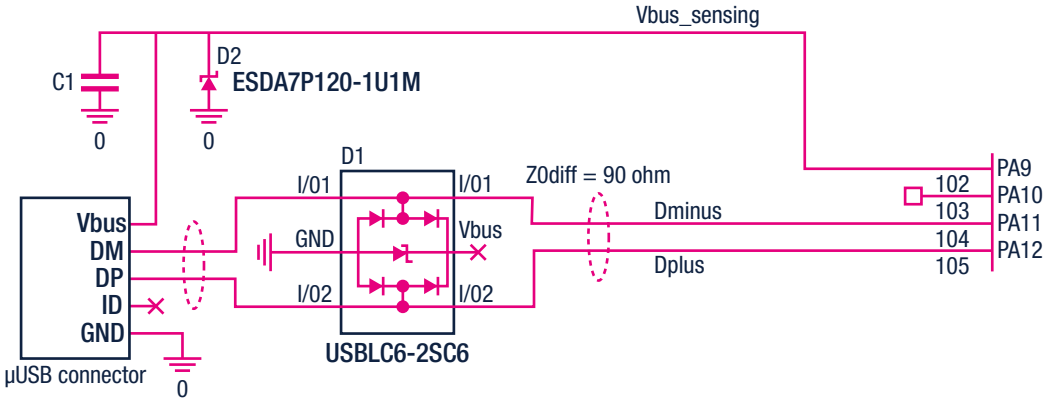
Ethernet protection



SLVU2.8 or DSL01

3 triple Trisil in one SO8/Transil + Trisil in one package

Example of application USB 2.0 Full speed without OTG



Design tip: Use a Transient Voltage Suppressor (TVS) to protect against 8/20 µs surges on DC power rails.

Featured products

USBLC6-2SC6

- ESD protection in SOT23-6L

SOT23-6L

GET IT ON Google Play

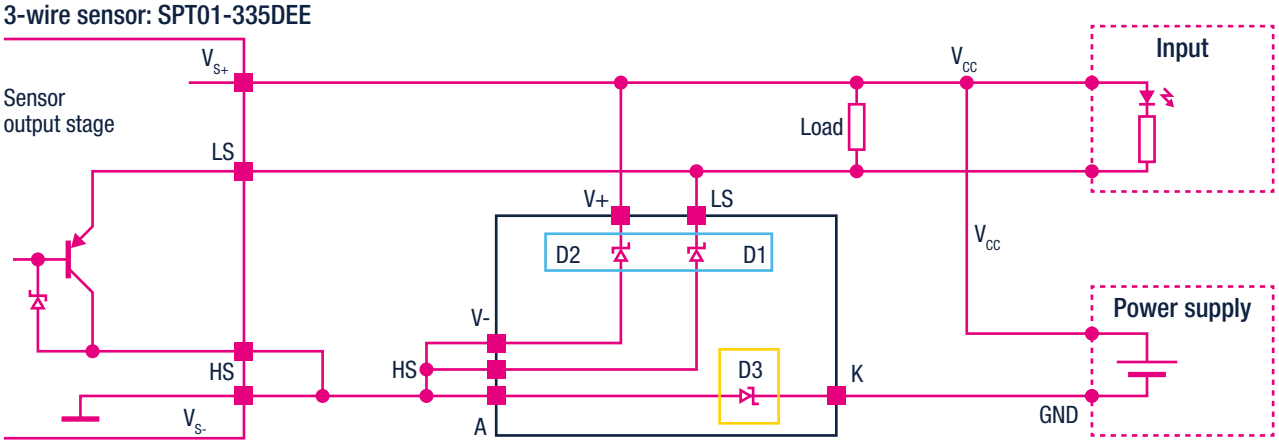
Download on the App Store

Wandoujia

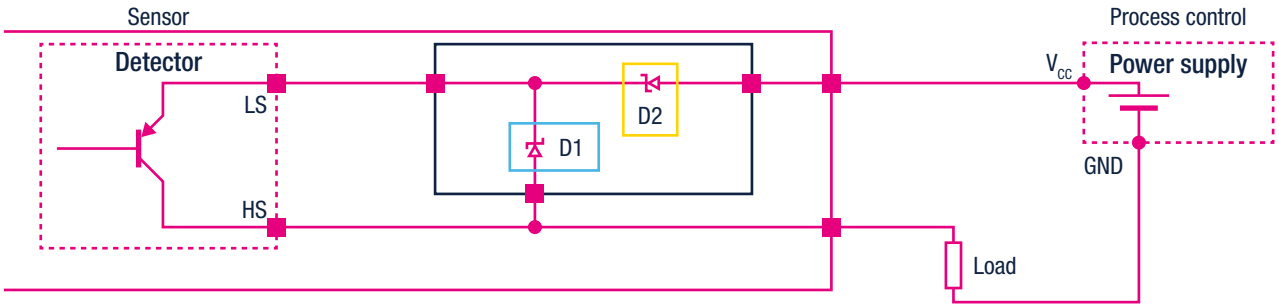
PROXIMITY SENSOR PROTECTION

ST has developed specific and dedicated 200 W (10/1000 µs) multi-line TVS for 2 and 3-wire proximity sensors. The SPT series provides reverse polarity and surge protection in compliance with IEC 61000-4-5, IEC 61131-2 and EN 60947-5-2.

3-wire sensor: SPT01-335DEE



2-wire sensor: SPT02-236DDB



2 features:

- Surge protection
- Reverse battery protection

FACTORY AUTOMATION NEEDS:

- 2-/3-line protection
- 36 V V_{RM} required (even if V_{supply} = 24 V typ)
- V_{CL} @ IPP = 46 V @ 2 A
- Diode specified in forward mode

The SEL-PROT-TVS transient voltage suppressor smart selection tool helps designers select the right TVS for their application with just a few clicks. Only two application parameters are necessary for device selection. The first parameter is the type of protection required, such as automotive, power line, analog or digital line. The second is the signal standard, e.g. CAN, USB, SD-Card, 10/1000 µs or custom.

MPUs AND MCUs

The STM32 family of 32-bit Flash microcontrollers and microprocessors* based on the Arm® Cortex®-M and Cortex-A processor is designed to offer new degrees of freedom to MCU users. It offers a 32-bit product range that combines very high performance, real-time capabilities, digital signal processing, and low power, low voltage operation, while maintaining full integration and ease of development.

The unparalleled and large range of STM32 devices, based on an industry-standard core and accompanied by a vast choice of tools and software makes this family of products the ideal choice, both for small projects and for entire platform decisions.

STM32 MCUs 32-bit Arm® Cortex®-M

10 YEARS LONGEVITY COMMITMENT

High Performance

- **STM32H7** — Up to 3224 CoreMark; Up to 550 MHz - Cortex-M7; 240 MHz - Cortex-M4
- **STM32F2** — 398 CoreMark; 120 MHz Cortex-M3
- **STM32F4** — 608 CoreMark; 180 MHz Cortex-M4
- **STM32F7** — 1082 CoreMark; 216 MHz Cortex-M7

Mainstream

- **STM32G0** — 142 CoreMark; 64 MHz Cortex-M0+
- **STM32F0** — 106 CoreMark; 48 MHz Cortex-M0
- **STM32F1** — 177 CoreMark; 72 MHz Cortex-M3
- **STM32G4** — 550 CoreMark; 170 MHz Cortex-M4
- **STM32F3** — 245 CoreMark; 72 MHz Cortex-M4

Optimized for mixed-signal applications

Ultra-low-power

- **STM32L4+** — 409 CoreMark; 120 MHz Cortex-M4
- **STM32L0** — 756 CoreMark; 32 MHz Cortex-M0+
- **STM32L1** — 93 CoreMark; 32 MHz Cortex-M3
- **STM32L5** — 443 CoreMark; 110 MHz Cortex-M33
- **STM32L4** — 273 CoreMark; 80 MHz Cortex-M4

Wireless

- **STM32WB** — 216 CoreMark; 64 MHz Cortex-M4; 32 MHz Cortex-M0+

Cortex-M0+ Radio co-processor

- **STM32WL** — 162 CoreMark; 48 MHz Cortex-M4; 48 MHz Cortex-M0+

Arm® Cortex® core: -M0 / -M0+ | -M3 | -M33 | -M4 | -M7

STM32 Ecosystem

- STM32Cube
- Evaluation tools
- Software tools
- Embedded Software
- Hardware Tools
- Security — STM32 Trust
- MadeForSTM32 — V1
- ST Partners — Partner Program

STM32 Solutions

- Artificial Neural Networks
- Audio/Voice
- Connectivity
- Digital Power
- Graphic User Interface
- Motor Control
- Safety — Safety Ready
- USB Type-C

STM32 Learning / Communities

- STM32 Community
- STM32 Education
- STM32 MCU Wiki
- STM32 GitHub

* STM32 microprocessors benefit from the proven software, tools and technical support of the STM32 family ecosystem. The release of OpenSTLinux Distribution, a mainlined open-source Linux distribution is a key element of the solution. OpenSTLinux Distribution is reviewed and accepted by the Linux community (Linux Foundation, Yocto project and Linaro) and is pre-integrated with OP-TEE secure OS.

Enhanced STM32Cube tools as well as evaluation boards and discovery kits complete the development suite available to designers.

It leverages a solid scalable software and hardware foundation to simplify and shorten the development time of industry-leading power-constrained applications. Developers are able to seamlessly reuse and migrate IPs from project to project. STM32 MPUs are included in ST's rolling 10-year longevity commitment.

To help developers choose the best solution for their applications, the ST-MCU-FINDER App lets them explore the complete portfolio of STM32 Arm® Cortex®-M and STM8 microcontrollers and development boards (only on mobile version) from any mobile device or directly from the developer's desktop environment. ST-MCU-FINDER features easy-to-use selection tools, self-maintaining documentation, and connections to MCU communities. Developers find the MCU part number that best fits their application thanks to an easy search with multiple criteria including core type, CPU frequency, memory, price, package, I/Os, temperature grade and peripherals such as control, timers, analog, connectivity, multimedia and security. You can also buy devices online using the ST MCU Finder.

In the desktop version, the development begins immediately after device selection by launching the STM32CubeMX initialization code generator directly from the application. ST-MCU-FINDER connects users with developer communities on popular social platforms such Facebook, Twitter, the STM32 YouTube channel, and ST Community.

as

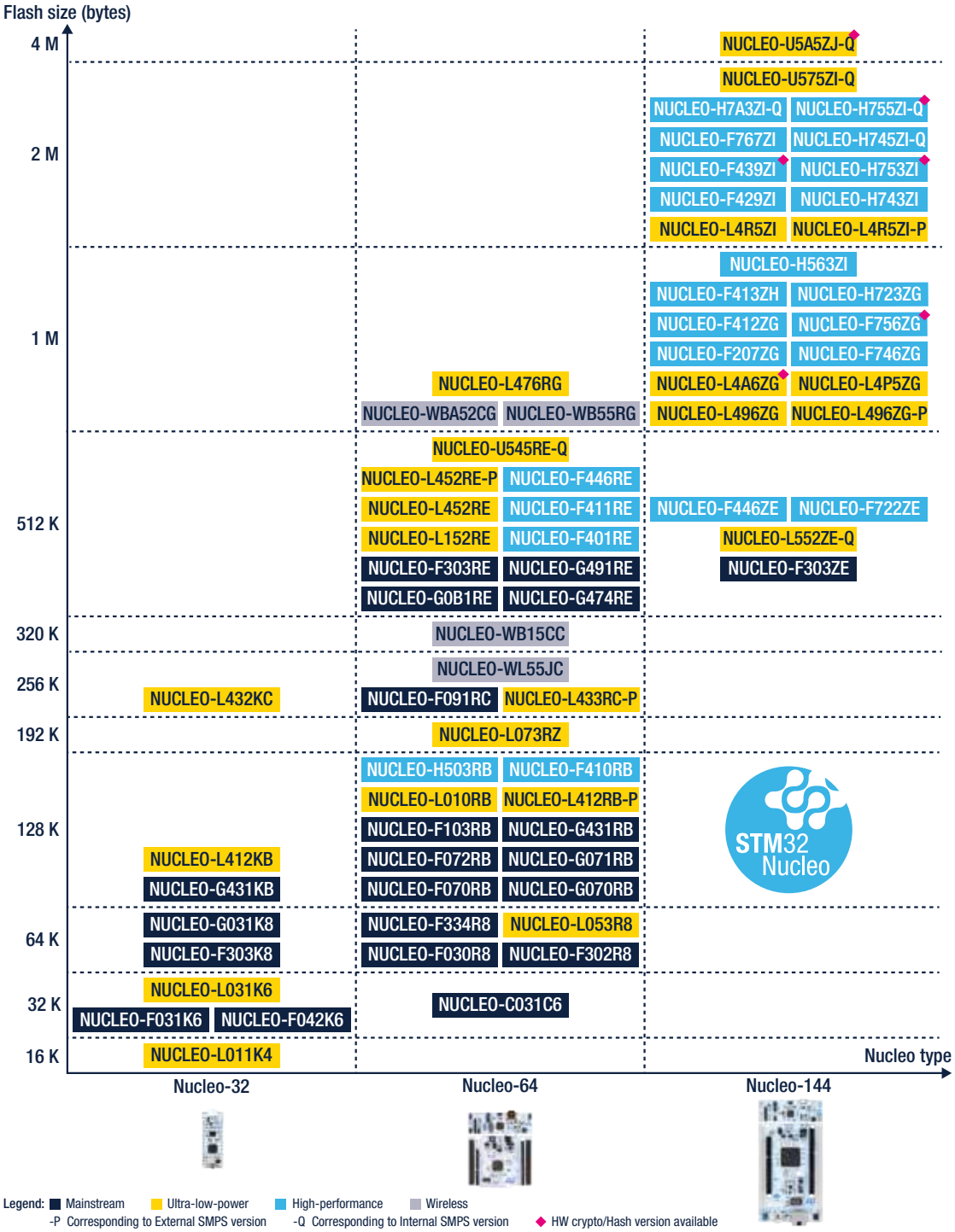
Hardware tools and ecosystem

ST's microcontrollers are supported by a complete range of high-end and low-cost Discovery Kit evaluation tools. They implement the full range of device peripherals and features of each product line. The evaluation tools also come with third-party solutions that use an integrated development environment and in-circuit debugger/programmer featuring the JTAG application interface. Developers who are new to these microcontroller cores and families can also benefit from the range of starter kits that are specially designed to help them evaluate device features and start their own applications.

STM32 Nucleo development boards

The highly affordable STM32 Nucleo boards allow anyone to try out new ideas and to quickly create prototypes with any STM32 MCU. STM32 Nucleo boards can easily be extended with a large number of specialized application hardware add-ons thanks to Arduino Uno Rev3 and ST morpho connectors on Nucleo-144 and Nucleo-64, ST Zio connectors on Nucleo-144, and Arduino Nano connectors on Nucleo-32. Moreover, Nucleo boards integrate an ST-Link debugger/programmer, so there is no need for a separate probe. A comprehensive STM32 software HAL library together with various software examples are provided with STM32 Nucleo boards and work smoothly with a wide range of development environments, allowing to build a complete application in only a few minutes.

STM32 Nucleo development boards can easily be expanded through a variety of add-on boards. These expansion boards open the door to any type of application leveraging the appropriate mix of performance/peripherals/power within the comprehensive STM32 family.

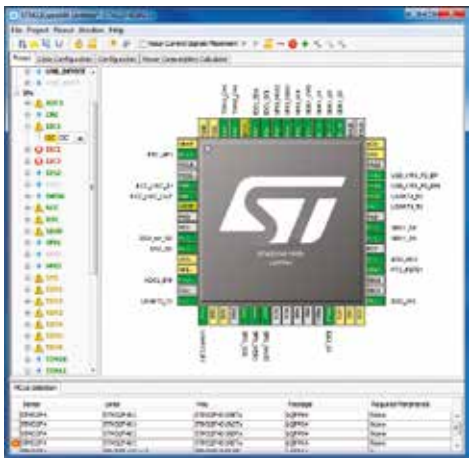


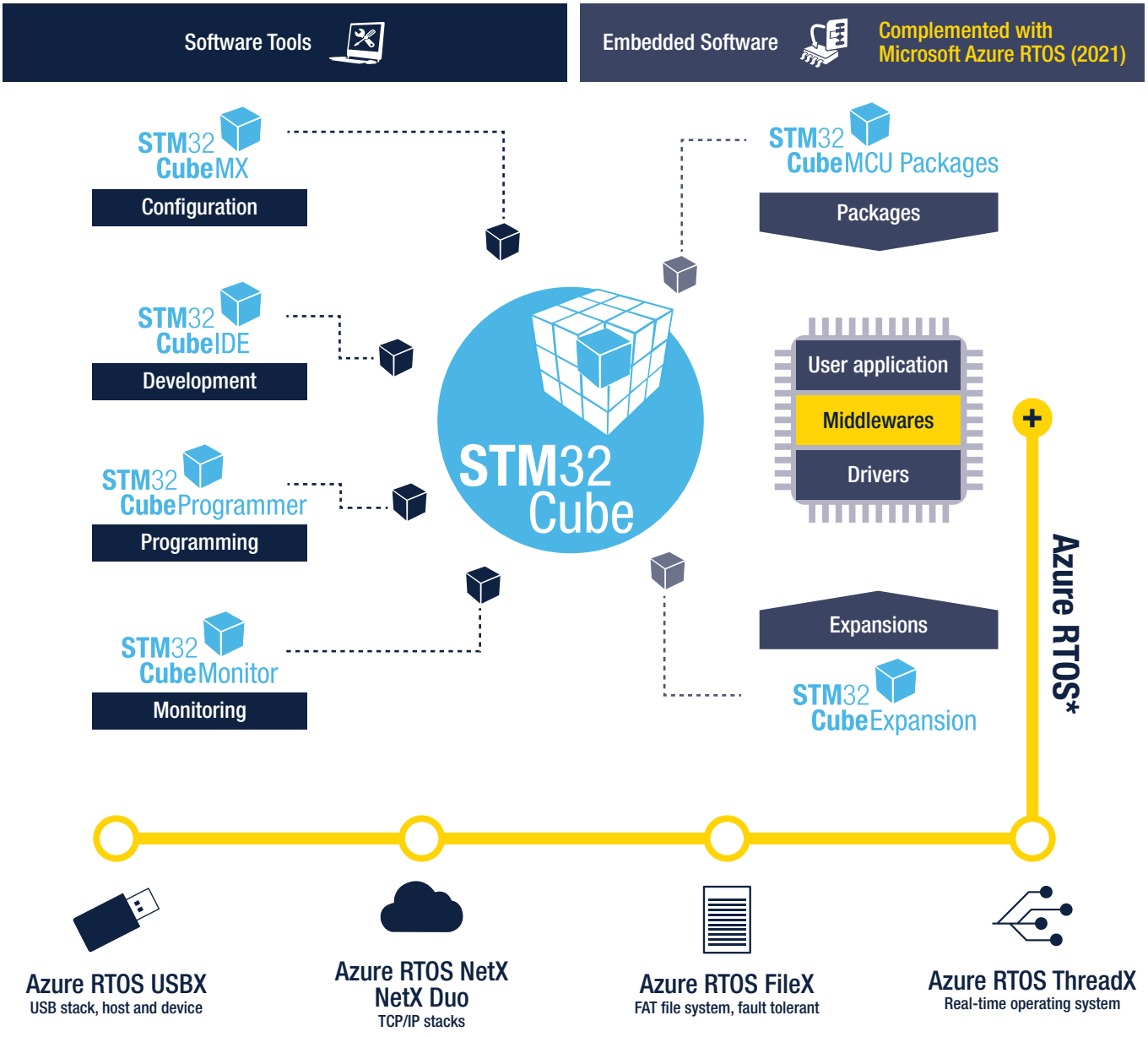
STM32Cube development software

STM32Cube is a set of free development tools and embedded software bricks to enable fast and easy development on the STM32 platform which simplifies and speeds up developers' work.

The embedded software bricks include a Hardware Abstraction Layer (HAL) for easy porting from one STM32 device to another and middleware bricks for the most common functions (such as RTOS, USB, file system, TCP/IP stack, touch sensing or graphics).

A large number of use-case code examples are also included, making it even easier to get started.





*Production License for any STM32

STM8 8-bit MCU family

ST's 8-bit microcontroller platform is implemented around a high-performance 8-bit core and a state-of-the-art set of peripherals. This platform is manufactured using an ST-proprietary 130 nm embedded non-volatile memory technology. It is able to reach 1.6 cycles per instruction and up to 24 MHz clock frequency, allowing customers to run their applications at low speed with high performance.

STM8 8-bit MCUs Core up to 24 MHz

Mainstream	Industrial, consumer and mass market	Robust and reliable Up to 125 °C	STM8**S** Data EEPROM, 3 and 5 V families, precise RC	
Ultra-low-power	Ideal combination of low-power performance and features	High-end analog IPs Active Halt < 1 µA	STM8**L** Data EEPROM, 1.65 and 3 V families, strong analog, LCD drivers, low-leakage technology	
Automotive	Long-term guarantee	AEC-Q100 Up to 150 °C	STM8**AF** Data EEPROM, 3 and 5 V families, precise RC, LIN, CAN, grade 0	ASIL Ready
	Long-term guarantee	AEC-Q100 Up to 125 °C	STM8**AL** Data EEPROM, 1.65 and 3 V families, strong analog, LCD drivers, low-leakage technology	ASIL Ready

Join the STM8 Community!
http://community.st.com/stm8

STM8 Ecosystem

Software tools

- STM8CubeMX Configuration tool
- Integrated Development Environments (IDE)
- STM Studio Monitoring tool
- ▶ More software tools

Embedded software

- Standard Peripheral Library for STM8L (8 kb)
- Standard Peripheral Library for STM8L/AL (64 kb)
- Standard Peripheral Library for STM8A/S
- X-CUBE-STL self-test library for safety
- ▶ More embedded software

Hardware tools

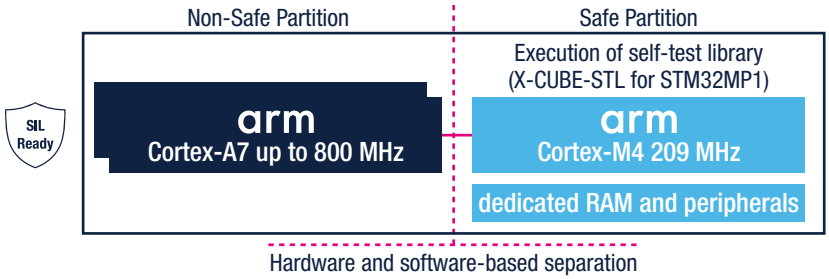
- STM8 Discovery kits, Nucleo and evaluation boards
- ST-LINK in-circuit debugger/programmer

Safety-certified systems based on STM8 and STM32

ST provides a comprehensive set of free-of-charge and certified Functional Safety packages based on robust built-in STM8 MCU and STM32 MCU and MPU safety features with the aim of significantly reducing the development efforts, time and cost required to meet functional safety standards. Automatically triggered when a risk of harming users is identified, safety mechanisms in software are embedded in many electronic systems present in Industry 4.0, medical, automotive and home electrical appliances and in all new safety-regulated markets such as battery management systems and drones.

STM32MP1 MPU dual Cortex-A7 and Cortex-M4 for safety

Safety function implementation confined in Cortex-M4 real-time side



The coexistence with non-safety related software on Cortex-A7 (e.g. Linux) is possible

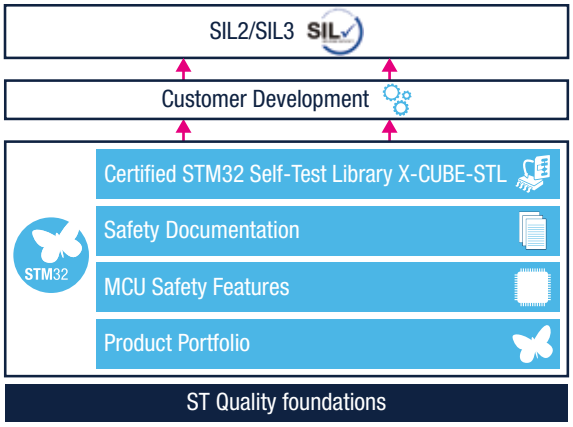
More details in UM2714 STM32MP1 Series safety manual

Partner Program

life.augmented

Several ST Authorized Partners are experts in functional safety and have expanded their know-how to STM8 and STM32 with software, tools, trainings and other services. Their solutions help designers at any stage of their project: from the mapping of safety requirements to the design and validation of hardware and software, certification phase included.

Achieving SIL2/3 with STM32



Package name	X-CUBE-CLASSB	STM8-SafeClassB
STM32 Series covered	V2.2.0 - STM32F0, F1, F2, F4, F7, STM32L0, L4	STM8AF - STM8AL - STM8L - STM8S
Self-test libraries based on	STM32CubeHAL	Optimized direct access to STM8 registers
Supported development environments	IAR Embedded Workbench®, Arm® KEIL®, STM32CubeIDE	IAR Embedded Workbench®, Cosmic® 5.4
Certification	UL@2017 & 2019	UL & VDE@2018
IEC 60335-1 and 60730-1 international standards coverage	IEC, UL and CSA	
Safety manual (guidelines)	AN4435	AN3181

STM32 for wireless connectivity

Migration to wireless connectivity is supported with the STM32 through the STM32WB and STM32WL product series enabling long-range and short-range technologies.

The STM32WB series is enabling point to point and meshed communication through multi-protocols: Bluetooth® Low Energy 5.4 including the Mesh capability; Zigbee, Thread, proprietary and Matter. Dual core and large memory capability make it able to endorse general purpose MCU together with wireless connectivity. The ecosystem includes STM32CubeWB with free of charge without the need of having RF expertise certified radio stacks and various low-cost PCB integration packages as well as module for a fast and easy time to market. STM32 Nucleo pack is the most cost-effective way to quickly get started developing STM32WB-based prototypes. A wide collection of packages allows great flexibility at application time.

All STM32 wireless products are guaranteed for 10 years longevity.

UQFN48
7 x 7 mm (p: 0.5 mm)

VQFN68
8 x 8 mm (p: 0.4 mm)

WLCSP100
4.39 x 4.37 mm

UFBGA129
7 x 7 mm (p: 0.5 mm) pitch

LGA86
7.3 x 11 mm (p: 0.435 mm)

The following picture summarizes the main features of our STM32WB and STM32WL Series.

STM32 Wireless MCUs
32-bit Arm® Cortex®-M4 and -M0+

STM32WB

- **Transceiver frequency: 2,4 GHz**
- **Open dev. features: HCI, Generic 802.15.4 MAC**
- Arm® Cortex®-M4 at 64 MHz and dedicated M0+ at 32 MHz supporting RF – 80 DMIPS
- From 256-Kbytes to 1 Mbyte of Flash memory
- Consumption:
  - M0+: RX: 4.5 mA, TX 5.2 mA (SMPS, 0dBm)
  - M4: < 50 µA/MHz (RF ON)
- Output power: +6 dBm
- Sensitivity BLE: -96 dBm, 802.15.4: -100 dBm

Note: ** SMPS, 0 dBm

OPENTHREAD

Bluetooth 5

Zigbee 3.0

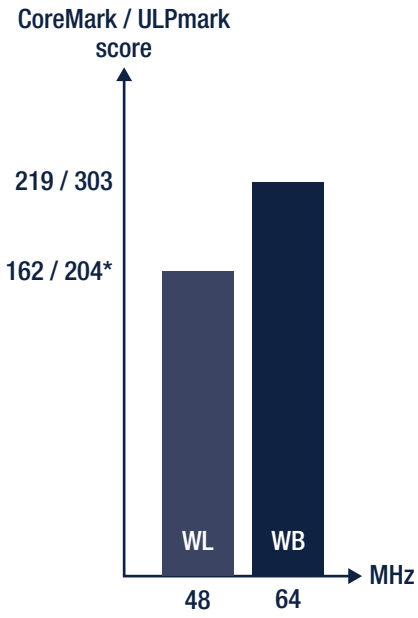
STM32WL

- **Transceiver frequency: 150 to 960 MHz**
- **Open dev. features: LoRa, (G)FSK, (G)MSK, BPSK**
- Arm® Cortex®-M4 and -M0+ at 48 MHz supporting RF – 60 DMIPS
- Flash memory from 64 Kbytes to 256 Kbytes
- Consumption:
  - M4/M0+: < 71 µA/MHz (RF ON)
  - RX: 4,82 mA (SMPS, LoRa 125 kHz)
  - TX 15 mA (SMPS, 10dBm, LoRa)
  - TX 87 mA (SMPS, 20dBm, LoRa)
- Dual Output power:
  - Up to 15 dBm
  - Up to 22 dBm
- Sensitivity LoRa®: -148 dBm

LoRaWAN

sigfox

M-Bus wireless



Note: * CoreMark from Flash memory @ 3 V
Pending certification

Complementing the STM32 RF connectivity portfolio, the STM32WL System-On-Chip integrates both a general purpose microcontroller and a sub-GHz radio on the same chip (one single silicon die inside).

LoRaWAN sigfox M-Bus wireless

Built on Arm® Cortex®-M4 and Cortex®-M0+ cores (single- and dual-core architectures available), STM32WL microcontrollers support multiple modulations– LoRa®, (G)FSK, (G)MSK, BPSK – to ensure flexibility in wireless applications with LoRaWAN®, Sigfox, W-MBUS or any other suitable protocol in a fully open way.

LoRa
(G)FSK
(G)MSK
BPSK
Multi-modulation

Massive integration
Cost saving

Open dual-core platform

Ultra-low-power

STM32 Security

256 KB
3.6 V
1.8 V
73-pin
48-pin
64 KB Flash
A large offer

STM32 Cube
STM32 CubeMonitor
End-to-end ecosystem
(advanced RF testing tool,
C code generation tool...)

No matter what!

The STM32CubeWL MCU Package is the best solution for embedded software resources and features HAL and LL peripheral drivers, a full set of middleware and radio stacks (LoRaWAN® and Sigfox) together with various preconfigured software examples for several popular IDEs such as Keil MDK-Arm®, STM32CubeIDE and IAR.

The STM32WL55 Nucleo board and STM32Cube Ecosystem form a consistent set of hardware and software development tools to quickly and easily start developing your application.

STM32WL MCU Series
32-bit Arm® Cortex®-M4/-M0+

RADIO
- Multi-modulation Sub-GHz radio
- 2 programmable power outputs
- Sensitivity down to -148 dBm

SECURITY
- AES 128/256-bit
- True Random Number Generator
- Private Key Acceleration
- PCROP/WRP
- 48-/96-bit unique IDs

CONNECTIVITY
- 2x SPI, 3x I²C 1x ULPUART, 2x USART
- 16- and 32- bit timer

ANALOG
- LDO and built-in DC/DC
- 1x ADC 12-bit
- 1x DAC 12-bit
- Temperature sensor

OTHER
- 2x DMA (7 channels)
- 7x Timers (16 and 32 bits)
- 2x ULP Comparators
- ART Accelerator™
- Low voltage 1.8 to 3.6 V

Product line	f_{CPU}	Flash Memory (Kbytes)	RAM (Kbytes)	Modulations				Radio Frequency Range (MHz)	Dual Power Output	Advanced Security Features	Operating Temperature Range
				LoRa®	(G)FSK	(G)MSK	BPSK				
Cortex®-M4 single-core line											
STM32WLE5	Up to 48	Up to 256	Up to 64	•	•	•	•	150 to 960	1 output up to 22 dBm 1 output up to 15 dBm (consumption-optimized)		-40 to 85 °C (with radio) -40 to 105 °C (without radio)
STM32WLE4					•	•	•				
Cortex®-M4 and -M0+ dual-core line											
STM32WL55	Up to 48	256	64	•	•	•	•	150 to 960	1 output up to 22 dBm 1 output up to 15 dBm (consumption-optimized)	Key Management Services Secure hardware isolation, secure boot, secure firmware update and secure firmware install	-40 to 85 °C (with radio) -40 to 105 °C (without radio)
STM32WL54					•	•	•				

STM32 Ecosystem

- STM32Cube
- Evaluation tools
- Software tools
- Embedded Software
- Hardware tools
- Security — STM32 Trust
- MadeFor STM32
- ST Partners

STM32 Solutions

- Connectivity

STM32 Learning / Communities

- STM32 Community
- STM32 Education
- STM32 MCU Wiki
- STM32 GitHub

STM32Trust

STM32Trust offers a robust multi-level strategy to enhance security in new product designs based on our STM32 microcontrollers and microprocessors augmented with STSAFE secure elements.

STM32Trust is the security framework combining our knowledge, ecosystem and security services. The solution offers a complete toolset for code and execution protection and ensures IP protection, firmware authenticity and secure firmware update, as well as secure data and the use of validated credentials.

STM32Trust brings 12 Security Functions to align with Customer Use Cases and Security Standards.

Security function	STM32F4/F7/L1/WB/G0/G4/H7/L0/L4		STM32MP1		STM32L5 WITH TRUSTZONE		+ STSAFE-A/TPM
	Silicon	Firmware	Silicon	Firmware	Silicon	Firmware	Silicon
Secure boot	✓	SBSFU	✓	TF-A	✓	TFM_SBSFU	✓
Secure Install/Update	✓		✓	OPTEE	✓		✓
Secure Storage	(L0/L4/H7/G0/G4)	(WB) SBSFU KMS	✓	OPTEE	✓	TFM SPE	✓
Isolation	✓		✓	OPTEE	✓	TFM	✓
Abnormal situations handling	✓		✓		✓		
Crypto Engine	✓	Crypto libraries	✓	OPTEE	✓	Crypto libraries TFM	✓
Audit/Log					✓	TFM	
Identification/Authentication/Attestation	✓		✓		✓	TFM Attestation	✓
Silicon Device Lifecycle	✓		✓		✓		
Software IP Protection	✓		✓	OPTEE	✓	TFM	
Secure Manufacturing	SFI (H7/L4) with STM32HSM		SSP with STM32HSM		SFI with STM32HSM		✓
Application Lifecycle	✓		✓		✓		✓

Note: * All those solutions are defined at www.st.com/stm32trust

Reference firmware proposed by ST
Firmware to be developed by user

CERTIFICATIONS

ST is fully committed at certifying its solutions by independent recognized authority.

To discover this complete offer, please visit **www.st.com/stm32trust**

Available now

Certifications

Arm® PSA
- **Level 1**
  STM32L4
  STM32L5
- **Level 2**
  STM32L5 (TFM)
- **API Compliant**
  STM32L5 (TFM)

COMMON CRITERIA
- **CC EAL5+**
  STSAFE-A110
  STSAFE-TPM

SESIP
- **Level 1**
  STM32L4 (SBSFU)
- **Level 3**
  STM32L4 (SBSFU)

Evaluations

PCI
- **Point of Sale application**
  STM32L4

Cross-layer design for end-to-end security

The STSAFE secure element family ranges from optimized to flexible Java-based and TCG-compliant TPM solutions.

Relying on CC EAL5+ certified chips running an ST-developed secure operating system, our solutions ensure state-of-the-art security for protecting Smart Industry networks and objects against main threats such as device cloning, counterfeiting, data corruption and eavesdropping.

Developers benefit from a comprehensive set of development tools and services:

- Expansion boards compatible with STM32 Nucleo and Arduino boards and kits
- Example code and software libraries to be embedded in the application microcontrollers
- Personalization services for trusted storage of secrets

STSAFE-A

STSAFE-A is an optimized solution providing strong USB-C PD authentication and QI wireless charging services. Its command set is tailored to address strong authentication compliant with USB-C and QI, establish a secure channel in the scope of a TLS session establishment, verify signatures offer secure storage as well as decrement counters for usage monitoring (it is also compliant to LoRa and Sigfox).

Relying on a Common Criteria EAL5+ platform, STSAFE-A is a highly secure authentication solution whose security is certified by independent parties.

Particularly well suited for applications exposed to fraud or counterfeiting, such as consumables like printer cartridges, accessories for phones or gaming, USB Type-C devices, IoT objects running critical credential or operating valuable services, STSAFE-A is the ideal solution for customers wishing to build a secure ecosystem and to focus on their application.

STSAFE-A110 ecosystem contains a complete set of tools for seamless integration:

- ODE STM32 Expansion board (X-NUCLEO-SAFEA2)
- STM32Cube development ecosystem (X-CUBE-SAFEA1 software package)
- Pre-personalized STSAFE-A110 available for fast evaluation
- Personalization service of customer's certificates and configuration at ST factory with no extra cost

STSAFE-A110 parts and X-NUCLEO-SAFEA2 expansion boards are now available at eDistribution, order your X-NUCLEO-SAFEA2 online at **www.st.com/stsafe-A110**

Very soon, a new IC in he family will be released, the STSAFE-A120.
Learn more at **www.st.com/stsafe-a**

STSAFE-J

STSAFE-J is a flexible solution based on Java Card operating system, which is freely available for customers who plan to run their own applet. STSAFE-J is also available with a generic applet ensuring securing on the host platform: strong authentication, secure connection establishment, usage monitoring and platform integrity.

Based on a Common criteria EAL5+ certified platform, Java 3.0.4 and GP 2.1.1, STSAFE-J100 generic applet allows to cover authentication, secure connection, secure data storage and is provided with personalization service. To ease development, a complete set of tools is available containing expansion board compatible with STM32 Nucleo and Arduino boards as well as example code and libraries to be embedded in the application microcontrollers (PKCS11 software package).

Learn more at **www.st.com/stsafe-j**

STSAFE-TPM

STSAFE-TPM is a widely deployed, standardized solution acting as the corner stone of Personal Computers and Server security. It is a perfect fit for ecosystems built on Windows and Linux operating systems.

Certified by Common Criteria and FIPS 140-2, all STSAFE-TPM products meet security and regulatory requirements. The product portfolio is qualified for consumer, industrial and automotive applications.

It provides a complete set of security features such as measured boot, platform integrity, authentication, secures storage as well as firmware upgrade and cryptographic toolbox.

A full development kit is available for a seamless integration with expansion board (STPM4RasPi) for Raspberry PI® and STM32MP1, Software package with driver and utilities (communication driver and firmware upgrade), Windows and Linux support, TCG Open Source or Third party TPM stacks.

Learn more at **www.st.com/stsafe-tpm**

	STSAFE-A110	STSAFE-J100	STSAFE-TPM
Typical applications	• Consumers/Industrial objects, • USB-C PD3.0 and QI authentication	• Gateways	• Computers • Gateways • Servers
Features	• Authentication (generic, USB-C, QI) • Signature verification • Secure channel establishment with distant server (TLS) • Secure data storage • Decrement counter	• Flexible crypto services (Java Card 3.0.4+ GP 2.1.1 + applet)	• TCG compliant TPM 1.2 & 2.0 • Consumer, Industrial and Automotive Grade
Personalization service at ST	Yes	Yes	Yes
Certification	CC EAL5+ HW	CC EAL5+	CCEAL4+ & TCG1.2 & 2.0, FIPS 140-2
Cryptography	ECC. AES	RSA, AES, ECC, SHA	AES, 3DES, RSA, SHA-1, SHA-256, ECC
Temperature range	–40 ÷ 105 °C	–40 ÷ 105 °C	-40 ÷ 105 °C
Package	SO8N, DFN (2 x 3 mm)	VQFN 32, DFN8 (4 x 4.2 mm)	TSSOP28, VQFN32, TSSOP20, WLCSP
Communication interface	I²C	I²C	SPI, I²C

RTCs, RESET, SUPERVISORS AND WATCHDOG ICs

Widest portfolio of RTC offers unlimited design solutions

In applications where the clock must not drift and correct time must be kept over long periods while unplugged and with minimal battery backup, a standalone real-time clock (RTC) offers significantly higher performance than an embedded RTC in the standard MCU.

ST offers a wide portfolio of RTC ICs with 8-bit parallel interface, high speed SPI and I2C compatible interface, including ultra-low-power devices and standard SMD SOX18 and SOX28 packages with embedded crystal and NVRAM up 256 Kbits.

All ST RTCs are Underwriters Laboratories® (UL) recognized.

ST's SNAPHAT® devices have a special removable/replaceable top that contains a lithium coin-cell battery and a 32-kHz crystal designed to be "snapped on" after the surface mount process.

Sub-families	Part numbers	Key features	Applications
Low-power	M41T82/83/93	Low stand-by current RTC with embedded crystal oscillator standard SMD packages World's smallest RTC with crystal oscillator Small packages	Portable HMI, Point of sales, Portable Barcode scanner, EV charging
Enhanced industry standard	M41T81S M41T00S M41T01 M41T80 M41T11 M41T82/83/93	Automatic battery switchover Analog calibration Embedded crystal oscillator	Sub-metering, HMI, Medical and Healthcare, Commercial HVAC, EV Charging, ATM
Highly-integrated	M41ST85W M41T94 M41ST87W	Embedded NVRAM Internal and external RAM clear MCU supervisor functions Tamper detect with timestamp	PLC, Local control, Servers, Data storage, Security, Medical and Healthcare, Commercial HVAC, EV Charging, ATM
Battery with crystal oscillator module (SNAPHAT)	M4T28 M4T32	Battery backup power Keyed insertion Removable battery	Sub-metering, Portable HMI, Local control, Medical and Healthcare, Commercial HVAC, EV Charging, ATM
Parallel 8 Bit legacy interface	M48Txx	SMD and PDIP packages NVRAM Memory up to 256 Kbits Embedded crystal and backup battery	Legacy Industrial control, ATM, Medical and Healthcare, Elevator control

Reset and supervisors ICs

ST's portfolio of microprocessor supervisors and reset ICs are designed to keep your application processor under control and your application running. Our product portfolio ranges from basic, single-voltage resets, to smarter resets with a watchdog or early power-fail detection function. We also offer highly integrated devices that include reset, battery switchover and tamper-detect functions. Find out our **STM181x** family of low power Reset circuits on **www.st.com**.

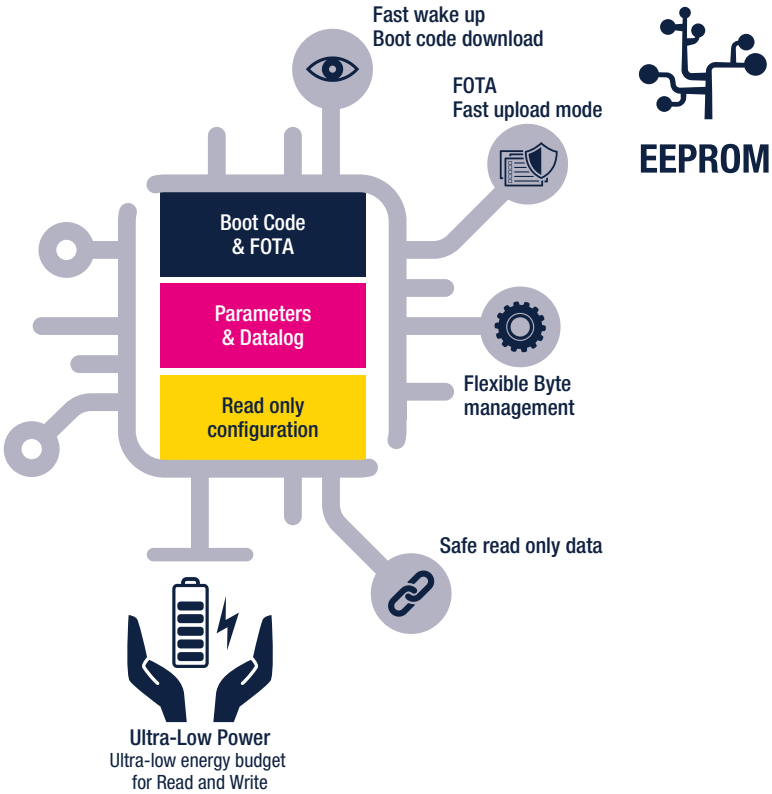
Watchdog ICs

ST offers watchdog timers as standalone devices for applications requiring a high security level. These devices are a robust, reliable means of monitoring software code execution, or hardware failures, and can trigger appropriate action, such as system reboot, high-level interrupt generation and others. Available in compact SOT23 and SC70 packages, watchdog timers can be added to space-conscious applications with minimal impact.

SERIAL EEPROM

STMicroelectronics offers a complete range of Serial EEPROM densities and packages which brings flexibility in smart industry designs.

Industrial grade lines offer robust devices from 1 Kbit to 2 Mbit with I²C, SPI and Microwire serial interfaces. All products feature up to 4 million write/erase cycles per byte, over 100 million cycles per device and 200 years data retention. The wide power supply range 1.7 V to 5.5 V fits any supply available on board.



Low power

85 °C at 1.6 V | 105 °C at 1.8 V

4 milliseconds

Up to 4 Mb

4 million cycles

Lockable page

X-NUCLEO-EEPRMA2

Standard I²C and SPI EEPROM memory expansion board based on M24xx and M95xx series for STM32 Nucleo.

SIGNAL CONDITIONING ICs

Operational amplifiers

I ST is a high-volume supplier of both standard and high-performance op amps (www.st.com/opamps):

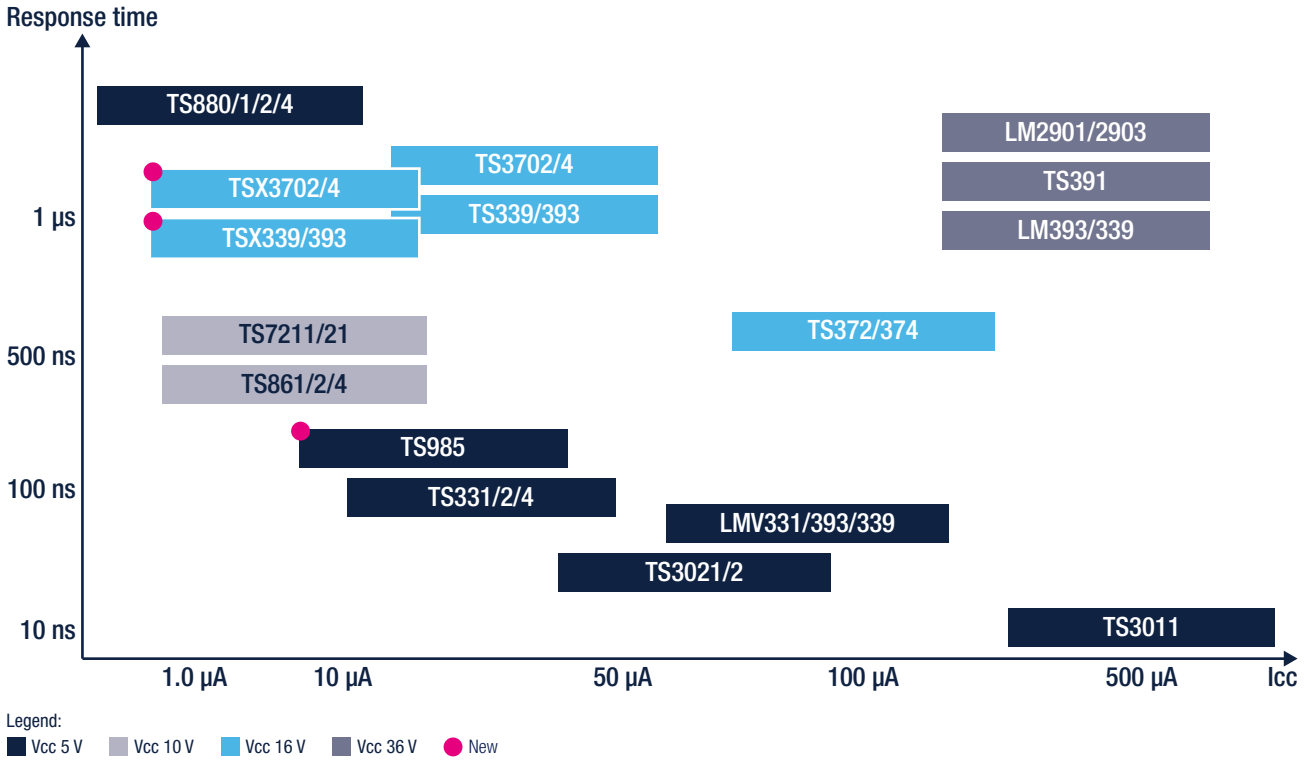
- Complete 5 V and 16 V CMOS portfolio including precision and power-saving op amps
- Brand new 36 V BiCMOS technology offering:
  - High ratios of performance-to-power consumption
  - Outstanding robustness (ESD tolerance 4 kV HBM)
  - Outstanding stability of performance versus temperature changes
- Space-saving packages such as DFN, QFN, SOT-23 and SC-70

ST Op Amps

5 V CMOS	16 V CMOS
Precision chopper TSZ Nano power TSU	High precision TSX7 High bandwidth TSX9
36 V BiCMOS	**Industrial Standards**
Precision chopper TSB18 Rail-to-rail TSB7 High power TSB58	LM LMV TL

Op amp series	Main features	Applications
TSB5 TSB6 TSB7 TSB18	Supply range up to 36 V, bandwidth from 0.56 to 22 MHz, 4 kV ESD, input offset down to 20 µV, output current up to 200 mA	Power applications: 24 V ± 15 V, High-voltage signal conditioning
TSX921 TSX9291 TSX711	Supply range up to 16 V, bandwidth up to 16 MHz, input offset down to 200 µV	Power applications: 12 V ± 5 V, AFE for high-voltage sensors
TSZ18 TSZ12 TSU11 TSU10 TSV77 TSV79	Supply range up to 5.5 V, input offset down to 5 µV, supply current down to 580 nA, bandwidth up to 50 MHz	Low voltage sensor signal conditioning. Interface with microcontrollers.

Comparators



ST is a leading supplier of comparators with a portfolio that 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 performance
- Outstanding robustness (ESD tolerance 4 kV HBM)
- Space-saving packages such as DFN, QFN, SOT-23 and SC-70

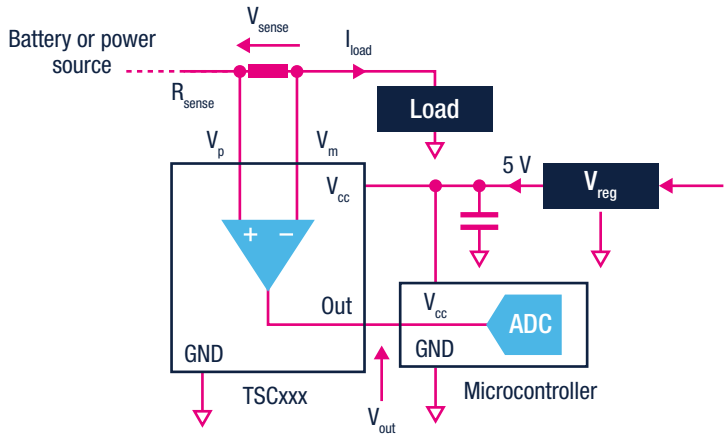
Comparators series	Main features	Applications
TS880/1/2/3/4	Nanopower Very low voltage	Gas, CO detectors Battery-operated security systems
TS3011	Nano-second response time High efficiency	Optical modules High-frequency systems Over-current detection
TS3021/2		
TSX3702/4	Micropower, 16 V operating High ESD tolerance	Voltage detector Motor control
TSX339/393		

High-side current sensing

Accurate sensing of currents is central to enhancing application safety. Controlling the current within set boundaries avoids overheating and short circuits.

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

- Up to 80 V line monitoring
- Integrated solutions (for example, inclusion of EMI filtering on output +++ "and embedded over-current detection comparator) 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 (maximum)
- 2.7 to 5.5 V supply voltage
- Gain: 60 V/V
- Gain error: 0.3% (maximum)
- Offset drift: 5 µV/°C (maximum)
- Gain drift: 10 ppm/°C (maximum)
- Quiescent current: 20 µA in Shutdown mode
- SO8 and Mini-SO8 package

Part number	Max. I_{cc} (µA)	Common mode operating range (V)		V_{cc} (V)		Voltage gain (V/V)	Operatin temperature (°C)	Package
		Min.	Max.	Min.	Max.			
Hide side current sensing								
TSC101	300	2.8	30	4	24	20, 50, 100	-40 ÷ +125	SOT23-5
TSC102	420	2.8	30	3.5	5.5	Adjustable	-40 ÷ +125	TSSOP8, SO8
TSC103	360	2.9	70	2.7	5.5	20, 25, 50, 100	-40 ÷ +125	TSSOP8, SO8
TSC2010/2011/2012	1500	-20.0	70	2.7	5.5	20, 60, 100	-40 ÷ +125	MiniSO8, SO8
TSC210/212/213	100	-0.3	36	2.7	26	200, 1000, 50	-40 ÷ +125	SC70-6, QFN10
TSC200	180	-16	80	2.7	18	20	-40 ÷ +125	SO8, MiniSo8

Part number	Description	Documentation
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-AETKT1V2	Evaluation kit for high voltage bidirectional current sense amplifier	DB4277

The ST Op Amps Mobile App

The ST Op Amps app (**ST-OPAMPS-APP**) is a free all-in-one design toolkit and smart selector for smartphones and tablets.

You can select the best product from among our operational amplifier, comparator, current-sensing, power and high-speed amplifiers portfolios for your application.

Sort, compare and filter electrical parameters or use the smart component value calculator with interactive schematics. Search using the competitor cross-reference tool and access 3D package data and product datasheets while away from the desk.

The ST Op Amps App is available on GooglePlay and AppStore **www.st.com/opamps-app**

ANALOG AND DIGITAL INPUT ICs

Modern control systems are highly complex applications. The current trend is to use as many integrated solutions as possible in such designs, either to increase the density or to reduce the physical dimensions of the modules.

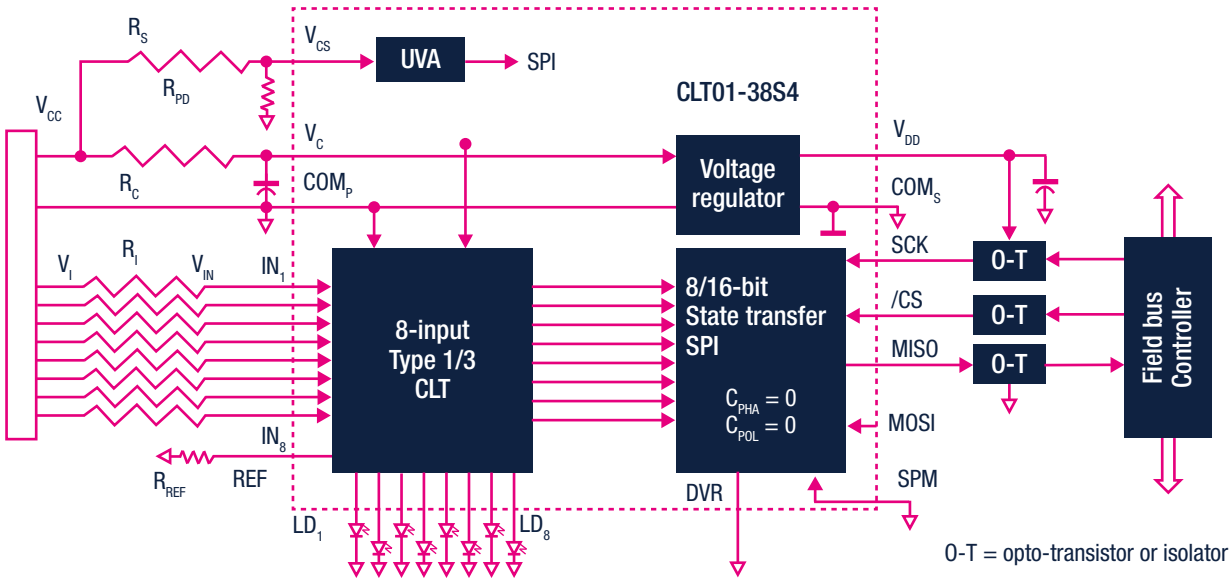
Either way results in more stringent requirements regarding the total power dissipation of the module.

Current-limiting termination (CLT) devices form a new series of intelligent protected terminations designed for digital-input modules and proximity-sensor interfaces in industrial and building automation systems. Today's designers face the challenge of increasing the number of IOs per volume unit and increasing the IO interface features.

The CLT series offers highly robust EMC compliant solutions in accordance with:

- Surge IEC 61000-4-5: 1 kV
- ESD IEC 61000-4-2: 15 kV
- EFT burst IEC 61000-4-4: 4 kV

Robustness is also a key parameter for CLT devices, including the CLT01-38S4, which operates with all types of sensors compliant with IEC 61131-2, type 1 and 3, with a 2.35 mA limited current, and type 2, using two inputs per sensor with the correct R_{REF}.



	CLT3-4BT6	PCLT-2AT4	SCLT3-8	CLT01-38	CLT03-2Q3	CLT03-1SC3
Number of inputs	4	2	8	8	2	1
Input IEC 61131-2	Type 1 and 3	Type 1, 2 and 3	Type 1, 2 and 3	Type 1, 2 and 3	Type 1 and 3	Type 1 and 3
Output type	Isolated	Isolated, Non-isolated	Isolated, Non-isolated SPI serialized transfer	Isolated, Non-isolated SPI serialized transfer	Isolated, Non-isolated	Isolated, Non-isolated
Output drive	Opto transistor	Opto transistor, CMOS compatible	Opto transistor, Electromagnetic isolator CMOS compatible	Opto transistor, Electromagnetic isolator, CMOS compatible	Opto transistor, Electromagnetic isolator, CMOS compatible	Opto transistor, Electromagnetic isolator CMOS compatible
Input current limiter	2.8 mA	2.5 to 7.5 mA	2.35 mA	2.35 mA	4 mA	4 mA
Current tolerance	25%	18%	10%	10%	23%	23%
Front-end LED status	Yes, using Type 1	Yes	Yes	Yes	No	No
Surge level	> 1 kV	Type 3: 1 kV Type 2: 0.5 kV	> 1 kV	> 1 kV	> 1 kV	> 1 kV
ESD level	8 kV	15 kV	15 kV	15 kV	2 kV	2 kV
Package	TSSOP-20	TSSOP-14	HTSSOP-38 QFN 7 x 7	HTSSOP-38 QFN 7 x 7	QFN-16L 2 x 4	SOT23-8L
Input datarate	10 kbit/s	10 kbit/s	40 kbit/s	400 kbit/s	70 kbit/s	70 kbit/s
Application note	AN 2527	AN 2482	AN 2846 and AN 3031	AN 4625		
Evaluation board	STEVAL-IFP008V1	STEVAL-IFP004V1	STEVAL-IFP007V1, STEVAL-IFP030V1	STEVAL-IFP023V1, STEVAL-IFP031V1, X-NUCLEO-PLC01A1	STEVAL-IFP035V1	

The **X-NUCLEO-PLC01A1** is an industrial input/output STM32 Nucleo expansion board based on the CLT01-38SQ7 and VNI8200XP for STM32 Nucleo. Compatible with the Arduino UNO R3 connector, it can be used as a simple PLC (programmable logic controller) in few steps.

The board is equipped with a set of diagnostic and activity LEDs to facilitate application debugging. The X-NUCLEO-PLC01A1 can be used to rapidly evaluate the ICs on the board performing a basic set of PLC operations in conjunction with the X-CUBE-PLC1 software package.

X-NUCLEO-PLC01A1 is not intended to evaluate single devices at their full specifications. The CLT01-38SQ7 provides protection and isolation in industrial operating conditions as well as an 'energy-less' status indication for each of the eight input channels, featuring minimal power consumption; it is designed for situations that are required to pass the IEC61000-4-2 8 kV and 15 kV test standards.

DIGITAL OUTPUT WITH INTELLIGENT POWER SWITCHES

ST offers a series of intelligent power switches (IPS) for high-side and low-side configurations that integrate a control section (logic interface, drivers, and protection) and a power stage.

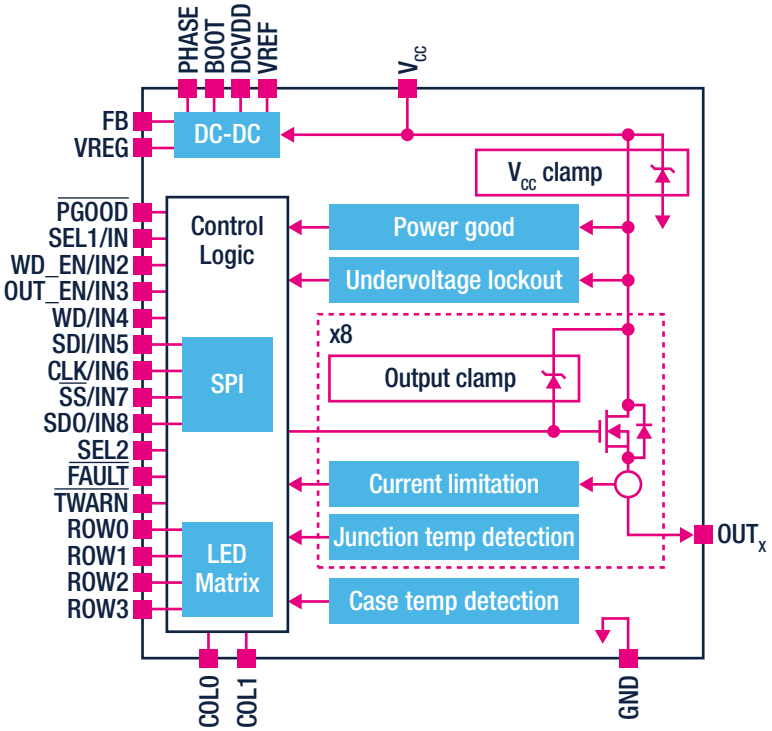
IPS are based on the consolidated bipolar, multipower BCD and VIPower®M0 technologies.

This provides increased system reliability, part count reduction, space saving and built-in protection. The high thermal capacitance of the power packages such as PowerSO-36, PowerSSO36, PowerSSO24, PowerSSO12 and HTSSOP20 allows the absorption of high-energy pulses when an inductive load is driven without any external freewheeling diode.

Technological evolution has led to smaller IPS devices, housed in tiny, flat, no-lead plastic packages (CSP, DFN, QFN) addressing size critical applications such as slim PLC modules.

The block diagram below shows one of the pillars of our offer, belonging to the broad 8 channel IPS compact line and high-end features family.

Typical octal intelligent power switch architecture (IPS8200HQ/IPS8200HQ-1)



The IPS8200HQ and IPS8200HQ-32 are octal high side switches housed in a tiny QFN 8x6x0.9 mm 48L package.

The ICs differ for the current limitation protection internal setting, 0.7 A for IPS8200HQ and 1.0 A for IPS8200HQ-1 per channel and are designed to drive any kind of load with one side connected to ground. The output stage is a N-channel power MOSFET with a typical R_{DSON} of 110 mΩ at ambient temperature.

They are offered with a selectable interface on the logic side of the chip: parallel or SPI (8-/16-bit SPI interface for IC command and control diagnostics).

Active channel current limitation combined with thermal shutdown (independent for each channel) and automatic restart, are protecting the IC against overload.

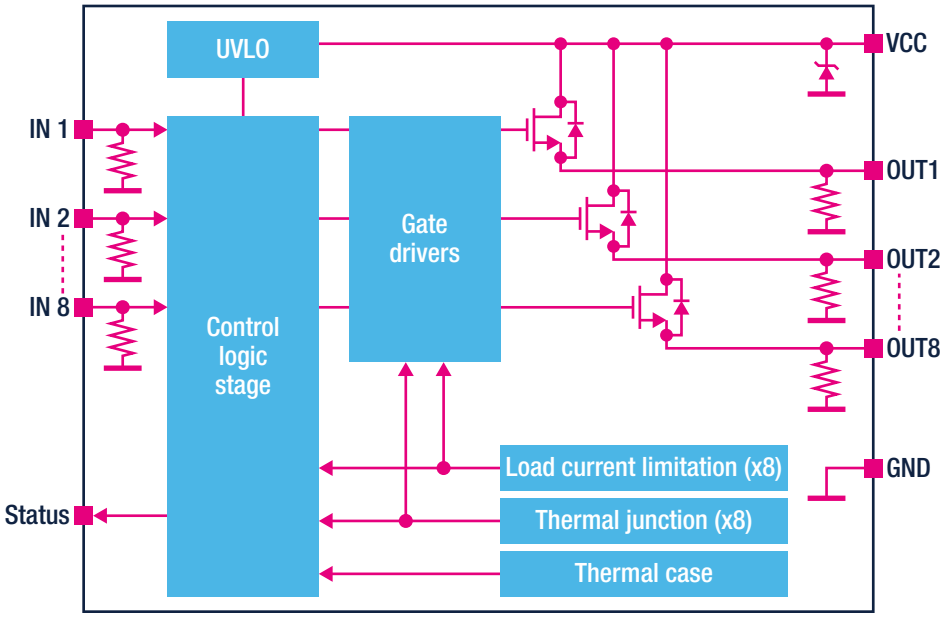
Dedicated diagnostics pins report the detection of invalid voltage range on V_CC rail (PGOOD pin), case overtemperature (TWARN pin), SPI fault or junction over-temperature (FAULT pin).

An internal LED matrix driver circuitry (4 rows, 2 columns) provides a visual indication of the status of each of the 8 output channels.

Output Stage	Part number (RPN)	Output Channels	Output current/ Chn (Inom) (A)	RDSON (Ω) Typ.	Supply voltage (V) AMR max.	Operating supply voltage range (V) min.	Package
High-side	TDE1747	1	<0.5		60	8	SO-14
	TDE3247	1	<0.5		36	8	SO-14
	IPS161H	1	0.5	0.06	65	8	PowerSSO12
	IPS161HF[1]	1	0.5	0.06	65	8	PowerSSO12
	L6375S	1	0.5	0.4	50	8	SO-8
	L6377	1	0.5	0.4	50	8	SO-14
	TDE1897R	1	0.5	0.4	50	18	SO-20
	TDE1898C	1	0.5	0.4	50	18	SO-20
	TDE1798DP	1	0.5		50	6	mini-DIP8
	IPS1025H	1	2	0.012	65	8	PowerSSO-24/QFN48L 8x6
	IPS1025HF[1]	1	2	0.012	65	8	PowerSSO-24/QFN48L 8x6
	VN540SP-E	1	2	0.05	45	10	PowerSO-10
	IPS160H	1	2	0.06	65	8	PowerSSO12
	IPS160HF[1]	1	2	0.06	65	8	PowerSSO12
	VN751PT	1	2	0.06	45	5.5	PPAK
	VN751S	1	2	0.06	45	5.5	SO-8
	L6370	1	2	0.1	50	9.5	PowerSO-20
	IPS1025H-32	1	5	0.012	65	8	PowerSSO-24/QFN48L 8x6
	VNI2140J	2	1	0.08	45	9	PowerSSO12
	IPS2050H	2	2	0.025	65	8	PowerSSO-24/QFN48L 8x6
	IPS2050H-32	2	5	0.025	65	8	PowerSSO-24/QFN48L 8x6
	VNQ860-E	4	<0.5	0.27	41	5.5	SO-20
	VNQ860SP-E	4	<0.5	0.27	41	5.5	PowerSO-10™
	VNI4140K	4	0.5	0.08	41	10.5	PowerSSO-24
	IPS4140HQ[3]	4	0.5	0.08	41	10.5	QFN48L 8x6
	VN330SP-E	4	0.5	0.2	45	10	PowerSO-10
	VN340SP-E	4	0.5	0.2	45	10	PowerSO-10
	L6376	4	0.5	0.64	50	9.5	PowerSO-20
	VNI4140K-32	4	1	0.08	41	10.5	PowerSSO-24
	IPS4140HQ-1[3]	4	1	0.08	41	10.5	QFN48L 8x6
	VN340SP-33-E	4	1	0.2	45	10	PowerSO-10
	VNI8200XP	8	0.5	0.11	45	10.5	PowerSSO-36
	VN808-E	8	0.5	0.15	45	10.5	PowerSO-36
	VN808CM-E	8	0.5	0.16	45	10.5	PowerSO-36
	IPS8160HQ	8	0.5	0.16	45	10.5	QFN48L 8x6
	IPS8160HQM	8	0.5	0.16	45	10.5	QFN48L 8x6
	IPS8200HQ	8	0.5	0.11	45	10.5	QFN48L 8x6
	IPS8160HQ-1	8	1	0.16	45	10.5	QFN48L 8x6
	VNI8200XP-32	8	1	0.11	45	10.5	PowerSSO-36
	IPS8200HQ-1	8	1	0.11	45	10.5	QFN48L 8x6
	VN808-32-E	8	1	0.15	45	10.5	PowerSO-36
	VN808CM-32-E	8	1	0.16	45	10.5	PowerSO-36
Isolated-High-side	ISO8200AQ	8	0.5	0.12	45	10.5	QFN 9x11
	ISO8200B	8	0.5	0.12	45	10.5	PowerSO-36
	ISO8200BQ	8	0.5	0.12	45	10.5	QFN 9x11
	ISO808	8	0.5	0.125	45	9	POWER-SO36/QFN 9x11
	ISO808A	8	0.5	0.125	45	9	POWER-SO36/QFN 9x11
	ISO808-1	8	1	0.125	45	9	POWER-SO36/QFN 9x11
	ISO808A-1	8	1	0.125	45	9	POWER-SO36/QFN 9x11
High/Low- side	TDE1708DFT[2]	1	<0.5		50	6	DFN 8L 4x4
	TDE1707[2]	1	0.5		50	6	SO-8
Low-side	IPS4260L	4	0.5	0.26	55	8	HTSSOP-20
Push-Pull	L6374FP	4	<0.5	4	50	10.8	SO-20

Note: 1. Suitable for SIL applications requiring for interface type C (or D) Class 3
2. The TDE1707 and TDE1708DFT are specific IPS developed to match all types of industrial detectors.
They can be coupled with inductive, capacitive, ultra-sonic or optical detectors and can be used in high-side or in low-side driver configuration in 3-wire networks
3. Available in Q1 2024

Typical octal intelligent power switch architecture (IPS8160HQ/IPS8160HQ-1)



The IPS8160HQ and IPS8160HQ-32 are octal high side switches housed in a tiny QFN 8x6x0.9 mm 48L package.

The operating-voltage ranges from 10.5V to 36V, the output current is 0.7 A for the IPS8160HQ or 1.0 A for the IPS8160HQ-1 (per channel), low power dissipation (RDSON=160mΩ/ch at ambient temperature) and finally a fully protected output stage of the power MOSFETs make these ICs suitable to drive heavy industrial loads.

Overload (OVL) and junction over-temperature (OVT) protection for each channel prevent damage to circuits.

There is also overvoltage protection, undervoltage lock-out (UVLO), short-circuit protection, output-current limitation and an over-temperature fault diagnostic pin.

The key applications are: programmable logic controllers (PLCs), vending machines, industrial PC peripheral input/output, computer numerical control (CNC) machines, general high-side switches.

International standards

IPS devices are designed to safely drive every kind of load in low-voltage applications (up to 60 V), handling data in and out of the microcontroller by means of status/input signals. IPS devices are designed to comply with the following international standards for EMC and PLC equipment:

- IEC 61000-4-4 (electrical fast transient/burst)
- IEC 61000-4-2 (ESD, immunity test contact/air)
- IEC 61000-4-5 (surge test immunity requirements)
- IEC 61000-4-6 (current injection test)
- IEC 61131-2 (programmable controller, equipment requirements and tests)

Galvanic Isolated Intelligent Power Switch (IPS)

The new ISO808 product family of galvanically isolated octal high-side switches has been launched in the market, extending the IPS portfolio flanking the currently available ISO8200 family (ISO8200B, ISO8200BQ, ISO8200AQ).

The new products family includes the ISO808, ISO808A, ISO808-1, ISO808A-1 offered in robust PowerSO36 package while the part numbers ISO808Q, ISO808AQ, ISO808Q-1, ISO808AQ-1 are coming in QFN package.

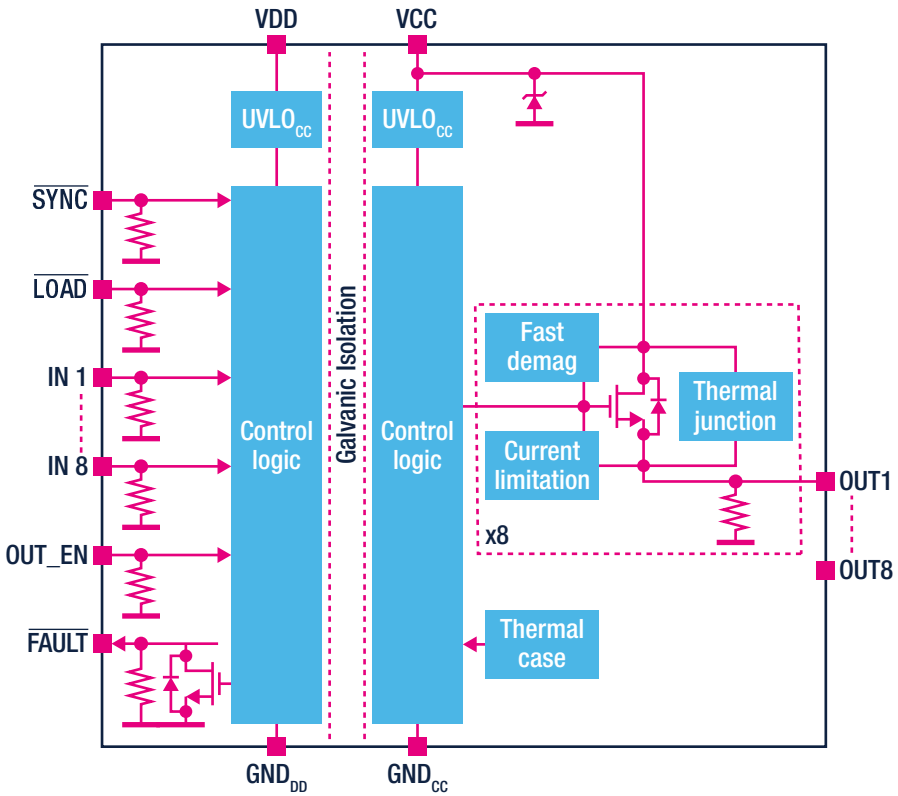
Any of those ICs embed two independent galvanically isolated voltage domains, VCC and VDD (for the process and the control logic stage respectively). The control logic stage can be supplied by 5 V or 3.3 V (TTL/CMOS) rails. The two stages communicate through the galvanic isolation channel by an ST proprietary protocol (RF communication for maximum noise immunity).

For the rich set of diagnostics and protection features, it is recommended to download the IC datasheet.

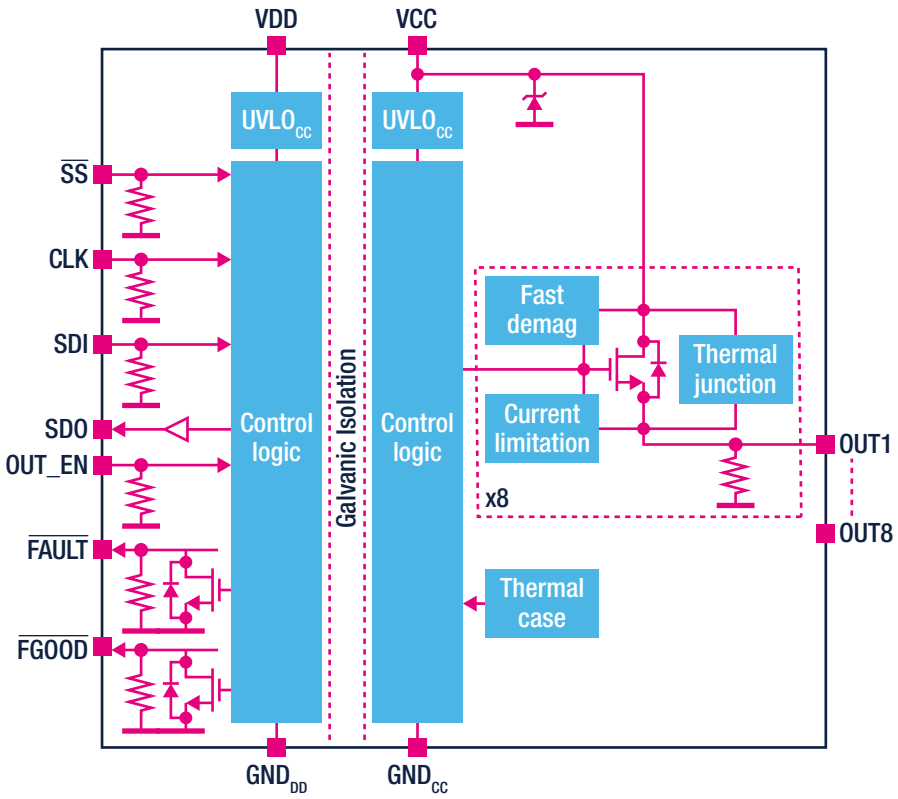
ISO8200 and ISO808 isolated IPS product families comply with the following international standards for isolation characteristics and tests:

- UL 1577 (isolation voltage)
- IEC 61000-4-8 (power frequency magnetic field immunity test)
- IEC 60747-5-2 (optoelectronic devices characteristics)
- I/O safety limits according to VDE V 0884-11
- UL 508 (standard for Safety for Industrial Control Equipment)

Parallel version block diagram



SPI version block diagram

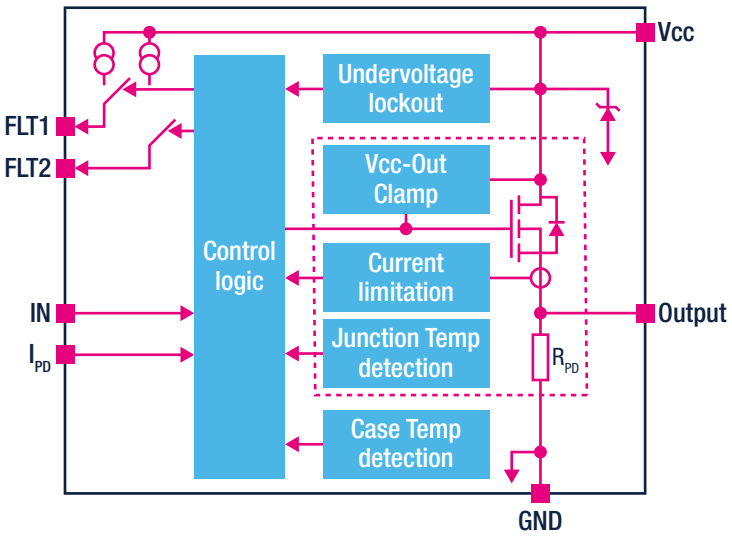


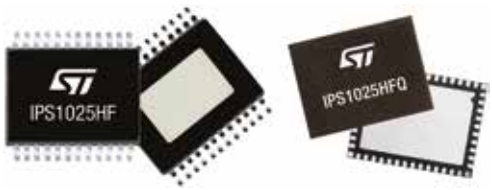
IPS 60 V - Suitable for Safety Integrity Level

With an operation supply voltage range up to 60 V, embedded protections (such as over-load and over-temperature), and extended diagnostics, the new single high-side switches families IPS1025H, IPS1025H-32, IPS1025HF (offered in PSSO24), as well as IPS1025HQ, IPS1025HQ-32 and IPS1025HFQ (equivalent QFN48L 8x6 mm package options) offer robustness and features for the design of safe systems.

The output stage is a N-channel power MOSFET with a typical R_{DSON} of 12.5 mΩ at ambient temperature, ensuring high energy efficiency and low thermal dissipation.

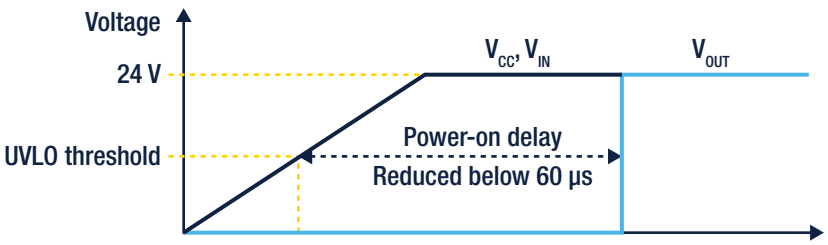
On-chip diagnostics include individual signaling of output overload and junction overtemperature and there is an extra thermal sensor to detect excessive case temperature. The devices are designed to meet IEC 61000-4-2 ESD, IEC 61000-4-4, and IEC 61000-4-5 specifications for ESD, fast-transient and surge immunity.





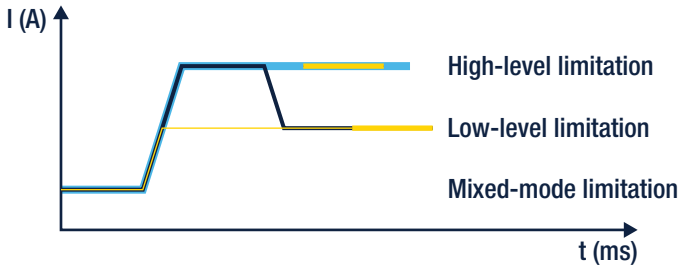
PSSO24 QFN48L

The IPS1025HF and IPS1025HFQ have a power-on delay time of less than 60 µs, that allows the ICs to satisfy standardized requirements for interface types C and D in Safety Integrity Level (SIL) class 3 applications.

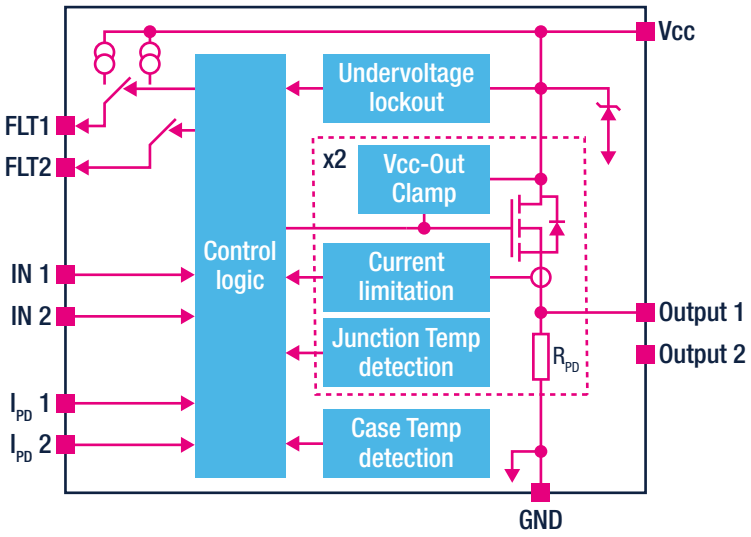


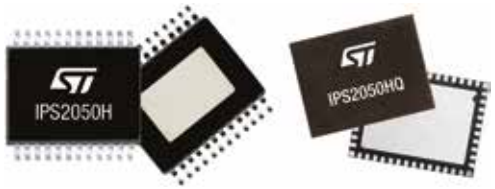
The IPS1025 family implement a unique active current limitation control function called smart load management. They offer two configurable operation modes for managing current limitations in overload conditions. Whenever turning-on actuators with inrush current (like capacitive loads, or filament lamps) or in the event of failure of an actuator or its wiring (overload, short-circuit), the smart load management comes into action.

The feature lies in the setting of the current limitation levels: IPS1025H/HQ and IPS1025HF/HFQ are suitable for load currents up to 2.4 A, while IPS1025H-32/HQ-32 fits for currents as high as 5.6 A.



Dual-channel high-side switches are also available with the following nomenclature: IPS2050H, IPS2050H-32, assembled in PowerSSO-24 package, while the IPS2050HQ and the IPS2050HQ-32 are assembled in QFN48L (8x6x0.9 mm) package, where the output stage is a N-channel power MOSFET with a typical RDSON of 25 mΩ at ambient temperature.





PSSO24
IPS2050H/-32

QFN48L
IPS2050HQ/-32

MOTION SENSORS

ST's motion sensor portfolio includes accelerometers, gyroscopes, digital compasses and inertial modules (**www.st.com/mems**), featuring:

- A high-performance and accuracy, unique sensor portfolio, from discrete to fully-integrated solutions, to meet every design need
- High-volume manufacturing capacity to provide cost-competitive solutions, fast time-to-market and security of supply
- High-performance sensor fusion to further improve the accuracy of multi-axis sensor systems to enable new emerging and highly demanding applications such as indoor navigation, location-based services and industrial controls
- High-level quality products, already tested in different application fields including mobile, portable, gaming, consumer, automotive, healthcare and industrial segments
  - Robotics and automation (accelerometers, gyroscopes)
  - Predictive maintenance
  - Inertial navigation, to increase the accuracy of wheel encoders and self-balancing robots
  - Condition monitoring of industrial equipment and transportation (high-g accelerometers)
  - Asset and parcel tracking and monitoring (high-g accelerometers, gyroscopes)
  - Impact detection and logging
  - Building and structure monitoring (accelerometers)
  - Vibration and tilt monitoring
  - Environmental noise-level detection (microphones)
  - Drills (accelerometers, gyroscopes)
  - Tilt detection

Part number	Full scale	Noise density (Typ.)	Package size (mm)	Key features
Accelerometers				
IIS2DLPC	±2, ±4, ±8, ±16 g	90 µg/√Hz	2 x 2 x 0.7 LGA-12	High-performance, high versatility, ultra-low-power 3-axis accelerometer for industrial applications
IIS2ICLX	±0.5; ±1; ±2; ±3	15 µg/√Hz	5 x 5 x 1.7 LGA-16	High-accuracy, high-resolution, low-power, 2-axis digital inclinometer with embedded machine-learning core
IIS3DHHC[1]	±2.5 g	45 µg/√Hz	5 x 5 x 1.7 LGA-16	High-resolution, high-stability 3-axis digital inclinometer
IIS3DWB	±2; ±4; ±8; ±16	60 µg/√Hz	2.5 x 3 x 0.86 LGA-14	Ultra-wide bandwidth, low-noise, 3-axis digital vibration sensor
Inertial Measurement Units				
ISM330ISN	±2, ±4, ±8, ±16 g ±125, ±250, ±500, ±1000, ±2000 dp	75 µg/√Hz (AXEL) 0.0038 °/s/√Hz (GYRO	2.5 x 3 x 0.83 LGA-14	iNEMO inertial module: 3D accelerometer and 3D gyroscope with digital output for industrial applications. can execute the machine learning libraries generated by ST's NanoEdge AI Studio, a powerful tool that allows anyone to easily create machine learning libraries with on-sensor learning
ISM330D				
ISM330IS HCX	±2, ±4, ±8, ±16 g ±125, ±250, ±500, ±1000, ±2000 dps	3.4 mdps/√Hz	LGA-14L (2.5 x 3.0 x 0.83 mm)	iNEMO inertial module: always-on 3D accelerometer and 3D gyroscope with embedded ISPU - intelligent sensor processing unit
Magnetometers				
IIS2MDC	±50 gauss	3 mgauss rms	2 x 2 x 0.7 LGA-12	High-accuracy, ultra-low-power, 3-axis digital output magnetometer

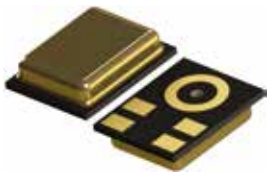
All sensors listed in the above table are included in the 10-year longevity program.
Note: This sensor cannot be evaluated with the X-NUCLEO

ENVIRONMENTAL SENSORS

STMicroelectronics offers a full range of environmental sensors, including pressure, microphones and temperature sensors. These sensors rely on dedicated mechanical structures that optimize performance even in challenging environmental conditions.

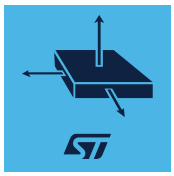
Part number	Full scale	Accuracy (Typ.)	Package size (mm)	Key features
Pressure sensors				
ILPS22QS	Supporting dual full-scale up to user selectable 4060 hPa	0.5 hPa absolute	HLGA-10L (2.0 x 2.0 x 0.73 mm)	Dual full-scale, 1260 hPa and 4060 hPa, absolute digital output barometer with embedded Qvar electrostatic sensor
ILPS28QSW			CCLGA-7L 2.8 x 2.8 x 1.95 mm	Dual full-scale, 1260 hPa and 4060 hPa, absolute digital output barometer with Qvar detection in a water-resistant package
Temperature sensors				
STLM20	-55 ÷ 130 °C	Accuracy: 1.50 °C max at 25 °C (±0.5 °C typ.)	1 x 1.3 x 0.5 UDFN-4L 2 x 2.1 SOT323-5L	Ultra-low current 2.4 V precision analog temperature sensor
STTS22H	-40 ÷ 125 °C	Accuracy: ±0.5 °C max -10 °C to +60 °C ±1 °C max -40 °C to +125 °C	2 x 2 x0.55 UDFN-6L	Low-voltage, ultra-low-power, 0.5 °C accuracy I²C/SMBus 3.0 temperature sensor
STTS751	-40 ÷ 125 °C	Accuracy: ±1.5 °C (max) 0 °C to +85 °C ±2.5 °C max -40 °C to +125 °C	2 x 2 x 0.5 UDFN-6L 2.9 x 2.8 SOT323-6L	2.25 V low-voltage local digital temperature sensor

Microphones based on MEMS technology offer excellent audio quality and fidelity. They are less susceptible to mechanical vibrations, temperature variations and electromagnetic interference compared to traditional electret microphones. Their use in industrial domains might be suitable in applications like ambient noise measurements or early detection of faulty equipment condition (pattern detection).



Part number	Port	Package size (mm)	Supply Voltage (V)	SNR (dB)	Sensitivity (dBV)	AOP (dB spl)	Current consumption (µA)	Key features
IMP23ABSU	Bottom	3.5 x 2.65 x 0.98	1.6 to 3.6	64	-38 ± 1	130	120	Single ended Analog Bottom port High performance MEMS microphone. Frequency response up to 80 kHz for ultrasound analysis and predictive maintenance applications
IMP34DT05	Top	4 x 3 x 1	1.6 to 3.6	64	-26 ± 3	122.5	650	Digital (PDM) Top port MEMS microphone with Enhanced ESD protection, High SNR and Acoustic Overload Point

EVALUATION BOARDS FOR SENSORS



The STEVAL-MKI109V3 is the default evaluation tool with which all ST's sensors can be evaluated and are supported.

Alternatively, the X-NUCLEO-IKS02A1 is an STM32 Nucleo expansion board for inertial and environmental sensor evaluation and software tuning. It is compatible with the Arduino UNO R3 connector layout and is designed around industrial grade devices.

The X-NUCLEO-IKS02A1 interfaces with the STM32 microcontroller via the I²C pin, and it is possible to change the default I²C port.

X-CUBE-MEMS

The X-CUBE-MEMS1 expansion software package for STM32Cube runs on the STM32 and includes drivers that recognize the sensors and collect temperature, humidity, pressure and motion data.

The expansion is built on STM32Cube software technology to ease portability across different STM32 microcontrollers.

The software comes with a sample implementation of the drivers running on the X-NUCLEO-IKS01A2/X-NUCLEO-IKS01A3/X-NUCLEO-IKS02A1 expansion boards connected to a featured STM32 Nucleo development board.

The software provides sample applications and advanced motion libraries: MotionAC accelerometer calibration, MotionAD airplane detection, MotionAR activity recognition, MotionAT active time, MotionAW activity recognition for wrist, MotionCP real-time carry position, MotionDI dynamic inclinometer, MotionEC real-time e-compass, MotionFA fitness activity, MotionFD real-time fall detection, MotionFX sensor fusion, MotionGC gyroscope calibration, MotionGR real-time gesture recognition, MotionID motion intensity detection, MotionMC magnetometer calibration, MotionPE real-time pose estimation, MotionPM real-time pedometer library, MotionPW real-time pedometer for wrist, MotionSD standing vs sitting desk detection, MotionTL tilt measurement and MotionVC vertical context libraries.

The X-CUBE-MEMS1 is a complete software to build applications using the following sensors:

- Temperature and humidity sensors: HTS221 for X-NUCLEO-IKS01A2 and X-NUCLEO-IKS01A3
- Pressure sensor: LPS22HB for X-NUCLEO-IKS01A2, LPS22HH for X-NUCLEO-IKS01A3, LPS33HW and LPS33K via DIL24 interface
- Temperature sensors: STTS751 for X-NUCLEO-IKS01A3 and STTS22H via DIL24 interface
- Motion sensors: LSM303AGR and LSM6DSL for X-NUCLEO-IKS01A2, LIS2MDL, LIS2DW12 and LSM6DSO for X-NUCLEO-IKS01A3, ISM330DHCX, IIS2DLPC and IIS2MDC for X-NUCLEO-IKS02A1, and ASM330LHH, ISM303DAC, ISM330DLC, LIS2DH12, LSM6DSOX, A3G4250D, AIS2DW12, AIS328DQ, AIS3624DQ, H3LIS331DL, LIS3MDL, LSM6DSR, LSM6DSRX, LSM6DSO32 and IIS2ICLX via DIL24 interface
- Audio sensor: IMP34DT05 for X-NUCLEO-IKS02A1

Compatible with the Unicleo-GUI graphical user interface to display sensor data and configure outputs.

Sample implementation available on the X-NUCLEO-IKS01A2/X-NUCLEO-IKS01A3/X-NUCLEO-IKS02A1 boards connected to a NUCLEO-F401RE, NUCLEO-L152RE, NUCLEO-L476RG or NUCLEO-L073RZ development board.

Advanced motion libraries with sample applications.

Package compatible with STM32CubeMX, can be downloaded from and installed directly into STM32CubeMX.

Easy portability across different MCU families, thanks to STM32Cube and free, user-friendly license terms.

FP-AI-PREDMNT2

FP-AI-PREDMNT2 is an STM32Cube function pack that programs the STWIN as an IoT Edge node, connected to the cloud, able to acquire sensor data, process them and send the results to the DSH-PREDMNT cloud dashboard. It includes dedicated algorithms for advanced time and frequency domain signal processing and analysis of 3D digital accelerometers with flat bandwidth up to 6 kHz.

The function pack helps to jump-start the implementation and development of condition monitoring applications designed with the NanoEdge™ AI Studio solution, thus easily enabling an AI-based predictive maintenance solution (the NanoEdge™ AI library generation is out of the scope of this function pack and must be generated using NanoEdge™ AI Studio).

The package includes pressure, relative humidity and temperature sensor monitoring, as well as audio algorithms to check acoustic emission (AE), up to 20 kHz, and ultrasound emission analysis up to 80 kHz.

Using the STBLESensor app you can set up Wi-Fi credentials and exchange cloud certificates to enable the connection to the dedicated DSH-PREDMNT web-based dashboard. The dashboard allows monitoring and logging the algorithm output, sensor data and equipment status.

The FP-AI-PREDMNT2, together with the suggested combination of STM32 and ST devices, can be used to develop specific industrial predictive maintenance applications for early detection of warning signs of potential failure.

The software runs on the STM32 microcontroller and includes all the necessary drivers for the STEVAL-STWINKT1B evaluation kit.

FP-AI-PREDMNT2 firmware is based on application-level modules (Sensor Manager, Digital Processing Units, etc.) that you can reuse and easily extend to build a customized application.

These application modules adopt state-of-the-art design patterns and natively support low-power modes. To enable this solution, the function pack has been built on top of eLooM, an embedded Light object-oriented fraMework for STM32 applications specifically designed for embedded low-power applications powered by STM32.

Professional MEMS Tool

The Professional MEMS Tool (STEVAL-MKI109V3 “Profi MEMS Tool”) is a motherboard designed to provide a ready-to-use development platform for MEMS devices mounted on adapter boards. It uses an STM32F401VE high-performance Arm® Cortex®-M4 microcontroller which functions as a bridge between the sensor on the adapter board and the PC on which it is possible to use the graphical user interface Unico-GUI downloadable from the ST website or dedicated software routines for customized applications.

BASIC FEATURES

- Compatible with all ST MEMS adapter boards with digital output
- Controlled by the high-performance STM32F401VET6 Arm® Cortex®-M4 microcontroller
- Includes a DIL24 socket for easy MEMS adapter connection
- 3.6 V on-board linear voltage regulator for microcontroller power supply
- DFU compatible for USB microprocessor firmware update
- USB 2.0 full-speed compliant
- Debugging connector for SWD/JTAG
- Connection pins for UART communication (Bluetooth®, serial port)
- RoHS compliant

Join our **MEMS and Sensor community** and participate in **Q&As**.

Our experts are there to help you!

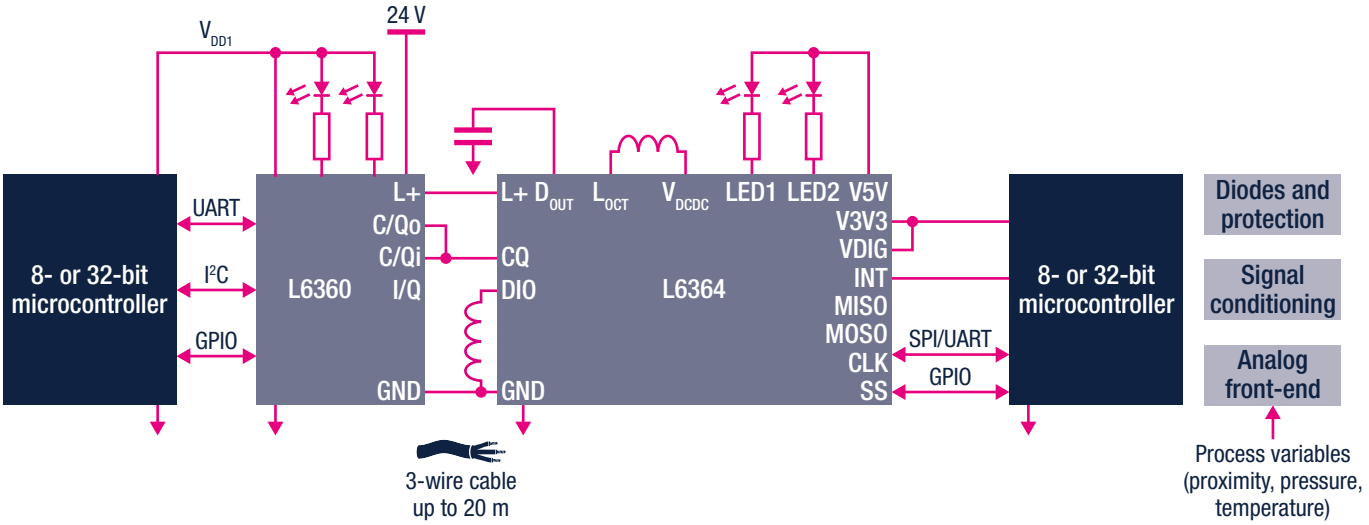
IO-LINK

As explained in the previous section focused on applications, ST offers a number of solutions for IO-Link to help customers quickly and easily prototype and develop their products.

The IO-Link transceivers L6360 (Master side), L6362A and the L6364 (Device side) enable master and device solutions for IO-Link.

These products feature a wide application spectrum thanks to their voltage range and current handling capabilities, maximum design flexibility, minimum power dissipation, and maximum efficiency. Designed in BCD technology that allows the design of the logic part, and robust low-voltage power MOSFETs in the same chip these ICs offer an efficient, compact and cost-effective way to drive any 3-wire digital sensor.

IO-Link Hub



These ICs ensure that IO-Link sensors and actuators can communicate without the need for special cables (standard M5, M8 or M12 cables and connectors can be used). They feature an advanced solution that can be integrated even in legacy systems, that is neutral to any fieldbus, and maintains P2P communication.

Moreover, the ICs are compliant with burst tests, surge tests and ESD immunity tests, based on the IO-Link specification and SIO mode requirements.

Part number	Supply voltage (V)	V_{DD} (V)	Output current (A)	I_{max} linear regulator (mA)	Technology	Output channels	Input channels	Package
L6360 (Master)	18 ÷ 32.5	3.3/5	0.5	65	MultiBCD	2	2	QFN 26L 3.5 x 5 mm
L6362A (Device)	7 ÷ 36	3.3/5	0.22	10	MultiBCD	1	1	DFN 12L 3 x 3 mm
L6364Q/W (Device)	6 ÷ 35	3.3 /5	0.25/0.5 (in join mode)	50	MultiBCD	2	2	QFN 20L 4 x 4 mm CSP 19 2.5 x 2.5 mm

Evaluation boards are available for our L6360, L6362A and L6364 IO industrial transceiver ICs: here below not all of our reference designs for IO-Link communication have been reported, for a complete list, please refer to www.st.com.

Order code	Description	Application Note or User Manual
STEVAL-IDP004V2	IO-Link master multi-port evaluation board based on L6360	AN5041
STEVAL-IOM001V1	IO-Link master evaluation board based on L6360 equipped with ST morpho connectors for STM32 Nucleo	UM2414
STEVAL-IDP003V1	IO-Link industrial modular sensor board based on L6362A	AN5041
STEVAL-IOD003V1	IO-Link (PHY) device evaluation board based on L6362A with Arduino connectors for STM32 Nucleo	UM2424
P-NUCLEO-IOM01M1	STM32 Nucleo pack for IO-Link master based on L6360 device with IO-Link v1.1 (PHY and stack)	UM2421
P-NUCLEO-IOD01A1	STM32 Nucleo pack for IO-Link device based on L6362A device fully compatible with IO-Link v1.1.3 (PHY and stack)	UM2425
X-NUCLEO-IOD02A1	Expansion board IO-Link device based on L6364Q device fully compatible with IO-Link v1.1 (PHY and stack)	UM2741
P-NUCLEO-IOD02A1	STM32 Nucleo pack for IO-Link device based on L6364 device fully compatible with IO-Link v1.1 (PHY and stack)	UM2782
STEVAL-BFA001V2B	Multi-sensor predictive maintenance kit with L6362A and IO-Link stack v.1.1	UM2663
P-NUCLEO-IOD04A1	STM32 Nucleo pack for IO-Link device applications based on L6364Q transceiver, IPS2050H-32 power switch and STM32L073RZ	DB5109
STEVAL-IOD04KT1	Industrial smart sensor kit based on L6364W dual IO-Link device transceiver	UM2942
STDES-8CHDOUTPT	8-channel digital output L6364 IO-Link hub	DB4838
STDES-8CHDINPUT	8-channel digital input IO-Link hub based on L6364	DB4843
STDES-8PH7TMG	8-port IO-Link master with TMG stack	DB4837
STDES-8PIOLM4P	8-port IO-Link master based on IOLM4P L6360	DB4847
STDES-IODLIGHT	IO-Link actuator for industrial tower light based on L6364	DB4841

The **STEVAL-IOD04KT1** is a reference design kit that exploits the features of the L6364W IO-Link dual-channel device transceiver.

The kit consists of the STEVAL-IOD004V1 main board (not available for sale), the STLINK-V3MINI programmer and debugger tool, a 14-pin flat cable, and an M8 to M12 standard industrial connector adapter.

The kit acts as a modern smart industrial sensor to be connected to a master IO-Link hub (or a suitable PLC interface).

The power supply for the MCU, sensors, and other logic devices derives from the DC-DC converter controller embedded in the L6364W.

The on-board STM32G071EB microcontroller runs an IO-Link demo stack v.1.1, which controls the IO-Link communication, and the software code that manages the L6364W transceiver and the MEMS industrial sensors (THE ism330dhcx iNEMO inertial module and the IIS2MDC 3-axis digital output magnetometer).

The tiny dimensions of the main board (45.8 x 8.3 mm) have been achieved thanks to the small sizes of the CSP package options of L6364W and STM32G071EB.

Connect the main board to an IO-Link master via the adapter and the M8 connector included in the kit for normal operation.

WIRELESS COMMUNICATION

Bluetooth®

BlueNRG-1 and BlueNRG-2: Ultra-low-power Bluetooth® Low Energy System-on-Chip

ST's BlueNRG Bluetooth® Low Energy System-on-Chip solutions, are based on 32-bit Arm® Cortex®-M0 and offering unique combination of low power consumption, scalable GPIO pins, with high radio performance, and large integrated memory and come with Bluetooth® 5.4 certification. In addition, the latest evolution of the BLE stack adds state-of-the-art security and privacy communication along with a faster data transfer. BlueNRG SoC provide the solution perfectly suited for replacing cable in industrial automation, enabling predictive maintenance applications, and seamless interfacing with sensors for remote monitoring.

Evaluation platforms are available (order code STEVAL-IDB007V2, STEVAL-IDB008V2 and STEVAL-IDB009V1) for enabling evaluation and helping in prototype building.

KEY FEATURES

- State of the art Security and privacy features
- Data length extension for faster data transfer
- Extends battery life
- Robust and reliable RF connections
- A full-featured SDK, including:
  - Templates, examples and iOS/Android apps
  - High-level abstraction layer APIs (no BLE expertise required)
  - Real-time debug capabilities
  - IAR, Keil, and Atollic support

KEY BENEFITS

- Single-core, ultra-low-power 32-bit Arm® Cortex®-M0
- Up to 256 Kbytes of Flash memory
- 24 Kbytes of ultra-low-leakage RAM (with full data retention)
- Operating temperature range up to +105 °C
- Ultra-low-power, sub-µA power current consumption in Sleep mode
- Ultra-fast sleep-to-active and active-to sleep switching
- Up to +8 dBm maximum output power
- On-chip PDM interface for digital MEMS microphone interfacing
- Embedded battery monitor and temperature sensor
- Integrated DC/DC step-down converter and linear regulator
- On-chip ADC analog front end with 10-bit resolution
- Up to 15 (QFN32) or 26 GPIOs (QFN48 package)
- QFN32 (5 x 5 x 1 pitch 0.5 mm), WLCSP34 (2.69 x 2.56 x 0.5 pitch 0.4 mm), QFN48 (6 x 6 x 1 pitch 0.5 mm) (BlueNRG-2 only), WLCSP 36

BlueNRG-2N: Bluetooth® Low Energy network processor

Combining Convenience and Scalability, with Bluetooth® 5.4 Features and Security, the BlueNRG-2N network coprocessor comes pre-programmed, ready for connecting to a host controller to provide Bluetooth® connectivity. The latest Bluetooth® enhancements featured in BlueNRG-2N include support for Data Length Extension, which accelerates over the air (OTA) firmware updates by as much as 2.5 times and raises data transfers to 700 kbit/s at the application level. Power consumption is lower compared with previous BlueNRG generations, with low transmit and receive current and drawing just 900nA in shutdown mode with the BLE stack running. At the same time, the device maintains robust and reliable radio performance, with +8 dBm programmable RF output power and up to a 96 dB link budget.

KEY FEATURES

- Bluetooth® 5.4 compliant master and slave roles simultaneously
- Multi-master to multi-slave communication guaranteed (2 masters to 6 slaves simultaneously, up to 8 simultaneous connections handled)
- Embedded Bluetooth® Low Energy protocol stack: GAP, GATT, SM, L2CAP, LL and RF-PHY
- On-chip non-volatile upgradable memory
- 6.2 mA Rx current consumption
- 6.8 mA Tx current consumption at -2 dBm
- 96 dB of RF link budget
- Up to +8 dBm available output power (at antenna connector)
- 16- or 32-MHz low-cost crystal oscillator
- 32-kHz crystal oscillator or integrated low frequency ring oscillator
- Operating supply voltage from 1.7 up to 3.6 V
- Available in QFN32 (5 x 5 mm) and WCSP34 (2.66 x 2.56 mm) packages

KEY BENEFITS

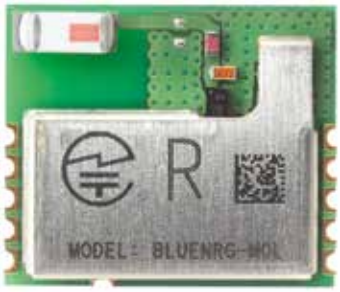
- Significantly extends battery life
- Long communication range in real-life environment
- Excellent co-existence performance in crowded 2.4 GHz bandwidth
- Single firmware for supporting master and slave roles
- Easy firmware upgrades in the field to maintain compliance with future releases of the Bluetooth® specification

Bluetooth® modules

ST offers Bluetooth® low energy modules

BLUETOOTH® LOW ENERGY MODULE FEATURES:

- Bluetooth® v4.2 compliant network processor module BlueNRG-M0, built around BlueNRG-MS
- Host interface: SPI
- BlueNRG-MS embeds all the Bluetooth® Smart 4.2 protocol stack
- Certifications:
  - EU (RED) Type certificate
  - FCC, IC modular approval certification
  - TYPE Japan Certification
  - WPC India Certification
  - BT SIG End Product QDID
- Output power +6 dBm
- Supply voltage from 1.7 to 3.6 V
- Small form factor: 11.5 mm x 13.5 mm

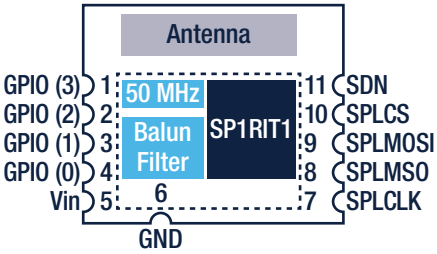


BLUETOOTH® LOW ENERGY MODULE FEATURES:

- Bluetooth® v5.0 compliant wireless processor module BlueNRG-M2, built around BlueNRG-2
  - High performance, ultra-low power Cortex-M0 32-bit based architecture core
  - Programmable embedded 256 KB Flash
  - 24 KB embedded RAM with data retention
  - Interfaces: 1 x UART, 1 x I²C, 1xSPI, 14 x GPIO, 2 x multifunction timer, 10-bit ADC, Watchdog & RTC, DMA controller, PDM stream processor, SWD debug Interface
- Max Tx power: + 7 dBm
- Excellent link reliability
- Small form factor: 11.5 mm x 13.5 mm
- Complemented with Bluetooth® low energy protocol stack library (GAP, GATT, SM, L2CAP, LL)
- Certifications:
  - EU (RED) Type certificate
  - FCC, IC modular approval certification
  - SRRC China Certification
  - TYPE Japan Certification
  - WPC India Certification
  - BT SIG End Product QDID
- Pre-programmed UART bootloader
- Operating supply voltage: from 1.7 to 3.6 V

SUB-1GHZ MODULE FEATURES:

- SPI host interface
- Output power up to +11.6 dBm
- Rx: 9 mA, Tx: 21 mA @ +11 dBm
- CE compliant and FCC certified
- Air data rate up to 500 Kbit/s
- Receiver sensitivity: -118 dBm
- Shutdown: 2.5 nA
- Operating temperature: -40 to 85 °C



SPSGRF-868 (868 MHz)
SPSGRF-915 (915 MHz)

S2-LP: Ultra-low-power, long range sub-1GHz RF transceiver

The ST ultra-low power sub-1GHz transceiver S2-LP is the ideal solution for allowing smart connected object to operate for up 10 years without replacing batteries, while the receiver sensitivity of -130 dBm enables wide-area coverage.

It supports point-to-point, star, as well as mesh networking topologies thus resulting in a very flexible wireless transceiver perfectly suited for building and factory automation, smart grid, alarm and security, and IoT applications.

Moreover, the S2-LP enables connectivity to the Sigfox global network, which is being rolled out worldwide to provide a reliable cost- and energy-efficient communication solution for billions of sensors.

For fast prototyping and easy evaluation, evaluation platforms are also available covering different ISM Sub-1GHz bandwidth (order code STEVAL-FKI433V2, STEVAL-FKI868V2 and STEVAL-FKI915V1 built around S2-LP transceiver; STEVAL-FKI512V1 built around S2-LPCB transceiver).

SPIRIT

SUB-1GHZ

Sub 1GHz

The Industrial, Scientific and Medical (ISM) unlicensed frequency bands below 1 GHz are widely used by wireless communication systems mainly in industrial, home and building automation. The flexibility offered by national regulations in selecting physical layer characteristics such as output transmitted power, modulation scheme, data rate and channel bandwidth, together with the possibility to develop proprietary protocols lets users find the best solution for their needs.

Moreover, either a star or mesh network topology can be implemented and, in principle, without any limitations in the number of nodes connected simultaneously.

Based on sub-1GHz systems, these standards guarantee interoperability between nodes from different manufacturers or system providers, but at the same time achieve high protocol efficiency for the dedicated use case.

Sub-1GHz proprietary solutions are widely used for the wireless connection of nodes in home networks and building automation systems as well as in industrial process applications. Real-time

monitoring and control of thousands of nodes enables process optimization, more efficient resource management, prevents breakdowns and saves energy (Smart Factory).

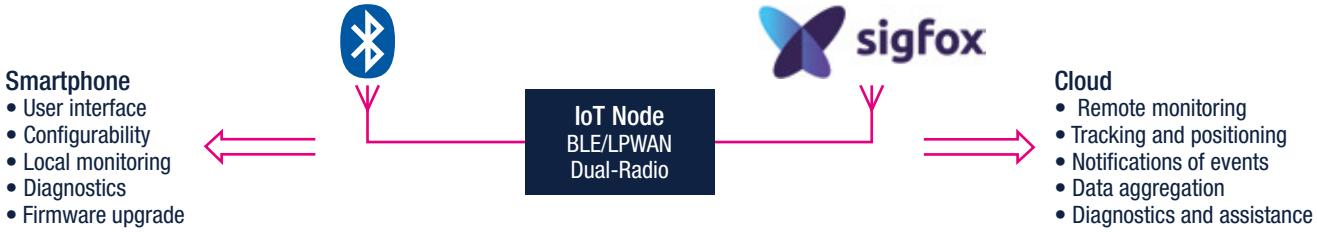
KEY FEATURES

- Frequency bands:
  413-479 MHz, 826-958 MHz (S2-LP)
  452-527 MHz, 904-1055 MHz (S2-LPCB)
- Modulation schemes:
  - 2(G)FSK, 4(G)FSK
  - OK, ASK
- Air data rate from 0.3 to 500 kbps
- Ultra-low current consumption:
  - 7 mA Rx and
  - 10 mA Tx @ +10 dBm
- Excellent receiver sensitivity down to-130 dBm
- Programmable RF output power up to +16 dBm
- Automatic packet acknowledgment and retransmission
- Embedded timeout protocol engine
- Antenna diversity algorithm
- Fully integrated ultra-low power RC oscillator
- Package: QFN24 4 x 4 mm

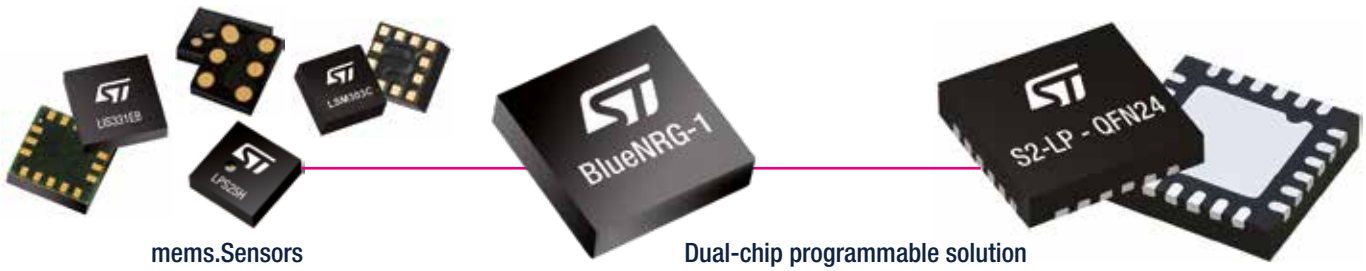
KEY BENEFITS

- Ultra-low-power design for prolonged battery lifetime in applications with sensors in the Smart Industry, Home and Building automation and Smart City
- Built-in support for Sigfox simplifying access to reliable, efficient, and cost-effective IoT connectivity
- Very flexible device supporting multiple protocol and multiple Sub-1GHz bandwidth

Combo-radio IoT node
Dual-Radio turn-key solution application example



Application scenarios are: wireless sensor nodes, asset trackers, remote diagnostics, finder/tags, smart parking, smart objects.



mems.Sensors

Dual-chip programmable solution

Evaluation tools for connectivity modules		Balun/filter
X-NUCLEO-IDB05A2	STM32 Nucleo Expansion board for BlueNRG-M0 and BlueNRG-M2 modules	BALF-NRG01D3
X-NUCLEO-BNRG2A1		
X-NUCLEO-IDS01A5 (4)	STM32 Nucleo Expansion board and USB dongle for SPSGRF modules	BALF-SPI01D3
STEVAL-IDS01V5M (4M)		

CONTACTLESS

Contactless technology in the smart industry domain is mostly about object tracking and recognition as well as granting people access or even configuring boxed electronic product along the production line.

NFC/RFID Tags, Dynamic Tags & Readers

ST offers a comprehensive portfolio of NFC/RFID products, which operate at 13.56 MHz frequency and are based on NFC and ISO standards:

- NFC/RFID Tags, ideal for wireless pairing (Bluetooth® or W i-Fi) and product identification, feature counters, data protection (password) and able to wake-up the Host chip thanks to a General Purpose Output
- Dynamic NFC tags, featuring a reliable EEPROM memory with data protection (password), an I2C interface to connect to a MCU and a RFID/NFC tag interface, enabling multiple use cases for Industrial, Factory Automation, Consumer and IoT.
- NFC/RFID Readers, which support multiple NFC protocols in Reader/Writer, Card Emulation or Peer-to-peer modes, accessed by SPI interface and able to cope with the most challenging environment thanks to High RF performances and advanced features

ST also offers a large range of discovery kits, Nucleo shields, reference software and documentations in order to ease the design process.

KEY FEATURES

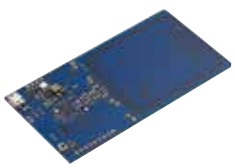
- Best-in-class RF performances
- HF 13.56 MHz frequency
- High reliable EEPROM with data protection
- I²C/SPI serial interface
- Energy harvesting capabilities
- Fast Transfer Mode
- Extended Temperature Range
- Tamper detection feature
- 10-year longevity commitment
- Automatic Antenna Tuning
- High and Dynamic Power Output

Part number	Mode	Protocol	Serial interface	Key features	Package
ST25R3911B ST25R3912	Reader/Writer P2P	ISO14443A/B ISO15693, FeliCa	SPI	Automatic Antenna Tuning, Dynamic Power Output (up to 1.4 W), Very High Baud Rate 6.8 Mbps, Capacitive and Inductive wake-up	QFN32 (5 x 5 mm)
ST25R3916B ST25R3917B ST25R3918	Reader/Writer Card Emulation P2p	ISO14443A/B ISO15693, FeliCa	SPI I²C	Automatic Antenna Tuning, Dynamic Power Output (up to 1.6 W) Noise Suppressor Receiver, Active Wave Shaping, Capacitive & Inductive wake-up	QFN32 (5 x 5 mm) WLCSP
ST25R200	Reader/Writer	ISO14443A/B ISO15693	SPI	Dynamic Power Output (up to 1.2 W) Improved low power wake-up Noise Suppressor Receiver, Active Wave Shaping	QFN24 (4 x 4 mm)
ST25DV-I2C	Dynamic Tag	ISO15693	I²C	EEPROM 4 kb, 16 kb & 64 kb, Fast Transfer Mode (256 B buffer), 64-bit password, Energy Harvesting, GPO MCU wake-up, Up to 105/125 °C operation, NFC Forum Certified	SO8, TSSOP8, FPN8, FPN12, WLCSP
ST25TA	Tag	ISO14443A	Not applicable	EEPROM 512 b, 2 kb, 16 kb & 64 kb, 128-bit password, 20-bit Counter, GPO MCU wake-up, NFC Forum Certified	Die, FPN5
ST25TV	Tag	ISO15693	Not applicable	EEPROM 512 b, 2 kb & 64 kb, 64-bit password, Tamper Detect loop, 20-bit Counter, GPO MCU wake-up, NFC Forum Certified	Die, FPN5

X-NUCLEO-NFC09A1
ST25R200 based NFC/RFID Reader Nucleo expansion board

X-NUCLEO-NFC07A1
ST25DV-I2C based Dynamic NFC tag Nucleo expansion board

ST25DV64KC-DISCO
ST25DV-I2C based Dynamic NFC tag Evaluation board



ST25R200-EMVCo
ST25R200 based NFC/RFID Reader Evaluation board

60-GHz Short-Range RF Transceivers

The **ST60** 60 GHz RF Transceiver provides a very power-efficient and high data rate wireless link enabling freedom from physical cables and connectors for short range (few centimeters) point-to-point communications.

ST60 offers best-in-class wireless performance with **transfer speeds up to 6 Gbps** along with **very low power consumption**.

ST60's unmatched efficiency, very small form factor and innovative architecture design for optimized system bill of material, make it ideally suited for a wide range of applications in personal electronics, industrial and computer & peripherals.

Eliminate cables and connectors with our innovative ST60 solution. This tiny, optimized, high-datarate wireless link transceiver is a breakthrough for short-range, point-to-point communications:

- Board-to-board contactless connections
  - To remove flex cables in electronics devices
  - To remove cables in Industrial electronic systems that move or undergo mechanical stress due to flexing and bending
- Connector-free solutions
  - For water and dust proof connector-free devices
  - For seamless docking and on-the-go device-to-device data sync
  - For harsh environments to avoid exposing internal electronics to environmental stress through connector ports
- Contactless connectors solutions for Industrial applications

At STMicroelectronics we create technology that starts with You

MIX
Paper from responsible sources
FSC® C003379

Order code: **BR2412SI**

For more information on ST products and solutions, visit www.st.com