life.augmented

Products and solutions for Smart industry

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Introduction

The Industrial world is changing in a trend that goes under a variety of names including Industry 4.0, the 4th industrial revolution, Industrial Internet of Thing (IIoT) and smart manufacturing. At ST we call this trend Smart Industry. We believe that it is a (r)evolution that builds on the many different technology advances over the past decades but which will fundamentally change the way factories and workplaces function. For us "Smart" means doing things more efficiently, more flexibly and in a more environmentally friendly manner. It also means the manufacturing will be safer for people working there.

To achieve this we see industrial infrastructure evolving in three directions:

More Efficient

With factories accounting for 40% of the world's energy consumption, reducing their energy use will play a major role in putting the planet on a more sustainable course. Higher efficiency can be improved at all points in power usage with a particular focus on power conversion & energy harvesting, power management, power storage and motor control. This is implemented in the factory by retrofitting existing machinery with new inverters and power boards containing the latest generation of ICs or silicon-carbide power devices, leading to improved efficiency, thermal management, size and cost.

More intelligent and aware

Machines are aware of the humans around them and provide new interfaces such as smart tools, augmented reality and touchless interfaces for easier and safer interactions. Sensors collect information about every machine all the time. Then safe & secure distributed local processing allows data to be turned into information, allowing real-time monitoring and predictive maintenance and repair. Products contain the instructions for their manufacturing and carry that information with them throughout their lifecycle. This will be achieved through the addition of local processing and sensor/actuator capabilities through the factory and connecting them in an efficient manner.

More Connected

Machines are connected inside the factory to the larger supply chain and to the cloud. When orders can be customized in real time and only what is needed is actually made, this enables optimal planning and flexibility in manufacturing. Real-time communication down to the lowest level of sensors and actuators, ensuring optimal reactivity and real-time analysis processes. And of course all of these communications are secure. To achieve this the existing industrial networking standard are still valid, but more is needed in modern factories improve cooperation among machines so they can decide where resources are needed and adapt the workload to better serve critical processes.

This is done using fieldbus protocols with advanced Machine-to Machine M2M communication systems based on IO-Link and industrial wireless networks.

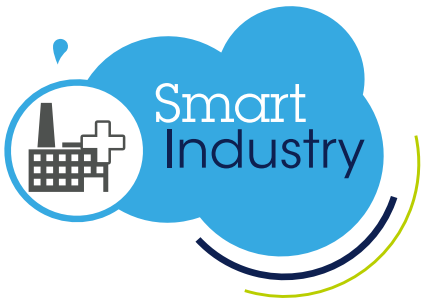
Smart Industry focuses on data management. Instead of being the vertex of the computer-integrated manufacturing (CIM) pyramid model, this creates a new paradigm where the supervisor level is now the backbone, ensuring the continuity between the two worlds. For instance, with communication protocols such as OPC Unified Architecture or IPv6-based network infrastructures.

Safety is also a key function which is pervasive and transversal to all levels of Smart Industry. Safety is implemented in many different ways ranging from ICs with an extended voltage range matching IEC 61508 requirements, to new hardware architectures, which help developers meet the challenges of qualifying their systems to SIL requirements.

Semiconductors are a key enabler behind this new Smart Industry, pervasive through the industrial infrastructure and behind the digital intelligence that it makes possible throughout the entire supply chain. As a supplier with over 30 years' experience in developing products for factory automation and industrial applications, ST is playing a leadership role with its catalog of products that help make smart industry a reality, today. Our goal is to provide products and solutions to support developers of the factory of tomorrow including product evaluation boards, prototyping systems and online design tools.

This document is organized in three main parts, each of them focusing on the Smart Industry's targets to become:

- More efficient by improving performance at all points in power usage, from power conversion and management to motion control
- More intelligent and aware through the use of sensors, MCUs and industrial IOs to collect information about every machine and the development of distributed local processing to turn data into information
- And more connected by creating networks between machines inside the factory, with the larger supply chain, and to the cloud



More efficient

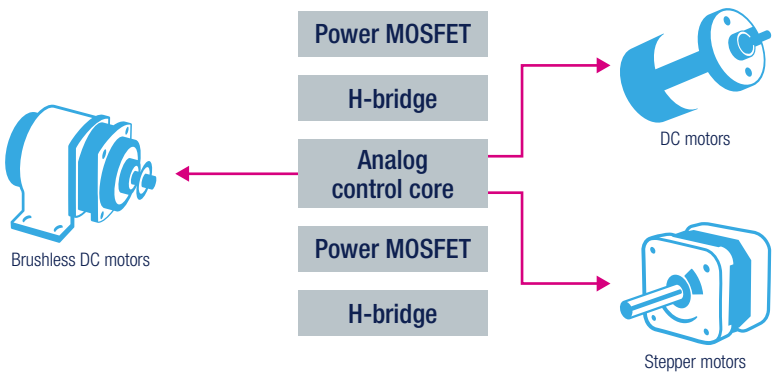
This section on how to become more efficient focuses on the capability to delivery and manage power in ever smart ways.
ST's latest inverter and energy harvesting technologies as well as wide bandgap materials such as Silicon Carbide are key enablers in this domain. Solutions based on these are addressed here with a selection of our ICs, highlighting the latest technologies for motion control systems.
You will find System-in-package solutions as well as isolated gate drivers and the latest power switches combined in our full featured power modules.
An overview of our power management ICs is also included.

Motor drivers	Gate drivers	IGBTs & Power MOSFETs	Diodes and SiC rectifiers	Thyristors & AC switches
SiC MOSFETs	Power & discrete modules	AC/DC & DC/DC regulators	Power management ICs	Display and LED controllers

MOTOR DRIVERS

MAIN APPLICATIONS

- Industrial and robotics
- Textile, sewing and pick-and-place machines
- Stage lighting
- Printers and 3D printers
- Security and surveillance



Our line-up of STSPIN motor control ICs has been developed with the objectives of modularity, scalability and robustness to provide designers a wide choice of solutions to fit different requirements and system architectures. All products have comprehensive built-in protection and diagnostic schemes to help attain the level of long term reliability and robustness requested to cope with harsh factory automation environments.

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

QFN 11 x 14

QFN 3 x 3

POWERSO36

HTSSOP38

Dip20

SO24

Stepper motor drivers

Scalable and robust portfolio featuring accurate positioning and smooth motion profile with up to 256 micro-steps per step.

All the devices listed in the following tables (stepper, brushless DC and brushed DC motor drivers) work in the -40 to 150 °C operating temperature range.

Part number	Package	General description	R_{DSON} (Ω)	Supply voltage (V)	Output Current - Max (A) - RMS max
STSPIN220	VFQFPN 16 3x3x1.0	Low-voltage driver up to 256 microsteps	0.2	1.8 to 10	1.3
L6472	HTSSOP28	Full-featured driver up to 16 (or 128 with the L6470) microsteps with SPI, motion engine and advanced current control	0.3	8 to 45	3
L6470	PowerSO 36				
L6474	HTSSOP28; PowerSO 36	Driver up to 16 microsteps with SPI and advanced current control	0.3	8 to 45	3
L6228	PDIP24, PowerSO 36, SO-24, VFQFPN 32 5x5x1.0 (L6228Q)	Driver with embedded current control	0.7	8 to 52	1.4
L6228Q					
L6208	PDIP24, PowerSO 36, SO-24, VFQFPN 48 7x7x1.0 (L6208Q)	Driver with embedded current control	0.3	8 to 52	2.8
L6208Q					
powerSTEP01	QFN 11x14	System-in-package integrating 10 A power MOSFETs	0.016	7.5 to 85	10
L6480	HTSSOP38	Controller with SPI, motion engine, gate drivers advanced current control featuring 16 or 128 (L6480) microsteps	-	7.5 to 85	-
L6482					
L6506	PDIP 18, SO-20	Stepper motor controller	-	4.5 to 7	-
L297	PDIP 20, SO-20	Stepper motor controller	-	4.75 to 7	-

Brushless DC motor drivers

Extensive diagnostics and fully-protected to reduce the number of external components, cost and complexity.

Part number	Package	General description	R_{DSON} (Ω)	Supply voltage (V)	Output Current - Max (A) - RMS max	Output Current - Max (A) max peak
STSPIN230	VFQFPN 16 3x3x1.0	Low-voltage triple half-bridge motor driver	0.2	1.8 to 10	1.3	-
L6229	PDIP24, PowerSO 36, SO-24, VFQFPN 32 5x5x1.0 (L6229Q)	6-step brushless motor driver with Hall decoding	0.7	8 to 52	1.4	3.55
L6229Q						
L6235	PDIP24, PowerSO 36, SO-24, VFQFPN 48 7x7x1.0 (L6235Q)	6-step brushless motor driver with Hall decoding	0.3	8 to 52	2.8	7.1
L6235Q						
L6230	PowerSO 36, VFQFPN 32 5x5x1.0	Triple half-bridge motor driver	0.7	8 to 52	1.4	3.55
L6234	PDIP 20, PowerSO-20	Triple half-bridge motor driver	0.3	7 to 52	2.8	5

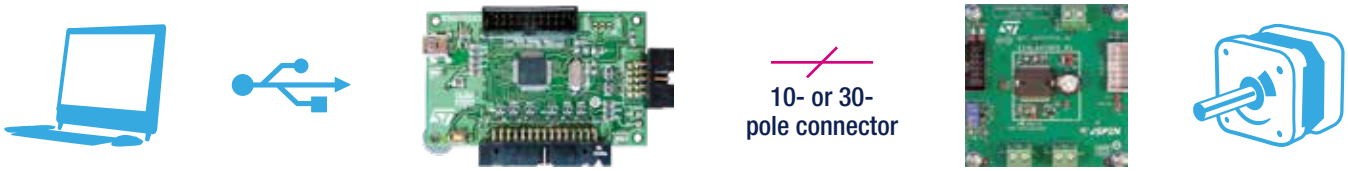
Brushed DC motor drivers

Simple, reliable and cost-effective solution to drive one or more brushed DC motors over a wide current and voltage range.

Part number	Package	General description	R_{DSON} (Ω)	Supply voltage (V)	Output Current - Max (A) - RMS max	Output Current - Max (A) max peak
STSPIN240	VFQFPN 16 3x3x1.0	Low-voltage dual brushed DC motor driver	0.2	1.8 to 10	1.3	-
STSPIN250*	VFQFPN 16 3x3x1.0	Low-voltage brushed DC motor driver	0.2	1.8 to 10	2.6	-
L6227	PDIP24, PowerSO 36, SO-24, VFQFPN 32 5x5x1.0 (L6227Q)	DMOS dual full-bridge driver with PWM current controller	0.7	8 to 52	1.4	3.55
L6227Q						
L6226	PDIP24, PowerSO 36, SO-24, VFQFPN 32 5x5x1.0 (L6226Q)	DMOS dual full bridge driver with PWM current controller	0.7	8 to 52	1.4	3.55
L6226Q						
L6225	PDIP24, PowerSO 36, SO-24		0.7	8 to 52	1.4	3.55
L6206	PDIP24, PowerSO 36, SO-24, VFQFPN 48 7x7x1.0 (L6206Q)		0.3	8 to 52	2.8	7.1
L6206Q						
L6205	PDIP20, PowerSO-20, SO-20		0.3	8 to 52	2.8	7.1
L6201	PowerSO-20, SO-20	DMOS full-bridge driver	0.3	12 to 48	1	5
L6202	PDIP 18 MW 11L (L6203)		0.3	4.5 to 36	1	10
L6203						
L298	MW 15L, PowerSO-20	Dual full-bridge driver	-	4.5 to 36	2	-
L293E	PDIP 20, PDIP 16 (L293B)	Push-pull 4-channel driver with diodes	-	4.5 to 36	1	2
L293B						
L293D	PDIP 16, SO-20	Push-pull 4-channel driver with diodes	-	4.5 to 36	0.6	1.2
L2293Q	VFQFPN 32 5x5x1.0	Push-pull 4-channel driver with diodes	-	2.8 to 36	0.6	1.2

To make it easier for developers to put their hands on our devices, a wide collection of Discovery kits, STM32 Nucleo boards and evaluation boards are available. They all are part of an ecosystem designed to speed up development time.

A typical evaluation board setup consists of the evaluation software, a companion board (when needed) and the evaluation board itself. When connected to the motor, and thanks to the sample application software available free online, you have all the ingredients to get started with your design.



Evaluation software **USB** **STEVAL-PCC009V2 Companion board (if needed)** **Evaluation board**

Moreover, when using one of our more than 30 different Discovery kits, there is no need for a companion board.

Evaluation software **USB** **Discovery kit**

Discovery boards with an embedded STM32 MCU are available with the following drivers: L6470, L6472, L6480 and L6482.

Evaluation software **USB** **X-NUCLEO expansion board plugged on STM32 Nucleo board**

The STM32 Nucleo ecosystem covers all of our motor driver families with expansion boards available for brushed DC, stepper and brushless DC motor drivers as well as for our complete line-up of STSPIN motor drivers. Visit st.com and enter the IC's part number in the search engine and browse through our comprehensive offering on the Resource tab.

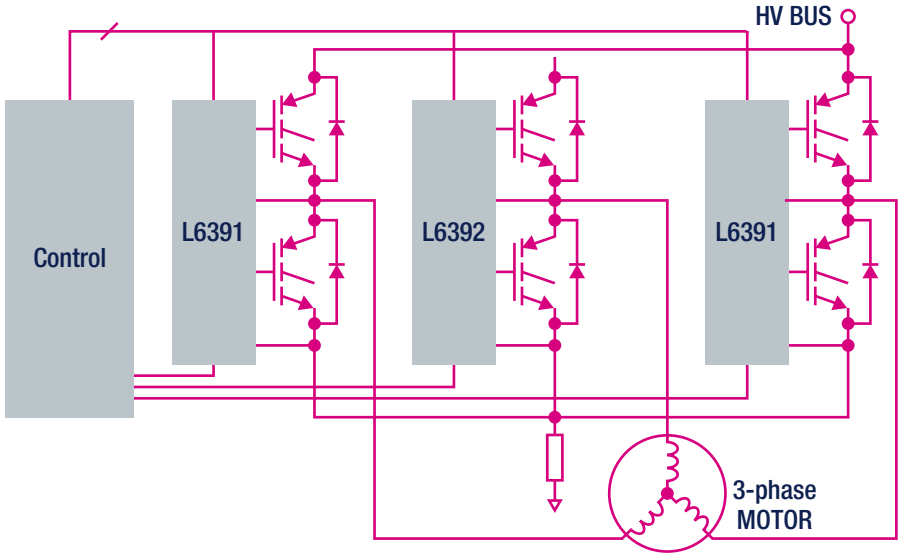
GATE DRIVERS

The STDRIVE family covers 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.

Part number	Package	General description	Supply voltage (V) Typ.	Supply voltage (V) Range	Supply Current (mA)	Output Current Max (A)
STGAP1S	SO-24	gapDRIVE: galvanically isolated single gate driver	15	4.5 to 36	6	5
L6384E	DIP-8, SO-8	High-voltage high- and low-side driver with embedded bootstrap diode	12	11.5 to 17	-	0.65
L6386AD	SO-14	High-voltage high- and low-side driver with embedded comparator and bootstrap diode	9.6	9.1 to 17	-	0.65
L6393	SO-14	Half-bridge gate driver	9.5	9 to 20	-	0.43
L6385E	DIP-8, SO-8	High-voltage high- and low-side driver with embedded bootstrap diode	9.6	9.1 to 17	-	0.65
L6391	SO-14	High-voltage high- and low-side driver	12	11.5 to 20	-	0.43
L6390	SO-16	High-voltage high- and low-side driver	12	11.5 to 20	-	0.43
L6395	SO-8	High-voltage high- and low-side driver	9.5	9 to 20	-	0.43
L6388E	DIP-8, SO-8	High-voltage high- and low-side driver with embedded bootstrap diode	9.6	9.1 to 17	-	0.65
L6491	SO-14	High-voltage high- and low-side 4 A gate driver	15	10 to 20	-	4
L6386E	SO-14	High-voltage high- and low-side driver with embedded comparator and bootstrap diode	12	11.5 to 17	-	0.65
L6398	DIP-8, SO-8	High-voltage high- and low-side driver	9.5	9 to 20	-	0.43
L6387E	DIP-8, SO-8	High-voltage high- and low-side driver	6	5.5 to 17	-	0.65
L6392	SO-14	High-voltage high- and low-side driver	12	11.5 to 20	-	0.43
TD310	PDIP-16, SO-16	Triple IGBT/MOSFET driver with current sense	-	-	2	-
TD220	SO-8	Gate driver with VREG and 2-point regulator	-	-	1	-
TD351	SO-8	Advanced IGBT/MOSFET driver	-	-	2.5	-
TD352	SO-8	Advanced IGBT/MOSFET driver	-	-	2.5	-
TD221	SO-8	Gate driver with VREG and 2-point regulator	-	-	1	-
TD350E	SO-14	Advanced IGBT/MOSFET driver	26	-	-	2.3

All the devices above listed work in the -40 to 125 °C operating temperature range. The TDxx family works in the -40 to 150 °C range, except for the TD350E which works in the -40 to 125 °C range.

A very efficient 3-phase PMSM can be designed using a reference design with the STEVAL-IHM021V2 evaluation board with an L6392 and two L6391 high-voltage, high- and low-side drivers, in single shunt configuration. This board also integrates our discrete IGBT to ensure high-level performance.



The 3-phase stand-alone power stage is suitable for FOC (Field Oriented Control) using our STM32 MCUs, with the following features:

- Fast torque and speed control
- High accuracy
- No need for position sensors
- Sensing and amplification provided by op-amp and two comparators

This results in a very compact solution for FOC that significantly reduces BOM and PCB costs, eliminates the need of a heatsink for thermal spread and ensures superior EMI performance.

Here is a list of the most commonly used evaluation boards. For a full list of available boards and tools, please visit our website.

Order code	Core product	Description
EVAL6393FB	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	STGAP1S	Evaluation board for STGAP1S 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

EVAL6491HB

EVALSTGAP1S

EVAL6393FB

In many cases, several evaluation tools are associated to a single part number. This is the case of our STGAP1S galvanically isolated single gate driver, where the EVALSTGAP1S evaluation board is connected in a multiple configuration.

EVALSTGAP1S

IGBTs AND POWER MOSFETs

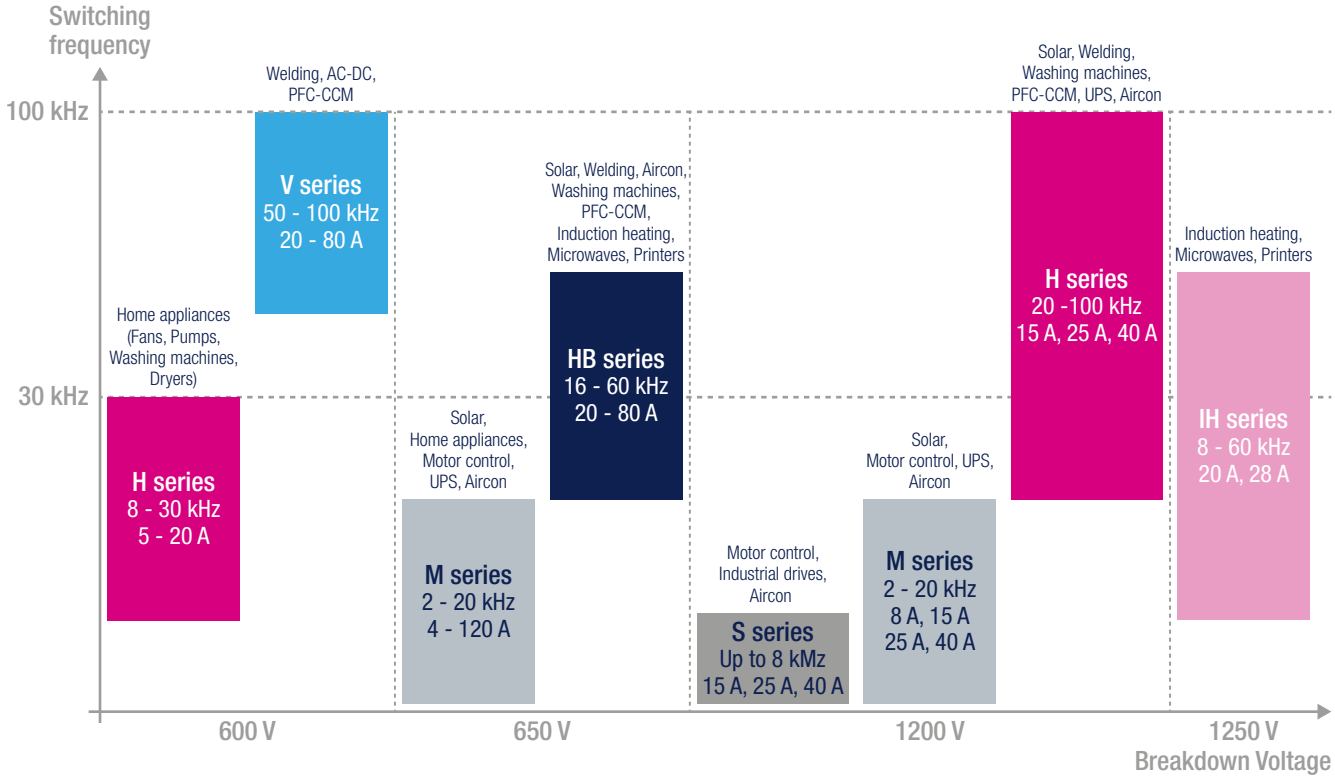
ST's portfolio of Insulated Gate Bipolar Transistors (IGBT) contains a comprehensive range of devices based on various process technologies with breakdown voltages from 300 to 1200 V and higher, offered as bare dice and/or as discrete components.

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
- Motor control
- Home appliances
- UPS/SMPS
- Welding and induction heating
- Solar inverters
- Automotive



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

STG	x	60	H	65	DD	F	z

Package

B	D²PAK
D	DPAK
F	TO-220FP
FW	TO-3PF
P	TO-220
W	TO-247
WA	TO-247 Long Leads
WT	TO-3P
YA	Max247® Long Leads

Max continuos current @ 100 °C

Breakdown voltage ÷ 10

IGBT series

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

Technology generation

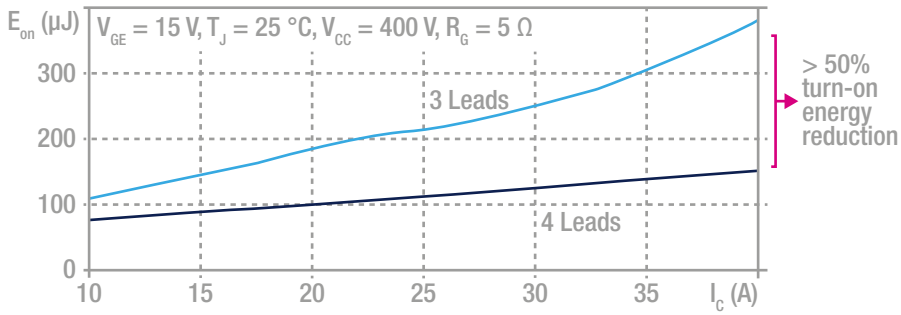
F	Trench gate field stop

Diode options

D	Very fast rescovery
DL	Low forward voltage*

Note: * For soft-switching applications only

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 (STGW40H65DFB-4, turn-on switching comparison, 3 vs 4 leads configuration).



TO247-4 product portfolio

IGBT P/N	BV_{CES} (V)	I_{CN} [1] (A)	$V_{CE(sat)}$ [2] (V)	E_{on} [3] (mJ)	E_{off} [3] (mJ)	FRD Option
STGW40H65DFB-4	650	40	1.6	0.2	0.41	Very Fast
STGW60H65DFB-4	650	60	1.6	0.35	1.16	Very Fast
STGW80H65FB-4	650	80	1.6	-	1.7	-
STGW80H65DFB-4	650	80	1.6	1.00	1.7	Very Fast

For further information about our IGBT product portfolio, visit www.st.com/IGBT or download our IGBT Finder smartphone app by scanning the QR codes below:

Available on the App Store

ANDROID APP 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

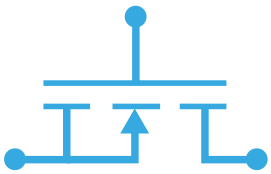
R	SOT-23
T	SOT-23-6L
N	SOT-223
S	SO-8
D	DPAK ("D..T4" for older P/N)
L	PowerFLAT™ 2x2; 3.3x3.3; 5x5; 5x6; 8x8
LD	PowerFLAT™ dual side cooling
B	D²PAK ("B..T4" for older P/N)
E	ISOTOP®
F	TO-220FP
FH	TO-220FP wide creepage
FI	I²PAKFP
FU	TO-220FP narrow leads
FW	TO-3PF
H	H²PAK-2 H²PAK-6
I	I²PAK
K	LFPAK
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
NS or PS	N-Ch or P-Ch plus Schottky Diode (electrically connected, monolithic included)



Technology

H5	STripFET™ H5 (12 V, 30 V)
H6	STripFET™ H6 (-30 V, 30 V)
H7	STripFET™ H7 (-20 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™ F3 (40 V to 120 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	Logic level 5 V drive optimized
LL	Logic level 4.5 V drive optimized
T	Temperature sensing
V	Super logic level (2.5 V - 2.7 V drive)
U	Ultra logic level (1.8 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 $R_{DS(on)}$ 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 * even at high temperatures and excellent switching performance versus the best-in-class 1200 V IGBTs in all temperature ranges, simplifying the thermal design of power electronic systems.

The main features and benefits of our SiC MOSFETs include:

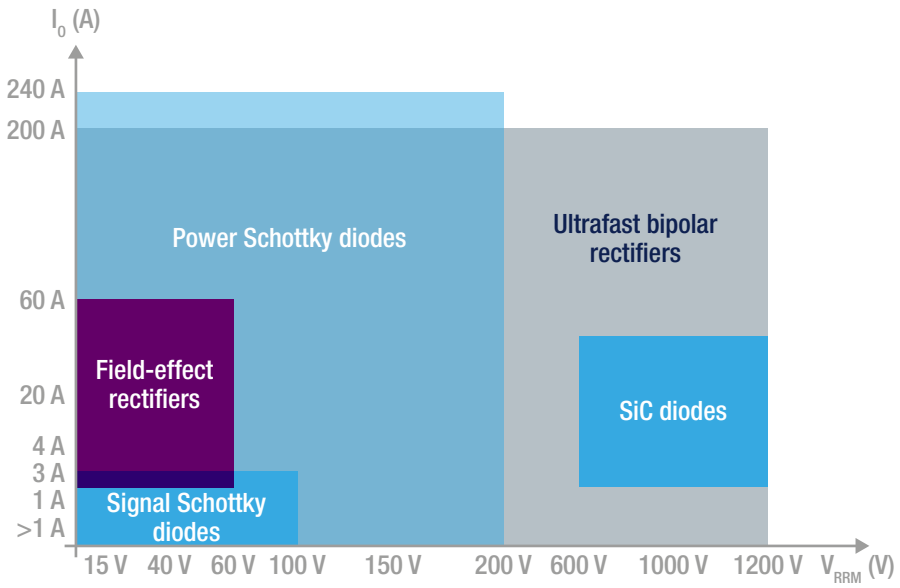
- Very high temperature handling capability (T_{Jmax} = 200 °C) leading to reduced PCB form factors (simplified thermal management) as well as improved system reliability
- Significantly reduced switching losses (minimal variation versus temperature) resulting in more compact designs (with smaller passive components)
- Low on-state resistance (80 mΩ typical at 25 °C) 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	Package	V_{DSS} (V)	$R_{DS(on)}$ (at V_{GS} = 10 V) max (Ω)	Drain current (Dc) (I_D) max (A)	Total power dissipation (P_D) max (W)	Total gate charge (Q_g) V_{GS} = 4.5 V (nC)
STW20N90K5		900	0.26	20		
STW40N90K5		900	0.099	40		
STW12N120K5	TO-247	1200	0.69	12	250	44.2
STW12N150K5	TO-247	1500	1.9	7	250	47
STW21N150K5	TO-247	1500	0.9	14	410	95
STW3N170	TO-247	1700	13	2.6	160	44
STFW3N170	TO-3PF	1700	13	2.6	63	44

DIODES AND SIC RECTIFIERS

This overview of ST's diode portfolio gives an idea of how many part numbers are available to fit all application needs.

For more information, please visit www.st.com/diodes



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 low-profile PowerFLAT™ packages. 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 V_F and high surge series of silicon carbide rectifiers.

STaa	bb	c	ddd	e	f	g	h

Technology

STPS	Power Schottky
STPSC	SiC
STTH	Ultrafast
FERD	Field effect rectifier

Current rating

Current: 0.5 A to 240 A
Code: 0.5 to 240

Connection type

Void	Two-lead configuration
C	dual common cathode
S	single in three-lead package

Automotive grade

Void	standard diode
-Y	automotive-grade diode

Series

For Schottky diodes (STPS)	
Void	medium V_F/I_H
H	high temperature (<120 V only)
L	low V_F from $I_0/2$ to I_0 (<120 V only)
M	low V_F from $I_0/4$ to $I_0 2$
S	low leakage current
SM	low V_F up to $I_0/4$
For ultrafast diodes (STTH)	
Void	medium V_F and Q_{rr}
L	low V_F (600 V mainly)
R	low Q_{rr} recovery
Note:	trade-off mainly used for 400 V and 600 V
FERD	
M	low IR
SM	medium VF/IR
U	Ultra low VF

Breakdown voltage

STPS (power Schottky)	
code:	V_{RRM} = 15 V to 600 V
STPSC (SiC)	
code:	V_{RRM} = 600 V/1200 V
H	high surge
Blank series	low Vf
STTH (ultrafast)	
code:	V_{RRM} divided by 100
200 V to 1200 V	
02 to 12	
FERD	
code:	V_{RRM} divided 45 V to 100

Packing type

Through-hole packages	
Void	Axial: DO-41, DO-15, DO-201
D	TO-220AC
DI	TO-220I
T	TO-220AB
FP	TO-220FPAB
PI	DOP3I
R	I²PAK
H	IPAK
W	TO-247, DO-247
SMD packages	
A	SMA
U	SMB
S	SMC
B	DPAK
G	D²PAK
TV1	ISOTOP (longitudinal)
TV2	ISOTOP (lateral)
DJF	Powerflat 5x6
DEE	Powerflat 3.3x3.3

Packing option

Void	for axis-bulk
Void	for SMA/B/C: tape and reel
Void	for other packages: tube
RL	tape and reel, for axial packages
TR	tape and reel, for other packages

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 (V_F).

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 MOSFETs

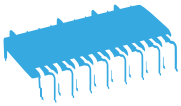
Based on the advanced and innovative properties of wide bandgap materials, ST's silicon carbide (SiC) MOSFETs feature very low $R_{DS(on)}$* area for the 1200 V rating combined with excellent switching performance, translating into more efficient and compact systems. Compared with silicon MOSFETs, SiC MOSFETs exhibit low on-state resistance* area even at high temperatures and excellent switching performances versus the best-in-class 1200 V IGBTs 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 (80 mΩ typical at 25 °C) 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)

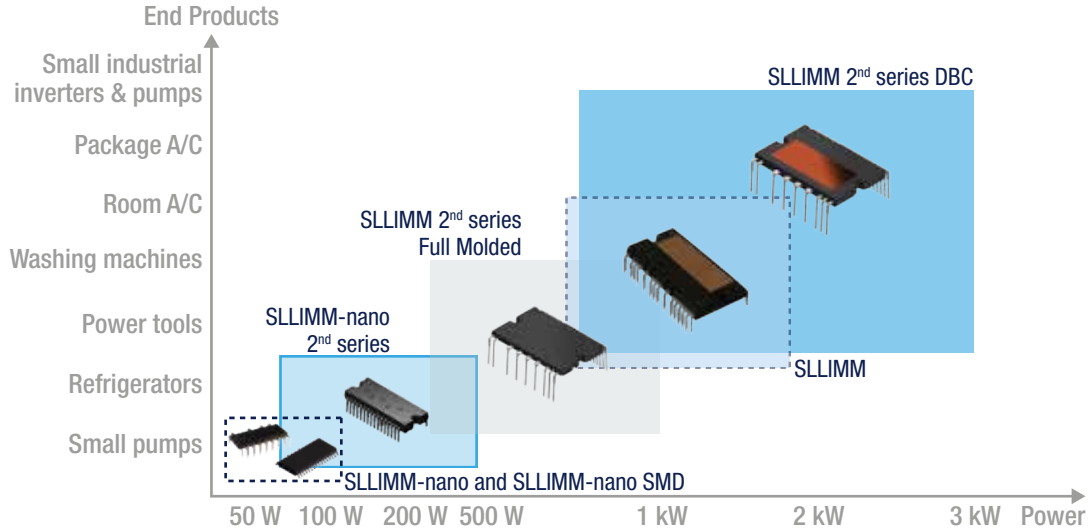
Part number	I_{Dmax} (A) (@ 25 °C)	V_{DSS} (V)	$R_{DS(on)}$ (max (Ω) (@ V_{GS} = 20 V)	Total gate charge Q_g typ (nC)	T_{jmax} (°C)	Package
SCT10N120	1200	12	0.69	22	200	HiP247™
SCT20N120	1200	20	0.239	45	200	HiP247™
SCT30N120	1200	45	0.1	105	200	HiP247™
SCT50N120	1200	65	0.069	122	200	HiP247™
SCTWA50N120	1200	65	0.069	122	200	HiP247™ long leads

INTELLIGENT POWER MODULES



ST offers a family of IPMs (Intelligent Power Modules), called SLLIMM™ (Small Low Loss Intelligent Molded Module). The range of SLLIMM families cover all motor control applications working in a power range up to more than 3.0 kW.

Today we offer SLLIMM nano products, IGBT, MOSFET and SJ MOSFET based switches, with different package options in order to cover power range from a few watts up to 500/600 W with the last 2nd series nano products. The latest SLLIMM 2nd series covers a power range from 0.5 KW to more than 3 KW reaching the lowest R_{thjc} on the market, thanks to the double packages offer (full molded and DBC). The optimum compromise between conduction and switching energy, with high robustness and EMI performance, makes the new SLLIMM series ideal to enhance the efficiency of home appliances and motor drives working up to 20 kHz in hard-switching circuitries.



A **new plastic power module** family called **ACEPACK™** (Adaptable Compact Easier package) has been developed to address mainly industrial applications such as industrial motor drives, solar panels, welding and power management solutions (DC-DC, AC-DC converters for UPS, chargers, etc.).

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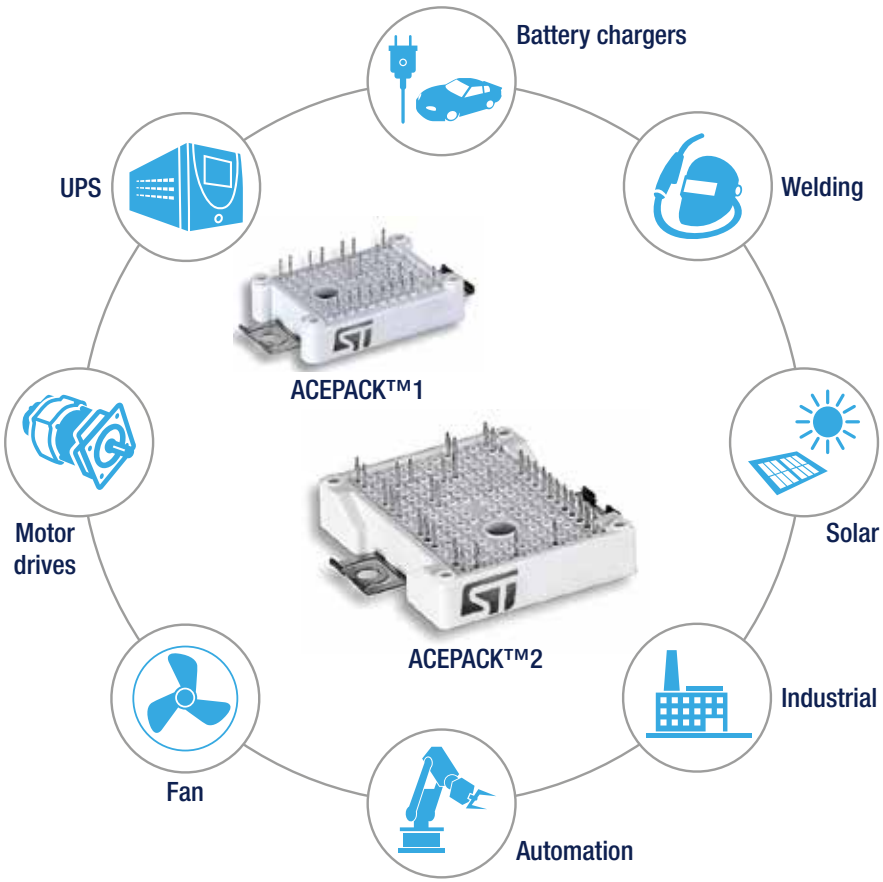
Two packages, ACEPACK™ 1 and ACEPACK™ 2 have been introduced, both with Six-pack and converter inverter brake (CIB) topologies.

With ACEPACK™ are going to be released the STEVAL-CTM001V1 and the STEVAL-CTM002V1, respectively a galvanically isolated driving and control stage and the power board capable to host the new A2C35S12M3-F (1200 V, 35 A) in CIB (Converter Inverter Brake) configuration.



THYRISTORS AND AC SWITCHES

ST offers a complete range of thyristors (silicon controlled rectifiers), TRIACs and AC switches with voltage ratings up to 1200 V, current ratings up to 80 A and a selection of packages from miniature mounted packages to high power dissipation isolated packages.

TRIACs 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:

	ACST AC switch	H Series TRIAC	High-voltage TRIAC
Solid state relays	•••		•••
Heating (1 phase current)	••	•••	
Heating (3 phases current)			•••
Motor starter		••	•••
Motor soft start	•••		••
Inrush current limiter motor drive		•••	

ACST AC switch: Overvoltage protection and high application robustness

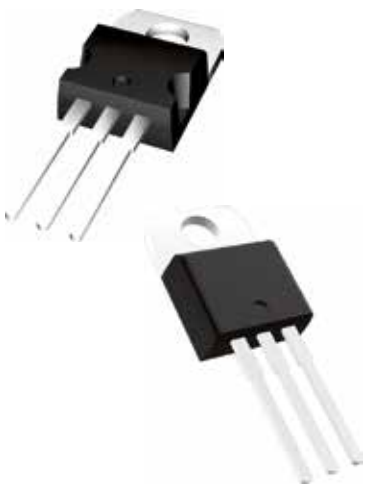
The ACST series, with integrated overvoltage crowbar protection and snubberless™ operations, eliminates the need for additional external protection to support IEC 61000-4-4 and IEC 61000-4-5 standards (Control Board Compliance). It makes for easier design, smaller boards and therefore more cost-effective 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) (A)	V_{DRM}/V_{RRM} (V)	I_{GT} (mA)	dV/dt (V/µs) (125°C/150 °C)	(dI/dt)c (A/ms) (125 °C/150 °C)	T_{jmax} (°C)
	TO-220AB	TO-220AB Ins.	DPAK	D²PAK						
ACST435-8	FP		B		4	800	35	1000	5	125
ACST610-8	FP	T		G	6	800	10	500	3.5	125
ACST830-8	FP	T		G	8	800	30	2000	8	125
ACST1035-8	FP	T			10	800	35	4000/2000	10/5	150
ACST1235-7		T		G	12	700	35	2000	14	125
ACST1235-8	FP				12	800	35	4000/2000	12/6	150
ACST1635-8	FP				16	800	35	1000/300	12/4	150

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			I_T (RMS) (A)	V_{DRM}/V_{RRM} (V)	I_{GT} (mA)	dV/dt (V/µs) 150 °C	(dI/dt)c (A/ms) 150 °C
	TO-220AB	TO-220AB Ins.	D²PAK					
T835H-6	T	I	G	8	600	35	1000	11
T850H-6	T	I	G	8	600	50	1500	14
T1035H-6	T	I	G	10	600	35	1000	13
T1050H-6	T	I	G	10	600	50	1500	18
T1235H-6	T	I	G	12	600	35	1000	16
T1250H-6	T	I	G	12	600	50	1500	21
T1635H-6	T	I	G	16	600	35	1000	21
T1650H-6	T	I	G	16	600	50	1500	28
T2035H-6	T	I	G	20	600	35	1000	27
T2050H-6	T	I	G	20	600	50	1500	36
T3035H-6	T	I	G	30	600	35	1000	33
T3050H-6	T	I	G	30	600	50	1500	44

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)

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)	V_{DRM}/V_{RRM} (V)	I_{GT} (mA)	dV/dt (V/µs) 125 °C	(dI/dt)c (A/ms) 125 °C	T_{jmax} (°C)
1200 V low-sensitivity industrial TRIACs							
T2550-12G	D²PAK	25	1200	50	2500	20	125
T2550-12T	TO-220AB	25	1200	50	2500	20	125
T2550-12I	TO-220AB Ins.	25	1200	50	2500	20	125
1200 V alternistors							
TXDV1212	TO-220AB Ins.	12	1200	100	2000	15	125
TPDP1225	TOP3 Ins.	25	1200	150	2000	20	125
TPDV1240	TOP3 Ins.	40	1200	200	200	35	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 (TN550H-12WY).

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.

Part number	Package			I_T (RMS) (A)	V_{DRM}/V_{RRM} (V)	I_{GT} (µA)	dV/dt (V/µs) 125 °C	T_{jmax} (°C)
	TO-92 "GAK"	TO-92 "KGA"	SMBflat-3L					
TS110-7	A1		UF	1.25	700	100	15	125
TS110-8	A1	A2	UF	1.25	800	100	200	125

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 20 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 TN5050H-12WY are fully qualified automotive-grade devices at T_j = 150 °C (AGAC).

Part number	Package					I_T (RMS) (A)	V_{DRM}/V_{RRM} (V)	I_{GT} (mA)	dV/dt (V/µs) 150 °C	T_{jmax} (°C)
	TO-220AB	TO-220FPAB	TO-247	D²PAK	D³PAK					
TN1205H-6	T			G		12	600	5	100	150
TN1605H-6		FP				16	600	5	200	150
TN1610H-6	T	FP				16	600	10	1000	150
TN2015H-6	T	FP				20	600	15	750	150
TN3050H-12			WY*	GY*		30	1200	50	1000	150
TN4015H-6	T			G		40	600	15	500	150
TN5050H-12			WY*			50	1200	50	1000	150
TM8050H-8					D3	80	600	50	1000	150

Note: * Automotive grade (AGAC)

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

- AGAC certified
- 1200 V (direct, reverse)
- Reduced stand-by losses, lower leakage
- Compact cooling system

AC/DC AND DC/DC REGULATORS

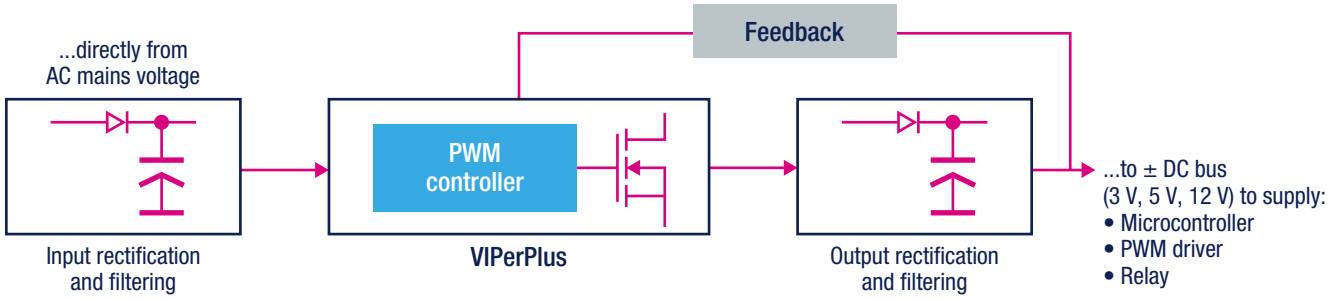
Focus on AC-DC converters

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 off-line switch mode power supplies (SMPS) with output power spanning from a few to twenty watts.

The VIPerPlus series (VIPer0P, 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 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.



VIPerPLUS

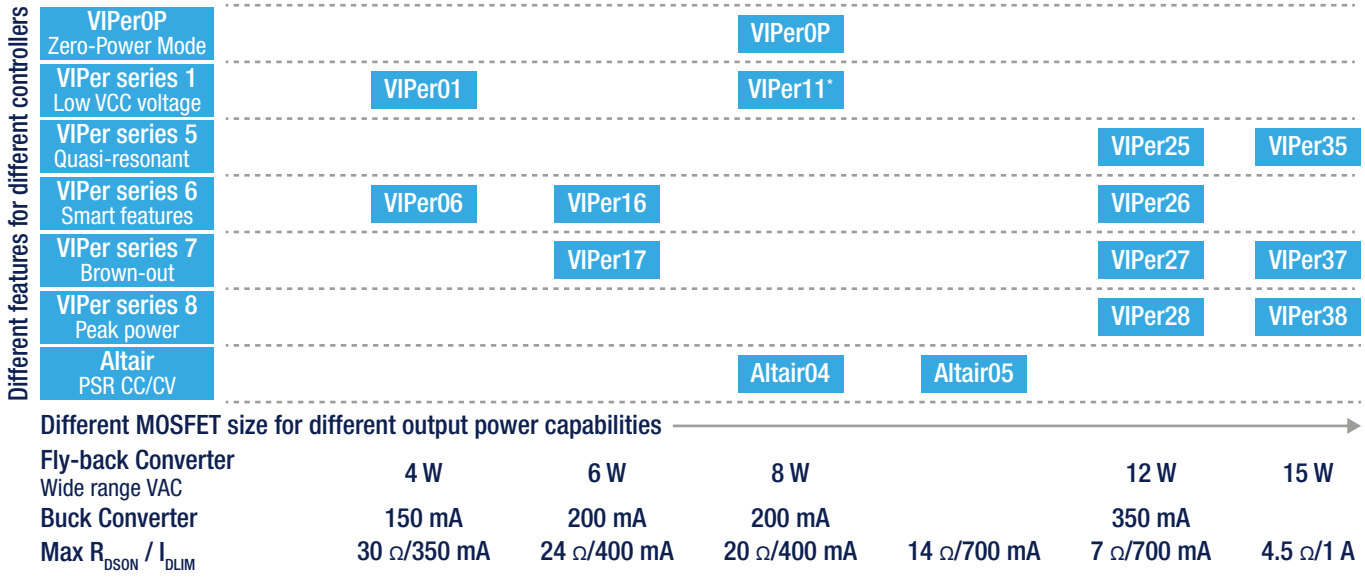
VIPERPLUS & ALTAIR

PWM controller + HV power MOSFET in the same package

- V800 V AR MOSFET for high robustness
- Extreme-low consumption
- High integration level for minimal BoM
- Flexible and easy to use

SUPPORTED TOPOLOGIES

- Isolated
  - Regulation with optocoupler using 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)

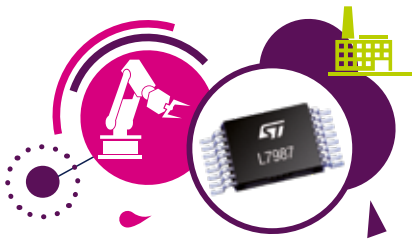


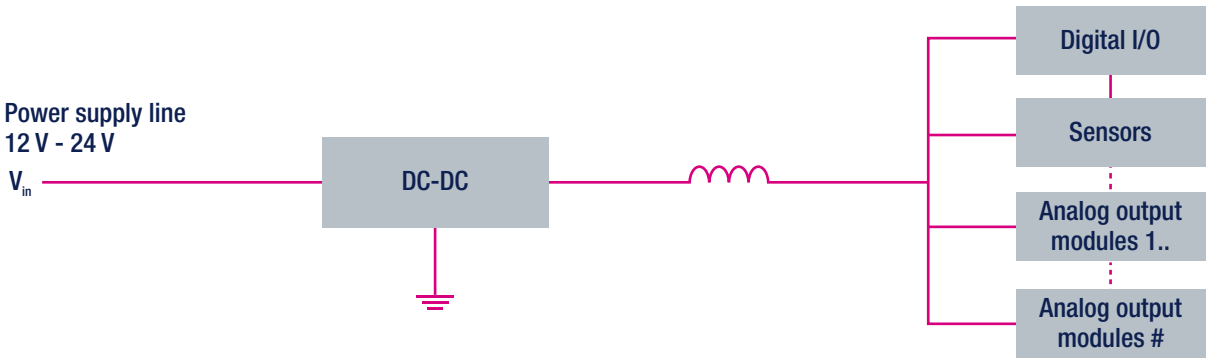
Note: * Coming soon

Focus on DC-DC converters

ST's DC-DC converters for industrial buses offer a wide choice of input voltage ranges ($V_{IN(max)}$) from 38 to 61 V) and features. The 61 V series (L7987/L) is designed to provide maximum reliability in fail-safe applications. The new synchronous DC-DC converter for industrial applications, the L6986, is the best choice when efficiency is of prime importance, both at full load (thanks to synchronous rectification) and at light load (thanks to the low standby consumption). Evaluation boards are available upon request. There are multiple package options, all offering compactness and high thermal performance to fit different applications.

The 61 V series (L7987/L) is designed to provide maximum reliability in fail-safe applications.





The L7987/L offers the following features:

- 3.3 V output voltage, 3 A DC output current
- 4.5 to 60 V input voltage
- 500 kHz switching frequency
- 3.5 ms programmed soft-start
- switch-over for improved efficiency at light load
- 180° out of phase synchronization available
- Open-drain PGOOD pin available
- Auto-recovery overcurrent and thermal protection

Explore all these features using the STEVAL-ISA152V1 (for the L7987) and the STEVAL-ISA198V1 (for the L7987L).

When looking for energy-saving synchronous step-down monolithic converters, the L6986, housed in a HTSSOP16 package, fits many applications in the factory automation environment. With its P-channel integrated power MOSFET, an ideal duty cycle pushed up to 100% guarantees output voltage from 0.85 V to V_{IN} or 38 V.

The highest efficiency is achieved with quiescent current as low as 30 µA and a low-consumption mode specific for light loads. Moreover, a significant reduction in passive components cost and size is can be achieved thanks to a switching frequency up to 2 MHz. All these features are can be seen in the STEVAL-ISA156V1 evaluation board.

Environmental energy harvesting from light and thermal gradients are the most effective ways to gather free energy if accompanied by very high efficiency and ultra-low power battery chargers.

STEVAL-ISA156V1

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 optimize energy-wise system autonomy, while ensuring a fast and safe battery charge without shortening its lifetime. In particular, the SPV1050 is suitable for any type of battery and supercap, and embeds two LDOs to boost system integration and reliability, and cuts down the BOM. This makes it possible for any companion chip like a transceiver, microcontroller or sensors to be flexibly powered by the power manager.

The table below summarizes the key features and main differences between the SPV1040 and the SPV1050.

	Architecture	Harvesting Source	Target Battery	Other features
SPV1040	Boost	PV	Any type*	Over-current and Over-temperature protection, Input reverse polarity protection
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)

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

Two fully autonomous multi-sensor node reference designs based on a full ST components package are available for your evaluation. They embed an SPV1050 ultra-low-power energy harvester and battery charger with embedded MPPT and LDOs, STM32 microcontroller, SPIRIT1 low-data-rate low-power sub-1GHz transceiver, accelerometer, temperature sensor and air-pressure sensor.

STEVAL-IDS002V1
Multi-sensor sub-1 GHz
RF node powered by PV cells

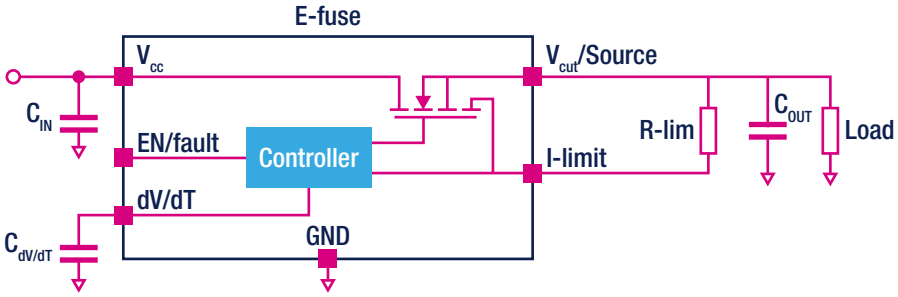
STEVAL-IDS003V1
Multi-sensor sub-1GHz
RF node powered by a
thermo-electric generator

Part Number	Maximum current (mA)	Quiscent Current (uA)	Typ Vdrop at max load (mV)	Input Voltage Range (V)	PSRR typ @ 1 kHz	Noise (uVrms)	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 3x3	Ultra Low Iq, High Vin
ST715	85	3.8	500	2.5-24	45	95	SOT23-5L, DFN8 3x3	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 2x2	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 1x1	High PSRR, Tiny Package
LDK120	200	30	150	1.9-5.5	60	51	SOT23-5L, SOT323-5L, DFN6 1.2x1.3	Cost Effective, Tiny Package
LDBL20	200	20	200	1.5-5.5	80	45	STSTAMP™	High PSRR, Tiny Package
LDK220	200	55	200	2.5-13.2	55	20	SOT23-5L, SOT323-5L, SOT-89, DFN6 1.2x1.3	Cost Effective, Tiny Package
LDK320	200	60	200	2.5-18	65	60	SOT23-5L, SOT-89	Cost Effective, High PSRR
STLQ020	200	0.3	160	2-5.5	40	135	DFN6 2x2, 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 1x1	High PSRR, Tiny Package
LD39030SJ	300	20	200	1.5-5.5	62	30	Flip Chip 4	High PSRR, Tiny Package
LD39130	300	1	300	1.4-5.5	70	38	DFN4 1.2x1.3, Flip Chip 4	Ultra Low Iq, Tiny Package
LDK130	300	30	200	1.9-5.5	60	51	SOT23-5L, SOT323-5L, DFN6 1.2x1.3	Cost Effective, Tiny Package
LDFM	500	150	125	2.5-16	62	45	DFN6 2x2, DFN6 3x3, DPAK, PPAK	High Vin
ST1L08	800	35	70	1-5.5	80	45	DFN8 2x3	Ultra LDO, High PSRR
LDF	1000	150	200	2.6-16	62	45	DFN6 2x2, DFN6 3x3, DPAK, PPAK	High Vin
LD39100	1000	20	200	1.5-5.5	65	30	DFN6 3x3	Low Noise, Low Iq
LDL112	1200	35	350	1.6-5.5	57	135	DFN6 2x2, DFN6 3x3, SO-8, PPAK	Low Iq, Reverse Current Protection
LDL212	1200	250	350	2.5-18	70	75	DFN6 2x2, DFN6 3x3, SO-8	Cost Effective, High PSRR
LD39200	2000	100	110	1.25-6	70	45	DFN6 3x3, DFN8 4x4	Ultra LDO, High PSRR, Reverse Current Protection

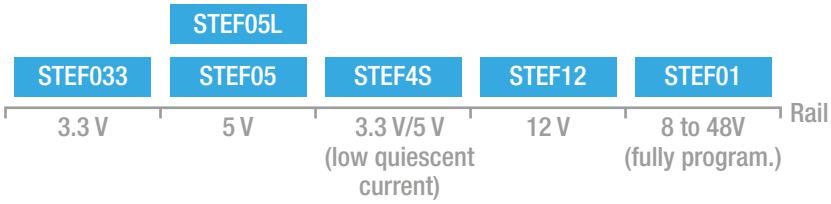
POWER MANAGEMENT ICs

ST offers a very broad portfolio of power management ICs.

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



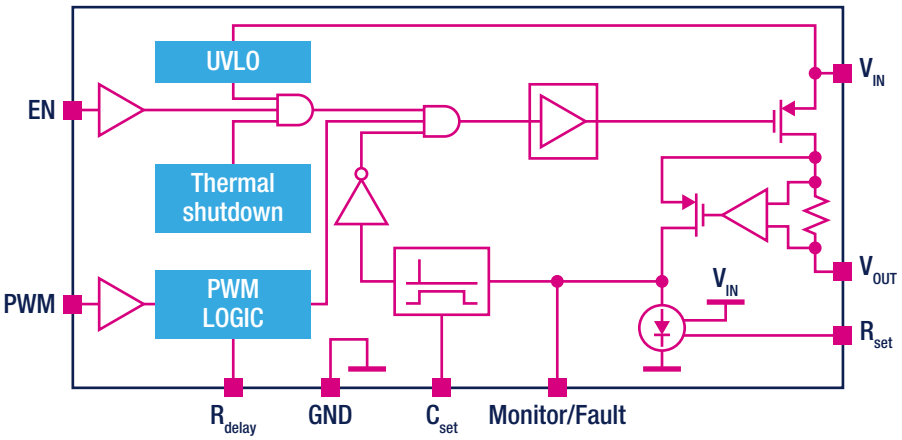
The industrial power rail range is fully covered with the STEF01, which is usable throughout the 8 to 48 V range thanks to its programmability options.



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.

The STPW05 (5 V rails) and 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

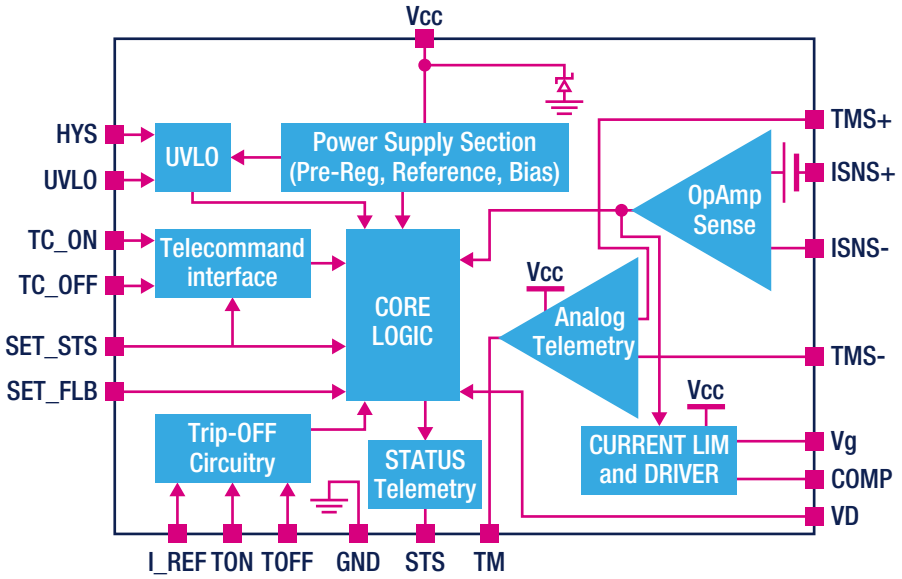


Power breakers offer also: programmable power limit masking time, over-temperature protection and internal under-voltage lockout.

Current limiter ICs are designed to work with an external MOSFET to protect power supplies from anomalous external current demands.

In order to match the industrial application range, the STFC01 is a reliable current limiter featuring:

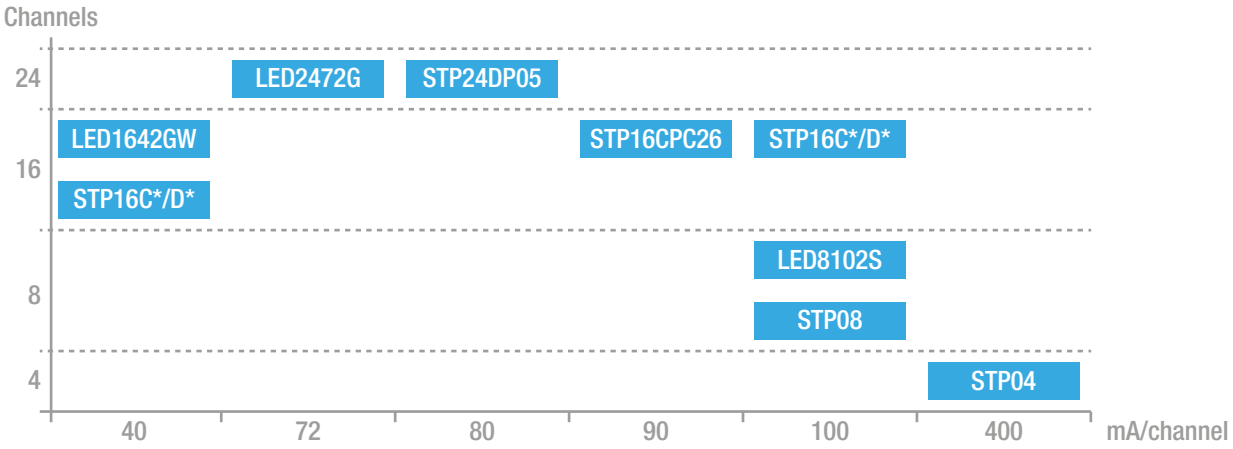
- Wide V_{CC} range from 10 to 48 V
- Fully programmable current limitation
- P-channel MOSFET driving capability
- Remote ON/OFF control
- Latch, autoretry or foldback configuration
- Analog and digital current monitoring (status telemetry)
- Under-voltage lockout



Display backlighting, signage and industrial panel applications demand reliability and efficiency that is delivered by dedicated LED drivers.

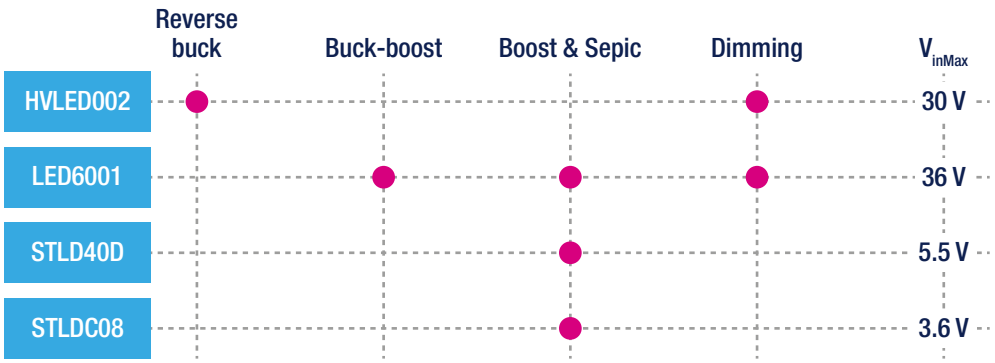
Ideal for parallel and series configurations, they enable high-efficiency, high-current accuracy, low-noise and small-size solutions. Topologies include buck regulator, boost regulator, offline LED drivers, and more.

The LED1642GW is a monolithic, low voltage, low current power 16-bit shift register designed for LED panel displays. The LED1642GW guarantees 20 V output driving capability allowing the user to connect several LEDs in series. In the output stage, 16 regulated current sources provide from 3 to 40 mA constant current to drive the LEDs. The current is programmed through an external resistor and can be adjusted by a 7-bit current gain register in two subranges. The brightness can be adjusted separately for each channel through 12-/16-bit grayscale control.



DC-DC LED drivers converters

DC-DC LED drivers controllers



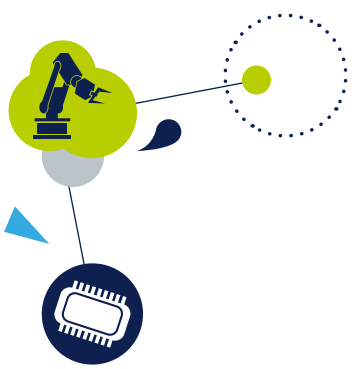
More Intelligent & Aware

More Intelligent and Aware is a trend where machines are aware of the humans around them and provide new interfaces such as smart tools, augmented reality and touchless interfaces for easier and safer interactions. This will be achieved through the addition of local processing and sensor/ actuator capabilities through the factory and connecting them in an efficient manner.
MCUs and motion, environmental and ranging sensors play a key role in this scenario, as well as peripherals, like industrial I/Os, which make it possible to drive loads efficiently and safely.
Safety is also key and at we offer new devices that meet the latest safety standards.

MCUs | Secure MCUs

RTC and memories | Signal conditioning | Analog and digital inputs | Intelligent power switches | Isolation

Motion MEMS | Environmental sensors | Ranging sensors



MCUs

The STM32 family of 32 bit Flash microcontrollers based on the ARM® Cortex® M processor is designed to offer new degrees of freedom to MCU users. 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.

Note: * From CCM-SRAM

To help developers choose the best solution for their applications, the ST-MCU-FINDER application 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.

Developers can quickly access data and technical resources to support their microcontroller projects. The technical documentation for a selected device (including datasheets, reference manuals, application notes, user manuals, programming manuals, and errata sheets) is available in one place and can be downloaded for off-line viewing. Documents are automatically updated with the latest version.

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 as Facebook, Twitter, the STM32 YouTube channel, and ST Community.

ANDROID APP ON Google play

Available on the App Store

Complete 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 complete 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 ECOSYSTEM

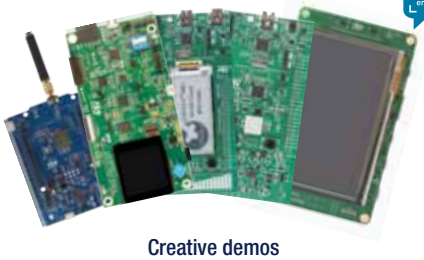
Hardware tools

www.st.com/stm32hardwaretools

STM32 Nucleo board

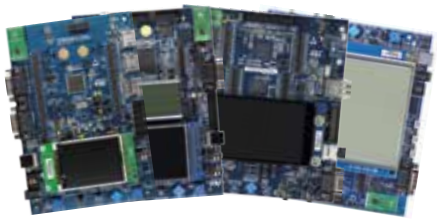
Flexible prototyping

Discovery kit



Creative demos

Evaluation board

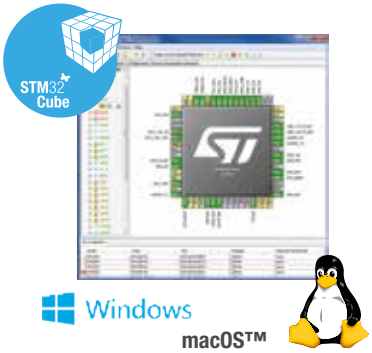


Full-feature evaluation

Software tools

www.st.com/stm32softwaretools

STM32CubeMX

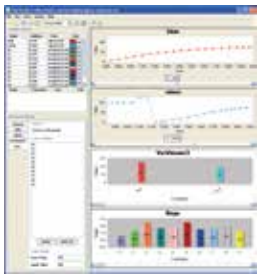


Partners IDEs

Free IDE

Note : Free full version of Keil MDK-ARM on all STM32L0 and STM32F0

STMStudio



Configure and generate code — Compile and debug — Monitor

Embedded software

www.st.com/stm32embeddedsoftware

STM32Cube LL (Low Layer)

STM32Cube HAL and middleware Std Libraries

CMSIS and mbed SDK

Virtual machines and models

High optimization low portability

Average optimization STM32 portability

Low optimization ARM portability

Low optimization large portability

ST COMMUNITY

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

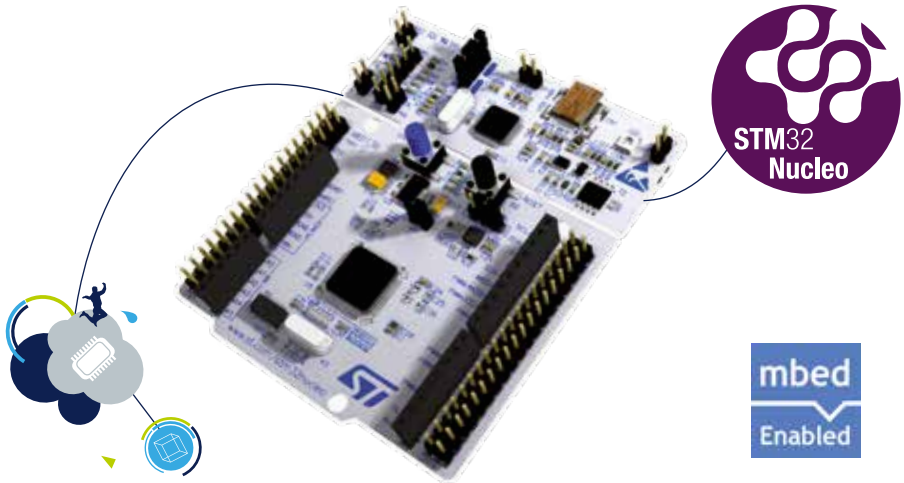
STM32 Nucleo development boards

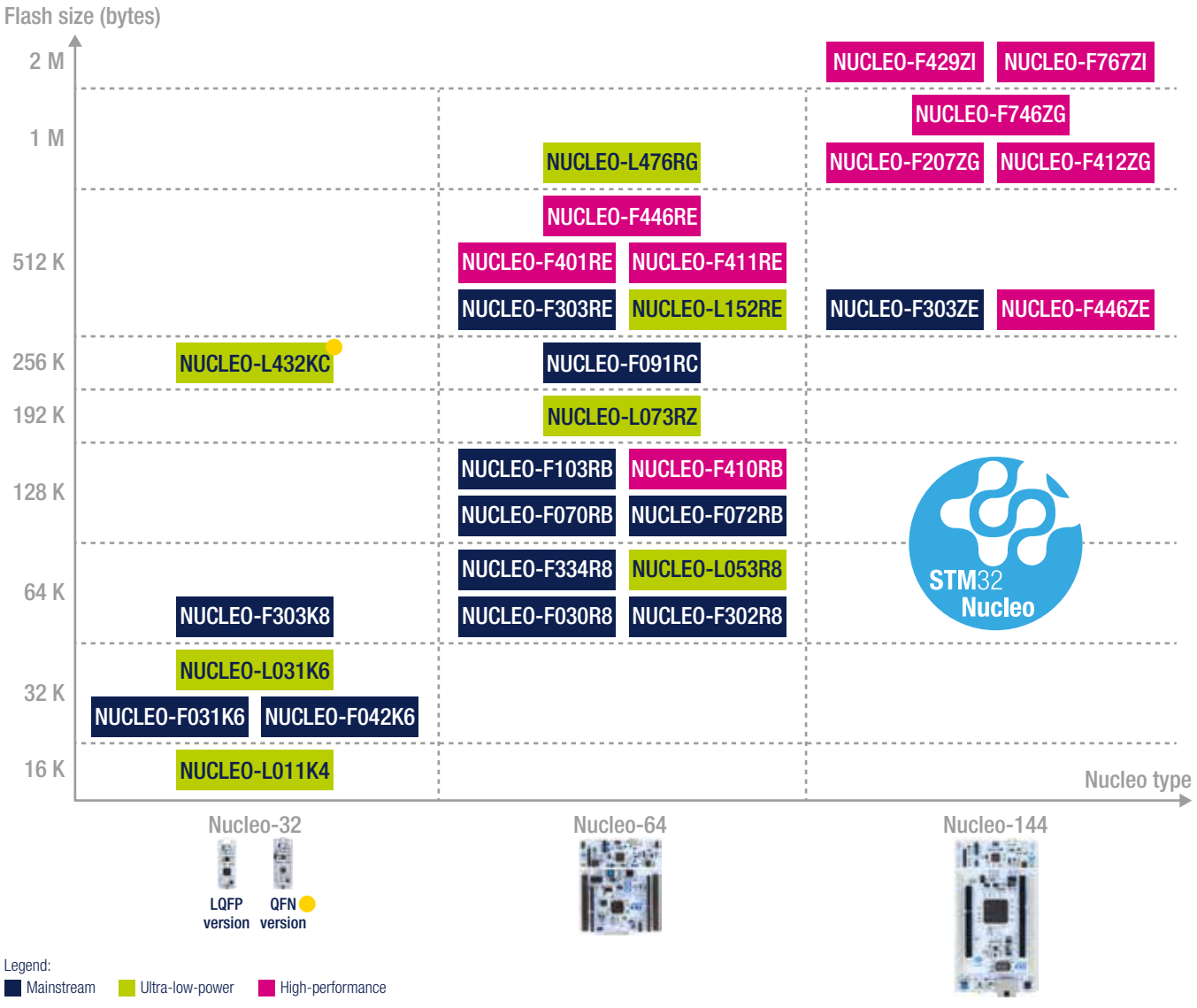
The highly affordable STM32 Nucleo development boards allow anyone to try out new ideas and to quickly create prototypes with any STM32 MCU.

Sharing the same connectors, STM32 Nucleo development boards can easily be extended with a large number of specialized application hardware add-ons such as the STM32 Nucleo expansion boards (Nucleo-64 boards include Arduino Uno rev3 & ST morpho connectors, Nucleo-32 boards include Arduino Nano connectors). STM32 Nucleo development 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 the STM32 Nucleo boards, and seamlessly work with a wide range of development environments including IAR EWARM, Keil MDK-ARM, mbed and GCC/LLVM-based IDEs.

All STM32 Nucleo users have free access to the mbed online resources (compiler, C/C++ SDK, and developer community) at www.mbed.org allowing you to build a complete application in only a few minutes.





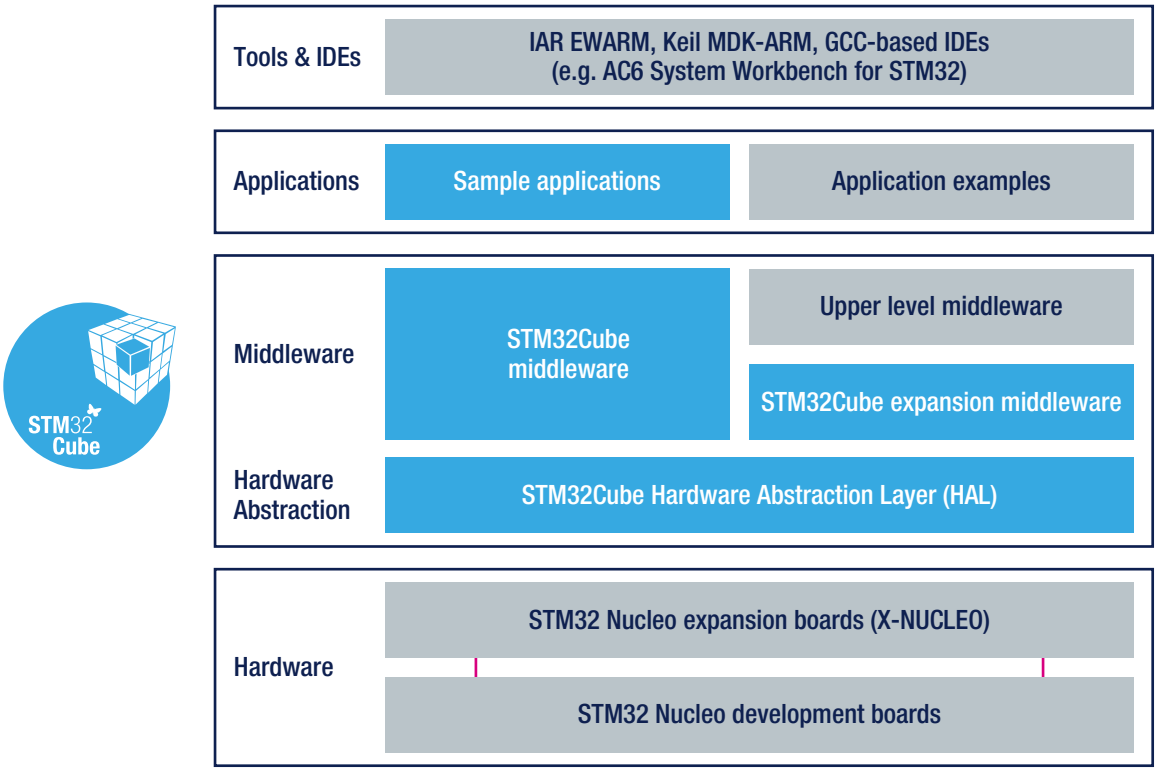
STM32Cube development software

STM32Cube is a set of free 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.

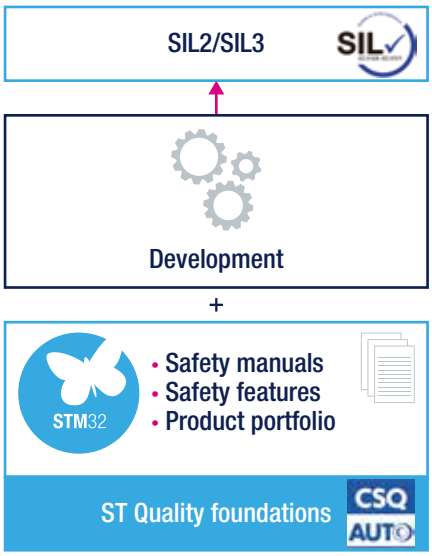
Find out more at www.st.com/stm32cube



STM32-SafeSIL

Functional safety manuals to achieve IEC 61508 Safety Integrity Level (SIL2/3) certification with STM32

On the basis of the ST Quality foundations, the STM32 product portfolio and the STM32 embedded safety features, the STM32-SafeSIL functional safety manuals help customers to quickly market safety-critical STM32-based systems, targeting the industry standard IEC 61508 Safety Integrity Level (SIL2/3).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.



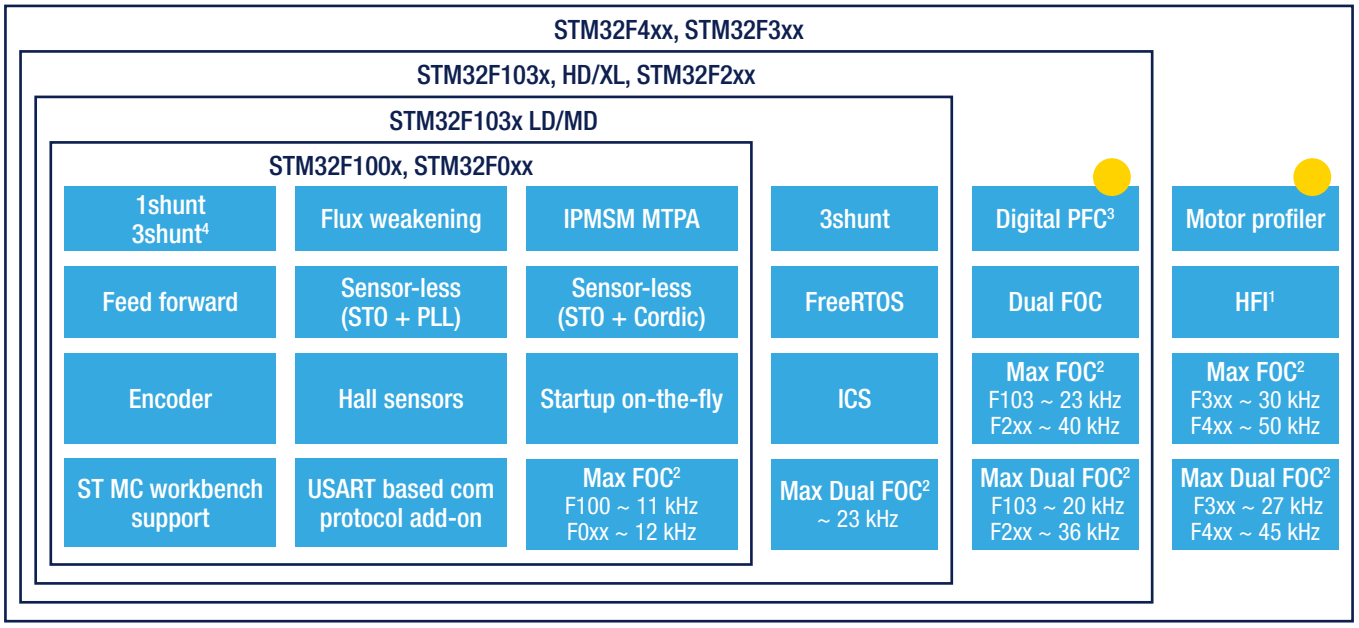
KEY FEATURES

- Detailed list of safety requirements (conditions of use) and examples to guide STM32 users to achieve Safety Integrity Level 2/3 according to IEC 61508 for the application-dependent layer (e.g. peripherals, watchdog)
- Available for STM32F0, STM32F1, STM32F2, STM32F3, STM32F4, STM32L0 and STM32L1 microcontroller series

STM32 dedicated motor control libraries

A complete motor control ecosystem (software, hardware, development tools, and documentation) helps designers to develop motor control applications faster.

The STM32 PMSM FOC SDK is a Motor Control Software Development Kit (SDK) for 3-phase permanent magnet synchronous motors (PMSM) based on field-oriented control (FOC) supporting STM32F103, STM32F100, STM32F2xx, STM32F4xx, STM32F0xx and STM32F30x microcontrollers.



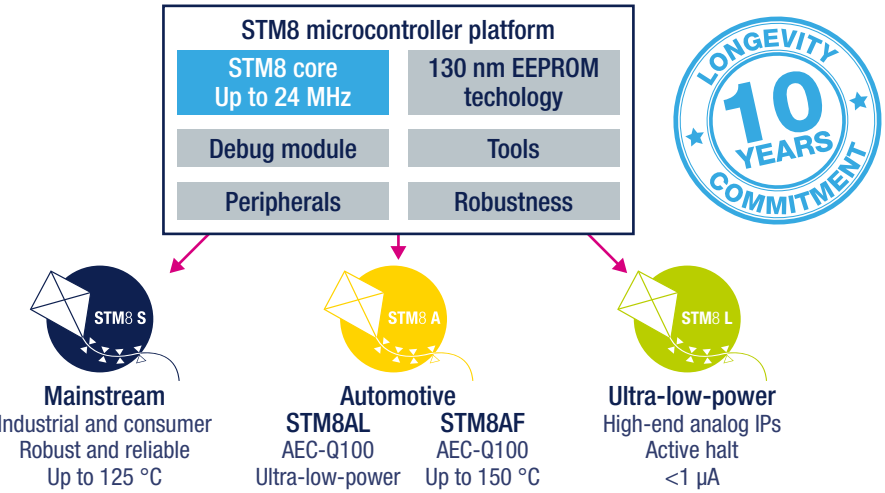
Note: 1 High frequency injection 2 Max FOC estimated in sensorless mode 3 STM32F03xC/D/E/F/G and STM32F303xB/C 4 No for STM32F100 New

Motor control SDK workflow

Set up the HW → Use motor specs or identity the motor using Motor profiler → Send commands with serial communication → Finalize the project with Workbench

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.



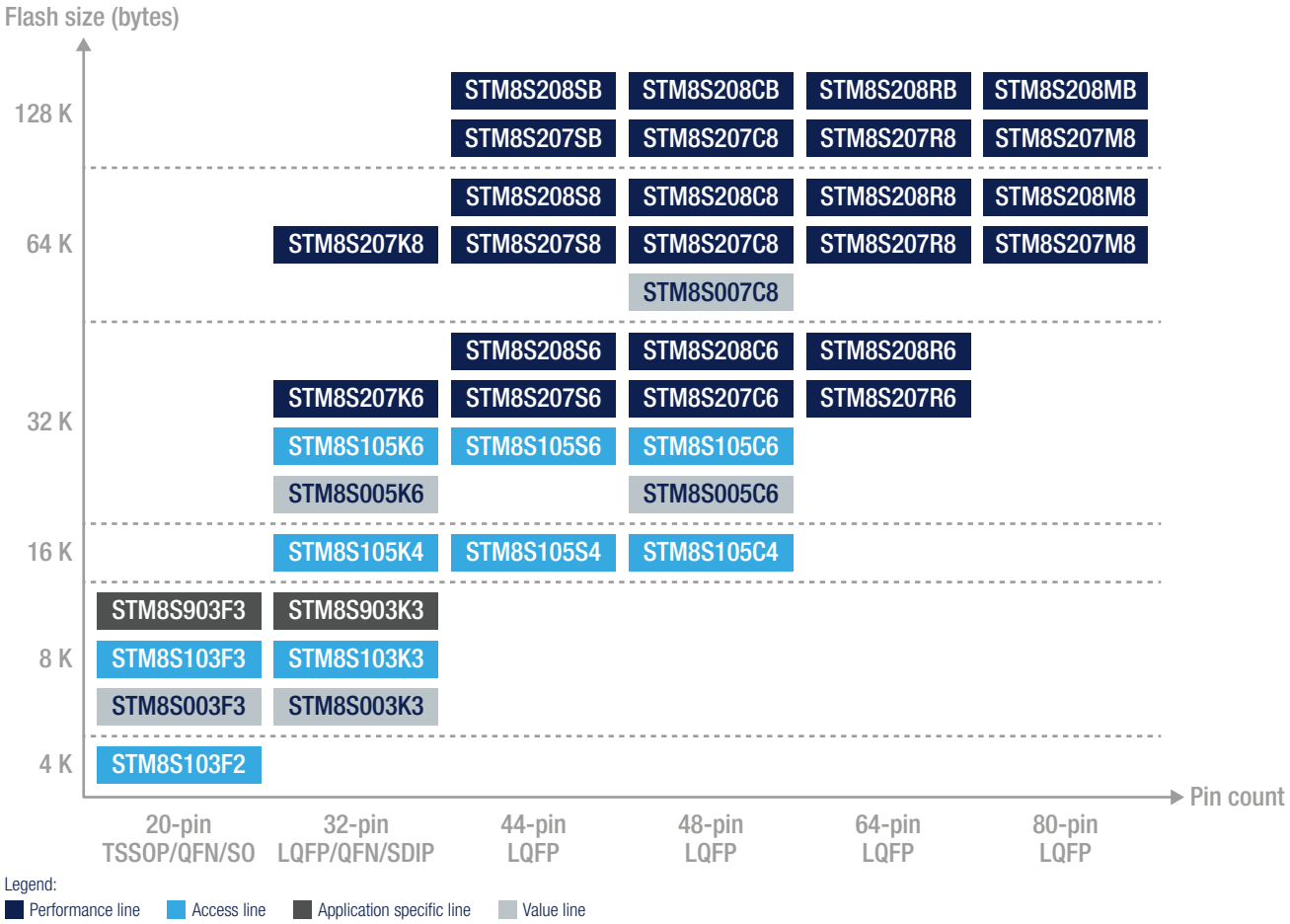
The flexibility of the architecture minimizes switching noise, resulting in improved system robustness and lower power consumption.

An innovative clock implementation provides benefits such as fast wake-ups in only 4 µs. It enables immediate on-the-fly clock switching to allow clock accelerations for PWM or calculation routines.

The 32-bit robust NVM memory addressed through a 3-stage pipeline interface, the 16-bit index registers and stack pointers and the advanced instruction set with hardware multiplication/division are key elements that significantly improve the efficiency of this 8-bit device family.

The STM8 allows fast and safe development through enhanced stack pointer operations, advanced addressing modes and new instructions.

The STM8 offer consists of a large product portfolio.



Security matters: STM32 & STSAFE™ security package

With the deployment of an increasing number of connected devices in the industrial environment, both the factory manufacturing infrastructure as well as the supporting process infrastructure offer more opportunities for cyber-attacks, making security a major topic to be addressed.

Smart Industry devices such as sensors, switches or motor control boxes, must be trusted and protected against cloning and counterfeiting, and must exchange data with control and supervisor servers in a secure manner.

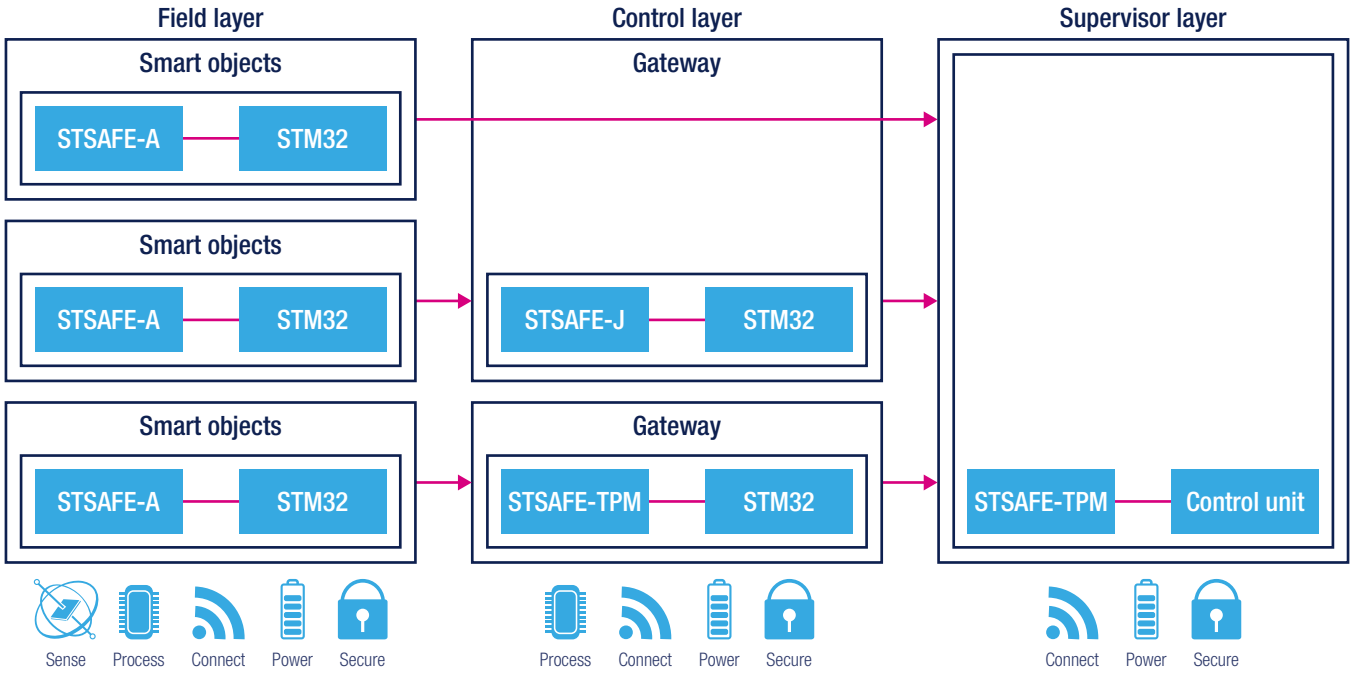
ST offers a wide range of secure solutions ensuring security for the protection of objects and Smart Industry networks at field, control and supervisor levels against attacks such as:

- Device cloning and counterfeiting
- Device malfunction
- User data corruption
- Service and network access corruption

To address the many new smart industry threats, ST offers a wide range of security solutions from embedded STM32 security features to a full ecosystem with ready-to-use Common Criteria certified STSAFE turnkey solutions.

Developers can strengthen system security by providing faster, more reliable and more robust applications through the use of an STM32 microcontroller combined with an STSAFE™ secure element, which provides state-of-the-art security with a Common Criteria certified solution for secure storage and crypto-services.

The complete range of STSAFE-A, STSAFE-J and STSAFE-TPM solutions covers all the security requirements in field, control and supervisor layers.



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

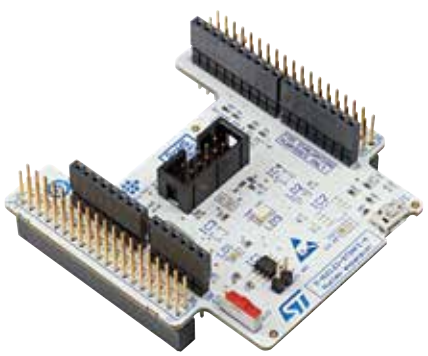
STSAFE-A is an optimized solution providing strong authentication services. Its command set is tailored to address authentication, establish a secure channel in the scope of a TLS session, verify signatures, and offer secure storage as well as decrement counters for usage monitoring.

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-A100 is provided with a complete ecosystem including:

- An STM32 Nucleo expansion board (X-NUCLEO-STA100) allowing to connect the STSAFE-A100 to a STM32 MCU on and STM32 Nucleo development board via its I^2C interface
- A software package including STM32 software to generate and run referenced STSAFE-A100 applications. The package is composed of:
  - STSAFE command wrapper
  - STSAFE reference example use case such as peripheral authentication, TLS handshake secure channel establishment, secure data storage with access control, local wrap/unwrap envelopes.
  - ARM mbed reference resources



STSAFE-J

With a flexible Global Platform and Java 3.0.4 -compliant command set, STSAFE-J is the new generation of KERKEY™ versatile secure solutions offering a wide range of cryptographic and secure services for applications which need to comply with pre-established schemes. Moreover, its EAL5+ Common Criteria certificate enables it to serve the market requiring strong security in concentrators, gateways, and IoT devices.

Moreover to ease development, ST provides a complete set of tools for the integration of STSAFE-J including a set of drivers, a software library (STLIBP11) running on Linux or Windows 7 or 10, and a development board for connecting a Raspberry Pi board.

STSAFE-TPM

STSAFE-TPM, ST's Trusted Platform Module, is an EAL4+ Common Criteria–certified solution in compliance with the TPM 1.2 & 2.0 TCG (Trusted Computing Group) standard designed to protect users' assets by monitoring platform integrity from the boot phase.

Used in devices where firmware integrity is a must, TPMs are largely deployed in desktops, notebooks, tablets, and servers and continue to spread into today's connected world, expanding from PCs to phones to home gateways to cars to infrastructures and more.

	STSAFE-A100	STSAFE-J100	STSAFE-TPM
Typical applications	• Consumers, industrial objects, • USB-C PD3.0 authentication	• Gateways	• Computers • Gateways • Servers
Features	• Authentication (generic, USB-C) • 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
Personalization service at ST	Yes	Yes	Yes
Certification	CC EAL5+ HW	CCEAL5+ HW CC EAL5+ Platform	CCEAL4+ & TCG1.2 & 2.0
Cryptography	ECC, AES	RSA, AES, ECC, SHA	AES, 3DES, RSA, SHA-1, SHA-256, ECC
Temp. range	–40 to 105 °C	–40 to 85 °C	–40 to 105 °C
Package	SO8N DFN (2 x 3 mm)	VQFN 32 DFN8 (4 x 4.2 mm)	TSSOP28 VQFN32
Comm. I/F	I²C	I²C	SPI, I²C

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 MCU. An extended range of products with the latest technological innovations is available, including ultra-low-power devices, embedded crystal oscillators, analog and digital calibration.

RTC functions include programmable alarm, battery switchover and many useful supervisory functions that enhance the application's reliability such as oscillator fail detect, battery low detect, early power fail warning, reset, watchdog, and more (www.st.com/rtc).

Key RTC products

Sub-families	Part numbers	Key features	Applications
Low-power	M41T6x	Low standby current World's smallest RTC with crystal oscillator Small packages	Portable HMI
Enhanced industry standard	M41T81S M41T00S M41T01 M41T80 M41T11 M41T82/83/93 M41T00CAP	Automatic battery switchover Analog calibration Embedded crystal oscillator	Sub-metering HMI
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
Battery with crystal oscillator	M4T28 M4T32	Battery backup power Keyed insertion Removable battery	Sub-metering Portable HMI Local control

SERIAL EEPROM

STMicroelectronics offers a complete range of Serial EEPROM densities and packages which brings flexibility in smart industry designs. ST's Standard series proposes Industrial grade EEPROMs that enlarge capabilities to safely store and refresh information coming from network modules and sensors.

On each ST Serial EEPROM device, more than 100 million samplings and updates are possible over an extended temperature range up to 105 °C.

Datalog in ST's serial EEPROM makes your network infrastructure flexible, efficient and reliable over time.

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.

Key features	Benefits
Complete range 2 Kbit to 2 Mbit in SPI and I²C	Flexibility in design and memory size upgrades without PCB upgrade
SO8N, TSSOP, DFN8, DFN5	Robust molded packages for harsh environments
Operating from -40 up to +105 °C	Adapted to new industrial requirements
200 Years data retention 4 Million Erase/Write Cycles	Highest level of reliability for long lasting systems
Lockable and Identification page	System integrity and basic security identification

Industrial 85 °C line offers competitive products with focus on low voltage and the smallest form factor. Packages such as DFN8, DFN5 and WLCSP ensure that they can fit in the tiniest modules.

		1 Kb	2 Kb	4 Kb	8 Kb	16 Kb	32 Kb	64 Kb	128 K	256 K	512 K	1 Mb	2 Mb
I²C	SO8N	•	•	•	•	•	•	•	•	•	•	•	•
	TSSOP	•	•	•	•	•	•	•	•	•	•	•	
	DFN8		•	•	•	•	•	•	•	•	•		
	DFN5		•	•	•	•	•	•	•				
	WLCSP				•	•	•	•	•	•	•	•	•
SPI	SO8N	•	•	•	•	•	•	•	•	•	•	•	•
	TSSOP	•	•	•	•	•	•	•	•	•	•	•	
	DFN8		•	•	•	•	•	•	•	•	•		
	WLCSP							•	•	•	•	•	•
Microwire	SO8N	•	•	•	•	•							
	TSSOP	•	•	•	•	•							
	DFN8			•		•							

Industrial 105 °C line offers robust products in SO8N and TSSOP8 packages to fit industrial applications requiring extended operating temperature ranges, improved traceability (lockable page) and long data retention after cycling.

		1 Kb	2 Kb	4 Kb	8 Kb	16 Kb	32 Kb	64 Kb	128 K	256 K	512 K	1 Mb	2 Mb
I²C	SO8N		•	•	•	•	•	•	•	•	•		
	TSSOP		•	•	•	•	•	•	•	•	•		
SPI	SO8N		•	•	•	•	•	•	•	•	•		
	TSSOP		•	•	•	•	•	•	•	•	•		

Lockable identification page offered on I2C and SPI Industrial-Plus products, allow to store sensitive information or identification data and lock it in read only mode. It helps increasing system integrity and gives basic security identification.

Read more at http://www.st.com/en/memories/standard-serial-eeprom.html

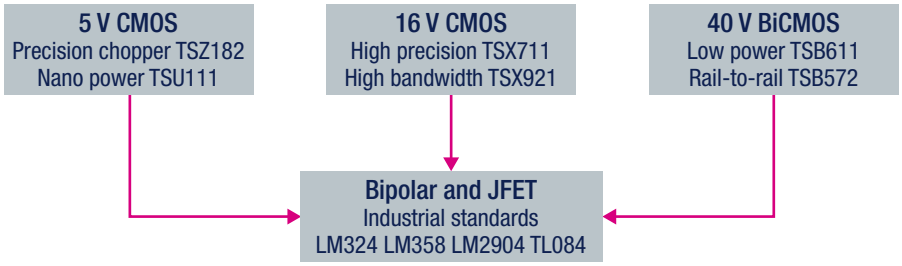
Product Selection guide – Datasheets – Application notes

SIGNAL CONDITIONING

Operational amplifiers

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 40 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



Op amp series	Main feature	Application
TSB611	Supply range up to 36 V, 2.5 MHz bandwidth, 4 kV ESD	Power applications: 24 V ±15 V, High-voltage signal conditioning
TSB572		
TSX921	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
TSX9291		
TSX711		
TSZ181 TSZ121	Supply range up to 5.5 V, input offset down to 5 µV, supply current down to 580 nA, bandwidth up to 20 MHz	Low voltage sensor signal conditioning. Interface with microcontrollers.
TSU111 TSU101		
TSV631 TSV991		

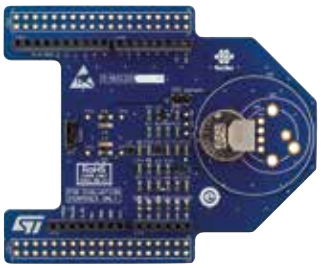
Note: Check out www.st.com for all commercial products and package options.

Electrochemical gas sensor evaluation pack

The **P-NUCLEO-IKA02A1** is an evaluation pack composed of the gas sensing expansion board and NUCLEO-L053. The STM32 Nucleo pack for electrochemical toxic gas sensors expansion board with CO sensor provides reference design for various electrochemical sensors.

Two **TSU111** operational amplifiers are used for signal conditioning. They are ideal for electrochemical sensing thanks to high precision and low power consumption.

Information on how to obtain the board can be found at www.st.com/x-nucleo under the reference **P-NUCLEO-IKA02A1**.



Multifunctional Op Amps expansion board for STM32 Nucleo

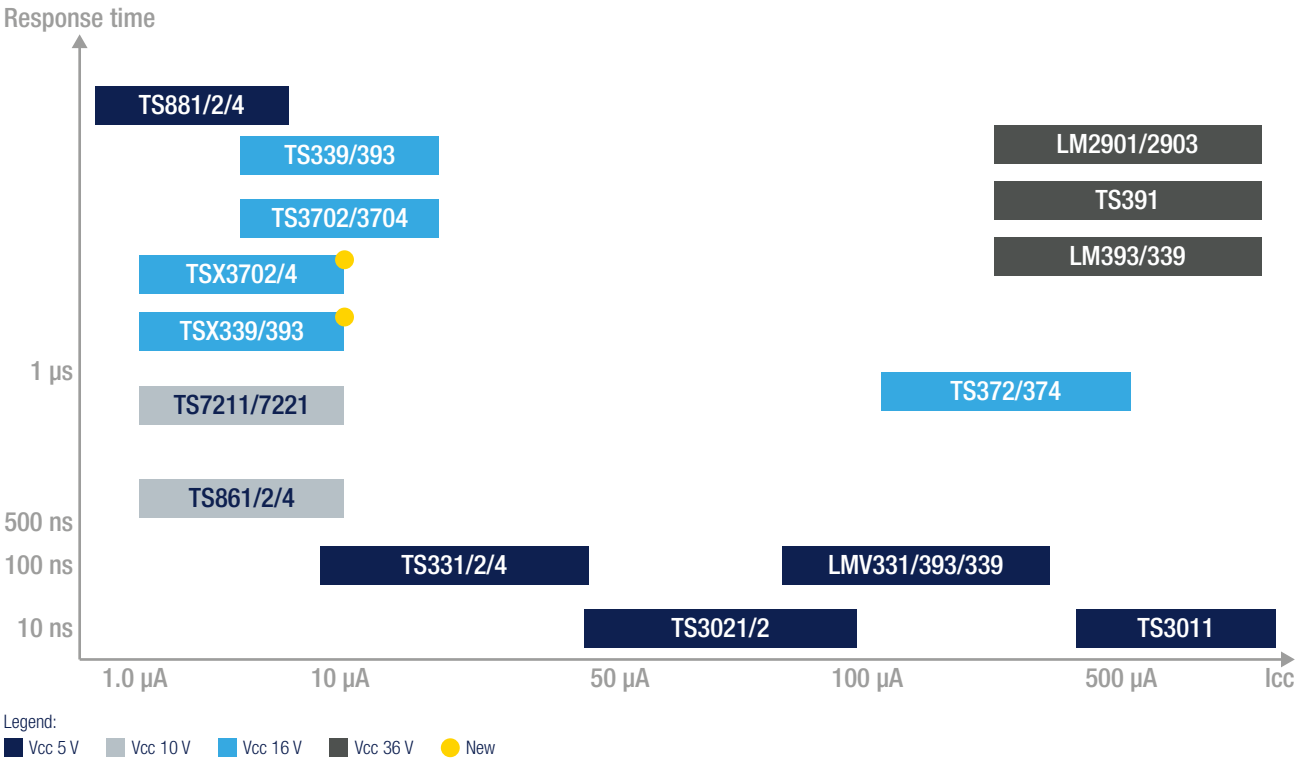
The **X-NUCLEO-IKA01A1** is a multifunctional STM32 Nucleo expansion board based on STMicroelectronics operational amplifiers. It provides an affordable and easy-to-use solution for various use cases with your STM32 Nucleo development board.

The board contains seven predefined configurations based on three different operational amplifiers

- **TSZ124** for instrumentation amplifier and current sensing configurations
- **TSU104** for a window comparator function and photodiode or UV sensor configurations
- **TSV734** for LED driver and buffer configurations

Information on how to obtain the board can be found at www.st.com/x-nucleo under the reference **X-NUCLEO-IKA01A1**

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 feature	Application
TS881/2/4	Nanopower Very low voltage	Gas, CO detectors Battery-operated security systems
TS3011	Nano-second response time High efficiency	Optical modules High-frequency systems
TS3021/2		
TSX3702/4	Micropower, 16 V operating High ESD tolerance	Voltage detector Motor control
TSX339/393		

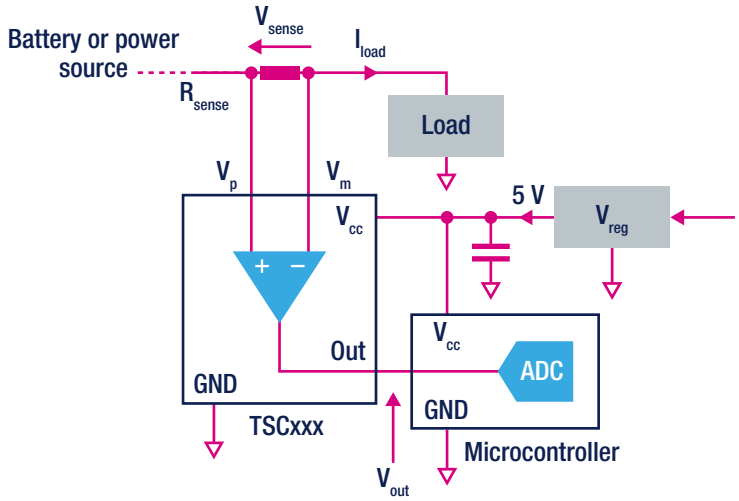
Note: Check out www.st.com for all commercial products and package options.

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. Current measurement is also an essential part of energy metering.

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

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



HIGHLIGHT: TSC103

- Common-mode voltage: 2.9 to 70 V
- Optional dual-supply configuration to reach -2.1 V to 65 V common-mode range
- Rugged input pin sustain -16 to +75 V and 2.5 kV ESD
- Pin-selectable gain: 20 V/V, 25 V/V, 50 V/V, 100 V/V
- Low current consumption: 360 µA

Part number	Max. I_{cc} (µA)	Common mode operating range (V)		V_{cc} (V)		Voltage gain (V/V)	Operating temperature (°C)		Package
		Min.	Max.	Min.	Max.		Min.	Max.	
Hide side current sensing									
TSC101	300	2.8	30	4	24	20, 50, 100	-40	125	SOT23-5
TSC888	1000	2.8	24	4	24	20, 50, 100	-40	125	SOT23-5
TSC102	420	2.8	30	3.5	5.5	Adjustable	-40	125	TSSOP8, SO8
TSC1021	300	2.8	30	3.5	5.5	20, 50	-40	125	TSSOP8
TSC103	360	2.9	70	2.7	5.5	20, 25, 50, 100	-40	125	TSSOP8, SO8
TSC1031	360	2.9	70	2.7	5.5	50, 100	-40	125	TSSOP8, SO8

Evaluation boards

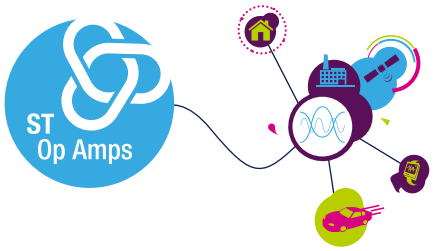
Order code	Description	Documentation
STEVAL-ISQ007V1	High-side current-sense amplifier demonstration board based on TSC101	AN2727
STEVAL-ISQ010V1	High-side current-sense amplifier demonstration board based on TSC102	DB0982
STEVAL-ISQ013V1	Low-side current sensing based on TS507	AN3222
STEVAL-ISQ014V1	Low-side current sensing based on TSZ121	UM1737

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.



Available on the App Store

ANDROID APP ON Google play

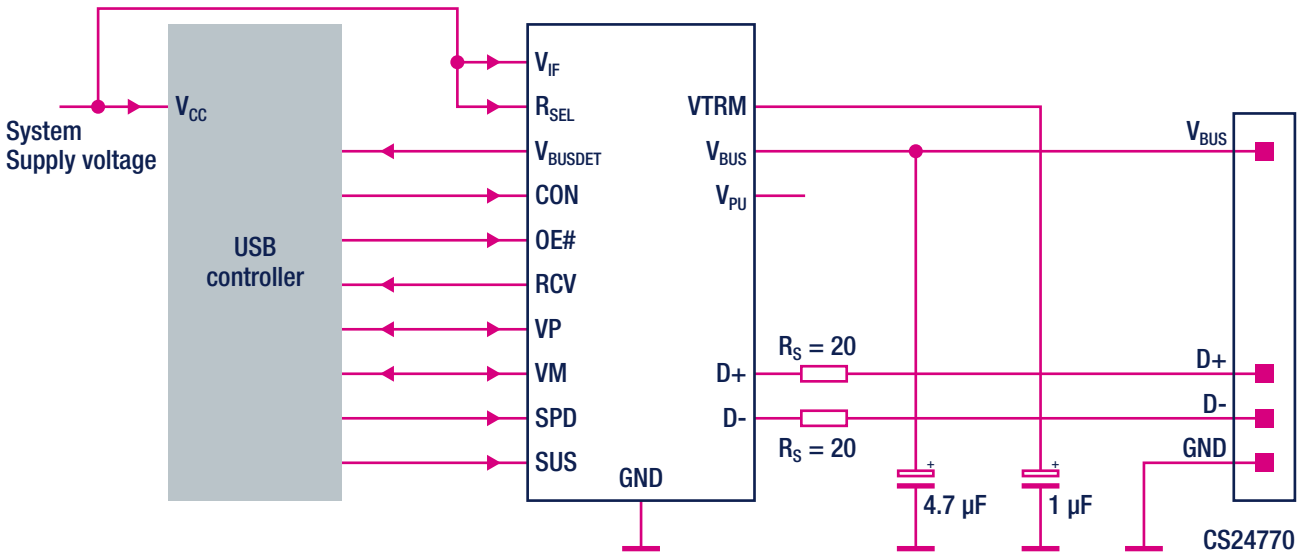
The ST Op Amps App is available on GooglePlay and AppStore

www.st.com/opamps-app

Data communication interface ICs USB transceivers and interfaces

ST's USB interface family includes high-speed USB OTG ULPI transceivers, full speed OTG transceivers and USB charger detection interfaces. They provide a complete solution to connect a digital USB-OTG and ULPI controller to the physical universal serial bus.

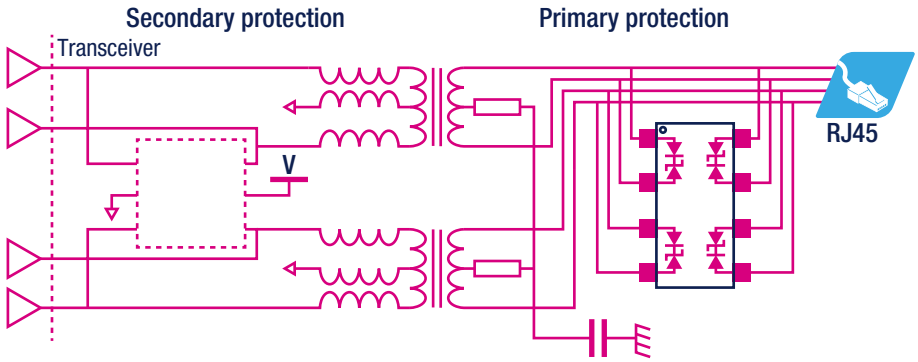
For example, the diagram below shows a typical application circuit using the STUSB03E.



The STUSB03E is a single-chip transceiver that complies with the physical layer specifications of the Universal Serial Bus (USB) v2.0 standard. It has an integrated 5 V to 3.3 V regulator which allows direct powering from V_{BUS}. The transceiver has an integrated voltage detector to detect the presence of V_{BUS} and features an internal D+ pull-up resistor implemented in accordance with the 27% resistor ECN.

For advanced protection devices, the SLVU2.8 series has been designed to protect Ethernet lines. Their low capacitance makes them compatible with gigabit Ethernet.

In this family, the SLVU2.8-4A1 is designed to be compatible with gigabit Ethernet and gigabit PoE by using two SO-8 packages, and can be used on 10/100 Mbit/s Ethernet with a single device. Surge capability is compatible with IEC 61000-4-5 class 2 (1 kV, 42 Ω, 24 A).



The diagram shows the use of the SLVU2.8-4A1, implementing 10/100 Mbit/s Ethernet protection.

The following table presents some examples of decreasing complexity of dedicated ICs, such as the ST485Ex, a family of ±15 kV ESD protected, low-power RS-485/RS-422 transceivers, for industrial applications (www.st.com/interface).

Part number	Temperature range (°C)	Supply voltage (V)	Data rate min (Mbit/s)	Communication standard supported	Number of nodes	Number of drivers/receivers	Package
ST4485EBDR	-40 ÷ 105	3.3	20	RS485, RS422	64	1/1	SO-8
ST3485EIDT	-40 ÷ 125	3.3	12	RS485, RS422	64	1/1	SO-8
ST485EBDR	-40 ÷ 85	5	5	RS485, RS422	256	1/1	SO-8
ST485EXDR	-55 ÷ 125	5	5	RS485, RS422	256	1/1	SO-8
ST232EB	-40 ÷ 85	5	0.23	RS232	.	2/2	SO-16, TSSOP 16

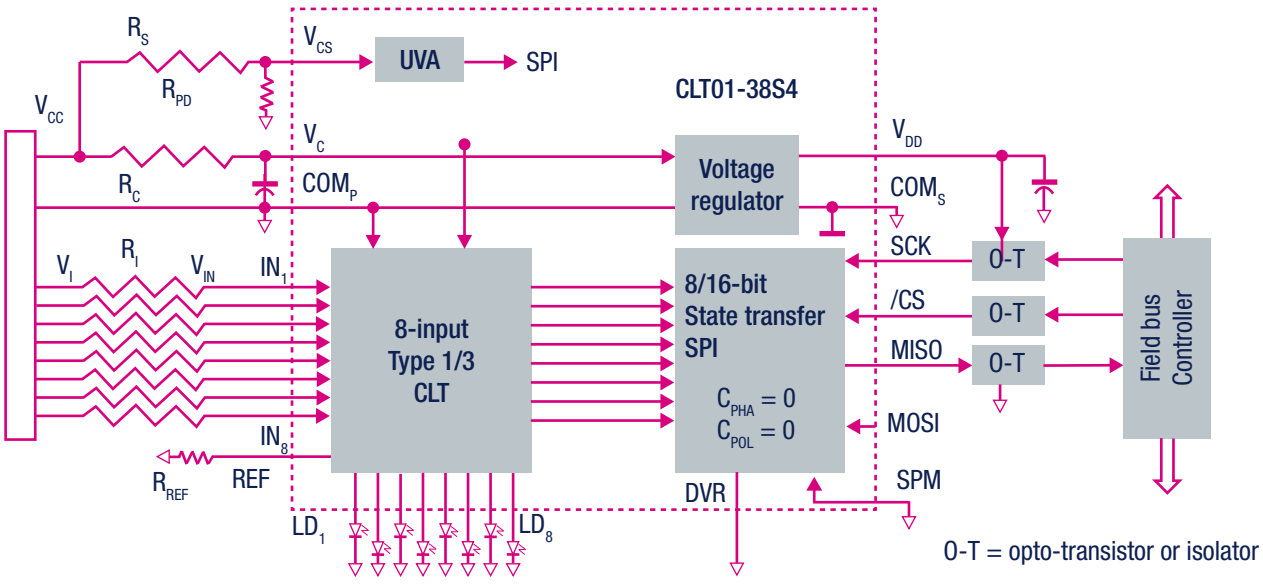
ANALOG AND DIGITAL INPUTS

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 I/Os per volume unit and increasing the I/O-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}.



CLT01-38S4 wiring diagram

The CLT series and its related evaluation boards, as well as the basic documentation, is shown in the table below, together with their most important features.

Additional information about current limiters is available at www.st.com/protection.

xCLT product	CLT3-4BT6	PCLT-2AT4	SCLT3-8	CLT01-38
Number of inputs	4	2	8	8
Input IEC 61131-2	Type 1 and 3	Type 1, 2 and 3	Type 1, 2 and 3	Type 1, 2 and 3
Output type	Isolated	Isolated, Non-isolated	Isolated, Non-isolated SPI serialized transfer	Isolated, Non-isolated SPI serialized transfer
Output drive	Opto transistor	Opto transistor, 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
Current tolerance	25%	18%	10%	10%
Front-end LED status	Yes, using type 1	Yes	Yes	Yes
Surge level	> 1 kV	Type 3: 1 kV Type 2: 0.5 kV	> 1 kV	> 1 kV
ESD level	8 kV	15 kV	15 kV	15 kV
Package	TSSOP-20	TSSOP-14	HTSSOP-38 QFN 7x7	HTSSOP-38 QFN 7x7
Input datarate	10 kbit/s	10 kbit/s	40 kbit/s	400 kbit/s
Application note	AN2527	AN2482	AN2846 and AN3031	AN4625
Evaluation board	STEVAL-IFP008V1	STEVAL-IFP004V1	STEVAL-IFP007V1, STEVAL-IFP030V1	STEVAL-IFP023V1, STEVAL-IFP031V1, X-NUCLEO-PLC01A1

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 and can be associated with an app available for Android and iOS devices.

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 VNI8200XP includes advanced protection and fault detection features. 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.

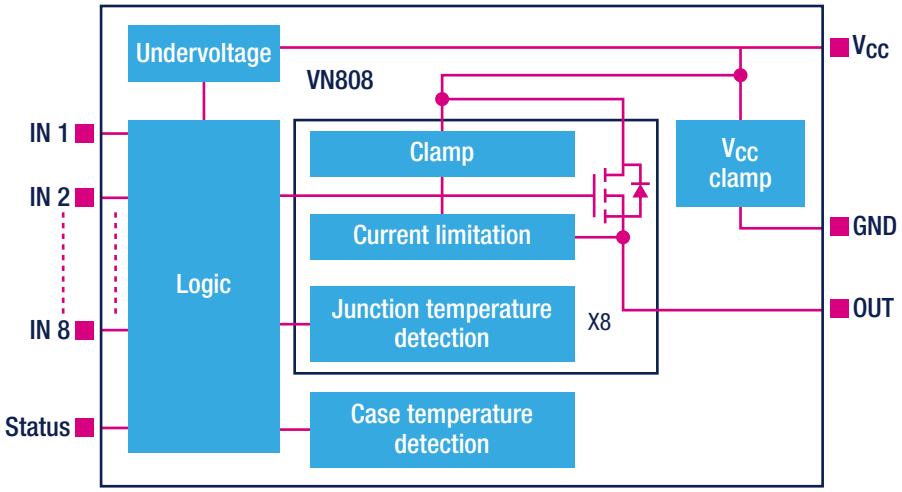
Available on the App Store

ANDROID APP ON Google play

INTELLIGENT POWER SWITCHES (IPS)

Digital outputs

ST offers a large family of intelligent power switches (IPS) that integrate a control part (logic interface, high-side drivers, and protection) with a power stage. IPS are based on ST-patented technologies, including bipolar, multipower BCD and VIPower M0 technologies. This provides increased system reliability, part count reduction, space saving and built-in protection, as well as smaller IPS devices that are housed in tiny, flat, no-lead plastic packages (DFN, QFN). The high thermal performance of the power packages such as PowerSO-36, PowerSSO24 and PowerSSO12 allows the absorption of high-energy pulses when an inductive load is driven without any external freewheeling diode. As an example, the block diagram below shows one of our latest IPSs, the VN808, designed using our proprietary VIPower technology.



Popular single-channel IPSs

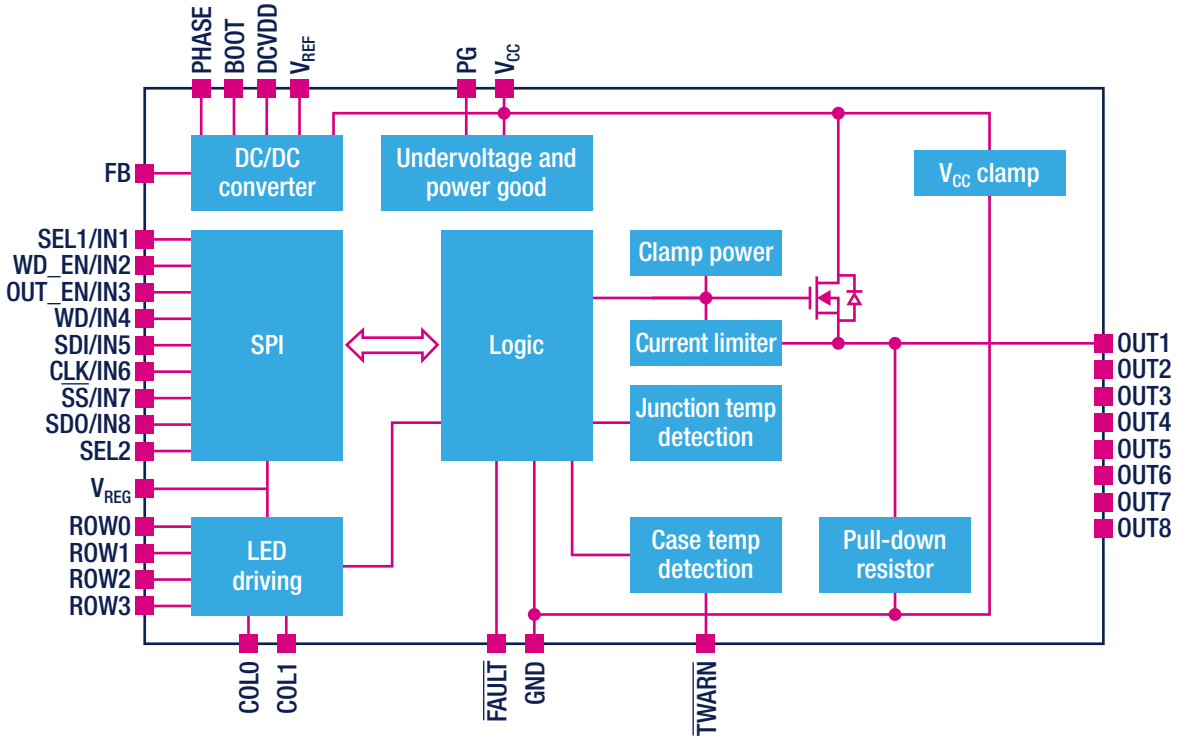
Part number	V_{CC}	R_{DSON} (Ω)	I_{OUT} (A)	Technology	Package	Channels
TDE1737DP	8 ÷ 50	-	0.5/Adjust	Bipolar	DIP-8	Low side
TDE1747FP	10 ÷ 60	-	0.45/Adjust	Bipolar	SO-14	High side
TDE1787ADP	6 ÷ 60	-	0.3/Adjust	Bipolar	DIP-8	High side
TDE1798DP	6 ÷ 50	-	0.5/0.7	Bipolar	DIP-8	High side
L6370Q	9.5 ÷ 50	0.10	2.5/Adjust	MultiBCD	QFN 48L 7x7	High side
L6375D	8 ÷ 50	0.40	0.5/0.75	MultiBCD	SO-20	High side
L6377D	8 ÷ 50	0.40	0.5/Adjust	MultiBCD	SO-14	High side
VN751PT/S	5.5 ÷ 41	0.060	2/2.5	VIPower	PPAK/SO-8	High side
IPS160H	8 ÷ 60	0.060	2/2.6	VIPower	PSO12	High side
IPS161H	8 ÷ 60	0.060	0.5/0.7	VIPower	PSO12	High side

Popular multi-channel IPSs

Part number	V_{CC}	R_{DSON} (Ω)	I_{OUT} (A)	Technology	Package	Channels
VNI2140J	9 ÷ 36	0.08	1.0	VIPower	PowerSSO-12	2
L6374	10.8 ÷ 35	4.0	0.1	MultiBCD	SO-20	4
L6376	9.5 ÷ 35	0.64	0.5	MultiBCD	PowerSO-20	4
VNI4140K	10.5 ÷ 36	0.08	0.7	VIPower	PowerSSO-24	4
VNI4140K-32	10.5 ÷ 36	0.08	1.0	VIPower	PowerSSO-24	4
VNQ860	5.5 ÷ 36	0.27	0.25	VIPower	SO-20/PowerSO-10	4
VN808/-32	10.5 ÷ 36	0.15/0.16	0.7/1.0	VIPower	PowerSO-36	8
VN808CM/-32	10.5 ÷ 36	0.15/0.16	0.7/1.0	VIPower	PowerSO-36	8
VNI8200XP/-32	45	0.11	0.7/1.0	VIPower	PowerSSO-36	8
ISO8200B	45	0.11	0.7	MultiBCD + VIPower	PowerSSO-36	8
ISO8200BQ	45	0.11	0.7	MultiBCD + VIPower	QFN 7x7 32L	8

The VNI8200XP is an octal, high-side smart-power solid-state relay, with a serial/parallel selectable interface on chip (8-/16-bit SPI interface for IC command and control diagnostics). The IC, built using ST's VIPower™ technology, is designed to drive any kind of load with one side connected to ground. Active channel current limitation combined with thermal shutdown, independent for each channel, and automatic restart, protect the device against overload. Additional embedded functions include:

- Loss-of-GND protection that automatically turns off the device outputs should ground be disconnected,
- Undervoltage shutdown with hysteresis,
- Power good diagnostic for valid supply voltage range recognition,
- Output enable function for immediate power output on/off programmable watchdog function for MCU safe operation



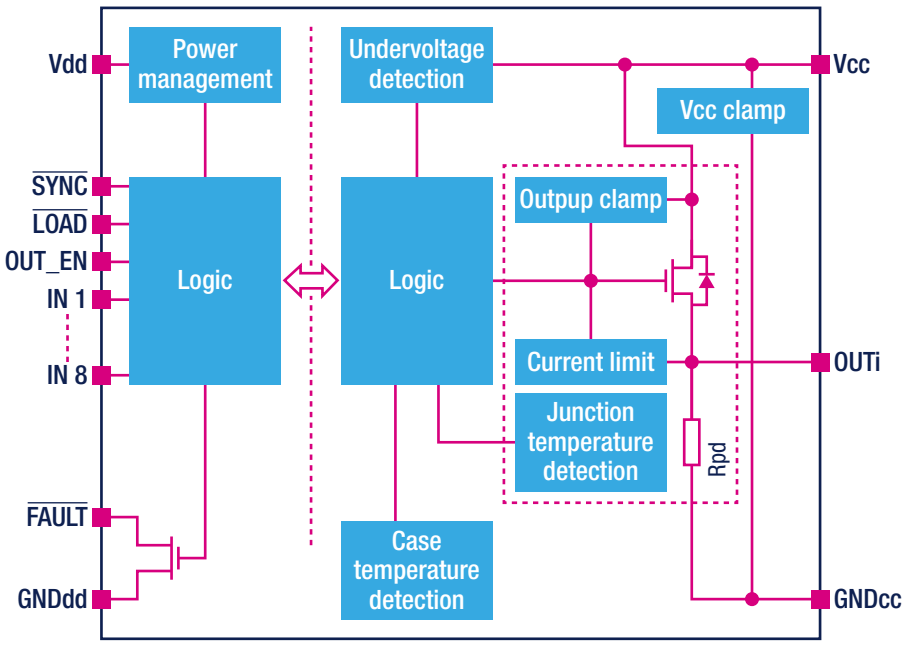
IPS devices are designed to safely drive every kind of load in low-voltage applications (up to 55 V), handling data in and out of the microcontroller by means of status/input signals. IPS devices are designed to comply with the following international standards:

- 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)

IPS devices come with evaluation boards available on Internet (www.st.com/ips).

ISOLATION

A recent introduction to the IPS family is the ISO8200B, a galvanic isolated 8-channel driver featuring a very low $R_{DS(on)}$ for the power stage. It contains 2 independent galvanic isolated voltage domains (V_{CC} for the power stage and V_{DD} for the digital stage). Additional embedded functions are loss-of-GND and loss-of-channel overtemperature protection and case overtemperature protection, undervoltage shutdown with hysteresis, reset function for IC output disable, overvoltage protection (V_{CC} clamping), direct and synchronous control mode, fast demagnetization for inductive loads, and ESD protection. The IC is intended to drive any kind of load with one side connected to ground with 3.3/5 V compatible inputs. Active channel current limitation combined with thermal shutdown (independent for each channel) and automatic restart protect the device against overload and short circuits. In overload conditions, if the junction temperature exceeds the threshold, the channel involved is turned off and then automatically on again after the IC temperature decreases below the reset threshold. If this condition causes the case temperature to reach the threshold limit, TCR, the overloaded channel is turned off and only restarts when the case and junction temperature decrease below the reset thresholds. Non-overloaded channels continue to operate normally. An internal circuit provides an OR-wired unlatched common fault indicator signaling the channel overtemperature. The fault pin is an open-drain active-low fault indication pin. The device is today available also with the new 7 x 7 mm QFN package, referenced as ISO8200BQ.



ISO8200B block diagram

The X-NUCLEO-OUT01A1 is an Industrial Digital output STM32 Nucleo expansion board based on ISO8200BQ.

It provides an affordable and easy-to-use solution involving galvanic insulation embedded in industrial power switch driver applications.

The Arduino™ UNO R3 connector compatibility allows to connect the following STM32 Nucleo development boards: NUCLEO-F103RB, NUCLEO-F302R8 and NUCLEO-F401RE.

The X-NUCLEO-OUT01A1 can be connected to the X-NUCLEO-PLC01A1 to get an industrial PLC prototype with 8 inputs and 16 outputs.

Part number	I_{OUT} (per channel)	Application note or relevant document	Evaluation board(s)
L6360	0.5	AN4075 AN5041	STEVAL-IFP016V1 STEVAL-IDP004V1
L6362A	0.3	DB2848 AN5041	STEVAL-IFP017V3 STEVAL-IDP003V1
TDE1708DFT	0.3	AN2679	STEVAL-IFS006V2
IPS160H	2.5	AN4781	STEVAL-IFP028V1
IPS161H	0.7		STEVAL-IFP034V1
L6370Q	2.5	AN3978	STEVAL-IFP020V1
VN751PT	2.5	DB0862	STEVAL-IFP005V2
VNI2140J	1	AN2985	STEVAL-IFP010V3
IPS4260L	3		STEVAL-IFP029V1(*)
VNI4140K	0.7	AN2684	STEVAL-IFP006V1
VNI4140K-32	1	AN4009	STEVAL-IFP019V1
VN808	0.7	AN2208	STEVAL-IFP002V1
VN808CM	0.7	AN2443	STEVAL-IFP001V1
VNI8200XP	0.7	AN4284	STEVAL-IFP022V1 X-NUCLEO-PLC01A1
VNI8200XP-32	1	DB2828	STEVAL-IFP032V1
ISO8200B	0.7	AN4373	STEVAL-IFP015V2
ISO8200BQ	0.7	DS10781	STEVAL-IFP033V1 X-NUCLEO-OUT01A1

MOTION SENSORS

ST's motion sensor portfolio includes accelerometers, gyroscopes, microphones, digital compasses and inertial modules (www.st.com/mems). ST is a worldwide leader in these devices thanks to:

- 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 (more than 13 billion parts shipped worldwide)
  - 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
  - Vibration monitoring
  - Environmental noise-level detection (microphones)
  - Drills (accelerometers, gyroscopes)
  - Tilt detection

Part number	Full scale	Noise density (Typ.)	Package size (mm)	Key features
Accelerometers				
IIS2DH[1]	±2, ±4, ±8, ±16 g	250 µg/√Hz	2 x 2 x 1 LGA-12	Ultra-low-power high-performance 3-axis accelerometer with digital output for industrial applications
IIS328DQ[1]	±2, ±4, ±8 g	218 µg/√Hz	4 x 4 x 1.8 QFPN-24	High-performance ultra-low-power 3-axis accelerometer with digital output for industrial applications
IIS3DHHC[1,2]	±2, ±5, ±8 g	65 µg/√Hz	5 x 5 x 1.7 LGA-16	16-bit, very-low-noise, high-stability MEMS digital output motion sensor (inclinometer) for double signal integration
Gyroscopes				
L20G20IS	±100, ±200 dps	0.0038 °/s/√Hz	2.0 x 2.0 x 0.7 LGA-16L	Ultra-compact, two-axis gyroscope for closed loop controls
I3G4250D[1]	±245, ±500, ±2000 dps	0.03 °/s/√Hz	4 x 4 x 1.1 LGA-16	Three-axis digital output gyroscope for industrial applications
Magnetometer				
IIS2MDC[1]	±50 gauss		2 x 2 x 0.7 LGA-12	16-bit data output, interrupt generator, self-test
Digital compasses				
ISM303DAC[1]	±2, ±4, ±8, ±16 g ±50 gauss	90 µg/√Hz 3.5 mgauss	2 x 2 x 1 LGA-12	Ultra-compact, high-performance e-compass 3D accelerometer and 3D magnetometer module
LSM303AH	±2, ±4, ±8, ±16 g ±50 gauss	90 µg/√Hz 3.5 mgauss	2 x 2 x 1 LGA-12	Ultra-compact, high-performance e-compass 3D accelerometer and 3D magnetometer module
Inertial modules				
ISM330DLC[1]	±2, ±4, ±8, ±16 g ±125, ±245, ±500, ±1000, ±2000 dps	0.0038 °/s/√Hz	13 x 13 x 2 PCB	iNEMO inertial module: 3D accelerometer and 3D gyroscope with digital output for industrial applications

Note: 1 These part numbers are part of the ST 10-years longevity program.
Note: 2 This sensor cannot be evaluated with the X-Nucleo system.

ENVIRONMENTAL SENSORS

STMicroelectronics offers a full range of environmental sensors, including pressure, humidity 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
Environmental sensors				
HTS221	-40 to +120 °C	± 3.5 % rH ± 0.5 °C	2 x 2 x 0.9 HLGA-6L	Capacitive digital sensor for relative humidity and temperature
LPS22HB	-40 to +85 °C	± 0.1 hPa	2 x 2 x 0.76 HLGA-10L	260-1260 hPa absolute digital output barometer (MEMS nano pressure sensor)
LPS33HW	-40 to +85 °C	± 0.1 hPa	2 x 2 x 0.76 HLGA-10L	Harsh environment 260-1260 hPa absolute digital output barometer
STLM20	-55 to +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
STTS751	-40 to +125 °C	Accuracy: ±1 °C (typ.) 0°C to +85°	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	SNR (dB)	Sensitivity (dBV)	Package size (mm)	Key features
MEMS Microphones				
MP23AB01DH	65dB	-38 dB ± 1 dB	3.35 x 2.5 x 0.98	Bottom port, analog differential output, and very high AOP (135 dBSPL)

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-IKS01A2 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 some consumer grade devices. Nevertheless, ST industrial sensors are fully supported thanks to the DIL24 adapter.

The X-NUCLEO-IKS01A2 interfaces with the STM32 microcontroller via the I²C pin, and it is possible to change the default I²C port.

Open Software Expansion

The Open Software Expansion development suite offers drivers, middleware and application software to start your STM32 design with ST products including MEMS, Bluetooth Low Energy modules, sensors, etc. It enables fast prototyping using the STM32 Open Development Environment with leading-edge components that can quickly be transformed into final designs. The Open Software Expansion environment is made up of several free libraries including:

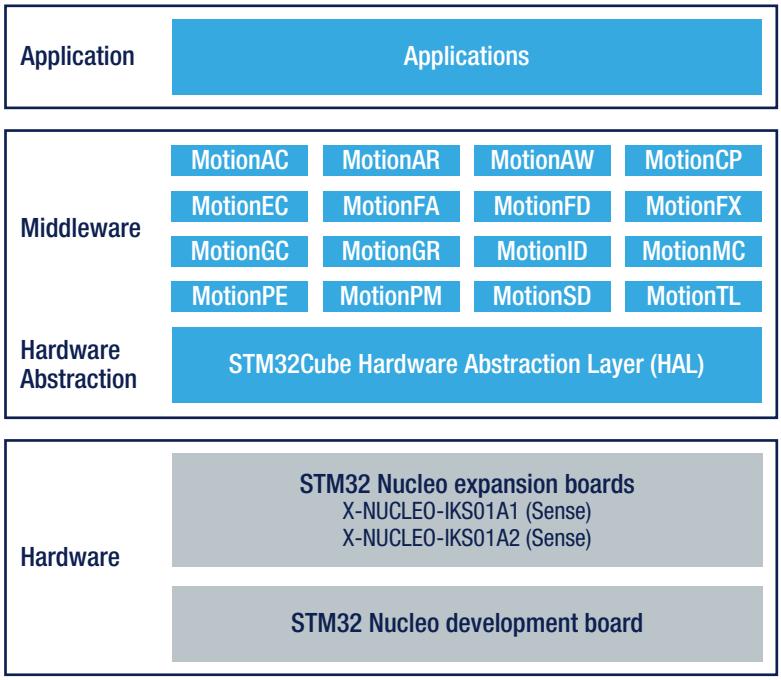
- Open.MEMS:
  - Sensor fusion library for STM32 platform (osxMotionFX)
  - Sensor carrying position for STM32 platform (osxMotionCP)
  - Sensor activity recognition for STM32 platform (osxMotionAR)
  - Sensor gesture recognition for STM32 platform (osxMotionGR)
- Open.RF: BlueNRG Bluetooth Low Energy library for the most commonly-used BT smart profiles
- Open.Audio:
  - Real-time beam forming algorithm for STM32 platform (osxAcousticBF)
  - Real-time sound source localization algorithm for STM32 platform (osxAcousticSL)
  - Real-time echo cancellation routine for STM32 platform (osxAcousticEC)
  - Bluetooth Low Energy and microphones for STM32 platform (osxBlueVoice)

X-NUCLEO-IKS01A2

X-CUBE-MEMS-XT1

The X-CUBE-MEMS-XT1 expansion software package for STM32Cube runs on the STM32 and includes drivers that recognize the industrial sensors not included in the X-NUCLEO-IKS01A2 shield.

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



STM32 Nucleo expansion boards

X-NUCLEO-IKS01A1 (Sense)
X-NUCLEO-IKS01A2 (Sense).

Hardware

The software comes with sample implementation and runs connected to a NUCLEO-F401RE, NUCLEO-L053R8, NUCLEO-L152RE or NUCLEO-L476RG development boards.

The software provides advanced motion libraries together with sample applications available only for NUCLEO-F401RE and NUCLEO-L476RG. The motion libraries include MotionAC (accelerometer calibration library), MotionAR (activity recognition library), MotionAW (activity recognition for wrist library), MotionCP (carrying position library), MotionEC (eCompass library), MotionFA (fitness activities library), MotionFD (fall detection library), MotionFX (sensor fusion library), MotionGC (gyroscope calibration library), MotionGR (gesture recognition library), MotionID (intensity detection library), MotionMC (magnetometer calibration library), MotionPE (pose estimation library) and MotionPM (pedometer library), MotionSD (standing and sitting desk detection library), MotionTL (tilt sensing library).

Key Features

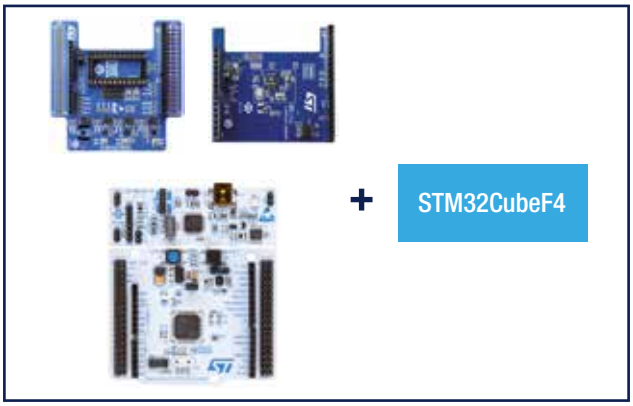
- Several examples to show the innovative inertial and environmental sensors
- Sample application to transmit real-time sensor data to a PC
- Compatible with the Unicleo-GUI graphical user interface to display sensor data and configure outputs
- Advanced motion libraries with sample applications available only for NUCLEO-F401RE and NUCLEO-L476RG
- Easy portability across different MCU families, thanks to STM32Cube
- Free, user-friendly license terms

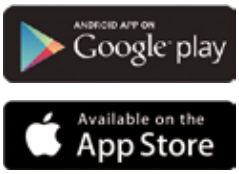
Multi-sensor, Bluetooth application development platform

The BLUEMICROSYSTEM1 framework uses Bluetooth Low Energy, inertial (e.g. motion MEMS) and environmental (e.g. humidity, pressure, temperature) sensors. It enables fusing together and transmitting real-time sensor data to a smartphone (Android or iOS based) via Bluetooth. BLUEMICROSYSTEM1 provides an implementation example for the STM32F4 Nucleo platform equipped with the STM32 Nucleo MEMS and environmental sensor expansion board (X-NUCLEO-IKS01A1) and the STM32 Nucleo Bluetooth Low Energy expansion board (X-NUCLEO- IDB04A1).

BLUEMICROSYSTEM1 is suitable for all applications and markets, including IoT and wearables, which need to effectively sense, process and transmit valuable information with very low power consumption and high performance.

Open.Framework:
BlueMicrosystem1 Application example





Professional MEMS Tool

The Professional MEMS Tool (STEVAL-MKI109V3 “Profi MEMS Tool”) is a motherboard designed to provide a complete 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 UNICO graphical user interface (GUI) downloadable from the ST website or dedicated software routines for customized applications.

BASIC FEATURES:

- Compatible with all available 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

STEVAL-MKI109V3

More connected

More Connected focuses on machine-to-machine communication. Well known by the acronym M2M, ST has been developing solutions that allow machines to communicate for many years now. This means that machines can cooperate with other machines in order to optimize the workload, perform predictive maintenance which goes in the direction of longer life for machines that can autonomously check their status as well as faults, and communicate to upper levels that it's time for a check-up.
M2M is about establishing communications between manufacturing and the back office. This one of the major evolutions in Smart Industry where the new PLC becomes the bridge between these two worlds.

IO-Link	Fieldbus	Wi-Fi	Bluetooth	Sub-GHz
NFC	RFID	Secure MCUs	ESD & EMI Protection	

IO-Link

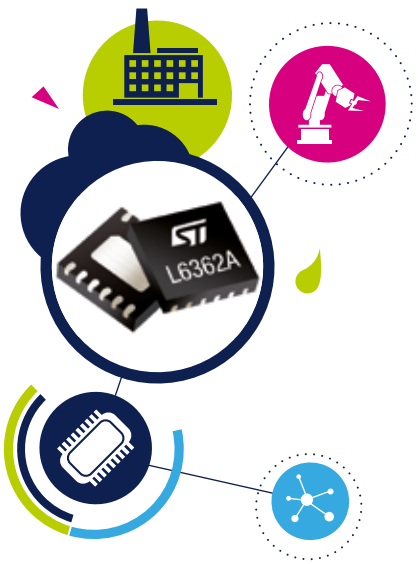
IO-Link is a powerful bidirectional point-to-point serial communication protocol that connects sensors and actuators. It was defined from the start with the following key benefits in mind:

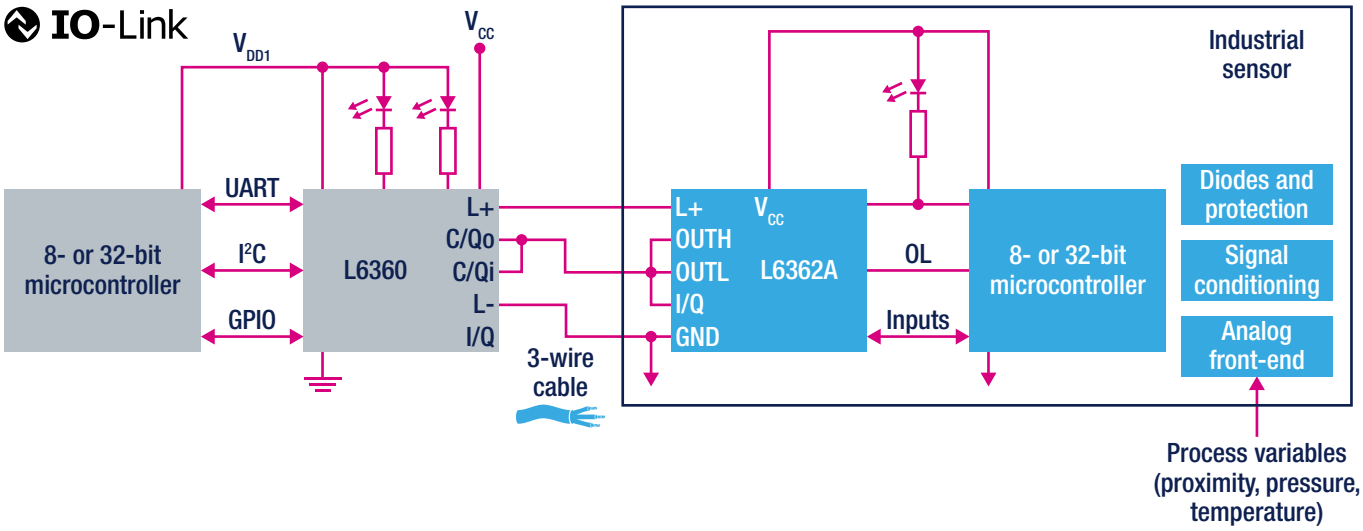
- Plug-and-play capability
- Integrated diagnostics
- Remote parameterization and calibration
- Backwards compatibility

IO-Link allows three types of data to be exchanged – Process data (about the state of sensors or actuators), service data (device information, configuration, detailed diagnostics or status), and events (alarms or informational messages that should be delivered as soon as something happens).

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 and L6362A enable a master and device solution 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 solutions offers an efficient, compact and cost-effective way to drive any 3-wire digital sensor.





These ICs ensure that IO-Link sensors and actuators can communicate without the need for special cables (standard 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.

Industrial transceiver 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 reg. (mA)	Technology	Output channels	Input channels	Package
L6360 (Master)	18 to 32.5	3.3 / 5	0.5	65	MultiPower BCD	2	2	QFN 26L 3.5 x 5 mm
L6362A (Device)	5 to 40	3.3 / 5	0.2	8	MultiPower BCD	1	1	DFN 12L 3 x 3 mm

Evaluation boards are available for our L6360 and L6362A I/O industrial transceiver ICs.

Order code	Description	Application notes
STEVAL-IFP016V2	IO-Link communication master transceiver demonstration board based on the L6360	AN4075
STEVAL-IFP017V3	IO-Link communication device transceiver demonstration board based on the L6362A	AN4828
STEVAL-IDP004V1	IO-Link master multi-port evaluation board based on L6360	AN5041
STEVAL-IDP003V1	IO-Link industrial modular sensor board based on L6362A	AN5041

ST IO-Link demonstration kit with STEVAL-IDP004V1 on the left and STEVAL-IDP003V1D on right.

The IO-Link protocol is the perfect match for Industry 4.0 hot topics like ad-hoc communication, predictive maintenance and data analytics.

FIELDBUS

ST provides fieldbus communication solutions with many valued development partners which provide protocol stacks for our STM32 as well as STM8 MCUs.

Provider	Solution name	Application	Model	Cost	Availability for STM32 series								
					F0	F1	F2	F3	F4	F7	L0	L1	L4
Andrea Informatique	DLMS/COSEM	Metering	Binaries	License	N[1]	Y	Y	N[1]	Y	N[1]	N[1]	Y	N[1]
CMX	CMX-CANopen	Automation, medical	Source		N	Y	Y	Y	Y	Y	N	N	N[1]
eCosCentric	eCosPro-CAN	Factory Automation			N	Y	Y	Y	Y	Y	N	N	Y
	CANopen	Factory Automation			N	Y	Y	Y	Y	Y	N	N	Y
	eCosPro-ModbusTCP	Factory Automation			N	N	Y	Y	Y	Y	N	N	Y
emtas	CANopen	Automation, medical			Y	Y	Y	N	Y	N[1]	N	N	Y
	J1939	Commercial vehicles			Y	Y	Y	N	Y	N[1]	N	N	Y
	EnergyBus	Commercial vehicles			Y	Y	Y	N	Y	N[1]	N	N	Y
	EtherCAT[2]	Automation, medical			Y	Y	Y	Y	Y	Y	Y	Y	Y
Hilscher	PROFIBUS DP Master[2]	Fieldbus Factory automation	Source + Binary[3]		Y	Y	Y	Y	Y	Y	Y	Y	Y
	PROFIBUS DP Slave[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	CANopen Master[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	CANopen Slave[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	DeviceNet Master[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	DeviceNet Slave[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	CC-Link Slave[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	OPC UA Server[2]	IIoT			Y	Y	Y	Y	Y	Y	Y	Y	Y
	MQTT Client[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	PROFINET RT/IRT IO-Device[2]	Industrial real-time Ethernet Factory automation			Y	Y	Y	Y	Y	Y	Y	Y	Y
	PROFINET RT/IRT IO-Controller[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	EtherCAT Slave[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	EtherCAT Master[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	Ethernet/IP Scanner[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	Ethernet/IP Adapter[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	sercos Master[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	sercos Slave[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	POWERLINK Controlled Node[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	Varan Client[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
	Open ModbusTCP[2]				Y	Y	Y	Y	Y	Y	Y	Y	Y
HMS	IXXAT® CANopen	Automation, medical	Source		N	Y	Y	Y	Y	Y	N	N	Y[1]
	IXXAT® SAE J1939	Transportation			N	Y	Y	Y	Y	Y	N	N	Y[1]
	EtherNet/IP Adapter	Factory automation			N	Y[1]	Y	N	Y	Y	N	N	Y[1]
	EtherNet/IP Scanner	Factory automation			N	Y[1]	Y	N	Y	Y	N	N	Y[1]
	IXXAT® IEEE1588	Factory automation			N	Y[1]	Y	N	Y	Y	N	N	Y[1]
	IXXAT® Safety over EtherCAT	Automation			N	Y[1]	Y	N	Y	Y	N	N	Y[1]
	IXXAT® CIP Safety (EtherNet/IP, sercos)	Automation			N	Y[1]	Y	N	Y	Y	N	N	Y[1]

Provider	Solution name	Application	Model	Cost	Availability for STM32 series								
					F0	F1	F2	F3	F4	F7	L0	L1	L4
Matrikon	OPC UA Server	Factory automation	Source	License	N	Y	Y	N	Y	Y	N	N	N
MESCO	HART Slave	Process automation		Lic.+Royal.	Y	Y	Y	Y	Y	N[1]	Y	Y	N[1]
MicroControl	CANopen	Automation, medical		License	Y	Y	Y	Y	Y	Y	N	N	Y
	J1939	Commercial vehicles			Y	Y	Y	Y	Y	Y	N	N	Y
	EtherCAT[1]	Factory automation			Y[2]	Y[2]	Y[2]	Y[2]	Y[2]	Y[2]	Y[2]	Y[2]	Y[2]
	PROFINET				N	Y	Y	N	Y	Y	N	N	N
Micrium	µC/Modbus				Y	Y	Y	Y	Y	Y	Y	Y	Y
Port	CANopen				Y	Y	Y	Y	Y	Y	N	N	Y
	EtherCAT[1]		Binaries/Source		Y[1]	Y	Y	Y	Y	Y[1]	N	N	Y[1]
	PROFINET		Source		N	N	N	N	Y	Y[1]	N	N	N
	EtherNet/IP[5]				N	N	N	N	Y[1]	Y[4,1]	N	N	N
	POWERLINK				N	N	Y[1]	N	N	N	N	N	N
SEGGER	emModbus				Y	Y	Y	Y	Y	Y	Y	Y	-
ST	DALI[6]	Lightning		Free	N	Y	N	N	N	N	N	Y	N
	DMX[6]	Lighting/home & building automation			N[5]	Y	N[5]	N[5]	N[5]	N[5]	N[5]	N[5]	N[5]
TAPKO	KAlstack KNX	Building automation	Binaries/Source	License + royalties	Y	Y	Y	Y	Y	Y	Y[1]	Y[1]	Y[1]
TEConcept	IO-Link Device	Factory automation	Source	License	Y	Y	N	N	N	N	Y	N	N
	IO-Link Master				N	Y	N	Y	Y	Y	N	N	N
TMGTE	IO-Link Device				Y	Y	Y	Y	Y	Y	Y	Y	Y
	IO-Link Master				N	Y	Y	Y	Y	Y	N	N	N
	Profibus DP				Y	Y	Y	Y	Y	Y	Y	Y	Y
	Profinet			License + royalties	N	N	Y	N	Y	Y	N	N	N
	Ethernet/IP				N	N	Y	N	Y	Y	N	N	N
Weinzierl	KNX	Home and Building automation		License	Y	Y	N[5]	N[5]	N[5]	N	N[5]	Y	N[5]

Note: 1 Supplier to be contacted 2 Requires external hardware 3 Source for STM32, binary for external hardware
4 PTPd ported on STM32 by ST 5 Can be ported 6 Provided on demand to sales office

In addition to the long list of solutions for STM32 microcontrollers, many partners develop fieldbus solutions for the STM8 microcontroller family.

Provider	Solution name	Application	Model	Cost	STM8 series		
					S	A	L
SEGGER	emModbus	Factory automation	Source	License	Y	Y	Y
ST	DALI	Lighting	Source	Free	Y	N[2]	N[2]
TEConcept	IO-Link Device	Factory automation	Source	License	Y	N[1]	Y
TMGTE	IO-Link Device	Factory automation	Source	License	Y	N[1]	Y
TAPKO	KAlstack KNX	Building automation	Binaries /Source	License+Royalties	N	N	Y

Note: 1 Supplier to be contacted 2 Can be easily ported

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 5.0 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-IDB007V1 and STEVAL-IDB008V1) 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)

BlueNRG-MS: Bluetooth® smart network processor

Among a plethora of Bluetooth® 4.1 compliant devices, the BlueNRG-MS IC, exhibiting an unparalleled low current consumption, is the ideal solution for all applications (Bluetooth® smart devices) that need to operate for months or even years while being powered from a small coin cell battery. The BlueNRG-MS runs the complete Bluetooth® Low Energy stack on an embedded Cortex®-M0 core and it is also connected through a proprietary SPI-based interface to a host MCU running the application. Supporting both master and slave roles, the BlueNRG-MS can operate as a central (managing up to 8 peripherals) or peripheral device without any change in the firmware. The Bluetooth® profiles are provided separately and meant to run in the host MCU.

KEY FEATURES

- Bluetooth® 4.1 compliant master and slave roles simultaneously
- Embedded Bluetooth® Low Energy protocol stack: GAP, GATT, SM, L2CAP, LL and RF-PHY
- On-chip non-volatile upgradable memory
- 7.3 mA RX current consumption
- 8.2 mA TX current consumption at 0 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
- Battery monitoring and temperature sensor
- 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 modules both for Bluetooth Classic as well as Bluetooth Low Energy.

BLUETOOTH CLASSIC MODULE FEATURES:

- Compliant with latest Bluetooth Classic 3.0 version
- Embedded firmware, including BT stack and profile, SPP and iAP* and a simple, easy-to-use interface AT command set
- RF certified according to CE, FCC, IC, and TELEC
- Low-power mode supported
- Smart cable and remote mode supported

SPBT2632 B3 SPP/iAP

BLUETOOTH LOW ENERGY MODULE FEATURES:

- Based on BlueNRG-MS (without MCU)
- Host interface: SPI
- BlueNRG-MS embeds all the Bluetooth Smart 4.1 protocol stack
- CE, FCC, and IC certified
- Output power +4 dBm (up to + 8dBm)
- Receiver sensitivity -88 dBm
- Supply voltage from 1.7 to 3.6 V

SPBTLE-RF

BLUETOOTH LOW ENERGY V4.2 MODULE FEATURES:

- Bluetooth v4.2 compliant module SPBTLE-1S
  - High performance, ultra-low power Cortex-M0 32-bit based architecture core
  - Programmable embedded 160 KB Flash
  - 24 KB embedded RAM with data retention
  - Interfaces:
    · 1 x UART, 2 x I^2C, 1xSPI, 14 x GPIO, 2 x multifunction timer, 10-bit ADC, Watchdog & RTC, DMA controller, PDM stream processor, SWD debug Interface
- Max Tx power: + 5 dBm
- Excellent link reliability
  - On-board chip antenna
  - 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 Chinese Certification
    · BT SIG End Product QDID
  - Pre-programmed UART bootloader
  - Operating supply voltage: from 1.7 to 3.6 V

SPBTLE-1S

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 as well as automatic meter reading applications. 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 as well as unmatchable performance and system efficiency at the expense of interoperability and development efforts. 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, certain standards target specific application cases. Such 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. Among others, the Wireless M-Bus is an open standard developed for very power efficient smart metering and Advanced Metering Infrastructure (AMI) applications and it is quickly spreading in Europe for gas, water and heat metering. 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).

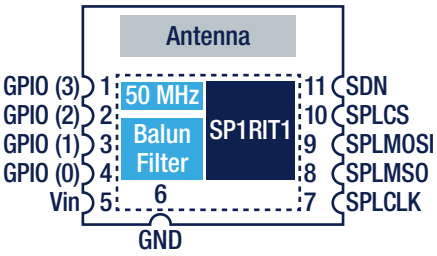
SPIRIT1 TRANSCEIVER, STM32L1 MCU AND BALF-SPI BALUN/FILTER:

- AT command set
- Output power up to +11.6 dBm
- CE compliant and FCC certified
- Air data rate up to 500 Kbit/s
- Modulation schemes: 2-FSK, GFSK, MSK, GMSK, OOK,
- 1.8 to 3.6 V supply voltage
- Operating temperature: -40 to 85 °C

SP1ML-868 (868 MHz)
SP1ML-915 (915 MHz)

SPIRIT1 TRANSCEIVER AND BALF-SPI-01D3 BALUN/FILTER:

- 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 -130dBm 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 and smart things.

For fast prototyping and easy evaluation, evaluation platforms are also available covering different ISM Sub-1GHz bandwidth (order code STEVAL-FKI433V1, STEVAL-FKI868V1, STEVAL-FKI915V1).

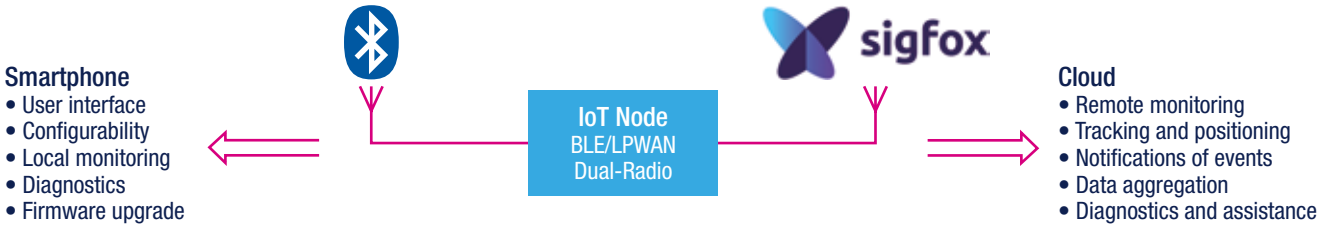
KEY FEATURES

- Frequency bands: 430-470 MHz, 860-940 MHz
- 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
- QFN 24 4 x 4 package

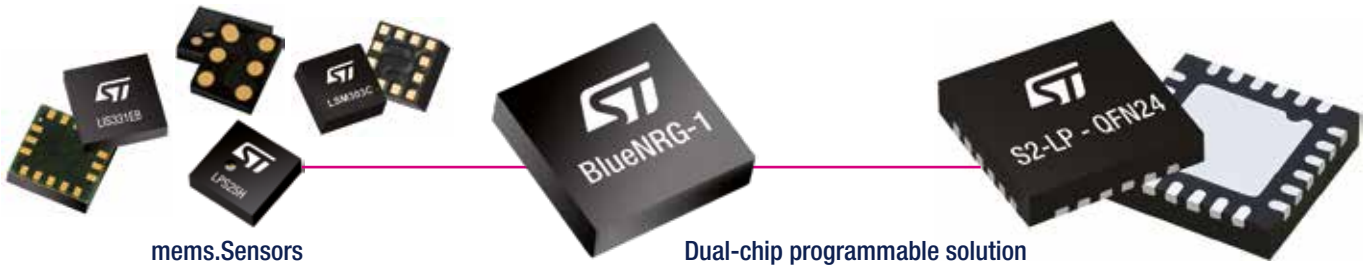
KEY BENEFITS

- Ultra-low-power design for prolonged battery lifetime in applications with sensors in the Smart Industry, Home and Building automation applications, 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 wireless modules

To quickly get started with our connectivity modules and devices, here is a list of suggested evaluation tools.

Evaluation tools for Connectivity modules		Balun /filter
STEVAL-SPBT3ATV3	USB dongle for Bluetooth Classic V3.0 modules	USBUF01W6
STEVAL-SPBT4ATV3		
X-NUCLEO-IDB05A1	STM32 Nucleo Expansion board and USB dongle for SPBTLE-RF module	BALF-NRG01D3
STEVAL-IDB006V1M		
STEVAL-IDW001V1	Daughter Board for Wi-Fi modules usable with STEVAL-PCC018V1 or with the STM32F0-Discovery	USBUF01W6
STEVAL-PCC018V1		
STEVAL-SP1ML915	USB dongle for SP1ML modules	USBUF01W6 on USB side BALFSPI01D3 onantenna side
STEVAL-SP1ML868		
X-NUCLEO-IDS01A5 (4)	STM32 Nucleo Expansion board and USB dongle for SPSGRF modules	BALF-SPI01D3
STEVAL-IDS01V5M (4M)		

CE RoHS compliant FC

ST CONTACTLESS TECHNOLOGY

Contactless technology in the smart industry domain is 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 Wi-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 Consumer, Industrial and IoT.
- NFC/RFID Readers, which support multiple NFC protocols in Reader 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 ST25R3913	Reader/Writer P2P	ISO14443A/B ISO15693, FeliCa	SPI	Automatic Antenna Tuning, 1.4 W Dynamic Power Output, Very High Baud Rate 6.8 Mbps, Capacitive & Inductive wake-up	QFN32 (5x5mm)
ST25R3910	Reader/Writer	ISO14443A/B ISO15693, FeliCa	SPI	Automatic Antenna Tuning, 0.7 W Power Output, Inductive wake-up	QFN32 (5x5mm)
CR95HF ST95HF	Reader/Writer Card Emulation	ISO14443A/B ISO15693, FeliCa	SPI	0.23 W Power Output, Inductive wake-up	QFN32 (5x5mm)
ST25DV	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
M24LR	Dynamic Tag	ISO15693	I²C	EEPROM 4 kb, 16 kb & 64 kb, 32-bit password, Energy Harvesting, GPO MCU wake-up	SO8, TSSOP8, FPN8
M24SR	Dynamic Tag	ISO14443A	I²C	EEPROM 4 kb, 16 kb & 64 kb, 128-bit password. GPO MCU wake-up	SO8, TSSOP8, FPN8, Die
ST25TA	Tag	ISO14443A	NA	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	NA	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-NFC05A1
ST25R3911B-based NFC/RFID Reader
Nucleo expansion board

X-NUCLEO-NFC04A1
ST25DV-based NFC/RFID Dynamic
Tag Nucleo expansion board

CLOUD-ST25TA
ST25TA-based NFC/RFID
Tag evaluation board

ST25TV e-SEAL
ST25TV-based NFC/RFID
Tag evaluation board

ESD & EMI PROTECTION

Power and data line protection

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

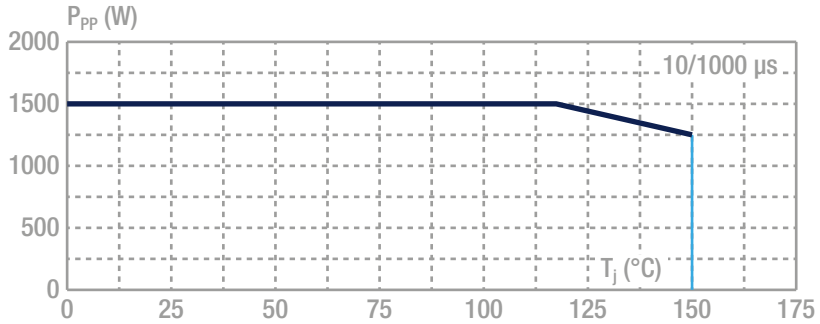
Power lines

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.

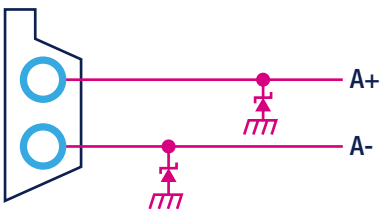
Peak pulse power dissipation versus initial junction temperature (printed circuit board)



Data lines

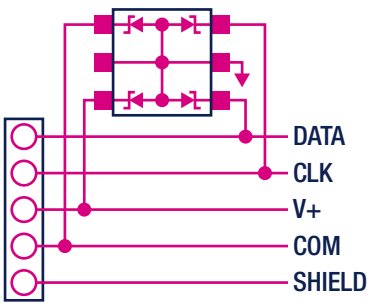
Communication buses, with long wires lengths, are particularly sensitive to electrostatic discharge (ESD). ST proposes multiline solutions in a single package, with various parasitic capacitance and voltage compromises, to address a wide range of industrial communication interfaces as shown below.

ASI interface
Actuator and sensor Interface



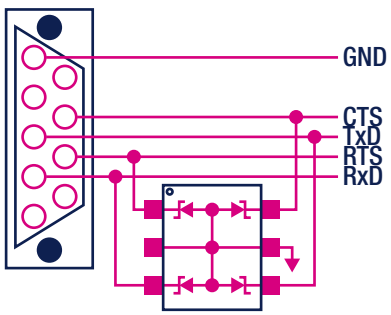
SMM4F33A
ESD with ± 30 kV contact

Seriplex interface



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

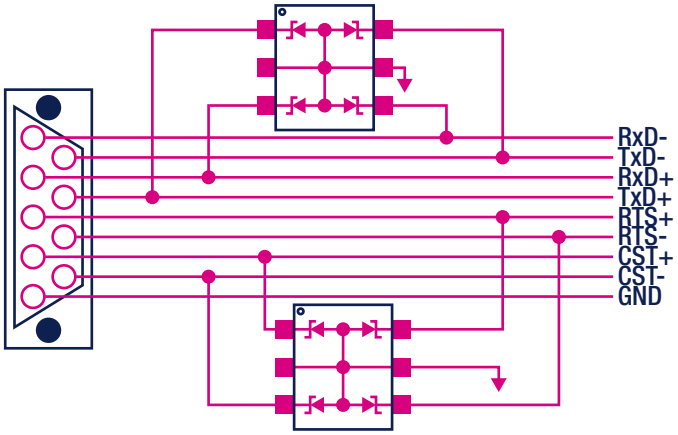
RS-232 interface
Modbus®



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

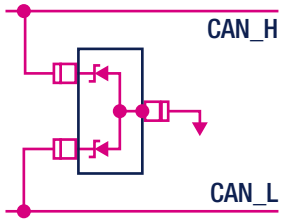
SOT23 package

SOT666 package

SO-8 package

CAN interface

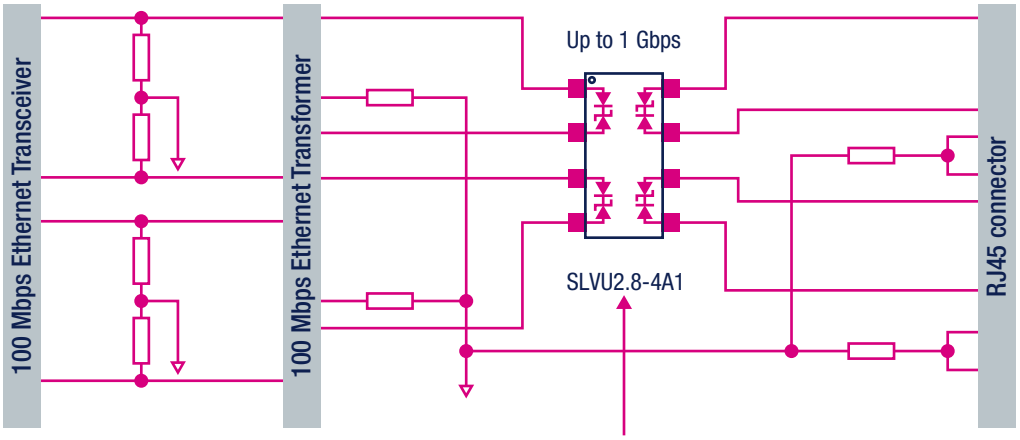
CANopen, DeviceNet™



ESDA6V1L/ESDALC6V1

ESD protection in SOT666/23

Ethernet protection



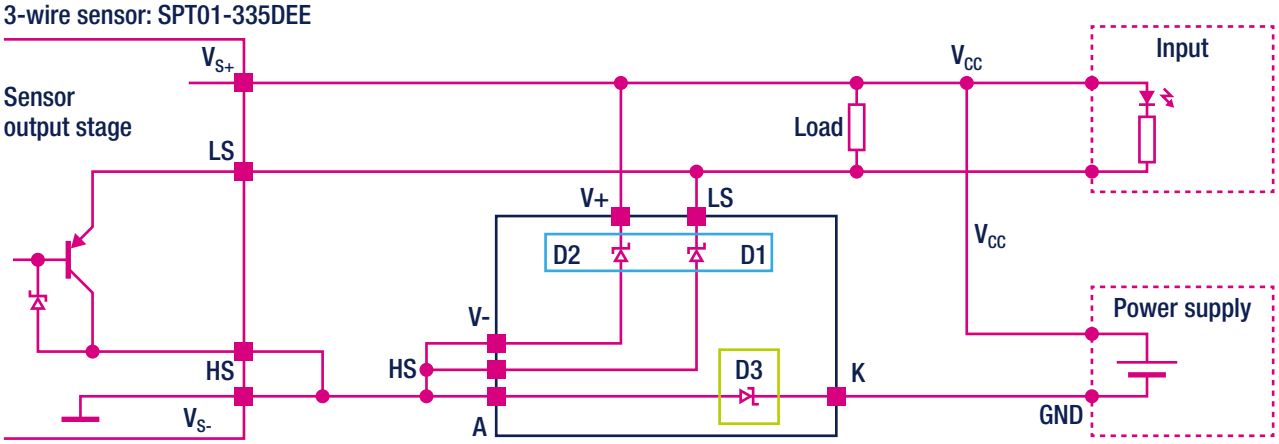
SLVU2.8 or DSL01

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

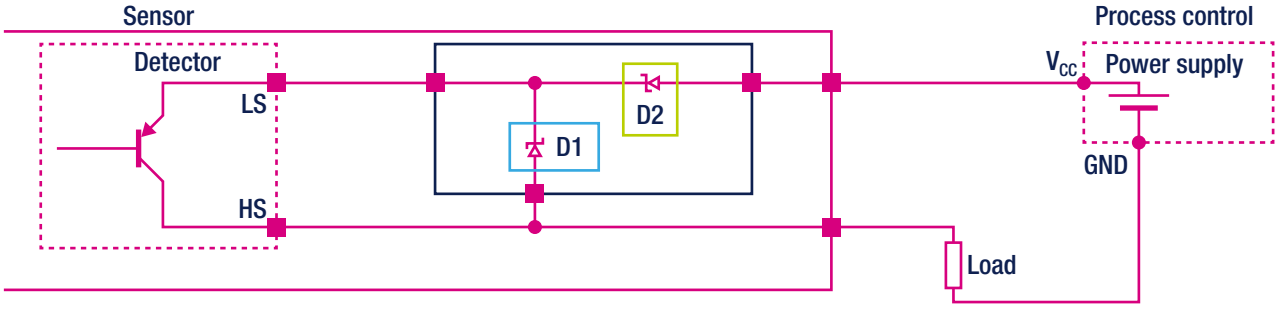
PROXIMITY SENSOR PROTECTION

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



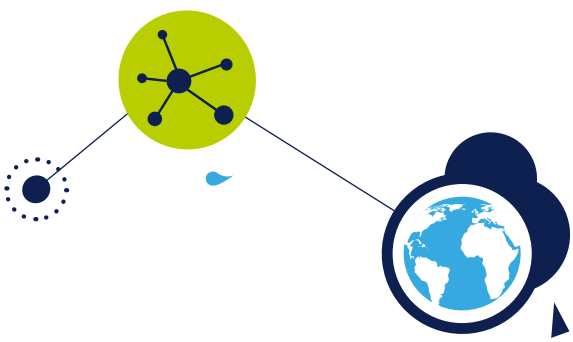
2 FEATURES:

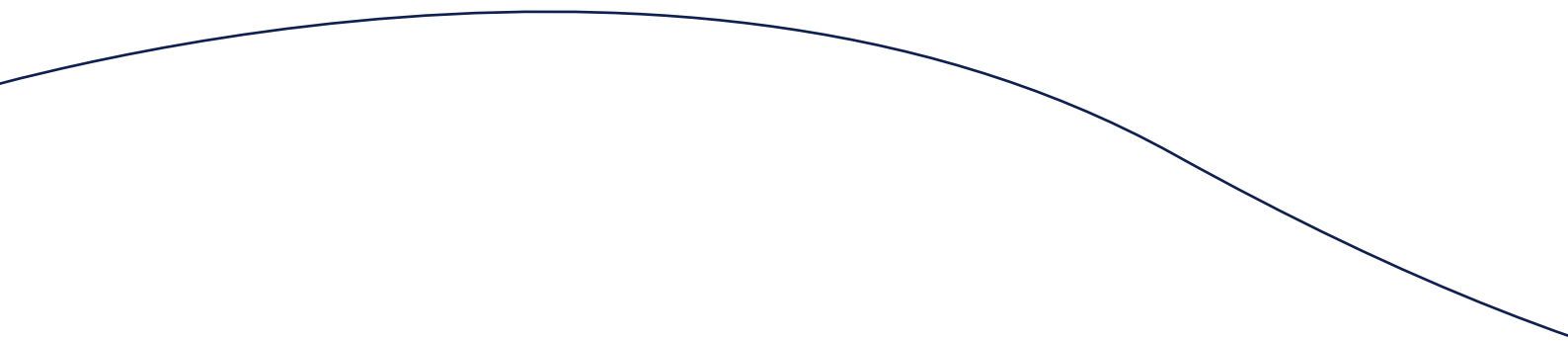
- Surge protection
- Reverse battery protection

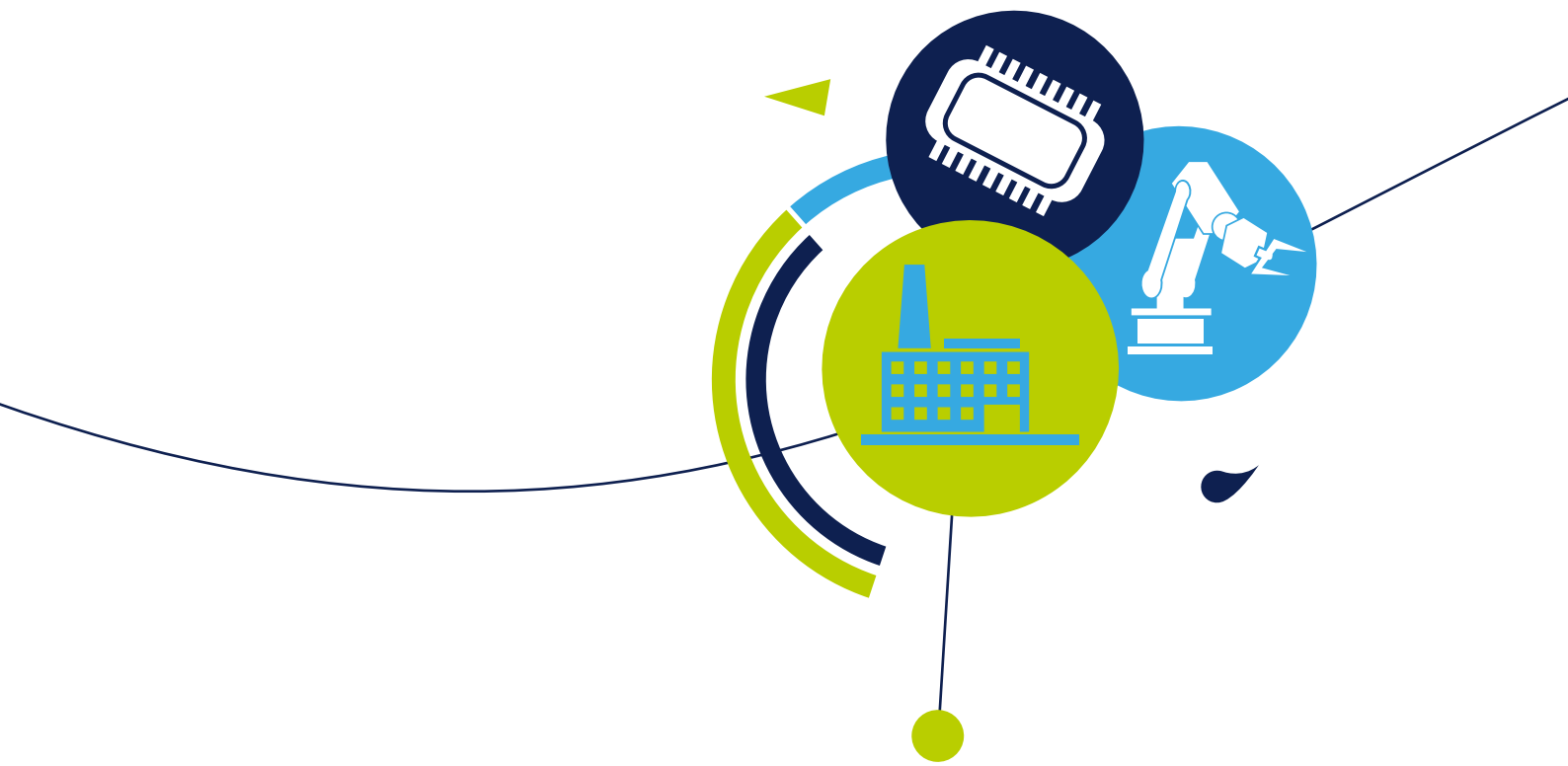
FACTORY AUTOMATION NEEDS:

- 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.







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