

# Power management Guide



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# Introduction



More than 30 years of technology innovation in power management directly resulting in value creation for our customers, from products to system solutions

When designing a power management system or sub-system, regardless of whether it is an energy generation or distribution system, a power supply or a LED driving circuit, an industrial SMPS or an electric vehicle power application, it must provide high efficiency and low standby power, as well as high power density, reliability and safety, while respecting specific cost constraints.

The key enablers for any such system are discrete and integrated power semiconductors, which play a crucial role in every step along the energy supply chain and, when applied in conjunction with advanced control technologies, can drive continuous improvement in energy savings for homeowners and communities, and ultimately for the entire planet.

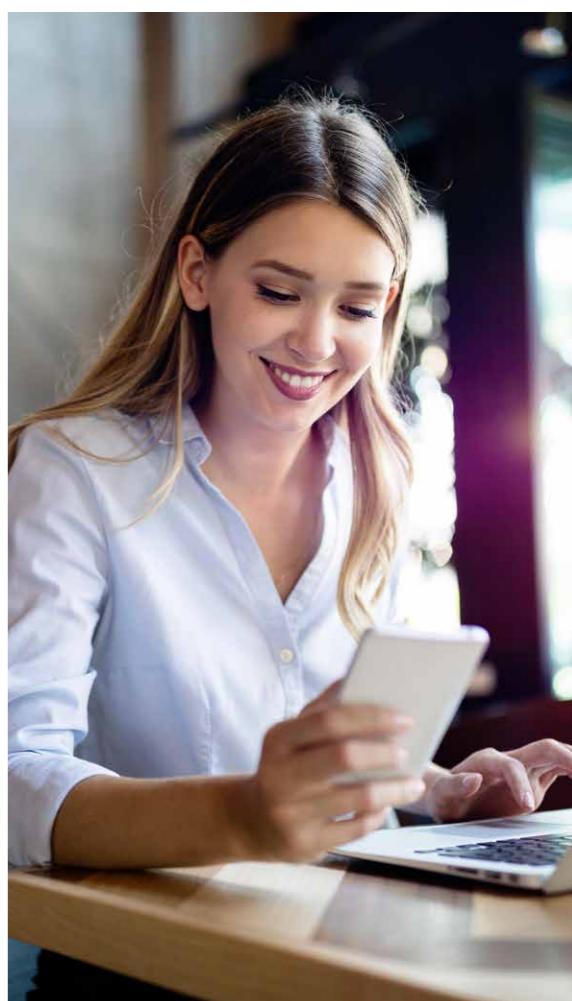
The technological innovation, which persists at the core of ST strategy for more than 30 years, is the reason why ST today can offer an extensive range of cutting-edge products for power and energy management. ST portfolio includes higher-efficiency power technologies such as:

- Silicon carbide power discretes
- GaN Power ICs
- HV and LV power MOSFET and IGBTs
- Customized power modules
- Diodes and Thyristors
- Protection devices and Filters
- AC-DC converters and controllers
- DC-DC converters
- Linear voltage regulators
- Analog ICs
- Battery management ICs
- STM32 microcontrollers
- MOSFET and IGBT gate drivers

Moreover, ST offers a variety of wireless and wired connectivity ICs as well as high-performance sensors to complement the latest smart power electronics applications with additional sensor-driven features and monitoring functions.

ST is also committed to the development of GaN power devices, which represent a major step forward in power electronics by providing high-frequency operation with increased efficiency and higher power density than silicon-based transistors.

Additionally, we provide a comprehensive range of reference designs and hardware and software evaluation and development tools, including the eDesignSuite tool that helps engineers design and optimize their high-efficiency power solutions.



# Applications

## ENERGY GENERATION AND DISTRIBUTION

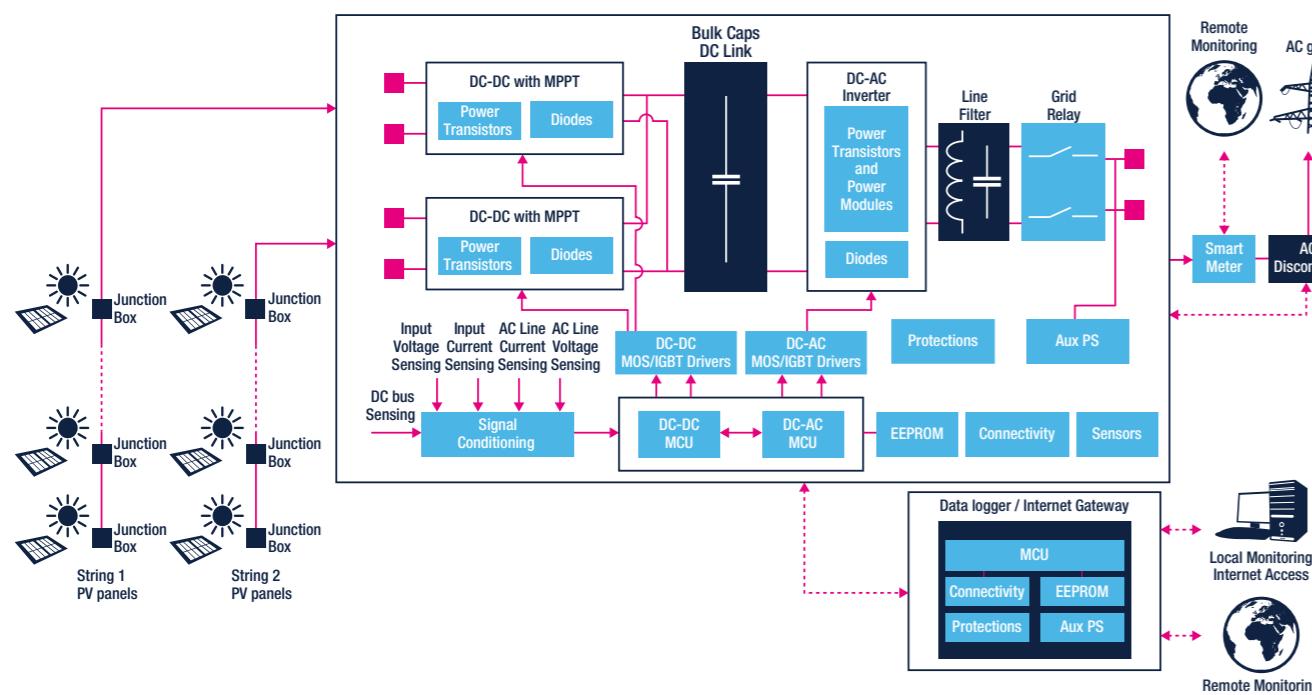
### Solar Centralized Generation - Solar Inverters (String and Central)

String and central inverters are the most common power conversion systems used for grid-connected solar applications. They comprise a DC-DC conversion stage to adapt voltage levels and implement the Maximum Power Point tracking (MPPT) function to maximize energy transfer from the panel, and a DC-AC conversion stage to correctly shape current and voltage waveforms transferred to the AC grid. The inverter has an anti-islanding function that guarantees safety in case of AC disconnection. With power ranging from a few kilowatts for string and multi-string inverters to tens or hundreds of kilowatts for central inverter solutions, the trend is to use topologies with very high input voltages (up to 1500 V).

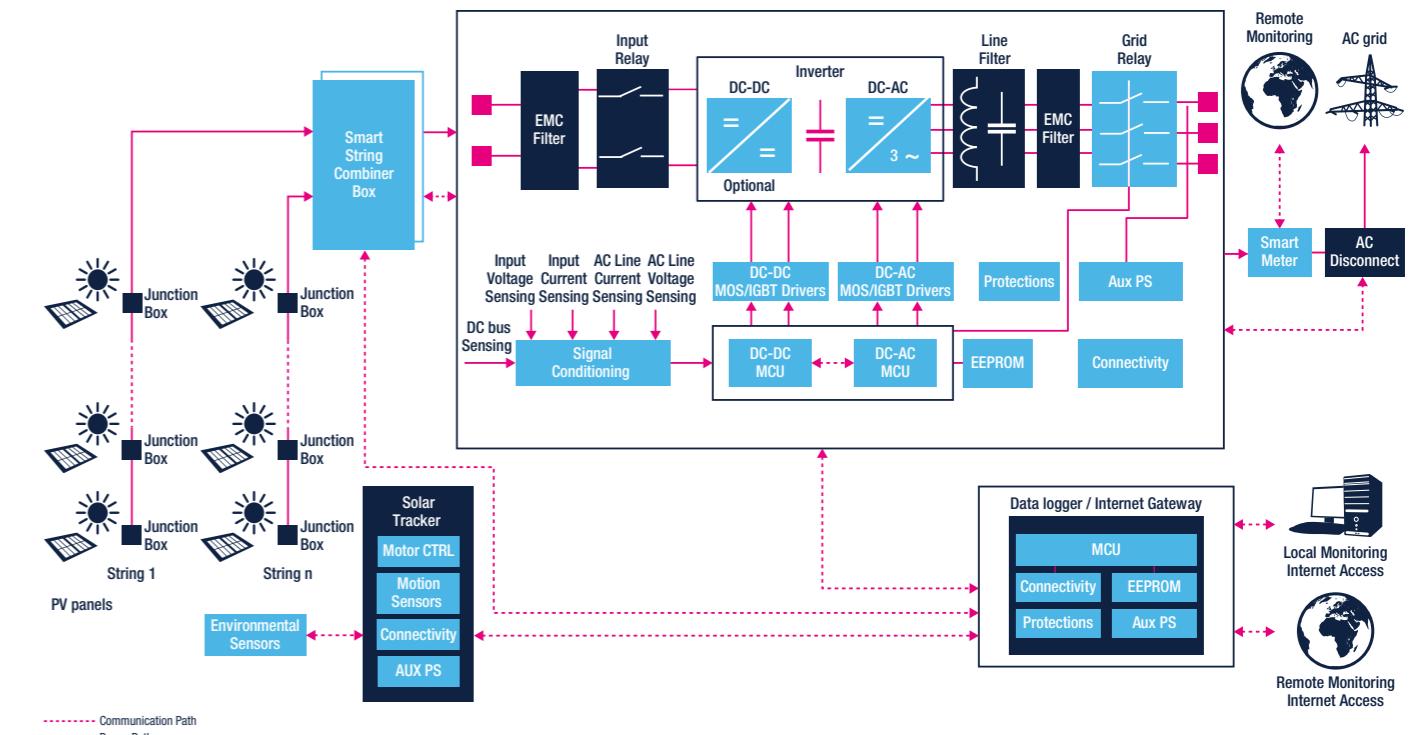


We offer a broad range of silicon-carbide (SiC) power MOSFETs - with the industry's highest operating junction temperature of 200°C - and trench-gate field-stop IGBTs, which are also integrated in our high-efficiency ACEPACK power modules. Together with galvanically-isolated gate drivers and high-performance STM32 microcontrollers, our solutions enable engineers to design high-efficiency string and central inverters. In addition, we have a range of wireless and wired connectivity solutions.

### Typical Block Diagram for String Inverter



### Typical Block Diagram for Central Inverter



### ST product offering for String and Central Solar Inverter

	Power MOSFETs	IGBTs	Power Modules	Diodes & Discretes
Inverter Power Stage DC-DC and DC-AC	600 V MDmesh DM9 ST*60N*DM9 600 V-650 V MDmesh DM6 ST*60DM6, ST*65DM6 600 V-650 V MDmesh DM2 ST*60DM2, ST*65DM2 650 V MDmesh M9 ST*65N*M9 650 V MDmesh M5 ST*65M5 1200 V MDmesh K5 ST*N120K5 650 V - 1200 V - 1700V SiC MOSFETs SCT*65G3AG, SCT*N65G2, SCT*120G3AG, SCT*N120G2, SCT*N120, SCT*N170	600 V V series STG*V60DF 650 V HB series STG*H65DFB 650 V HB2 series STG*H65DFB2 1200 V H series STG*H120DF2 1200 V M series STG*M120DF3	ACEPACK Power Modules A1P50S65M2 A1P25S12M3 A1P35S12M3 A2P75S12M3 A2F12M12W2-F1 A1F25M12W2-F1 <sup>1</sup> A2U12M12W2-F2	600 V Ultrafast STTH*06 STTH*R06 1200 V Ultrafast STTH*12 100 V Power Schottky STPS*100 SiC Diodes STPSC*065 STPSC*H12 TVS for Power MOSFET & IGBT Protection SMA4F, SMA6F, SMB15F series
Inverter Driving & Control stage	MCUs STM32F334 STM32G4 STM32H7 STM32F3 STM32F4 STM32F7	MOSFET and IGBT Gate Drivers HV HB Gate Drivers L649* Isolated Gate Drivers STGAP* Multiple LS Gate Drivers PM8834 LDO L78xx, LD1117, LD39200, ST730/2	Protections TVS for Power Rail Surge Protection SMAJ, SM6T, SM15T, SMC30J series ESD and High Speed Port series for Ethernet and USB Protection	Zigbee, Thread STM32WB Bluetooth Low Energy BlueNRG, STM32WB Power Line Transceivers ST8500, ST7580 RS-422 and RS-485 ST3485*, STR485* Isolated Interfaces for wired connectivity STIS062x
Data Logger/Internet Gateway	MCUs STM32F0 STM32G0 STM32F1 STM32F3	EEPROM	Protections Standard Serial EEPROM	ESD and High Speed Port series for Ethernet and USB Protection
Solar Tracker	Motor CTRL 3-phase Field Oriented Control (FOC)	Motion Sensors Accelerometer IIS3DHHC, IIS2DH, IIS2ICLX Magnetometer-IIS2MDC eCompass-ISM303DAC 6 axis IMU-ISM330DLC , ISM330DHGX	Environmental Sensors Pressure - LPS22HH Pressure water proof - LPS33W Temperature - STTS22H Humidity - HTS221	Bluetooth Low Energy BlueNRG, STM32WB

Note: \* is used as a wildcard character for related part number

1 samples available in Q4 2022

## Solar Distributed Generation - Microinverter

In residential photovoltaic systems, Microinverters are often used as an alternative to string inverters to perform DC to AC power conversion at the panel level, helping maximize energy yield and mitigate problems related to partial shading, dirt, or single panel failures. A microinverter consists of a DC-DC converter implementing maximum power point tracking MPPT, and a DC-AC inverter to shape current and voltage for injection into the AC grid. Data (including voltage, current and power generated) from all the microinverters in the installation are collected by a concentrator and dispatched to a local or remote monitoring and control access point.

Our solution includes MDmesh and STripFET power MOSFETs, high-voltage, galvanically isolated gate drivers, high-voltage silicon carbide (SiC) diodes, together with high-performance STM32 microcontrollers featuring dedicated peripherals to help implement complex power conversion control algorithms. A range of wireless and wired connectivity solutions including multi-standard power line modems complete the solution.

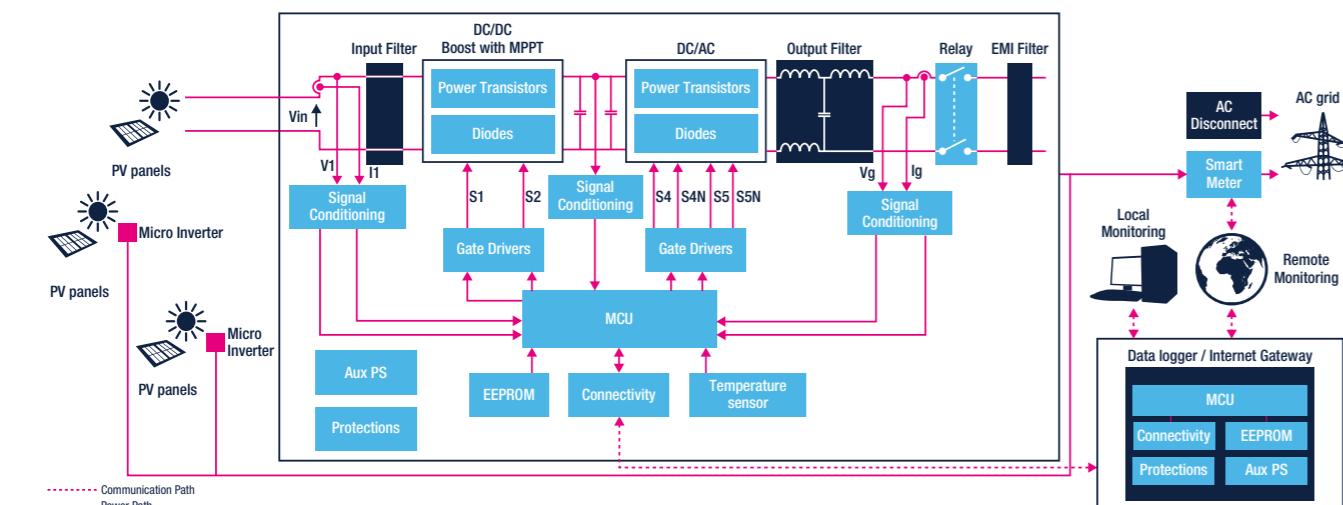
## ST product offering for Microinverter

	Power MOSFETs	Diodes	Protections	Signal Conditioning
Microinverter Power Stage	60 V-100 V STripFET F7 ST*N6F7, ST*N8F7, ST*N10F7 600 V MDmesh DM9 ST*60N*DM9 600 V-650 V MDmesh DM6 ST*60DM6, ST*65DM6 600 V-650 V MDmesh DM2 ST*60DM2, ST*65DM2 650 V MDmesh M9 ST*65N*M9 600 V MDmesh M6 ST*60M6 650 V MDmesh M5 ST*65M5 800 V MDmesh K6 ST*80*K6 800 V-900 V MDmesh K5 ST*80K5, ST*90K5 650 V SiC MOSFETs SCT*65G3AG, SCT*N65G2	600 V Ultrafast STTH*RO6 1200 V Ultrafast STTH*S12 100 V Power Schottky STPS*100 SiC Diodes STPSC*065 STPSC*H12	TVS for Power MOSFET and Power Rail Surge Protection SMAJ, SM6T, SM15T series <b>Thyristors SCRs &amp; Triacs</b> Thyristors SCRs & Triacs for Grid Relay TN815-800B, TN1515-600B, T1635H-8G, T2550-12G	Precision Op Amps (<50 MHz) TSZ*, TSV*, TS9*, LMV* Current Sensing TSC*
Microinverter Driving & Control stage	MCUs STM32F334 STM32G4 STM32H7 STM32F3 STM32F4 STM32F7	MOSFET and IGBT Gate Drivers HV HB Gate Drivers L638*, L639*, L649* Isolated Gate Drivers STGAP* Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1	Sensors Pressure - LPS22HH Pressure water proof - LPS33W Temperature - STTS22H Humidity - HTS221 <b>Protections</b> TVS for Power Rail Surge Protection SMAJ, SM6T, SM15T, SMC30J series	EEPROM Standard Serial EEPROM
Data Logger/Internet Gateway	STM32F0 STM32G0	Standard Serial EEPROM	ESD and High Speed Port (HSP) series for Dataline ESD and EOS Protection RS-422, RS-485 and RS-232 ST3485*, STR485*, ST3232* Isolated Interfaces for wired connectivity STIS062x	Protections ESD and High Speed Port series for Dataline ESD and EOS Protection

Note: \* is used as a wildcard character for related part number

1 for Data Logger/Internet Gateway only

## Typical Block Diagram



## Solar Distributed Generation - Power Optimizer

In architectures based on the use of power optimizers, the maximum power point tracking (MPPT) function is performed at the level of photovoltaic panels, individually operating each one at its optimal I-V point which ensures maximum power generation. This results in an improved energy yield of the overall solar system compared to traditional string or central inverter based architectures.

Power optimizers can help minimize system design constraints as well as improve reliability and safety by helping ensure compliance with the latest NEC 2017 regulations that require rapid shut-down in the event of grid disconnection, while reducing maintenance costs.

We provide high-performance STM32 microcontrollers and high-efficiency STripFET F7 LV Power MOSFETs, Diodes, SiC MOSFETs and trench gate field-stop IGBTs, galvanically-isolated gate drivers, and power line communication solutions to help achieve superior efficiency and reliability for power optimizer based architectures.

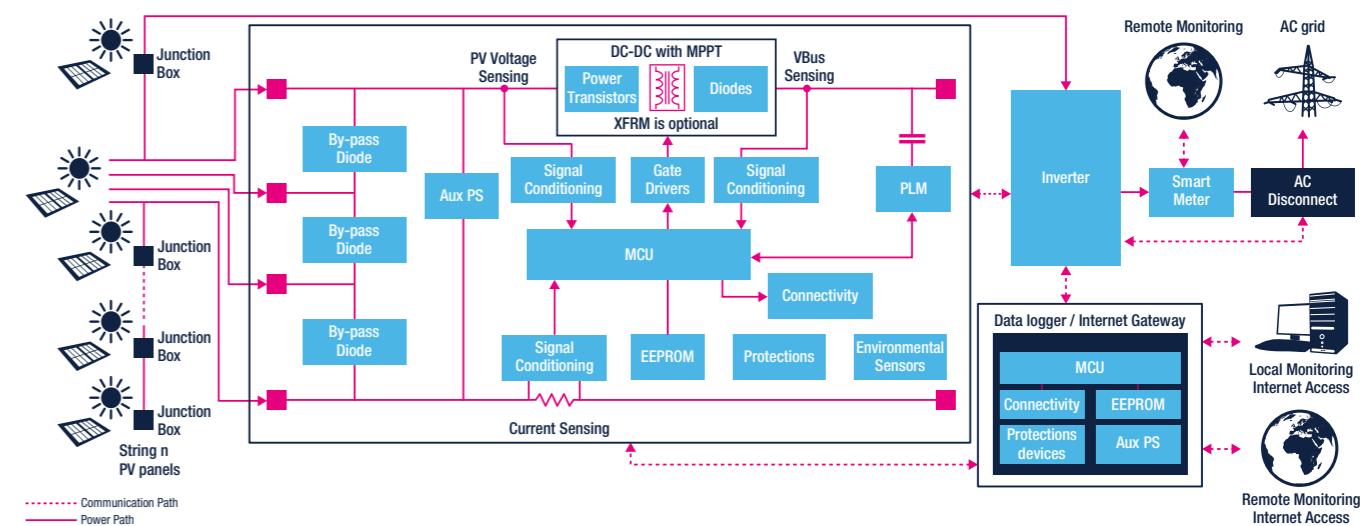
## ST product offering for Power Optimizer

	MCUs	Power MOSFETs	Gate Drivers	By Pass Diodes	Diodes	Protections	Signal Conditioning
Power Optimizer	STM32F334 STM32F0 STM32G0 STM32F3 STM32F4 STM32G4	60 V to 100 V STripFET F7 ST*N6F7 ST*60M6 ST*65M6 600 V-1200 V SiC MOSFETs STM32H7 STM32F3 STM32F4 STM32F7	HV HB Gate Drivers L638*, L639*, L649* Isolated Gate Drivers STGAP* Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1	30 V to 45 V Power Schottky STPS*30 STPS*45 45 V FERD FERD*45	100 V to 200 V Power Schottky STPS*100 STPS*200 100 V FERD FERD*100	TVS for Power MOSFET & IGBT Protection SMAJ, SM6T, SM15T, SMC30J series TVS for Power Rail Surge Protection SMAJ, SM6T, SM15T, SMC30J series ESD Protection for I/O interfaces	Precision Op Amps (<50 MHz) TSZ*, TSV*, TS9*, LMV* Current Sensing TSC* Connectivity
	MCUs	Power MOSFETs		IGBTs	Diodes		
Inverter	STM32F334 STM32G4 STM32H7 STM32F3 STM32F4 STM32F7	650 V - 1200V SiC MOSFETs STM32H7 STM32F3 STM32F4 STM32F7	Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1	600 V Ultrafast STTH*06 650 V HB series STG*H65DFB 650 V HB2 series STG*H65DFB2 1200 V H series STG*H120DF2 1200 V M series STG*H120DF3	600 V Ultrafast STTH*06 650 V HB series STG*H65DFB 650 V HB2 series STG*H65DFB2 1200 V H series STG*H120DF2 1200 V M series STG*H120DF3	ESD and High Speed Port series for Dataline ESD and EOS Protection	Zigbee, Thread STM32WB <sup>1</sup> Bluetooth Low Energy BlueNRG STM32WB Power Line Transceivers ST8500, ST7580 Isolated Interfaces for wired connectivity STIS062x
	MCUs	EEPROM					
Data Logger/Internet Gateway	STM32F0 STM32G0	Standard Serial EEPROM					

Note: \* is used as a wildcard character for related part number

1 for Data Logger/Internet Gateway only

## Typical Block Diagram



## Energy Distribution - Home & Commercial Battery Storage Systems

The adoption of energy storage devices, whose reserve capacity can be used for balancing purposes, peak-load shaving, or to shift loads, is increasingly widespread in energy distribution networks.

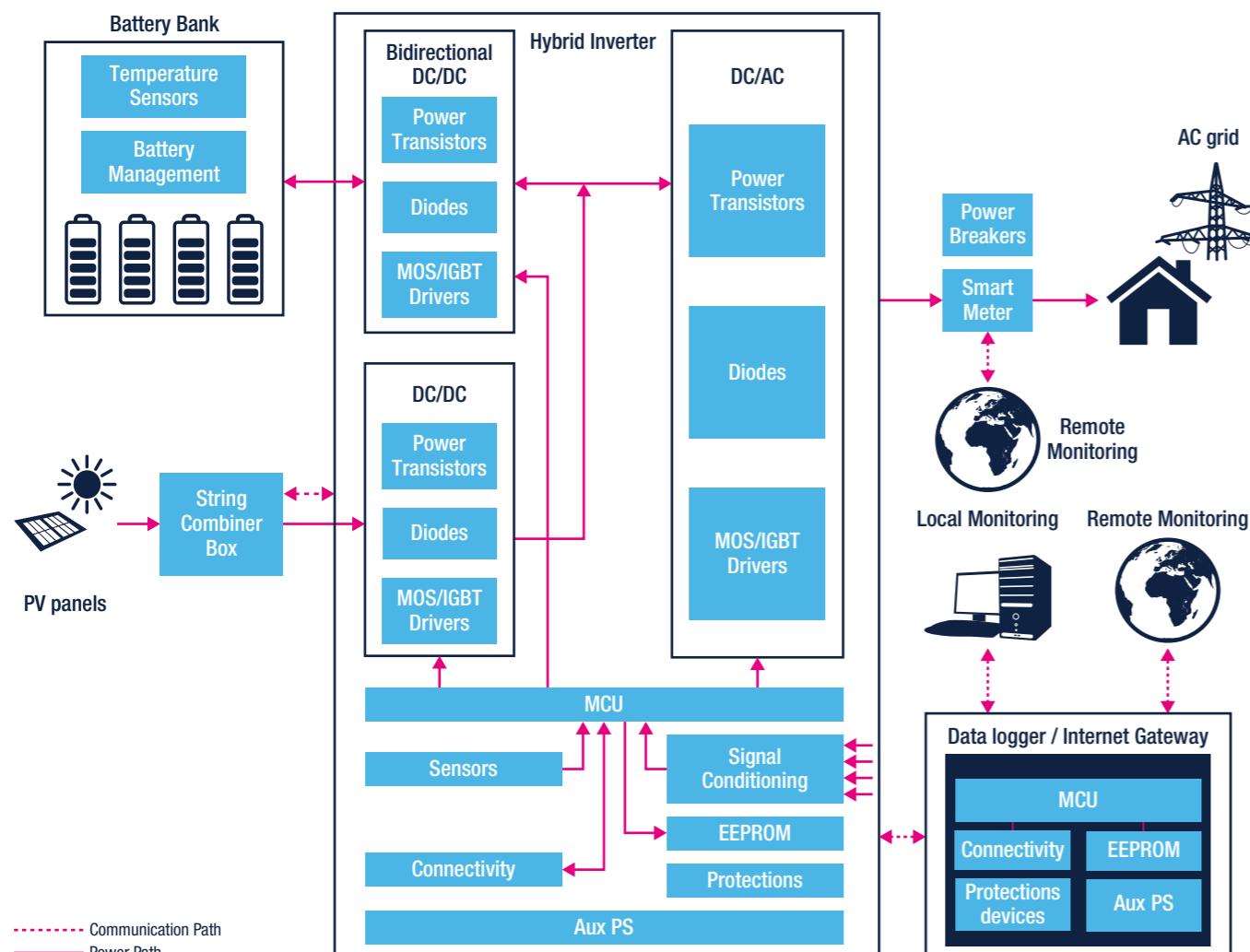
Two use cases are particularly important: in residential or commercial buildings to help reduce consumer electricity bills by reducing energy consumption from the grid during peak hours, and to help avoid problems with stability and voltage drop associated with the fast-charging requirements of an increasing number of electric vehicles (EV).

By interacting with the grid, batteries, and potentially solar panels, power converters at the heart of these systems must operate with high-efficiency and superior reliability over time.

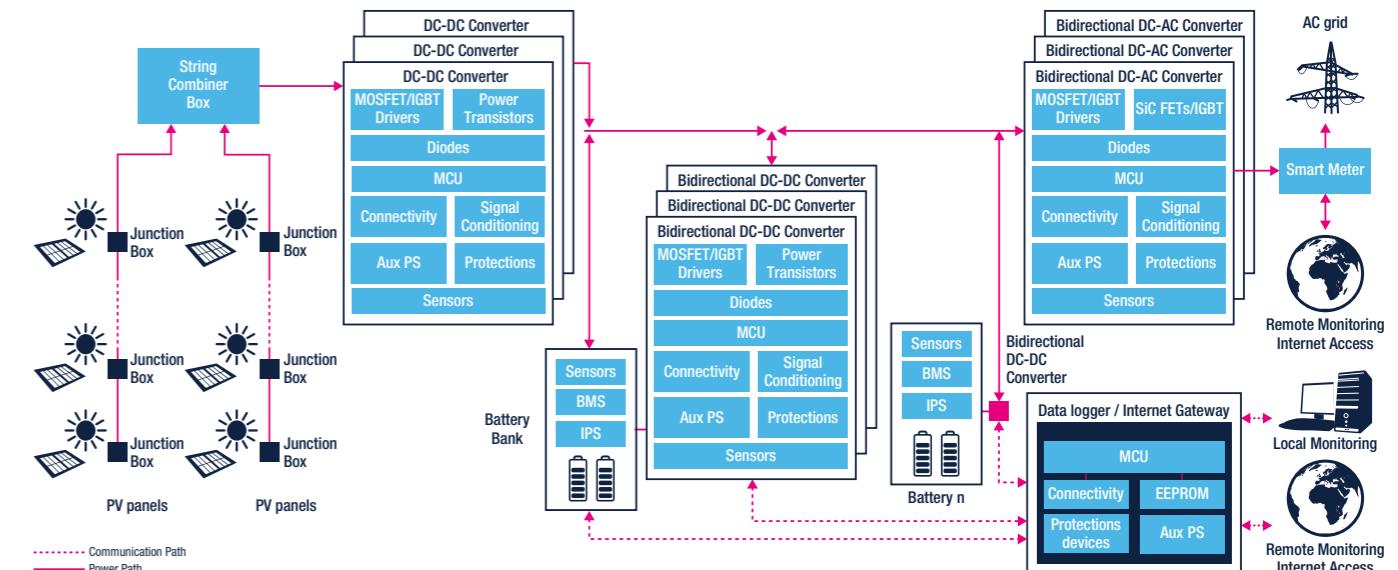
We provide a range of power discretes, including silicon carbide (SiC) and silicon power transistors, ACEPACK power modules, silicon carbide and silicon diodes, isolated gate drivers and high-performance STM32 microcontrollers, as well as energy metering ICs for high-efficiency commercial battery storage systems.



### Typical Block Diagram - Home Battery Storage System



## Typical Block Diagram - Commercial Battery Storage System



## ST product offering for Home & Commercial Battery Storage Systems

	Power MOSFETs	IGBTs	Power Modules	MOSFET and IGBT Gate Drivers	Diodes & Discretes
<b>DC-DC Converter &amp; Bidirectional DC-DC Converter</b>	40 V-100 V STripFET F7 <sup>1</sup> ST*N4F7, ST*N6F7, ST*N8F7, ST*N10F7 600 V MDmesh DM9 ST*60N*DM9 600 V-650 V MDmesh DM6 ST*60DM6, ST*65DM6 600 V-650 V MDmesh DM2 ST*60DM2, ST*65DM2 650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2 800 V MDmesh K6 ST*80*K6 800 V to 1200 V MDmesh K5 ST*80K5, ST*9*K5 ST*105K5, ST*120K5 650 V to 1700 V SiC MOSFETs SCT*65G3AG, , SCT*N65G2, SCT*120G3AG, SCT*N120G2, SCT*N120, SCT*N170		ACEPACK Power Modules A1P50S65M2 A1P25S12M3 A1P35S12M3 A2P75S12M3 A2F12M12W2-F1 A1F25M12W2-F1 <sup>3</sup> A2U12M12W2F1	HV HB Gate Drivers L649* Isolated Gate Drivers STGAP* Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1	600 V Ultrafast STTH*06 STTH*06 800 V to 1200 V Ultrafast STTH*08 STTH*10 STTH*12 SiC Diodes STPSC*065 STPSC*H12 TVS for Power MOSFET & IGBT Protection and for Power Rail Surge Protection SMA4F, SMA6F, SMB15F, series
<b>Power Stage</b>	600 V V series STG*V60DF 650 V HB series STG*H65DFB 650 V HB2 series STG*H65DFB2 650 V M series STG*M65DF2 800 V MDmesh K6 ST*80*K6 800 V to 1200 V MDmesh K5 ST*80K5, ST*9*K5 ST*105K5, ST*120K5 1200 V H series STG*H120DF2 1200 V M series STG*M120DF3	Thyristors SCRs	Thyristors SCRs for Power Breakers TS110-8 X0115	LDO LD1117xx, ST730/2, L78xx DC-DC Converters L6983, L6982, L6981	
<b>DC-AC Converter</b>					
<b>Power Stage</b>					
<b>System Control Stage</b>	MCUs STM32F334 STM32G4 STM32H7 STM32F3 STM32F4 STM32F7	Signal Conditioning Precision Op Amps (<50 MHz) TSZ*, TSV*, TS9*, LMV*	EEPROM Standard Serial EEPROM Protections Precision Op Amps (<50 MHz) TSZ*, TSV*, TS9*, LMV*	Sensors Pressure - LPS22HH Pressure water proof - LPS33W Temperature - STTS22H Humidity - HTS221 BMS L9961, L9963E, L9963T IPS IPS2050H, IPS2050H-32, IPS1025H, IPS1025H-32, IPS4260L	Connectivity Power Line Transceivers ST8500, ST7580 RS-485 and RS-232 STR485*, ST3232* Isolated Interfaces for wired connectivity STIS062x
<b>Data Logger/Internet Gateway</b>	MCUs STM32F0 STM32G0 STM32F1 STM32F3	Protections ESD and High Speed Port series for Dataline ESD and EOS Protection	EEPROM Standard Serial EEPROM	Connectivity Power Line Transceivers ST8500, ST7580 Bluetooth Low Energy BlueNRG, STM32WB RS-485 and RS-232 STR485*, ST3232* Sub-1GHz RF Transceivers <sup>2</sup> S2-LP, SPIRIT1 Sub-1GHz Wireless MCU <sup>3</sup> STM32WL Zigbee, Thread, STM32WB Isolated Interfaces for wired connectivity STIS062x	

Note: \* is used as a wildcard character for related part number

1 only for bidirectional dc-dc converter

2 only for commercial battery storage systems

3 samples available in Q4 2022

## POWER SUPPLIES

### Auxiliary SMPS

Appliances and equipment often require a switch-mode power supply (SMPS) that works separately from the main power supply to support auxiliary functions like standby operation. Power ratings can vary from a few watts to tens of watts for these auxiliary supplies, which can be either isolated or non-isolated. To ensure good performance, engineers must choose the power topology including fixed frequency or quasi-resonant flyback, that best meets the efficiency, size, safety, and cost requirements. ST offers a wide portfolio of highly-integrated high-voltage converters for applications up to 100 W, with an extremely low total standby consumption (down to less than 4 mW) and breakdown voltages as high as 1050 V. In addition to PWM switching controllers, power MOSFETs, and diodes, we offer an extensive set of evaluation and development tools, as well as reference designs to help engineers develop high-efficiency and compact auxiliary power supply solutions.

### Isolated Auxiliary SMPS

ST helps the designers of high-power-density and cost-effective isolated auxiliary power supplies with higher switching frequency solutions to minimize transformer and output capacitor size.

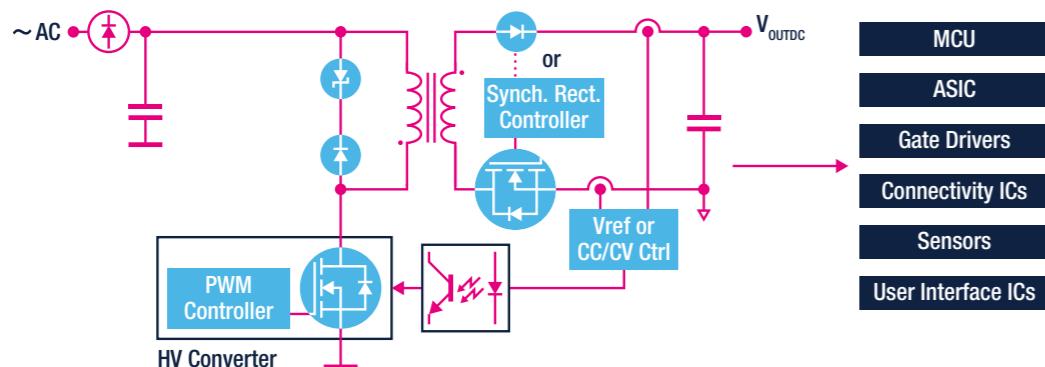
In the 20 to 100 W power range, the need to meet increasingly tight efficiency and standby requirements for auxiliary power supplies has pushed the use of quasi-resonant topologies in place of more mainstream fixed-frequency-based designs. The power stage is managed by a high-voltage converter.

### ST recommended products for Isolated Auxiliary SMPS

		HV converters		Offline controllers	HV Power MOSFETs	MOSFET Protection	Voltage Ref CC/CV Ctrl	Output diodes	Synch Rect	LDO
Isolated flyback	PSR-CV			HVLED001*	800 V MDmesh K6 ST*80*K6 800 V to 1700 V MDmesh K5 ST*80K5, ST*9K5, ST*105K5, ST*120K5, ST*150K5, ST*12N170K5 650 V MDmesh M9 ST65N*M9	Power MOSFET Protection SMAJ, SM6T, SM15T series Reverse blocking diodes 600 V Ultrafast T*431 T*432	Schottky, FERD STPS*	SR Controllers SRK1000*, SRK1001 LV Power MOSFETs 40 V-100 V STripFET F7 ST*N4F7, ST*N6F7, ST*N8F7, ST*N10F7	Low Dropout (LDO) Linear Regulators LDF LDFM LDK220 LDK320 LDL212 ST730 ST732	
	Regulation with optocoupler	VIPer*5 VIPer*7 VIPer*8 VIPerGaN50 VIPerGaN65 VIPerGaN100	VIPerOP VIPer*1 VIPer*6 VIPer122 VIPer222 ALTAIR*		STCH03 L6566B L6566BH L6565 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V MDmesh DM9 ST60N*DM9 650 V SiC MOSFETs SCT*65G3AG, SCT*N65G2	Voltage and Current Ctrl TSM*, SEA05*				

Note: \* is used as a wildcard character for related part number

### Typical configuration for Isolated Auxiliary Power Supply up to 100 W



### Main application boards and reference designs



**STEVAL-VP26K01F**

Three outputs, isolated SSR flyback converter with extended input voltage range for Smart Meter and Power Line Communication



**STEVAL-VP318L1F**

15 V/1.2 A Isolated SSR Flyback converter



**EVAL-STCH03-45W**

45 W/12 V QR flyback with adaptive synchronous rectification



**EVLVIPGAN50FL**

15 V - 50 W QR flyback

### Non-Isolated Auxiliary SMPS

In a number of applications, the reference of the secondary circuit is connected to the same reference as the primary; that is, the AC mains. In such cases, an off-line non-isolated auxiliary power supply can be used to provide a regulated DC voltage using an inductor or low-cost transformer, with simplified isolation, as an energy transfer element by modulating the power supply's duty-cycle.

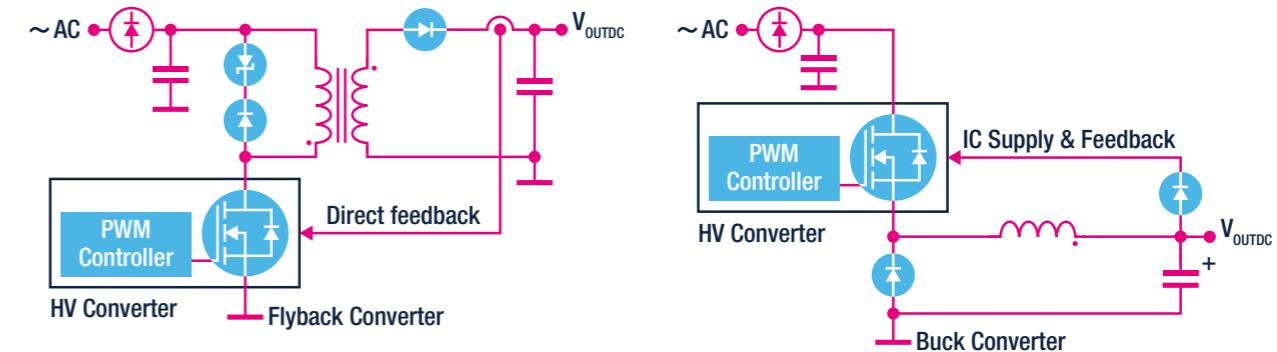
A buck (step-down) topology can be used to generate a positive output with respect to the common terminal and a buck-boost when the output voltage needs to be negative. A non-isolated flyback converter is the alternative when a higher output power is required.

### ST recommended products for Non-Isolated Auxiliary SMPS

	HV converters	ViPer Protection	Reverse blocking diodes	Output diodes	LDO
Buck				600 V Ultrafast STTH*06 800 V to 1200 V Ultrafast STTH*08 STTH*10	
Buck-boost					Low Dropout (LDO) Linear Regulators LDF, LDFM, LDK220, LDK320, LDL212, ST730, ST732
Non-isolated flyback	VIPerOP VIPer*1 VIPer*6 VIPer122 VIPer222	SMAJ, SM6T, SM15T series	600 V Ultrafast STTH*06 800 V to 1200 V Ultrafast STTH*08 STTH*10 STTH*12	Schottky, FERD STPS* FERD*45, FERD*50, FERD*60, FER*100	

Note: \* is used as a wildcard character for related part number

### Typical configurations for Non-Isolated Auxiliary Power Supply



### Main application boards



**STEVAL-VP12201B**  
15 V/200 mA buck converter



**STEVAL-VP319X1B**  
5 V/600 mA buck converter



**STEVAL-VP22201B**  
5 V/0.36 A buck converter



**STEVAL-ISA196V1**  
5 V/1.2 A non-isolated flyback converter

## Smart Chargers and Adapters

### USB Type-C® PD Adapters and Quick Chargers

The new slim and reversible USB Type-C connector with USB Power Delivery (PD) feature provides up to 240 W (48 V, 5 A) enabling a faster and more efficient charging solution.

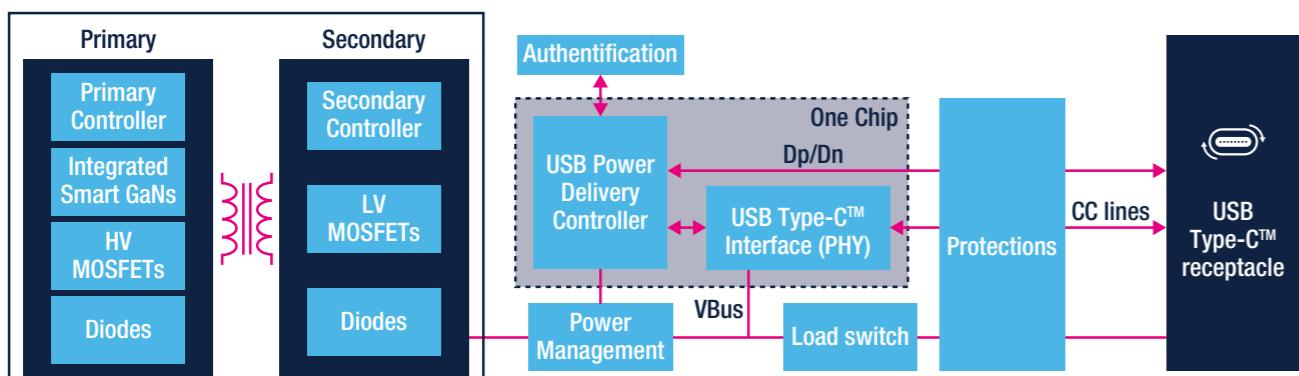
Designers of USB Type-C and Power Delivery compliant adapters and wall chargers can benefit from the ST-ONE, the world's most integrated digital controller, the MasterGaN series, an advanced power system-in package integrating a gate driver and two e-mode GaN transistors in half-bridge configuration, from standalone controllers, from STM32 microcontrollers and their associated protocol stack, as well as a specifically developed range of protection devices. Customers can also choose from the VIPerGaN series, which can provide up to 100 W power. The VIPerGaN HV converter series embeds an innovative and advanced quasi resonant PWM controller and a 650 V HEMT GaN-FET with highly efficient performance.

### ST recommended products for USB Type-C Power Delivery Smart Chargers and Adapters

Primary Controller	Power Stage Primary Side			Fully integrated controller	Power Stage Secondary Side			LDO/DC-DC		
	Integrated Smart GaNs	HV MOSFET	Diodes		Secondary Controller	LV MOSFET	Diodes			
PFC L656* Isolation Stage VIPerGaN50 VIPerGaN65 VIPerGaN100 STCH03 L6599*,L6699	MASTERGAN1 MASTERGAN2 MASTERGAN3 MASTERGAN4 MASTERGAN5	600 V-650 V MDmesh M6 ST*60M6, ST*65M6 650 V MDmesh M9 ST*65N*9 650 V MDmesh M5 ST*65M5	600 V Ultrafast for TM STTH*L06, STTH*06	ST-ONE	SR Analog Controllers SRK1000, SRK1001 for Flyback SRK2000A, SRK2001, SRK2001A for LLC	100 V STripFET F7 ST*N10F7	Output Diodes for Flyback Schottky STPS*, FERD FERD*45, FERD*50, FERD*60, FERD*100 Output Diodes for LLC Schottky STPS*, FERD FERD*45, FERD*50, FERD*60, FERD*100			
<b>Type-C and USB-PD Controllers</b>										
<b>Programmable Solutions</b>			Standalone Solutions	Vrm	High surge current compact protection (V <sub>BUS</sub> )	Single and multi lines protection for MCUs Communication Channel (CC) and Side Band Use (SBU)	Type C Port protection Over voltage protection for USB-C and PD 3.0 controllers	Load Switch		
Fully integrated controller	MCUs	Type-C Controller/interface		20 V	ESDA25P35-1U1M ESDA24P140-1U3M	ESDL20-1BF4 ESDA25W	TCPPO1-M12 TCPPO2-M18 TCPPO3-M20			
ST-ONE	STM32G0, STM32G4, STM32L5			15 V	ESDA17P100-1U2M ESDA15P50-1U1M	ESDA17P20-1U1M				
	STM32F0 STM32F3	STUSB1602A		9 V	ESDA13P70-1U1M					
				5 V	ESDA7P120-1U1M	ESDA6V1L ESD051-1F4				
							STELPD01			

Note: \* is used as a wildcard character for related part number

### Typical configuration



### Main application boards and reference designs



**EVALMASTERGAN\***  
High power density half-bridge high voltage driver with two 650 V enhanced mode GaN HEMT



**EVLOWNE65W**  
65 W USB Type-C Power Delivery reference design with integrated GaN



**EVLVIPGAN65PD**  
65 W ACF USB PD adapter reference design with GaN

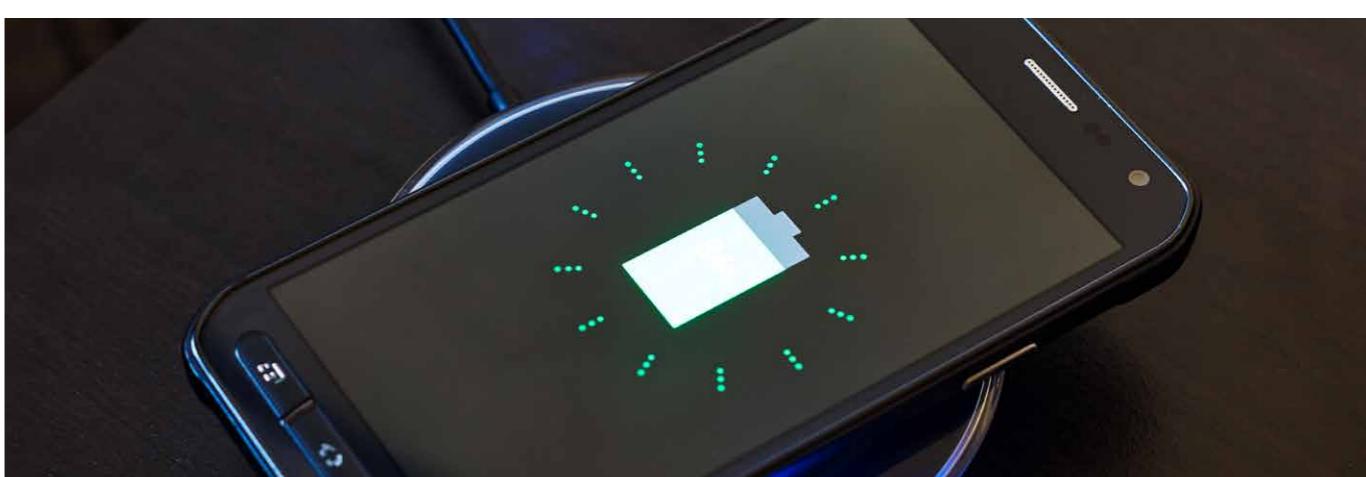
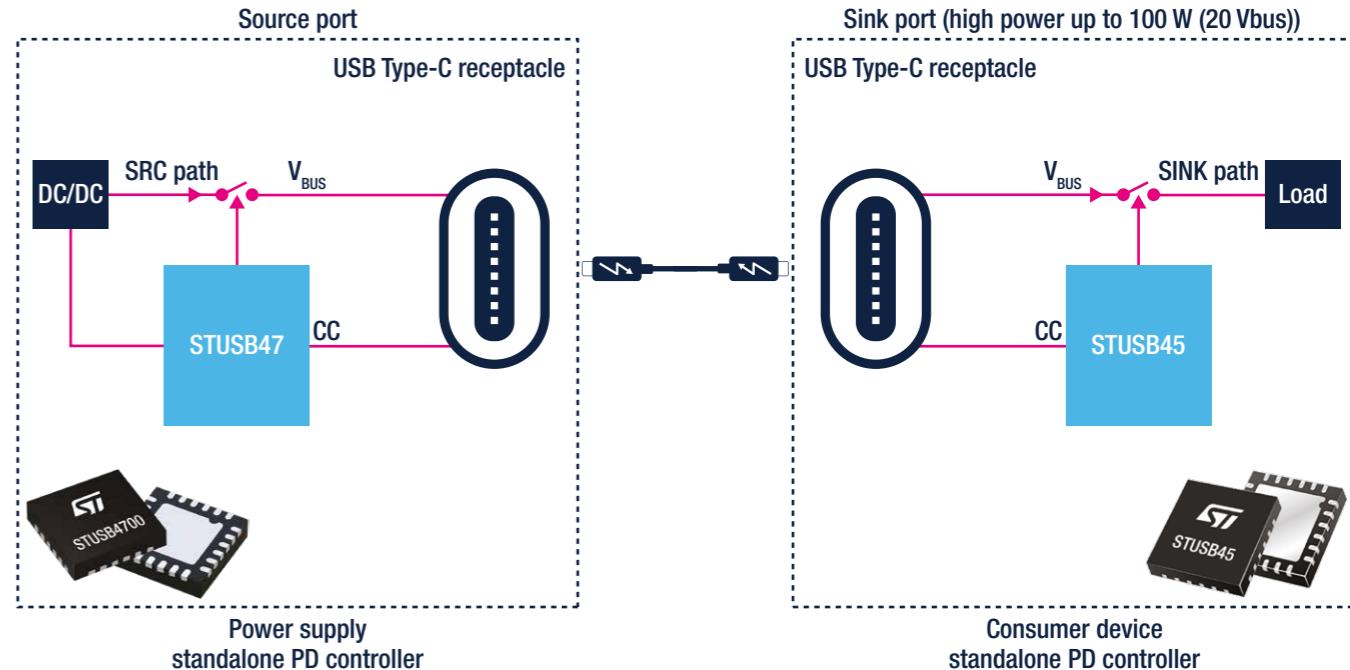


**STEVAL-USBDP27S**  
27 W USB Type-C Power Delivery 3.1 adapter with PPS feature



**STEVAL-2STPD01**  
USB Type-C Power Delivery dual port adapter

### Typical block diagram with Certified Source and Sink Standalone Controllers



### Main application boards and reference designs



**STEVAL-ISC004V1**  
STUSB4710A USB Power Delivery evaluation board (with on-board DC-DC)



**STEVAL-ISC005V1**  
STUSB4500 USB Power Delivery evaluation board



**EVAL-SCS001/2V1**  
SINK USB-PD reference design (EVAL-SCS001V1: migration from DC barrel)  
(EVAL-SCS002V1: migration from USB micro-B)



**X-NUCLEO-SRC1M1**  
USB Type-C™ Power Delivery Source expansion board based on TCPP02-M18



**X-NUCLEO-SNK1M1**  
USB Type-C™ Power Delivery SINK expansion board based on TCPP01-M12



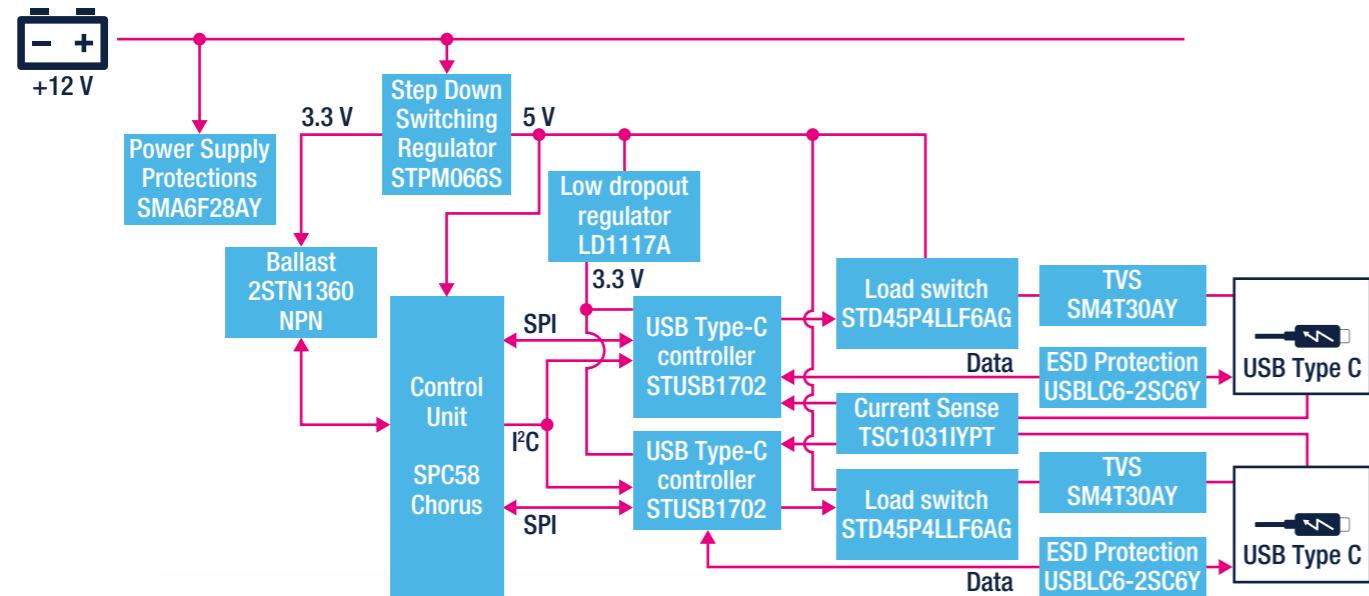
**X-NUCLEO-DRP1M1**  
USB Type-C Power Delivery Dual Role Power expansion board based on TCPP03-M20

## Automotive-grade USB Type-C and Power Delivery solution

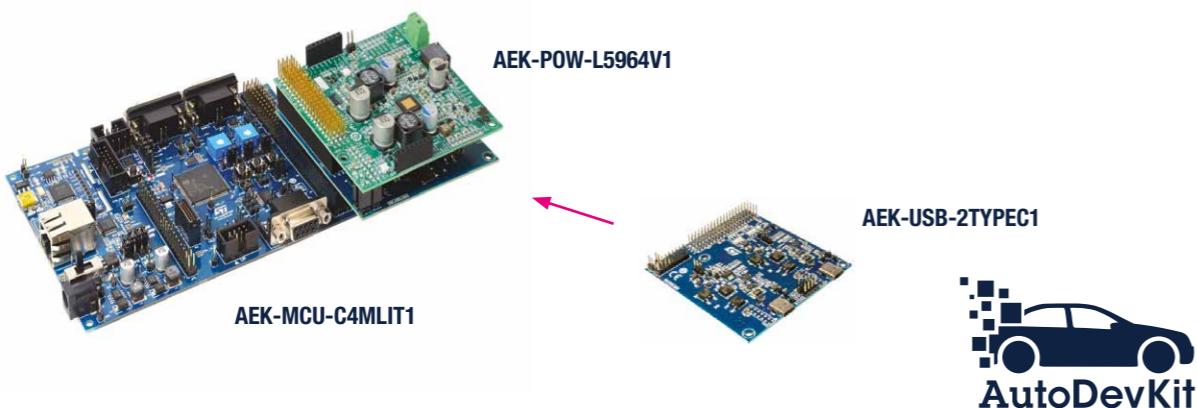
The USB Type-C and USB Power Delivery specifications allow smarter connectivity with fewer cables, less connectors and universal chargers.

The Type-C connector supports all the features of previous standards, and ports can be configured to only supply power in a Provider role, only sink power in a Consumer role, or be able to switch between both in a Dual role. Both data and power roles can be independently and dynamically swapped using the USB Power Delivery protocol. Most of the automotive applications require support for the Provider role only. When a USB device is connected, the Provider and the device (Consumer) negotiate a contract for the power objects through configuration channels.

### Typical Block Diagram for Automotive grade USB Power Delivery



Complete USB Power Delivery version 3.0 including software stack available in AutoDevKit.



Digitally controlled dual-channel DC-DC suitable for USB Power Delivery 3.0

#### KEY FEATURES

- Dual independent channel up to 3 A each
  - Compatible with both 12 V and 24 V input
  - Combined channels for up to 100W
  - Digitally selectable fixed output voltages: 3.3 - 5 - 9 - 15 - 20 V
  - PPS-V: PWM programmable output voltages with 20 mV steps
  - PPS-I: PWM programmable output current with 50 mA steps
- More details available on AN5362

## Adapters for Tablets, Notebook and All-in-One (AIO) Computers

Power AC-DC adapters for notebooks, tablets and AIO need to be small, thin, lightweight, and provide excellent EMI performance, as well as ultra-low, highly efficient standby power, regardless of the load conditions.

A typical high-efficiency design includes a flyback or an active clamp flyback stage with synchronous rectification, and for higher power, a Power Factor Corrector (PFC) working in Transition Mode (TM) followed by a flyback, forward, or half-bridge LLC resonant stage with synchronous rectification.

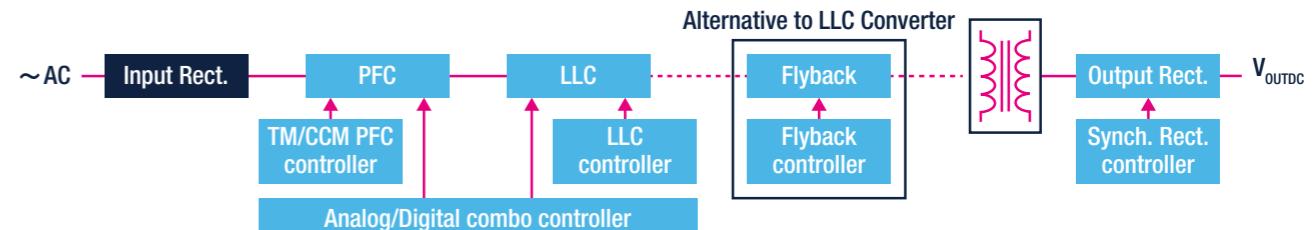
ST has recently introduced GaN Power ICs and offers a broad range of high-voltage MDmesh and low-voltage STriPfET power MOSFETs, as well as standard and field-effect rectifiers (FERD). Our offering also includes a range of PFC, PWM primary controllers, synchronous rectification controllers, and single-chip analog and digital combo controllers.

## ST recommended products for Tablets, Notebook and AIO Adapters

	Controllers	Power MOSFETs	Diodes	
PFC Block	TM Analog Controllers L6562A*, L6563*, L6564* CCM Analog Controllers L4985, L4986, L4981*, L4984D	650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2-EP 650 V MDmesh M5 ST*65M5	600 V Ultrafast for TM STTH*L06, STTH*06, STTH15AC06* 600 V Ultrafast for CCM STTH*R06, STTH*T06	
Converters & Controllers	Fully Integrated Controller for Active Clamp Flyback (ACF) ST-ONE HV Converters for Flyback SSR: VIPer*5, VIPer*7, VIPer*8 PSR: VIPerOP, VIPer*1, VIPer122, VIPer222, VIPer*6, ALTAIR*	High Voltage GaN Converters VIPerGaN50, VIPerGaN65, VIPerGaN100 Integrated Smart GaNs 600 V MASTERGAN*	Output Diodes for Flyback Schottky, FERD, STPS*, FERD*45, FERD*50, FERD*60, FERD*100	Voltage Reference, CC/CV Ctrl Voltage Reference T*431, T*432 Voltage and Current Ctrl TSM*, SEA05*
Isolation Stage	Flyback Controllers STCH03, L6566A, L6566B, L6565 PFC & LLC Combo Controllers STCMB1, STNRG011, STNRG011A LLC Analog Controllers L6599*, L6699 SR Analog Controllers SRK1000, SRK1001 for Flyback SRK2000A, SRK2001, SRK2001A for LLC	600 V MDmesh DM9 ST*60N*DM9 600 V MDmesh DM6 ST*60DM6 600 V-650 V MDmesh DM2ST*60DM2, ST*65DM2 650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2-EP 800 V MDmesh K6 ST*80K6 800 V to 950 V MDmesh K5 ST*80K5, ST*9*K5 40 V-100 V STriPfET F7 ST*N4F7, ST*N6F7, ST*N8F7, ST*N10F7	Clamping Diodes for Flyback 600 V to 1000 V Ultrafast STTH*06, STTH*08, STTH*10 Output Diodes for LLC Schottky, FERD, STPS* FERD*45, FERD*50, FERD*60, FERD*100 MOSFET protection for Flyback SM6T, SM15T series	Post Regulation DC-DC Converters ST1S*, ST1S40, ST1S50 Low Dropout (LDO) ST715 Linear Regulators LDK320 ST715 ST730 ST732

Note: \* is used as a wildcard character for related part number

## Typical Block Diagram with PFC Front-End



## Main application boards and reference designs



Note: EU CoC ver. 5 Tier 2 and EuP lot 6 Tier 2 compliance ensured

## Wireless Charging

Wireless chargers, are expected to become ubiquitous in hotels, airports, cafes and other public places as they enable topping charging of portable and wearable devices without any cables.

In a wireless battery charging system, power is transferred by electromagnetic induction (inductive power transfer) between a transmitting pad (TX) and a battery-powered device (RX) such as a smartphone, smartwatch, or sports gear.

The power transmitter unit controls the current in the transmitting coil to transfer the correct amount of power as required by the receiver unit, which continuously provides this information to the transmitter by modulating the transmitter carrier frequency through controlled resistive or capacitive load insertion. Generating the correct amount of power guarantees the highest level of end-to-end energy efficiency and helps limit the device's operating temperature.

ST has a wide range of wireless charger IC solutions, including transmitters and receivers providing low standby power, accurate foreign object detection (FOD) and reverse charging features. In order to prevent unwanted damage to any NFC Cards that might be close to the wireless charging source during operation, it is recommended to add an NFC Reader. The NFC Reader is able to detect the presence of the NFC Card or Tag (ST Reader ICs can detect Type A, B, F, or V NFC Cards), and therefore instruct the operating system to stop transmitting power.

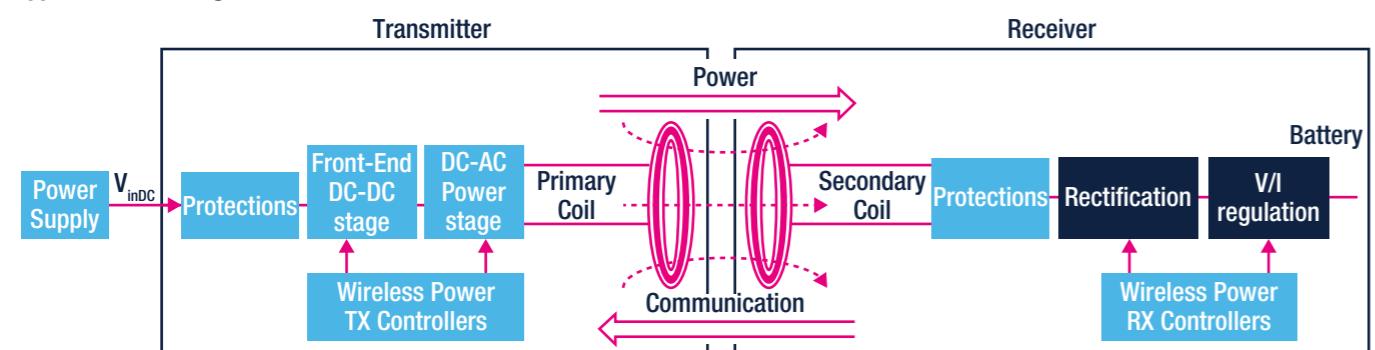
ST also offers evaluation and development tools and reference designs to help develop high-efficiency and compact wireless chargers that are Qi compliant for both Baseline Power Profile (BPP) and Extended Power Profile (EPP). Moreover, easy to use reference designs and evaluation boards enables customization with ST Super Charge protocol for personal electronics, industrial and medical applications.

## ST recommended products for Wireless Charging

	Wireless charging ICs	Battery Charger ICs	MCUs	Power MOSFETs	Protections	Diodes	NFC reader
Transmitter	STWBC86 STWBC2-HP			STM32G0 STM32F334 STM32G4	STL10N3LLH5, STL8DN6LF3, ST*N2VH5, STL8DN10LF3, STL6N3LLH6, STL10N3LLH5	SMAJ, SM6T, SM15T series TVS USB Port Protection TCPP01-M12 STPS*L30 STPS*45/60/100 FERD*45/60/100	ST25R3911B ST25R3912 ST25R3916B
Receiver	STWLC38 STWLC86 STWLC98	STBC02			ESDALC14V2-1U2	BAT30F4, BAR46	

Note: \* is used as a wildcard character for related part number

## Typical Block Diagram



## Main application boards and reference designs

### Receivers



**STEVAL-WLC38RX<sup>1</sup>**

Qi-based wireless power receiver evaluation board for applications up to 5W BPP and 15W EPP

<sup>1</sup> available in Q1 2023



**STDES-ISB38WA<sup>2</sup>**

Qi-based wireless power receiver reference design for wearable applications up to 2.5 W

<sup>2</sup> available in Q2 2023

### Transmitters



**STEVAL-WBC86TX**

Qi wireless power transmitter reference design for Baseline Power Profile (BPP) applications up to 5 W

### NFC Readers



**ST25R3911B-DISCO**

ST25R3911B based NFC Reader discovery board



**X-NUCLEO-NFC08A1**

ST25R3916B based Nucleo expansion board

## Desktop PC Power Supply

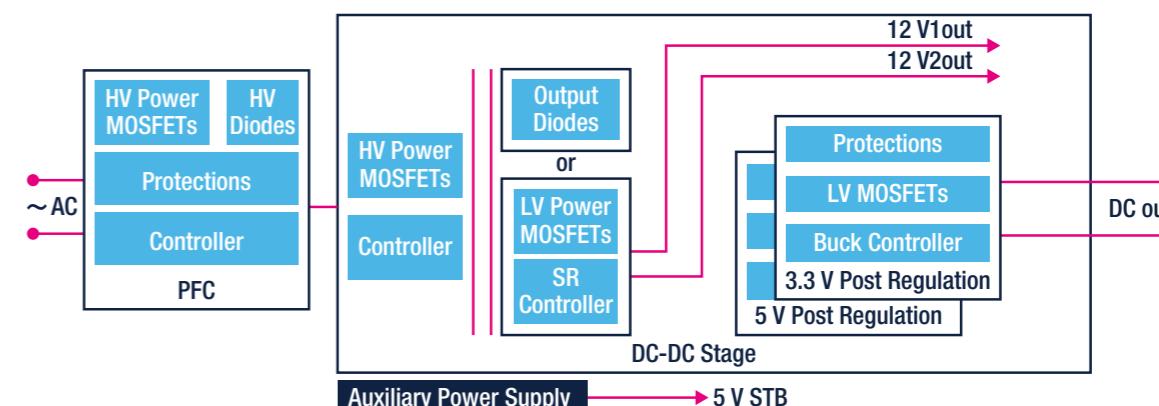
The requirements for the standard ATX PC power market are small form factor with better performance. An intelligent control scheme that enables adaption to load variation to minimize power consumption, together with optimized power semiconductors, are key to meeting market demands. Smart analog and digital controllers such as the STCMB1 and the STNRG011, GaN Power ICs such as the MASTERGAN series and the GaN Drivers, high-voltage MDmesh Power MOSFETs, low-voltage STrifET Power MOSFETs, and SiC diodes (STPSC\*) help designers develop the best PC power supply solutions to improve efficiency. ST DC-DC converters guarantee high power density for the post-regulation.

## ST recommended products for Desktop PC's Power Supply

	Controllers	Power MOSFETs	Diodes & Discretes	Opamp V/I Sensing
PFC Block	TM Analog Controllers L6562A*, L6563*, L6564* CCM Analog Controllers L4985, L4986, L4981*, L4984D MCUs & Digital Controllers STM32F0, STM32G0, STM32F301, STM32F334, STM32G4, STNRG388A	650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP 650 V MDmesh M5 ST*65M5	600 V Ultrafast for TM STTH*L06, STTH*06, STTH15AC06* 600 V Ultrafast for CCM STTH*R06, STTH*T06 SiC Diodes STPSC*065 TVS for Power Rail Surge Protection SMAJ40CA-TR	Precision Op Amps (<50 MHz) TSZ*, TSV*, TS9*, LMV* <b>MOSFET and IGBT Gate Drivers</b> Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1
Isolation DC-DC Stage	Controllers PFC & LLC Combo Controllers STCMB1, STNRG011, STNRG011A LLC Analog Controllers L6599*, L6699 Asymmetrical HB Controllers L6591 MCUs & Digital Controllers STM32F0, STM32G0, STM32F301, STM32F334, STM32G4, STNRG388A SR Analog Controllers SRK2000A, SRK2001, SRK2001A for LLC	600 V MDmesh DM9 ST*60N*DM9 600 V-650 V MDmesh DM6 ST*60M6, ST*65M6 600 V-650 V MDmesh DM2 ST*60M2, ST*65M2 650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP 40 V-100 V STrifET F7 ST*N4F7, ST*N6F7, ST*N8F7, ST*N10F7	Output Diodes Schottky, FERD STPS*, FERD*45, FERD*50, FERD*60, FERD*100 TVS for Power MOSFET and Power Rail Surge Protection SMAJ, SM6T, SM15T series <b>LDO</b> Low Dropout (LDO) Linear Regulators LDF, LDFM, LDK320, LDL212, LD39200, LD117	STEF01 STEF05-STEF05S STEF12-STEF12S STEF12H60M <b>MOSFET and IGBT Gate Drivers</b> Integrated smart GaNs 600 V MASTERGAN* HV HB Gate Drivers for GaNs STDRIVEG600 HV HB Gate Drivers L649* Isolated Gate Drivers STGAP* SR Multiple LS Gate Drivers PM8834
Post Regulation	Controllers L6726A, L673*, PM6680	Power MOSFETs STL90N3LLH6	Voltage Reference T*431, T*432, TS33*	

Note: \* is used as a wildcard character for related part number

## Typical configuration



## Main application boards and reference designs



**EVL011A150ADP**

12 V - 150 W power supply based on TM PFC and HB LLC digital combo controller



**EVL4986-350W**

Low-THD 350W CCM-PFC pre-regulator



**EVL4985-350W**

Low-THD 350W CCM-PFC pre-regulator



**EVL400W-80PL**

12 V - 400 W adapter based on CCM PFC and HB LLC analog controller

## Server & Telecom Power

### AC-DC PSU & DC-DC power distribution

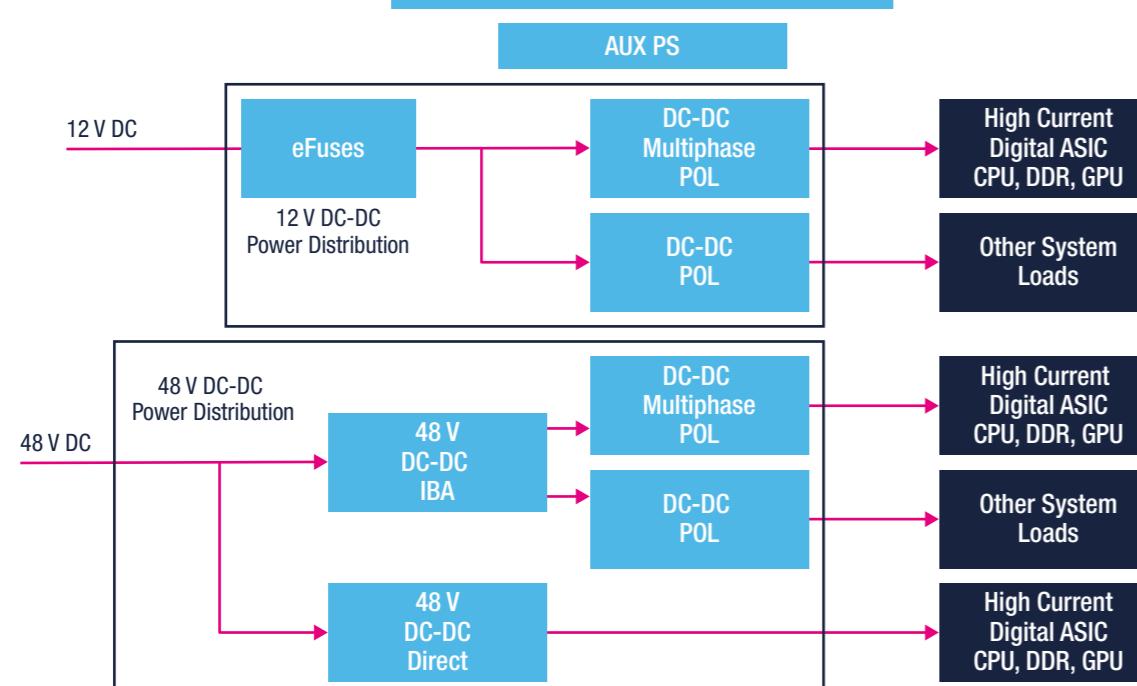
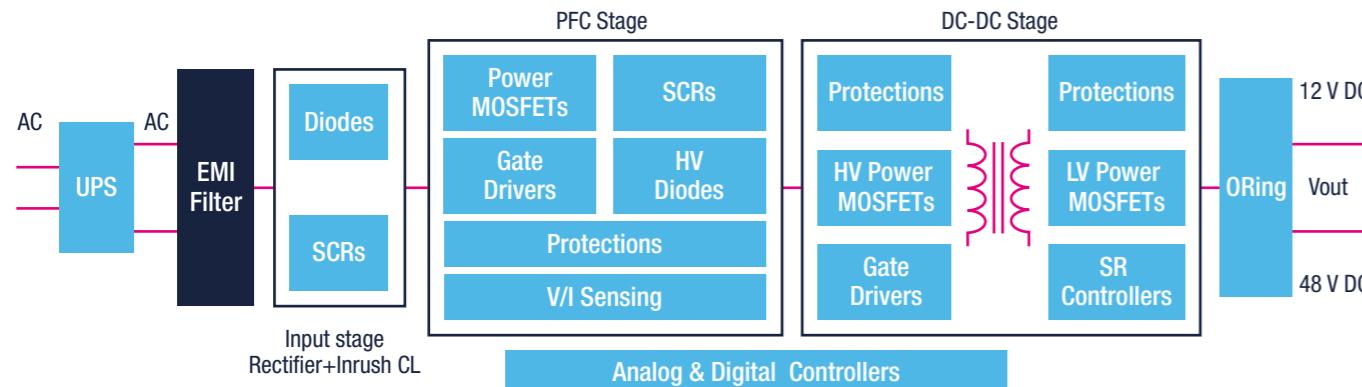
Data centers house thousands of servers usually built in very dense network farms. Data center power requirements are constantly increasing and traditional power systems are no longer sufficient to meet this growing demand. The power distribution chain, from the front-end AC-DC stage to the back-end DC-DC power distribution, needs to deliver the best performance in terms of efficiency, power density, and the ability to interface with the digital world.

In telecom system power, the use of complex digital ASICs for managing growing data traffic is pushing the power envelope higher. Telecom power management systems have to be highly energy-efficient and very dense to deliver the required high levels of power, while maintaining reasonable power consumption.

ST offers extensive product and solution coverage to ensure the most optimized power design across the entire distribution chain. Our digital and analog controllers combined with MOSFETs and drivers are key ingredients for implementing the most efficient and most dense AC-DC power delivery. On the back-end DC-DC power distribution, ST offers advanced solutions for Point-of-Load conversion and a recently developed innovative DC-DC conversion from a 48 V DC supply.



### Typical Block Diagram for Server PSU



## ST product offering for Server and Telecom AC-DC PSU

Input Stage (Rect. & inrush current limiter)	Controllers	SCRs	Diodes
PFC Block	CCM Analog Controllers L4985, L4986, L4981*, L4984D MCUs & Digital Controllers STM32F0, STM32G0, STM32F301, STM32F334, STM32G4, STNRG388A	High Temp. SCR TN*015H-6, TM8050H-8, TN*050H-12 Power MOSFETs 650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2 650 V MDmesh M5 ST*65M5 650 V SiC MOSFETs SCT**65G3AG, SCT*N65G2	Bridge Rectifier Diodes STBR*08, STBR*12 Diodes & Protections 600 V Ultrafast for CCM STTH*R06 STTH*T06 SiC Diodes STPSC*065
Isolation DC-DC Stage	LLC Analog Controllers L6599A, L6699 Asym. HB Analog Controllers L6591 MCUs & Digital Controllers STM32F334, STM32G4, STNRG388A SR Analog Controllers SRK2000A, SRK2001, SRK2001A	V/I Sensing TVS for Power MOSFET and Power Rail Surge Protection SMAJ, SM6T, SM15T, series Power MOSFETs 600 V MDmesh DM9 ST*60N*M9 600 V-650 V MDmesh DM6 ST*60DM6, ST*65DM6 600 V-650 V MDmesh DM2 ST*60DM2, ST*65DM2 650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2-EP SR 60 V-100 V STripFET F7 ST*N6F7, ST*N8F7, ST*N10F7 DC-DC L3751	Isolated Sigma-Delta ADC ISOSD61, ISOSD61L Precision Op Amps (<50 MHz) TSZ*, TSV*, TS9*, LMV* Diodes & Protections Output Diodes for LLC Schottky, FERD STPS* FERD*45, FERD*50, FERD*60 TVS for Power MOSFET and Power Rail Surge Protection SMAJ, SM6T, SM15T, series LDO Low Dropout (LDO) Linear Regulators LDF, LDFM, LD39050, LD39100, LD39200, LDL112, LDL212, LD59100, LD57100 eFuses STEF01 STEF05-STEFO5S STEF12-STEF12S STEF12H60M

Note: \* is used as a wildcard character for related part number

### Main application boards and reference designs



## Power Distribution for Modern Data Center

To support the evolution and expansion of cloud services, the internet of things, mobile apps, and new generation of telecommunication infrastructure, the demand for data centers performance is growing exponentially with more powerful CPUs, and this segment is expanding in artificial intelligence and machine learning.

In the newest architecture, a 48 V DC rail is generated from the AC-DC power supply unit , which is then converted to provide the number of DC rails needed to supply the various loads and circuits in the server. This conversion must meet stringent efficiency targets requiring innovative architectures like those developed by ST.

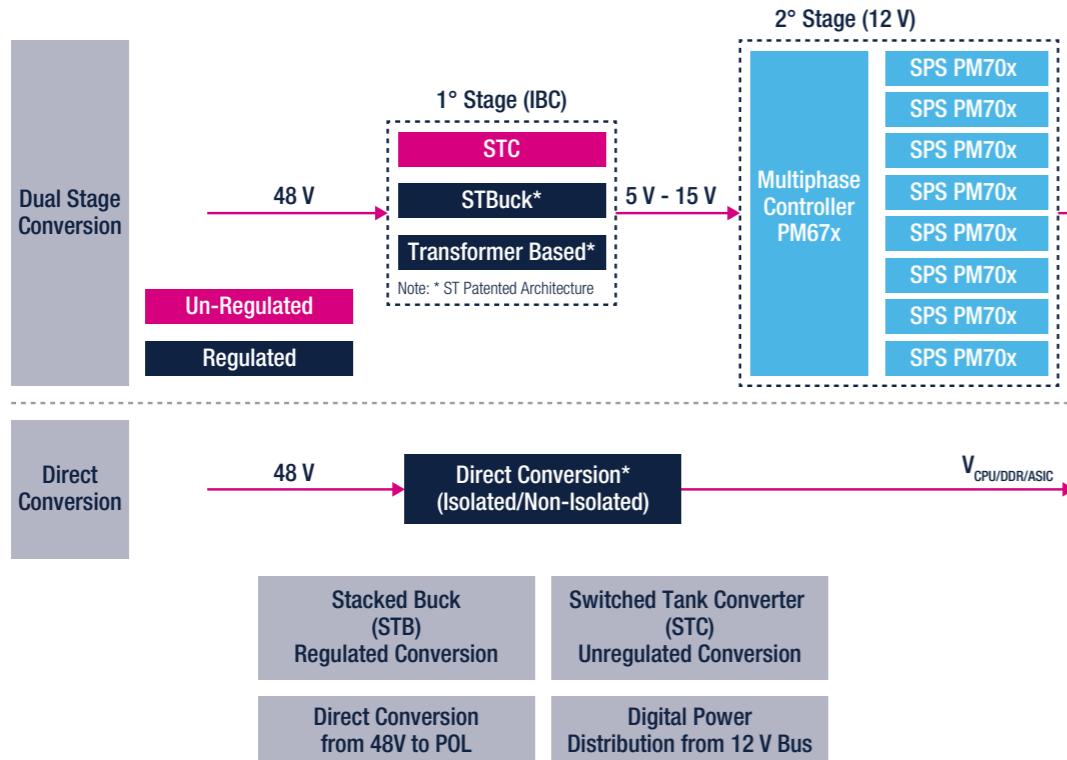
We offer a wide range of high-efficiency regulated and unregulated DC-DC conversion solutions, including STB, STC, HSTC for 48 to 12 V intermediate bus conversion.

Moreover, we offer 12 V to Point of Load conversion, including multi-phase digital controller and Smart Power Stages (SPS) to support the most recent INTEL and AMD CPU specifications.

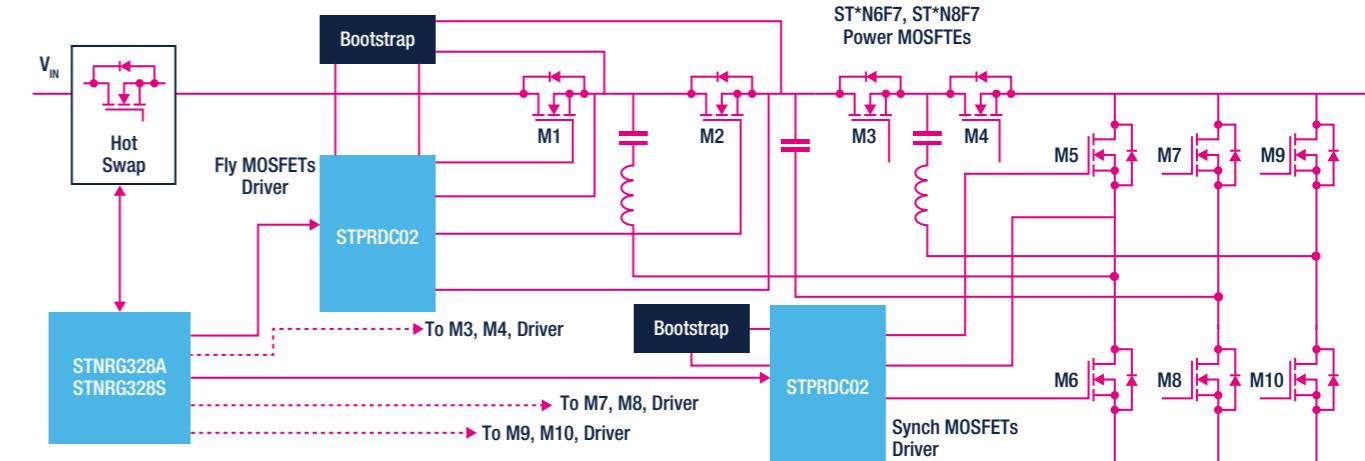
Finally, ST offers direct conversion solutions, from 48 V to point-of-load, based on the Power Stamp Alliance (PSA) products.



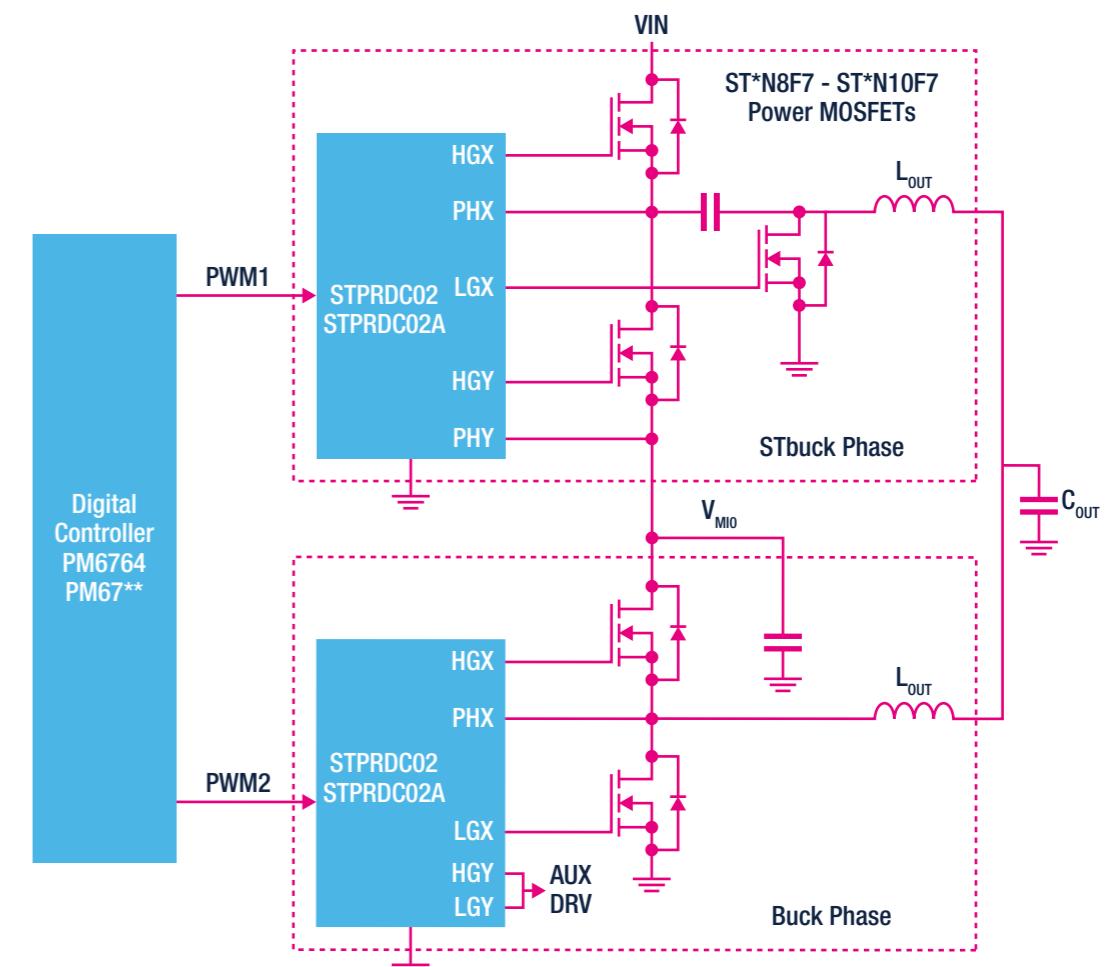
## Power Delivery for Modern Data Center



## Typical Configuration for Switched-Tank Converter (STC) System - 48 V to 12 V non isolated unregulated IBC

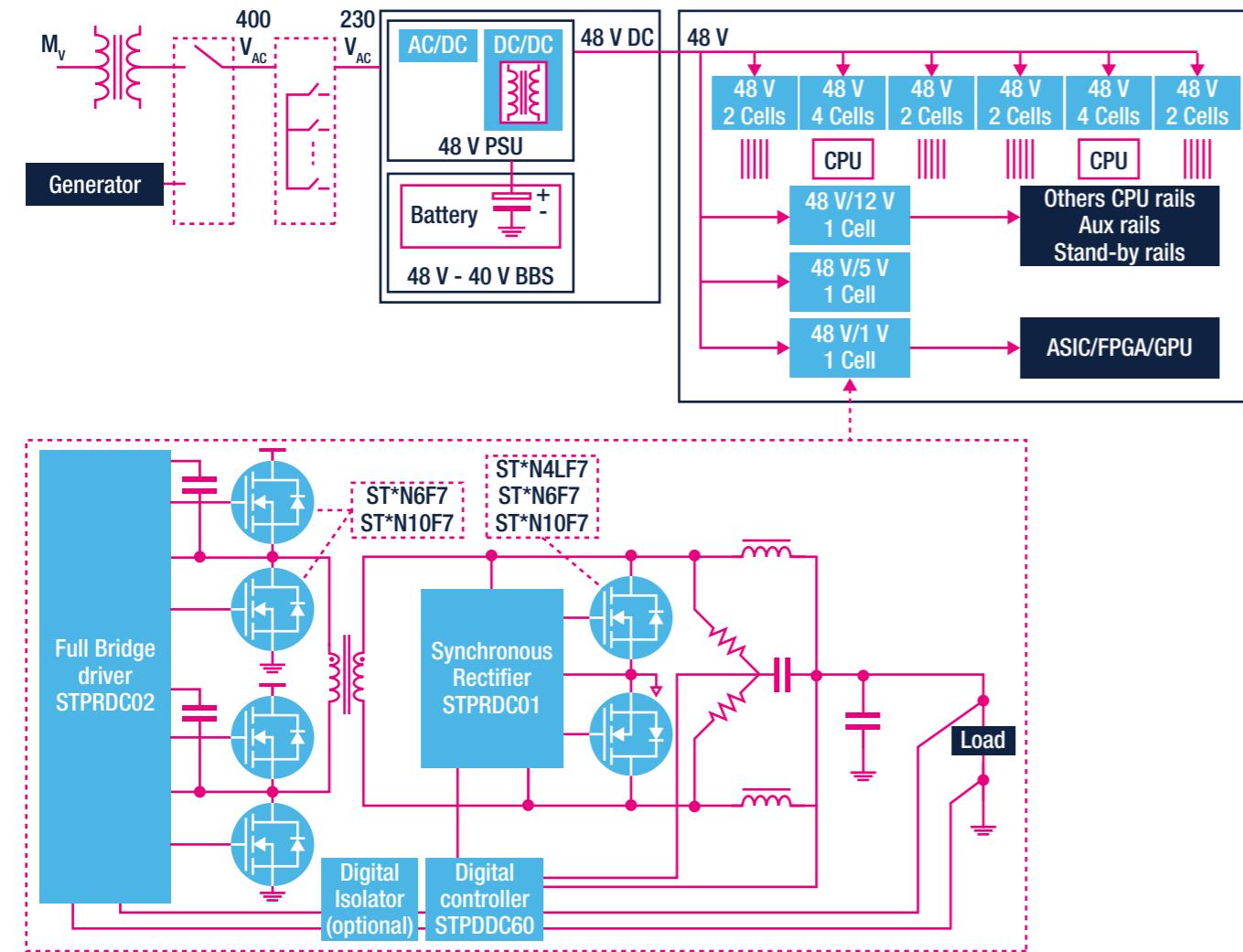


## Typical Configuration for STBUCK - 48 V to 12 V non isolated regulated IBC



Note: \* is used as a wildcard character for related part number

### Typical Configuration for 48 V Isolated Direct Conversion



Note: \* is used as a wildcard character for related part number

### SSD Power Management

Solid State Drives (SSD) serve the same function as Hard Disk Drives, but they have a different set of internal components; they have no moving parts and data is stored in flash memory. SSDs can access data faster than HDDs and have several other advantages such as better performance and robustness and lower power consumption. SSDs are widely used in desktop and notebook computers, as well as for storage in data centers.

ST offers state-of-the-art products for SSD system architecture, including Power Management ICs featuring protections and communication bus. Our portfolio of high-quality components allows the design of solutions that meet the most demanding requirements of both consumer SSD and enterprise-grade SSDs.

The ST device family is ideal for designing advanced power management solutions for microcontroller, DDR, Flash memory, on SSD server and consumer applications.

The IC series features multiple Buck and LDOs with programmable outputs and supports conversions from a wide range of input voltage buses like 12 V, 5 V and 3.3 V.

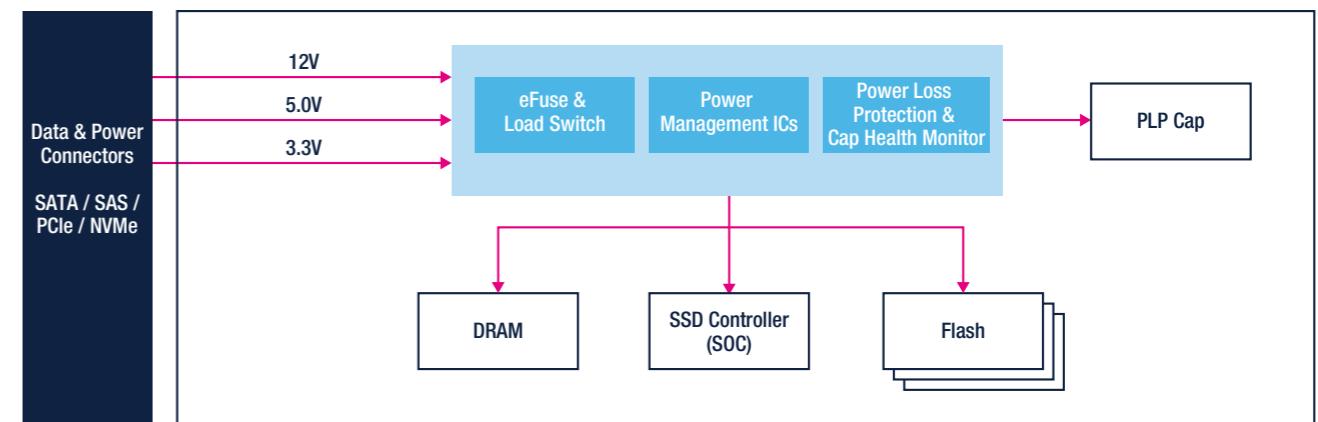
Electronic fuses (eFuses) for 3.3, 5 and 12 V located at the power connector minimize system down-time by protecting the SSD and the host from failures.

High switching frequency eases the design of compact applications, while specific control techniques ensure best-in-class efficiency at heavy and light load operation.

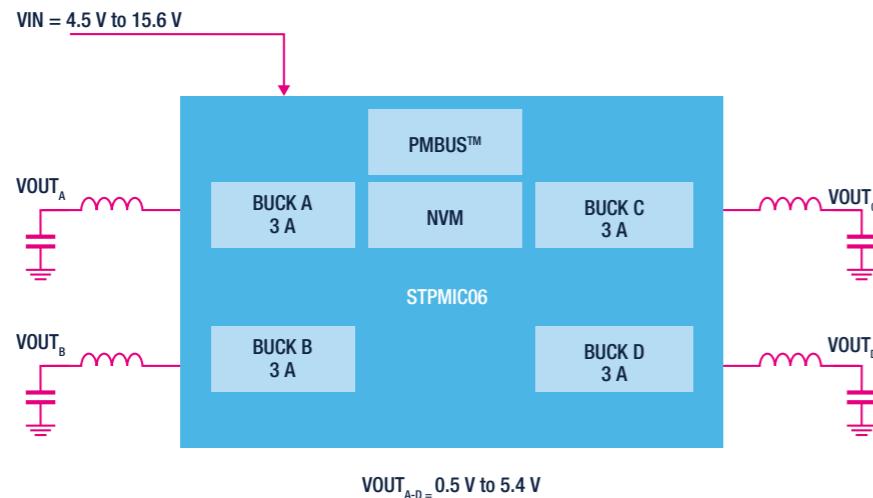
Full programmability via high speed serial interfaces like I<sup>2</sup>C and PMBus® allows configurability for different application requirements.



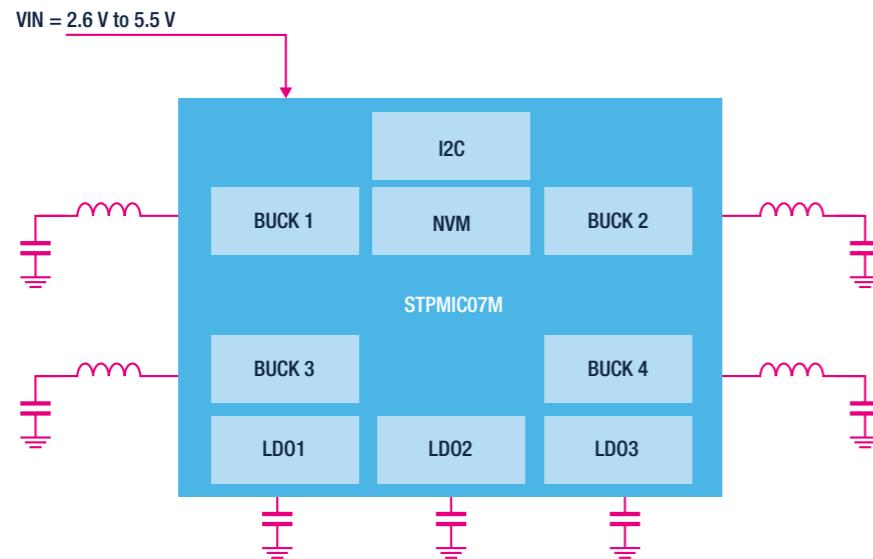
### Typical Block Diagram for SSD Power Management



## STPMIC06



## STPMIC07M



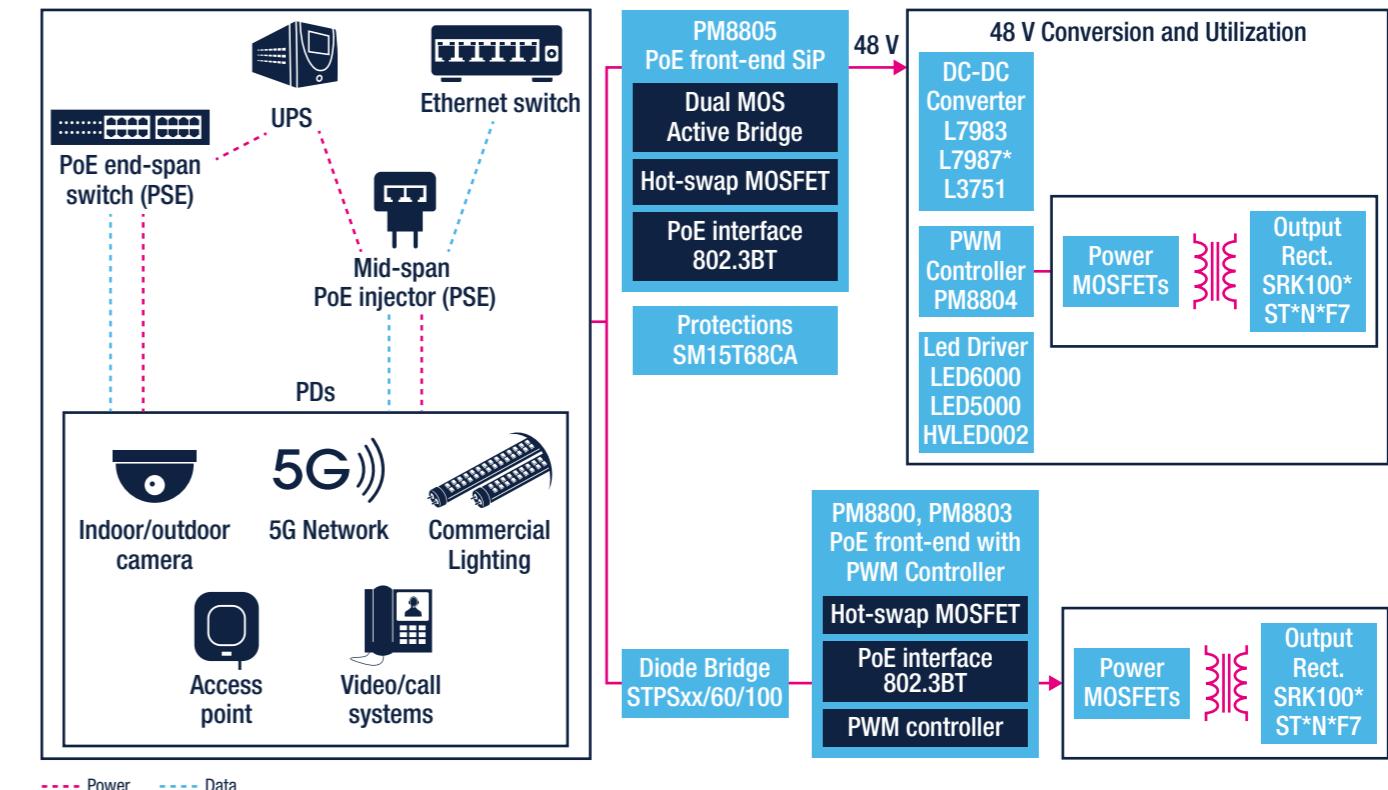
## Power over Ethernet (PoE)

Power over Ethernet (PoE) is a widely adopted technology used to transfer power and supply the powered device (PD), including wireless access points, VoIP phones over an RJ-45 cable also carrying data as described in the IEEE 802.3 standard, and its evolutions including IEEE 802.3bt, IEEE 802.3at, and IEEE 802.3af.

We offer a range of products for complete interface with all the functions required by the communication standard, including detection and classification, as well as protection features such as under-voltage lockout (UVLO) and in-rush current limitation. In addition, these products can control hot-swap power MOSFETs that can greatly simplify the development of IEEE 802.3 compliant solutions for powered devices (PD).



## Typical block diagram for PoE Power Management



## Main application boards and reference designs



**STEVAL-POE001V1**

Power Over Ethernet (PoE) - IEEE 802.3bt compliant interface



**STEVAL-POE002V1**

5 V/8 A, synchronous flyback converter, Power over Ethernet (PoE) IEEE 802.3bt compliant reference design



**STEVAL-POE003V1**

5 V/20 A, active clamp forward converter, Power Over Ethernet (PoE) - IEEE 802.3bt compliant reference design



**STEVAL-POE005V1**

12 V/8 A, active clamp forward converter, Power Over Ethernet (PoE) IEEE 802.3bt compliant reference design



**STEVAL-POE006V1**

3.3 V/20 A, active clamp forward converter, Power Over Ethernet (PoE) IEEE 802.3bt compliant reference design

Note: \* is used as a wildcard character for related part number

## LED TV Power Supply

Beyond their outstanding image quality, new-generation televisions have a very thin design, are highly power-efficient and feature a stand-by power mode. Power Supply Units (PSUs) play a key role in ensuring TVs meet market requirements and have an elegant form factor.

To achieve these stringent requirements, PSUs typically have a Power Factor Corrector (PFC) stage and use advanced topologies like half-bridge LLC (HB-LLC) resonant.

ST offers a broad portfolio of high-voltage MDMesh and low-voltage STripFET power MOSFETs, field-effect rectifier diodes (FERD), Schottky and Ultrafast diodes, a full range of protection ICs, as well as dedicated analog and digital switching controllers, which negate the necessity of auxiliary power by consuming very low power at no load. In addition, STM32 microcontrollers enable developers to exploit the full potential of digital PSU implementations.

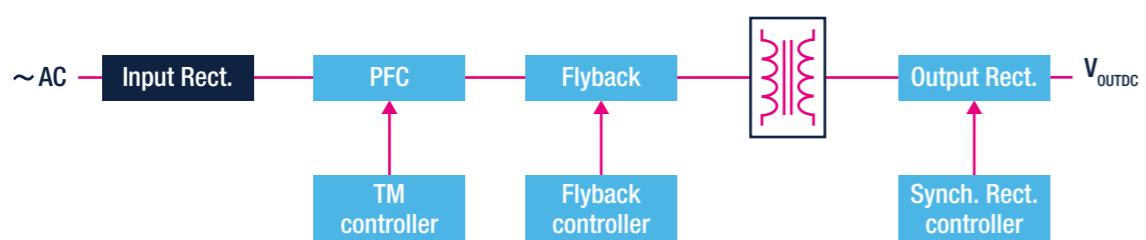


## ST recommended products for LED TV Power Supply

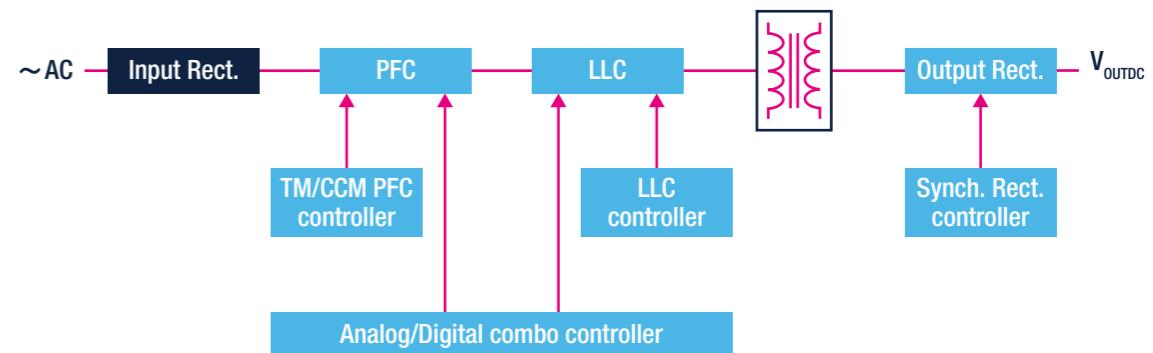
SCR				
Input Rectifier	High Temp. SCR TN*015H-6, TM8050H-8, TN*050H-12			
	Controllers	Power MOSFETs	Diodes	Opamp V/I Sensing
PFC Block	TM Analog Controllers L6562A*, L6563*, L6564*  CCM Analog Controllers L4985, L4986, L4981*, L4984D  MCUs & Digital Controllers STM32F0, STM32G0, STM32F301, STM32F334, STM32G4, STNRG388A	650 V MDMesh M9 ST*65N*M9  600 V-650 V MDmesh M6 ST*60M6, ST*65M6  600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP  650 V MDmesh M5 ST*65M5	600 V Ultrafast for TM STTH*L06 STTH*06 STTH15AC06*  600 V Ultrafast for CCM STTH*R06 STTH*T06  SiC Diodes STPSC*065	Precision Op Amps (<50 MHz) TSZ*, TSV*, TS9*, LMV*  MOSFET and IGBT Gate Drivers  Multiple LS Gate Drivers PM8834  Single LS Gate Drivers PM88*1
	Controllers	GaN Power ICs	Diodes & Protections	MOSFET and IGBT Gate Drivers
	Flyback Controllers L6566A, L6566B, L6565, L6668, STCH03  PFC & LLC Combo Controllers STCMB1, STNRG011, STNRG011A  LLC Analog Controllers L6599*, L6699  Asymmetrical HB Controllers L6591  MCUs & Digital Controllers STM32F0, STM32G0, STM32F301, STM32F334, STM32G4, STNRG388A  SR Analog Controllers SRK1000, SRK1001 for Flyback SRK2000A, SRK2001, SRK2001A for LLC	Integrated Smart GaNs 600 V MASTERN  HV HB Gate Drivers for GaNs STDRIVEG600  Power MOSFETs  600 V MDmesh DM9 ST*60N*DM9  600 V MDmesh DM6 ST*60DM6  600 V-650 V MDmesh DM2 ST*60DM2, ST*65DM2  650 V MDmesh M9 ST*65N*M9  600 V-650 V MDmesh M6 ST*60M6, ST*65M6  600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP  60 V-100 V STripFET F7 ST*N6F7, ST*N8F7, ST*N10F7	Output Diodes for Flyback Schottky, FERD, Ultrafast STPS*, FERD*, STTH*  Clamping Diodes for Flyback 600 V to 1000 V Ultrafast STTH*06, STTH*08, STTH*10  Output Diodes for LLC Schottky, FERD STPS*  FERD*45, FERD*50, FERD*60, FERD*100  MOSFET Protection for Flyback SMAJ, SM6T, SM15T series  Voltage Reference  T*431, T*432	HV HB Gate Drivers L649*  Isolated Gate Drivers STGAP*  SR Multiple LS Gate Drivers PM8834  SR HV HB Gate Drivers L649*  Isolated Interfaces for wired connectivity STIS062x  Post Regulation  DC-DC Converters ST1S12, ST1S3*, ST1S4*, ST1S50 Low Dropout (LDO) Linear Regulators LD1117xx, ST730/2, L78xx, LD39100

Note: \* is used as a wildcard character for related part number

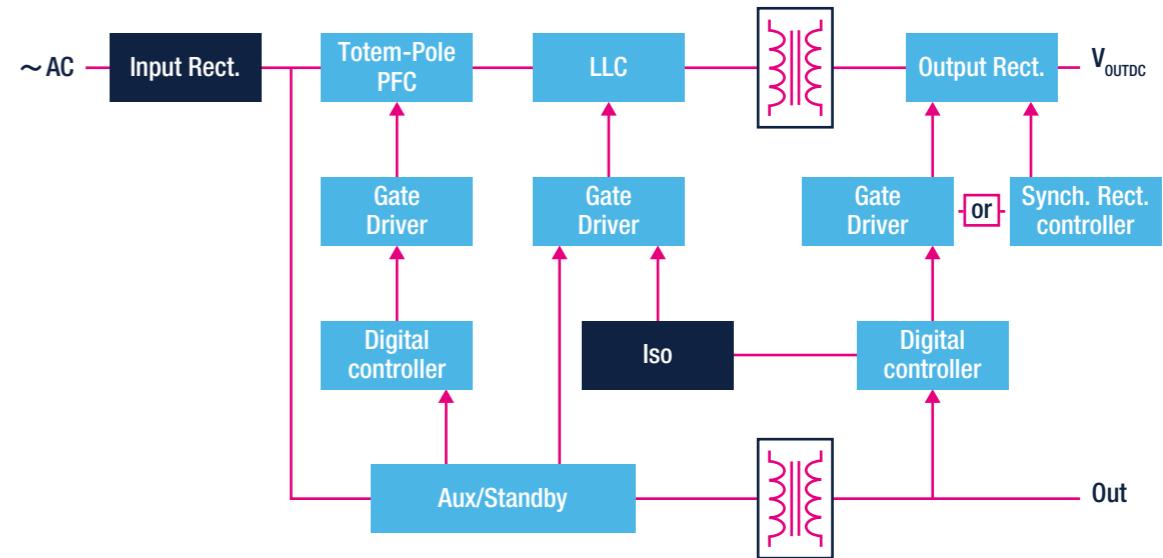
## Typical Block Diagram for Analog Control Solutions for Small Panel Size



## Typical Block Diagram: Analog Control Solutions with no Aux supply, for Small/Medium Panel Size



## Typical Block Diagram for Digital Control Solutions for Medium/Large Panel Size



## Main application boards and reference designs



**EVLMG1-250WLLC**  
250 W Resonant DC-DC  
Converter based on LLC analog  
controller and GaN



**STEVAL-NRG011TV**  
200 W power supply based  
on STNRG011 digital combo  
for LED TV



**STEVAL-DPSTPFC1**  
3.6 kW PFC Totem-Pole with  
digital inrush current limiter



**EVLCMB1-90WADP**  
19 V - 90 W adapter based on TM PFC  
and HB LLC analog combo controller



**EVLSTNRG011-150**  
12 V - 150 W power supply  
based on TM PFC and HB LLC  
digital combo controller



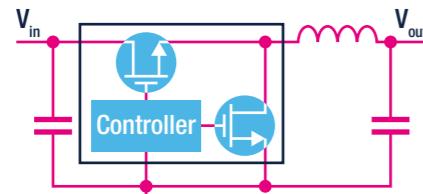
**EVL400W-80PL**  
12 V - 400 W adapter based on  
CCM PFC and HB LLC analog  
controller

## DC-DC Conversion

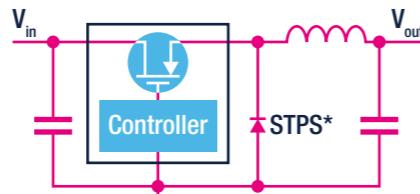
A DC-DC switching converter is used to locally supply any component or part of a system with the desired DC voltage and current. Depending on the application's relationship between the input and output voltage, engineers have to choose the best power topology: buck, boost, buck-boost or inverting, with or without synchronous rectification. In addition, they can decide to use an implementation based on monolithic ICs, or with discrete power switches and controllers, or even an advanced digital implementation. Whatever the choice, the right semiconductor products are key to meeting the specific efficiency and size design targets.

ST broad product portfolio includes highly-integrated DC-DC converters and PWM controllers, power MOSFETs and rectifiers, protection ICs, and linear voltage regulators to address a wide range of topologies and power requirements. We also provide a comprehensive range of hardware and software evaluation and development tools, including eDesignSuite, which helps engineers design high-efficiency DC-DC converters.

### Typical buck configuration: up to 61 Vin/3 A Iout

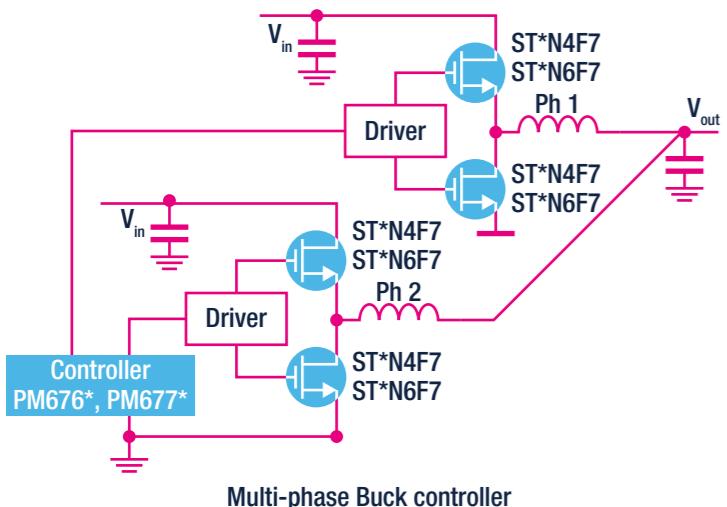


Synchronous buck converter



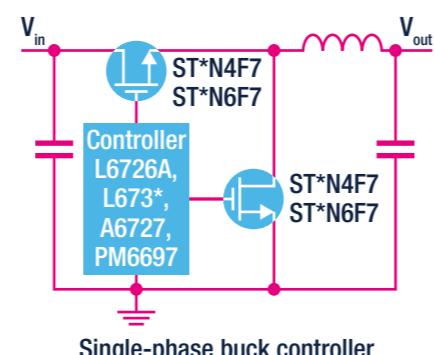
Asynchronous buck converter

### Typical multi-phase configuration: up to 12 Vin, very high output current



Multi-phase Buck controller

### Typical single phase discrete configuration: up to 18 Vin, high output current



Single-phase buck controller

### Main application boards and reference designs



**STEVAL-L7983ADJ**

Synch. buck up to 60 Vin,  
12 Vout - 0.3 A Iout



**STEVAL-L6986IV1**

38 V, 5 W synchronous  
iso-buck converter



**STEVAL-1PS03A**

Synch. Buck with Load Switch,  
5.5 Vin, Dynamic Voltage  
Selection up to 3.3 V - 400 mA

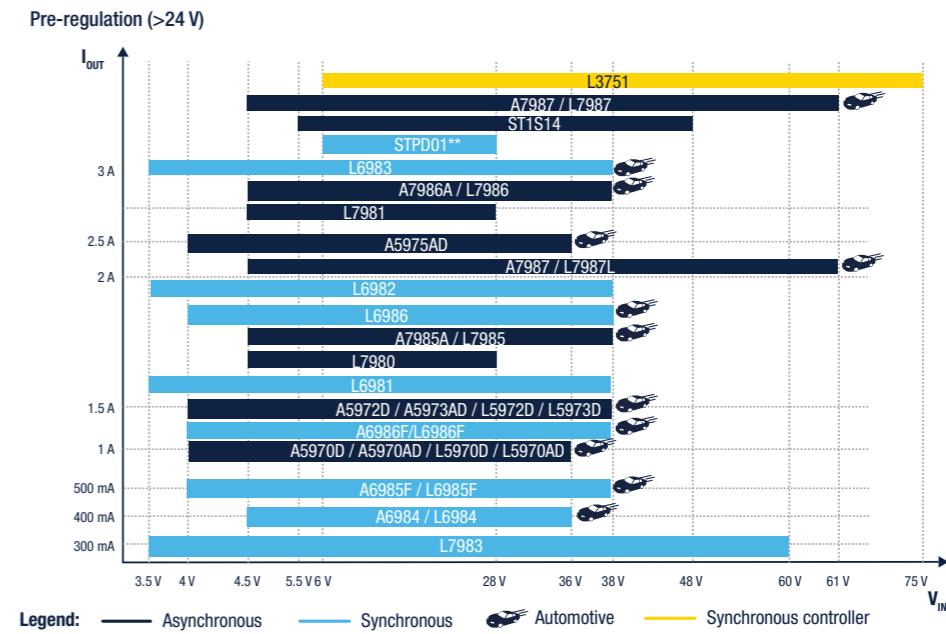


**STEVAL-L3751V12**

75 V 15 A DC-DC converter  
buck regulator

Note: \* is used as a wildcard character for related part number

## ST product offering for Switching Converters (DC-DC)



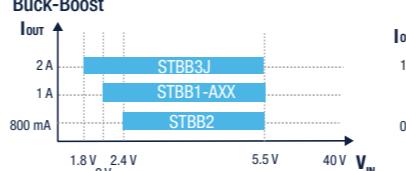
Note: \* under development, \*\* for USB PD, up to 60 W output power (20 V, 3 A)

### Post-Regulation (<24 V)



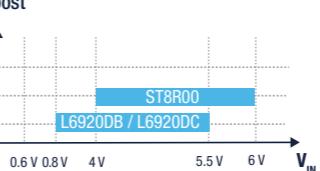
Note: \* under development

### Buck-Boost

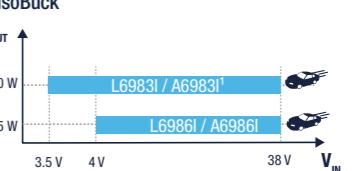


Note: 1 available in Q2 2023

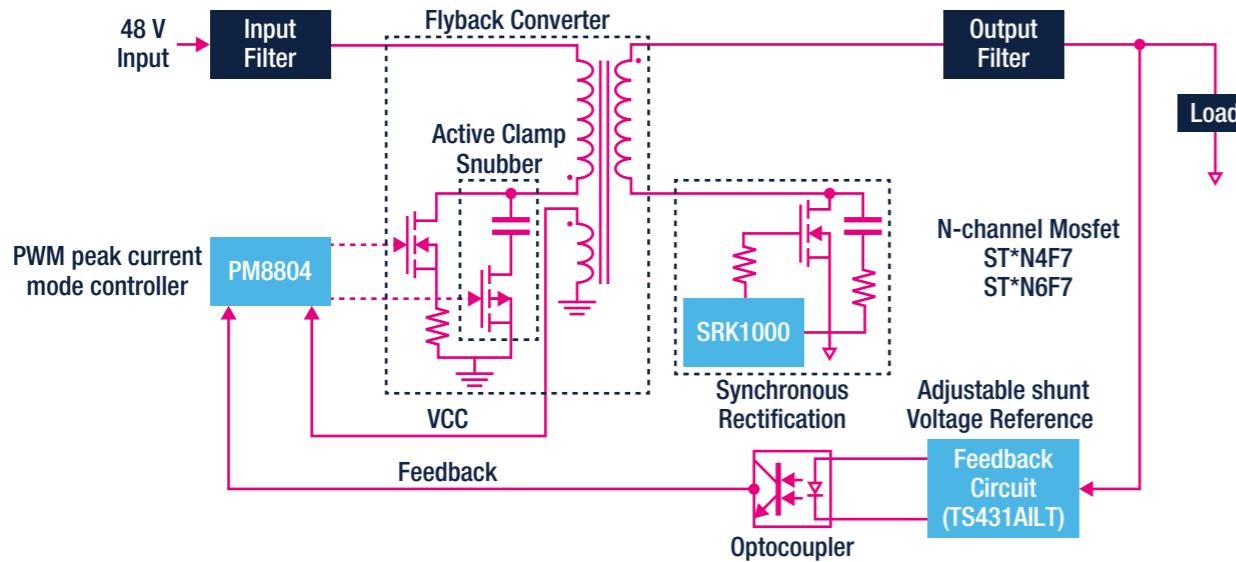
### Boost



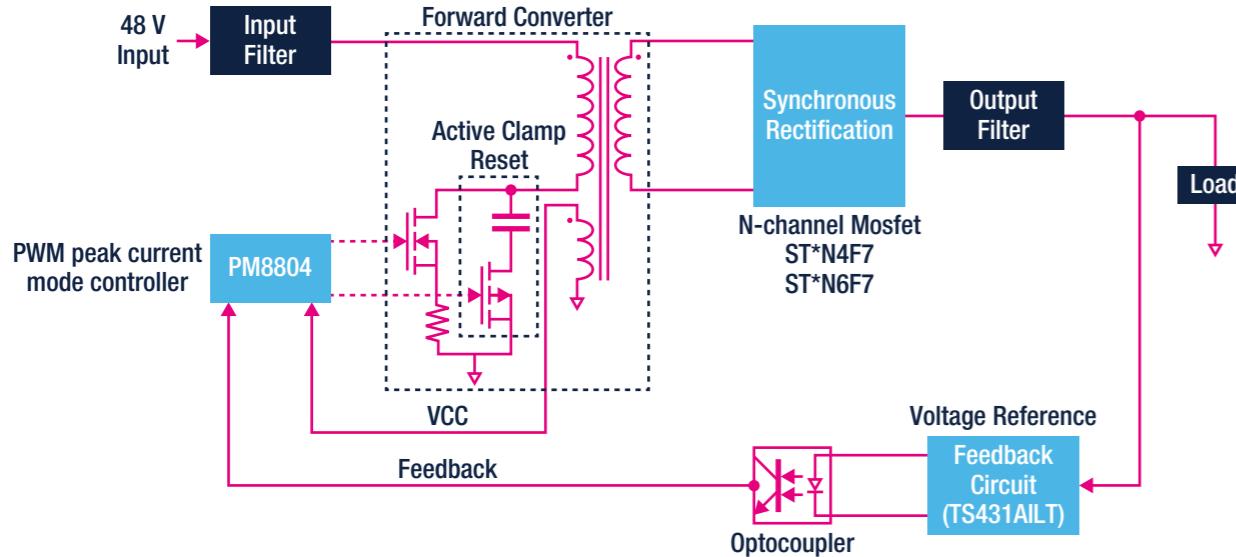
### IsoBuck



### Typical 48 Vin, up to 65 W Pout, Synchronous Flyback configuration



### Typical 48 Vin, > 65 W Pout, Active Clamp Forward configuration



### Main evaluation boards



**STEVAL-ISA203V1**

- Input Voltage range: 42 - 56 V DC
- Switching Frequency - 250 kHz
- Output:
- Power - 60 W
- Voltage - 12 V DC
- Current - 5 A
- Peak Efficiency > 94%



**STEVAL-ISA204V1**

- Input Voltage range: 42 - 56 V DC
- Switching Frequency - 250 kHz
- Output:
- Power - 100 W
- Voltage - 5 V DC
- Current - up to 20 A
- Peak Efficiency > 94%

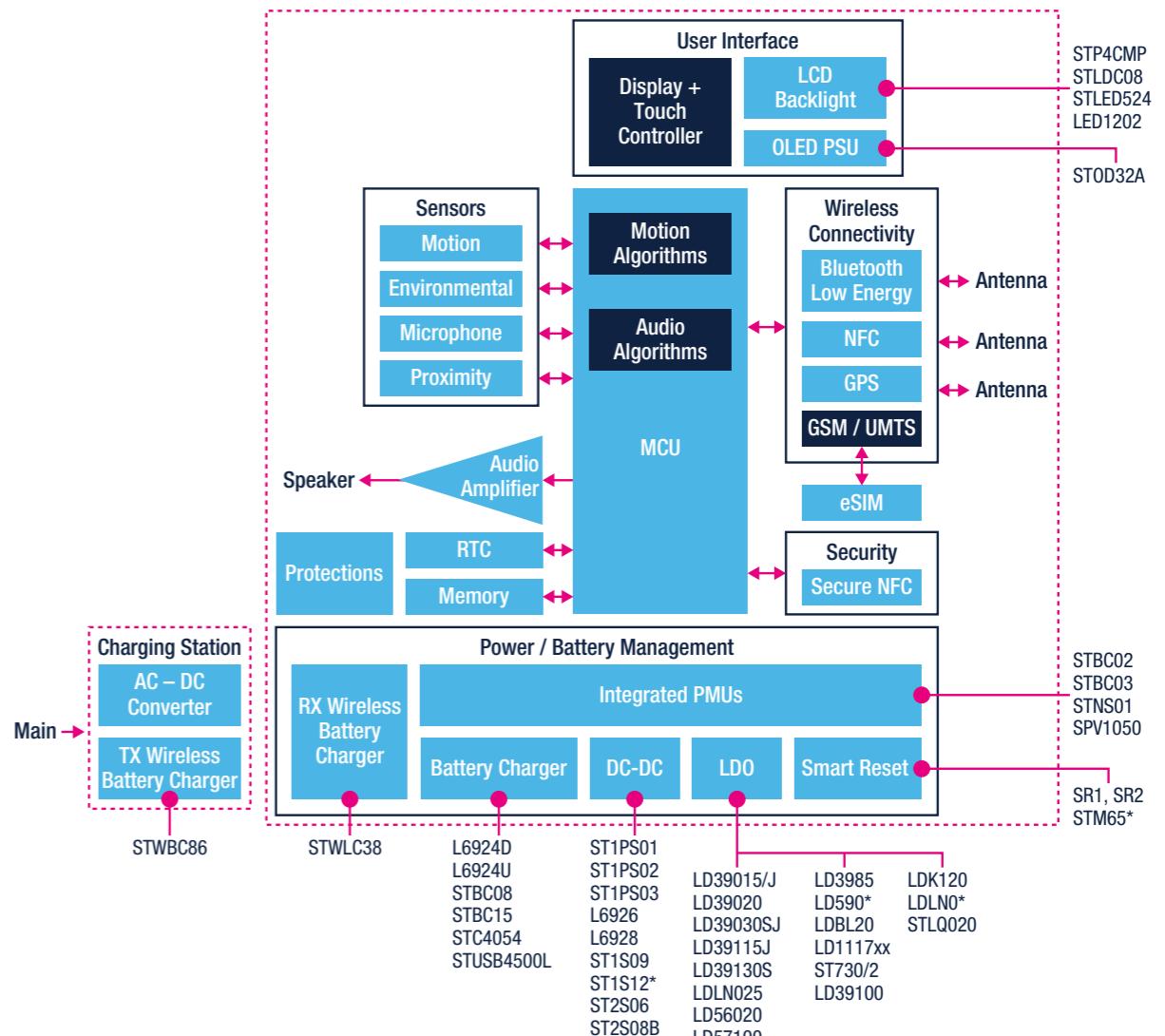
Note: \* is used as a wildcard character for related part number

### WEARABLE DEVICES - POWER MANAGEMENT

Wearable devices, by their very nature, must be compact and comfortable for the user. They need to deliver precise information about user states and conditions, have low power consumption, and the right level of performance to make them convenient and easy to use. ST products for wearable devices are designed to meet the needs of the most demanding systems with a portfolio covering smart watches, fitness trackers, heart-rate monitors, sports equipment, and a variety of other wearable devices. Our portfolio includes digital processing, sensors, connectivity, security, and power management solutions that can make the difference in a challenging and competitive market.

Specifically for power management, ST provides a range of solutions to allow very small form factor with outstanding efficiency performance and longer battery life.

### Typical Block Diagram of a Smart Watch



### Main application boards and reference designs



**STEVAL-1PS01AJR/DJR/EJR**

Evaluation board based on the ST1PS01 400 mA nano-quiescent synchronous step-down converter with digital voltage selection



**STEVAL-1PS02B**

Evaluation board based on the ST1PS2 400 mA nano-quiescent synchronous step-down converter with digital voltage selection and AUX switch



**STEVAL-1PS03A**

Evaluation board based on ST1PS03AQTR 400 mA nano-quiescent synchronous step-down converter with load switch



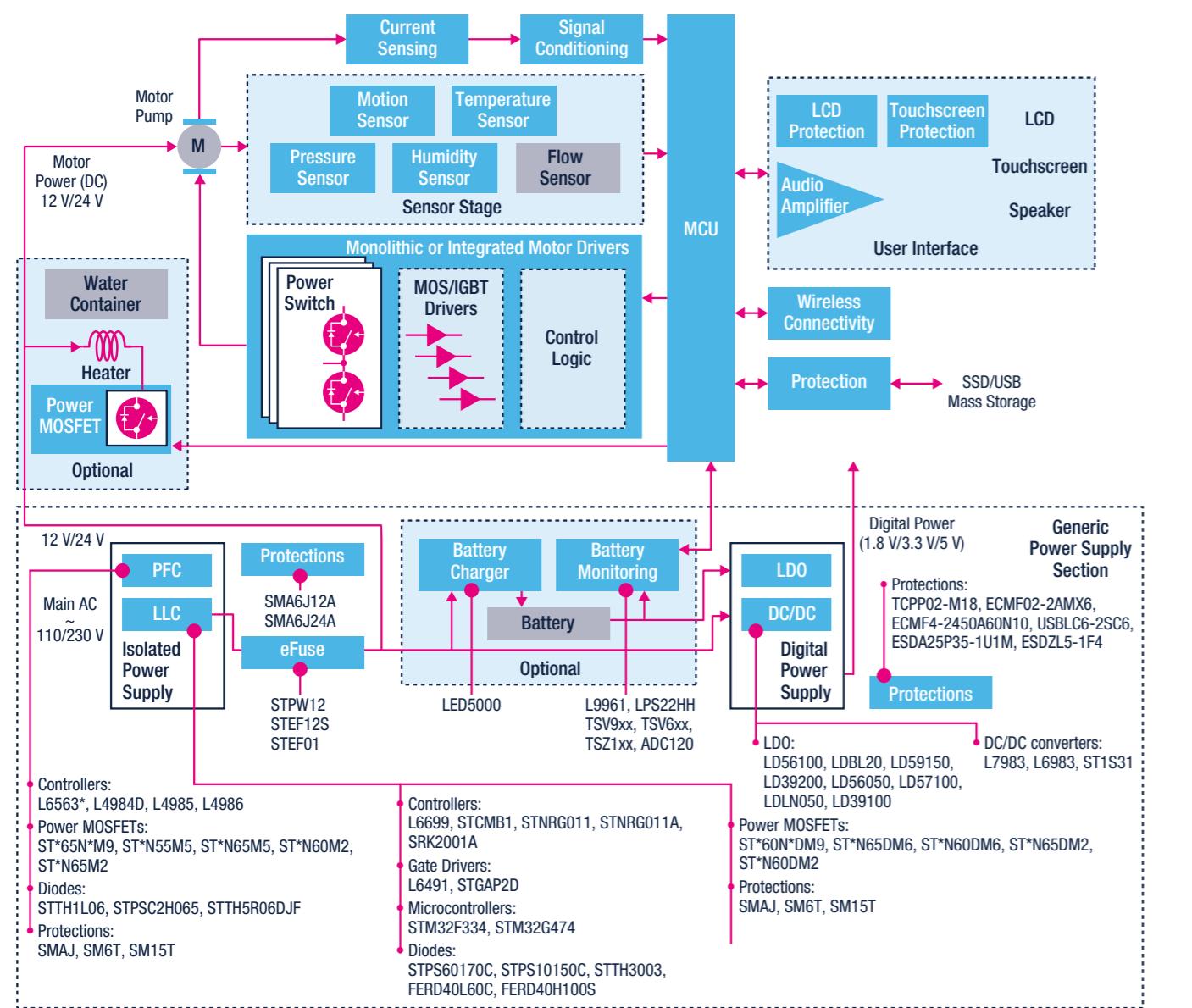
**STEVAL-LDO001V1**

Quad high performance LDO evaluation board based on LDBL20, LDLN025, LD39130S and STLQ020

## MEDICAL POWER SUPPLY

The mission critical nature of medical devices demands high quality, reliable, and safe products. Our goal is to consistently deliver products that meet this criteria and help our customers meet this goal. Medical power supplies are a crucial part of the equipment, usually you with open frame, enclosed, fanless, and configurable models, as well as wall-mount adapters and DC-DC modules. Often, the backup battery is part of the power supply to guarantee continuity of operation when the main supply is interrupted.

Typical Block Diagram of a Medical Power Supply for Artificial Ventilators



### Main application boards and reference designs



**EVL6563S-100W**  
100 W transition-mode PFC pre-regulator



**EVLSTNRG011-150**  
12 V - 150 W power supply based on TM PFC and HB LLC digital combo controller



**STEVAL-L7983ADJ**  
12 V/0.3 A step down DC/DC converter (VIN = 12 to 60 V)

Note: \* is used as a wildcard character for related part number



## LED LIGHTING AND CONTROLS

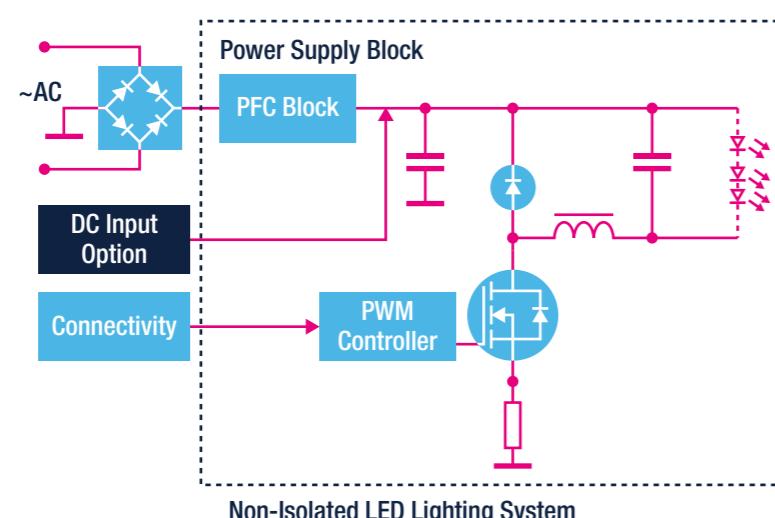
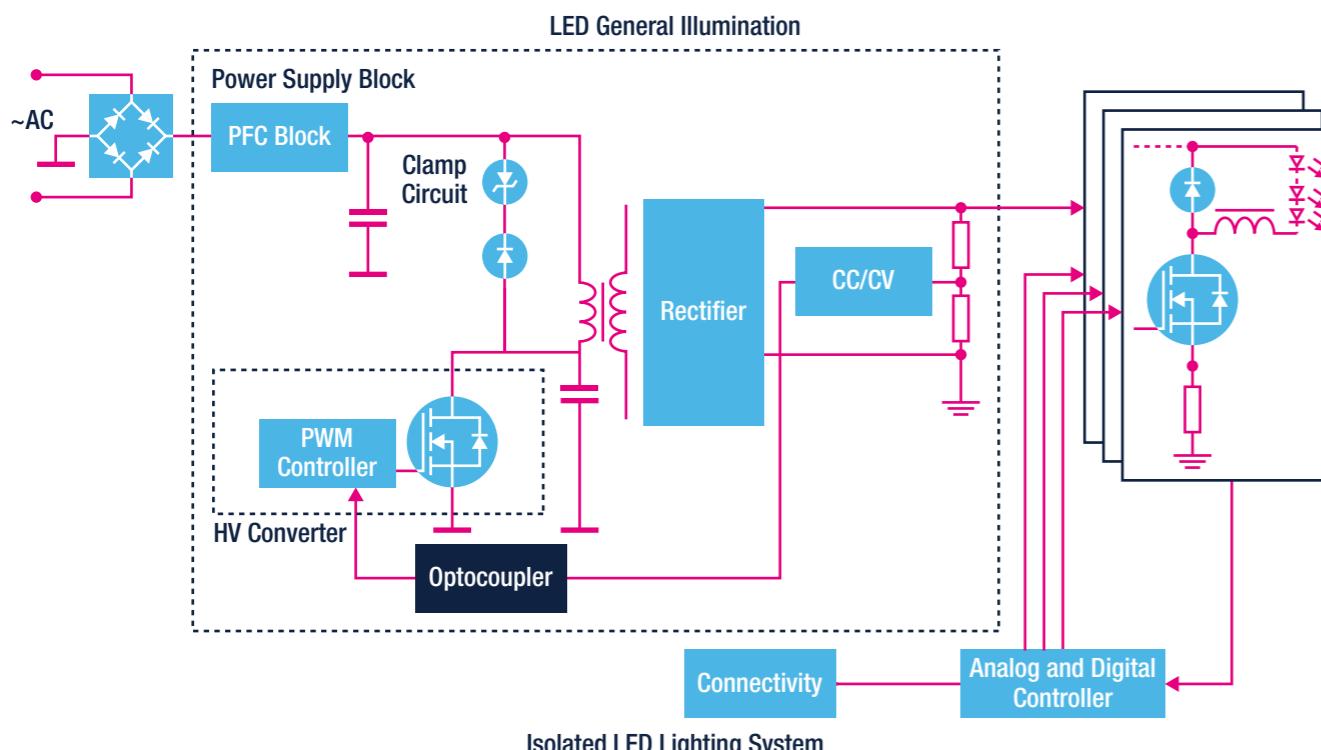
### LED General Illumination

LED lamps and bulbs can have a number of different form-factors, depending on the specific use, size, and dimensions of the application, including retrofit bulbs, high-bay lights, low-bay lights and emergency lights. Driving a string of LEDs involves AC-DC and DC-DC conversion designed using non-isolated, isolated, single stage or multi-stage topologies, which must ensure high efficiency and reliability at a competitive cost point.

Modern applications include a range of connectivity features to implement remote monitoring and control, making LED lighting a pillar of smart home, smart building and smart city environments. ST portfolio includes a variety of RF transceivers, wireless MCUs, network processor ICs and fully certified modules for key wireless connectivity technologies. Our embedded software for BLE Mesh enables mesh networking of connected smart lighting end products.

For the LED driving stage, we have a range of pulse-width modulation (PWM) and power factor correction (PFC) controllers, power MOSFETs and diodes, as well as a comprehensive set of hardware evaluation and development tools, including reference designs to help developers design high-efficiency LED lighting solutions.

### Typical Block Diagram



### ST product offering for LED General Illumination

	Controllers	Power MOSFETs	Diodes	MOSFET and IGBT Gate Drivers
PFC Block	TM Analog Controllers L6562*, L6563*, L6564* CCM Analog Controllers L4985, L4986, L4981*, L4984D MCUs & Digital Controllers STM32F0, STM32G0, STM32F301, STM32F334, STM32G4, STLUX, STNRG388A	650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP 800 V MDmesh K6 ST*80*K6 800 V to 1200 V MDmesh K5 ST*80K5, ST*9K5, ST*105K5, ST*120K5 650 V SiC MOSFETs SCT**65G3AG, SCT*N65G2	600 V Ultrafast for TM STTH*L06, STTH*06, STTH15AC06* 600 V Ultrafast for CCM STTH*R06, STTH*T06 SiC Diodes STPSC*065	Single LS Gate Drivers PM881* Multiple LS Gate Drivers PM8834
Isolation Stage	Offline LED Drivers HVLED101, HVLED001A/B, HVLED007, HVLED8* HV Converters VIPerOP, VIPer*1, VIPer*6, VIPer122, VIPer222, VIPer*5, VIPer*7, VIPer*8 LLC Analog Controllers L6599*, L6699 PFC & LLC/LCC Combo Controllers STCMB1, STNRG011, STNRG011A, STNRG012 MCUs & Digital Controllers STM32F0, STM32G0, STM32F301, STM32F334, STM32G4, STM8S, STLUX, STNRG388A SR Analog Controllers SRK1000, SRK1001 for Flyback SRK2000A, SRK2001, SRK2001A for LLC	600 V MDmesh DM9 ST*60N*DM9 600 V MDmesh DM6 ST*60DM6 600 V-650 V MDmesh DM2 ST*60M2, ST*65M2 950 V MDmesh DK5 ST*95DK5 650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP 800 V MDmesh K6 ST*80*K6 800 V to 950 V MDmesh K5 ST*80K5, ST*9K5 60 V-100 V STripFET F7 ST*N6F7, ST*N8F7, ST*N10F7 Integrated Smart GaNs 600 V MASTERGAN*	Clamping Diodes for Flyback 600 V to 1000 V Ultrafast STTH*06, STTH*08, STTH*10 Output Diodes for Flyback Schottky, FERD, Ultrafast STPS*, FERD*, STTH* Output Diodes for LLC/LCC Schottky, FERD STPS* FERD*45, FERD*50, FERD*60, FERD*100 MOSFET Protection for Flyback SMAJ, SM6T, SM15T series SCR protection switch TNx015H-6"	Voltage Reference, CC/CV Ctrl Signal Conditioning TSB*, TSX*, TSV* MOSFET and IGBT Gate Drivers HV HB Gate Drivers L649* Isolated Gate Drivers STGAP* Multiple LS Gate Drivers PM8834
Multiple strings management	Offline LED Drivers HVLED002 MCUs & Digital Controllers STM32F0, STM32G0, STM32F334, STM32G4, STM8S, STLUX, STNRG388A	600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 STripFET F7 ST*N4F7, ST*N6F7, ST*N10F7	Schottky Diodes STPS* FERD Diodes FERD* ≥ 200 V Ultrafast Diodes STTH*	HV HB Gate Drivers L649*, L6395 Single LS Gate Drivers PM881* Multiple LS Gate Drivers PM8834
Wireless Connectivity	BLE 5.2 SoC BlueNRG-1, BlueNRG-2 BlueNRG-LP, BlueNRG-LPS BLE Network Processor BlueNRG-2N Baluns BALF-NRG-0*D3, BALF-NRG-02J5 Dual core MCUs BLE 5.2 STM32WB IPD (Integrated Passive Device) MLPF-WB5-01E3, MLPF-WB5-02E3	BlueNRG Modules BlueNRG-M0 BlueNRG-M2 STM32 Wireless Module STM32WB5MMG	2.4 GHz Dual Core Wireless MCUs STM32WB	Sub-1GHz Wireless MCU STM32WL Sub-1GHz Transceivers S2-LP, SPIRIT1 MCUs STM32F0, STM32G0, STM32L0 Baluns BALF-SPI-0*D3, BALF-SPI2-0*D3

### Main application boards



**EVLHVLED007W35F**  
35 W LED driver with very low THD, based on Transition Mode Flyback converter (CVout)



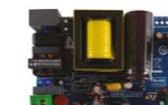
**EVAL-PSR01B-35W**  
35 W LED Driver with very high efficiency based on QR flyback converter with PSR (CVout)



**EVAL-SSR01B-35W**  
35 W LED Driver with very high efficiency based on QR flyback converter with SSR (CC / CV)



**EVAL-IBD002-35W**  
35 W Inverse buck with LED current control and with Analog/PWM dimming



**STEVAL-LLL012V1**  
Smart LED driver with high power factor using BLE Mesh network for indoor lighting



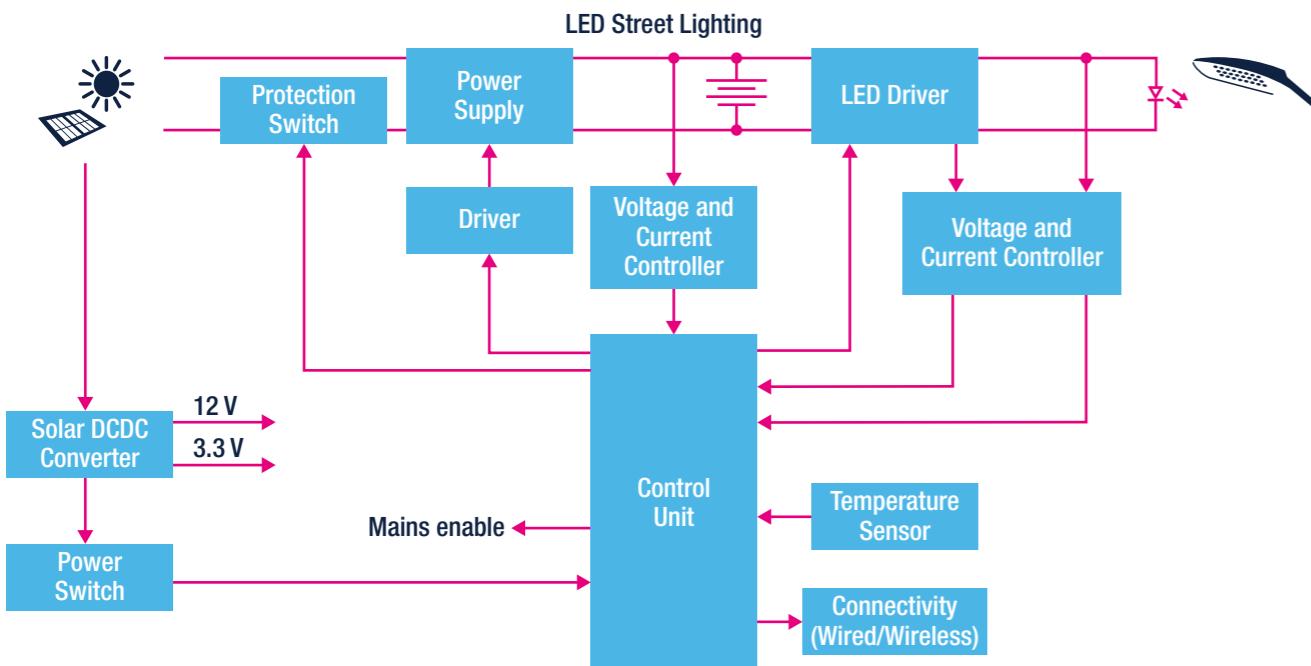
**STEVAL-ILL078V1**  
1A, up to 60 V Vin, buck LED driver with digital dimming

## LED Street Lighting

Street lighting installations have evolved from basic energy-hungry illumination spots to central devices enabling a set of services, such as presence and traffic-level monitoring and incident-detection surveillance, while optimizing illumination levels to specific road and weather conditions to support administrations in transforming cities in smart cities.

We have a broad range of wired and wireless connectivity, power management, and LED driving solutions. A range of high-performance and low-power STM32 microcontrollers, together with presence, proximity, camera, and environmental sensors, as well as MEMS microphones, enable design of advanced street lighting systems.

### Typical Block Diagram

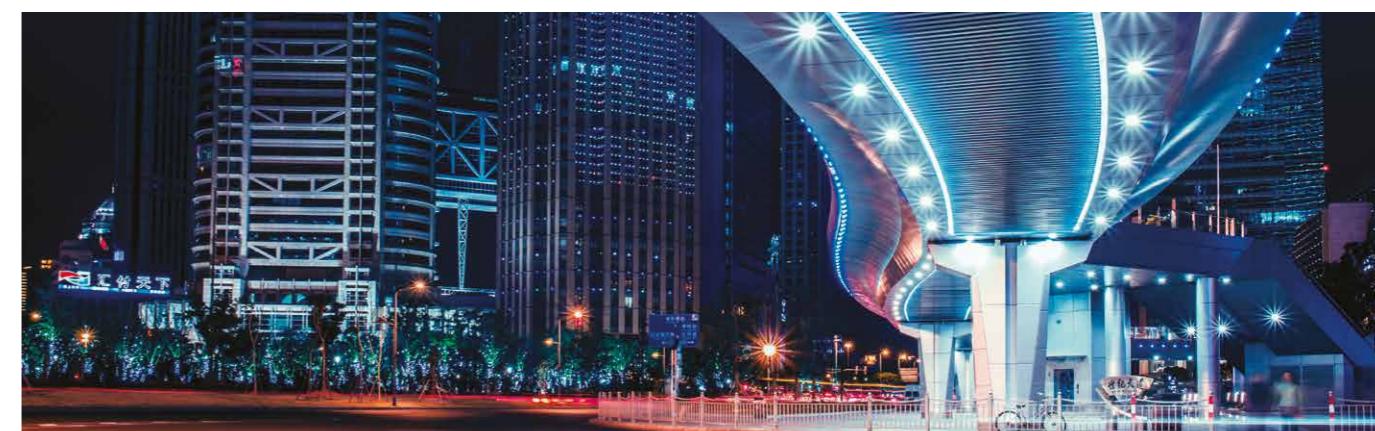


## ST product offering for LED Street Lighting

	Controllers	Power MOSFETs	Diodes & Protections	MOSFET and IGBT Gate Drivers
<b>Power Supply</b>	TM PFC Analog Controllers L6562*, L6563*, L6564* CCM PFC Analog Controllers L4985, L4986, L4981*, L4984D Offline LED drivers HVLED101, HVLED001B, HVLED001A, HVLED007 PFC & LLC/LCC Combo Controllers STCMB1, STNRG011, STNRG011A, STNRG012 LLC/LCC Controllers L6599A*, L6699 MCUs & Digital Controllers STM32F0, STM32G0, STM32F301, STM32F334, STM32G4, STLUX, STNRG388A SR Analog Controllers SRK1000, SRK1001 for Flyback SRK2000A, SRK2001, SRK2001A for LLC	600 V MDmesh DM9 ST*60N*DM9 600 V MDmesh DM6 ST*60DM6 600 V-650 V MDmesh DM2 ST*60DM2, ST*65DM2 650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP 800 V MDmesh K6 ST*80*K6 950 V MDmesh DK5 ST*95DK5 800 V to 1050 V MDmesh K5 ST*80K5, ST*9*K5, ST*105K5 650 V SiC MOSFETs SCT**65G3AG, SCT*N65G2 60 V-100 V STripFET F7 ST*N6F7, ST*N8F7, ST*N10F7 GaN Power ICs Integrated Smart GaNs 600 V MASTERGAN*	600 V Ultrafast for TM PFC STTH*L06, STTH*06, STTH15AC06* 600 V Ultrafast for CCM PFC STTH*R06, STTH*T06 SiC Diodes STPSC*065 Output Diodes for Flyback Schottky, FERD, Ultrafast STPS*, FERD*, STTH* Clamping Diodes for Flyback 600 V to 1000 V Ultrafast STTH*06, STTH*08, STTH*10 Output Diodes for LLC/LCC Schottky, FERD STPS*, FERD*45, FERD*50, FERD*60, FERD*100 MOSFET Protection for Flyback SMAJ, SM6T, SM15T series SCR protection switch TNx015H-6	HV HB Gate Drivers for GaNs STDRIVEG600 Single LS Gate Drivers PM88*1 Multiple LS Gate Drivers PM8834 HV HB Gate Drivers L649* Isolated Gate Drivers STGAP*
<b>Voltage Reference, CC/CV Ctrl</b>	Voltage Reference T*431, T*432	Voltage and Current Ctrl TSM*, SEA05*	Signal Conditioning	
<b>LED Driver</b>	Offline LED drivers HVLED002	DC-DC Buck LED Drivers LED5000, LED6000, ST1CC40, LED2000, LED2001	DC-DC Boost LED Drivers LED6001, LED7707, LED7708	LED Array Drivers STP04/08/16/24, STCS*, LED8102S
<b>Temperature Sensors</b>	STLM20 STTS751 LM135Z	Control Unit MCUs STM32F0, STM32G0	Protection Switch 60 V-100 V STripFET F7 ST*N6F7, ST*N8F7, ST*N10F7	Diodes & Discretes LBP01
<b>Connectivity</b>	Wired - Power Line Communication Power Line Transceivers ST7570, ST7580	Wireless - Sub-1GHz Sub-1GHz Wireless MCU STM32WL Sub-1GHz Transceivers S2-LP MCUs STM32L0, STM32L4 Baluns BALF-SPI2-0*D3, BALF-SPI2-0*D3	Wireless - Sigfox Sub-1GHz Wireless MCU STM32WL Sub-1GHz Transceivers S2-LP MCUs STM32L0, STM32L4 Baluns BALF-SPI2-0*D3, BALF-SPI2-0*D3	Wireless - LoRa LoRa Wireless MCU STM32WL Embedded Software I-CUBE-LRWAN Secure MCUs STSAFE-A100

Note: \* is used as a wildcard character for related part number

### Main application boards



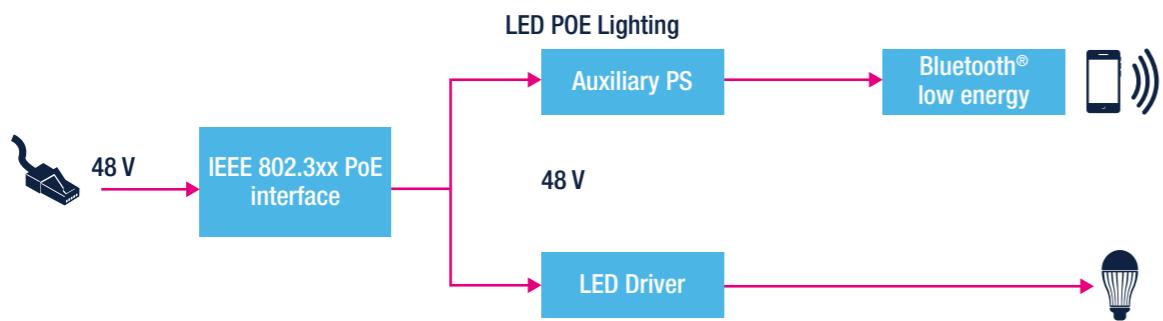
## LED POE Lighting

Power over Ethernet (PoE) is a widely adopted technology used to supply a powered device (PD) over an RJ-45 cable while carrying data. Described in the IEEE 802.3 standard and its enhancements including IEEE 802.3bt, IEEE 802.3at and IEEE 802.3af, this technology is becoming attractive for LED lighting.

We have a range of products providing a complete interface with all the functions required by the communication standard, including detection and classification, protection features such as under-voltage lockout (UVLO) and in-rush current limitation, as well as the control of hot-swap power MOSFETs that can greatly simplify the development of IEEE 802.3 compliant solutions for powered devices (PD). We also have high-efficiency and optimized DC-DC conversion solutions for supplying LEDs.



### Typical Block Diagram



### ST product offering for LED PoE Lighting

PoE Interface	Protections	Auxiliary Power Supply	LED Driver		Bluetooth LE
IEEE 802.3bt PM8805			Buck Converter L7983 L7987L	Buck LED6000, LED5000 Inverse Buck HVLED002	60 V-100 V STripFET F7 ST*N6F7, ST*N8F7, ST*N10F7 Schottky Diodes STPS*
IEEE 802.3at PM8803	TVS for Power Rail Surge Protection SMAJ, SM15T				Bluetooth Low Energy SoC, Wireless MCUs, Modules BlueNRG-*, STM32WB*
IEEE 802.3af PM8800A					

Note: \* is used as a wildcard character for related part number

## Lighting Controls

Lighting controls have evolved from simple triac dimmers to more sophisticated architectures, including light sensors, digital and PWM dimmers, DALI network-based systems, and wireless programming solutions.

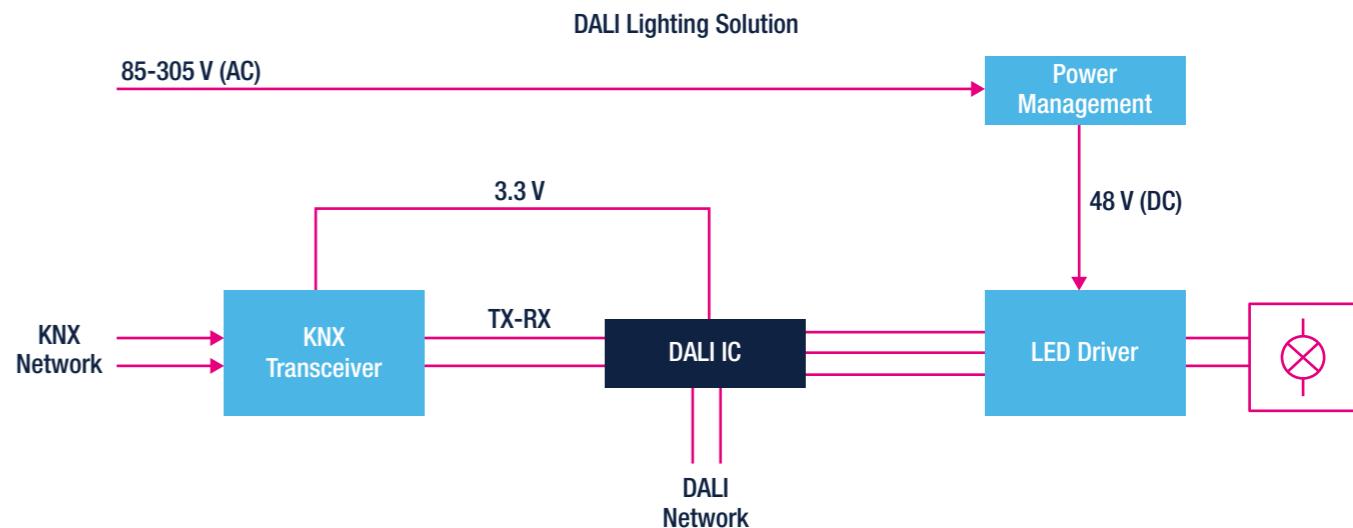
ST long-term partnerships with major lighting suppliers combined with our leadership in discrete and integrated power devices enable us to offer high efficiency and cost-optimized solutions for all types of lighting applications and their control, both wired (e.g. Powerline) or wireless (RF), for industrial, residential, commercial, and architectural lighting applications.

### DALI Lighting Solution

Digital Addressable Lighting Interface (DALI) is a trademark for a network-based technology used to effectively control lighting in building automation. Originally defined in IEC 60929 standards, it has been updated for IEC 62386, which includes LED device types.

We provide a range of analog and digital controllers, including the STLUX family and the STM32 microcontrollers to implement the AC-DC and DC-DC power converter and run the DALI protocol.

### Typical Block Diagram for DALI Lighting System



### ST product offering for Lighting Controls

LED Driver	Power Management	KNX Transceiver
Digital Controllers STLUX Development Tools STSW-STLUXLIB02, STSW-STLUXSMED02	MCUs STM32F1, STM32L1, STM8 Embedded Software STSW-DALI002, STSW-DALI001, STSW-STM8025	Refer to LED General Illumination section
		TVS Protection on KNX Bus SMAJ40CA-TR STKNX

### Main application boards



**STEVAL-POEL45W1**  
45 W PoE powered LED lighting with BLE control



**STEVAL-ILL078V1**  
1 A, up to 60 V in, buck LED driver board based on the LED6000



**STEVAL-ILL056V1**  
3 A Buck LED driver board based on the LED5000

### Main application boards



**STEVAL-ILL066V2**  
100 W LED street lighting evaluation board with DALI2.0 communication interface using the STLUX385A digital controller



**STEVAL-ILM001V1**  
Plug-in hardware module for the STM8S-DISCOVERY interface for DALI communication



**EVALKITSTKNX**  
Miniature transceiver STKNX evaluation and development kit

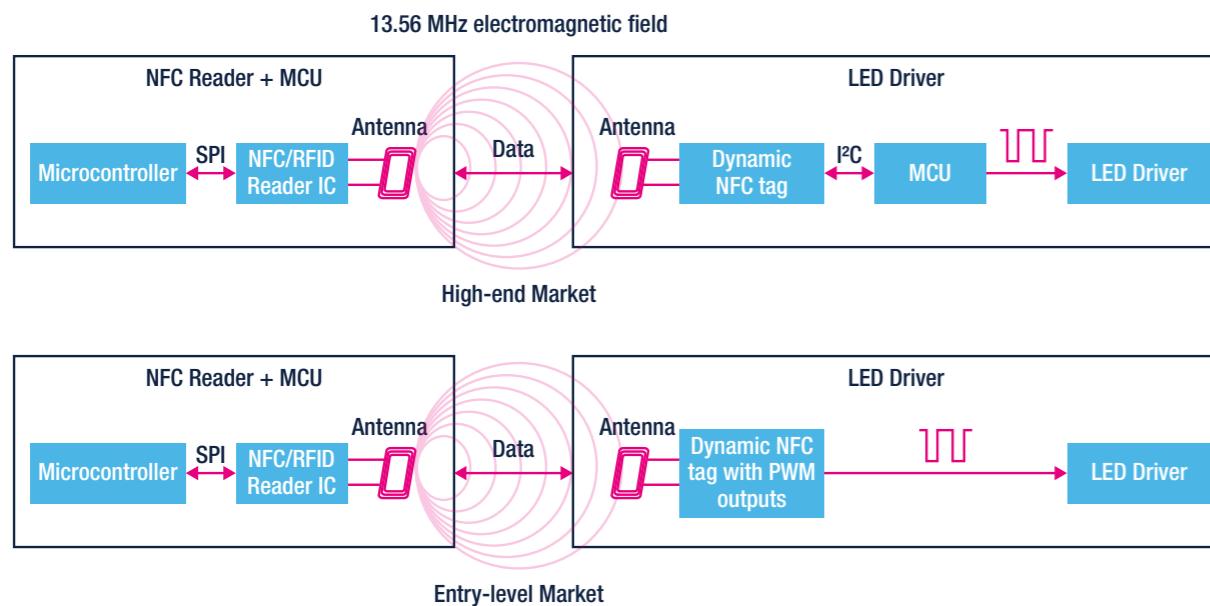
## LED Wireless Programming

Today's smart LED bulbs let users control features including brightness and color. These properties are controlled through the driver and can be programmed and modified at any time during manufacturing, distribution, installation, or maintenance.

The use of NFC technology enables wireless programming using a smartphone, tablet, or portable RFID/NFC reader, without having to power up the LED driver and brings enhanced flexibility and energy savings in addition to reducing development time and cost.

STMicroelectronics offers optimized and complete LED driver programming solutions with its comprehensive NFC portfolio, fully addressing the lighting market and featuring all the functions needed for wireless LED programming.

### Typical Block Diagram of LED Wireless Programming



## ST product offering for LED Wireless Programming

	NFC/RFID Reader IC	Protections	Microcontrollers	LED Driver
NFC Reader + MCU	ST25R	Antenna Protection Reader: ESDZV18-1BF4 Tag: USBULC6-2M6	STM8S STM32F0, STM32G0	HVLED101, HVLED001*, HVLED002 LED600*, LED5000, LED2000 STP04/08/16/24
	Dynamic NFC Tag		MCUs and Digital Controllers STM8S STM32F0, STM32G0 STM32F3, STM32F334, STM32G4 STLUX	
LED Driver for high-end market	ST25DV-I <sup>C</sup> Series		STM8S STM32F0, STM32G0 STM32F3, STM32F334, STM32G4 STLUX	HVLED101, HVLED001*, HVLED002 LED600*, LED5000, LED2000 STP04/08/16/24, LED12/16/24*, LED8102S
	Dynamic NFC Tag with PWM Output			
LED Driver for entry-level market	ST25DV-PWM Series			

Note: \* is used as a wildcard character for related part number

### Main application boards



**ST25R3911B-DISCO**

Discovery kit for ST25R3911B high performance HF reader/NFC



**ST25DV-PWM-eSET**

Discovery kit for the ST25DV-PWM NFC/RFID tag IC

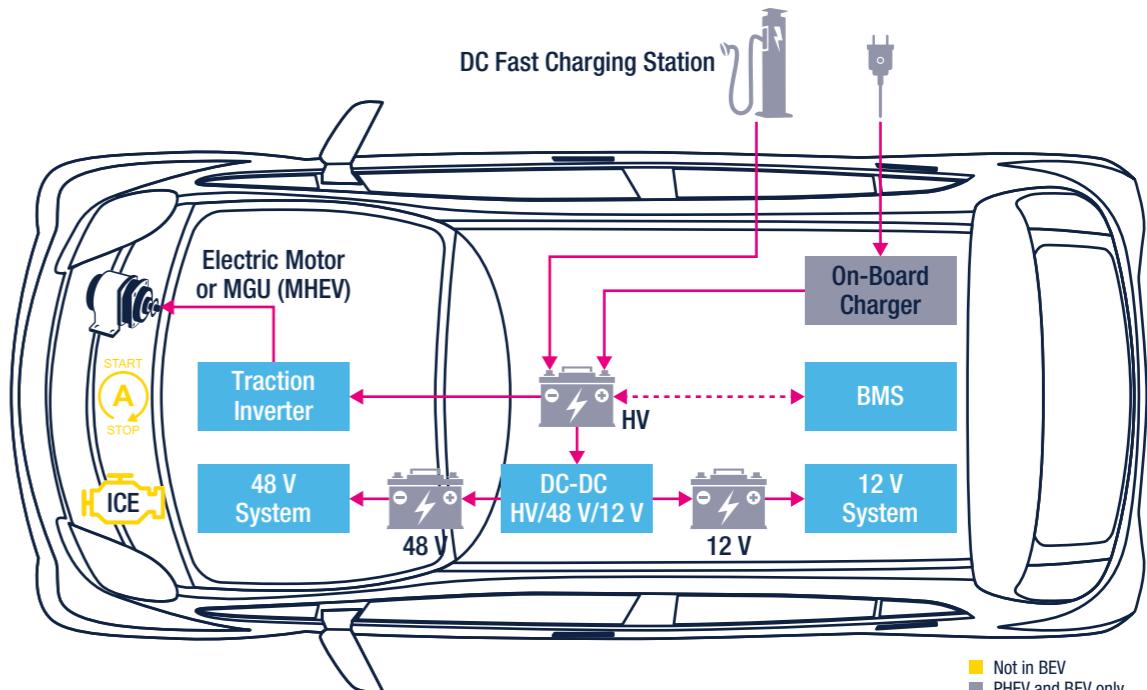


**ST25DV64KC-DISCO**

Discovery kit for the ST25DV64KC dynamic NFC/RFID tag

## ELECTRO-MOBILITY

### Key applications



### Solutions

ST key products and solutions for Electro-Mobility applications include:



HW & SF Development Tools – Sample Kits, Evaluation Kits, Product Selectors



### FIND OUT MORE

[www.st.com/electro-mobility](http://www.st.com/electro-mobility)

Battery Management System (BMS)  
Charging Station  
DC-DC Converter  
Small Electric Vehicles  
Electric Traction (Main Inverter)  
Mild Hybrid 48 V Systems



On Board Charger (OBC)  
Acoustic Vehicle Alerting System (AVAS)  
HV Battery Disconnect & Fire-off System  
Vehicle Control Unit (VCU)

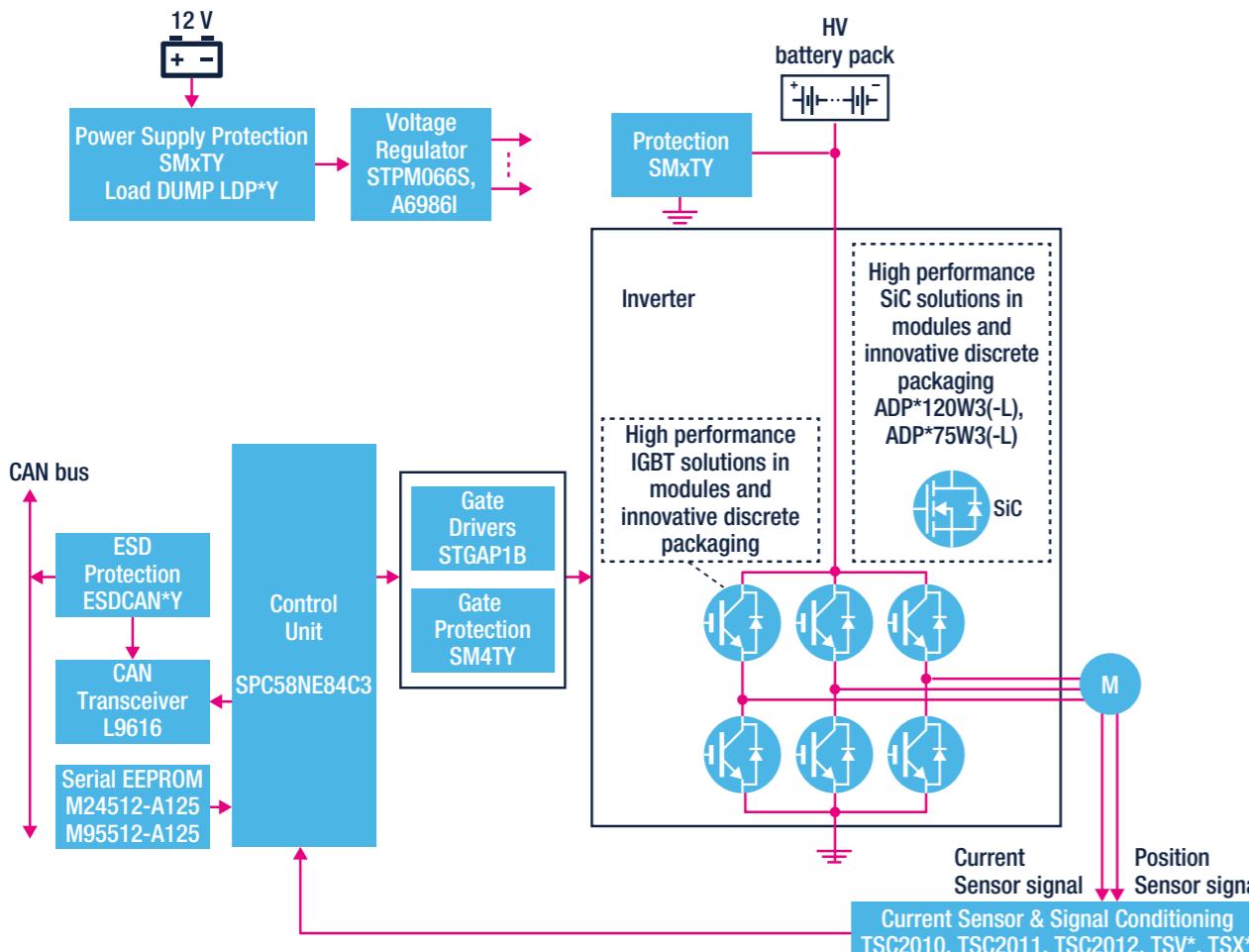
## Main Traction Inverter

The traction inverter converts energy from the vehicle battery to drive the electrical engine. This key component has a direct impact on vehicle road performance, driving range, and reliability, which also depends on inverter weight and size.

Subject to all the possible stress found in a road vehicle from heat and vibrations, these converters must be able to handle high power and current along with the associated Electro Magnetic Compatibility (EMC) challenges, as well as provide fail-safe operation to ensure reliability and safety for the driver and passengers.

To help developers increase inverter power efficiency and reduce size and weight, ST has a wide portfolio of discrete semiconductors, including AEC-Q101 qualified silicon and silicon carbide (SiC) MOSFETs and diodes, as well as IGBTs. These are complemented by AEC-Q100 qualified galvanically isolated IGBT and MOSFET gate drivers and SPC5 32-bit automotive microcontrollers for implementing scalable, cost-effective, and energy-efficient solutions. Furthermore, ST offers a compact and high-power-density solutions with the 750V and 1200V ACEPACK DRIVE power modules based on SiC Gen3 technology.

### Typical Block Diagram - Main Inverter



Note: \* is used as a wildcard character for related part number

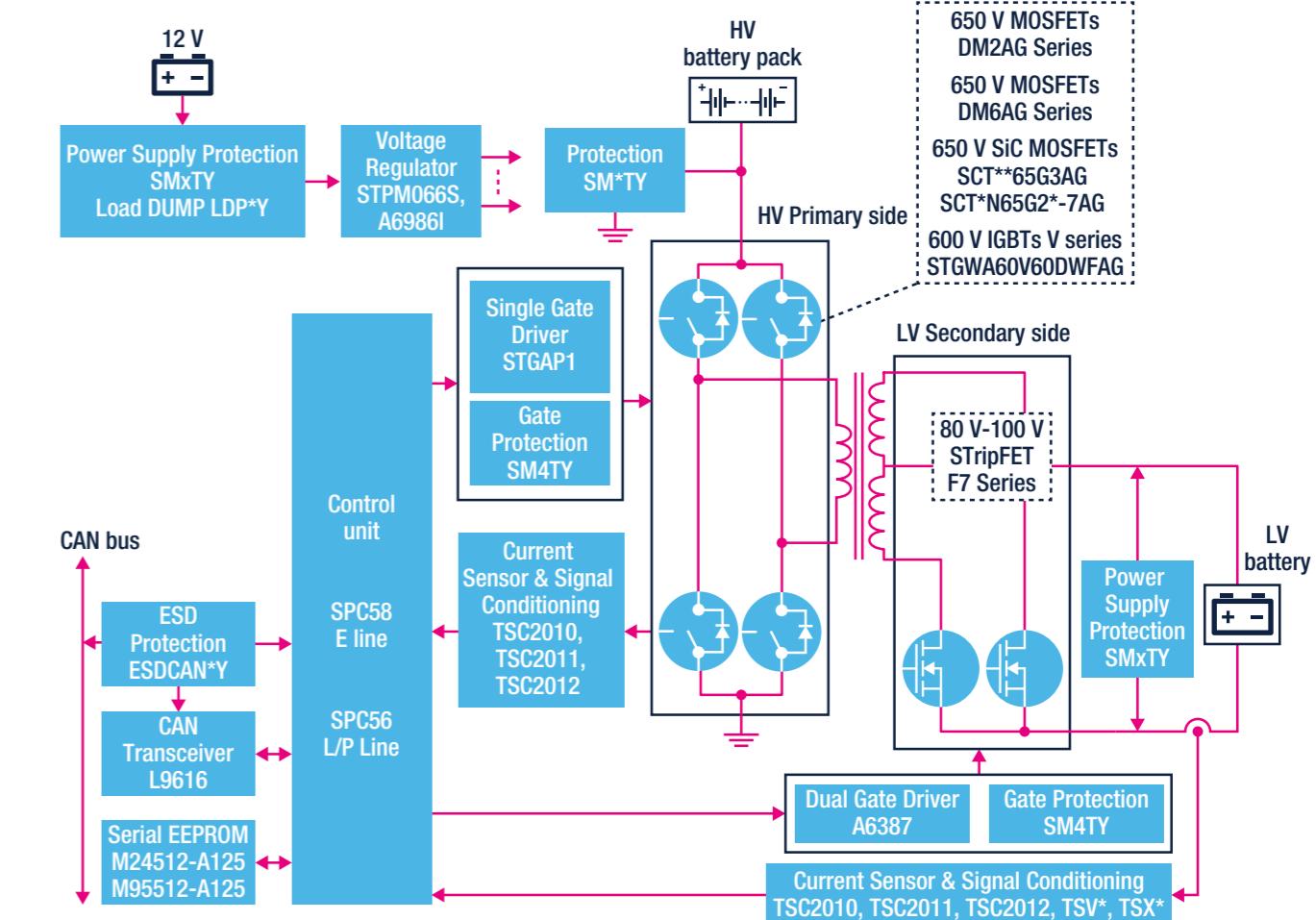
## Bidirectional DC/DC Converter

Electric vehicles (EV) use two different power systems, a high-voltage battery (200 to 800 V<sub>DC</sub>) for traction and a low-voltage (12/48 V) one for supplying all the electric appliances in the vehicle. Traditionally, the low-voltage battery was charged from the alternator, but in today's vehicles, it gets its power from the high-voltage battery pack. However, in specific electric car architectures, this low-voltage battery should be ready to help recharge the high-voltage battery pack in order to provide energy for cranking the car. This means that the on-board DC-DC converter must be bidirectional and very efficient, as well as highly reliable in order to run the complex control algorithms needed to ensure an energy-efficient solution.

ST has a wide offer of discrete semiconductors including AEC-Q101 qualified silicon and silicon carbide (SiC) MOSFETs and diodes, as well as IGBTs. These are complemented by AEC-Q100 qualified galvanically isolated IGBT and MOSFET gate drivers and SPC5 32-bit automotive microcontrollers to enable scalable, cost-effective, and energy-efficient solutions for implementing these challenging converters.



### Typical Block Diagram - Bidirectional DC/DC Converter



Note: \* is used as a wildcard character for related part number



## FIND OUT MORE

[www.st.com/main-inverter-electric-traction](http://www.st.com/main-inverter-electric-traction)



## FIND OUT MORE

[www.st.com/bidirectional-dc/dc-converter](http://www.st.com/bidirectional-dc/dc-converter)

## 48 V Start-Stop System

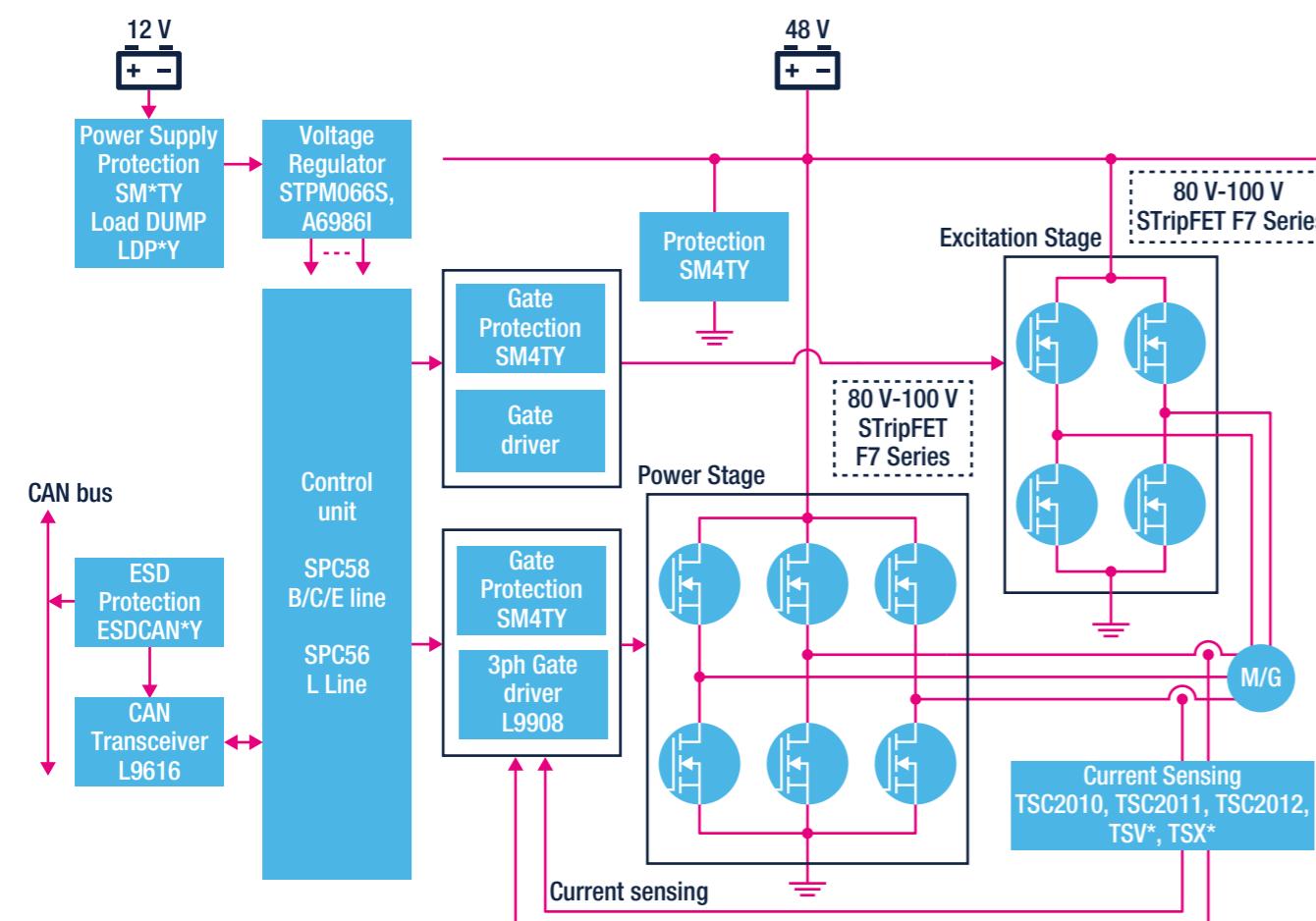
A start-stop system aims at reducing the amount of engine idle time by shutting down and restarting the internal combustion engine automatically when the vehicle stops. Thus, it contributes to improving fuel economy and reducing CO<sub>2</sub> emissions. This is especially useful in urban environments where vehicles can spend significant amounts of time in traffic.

Start-stop operations require power electronics that can handle high current during cranking and ensure reliability during start-stop cycles, operating on/off at high temperatures.

ST solutions include silicon power MOSFETs, protections, gate drivers, and microcontrollers in accordance with AEC-Q100 and AEC-Q101 standards.



### Typical Block Diagram - Start-Stop system



Note: \* is used as a wildcard character for related part number

## On-Board Charger (OBC)

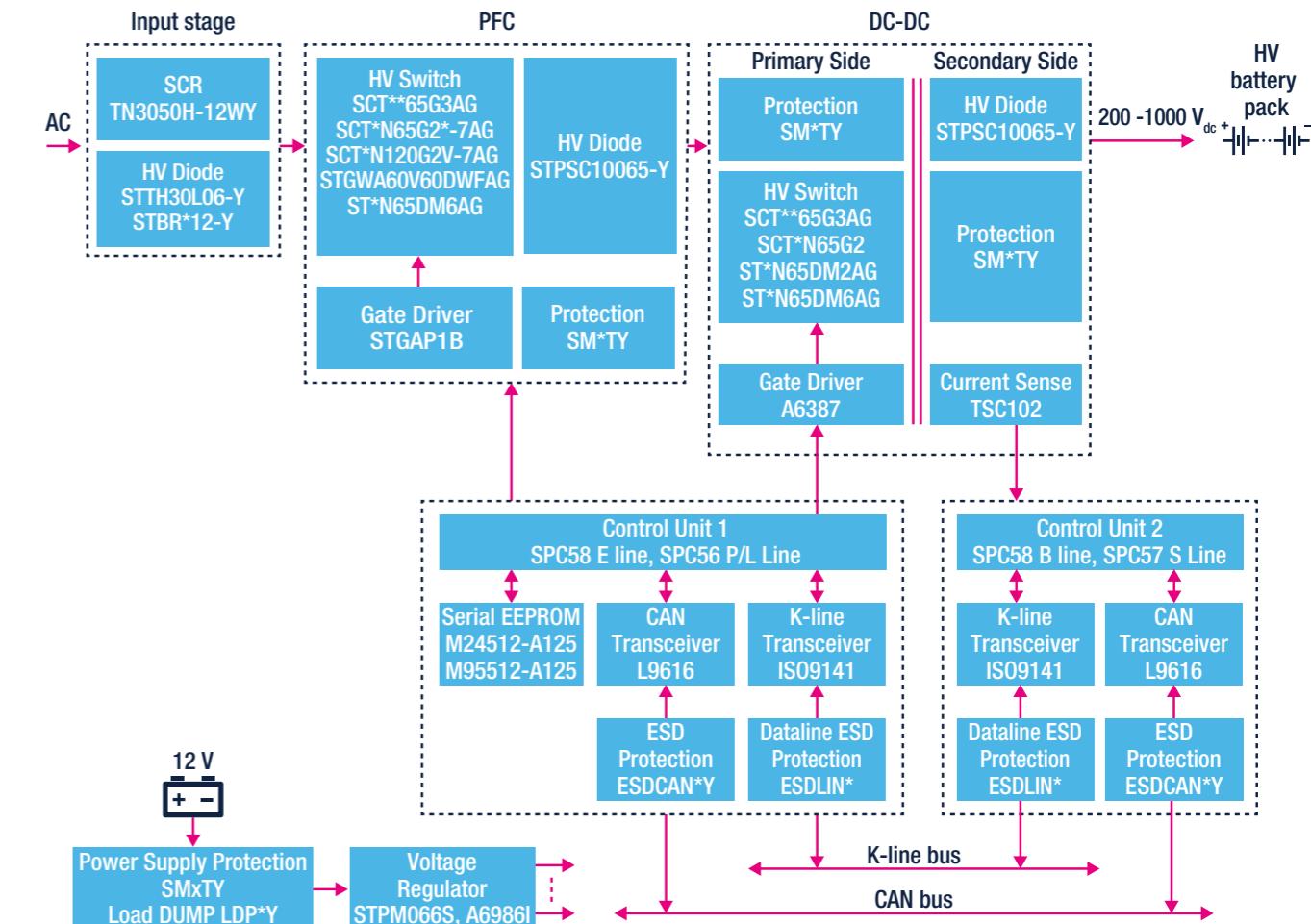
At the heart of any electric (EV) or plug-in hybrid (HEV) vehicle lies the high-voltage (200 to 800 Vdc) battery and its associated charging system. The on-board charger (OBC) provides the means to recharge the battery from the AC mains either at home or from outlets found in private or public charging stations.

From a 3.6 kW single-phase to a 22 kW three-phase high-power converter, today's OBCs must have the highest possible efficiency and reliability to ensure rapid charging times, as well as meet the limited space and weight requirements.

ST has a wide offer of discrete semiconductors, including AEC-Q101 qualified silicon and silicon-carbide (SiC) MOSFETs and diodes, as well as IGBTs. These are complemented by AEC-Q100 qualified galvanically isolated IGBT and MOSFET gate drivers and SPC5 32-bit automotive microcontrollers for implementing these challenging converters.



### Typical Block Diagram - OBC



Note: \* is used as a wildcard character for related part number

## FIND OUT MORE

[www.st.com/48v-start-stop-system](http://www.st.com/48v-start-stop-system)



## FIND OUT MORE

[www.st.com/on-board-charger](http://www.st.com/on-board-charger)



## Battery Management

Automotive Battery Management System (BMS) must be able to meet critical features such as voltage, temperature and current monitoring, battery state of charge (SoC), and cell balancing of lithium-ion (Li-ion) batteries.

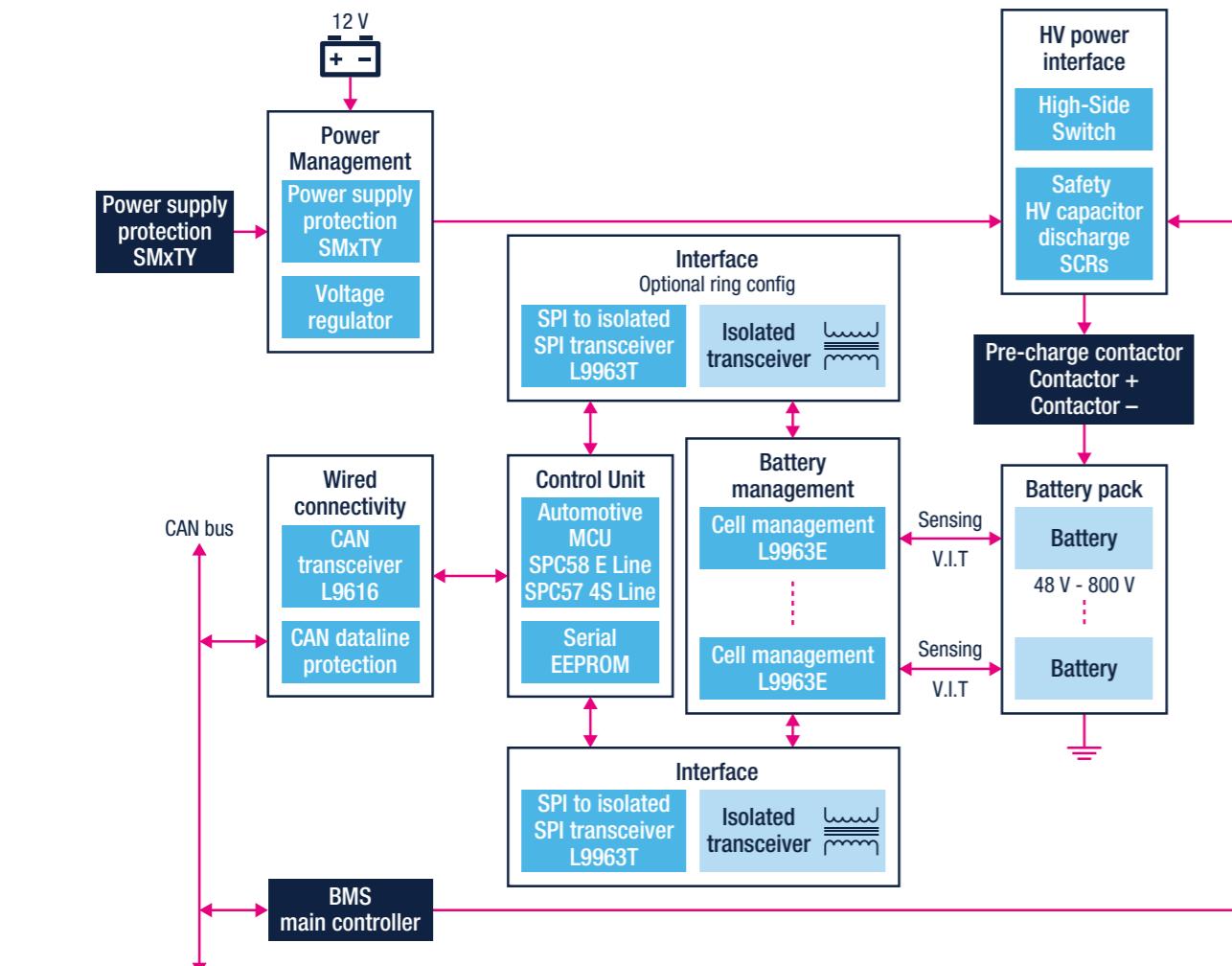
Indeed, the main functions of a Battery Management System for electric vehicles are:

- **Battery protection** in order to prevent operations outside its safe operating area
- **Battery monitoring** by estimating the battery pack state of charge (SoC) and state of health (SoH) during charging and discharging
- **Battery optimization** thanks to cell balancing that improves the battery life and capacity, thus optimizing the driving range for hybrid (HEV), plug-in (PHEV) and full electric vehicles (BEV)

A discharge circuit is present using a HV Power MOSFET (MDmesh K5) working in linear mode to discharge the battery in case of malfunctioning or accident.

ST25R NFC Reader and ST25D NFC dynamic tags will help fulfill government requirements in certain countries to track batteries for light electric vehicles (like EV motorbikes) and exchange data between the battery and the vehicle.

### Typical Block Diagram - Automotive Battery Management System (BMS)



### FIND OUT MORE

<https://www.st.com/en/applications/electro-mobility/automotive-battery-management-system-bms.html>



## DC Fast Charging Station

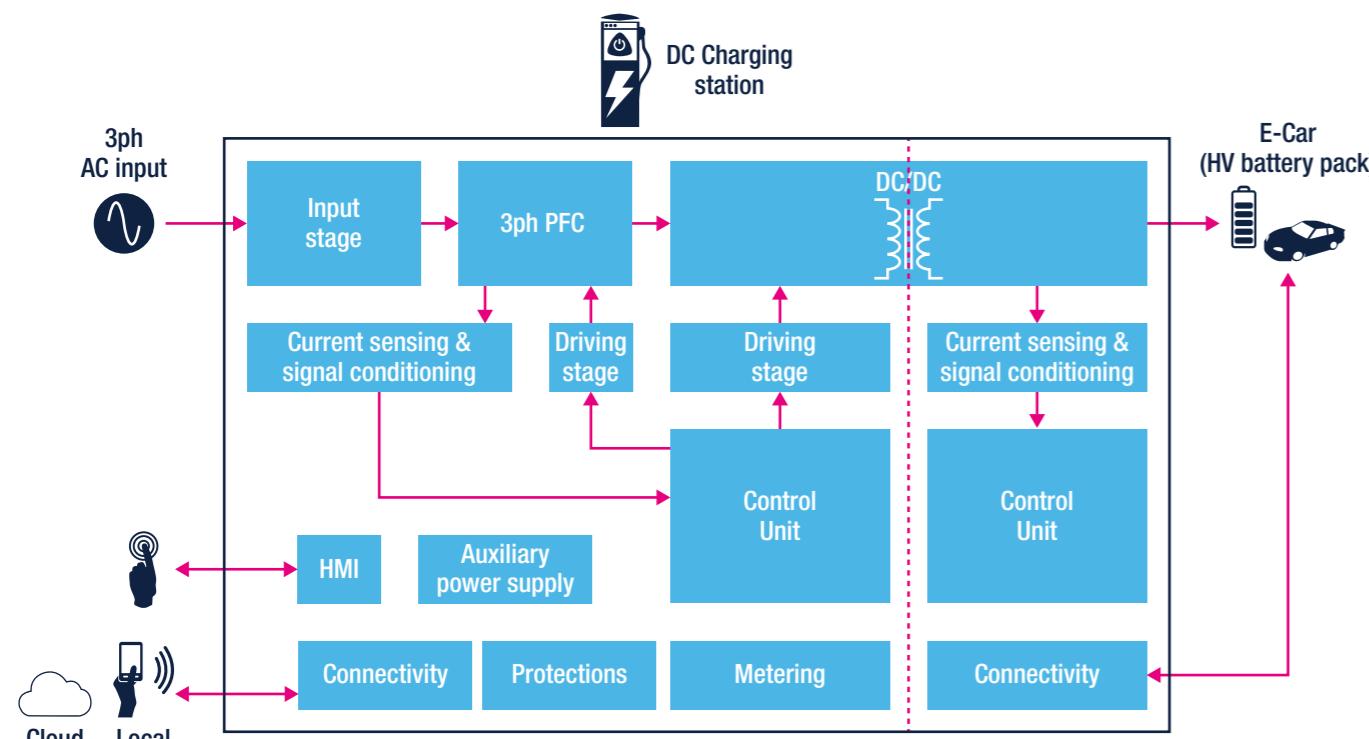
The number of full electric vehicles (EVs) is rapidly growing and, as a result, the charging infrastructure is also expanding, including DC fast charging stations, which have the attractive capability of providing the vehicle with a 100 km driving range in just 10-12 minutes.

While architectures based on renewable sources and battery storage technologies to take charging stations off-grid are emerging, mainstream solutions are fed from the grid, and a converter, in the range of 120 kW or more, has a 3-phase input Power Factor Correction (PFC) stage and an isolated DC-DC converter. DC Charging stations also provide secure connectivity and authentication with the vehicle.

We can provide a range of power discretes including silicon carbide (SiC) and silicon power MOSFETs and diodes, isolated gate drivers, as well as high-performance STM32 microcontrollers to help develop high-efficiency, high-power density DC charging stations.

ST25R NFC readers will help compliance with rules in certain countries to accept credit cards following the EMVCo standard or accept closed-loop payment and even track charging in private environments.

### Typical Block Diagram - DC Fast Charging Station



### Main application boards and reference designs



**STDES-PFCBIDIR**  
15 kW, three-phase, three-level Active Front End (AFE) bidirectional converter



**STDES-VIENNARECT**  
15 kW, three-phase Vienna rectifier with low cost mixed-signal control for power factor correction



**STDES-30KWVRECT**  
30 kW Vienna PFC rectifier reference design with digital control



**STEVAL-DPSTPFC1**  
3.6 kW PFC totem pole with digital inrush current limiter

## ST product offering for DC Fast Charging Station

	Input stage	3ph PFC	DC/DC		Control units		Driving stage	Current sensing & signal conditioning	Aux SMPS	HMI	Metering	Connectivity	
			1^ side	2^ side	1^ side	2^ side						1^ side	2^ side
<b>Rectifiers</b>	SiC series - 650 V				•								
	SiC series - 1200 V				•								
	Ultrafast RQ series - 600 V				•	•							•
	Ultrafast R series - 600 V				•	•							
	STBR series - 800 V/1200 V		•	•									
	Schottky series - 40/45/60/100 V												•
<b>Thyristors</b>	TN series - 1200 V				•								
	TYN series - 1200 V				•								
	TM8050H series - 800 V				•								
	TN3050H, TN6050HP series -1200 V				•								
<b>TVS protections</b>	SM4TY, SM6TY, SM15TY, SM30TY				•	•	•						•
	HMI ESD protections	ESDAXX Y series, EMIF06-1005MX12Y											•
<b>Power MOSFETs</b>	SiC series - 650 V/1200 V				•	•							
	M5 series - 650 V				•								
	M6 series - 600 V/650 V				•	•							
	DM6 series - 600 V/650 V				•								
	DM2 series - 600 V/650 V				•								
	K5 series - 1200 V				•								•
	M9 series - 650 V				•	•							
	DM9 series - 600 V				•								
	H series - 1200 V				•								
<b>IGBTs</b>	HB series - 650 V				•	•							
	HB2 series - 650 V				•	•							
	V series - 600 V				•	•							
	ACEPACK Power Modules	A2F12M12W2-F1, A2U12M12W2-F2, A1F25M12W2-F1			•	•							
<b>MCUs (32bit)</b>	STM32F334, STM32G4, STM32F3				•	•							
	STM32F0, STM32F1, STM32G0						•	•					
								•	•				
<b>Gate drivers</b>	L6491											•	
	STGAP2*											•	
<b>Iso Sigma-Delta ADC</b>	ISOSD61, ISOSD61L											•	
	TSC102, TSC2010, TSC2011, TSC2012, TSV*, TSZ*											•	
<b>Current sense amplifiers</b>	VIPer*7, VIPer*6, VIPer26K											•	
												•	
<b>HV converters</b>	L6566BH, STCH03											•	
	STPM066S, L5965, L9396, A6986I, A798*, A698*											•	
<b>Offline controllers</b>	ST7540, ST7580, ST8500											•	
												•	
<b>Voltage regulators</b>	L9616											•	
	ST2100											•	
<b>CAN transceivers</b>	ESDCAN Y Series											•	
	ST7540, ST7580, ST8500											•	
<b>Power line transceivers</b>	BlueNRG-* MCUs	BlueNRG-* STM32WB5*										•	
	STM32 Wireless Module	STM32WB5MMG										•	
	Modules	BlueNRG-M0, BlueNRG-M2										•	
<b>NFC/RFID</b>	Dynamic tags	M24SR, ST25DV-I2C										•	
	Readers	ST25R										•	
<b>Metering ICs</b>	STPM32, STPM33, STPM34, STPM32, STIS0621											•	
												•	
<b>LED array drivers</b>	LED1642, STP08, STP16, LED77*, LED8102S, LED1202, STLED316S											•	
												•	

Note: \* is used as a wildcard character for related part number

## INDUSTRIAL POWER & TOOLS

### Industrial Welding

Arc welding is an assembling process that joins metal parts by causing their fusion through high-current flowing through the electrode and the base material. The current, either DC or AC, is generated by a specifically designed high-frequency inverter switched mode power supply (SMPS), usually based on half-bridge, full-bridge, and two-transistor forward topologies.

The main requirements in an SMPS for welding are high efficiency and reliability, as well as power density to enable lighter and more compact designs.

We have a range of power MOSFETs and diodes – both Si and SiC based for higher efficiency – and IGBTs as well as galvanically isolated gate drivers and high-performance 32-bit STM32 microcontrollers to enable compact designs with higher efficiency.

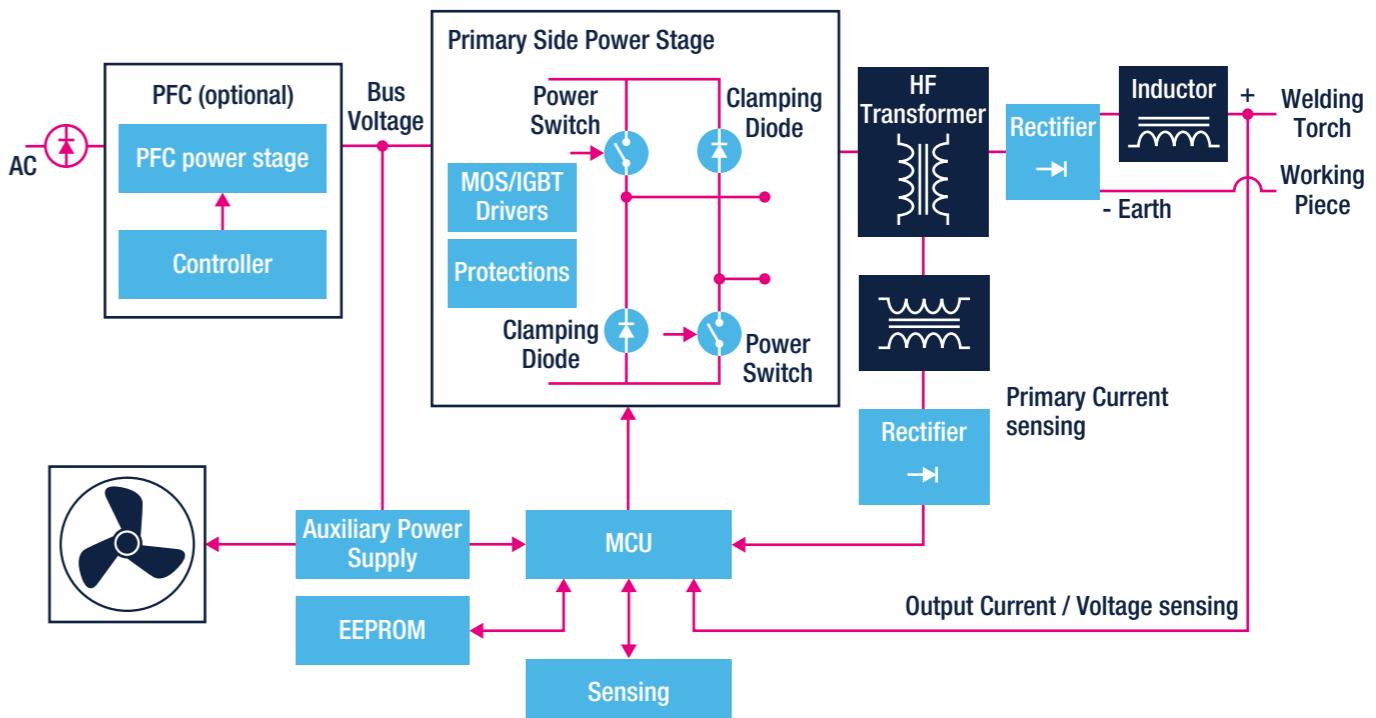


### ST product offering for Industrial Welding

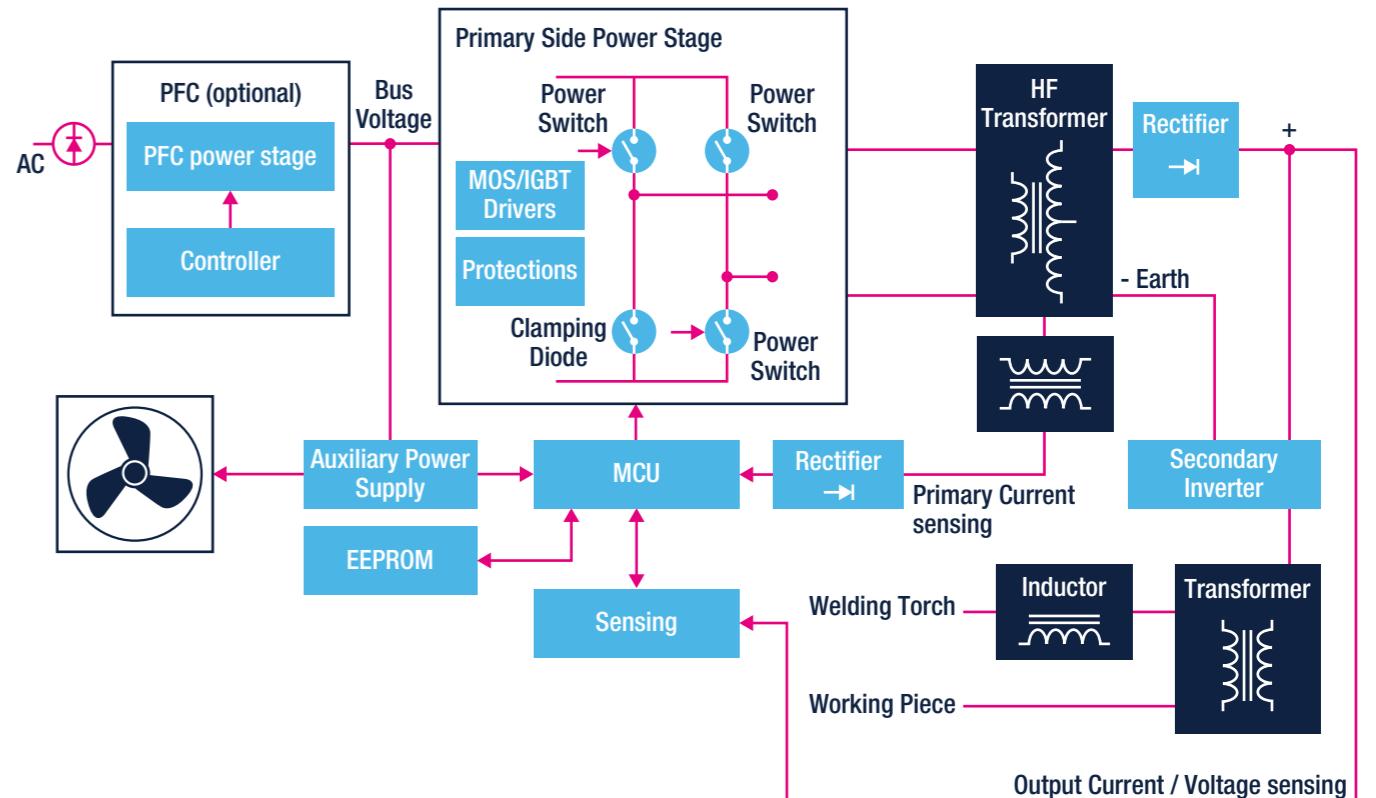
	MCUs & Digital Controllers	MOSFET/IGBT Gate Drivers	IGBTs & Power Modules	Power MOSFETs	Diodes & Protections
PFC	MCUs STM32F0 STM32G0 STM32F301 STM32F334 STM32G4  Digital Controllers STNRG388A	Single LS Gate Drivers PM88*1, TD35*  Multiple LS Gate Drivers PM8834  Isolated Gate Drivers STGAP*  HV HB Gate Drivers L649*	600 VV series STG*V60F  650 V HB series STG*HP65FB  650 V HB2 series STG*HP65FB2  1200 V H series STG*H120F2	650 V MDmesh M9 ST*65N*M9  600 V-650 V MDmesh M6 ST*60M6, ST*65M6  600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP  650 V MDmesh M5 ST*65M5  650 V-1200 V SiC MOSFETs SCT*65G3AG, SCT*N65G2, SCT*120G3AG, SCT*N120G2, SCT*N120	600 V Ultrafast STTH*W06, STTH*R06, STTH*T06  1200 V Ultrafast STTH*S12  SiC Diodes STPSC*065, STPSC*H12  TVS for Power Rail Surge Protection SM*T, SMC30J series
DC-DC TTF			600 VV series STG*V60DF  650 V HB series STG*H65DFB  650 V HB2 series STG*H65DFB2  1200 V H series STG*H120DF2  ACEPACK Power Modules Customized Modules	600 V MDmesh DM9 ST*60N*DM9 600 V-650 V MDmesh DM6 ST*60DM6, ST*65DM6 600 V-650 V MDmesh DM2 ST*60DM2, ST*65DM2  650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP  650 V MDmesh M5 ST*65M5 950 V to 1050 V MDmesh DK5 ST*95DK5, ST*105DK5 800 V MDmesh K6 ST*80*K6 800 V to 1200 V MDmesh K5 ST*80K5, ST*9*K5, ST*105K5, ST*120K5  650 V-1200 V SiC MOSFETs SCT*65G3AG, , SCT*N65G2, SCT*120G3AG, SCT*N120G2, SCT*N120	600 V Ultrafast STTH*R06, STTH*W06 1000-1200 V Ultrafast STTH*10, STTH*12  TVS for Power Rail Surge Protection SM*T, SMC30J series
DC-DC PS-FB	STM32F334 STM32G4 STM32F301 STM32F1 STM32F3	Isolated Gate Drivers STGAP*  HV HB Gate Drivers L649*	600 VV series STG*V60DF  650 V HB series STG*H65DFB  650 V HB2 series STG*H65DFB2	600 V-650 V MDmesh M2 ST*60M2, ST*65M2, ST*60M2-EP 600 V-650 V MDmesh DM2 ST*60DM2, ST*65DM2 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V MDmesh DM6 ST*60DM6	200 V to 400 V Ultrafast STTH*W02, STTH*W03, STTH*W04  Power Schottky High Temperature STTH*10, STTH*12  TVS for Power Rail Surge Protection SM*T, SMC30J series
Secondary Inverter					

Note: \* is used as a wildcard character for related part number

Typical configuration for Single-Phase Architecture for Low/Medium Power Welding



Typical configuration for Single and Three-Phase Architectures for Medium/High Power Welding



## Uninterruptable Power Supplies (UPS)

Uninterruptable Power Supplies (UPS) ensure continuity of supply by converting the DC voltage from a battery or battery bank to an AC voltage with the requested amplitude and frequency in case of power outages.

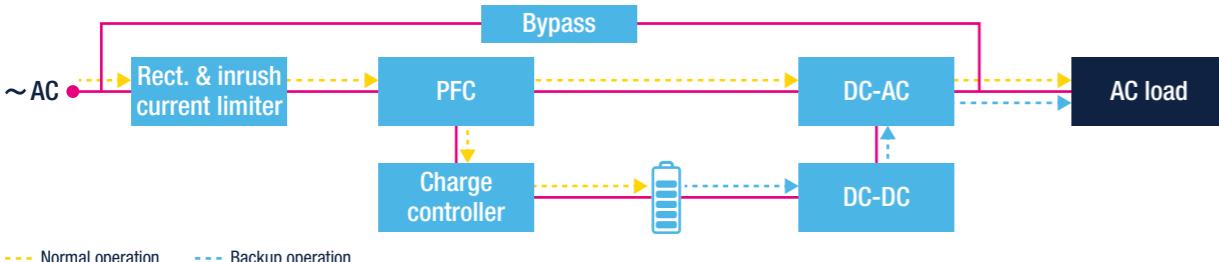
Depending on application requirements, an UPS can be built with a simple off-line configuration or with a double conversion online method for high-end, medium, or high-power UPSs. This also improves the quality of the power supplied to sensitive loads, including computers, servers, smart industry machines, instrumentation, and telecommunication equipment. We offer high-performance discrete devices, including high- and low-voltage power MOSFETs, IGBTs, thyristors, and silicon carbide (SiC) diodes and power MOSFET as well as galvanically-isolated and high-voltage gate drivers, PFC controllers, and high-performance STM32 microcontrollers to enable high-efficiency, high-reliability UPS designs.

## ST product offering for Uninterruptable Power Supplies (UPS)

	SCRs & TRIACs		Diodes			SCRs & TRIACs	
Rect. & inrush current limiter	High Temp. SCR TN*015H-6, TN*050H-8, TN*050H-12W High Temp. Triacs T1635T		Bridge Rectifier Diodes STBR*08, STBR*12		Bypass	Standard SCR TYN6*, TYN8*, TYN10*, TYN12* High Temp. SCR TN5050H-12WY Standard and Snubberless Triacs T2550-12, TPDV*	
	MCUs & Digital Controllers	Power MOSFETs	IGBTs	Diodes	Opamp V/I Sensing	Protections	
PFC Block	MCUs STM32F0, STM32G0, STM32F301, STM32F334, STM32G4 Digital Controllers STNRG388A	650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2 650 V MDmesh M5 ST*65M5 650 V - 1200 V SiC MOSFETs SCT*65G3AG, SCT*N65G2, SCT*120G3AG, SCT*N120G2, SCT*N120	600 V V series STG*V60F 650 V HB series STG*HP65FB 650 V HB series STTH*R06 1200 V Ultrafast STTH*12 1200 V H series STG*H120F2	600 V Ultrafast for CCM STTH*R06 STTH*T06 Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1 HV HB Gate Drivers L649* Isolated Gate Drivers STGAP*	Precision Op Amps (<50 MHz) TSZ*, TSV*, TS9*, LMV* <b>MOSFET and IGBT Gate Drivers</b>	TVS for Power MOSFET Protection SMAJ, SM6T, SM15T series	
		600 V MDmesh DM9 ST*60N*DM9 600 V-650 V MDmesh DM6 ST*60M6, ST*65M6 600 V-650 V MDmesh DM2 ST*60M2, ST*65M2 650 VMDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2	600 V Ultrafast STTH*06 1200 V Ultrafast STTH*12	600 V Ultrafast STTH*06 1200 V Ultrafast STTH*12	HV HB Gate Drivers L649* Isolated Gate Drivers STGAP*		
		600 V series STG*V60DF 650 V HB series STPSC*065 650 V HB series STG*H65DFB2 650 V HB series STG*H65DFB2 1200 V H series STG*H120DF2	600 V series STG*V60F 650 V HB series STG*HP65FB 650 V HB series STG*H65FB2 650 V HB series STG*H65FB2 1200 V H series STG*H120F2	Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1 HV HB Gate Drivers L649* Isolated Gate Drivers STGAP*	<b>MOSFET and IGBT Gate Drivers</b>		
		650 V-1200 V SiC MOSFETs SCT*65G3AG, SCT*N65G2, SCT*120G3AG, SCT*N120G2, SCT*N120	600 V series STG*V60DF 650 V HB series STG*H65DFB 650 V HB series STG*H65DFB2 1200 V H series STG*H120DF2	DC-DC Converters L698*, ST1S14, L7983, L7985, L7986, L7987* Low Dropout (LDO) Linear Regulators LDF, LDFM, LDK220, LDK320, LDK715, LDL212, ST730/2	<b>Post Regulation</b>		
		60 V-100 V StripFET F7 ST*N6F7, ST*N8F7, ST*N10F7					
Charge Controller	STM32F334 STM32G4 STM32F4 STM32F7 STM32H7	Power MOSFETs	IGBTs			HV HB Gate Drivers L649* Isolated Gate Drivers STGAP*	
DC-AC Stage		Power MOSFETs	IGBTs				
DC-DC Stage		650 V-1200 V SiC MOSFETs SCT*65G3AG, SCT*N65G2, SCT*120G3AG, SCT*N120G2, SCT*N120	600 V series STG*V60DF 650 V HB series STG*H65DFB 650 V HB series STG*H65DFB2 1200 V H series STG*H120DF2	Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1 HV HB Gate Drivers L649* Isolated Gate Drivers STGAP*	<b>MOSFET and IGBT Gate Drivers</b>		
		60 V-100 V StripFET F7 ST*N6F7, ST*N8F7, ST*N10F7					

Note: \* is used as a wildcard character for related part number

### Typical block diagram for Online UPS with double conversion stage



## MAJOR HOME APPLIANCES

### Refrigeration, Washing, Drying, and Miscellaneous Equipment

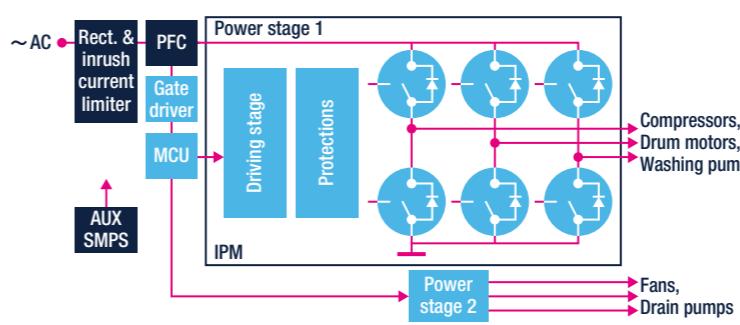
The white goods market requires low-cost and high-energy-efficiency solutions. The refrigeration, washing, drying, and miscellaneous (air conditioner, water heater) equipment are some of the major home appliance applications that ST, thanks to its wide product portfolio, is able to satisfy with suitable and dedicated power products and high-performing STM32 microcontrollers combined with complementary gate drivers (L638\* and L649\*). Using SiC diodes (STPSC\*), new high-voltage MDmesh MOSFETs or suitable field stop trench-gate IGBTs, high-efficiency PFC is guaranteed. To reduce the 3-phase inverter design effort, ST offers the SLLIMM family (small low-loss intelligent molded module) of highly-integrated, high-efficiency intelligent power modules (IPM) integrating the power stage (both on IGBT and MOSFET discretes), driving network and protections. Another approach for designing a 3-phase inverter is based on the use of six discrete IGBTs/MOSFETs with the new 3-phase gate drivers STDRIVE601. High reliability against the inrush current is ensured by new SCRs in the front-end stage. STPW programmable electronic power breaker family provides a convenient, integrated solution for quickly and safely disconnecting a faulty load from a 12 V bus.

### ST product offering for Refrigeration, Washing, Drying and Miscellaneous Equipment

	SCRs & TRIACs		Diodes			LED Drivers		HV Converters
Rect. & inrush current limiter	High Temp. SCR TN*015H-6, TN1610H-6, TN*050H-12W High Temperature T-Series and 8H-Triacs Txx35T-8 and Txx35H-8		Bridge Rectifier Diodes STBR*08, STBR*12		User Interface	LED Array Drivers STP04/08/16/24 LED12/16/24* STLED3165S STLED524 STCS*, LED8102S	AUX SMPS	ViPerPlus
	MCUs & Digital Controllers	IGBTs	Diodes	Opamp V/I Sensing	Power MOSFETs	Power Breakers		
PFC Block	MCUs STM32F0, STM32G0, STM32F301, STM32F334, STM32G4 Digital Controllers STNRG388A	600 V V series STG*V60F 650 V HB series STG*HP65FB 650 V HB series STTH*R06 1200 V Ultrafast STTH*12 1200 V H series STG*H120F2	600 V Ultrafast for CCM STTH*R06 STTH*T06 Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1 HV HB Gate Drivers L649* Isolated Gate Drivers STGAP*	Precision Op Amps (<50 MHz) TSZ*, TSV*, TS9*, LMV* <b>MOSFET and IGBT Gate Drivers</b>	650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2 650 V MDmesh M5 ST*65M5 650 V - 1200 V SiC MOSFETs SCT*65G3AG, SCT*N65G2, SCT*120G3AG, SCT*N120G2, SCT*N120	650 V MDmesh M9 ST*65N*M9 600 V-650 V MDmesh M6 ST*60M6, ST*65M6 600 V-650 V MDmesh M2 ST*60M2, ST*65M2	STPW12	Protections
Charge Controller	STM32F334 STM32G4 STM32F4 STM32F7 STM32H7	Power MOSFETs	IGBTs		HV HB Gate Drivers L649* Isolated Gate Drivers STGAP*	650 V MDmesh M5 ST*65M5 650 V SiC MOSFETs SCT**65G3AG, SCT*N65G2	TVS for Power Rail SMAJ, SM6T, SM15T, SMC30J series	Post Regulation
DC-AC Stage		Power MOSFETs	IGBTs					
DC-DC Stage		650 V-1200 V SiC MOSFETs SCT*65G3AG, SCT*N65G2, SCT*120G3AG, SCT*N120G2, SCT*N120	600 V series STG*V60DF 650 V HB series STG*H65DFB 650 V HB series STG*H65DFB2 1200 V H series STG*H120DF2	Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1 HV HB Gate Drivers L649* Isolated Gate Drivers STGAP*				
		60 V-100 V StripFET F7 ST*N6F7, ST*N8F7, ST*N10F7						

Note: \* is used as a wildcard character for related part number

### Typical configuration



### Main application boards



**STEVAL-IHT008V1**  
1 kW, digital inrush current limiter based on Triac



**STEVAL-IPM\***  
300 W to 3 kW Power board based on SLLIMM™

# Software tools

## Induction Cooking

Induction cooking ranges must be efficient, safe, and provide friendly user interfaces. Resonant-switching topologies are typically used for the power converter in these appliances as they also help achieve lower levels of electro-magnetic interferences (EMI).

We have specifically developed trench gate field-stop IGBTs and diodes that, together with a selection of high-voltage gate drivers and high-performance STM32 microcontrollers, are ideal for high-efficiency converters. ST also offers environmental sensors and LED and LCD display drivers, touchscreen controllers, and proximity and sensors required for touch or touch-less user interfaces. The ST25R NFC reader portfolio will allow induction hubs to communicate with cookware to negotiate power transfer, making kitchen appliance, cordless.

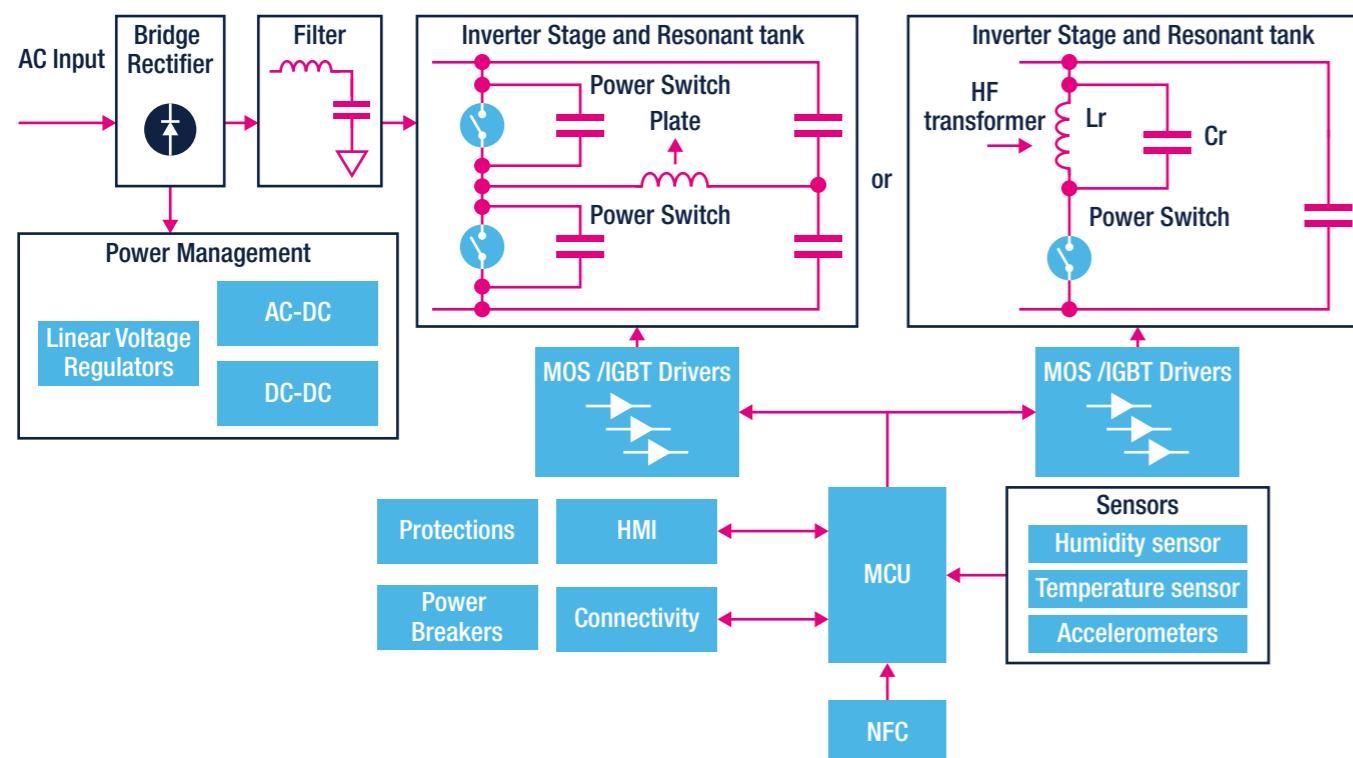


## ST product offering for Induction Cooking

	MCUs	IGBTs	Gate Drivers	Sensors	NFC
Single-switch quasi-resonant (voltage resonance)	STM8 STM32G0 STM32F0 STM32F301	1250 V IH series STG*IH125DF	Multiple LS Gate Drivers PM8834 Single LS Gate Drivers PM88*1	Environmental Sensors Humidity - HTS221 Temperature - STLM20 Temperature - STTS751 Motion Sensors Accelerometer - IIS3DHHC	ST25R3916, ST25R3918
HB series resonant (current resonance)	MCUs  STM32F0, STM32G0, STM32F303, STM32G4	IGBTs 600 V HB series STG*H60DLFB 650 V IH series STG*IH65DF	Gate Drivers HV HB Gate Drivers L649* Isolated Gate Drivers STGAP*	Proximity Sensors ToF - VL53L*, VL6180*  Connectivity Bluetooth Low Energy SoC, Wireless MCUs, Modules BlueNRG-*, STM32WB*	
User interface (front panel)	MCUs  STM8, STM32F0, STM32G0, STM32F4, STM32F7	LED Drivers LED Array Drivers STLED316S, STLED524, STP04/08/16/24, LED1642GW, LED8102S, LED12/16/24*	LED Drivers Power Management	AC-DC VIPerPlus	DC-DC LDO Power Breakers  Power Management L698*, ST1S14, L7983, L7985, L7986, L7987*  LDF, LDFM, LDK220, LDK320, LDK715, LDL212, ST730, ST732  STPW12

Note: \* is used as a wildcard character for related part number

## Topology example



eDesignSuite is a comprehensive easy-to-use design aid tool supporting a wide range of ST products



## eDesignSuite - Power Management Design Center

eDesignSuite is a comprehensive and flexible suite of design aid utilities and engineering tools that streamlines development of winning solutions with a wide range of ST products meeting user application requirements. Explore the advanced features of our Power Management Design Center, an on-line design tool that smartly helps designers of power management systems and subsystems accelerating the engineering development process (select, evaluate, refine, and prototype) for a large and growing number of ICs and Discrete devices in our broad portfolio. The software tool supports a variety of switching power converters in power supply, digital power, LED lighting, and battery charger applications, simplifying the design path from user specification to circuit analysis and customization. The main features of the tool are automatic proposal for complete solution or fully customizable design, fully annotated and interactive schematics, complete and interactive bill of materials, main current and voltage simulations, efficiency curves, Bode stability and power-loss data, and fully interactive transformer design.

### POWER SUPPLY DESIGN TOOL

- SMPS design, by topology, by type and by product
- PFC design with analog and digital control
- Supports various PCB configurations

### LED LIGHTING DESIGN TOOL

- Handles AC-DC and DC-DC design in common topologies
- Displays interactive and annotated schematic
- Provides current/voltage graphs, Bode plots, efficiency curves and power-loss data

### DIGITAL POWER WORKBENCH

- Provides a step-by-step optimized design of power section and control loop
- Generates the STM32Cube embedded software package for custom applications and allows firmware project generation, compatible with multiple STM32 IDEs

### POWER TREE DESIGNER

- Specify input/output power for each node in the tree
- Check for consistency
- Design each individual node



eDSim is a fast and powerful electrical simulation tool for SMPS and analog ICs integrated in the eDesignSuite tool. It features enhanced accuracy and higher convergence speed for SMPS, enabling a simulation time 10-50x faster than the classic analog SPICE simulators. Design your analog circuit using the eDesignSuite engine, display a preview with full annotated schematic and BOM, and then run the electrical simulation through eDSim to get fast and accurate simulations and reliable design validation, thus reducing the effort and risks related to hardware prototyping. With the eDSim tool, you can also create your schematic from scratch using ST models or simulate your SMPS and analog ICs from a list of predefined ST application schematics-test benches, that you can partially modify according to your needs.



# Products



## GALLIUM NITRIDE (GaN) POWER ICs

### Integrated Smart GaNs - MASTERGAN

Gallium nitride (GaN) is revolutionizing the power engineering world by enabling higher speed, efficiency and power density than ever before possible with silicon MOSFETs. Integrating GaN transistors and gate drivers, our advanced MASTERGAN system-in-package offer high efficiency due to their optimized gate drive layout, high power density, and increased switching frequency due to minimal parasitic effects, translating in a number of benefits for fast chargers, USB PD adapters, LED lighting drivers, TV power supplies, and server/telecom power designs.

#### KEY FEATURES AND BENEFITS

- QFN 9 x 9 x 1 mm package
- Accurate internal timing match
- Embedded gate driver easily supplied by the integrated bootstrap diode
- Interlocking function
- -40 to 125°C operating temperature range
- No investment to learn GaN required
- Overtemperature protection
- High switching frequency >1 MHz
- Fast time-to-market
- Extended 3.3 to 15 V input range with hysteresis and pull-down

Part Number	General description	Output current max (A) @25 °C	High side R <sub>DS(on)</sub> (mΩ)	Low side R <sub>DS(on)</sub> (mΩ)	Supported topologies
MASTERGAN1	High power density 600 V half-bridge high voltage driver with two 650 V enhancement mode GaN HEMT	10	150	150	Resonant, ACF
MASTERGAN2		6.5	225	150	ACF
MASTERGAN3		4	450	225	ACF
MASTERGAN4		6.5	225	225	Resonant, ACF, inverse buck
MASTERGAN5		4	450	450	Resonant, ACF

### STDRIVE GaN Drivers - STDRIVEG600

The GaN driver devices are 600 V half-bridge gate drivers for enhancement mode GaN FETs or N-channel power MOSFETs. This single chip with integrated bootstrap diode allows designers to implement GaN performance advantages and simplify design and bill-of-material requirements at the same time.

#### KEY FEATURES AND BENEFITS

- Highest robustness, efficiency and integration:
- Up to 20 V gate driver
- Voltage rail to 600 V
- 5.5 A / 6 A source/sink currents
- 45 ns short propagation delay
- Integrated bootstrap diode
- Separate ON-OFF outputs for easier tuning
- 3.3 V / 5 V logic inputs
- UVLO on Vcc and VBOOT
- Thermal shutdown
- Interlocking function
- Shut-down pin
- SO16 narrow package

Part Number	General description	Package
STDRIVEG600	High voltage and high-speed half-bridge gate driver for GaN Transistors	SO-16
STDRIVEG600TR		SO-16
STDRIVEG600W		Wafer

#### MAIN APPLICATIONS



SMPS



USB PD Adapter



UPS



Solar



LED Lighting

### High-voltage GaN converters – VIPerGaN series

The high-voltage power converters series is enriched by the introduction of GaN HEMT (high-electron-mobility transistor) technology, in a small QFN5x6 package. The VIPerGaN series offers excellent design opportunities for compact and light fast chargers, adapters, and power supplies up to 100W with a wide input range.

Part Number	Package	R <sub>ON</sub> @ 25°C	Max GaN HEMT transient voltage	Max P <sub>OUT</sub> @ 85-265 V <sub>AC</sub>	Max P <sub>OUT</sub> @ 185-265 V <sub>AC</sub>
VIPERGAN50TR	QFN 5x6 with exposed pad	0.45 Ω	850 V	50 W	75 W
VIPERGAN65TR		0.26 Ω	850 V	65 W	85 W
VIPERGAN100TR		0.26 Ω	850 V	75 W*	100 W

\*100 W with a PFC in the front end

#### KEY FEATURES AND BENEFITS

- Quasi-resonant (QR) flyback controller
- 650 V E-mode power GaN transistor (850 V transient voltage)
- Minimal standby power consumptions
- Embedded sense FET
- Dynamic blanking time and adjustable valley synchronization delay
- Output OVP
- Input OVP protection
- Embedded thermal shutdown
- Protection
- Brown-in and brown-out
- Input OPP variation



#### MAIN APPLICATIONS



USB PD Adapter



Air Conditioning



TV Power Supply



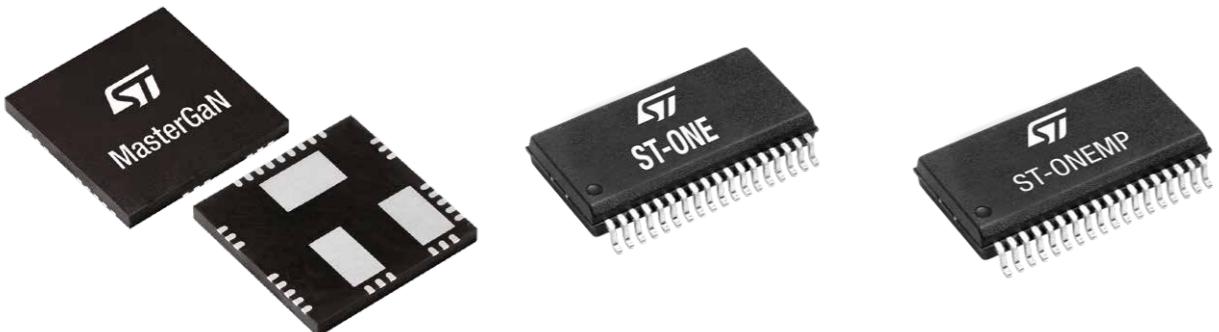
Home appliances

## AC-DC CONVERSION ICs

### ST-ONE all-in-one digital controller for USB-PD adapters

**ST-ONE** (single USB port) and **ST-ONEMP** (multiple USB port) are the world's first digital controllers embedding ARM Cortex M0+ core, an offline programmable controller with synchronous rectification, and USB PD PHY in a single package. Such a system is specifically designed to control ZVS non-complementary active clamp flyback converters to create high-power-density chargers and adapters with USB-PD interface. The device includes an active clamp flyback controller and its HV startup on the primary side, a microcontroller, and all the peripherals required to control the conversion and the USB-PD communication on the secondary side. The two sides are connected through an embedded galvanically isolated dual communication channel. By using a novel non-complementary control technique and specifically designed power modes, the device enables high efficiency and low no load power consumption.

The device is delivered with pre-loaded firmware that handles both the power conversion and the communication protocols for USB-PD including optional PPS and electronically marked cable management.



#### KEY FEATURES & BENEFITS

- All-in-one digital controller for USB-PD chargers up to 100 W
- ZVS Active Clamp Flyback + Synchronous rectification
- USB-PD 3.1 PPS interface and integrated 24 V USB-PD PHY
- >94 % peak efficiency soft switching topology
- >1 Mhz operation with MasterGaN and planar transformers
- Small weight and size solution with >30 W/inch<sup>3</sup> power density

- 32bit Cortex M0+ core with 64 kB embedded flash memory
- >6.4 kV reinforced galvanically isolated dual communication channel

#### MAIN APPLICATIONS



Tablet AC chargers



Smartphone AC chargers



Power Adapter for laptops and desktops Wall plug USB-C chargers

[www.st.com/ac-dc-converters](http://www.st.com/ac-dc-converters)  
[www.st.com/pfc-controllers](http://www.st.com/pfc-controllers)

Note: \* is used as a wildcard character for related part number

### High-voltage converters

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

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

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

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

1050 V	10 W	VIPer26K	Very High Voltage SMPS Embedded E/A for direct output regulation/fly-back or buck converter
900 V	7 W	Altair04	Accurate Primary Side Regulation Constant current/constant voltage
800 V	Up to 18 W	VIPer01-11-31	Logic Level MOSFET - 5 V supply voltage Embedded E/A, Very low standby consumption, 18 V DC start-up voltage
	6 W	VIPer0P	Zero Power Mode Smart standby management through buttons or MCU
	Up to 15 W	VIPer06-16-26	Embedded E/A Direct output regulation/settable current limit/fly-back or buck converter
		VIPer17-27-37	Brown-out Output OVP, current limit, fly-back with optocoupler
		VIPer28-38	Peak Power Output OVP, current limit, fly-back with optocoupler
		VIPer25-35	Quasi Resonant Output OVP, current limit, fly-back with optocoupler
730 V	Up to 8 W	VIPer122-222	Embedded E/A, 730 V BV Optimized for low power

#### Flyback Primary side regulation

VIPer01-11-31	VIPer122-222
VIPer26K	VIPer06-16-26
Altair04-05	VIPer0P

#### Flyback Secondary side regulation

VIPer01-11-31	VIPer122-222	VIPer28-38
VIPer26K	VIPer06-16-26	VIPer25-35
VIPer27-37	VIPer0P	VIPer122-222

#### Buck Converter Up to 600 mA Output Current

VIPer01-11-31	VIPer122-222
VIPer26K	VIPer06-16-26

#### MAIN APPLICATIONS

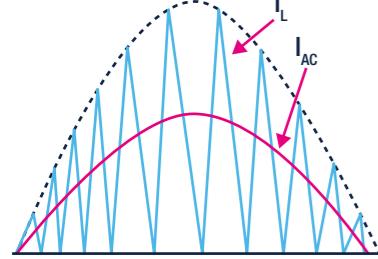


## PFC controllers

ST power factor correction (PFC) controllers operate in transition mode (TM, suitable for  $P \leq 250$  W) and continuous current mode (CCM, suitable for  $P > 250$  W), and are suitable for wide-range-mains operation.

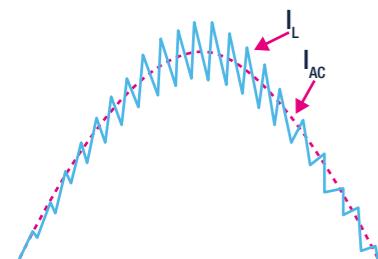
These devices embed advanced protection features, which make the SMPS more robust and compact, requiring fewer external components. These features include output overvoltage, brown-out, feedback disconnection, and boost inductor saturation protection. The high-voltage start-up capability present in the L6564H and L6563H helps improve the SMPS standby efficiency in systems that do not include an auxiliary power supply.

### TM PFC controllers



	Basic features	Advanced protections	Remote on/off control	Tracking boost function	Interface for cascaded converter
L6562A*	●				
L6564*	●	●	●		
L6563*	●	●	●	●	●

### CCM PFC controllers



L4984D	Line-modulated, fixed-off-time (LM-FOT) control
L4981A	Fixed frequency, average-current mode
L4981B	Line modulated frequency, average-current mode
L4985A/B	Quasi-fixed frequency, peak-current mode
L4986A/B	Quasi-fixed frequency, peak-current mode, adjustable PGOOD

## MAIN APPLICATIONS



Adapters and TVs  
L6562A\*, L6563\*, L6564,  
L4985, L4986



Commercial and street lighting  
L6562A\*, L6563\*, L6564\*,  
L4985, L4986, L4981\*, L4984D



Desktop PCs and Server  
L4985, L4986,  
L4981\*, L4984D

## PWM and resonant controllers

ST portfolio of advanced controllers includes a variety of **primary controllers** intended to fit high-performance applications. Very high efficiency is achieved with single-ended topologies at a fixed switching frequency or with quasi-resonant operation. The new STCH03 offline constant-current primary-side regulation controller (PSR-CC) guarantees very low power consumption at no load condition. For high-power, high-current applications, ST offers controllers for half-bridge resonant and asymmetrical half-bridge topologies. The STCMB1 and STNRG011 combo controllers with high-voltage start-up, Xcap discharge circuit, and PFC and resonant driving stages, guarantee high performance and high integration with a smaller pinout. The new STNRG012 is specifically designed to support LED lighting and industrial applications requiring DC source management, with additional THD optimizer function.

### Flyback controllers

#### STCH03

- Offline quasi-resonant controller in SO-8 package
- Constant-current primary-side regulation mode (PSR-CC) or constant-voltage regulation with optocoupler
- Advanced burst mode operation (< 10 mW consumption @ no load)
- UVP, autorestart/latched OVP and internal OTP
- 650 V HV start up

#### L6566\*

- Offline fixed-frequency or quasi-resonant controllers
- Suited for SMPS with PFC front-end (A version)
- Suited for SMPS with 3-phase mains (BH version)
- 700 V start up (A/B version), 840 V start up (BH version)
- Brownout protection

#### L6565

- Offline quasi-resonant controller
- Constant power vs mains change
- Ultra-low start-up current

### HB-LLC resonant controllers

	Basic features	Anti-capacitive protection	Self-adjusting dead-time	Soft burst mode	Smooth Start-up
L6699	●	●	●	●	●
L6599A*	●				

### Analog combo controller (PFC+LLC/LCC)

#### STCMB1

- 800 V start-up voltage
- Embedded X-cap discharge circuit
- Transition Mode (TM) PFC control method
- Enhanced fixed on time TM PFC controller
- Self-adjusting dead-time and ant capacitive mode for LLC
- Time-shift control of resonant half-bridge

### Asymmetrical half-bridge controller

#### L6591

- PFC interface
- Brown out
- 700 V start-up voltage

## MAIN APPLICATIONS



Tablets and smartphones  
L6565, L6566\*, STCH03



Laptops  
L6565, L6566\*, STCH03,  
STCMB1



High-power adapters and TVs  
L6565, L6566\*, L6599A\*,  
L6699, STCMB1



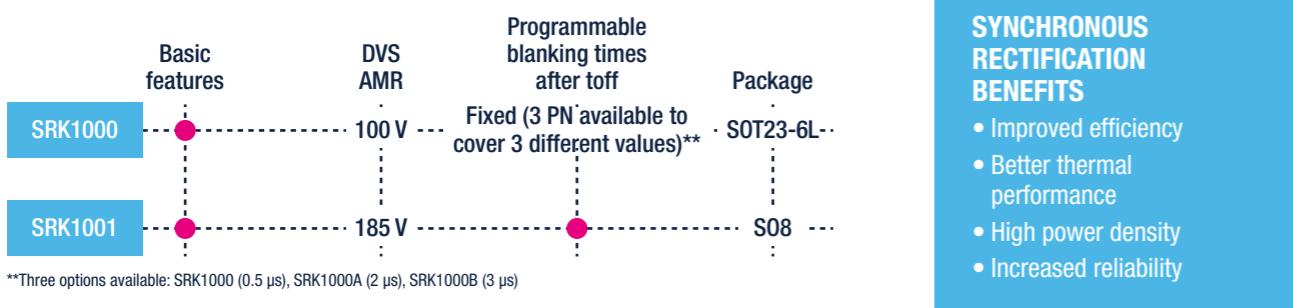
Desktop PCs, commercial  
and street lighting  
L6599A\*, L6699, STCMB1

## Synchronous rectification controllers

**Synchronous rectifiers** are used to drive power MOSFETs that replace the rectification diodes in the secondary side of SMPS, thus providing high efficiency especially in low-output-voltage, high-current power supplies.

The product portfolio supports the most common flyback and LLC resonant topologies. The main benefits include high efficiency, space saving, cost reduction, and high reliability.

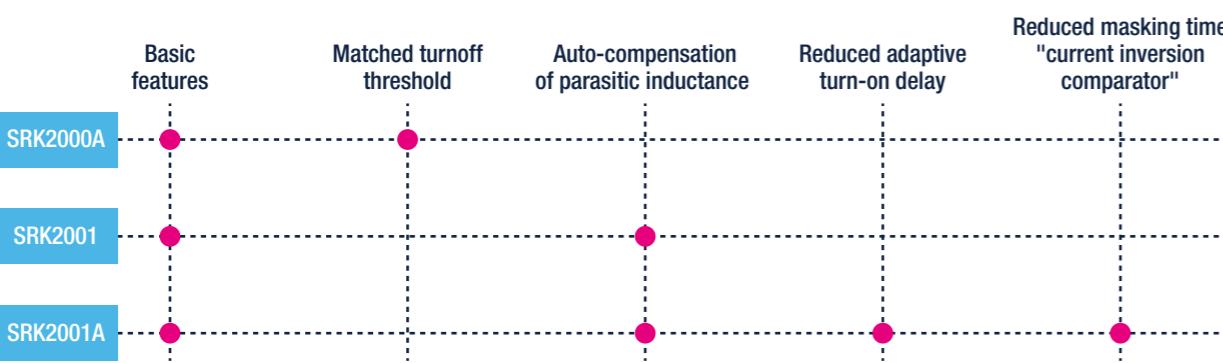
### SR Controllers for Flyback



### SYNCHRONOUS RECTIFICATION BENEFITS

- Improved efficiency
- Better thermal performance
- High power density
- Increased reliability

### SR controllers for LLC resonant



## MAIN APPLICATIONS



High-power adapters and TVs  
SRK1000, SRK1001



Desktop PCs and Server/Telecoms  
SRK2000A, SRK2001, SRK2001A

[www.st.com/ac-dc-converters](http://www.st.com/ac-dc-converters)  
[www.st.com/synchronous-rectification-controllers](http://www.st.com/synchronous-rectification-controllers)

Note: \* is used as a wildcard character for related part number

## Signal conditioning

Signal conditioning devices include **Operational Amplifiers** and **Current Sense Amplifiers**. These devices enable accurate and fast current measurement in power supplies. **Comparators** are also very powerful allies of the power supply designer to implement protection features such as over-temperature, over-current, and over/under voltage.

### Operational Amplifiers

#### TSZ181, TSZ182

- Operating voltage 2.2 to 5.5 V
- 5 V zero-drift amplifier
- Input offset voltage 25 µV max
- Temperature up to 175 °C
- Gain bandwidth 3 MHz

#### TSV772/TSV782

- Operating voltage 2.0 to 5.5 V
- Rail-to-rail input and output
- V<sub>io</sub> max 200 µV
- Gain bandwidth 20/30 MHz

### Current Sense Amplifiers

#### TSC103

- Operating voltage 2.9 to 70 V
- Surviving voltage on shunt -16 to 75 V
- Amplification gain x50 x100
- Package TSSOP8, SO8

#### TSC2010/1/2

- Bi-directional
- Operating voltage -20 to 70 V
- Amplification gain x20 x60 x100
- Offset voltage ± 200 µV max
- 2.7 to 5.5 V supply voltage
- Gain error 0.3% max
- Packages MiniSO8 SO8

### Comparators

#### TS3021, TS3022

- Propagation delay 38 ns
- Low current consumption: 73 µA
- Rail-to-rail inputs
- Push-pull outputs
- Supply operation from 1.8 to 5 V

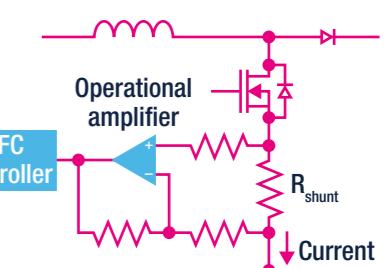
#### TS3011

- Propagation delay 8 ns
- Low current consumption 470 µA
- Rail-to-rail inputs
- Push-pull outputs
- Supply operation from 2.2 to 5 V

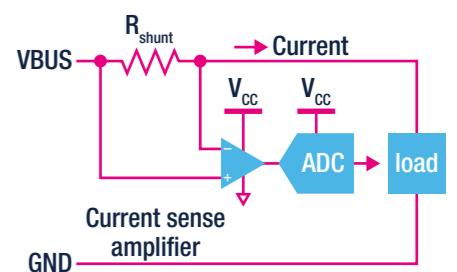
## MAIN APPLICATIONS



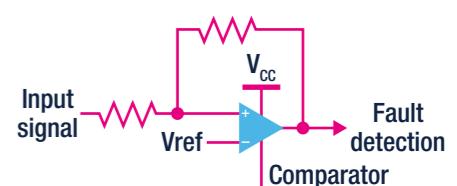
### Typical application schematic for low-side current measurement in a PFC



### Typical application schematic for high-side current measurement



### Typical application schematic for fault detection using a non-inverting comparator, with hysteresis



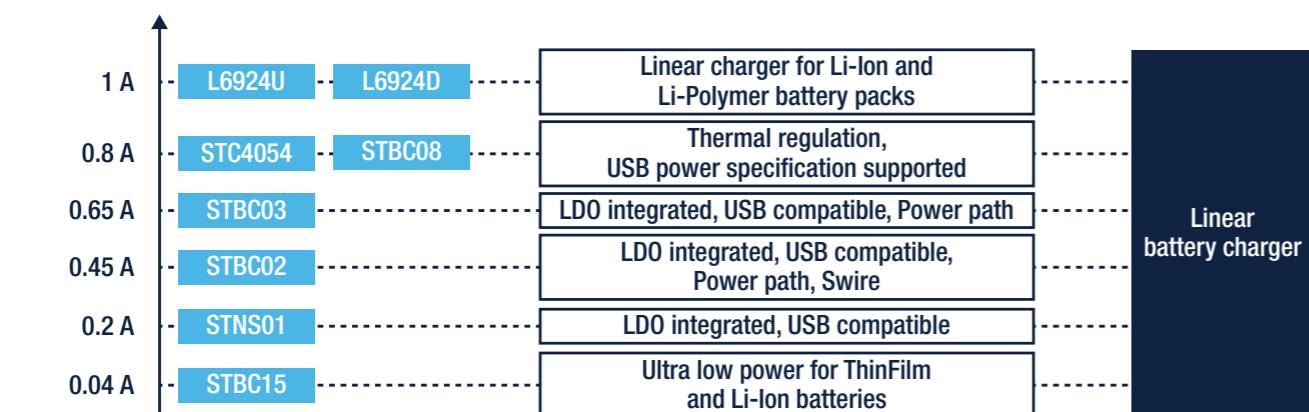
[www.st.com/opamps](http://www.st.com/opamps)  
[www.st.com/current-sense-amplifiers](http://www.st.com/current-sense-amplifiers)  
[www.st.com/comparators](http://www.st.com/comparators)

## BATTERY MANAGEMENT ICs

### Battery chargers and battery monitoring ICs

ST **battery chargers** are specifically designed for the portable and mobile markets and add value to new designs by minimizing power consumption and reducing the space on the PCB. These products offer charge currents from as little as 40 mA up to 1.2 A and can be used for any rechargeable lithium-ion and Li-Polymer battery. Using very simple topologies, some of these devices also feature a power-path function, offering instant-on operation and thermal regulation according to the JEITA international standard.

#### Battery chargers



- STBC02/STBC03
  - Embed a linear battery charger, a 150 mA LDO, 2 SPDT load switches and a protection circuit module
  - STBC02 embeds a smart reset/watchdog and a single wire interface for IC control
  - Use a CC/CV algorithm with programmable (only STBC02) fast charge, precharge and termination current
- STBC15
  - Microbatteries charging and monitoring circuit
  - Charging current up to 40 mA (set by dedicated pin)
  - 150 nA quiescent current

**ST battery fuel gauge ICs** can be located in the battery pack or in the handheld device and integrate functions to monitor the battery voltage, current, and temperature. Using a built-in Coulomb counter, these fuel gauge ICs calculate battery charge and store the data in 16-bit register resolution for retrieval by the system controller. Access is via an industry-standard I<sup>2</sup>C interface, enabling the controller to create an accurate graphical representation of the remaining battery operating time.

- STC3115
  - OptimGauge algorithm for STC3115
  - OptimGauge+ algorithm for SCT3117
  - Coulomb counter and voltage gas gauge operations
  - Programmable low battery alarm
  - Internal temperature sensor
- STC3117

- FUEL GAUGE ICS MAIN BENEFITS**
- 3% accuracy of battery state of charge no need for shunt resistor
  - Accurate estimation of battery state of charge at power-up
  - Reliable battery swap detection
  - SoH and impedance tracking with OptimGauge+ algorithm (ST IP)
  - Charger enable and system reset control for accurate OCV reading

### MAIN APPLICATIONS



Bluetooth accessories  
STC4054



USB  
L6924U, STC4054, STBCFG01



Fitness  
STNS01, STBC02, STBC03



Smartphones  
STBCFG01, STC3115, SCT3117

## Wireless charging ICs

ST fully covers wireless charging applications with **dedicated ICs for both transmitter and receiver**. The STWBC, compatible with Qi standard, and the STWBC86 dedicated to wearable applications, make up the ST wireless power transmitters (Tx) family. The receiver family (Rx) consists of the STWLC38 dedicated to Qi compliant consumer applications, the STWLC86 and the STWLC98 for higher power applications.



### Wireless charger transmitter ICs

STWBC2-HP    STWBC86

#### STWBC2-HP

- Supports applications up to 70 W
- Qi 1.2.4 / 1.3 compatible
- Qi certified reference design with MP-A2 topology and supports MP-A22

#### STWBC86

- Optimized for standard Qi Baseline Power Profile (BPP) applications for up to 5 W
- Monolithic solution with integrated full-bridge inverter
- Popular applications are not only Tx for public spaces like restaurants, offices, and airports, but also chargers for wearable and hearable devices

### Wireless charger receiver ICs

STWLC38    STWLC86    STWLC98

#### STWLC38

- Qi 1.3 compatible
- Supports up to 15 W Rx for Qi Extended Power Profile
- Supports up to 5 W Rx for Qi Baseline Power Profile

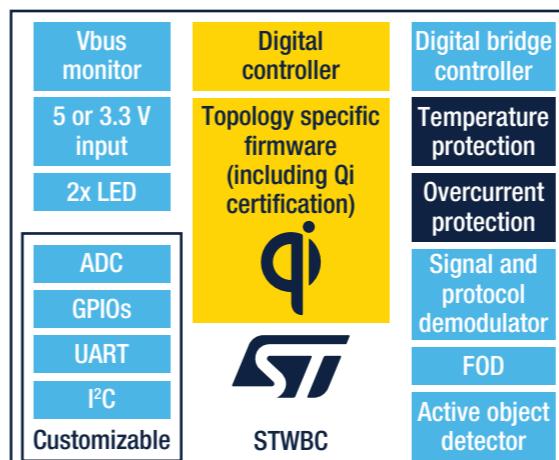
#### STWLC86/98

- Qi 1.3 compatible
- Supports up to 30 W (STWLC86) /70W (STWLC98) Rx
- Supports up to 7.5 W (STWLC86) /15 W (STWLC98) in Tx mode (coil dependent)
- Embedded OS for Qi 1.3 standalone certification (STWLC98)

- Supports up to 5 W in Tx mode (coil dependent)
- ARC (Adaptive Rectifier Configuration) mode for enhanced spatial freedom

#### Common features

- Industry leading efficiency
- Accurate foreign object detection (FOD)
- Best-in-class power consumption with smart standby
- GUI for run-time analysis, tuning and basic customization
- Firmware customization via API
- Robust device protection from over-voltage, over-current and over-temperature events



### MAIN APPLICATIONS



Wireless charger transmitters  
STWBC2-HP, STWBC86



Smartphones, Tablets, and Laptops  
STWLC86, STWLC98

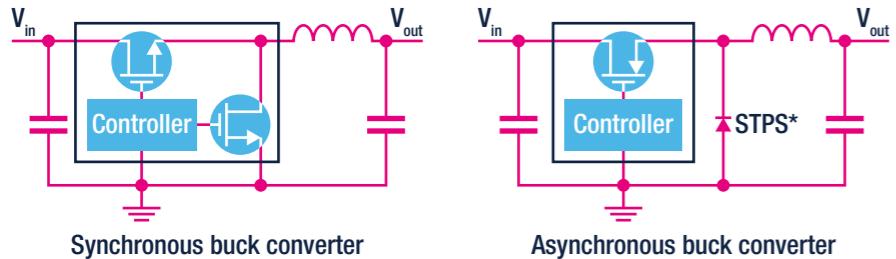


Wearables and Hearables  
STWLC38, STWBC86

## DC-DC SWITCHING CONVERSION ICs

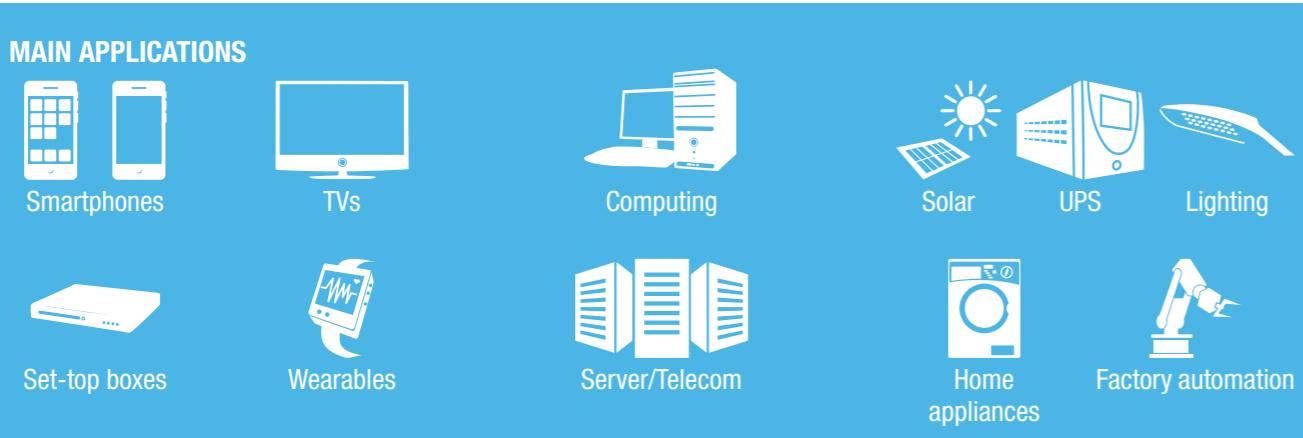
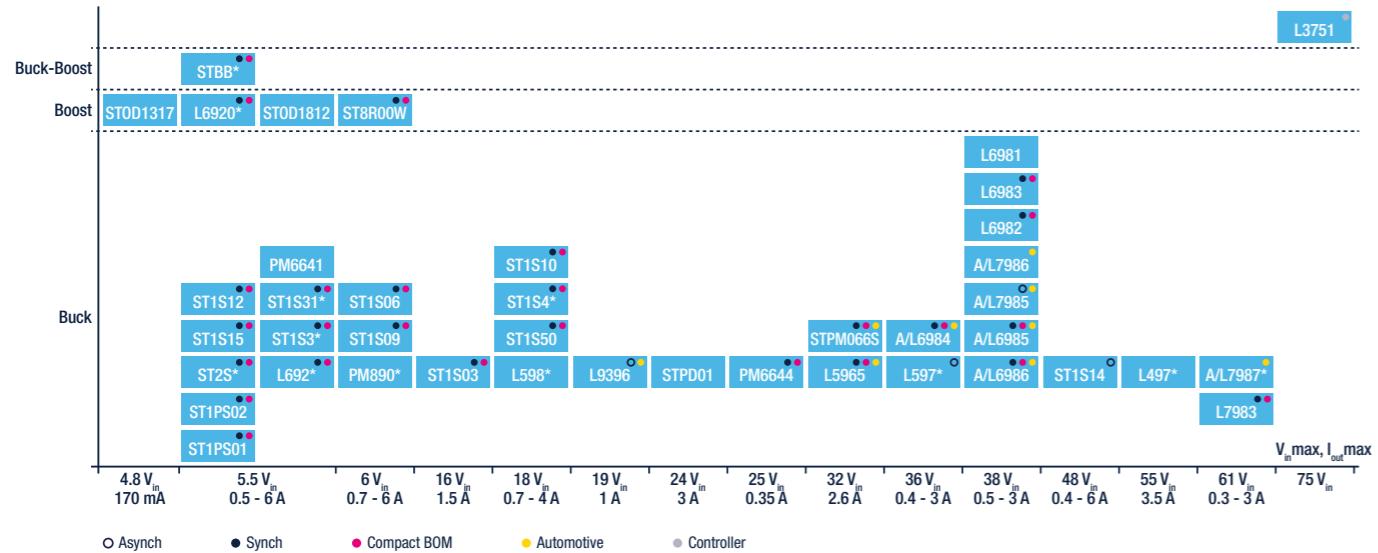
### DC-DC converters

ST offers a wide portfolio of monolithic **DC-DC switching converters** (i.e., controller and MOSFET in the same package). This broad portfolio of ICs consists of highly specialized products to meet every market requirement. High reliability and robustness for industrial (factory automation, UPS, solar, home appliances, lighting, etc.) and other high-voltage applications. High efficiency at any load and a high level of performance for consumer (smartphones, digital cameras, portable fitness devices, LED TVs, set top boxes, Blue-ray players, computer & storage, etc.) and server/telecom applications.



### DC-DC CONVERTERS MAIN FEATURES

- Up to 61 VIN/3 A
- Synchronization capability
- Internal compensation
- Low consumption
- Adjustable fsw
- Internal soft start
- Low quiescent current



[www.st.com/dc-dc-switching-converters](http://www.st.com/dc-dc-switching-converters)

Note: \* is used as a wildcard character for related part number

### DC-DC controllers

ST offers a wide portfolio of **DC-DC switching controllers** for server and telecom applications according to market requirements: single-phase controllers with embedded drivers, advanced single-phase controllers with embedded non-volatile memory (NVM), and our newest controllers with or without SPS (Smart Power Stage) compatibility, as well as multiphase digital controllers for CPU & DDR memory power supplies.

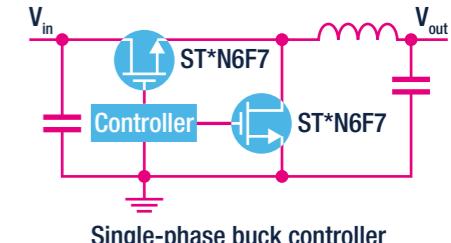
### Single-phase Buck controllers

L6726A Single-phase cost effective PWM controller

A6727 Single-phase cost effective PWM controller for automotive applications

L6739 Single-phase PWM controller with embedded driver and light load efficiency optimization

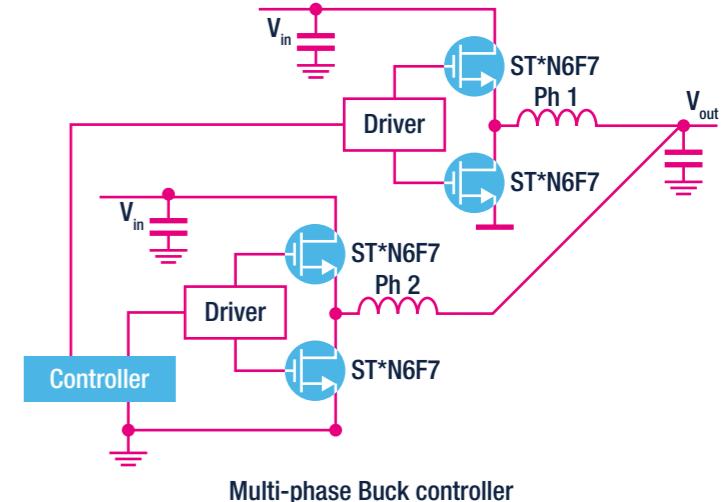
PM6680 Dual-output PWM controller up to 36Vin



### Multi-phase Buck controllers

PM676\* Fully digital buck controller with PMBus for CPU/DDR

PM677\* Fully digital buck controller with PMBus for advanced CPU/DDR



### MAIN APPLICATIONS



[www.st.com/dc-dc-switching-converters](http://www.st.com/dc-dc-switching-converters)  
[www.st.com/single-phase-controllers](http://www.st.com/single-phase-controllers)  
[www.st.com/multi-phase-controllers](http://www.st.com/multi-phase-controllers)

Note: \* is used as a wildcard character for related part number

## Highly integrated power management IC for micro-processor units

**STPMIC1**, a high performance fully integrated power management IC, is the ideal companion chip of the **STM32MP1 microprocessor** series, being also optimized for power applications requiring low power and high efficiency. The STPMIC1 integrates buck and boost converters, linear regulators with sink/source capability, power switches specifically designed to supply all required power rails for the STM32MP1 and for other components on the board such as DDR, Flash memory, Wi-Fi and Bluetooth connectivity ICs, providing a total system solution.



### STPMIC1 versions

	5 V power supply application		Battery power supply application		Custom application, no output turned ON		5 V power supply application		Battery power supply application	
	STPMIC1A		STPMIC1B		STPMIC1C		STPMIC1D		STPMIC1E	
	Default output Voltage (V)	Rank	Default output Voltage (V)	Rank	Default output Voltage (V)	Rank	Default output Voltage (V)	Rank	Default output Voltage (V)	Rank
LD01	1.8	0	1.8	0	1.8	0	1.8	0	1.8	0
LD02	1.8	0	2.9	2	1.8	0	1.8	0	1.8	0
LD03	1.8	0	1.8	0	1.8	0	1.8	0	1.8	0
LD04	3.3	3	3.3	3	3.3	0	3.3	3	3.3	3
LD05	2.9	2	2.9	2	1.8	0	3.3	2	2.9	2
LD06	1.0	0	1.0	0	1.0	0	1.0	0	1.0	0
REFDDR	0.55	0	0.55	0	0.55	0	0.55	0	0.55	0
BOOST	5.2	N/A	5.2	N/A	5.2	N/A	5.2	N/A	5.2	N/A
BUCK1	1.2	2	1.2	2	1.1	0	1.2	3	1.2	3
BUCK2	1.1	0	1.1	0	1.1	0	1.1	0	1.1	0
BUCK3	3.3	1	1.8	1	1.2	0	3.3	1	1.8	1
BUCK4	3.3	2	3.3	2	1.15	0	1.2	2	1.2	2

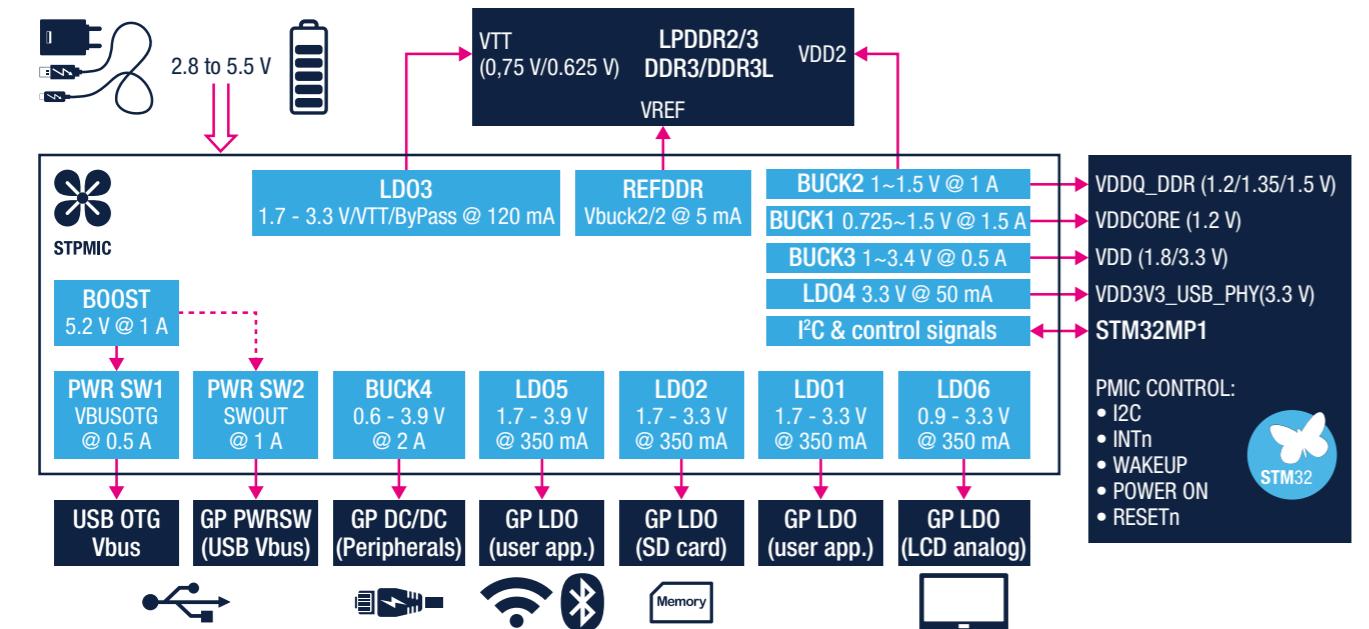
Rank = 0: rail not autom. turned ON

Rank = 2: rail autom. turned ON after further 3 ms

Rank = 1: rail autom. turned ON after 7 ms

Rank = 3: rail autom. turned ON after further 3 ms

### STPMIC1 and STM32MP1



### MAIN APPLICATIONS



Home automation



Industrial control



POS terminals



Networking



Medical monitoring

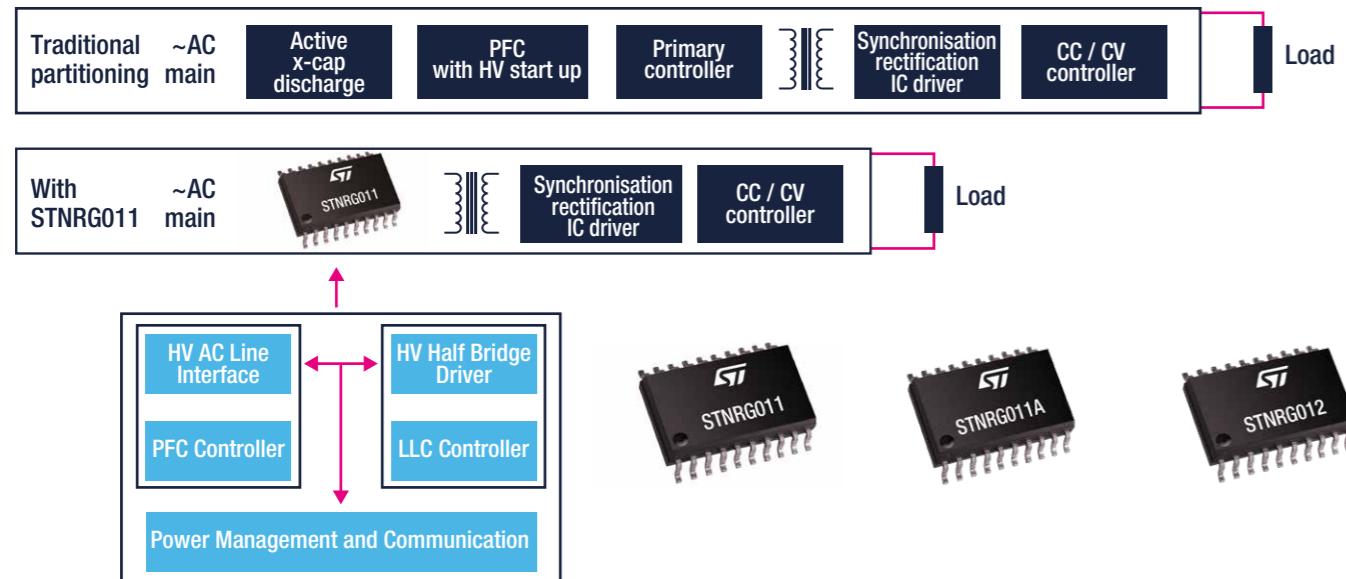


## DIGITAL POWER CONTROLLERS AND MICROCONTROLLERS

### STNRG Digital Power Controllers

The high level of integration of today's latest features and functions make **STNRG011**, **STNRG11A**, and **STNRG012** ideal for SMPS and lighting applications required to comply with the most stringent energy-saving regulations and guarantees high reliability, safety and BOM optimization. Configurable through an intuitive GUI, ST STNRG digital controllers provide high-end performance and flexibility and do not require any firmware implementation. All the key application parameters of the device are stored in an internal NVM, allowing wide configurability and calibration.

#### Simplified 2-stage digital smps design with high performance and low component count



#### Multi-mode digital combo controller (PFC+LLC/LCC)

**STNRG011**   **STNRG011A**   **STNRG012**

- Onboard 800 V startup circuit, line sense and X-cap discharge compliant with IEC 62368-1, for reduced standby power (STNRG011 only)
- DC source management with no X-cap discharge (STNRG012 only)
- THD optimizer for LED Lighting applications (STNRG012 only)
- Enhanced fixed on time multi-mode TM PFC controller

- Time-shift control of resonant half-bridge
- ROM memory for SW digital algorithms
- NVM memory for programmable key application Parameters
- Advanced OLP - Over Load Management (STNRG011A only)



#### MAIN APPLICATIONS



TV Power Supply and All-in-One  
STNRG011, STNRG011A



High power adapters  
STNRG011,  
STNRG011A



LED Lighting  
STNRG012



Industrial and medical equipment  
STNRG012



Emergency Lighting  
STNRG012

### Microcontrollers for digital power

The **32-bit microcontrollers** most suitable for power management applications are the STM32F334 and the STM32G474 MCU from the mixed-signal **STM32F3 series** and **STM32G4 series**, the STM32H743 MCU from the high performance **STM32H7 series**, and those of the entry-level **STM32G0 series**.

The STM32G0 series has a 32-bit ARM® Cortex®-M0+ core (with MPU) running at 64 MHz, and is well suited for cost-sensitive applications. STM32G0 MCUs combine real-time performance, low-power operation, and the advanced architecture and peripherals of the STM32 platform.

The STM32F3 series MCU combines a 32-bit ARM® Cortex®-M4 core (with FPU and DSP instructions) running at 72 MHz with a high-resolution timer and complex waveform builder plus event handler.

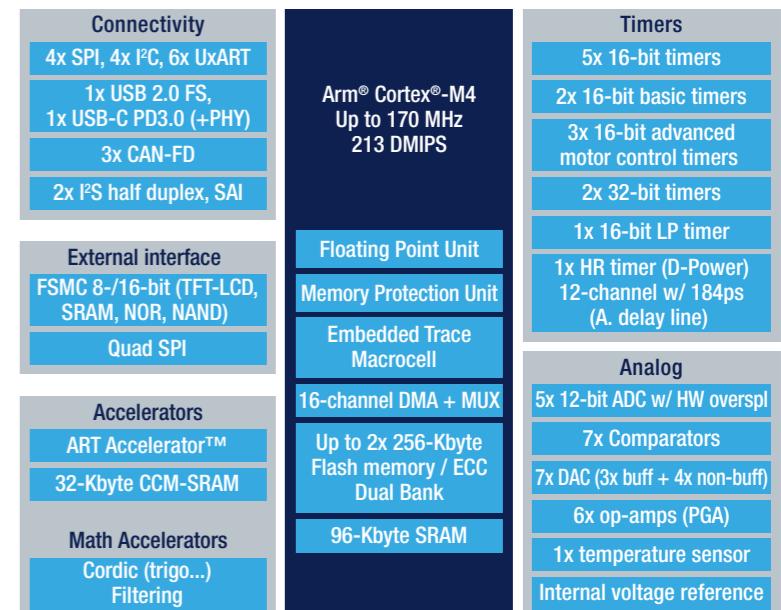
The STM32G4 series with 32-bit ARM® Cortex®-M4 core running at 170 MHz continues the STM32F3 series, keeping leadership in analog, leading to cost reduction at the application level and a simplification of the application design.

Finally, the STM32H7 series has a 32-bit ARM® Dual core Cortex®-M7 + Cortex®-M4 (480 MHz + 240 MHz) or single-core Cortex®-M7 (480 MHz) with precision FPU, DSP, and advanced MPU.

STM32 F3, G4, and H7 series contain a flexible high-resolution timer to generate highly accurate pulse-width modulated (PWM) signals for stable control of switched-mode power circuits.

These MCUs specifically address digital power conversion applications, such as digital switched-mode power supplies, lighting, welding, solar, wireless charging, motor control, and much more.

#### STM32G474 block diagram



#### STM32G0

- Cortex®-M0 core
- Very low power consumption
- Timer frequency up to 128 Mhz resolution (8ns)
- High-speed ADCs for precise and accurate control
- More RAM for Flash: up to 36 KB SRAM for 128 KB and 64 KB Flash memory

#### STM32F334

- Cortex®-M4 core
- High resolution timer V1 (217ps resolution) with waveform builder and event handler
- 12-bit ADCs up 2.5 Msps conversion time
- Built-in analog peripherals for signal conditioning and protection (25ns from fault input to PWM stop)

#### STM32G474

- Cortex®-M4 core
- High resolution timer V2 (184ps resolution) with waveform builder and event handler
- Mathematical accelerator, digital smps and power factor correction
- High-speed ADCs for precise and accurate control (4Msps)

- Dual bank flash for live upgrade
- Digital Power Supply and PFC Design Workshop with STM32 MCUs in collaboration with the company partner Biricha



#### STM32H743

- Cortex®-M7 core
- High performance up to 480 MHz
- High resolution timer V1 (2.1ns resolution) for real time control
- High-speed ADCs for precise and accurate control (3.6 Msps)

#### MAIN APPLICATIONS



Energy Generation and Distribution



Welding



Commercial, architectural and street lighting



Server/ Telecom



UPS

## Automotive microcontrollers for in-car digital power

**SPC5** automotive microcontrollers are suited for in-car digital power applications, such as traction inverters, on-board chargers, bidirectional DC/DC, and Battery Management Systems.

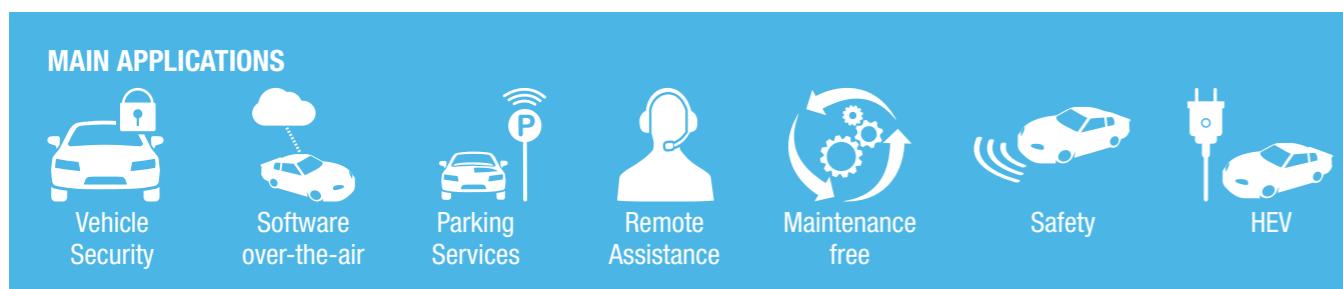
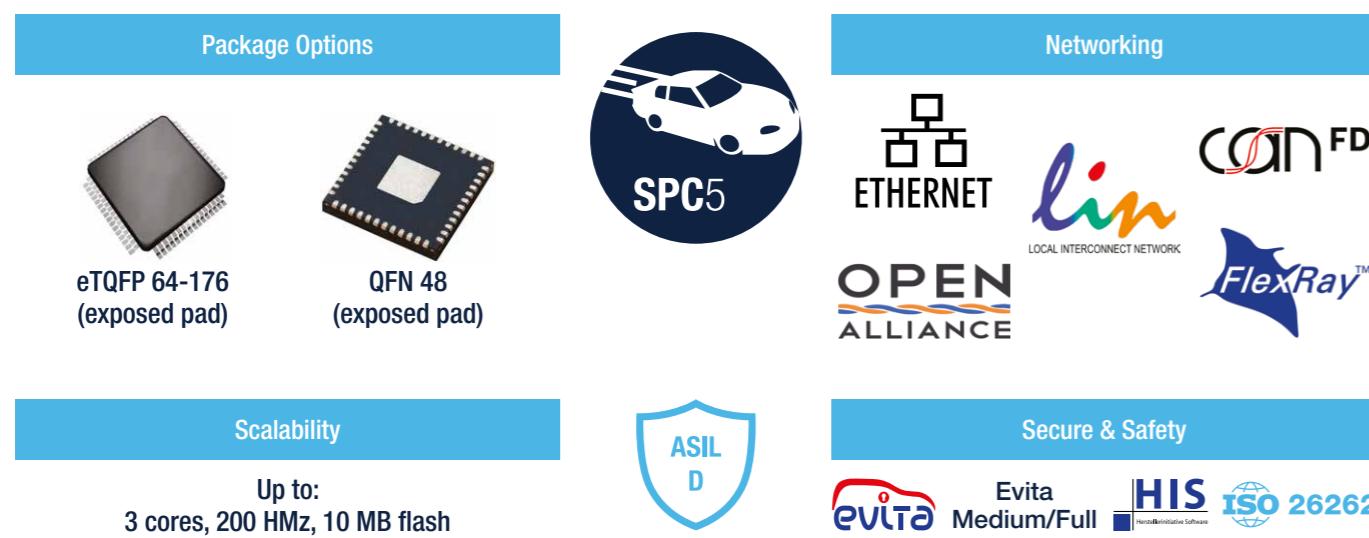
**SPC58 E-line** combines real-time behavior with ISO26262 ASIL-D safety.

The embedded hardware security module (HSM) ensures protection against cyber security attacks.

The Generic Time Module (GTM) completes the peripheral set by delivering a high-performance timer, synchronization units, embedded hardware DLL, and micro-cores.

**SPC58 Chorus** family provides a connected, secure, and scalable platform delivering a wide range of communication interfaces and low-power capabilities to complete the in-car connectivity needs.

SPC5		SPC58 E Line
Core		Triple 3x e200z4d @ 180 MHz
eFlash Code		4 MB to 6 MB
Timers		GTM3
Safety		ASIL-D
Advanced Networking		8x CAN-FD FlexRay 2x Ethernet
Security		HSM medium
ADC		5x 12 bit (SAR) 3x 10 bit (SAR) 6x 16 bit (SigmaDelta)
High Temperature support (165 °C)		Qualified



## AutoDevKit, a viable, simple, low-cost toolset for automotive application engineers

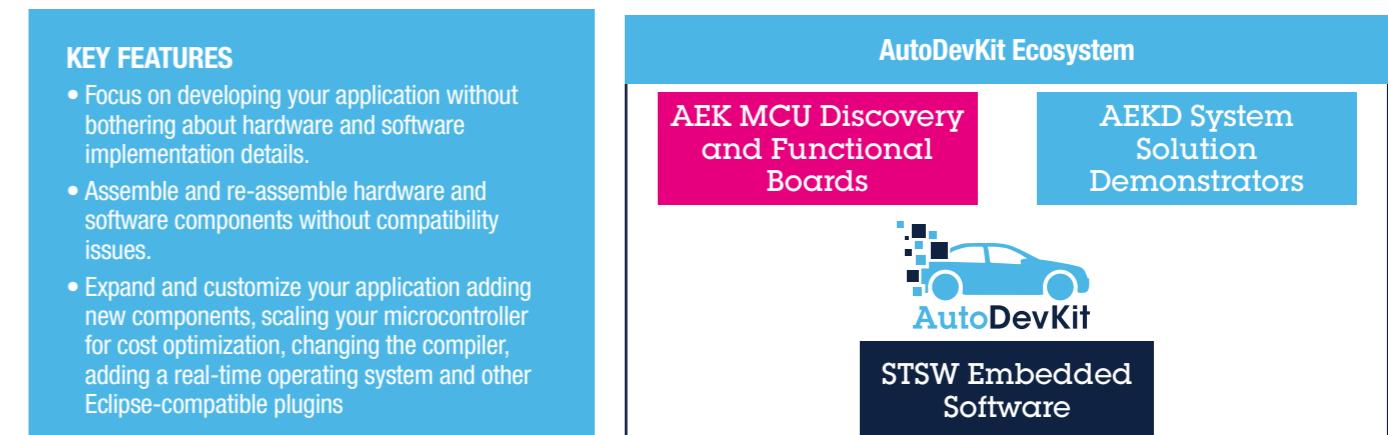
AutoDevKit is a new development flow and toolset dedicated to the Automotive & Transportation market, offering engineers the best and easiest approach to quick evaluation and rapid prototyping in a common, integrated, and flexible environment supporting complete ECU-like development.

AutoDevKit is an Eclipse plugin running under the SPC5Studio Integrated Development Environment.



### KEY FEATURES

- Focus on developing your application without bothering about hardware and software implementation details.
- Assemble and re-assemble hardware and software components without compatibility issues.
- Expand and customize your application adding new components, scaling your microcontroller for cost optimization, changing the compiler, adding a real-time operating system and other Eclipse-compatible plugins



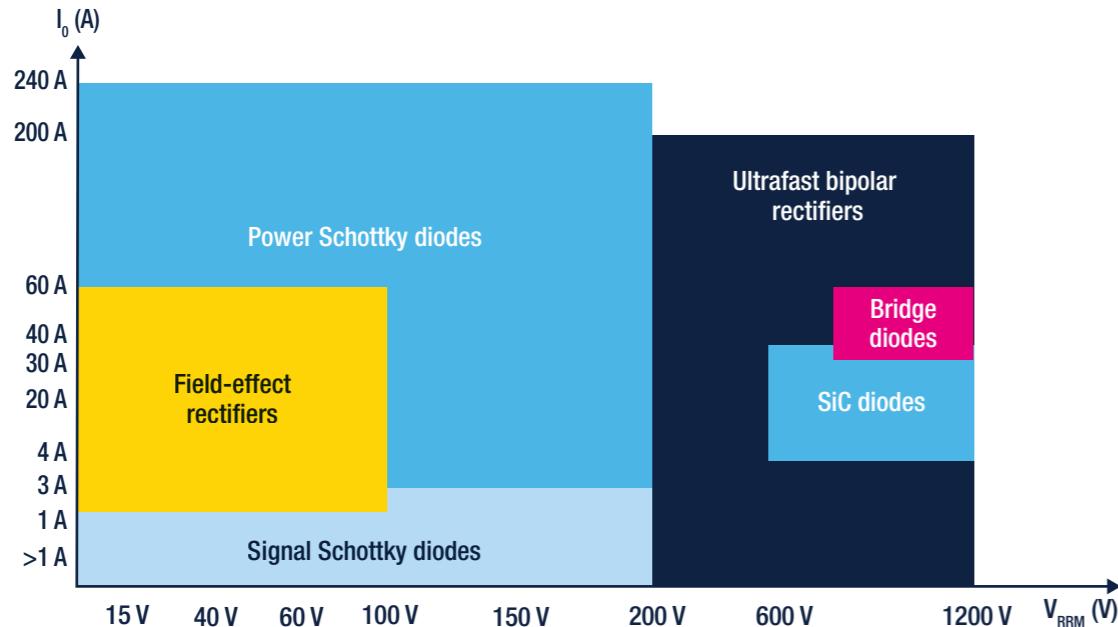
Find out more at [www.st.com/autodevkit](http://www.st.com/autodevkit)  
Software download [www.st.com/autodevkitsw](http://www.st.com/autodevkitsw)  
Join our Community at <https://community.st.com/autodevkit>

## DIODES AND RECTIFIERS

ST Schottky and Ultrafast diode portfolio includes 650 to 1200 V SiC and 45 to 100 V field-effect rectifier diodes (FERD), ensuring that designers can take advantage of the very latest technologies to develop cost-efficient, high-efficiency converter/inverter solutions. Depending on the targeted application and its voltage, developers can choose from a wide range of devices to ensure the best compromise in terms of forward voltage drop (VF) and leakage current (IR) as well as other characteristics.



AEC-Q101 automotive-grade qualified diodes and rectifiers >



### Field-effect rectifiers (FERD)

**FERD\*** Low voltage diodes, for high efficiency and high power density applications

### Power Schottky diodes

**STPS\*** Power Schottky diodes for low voltage general purpose applications

### Ultrafast rectifiers

**STTH\*** Ultrafast high voltage diodes for general purpose application

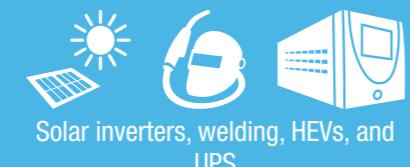
## MAIN APPLICATIONS



Adapters and TVs



Battery chargers



Solar inverters, welding, HEVs, and UPS



Residential, commercial, architectural and street lighting



PC Desktop and Server/  
Telecoms



HEV charging stations



Factory automation



Home appliances



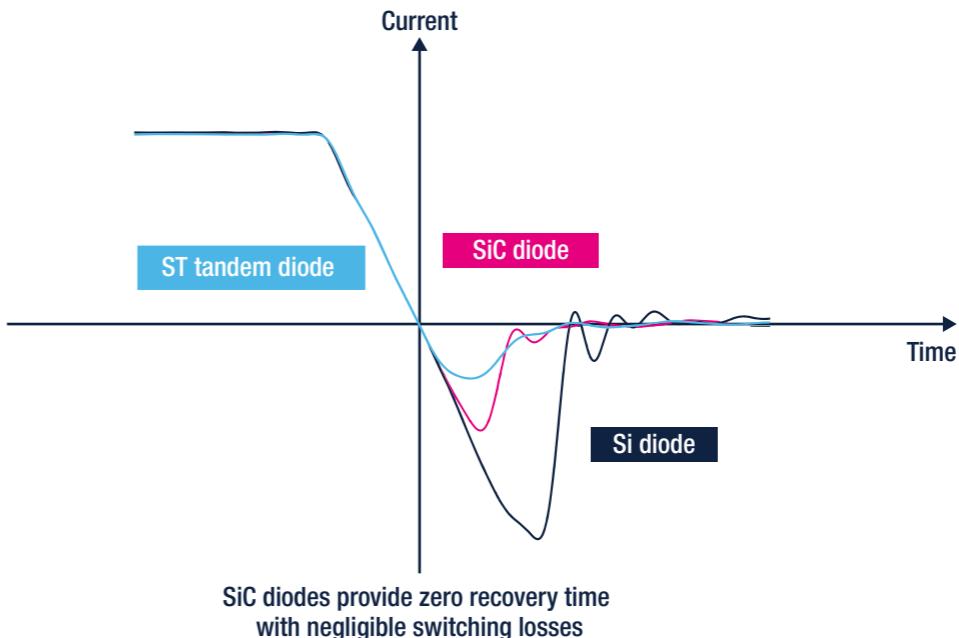
Consumer electronics

## SiC diodes

In addition to ensuring compliance with today's most stringent energy efficiency regulations (Energy Star, 80Plus, and European Efficiency), ST silicon carbide diodes feature four times better dynamic characteristics with 15% less forward voltage (VF) than standard silicon diodes. Silicon carbide diodes belong to the STPOWER family.

The efficiency and robustness of solar inverters, motor drives, uninterruptible power supplies, and circuits in electrical vehicles are therefore greatly improved by the use of silicon carbide (SiC) diodes.

ST proposes a 600 to 1200 V range with single and dual diodes in packages ranging from DPAK to TO-247, including the ceramic insulated TO-220 and the slim and compact PowerFLAT 8x8 featuring excellent thermal performance and representing, the new standard for high-voltage (HV) surface-mount (SMD) packages and available for 650 V SiC Diodes from 4 to 10 A.



### SIC DIODES BENEFITS

- High efficiency adding value to the power converter
- Reduced size and cost of the power converter
- Low EMC impact, simplifying certification and speeding time to market
- High robustness ensuring high reliability of the power converter
- Gain on PCB and mounting cost with the dual diodes

### 650 V SiC diodes in insulated TO-220 packages: the solution to speed production

**STPSC\*065** **STPSC\*H12**

- 650 V (STPSCx065)
- 1200 V (STPSC\*H12)
- 2 available trade-offs, low VF and High surge

## MAIN APPLICATIONS



Solar inverters  
STPSC\*065, STPSC\*H12



HEV  
STPSC\*065



UPS  
STPSC\*065, STPSC\*H12



Charging Station  
STPSC\*065,  
STPSC\*H12



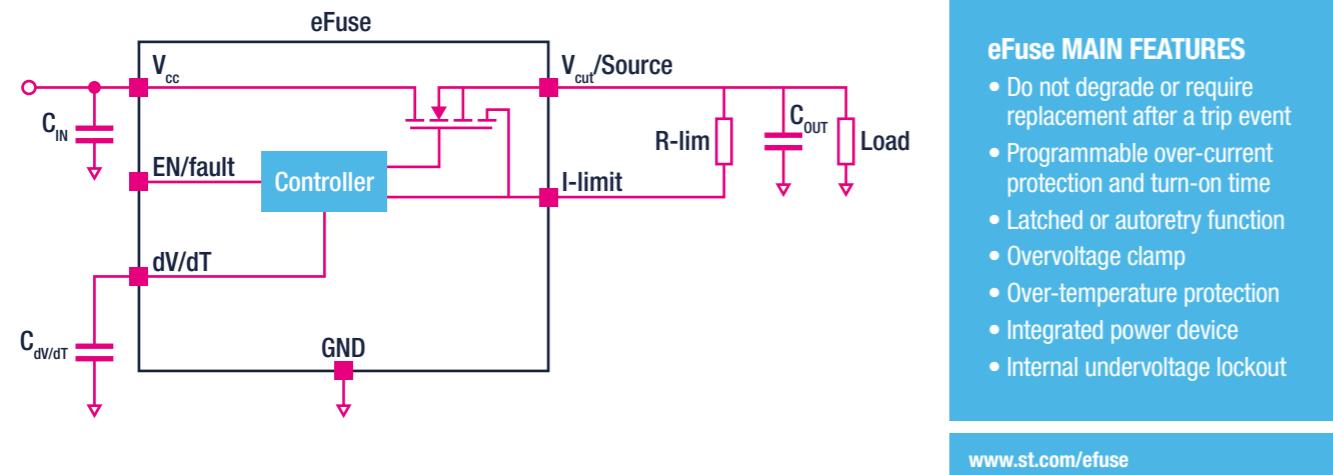
Server/Telecoms and PFC  
STPSC\*065, STPSC\*H12

## eFuses AND HOT-SWAP ICs

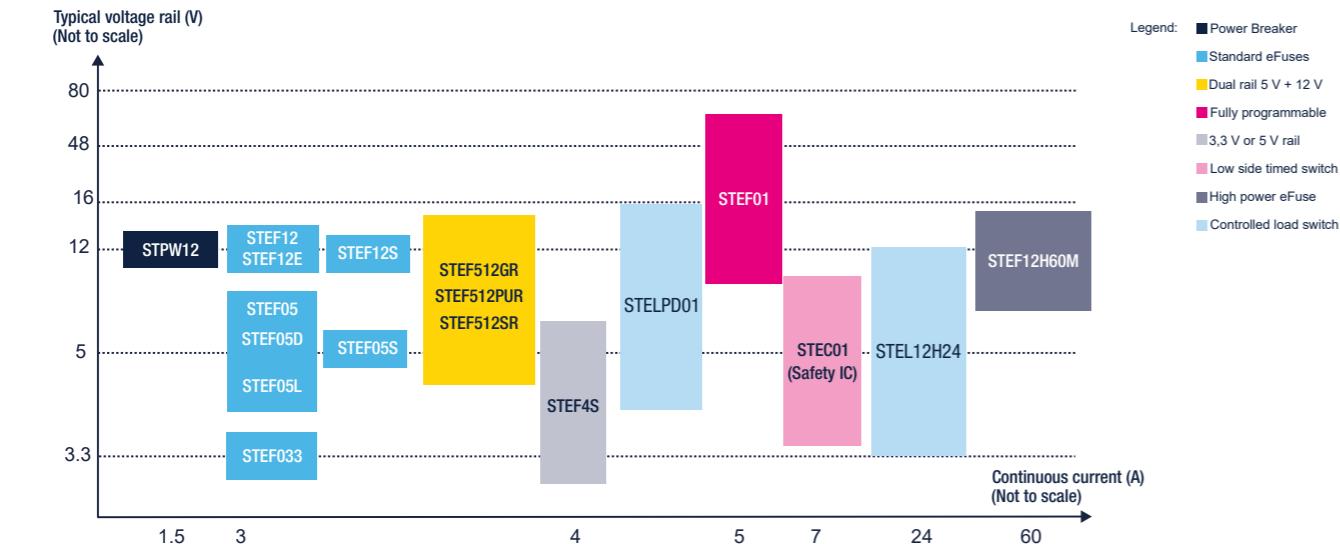
### eFuses

**eFuses** are electronic fuses that can replace larger conventional fuses or other protections, reducing ownership costs in production and in the field.

Unlike fuses, they offer complete and flexible management of the fault (overcurrent/overvoltage) without requiring replacement after actuation. They thus help improve equipment uptime and availability, and also reduce maintenance costs and false returns. Compared to traditional protection devices, these new electronic fuses enable versatile and simple programming of protection parameters such as overcurrent threshold and start-up time.



### eFuses, a smart offer for a lots applications



### MAIN APPLICATIONS



Home appliances  
STEF05, STEF01,  
STEF12, STEF12S



Server and Data Storage  
STEF033, STEF05, STEF05L,  
STEF12, STEF12S,  
STEF05S, STEF12S,  
STEF512, STEF512SR,  
STEL12H24



USB connections  
STEF05, STEF05L,  
STEF05S, STEF12S,  
STEF512, STEF512SR,  
STEL12H24



Factory automation  
STEF01,  
STEF12, STEF12S,  
STEF05S, STEF12S,  
STEF512, STEF512SR,  
STEL12H24



Set-top boxes  
STEF12,  
STEF12S,  
STEF12S

### Power breakers

Connected in series to the power rail, ST **power breakers** are able to disconnect the electronic circuitry when power consumption exceeds the programmed limit. When this happens, the device automatically opens the integrated power switch, disconnecting the load, and notifies the remote monitoring feature.

The STPW programmable electronic power breaker family provides a convenient and integrated solution for quickly and safely disconnecting a faulty load from a 12 V bus.

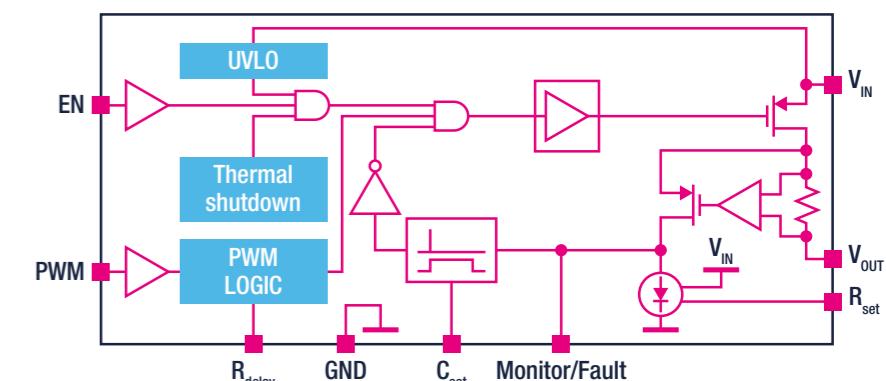
Inserted between the power rail and the load, STPW power breakers contain a low-resistance (50 mΩ) power switch and precision circuitry for sensing the load power. If the user-programmed limit is exceeded, the switch turns off and a signal on the dedicated monitor/fault pin informs the host system. In normal operation, this output presents an analog voltage proportional to the load power to permit continuous monitoring.

Also featuring built-in auto-restart after a user-adjustable delay and programmable PWM masking time to prevent protection triggering by inrush current, the STPW family simplifies design for safety and eases certification for standards such as the UL 60730 specifications for abnormal operation. This integrated solution effectively replaces discrete circuitry or a combination of ICs such as a current-sense amplifier or a hot-swap controller plus MOSFET switches, by offering improved accuracy and saving board space and bill of materials for each load protected.

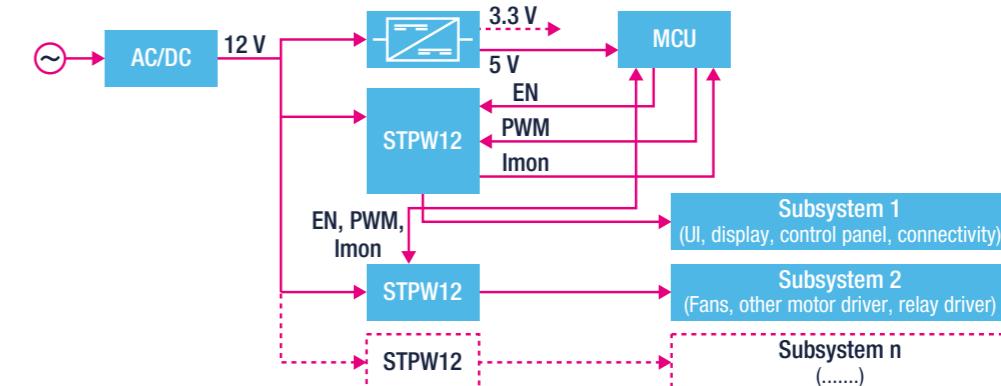
### Power breakers

#### STPW12

- Auto-retry function with programmable delay
- Adjustable precise power limitation from 11 to 16 W
- 12 V rails
- Programmable power limit masking time
- Over-temperature protection
- Integrated N-channel power MOSFET
- Internal undervoltage lockout



### Typical home appliance block diagram for STPW12



### MAIN APPLICATIONS



Home appliances  
STPW12



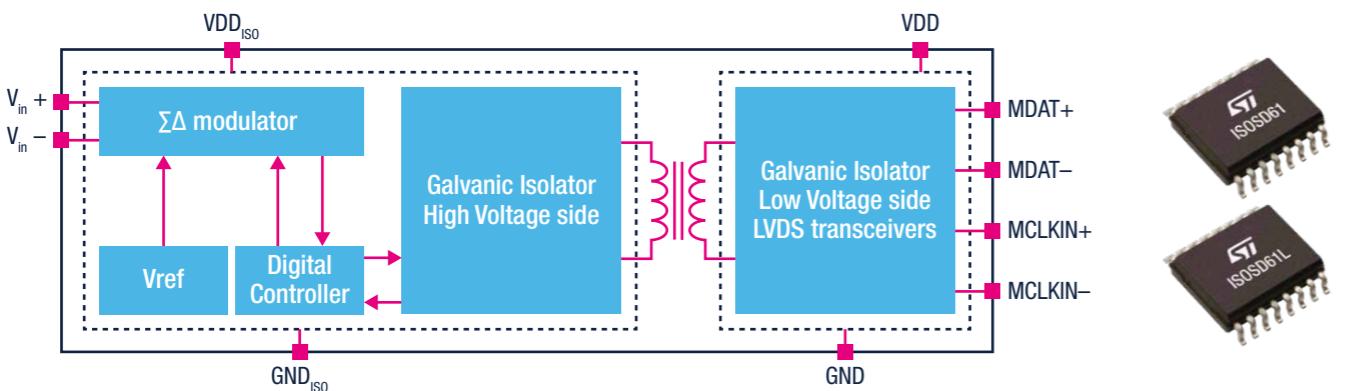
Air conditioning  
STPW12



Factory automation  
STPW12

## GALVANIC ISOLATED SIGMA-DELTA ADC

The galvanically isolated **ISOSD61/ISOSD61L** second order Sigma-Delta modulator, based on the highly successful ST transformer coupling technology, is available in the single-ended (**ISOSD61**) and differential (**ISOSD61L**) signaling versions. It converts analog input signals into high-speed single-bit digital data streams, from which analog information can be recovered by a low-pass filter and further processed by a host controller. The modulator protects the output peripheral interface with a galvanic isolation barrier that separates low and high voltage domains and blocks stray currents between different grounds. The silicon-based isolation technology offers a number of advantages over traditional opto-coupling, including significantly lower power consumption, higher data transfer rates, and greater reliability for longer device lifetime, and over Hall-effect sensors in terms of accuracy, noise rejection, latency, form factor, and cost.



### KEY FEATURES

- 2nd order 16-bit Sigma-Delta Modulator
- $\pm 320 \text{ mV}$  Full Scale Differential Input Signal Range
- Up to 25 MHz external clock input for easier synchronization
- Up to 50 kHz Bandwidth
- 86 dB typical SNR
- - 83 dB typical THD
- 30 kV/ $\mu\text{s}$  typical Common-Mode Transient Immunity
- 6 kV VPEAK Highest Allowable Over-Voltage ( $V_{IOTM}$ )
- 6 kV VPEAK Maximum Surge Insulation Voltage ( $V_{ISM}$ )
- 1.2 kV  $V_{PEAK}$  Maximum Working Insulation Voltage ( $V_{IORM}$ )
- Flexible interface options: Low Voltage Differential Signaling (LVDS) and Single Ended (TTL/CMOS) options
- -40 °C to +125 °C extended industrial temperature range
- SO-16 wide package

### Product table

Part Number	Version	Input Range	Max. Clock Frequency	Resolution	SNR	Isolation	CMTI	Package & Packing
ISOSD61	TTL/CMOS	$\pm 320 \text{ mV}$	25 MHz	16-bit	86 dB	1.2 kV $V_{IORM}$	30 kV/ $\mu\text{s}$	SO16W Tray
ISOSD61TR	TTL/CMOS							SO16W Tape & Reel
ISOSD61L	LVDS							SO16W Tray
ISOSD61LTR	LVDS							SO16W Tape & Reel

### MAIN APPLICATIONS



Servo drive



Factory automation



EV charging station



Server & telecom power



## IGBTs

ST offers a comprehensive portfolio of **IGBTs (Insulated Gate Bipolar Transistors)** ranging from 600 to 1700 V in trench gate field-stop (TGFS) technologies.

Featuring an optimal trade-off between switching performance and on-state behavior (variant), ST IGBTs are suitable for industrial and automotive segments in applications such as general-purpose inverters, motor control, home appliances, HVAC, UPS/SMPS, welding equipment, induction heating, solar inverters, traction inverters, on-board chargers, and fast chargers.

### Industrial

#### Breakdown Voltage

600 V	650 V	1200 V	1250 V	1700 V
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#### Nominal Current

4 to 20 A	20 to 80 A	4 to 200 A	15 to 100 A	20 to 50 A	8 to 75 A	15 to 75 A	20, 30 A	50 A (bare die)
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#### Switching frequency

8 to 30 kHz	50 to 100 kHz	2 to 20 kHz	16 to 60 kHz	2 to 20 kHz	20 to 100 kHz	16 to 60 kHz	2 to 20 kHz
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#### IGBT Series

H	V	M	HB/HB2	IH	M	H	IH	M
---	---	---	--------	----	---	---	----	---

#### Focus Applications

Home appliances	Welding, PFC, solar, UPS, charger	Industrial motor control, automotive traction inverter, GPI, Air-Con	PFC, Solar, UPS, Charger, Welding and soft switching	Induction heating and soft switching	Industrial motor control, GPI, Air-Con	Welding, PFC, solar, UPS, charger	Induction heating, microwave and soft switching	Industrial motor control, GPI, Windmill
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### Automotive

#### Breakdown Voltage

600 V	650 V	750 V	1200 V
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#### Nominal Current

20 to 80 A	30 to 200 A	20 to 80 A	15 to 100 A	200 to 500 A	15 to 40 A
------------	-------------	------------	-------------	--------------	------------

#### Switching frequency

50 to 100 kHz	2 to 20 kHz	16 to 60 kHz	2 to 20 kHz	2 to 20 kHz
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#### IGBT Series

V	M	HB	HB2 (eligible)	MH	MS
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#### Focus Applications

OBC (PFC section)	Traction inverter, Motor Control, Aux loads, PTC heaters	OBC (PFC), Air-Con	EV, HEV Traction inverter	Motor Control, Aux loads, PTC heaters, Battery thermal management	Development
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### H series

#### STG\*H\*

- H\* - 600 V family
- 3  $\mu$ s of short-circuit capability
- Low saturation voltage
- Minimal collector turn-off
- Series optimized for home appliance applications

### H - 1200 V family

- 5  $\mu$ s of short-circuit capability @ starting  $T_J = 150^\circ\text{C}$
- Low turn-off losses
- Up to 100 kHz as switching frequency

### HB series

#### STG\*H\*B

- Low saturation voltage
- Minimal tail current turn-off
- Different diode option
- Optimum trade-off between conduction and switching losses
- Low thermal resistance
- 4 leads package available
- Very high robustness in final application
- Automotive eligible

### MH series

#### STG\*MH\*

- Increased BV robustness and current density
- Low  $V_{CE(sat)} = 1.3 \text{ V}$  (typ.) @ IC = 300A
- Integrated Kelvin and current sensing option
- Enhanced switching performances
- Dice top and back metallization suitable for high performance linking
- High current and temperature fully tested
- Rebuilt wafers for customized modules

### V series

#### STG\*V60\*F

- Optimized for high switching frequencies
- Negligible current tail at turn-off
- Very low turn-off switching losses
- Soft and very fast recovery antiparallel diode
- Up to 100 kHz in hard switching topologies
- AEC-Q101 qualified device

### HB2 series

#### STG\*H\*FB2

- Very low saturation voltage
- Reduced gate charge
- Different diode option
- Optimum trade-off between conduction and switching losses
- Low thermal resistance
- 4 leads package available
- High efficiency in final application
- Automotive eligible

### M series

#### STG\*M\*

- 650 V family
- 6  $\mu$ s of min short-circuit capability @ starting  $T_J = 150^\circ\text{C}$
- Wide safe operating area (SOA)
- Very soft and fast recovery antiparallel diode
- Suitable for any inverter system up to 20 kHz AEC-Q101 qualified devices
- 1200 V family
- 10  $\mu$ s of min short-circuit capability @ starting  $T_J = 150^\circ\text{C}$
- Freewheeling diode tailored for target application
- Suitable for any inverter system up to 20 kHz

### IH series

#### STG\*IH\*

- 650 V IH family
- Very low  $V_{CE(sat)}$ : 1.5 V @ ICN
- Very low Eoff
- Low drop forward voltage diode
- Designed for soft commutation application only
- 1250 V IH family
- Minimized tail current
- Very low drop freewheeling diode
- Tailored for single-switch topology

### MS series

#### STG\*MS\*

- Designed for automotive application
- 8  $\mu$ s of short-circuit withstanding time @  $V_{CC} = 800 \text{ V}$ ,  $V_{GE} = 15 \text{ V}$ ,  $T_J - \text{start} = 150^\circ\text{C}$
- Maximum continuous operating junction temperature:  $T_J = 175^\circ\text{C}$
- Low  $V_{CE(sat)} = 1.95 \text{ V}$  (typ.) @ IC = 40A

### MAIN APPLICATIONS



Note: \* is used as a wildcard character for related part number

[www.st.com/ibt](http://www.st.com/ibt)

## INTELLIGENT POWER MODULE - SLLIMM

The **SLLIMM**, small low-loss intelligent molded module, is the ST family of compact, high efficiency, dual-in-line **intelligent power modules (IPM)** with extra optional features. This family includes different solutions in terms of package (SMD, through hole, full molded, and DBC) and silicon technology (IGBT, MOSFET and superjunction MOSFET). Optimally balancing conduction and switching energy with an outstanding robustness and EMI behavior makes the new products ideal to enhance the efficiency of compressors, pumps, fans, and any motor drives working up to 20 kHz in hard switching circuitries and for an application power range from 10 W to 7 kW.

### KEY FEATURES

- Low  $V_{CE(sat)}$ , Low  $R_{DS(on)}$
- Optimize driver and silicon for low EMI
- Lowest R<sub>th</sub> value on the market for the DBC package versions
- Internal bootstrap diode
- Maximum junction temperature: 175 °C for IGBT and 150 °C for SJ-MOSFET
- Separate open emitter outputs
- NTC on board
- Integrated temperature sensor
- Comparator for fault protection
- Shutdown input/fault output

### KEY BENEFITS

- Integrated and efficient solution
- Easy to drive through microcontroller
- Higher robustness and reliability
- Plug'n Play solution

SLLIMM nano SMD	SLLIMM nano	SLLIMM nano 2nd series	SLLIMM 2nd series	SLLIMM HP
600 V IGBT 500 V MOSFET 1 up to 3 A	600 V IGBT 500 V MOSFET 1 up to 3 A	600 V IGBT 600 V SJ-MOSFET 3 up to 8 A	600 V IGBT 600 V SJ-MOSFET 8 up to 35 A	IGBT 650 V, 50 A 1200 V, 10 A
 NSDIP-26L (SMD) 12.45 x 29.15 x 3.10 mm	 NDIP-26L (TH) 12.45 x 29.15 x 3.10 mm	 N2DIP-26L (TH) 12.45 x 32.15 x 4.10 mm VISO = 1.5kVrms/min	 SDIP2F-26L SDIP2B-26L 24 x 38 x 3.5 mm VISO = 1.6kVrms/min	 SDIPHP-30L 31 x 52 x 5.6 mm VISO = 2.5kVrms/min
Power rating: 10 to 80W   	Power rating: 60 to 110W   	Power rating: 100 to 600W   	Power rating: 300W to 3kW   	Power rating: 3 to 7kW   

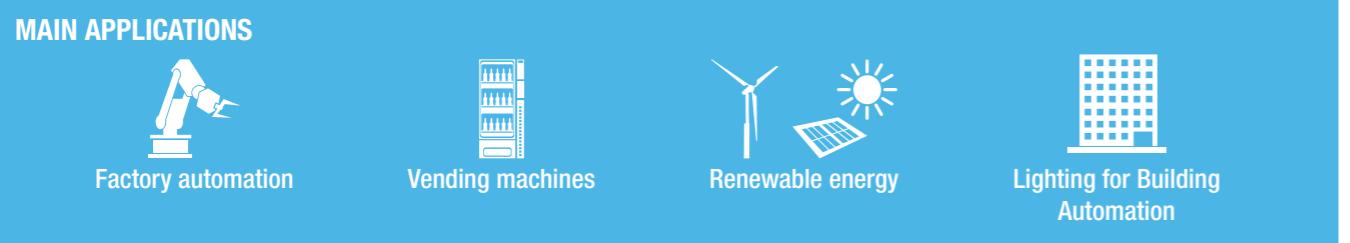
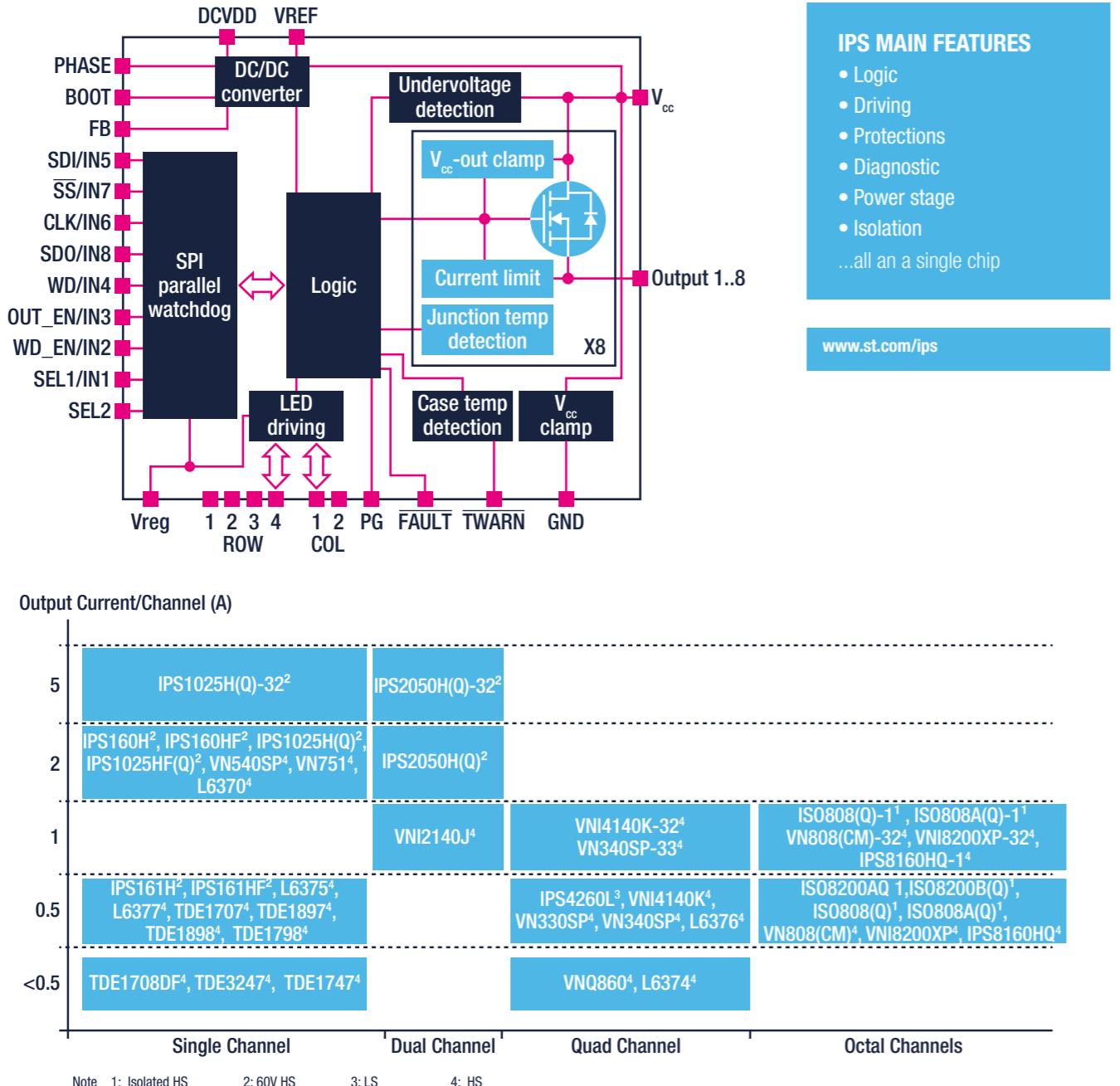
[www.st.com/igbt](http://www.st.com/igbt)



## INTELLIGENT POWER SWITCHES

STMicroelectronics offers **intelligent power switches (IPS)** for low- and high-side configurations. ST IPS feature a supply voltage range from 6 to 60 V, overload and short-circuit protection, current limitation set for industrial applications, different diagnostic types, high-burst, surge and ESD immunity, very low power dissipation, and fast demagnetization of inductive loads.

The devices are designed using ST latest technologies for state-of-the-art solutions in any application field.

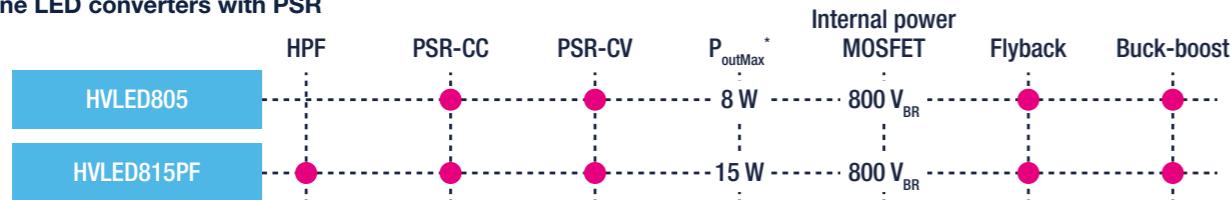


## LED DRIVERS

### Offline LED drivers

Dedicated **LED drivers** operating from the AC mains ensure highly accurate LED control to provide a high level of light quality and avoid flickering. By combining state-of-the-art low-voltage technology for the controller and extremely robust 800 V technology for the power MOSFET in the same package, HVLED8\* converters (i.e., controller + MOSFET in the same package) feature an efficient, compact, and cost-effective solution to drive LEDs directly from the rectified mains. This family of converters works in constant-current/constant-voltage primary-side regulation (PSR-CC/CV). HVLED001A and HVLED001B controllers are also available for high power needs working in constant-voltage (PSR-CV) primary-side regulation; a dimming function is also available. For both families (HVLED converters and controllers), the primary-side regulation cuts bill-of-material costs, while also simplifying design and reducing the space occupied by LED control circuitry.

### Offline LED converters with PSR



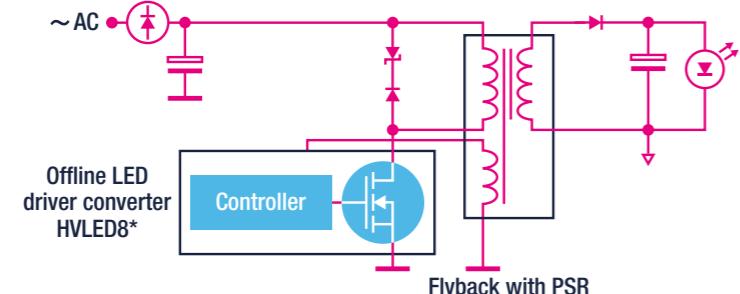
### Offline LED controllers with PSR



### Offline LED controllers



### Topology example



### MAIN APPLICATIONS



Residential lighting  
HVLED815PF



Commercial and street lighting  
HVLED001A, HVLED001B, HVLED007

### DC-DC LED drivers

ST monolithic buck switching regulators offer input voltage capability up to 61 V and deliver output currents up to 4 A with high switching frequency. They enable simple, efficient, and cost-effective solutions for driving high-brightness LEDs. They also feature dedicated circuitry for dimming. Boost regulators provide the necessary high voltages to drive multiple LEDs in series, guaranteeing accurate LED current matching.

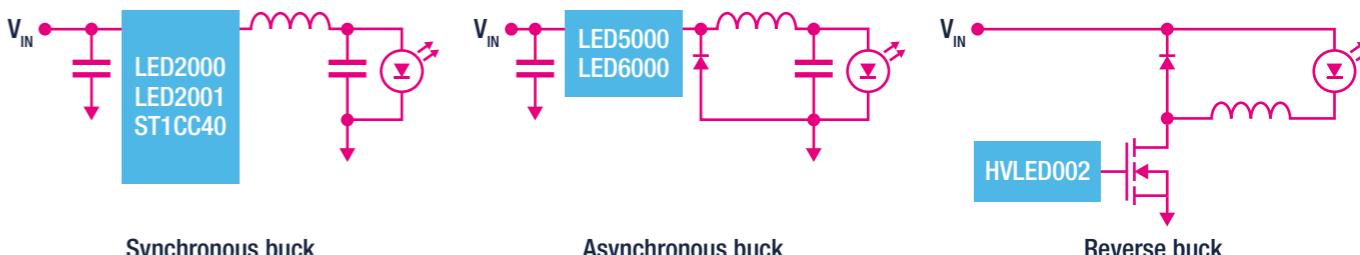
### DC-DC LED drivers converters

	Buck	Buck-boost	$I_{outMax}$	Dimming	$V_{inMax}$	Synchronous
LED2000	●		3 A	●	18 V	●
LED2001	●		4 A	●	18 V	●
ST1CC40	●		3 A	●	18 V	●
LED5000	●	●	3 A	●	48 V	
LED6000	●	●	3 A	●	61 V	

### DC-DC LED drivers controllers

	Reverse buck	Buck-boost	Boost & Sepic	Dimming	$V_{inMax}$
HVLED002	●			●	150 V
LED6001		●	●	●	36 V
STLDC08			●	●	3.6 V

### Topology examples



### MAIN APPLICATIONS



Halogen bulbs replacements and home appliances  
LED2000, LED2001, ST1CC40, LED5000, LED6000



Traffic signals  
LED2000, LED2001, ST1CC40, LED5000, LED6000



Street lighting  
LED5000, LED6000, HVLED002



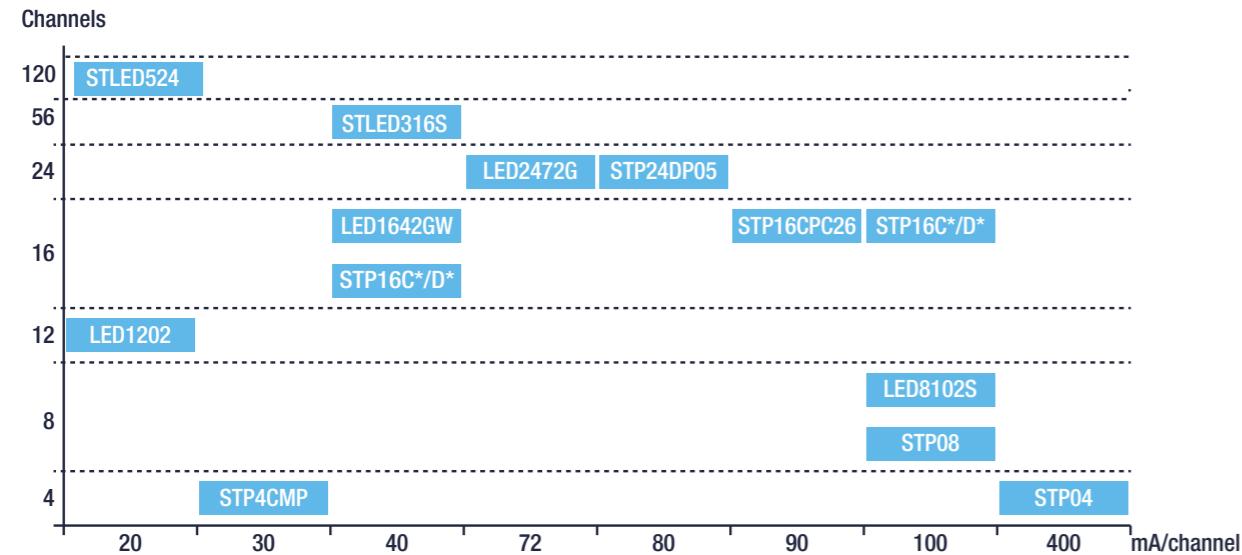
Emergency lighting  
LED6001, ST1CC40



Commercial and architectural lighting  
LED5000, LED6000, LED6001, HVLED002

## LED array drivers

ST **LED array drivers** fully integrate all functions required to drive high-brightness LEDs. These devices allow constant-current control in a single-chip solution. The external parts are reduced to only one resistor that sets the preferred maximum current for all outputs. Devices also come with additional features such as high current, high precision, local and global LED brightness adjustment, thermal shutdown, error detection, and auto power-saving functionalities.



### 24 channel RGB (8x3) drivers

- Current gain control (LED2472G), constant current (STP24DP05)
- Error detection
- Autopower saving (LED2472G)

### 12/16 channel drivers

- Current gain control (LED2472G), constant current (STP24DP05)
- Error detection (STP16C\*/D\*)
- Dot correction (LED1202)
- Autopower saving

### 4/8 channel drivers

- Constant current (LED1642GW), constant current (STP16C\*/D\*)
- Error detection (STP08)
- Global dimming
- Direct I/O (LED8102S)
- 6 Key-scanning (8 x 2 matrix)
- Error detection (STP08)
- 3-wire serial bus interface

### 16 Digit, 56 LED Matrix

- 40 mA Current capability
- 6 Key-scanning (8 x 2 matrix)
- Error detection (STP08)
- Global dimming

### 5x24 matrix drivers

- 20 mA/dot
- Adjustable luminance for each LED (dot)

## MAIN APPLICATIONS



Traffic signals  
LED8102S, LED2472G,  
STP24DP05, STP04



Large panel signs  
LED1642GW, LED2472G,  
STP24DP05, STP16,  
STP08



Home appliances  
LED8102S, STP16,  
STP08, LED1642GW,  
LED2472G, LED8102S  
STP4CMP, STLED524



Special lighting  
STP04, LED1642GW,  
LED2472G, LED8102S  
STP4CMP, STLED524



Smartphones /  
Wearable  
STLED524, LED1202

## LED row drivers

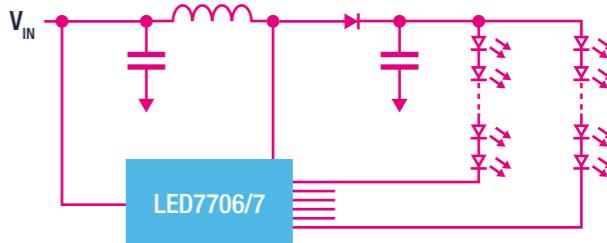
**LED row drivers** are essentially boost regulators that provide the necessary high voltages to drive multiple LEDs in series, guaranteeing accurate LED current matching.

ST offers both single- and multi-channel high-efficiency boost LED drivers featuring a wide dimming range, low noise, and small footprint. They also embed protection functions such as overvoltage and overcurrent protection, thermal shutdown, and LED-array protection.

### LED row driver converters

6 rows	LED7707	• 85 mA/row
1 row	LED7706	• 30 mA/row
	STLA02*	• 20 mA/row
	STLD40D	• 0.5 A/1.5 A/ 2 A/row
	STCS*	• 0.5 A/1.5 A/ 2 A/row

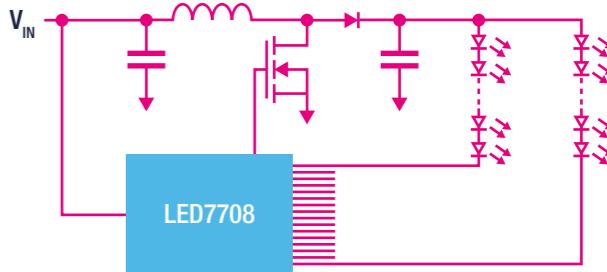
### Global dimming



### LED row driver controllers

16 rows	LED7708	• 85 mA/row • Grouped or independent row dimming
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### 16 rows



## MAIN APPLICATIONS



Smartphones  
STLA02, STLD40D



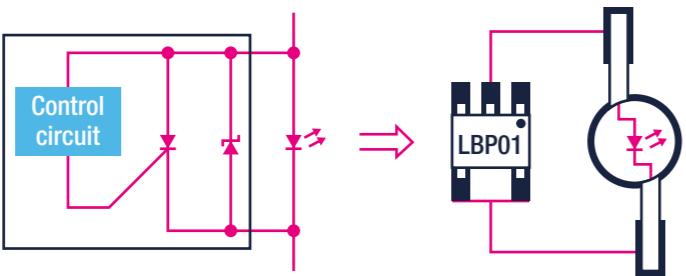
Keyboard and accessories  
STLA02\*



Home appliances and ATMs  
LED7706, LED7707, LED7708, STCS\*

## LED bypass protection

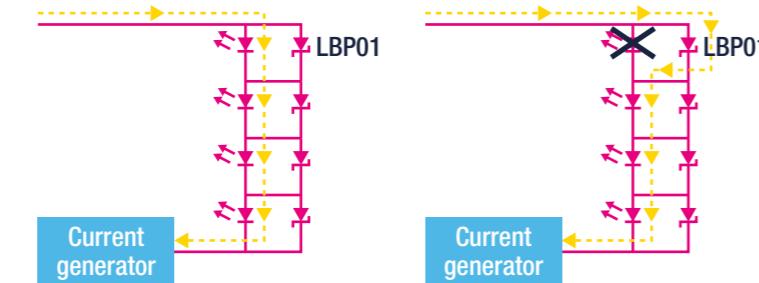
The **LBP01 series** of LED bypass protection devices are bypass switches that can be connected in parallel with 1 or 2 LEDs. In the event of a LED failure, this device shunts the current through other LEDs. It also provides overvoltage protection against surges as defined in IEC 61000-4-2 and IEC 61000-4-5



### Ibp01 get reliable your led application

#### LBP01

- Keep LED strings on in case of LED open mode failure
- Reduced maintenance cost
- Increase lifetime of the lighting system



## LINEAR VOLTAGE REGULATORS

ST offers a complete portfolio of industry-standard **high-performance regulators** for both positive and negative outputs. Among our products, you can find the optimal combination of ultralow dropout voltage (from 50 to 220 mV for 100 mA to 3 A load current) and low quiescent current - for the highest efficiency design – (from 0.3 to 20  $\mu$ A for 50 mA to 2 A) or dynamic performance for the best transient response, power supply ripple rejection (up to 92 dB at 1 kHz), and low noise (as low as 6.3  $\mu$ Vrms). This is coupled with a range of the smallest form factor packages for size-conscious applications, such as a 0.47 x 0.47 mm STSTAMP package.



STLQ015	LDK120/130	LD39015	Ultra-low dropout	Low $I_q$	Low noise, high PSRR
STLQ50	LD040L	LD59030			
ST/LDK715	LDK220	LD39020/30			
ST1L08	LDK320	ST730/2			
LD56100	LD56050	LD39050/100/49100			
LDBL20	LDCL015	LD57100			
LDFM/LDF	LDLN015	LD39115J			
LD59100	LDL112	LD39130S			
STLQ020	LDL212	LD39200			
LDLN025/30/50	LD59015	LD59150			
L5050	L5150	L5300			
L99VR01	L4949	L4995			

#### Ultra-low dropout

- High efficiency in low-/medium-power applications
- Best cost/performance trade-off
- Large offer for  $I_{out}$  capability and packaging

#### Low quiescent current $I_q$

- Extending battery life
- Suitable for space-constrained battery-powered applications

#### Low noise, high PSRR

- High signal fidelity
- Reduced size of external filter components

## MAIN APPLICATIONS



Display panels



Residential, commercial, architectural and street lighting



Emergency lighting



Traffic signals

[www.st.com/lbp01](http://www.st.com/lbp01)

## MAIN APPLICATIONS



Tablets, smartphones, and wearables  
LD39115, LD39130, LD39020/30,  
ST1L08, LDBL20, LD59015,  
LDLN025/30/50, STLQ020,  
LD56030, LD56050, LD56100,  
LD57100, L99VR01



Healthcare  
STLQ015, STLQ020,  
ST715, LD39130



Home appliances  
LDK220/320,  
LDF, LDFM,  
LDL212, ST730/2



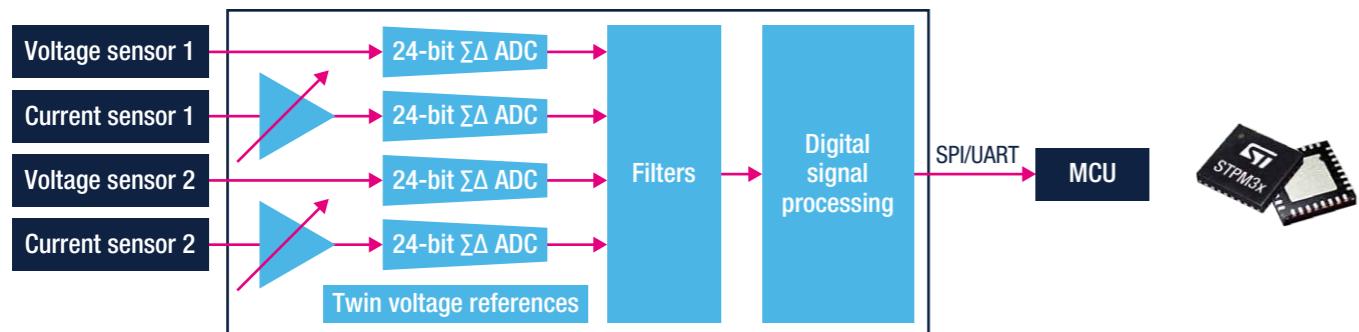
Automotive ADAS, ECU  
LDK130, LD39100,  
LD59150, LD040L,  
L5050, L5150,  
L99VR01, L4949,  
L4995, L5300

[www.st.com/linear-regulators](http://www.st.com/linear-regulators)

## METERING ICs

**STPM32, STPM33, and STPM34** are high accuracy AFE (Analog Front End) for DC and AC energy measurement, offering high accuracy down to extremely low current typical of home appliances in standby. A full set of on-board features provides high system integration and enables on-chip power quality monitoring, reducing smart-meter cost of ownership, and contributing to a fast and easy design to dramatically reduce manufacturing time and cost.

### STPM34: 4 independent channels block diagram



#### KEY FEATURES

- Up to 4 independent 24 bits 2<sup>nd</sup> order  $\Delta$  ADC with PGA Integrated DSP for "turn-key" energy parameters calculations
- Built-in twin independently temperature compensated voltage references
- Double LED output programmable for active and reactive energy pulses generation
- Applicable to Class 0.2 meters
- < 0.1% active power accuracy over a dynamic range of 5000:1
- 3.6 kHz Bandwidth
- Very fast single point calibration
- AC and DC measurement
- Multiple sensors support: Shunt, current transformer, Rogowsky coils
- Multiple host interfaces 5 and 3 wires SPI, UART
- I, V bit stream available to host controller for customer own processing
- Case removal and Neutral Anti-tamper detection
- Exceeds 50-60 Hz EN 50470-x, IEC 62053-2x, ANSI12.2x

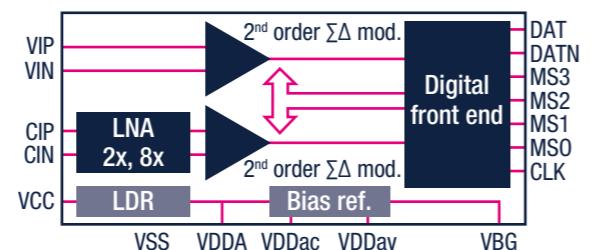
## STPMS2

The STPMS2, also called smart-sensor, is a dual SD modulator with embedded PGA. In combination with a microcontroller that embeds DFSDM filters, it allows you to position the A/D conversion (STPMS2) very close to the current transducers, therefore minimizing noise capture from the analog tracks. Once converted, the SD streaming of voltage and current are multiplexed and transferred through a single-wire data line to the MCU.

#### KEY FEATURES

- Two 2<sup>nd</sup> order SD modulators
- 0.1% active energy max. error over 1:2500 dynamic range
- Standards supported: EN 50470-1, EN 50470-3, IEC 62053-21, IEC 62053-22, IEC 62053-23, ANSI C12.1-2001, ANSI C12.10-1997, ANSI C12.20-2002
- Fast digital calibration
- Allows the use of multiple shunts

## STPMS2



## MAIN APPLICATIONS



Energy metering



EV charging



Lighting



Smart plug



Servers power monitor



Solar charging

## PHOTOVOLTAIC ICs

### DC-DC converters with embedded MPPT algorithm

The maximum power point tracking (MPPT) algorithm maximizes the power output by photovoltaic panels according to temperature and solar irradiation conditions.

The SPV1040 is a monolithic DC-DC synchronous boost converter able to harvest the energy generated by even a single solar cell characterized by a very low output voltage. It is especially designed to work in outdoor environments with loads up to about 3 W.

The SPV1050 is an ultra-low-power battery charger and energy harvester (from photovoltaic cells or thermo-electric generators) that guarantees a very fast charge of supercapacitors and any type of battery, including thin-film solid-state batteries. It is specifically designed to work in indoor environments or with very small thermal gradients with loads up to about 350 mW.

	Input Power Capability	Harvesting Source	Target Battery	Topology	Other Features
SPV1040	Outdoor solar battery charger with embedded MPPT 400 mW to 3 W	PV	Any type*	Sync Boost	Over-current and Over-temperature protection, input reverse polarity protection
SPV1050	Indoor ultra-low-power energy harvester and battery charger with embedded MPPT and LDOs < 400 mW	PV and TEG	Any type (including supercap)	Sync Boost Sync Buck-Boost	Over-voltage and under-voltage battery protection, n. 2 embedded LDOs (1.8 V and 3.3 V)

**Solar curves**

**Thermo-electric generator (TEG)**

### MAIN APPLICATIONS



Smartphones, digital cameras, and camcorders  
SPV1040



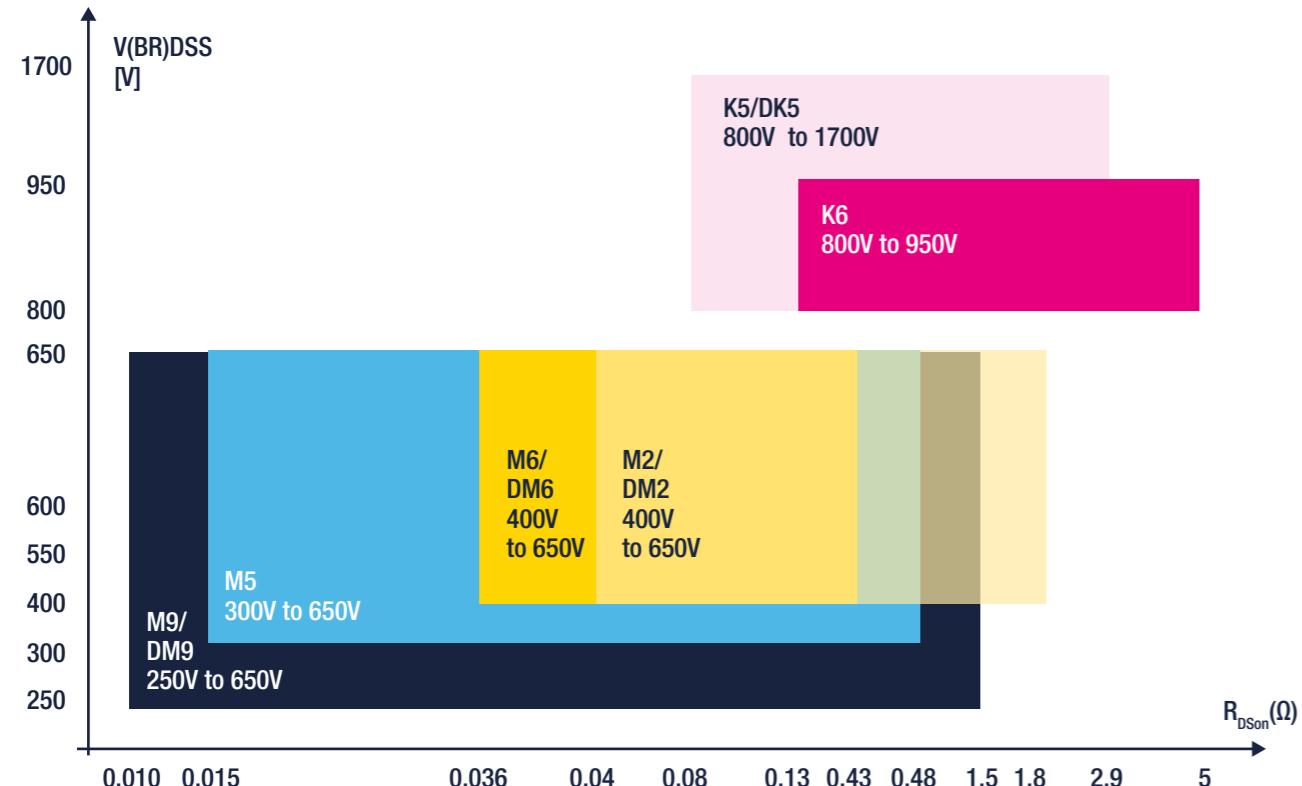
Fitness, climate, home and factory automation monitoring  
SPV1050

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

## POWER MOSFETs

### High-voltage power MOSFETs

The ST **HV Power MOSFETs** portfolio offers a broad range of breakdown voltages from 250 to 1700 V with low gate charge and low on-resistance, combined with state-of-the-art packaging. The **MDmesh** high-voltage MOSFET technology has enhanced power-handling capability, resulting in high-efficiency solutions. Supporting applications for a wide voltage range, such as switch mode power supplies, lighting, DC-DC converters, motor control, and automotive applications, ST has the right Power MOSFET for your design.



### M9 series

#### ST\*N\*M9

- Best Figure of Merit ( $R_{DS(on)} \times Q_g$ ) on the market
- Industry's best  $R_{DS(on)}$  for 650V voltage range
- Lowest  $Q_g$
- Higher reverse diode dv/dt and MOSFET dv/dt ruggedness

### M2/M2-EP series

#### ST\*N\*M2

- Extremely low  $Q_g$
- Optimized for light load conditions
- Tailored for high-frequency applications (M2-EP)
- Suited for hard switching & ZVS/LLC topologies

### K5 & K6 series

#### ST\*N\*K5/6

- Very low  $R_{DS(on)}$
- Small  $Q_g$  and capacitance
- Small packages
- Suited for hard switching topologies

### M5 series

#### ST\*N\*M5

- Very low  $R_{DS(on)}$
- High switching speed
- Suited for hard switching topologies

### DM9 series

#### ST\*N\*DM9

- Best Figure of Merit ( $R_{DS(on)} \times Q_g$ ) on the market
- Improved intrinsic diode reverse recovery time (trr)
- Higher dv/dt and di/dt capability
- Optimized body diode recovery phase and softness

### DK5 series

#### ST\*N\*DK5

- Lowest trr @ Very High Voltage BVDSS
- High dv/dt capability
- Targeting high power 3-phases industrial equipment

### M6 series

#### ST\*N\*M6

- Lower  $R_{DS(on)} \times$  area vs previous generation
- Extremely low gate charge ( $Q_g$ )
- Optimized capacitances profile for better efficiency @ light load
- Optimized threshold voltage (VTH) and gate resistance (RG) values for soft switching

### DM6/DM2 series

#### ST\*N\*DM6

#### ST\*N\*DM2

- Improved trr of intrinsic diode
- High dv/dt capability
- Suited for ZVS/LLC topologies

### MAIN APPLICATIONS



Adapters  
K5, M5, M2, M2-EP,  
M6



Solar inverters, EV Charging stations,  
Energy storage systems and UPS  
K5, M5, DM2, DM6, DK5



Welding, residential,  
commercial and street lighting  
K6, K5, DK5



5G  
Server/Telecoms  
M9, M5, M6, M2, DM9,  
DM6, DM2

Note: \* is used as a wildcard character for related part number

[www.st.com/mosfet](http://www.st.com/mosfet)

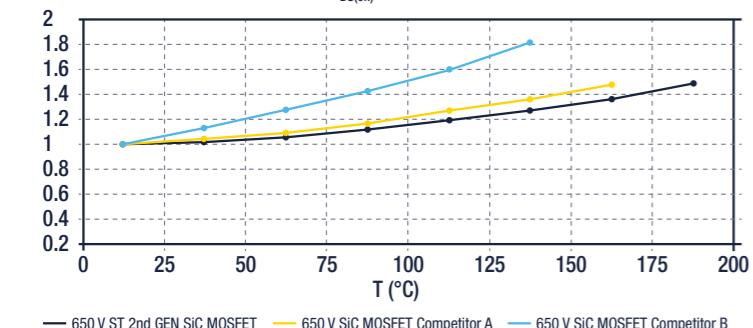
## SiC MOSFETs

Based on the advanced and innovative properties of wide-bandgap materials, ST **silicon carbide (SiC) MOSFETs** feature very low  $R_{DS(on)}$  per area for the 650 V/1200 V Gen2 and the new Gen3 product families, combined with excellent switching performance, translating into more efficient and compact designs.

ST is among the first companies to produce high-voltage SiC MOSFETs. These new families feature the industry's highest temperature rating of 200 °C for improved thermal design of power electronics systems.

Compared to silicon MOSFETs, SiC MOSFETs also feature significantly reduced switching losses and minimal variation with the temperature. These features render the device perfectly suitable for high-efficiency and high-power-density applications.

ST's SiC Mosfet 650 V - Normalized  $R_{DS(on)}$  vs Temperature



Sic mosfets, the real breakthrough in high voltage switching

SCT\*N120G2    SCT\*N65G2    SCT\*N170    SCT\*\*65G3AG

- VBR = 1700 V (SCT\*N170), 1200 V (SCT\*N120G2), 650 V (SCT\*N65G2), 650 V (SCT\*\*65G3AG)
- Low power losses at high temperature
- High operating temperature capability (200 °C)
- Body diode with no recovery losses
- Low power losses at high temperatures
- Easy to drive
- Low gate charge (SCT\*N65G2)



### SiC MOSFETS MAIN BENEFITS

- Smaller form factor and higher power density
- Reduced size/cost of passive components
- Higher system efficiency
- Reduced cooling requirements and heatsink size

### THROUGH-HOLE EXTENDED PACKAGE RANGE



### SURFACE MOUNT EXTENDED PACKAGE RANGE



### MAIN APPLICATIONS



Motor drive &  
factory automation



HEVs / EVs  
(Traction Inverter, OBC, DC/DC)



Charging station



UPS & Data center  
Power supply

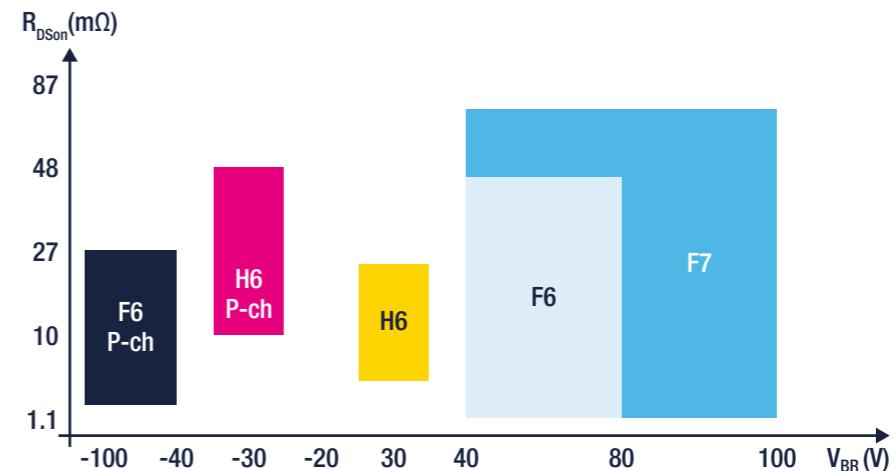


Solar inverters

## Low-voltage power MOSFETs

ST **LV Power MOSFET** portfolio offers a broad range of breakdown voltages from -100 V to 100 V, with low gate charge and low on-resistance, combined with state-of-the art packaging.

ST **STripFET** low-voltage MOSFETs support a wide voltage range for synchronous rectification, UPS, motor control, SMPS, power-over-Ethernet (PoE), inverter, automotive, and other applications in a wide range of miniature and high-power packages: DPAK, D2PAK, SOT-223, TO-220, TO-220FP, TO-247, PowerFLAT (5 x 6)/(3.3 x 3.3)/(2 x 2), SO-8 and SOT23-6L.



### H6 series

ST\*N\*H6

- Very good  $R_{DS(on)}$
- Soft diode recovery
- Suited for OR-ing, square-wave HB, battery management

### F6 series

ST\*N\*F6

- Wide voltage range
- Soft diode recovery
- Very good  $R_{DS(on)}$
- Suited for load-safety switch, buck and sync rectification

### F7 series

ST\*N\*F7

- Extremely low  $R_{DS(on)}$
- Optimized body diode (low Qrr) and intrinsic capacitance for an excellent switching performance
- Proper Crss/Ciss ratio for best-in-class EMI performance
- Outstanding performance for motor control and synchronous rectification



### MAIN APPLICATIONS



Small motor control and  
USB battery chargers  
F6



HDD, power tools, STB,  
and game consoles  
H6



Server/Telecoms  
and SMPS  
F7



UPS, e-bikes,  
and fans  
F6, F7



Solar inverters,  
forklifts, and EHVs  
F7

Note: \* is used as a wildcard character for related part number

[www.st.com/sicmos](http://www.st.com/sicmos)

Note: \* is used as a wildcard character for related part number

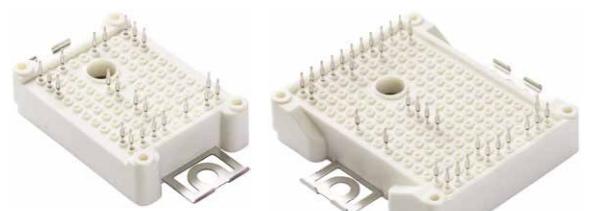
[www.st.com/mosfet](http://www.st.com/mosfet)

## POWER MODULE – ACEPACK PACKAGES OPTIONS

ST ACEPACK power modules come with several topologies that address industrial applications such as motor drives, solar inverters, charging stations, UPS, welding tools, and power converter solutions, while they are also suitable for electric vehicle power applications like on-board chargers (OBC), electric traction drives, and power converter solutions.

These highly reliable and compact power modules feature an embedded NTC thermistor and offer the best compromise between conduction and switching losses, maximizing the efficiency of any converter system in hard-switching circuitries for an application range from few kW to hundreds of kW. For flexible and stable mounting, PressFIT and additional soldered pin options are provided. These power modules implement power semiconductor switches based on ST state-of-the-art SiC MOSFET and IGBT technologies.

### ACEPACK 1 Up to 15 kW



### ACEPACK 2 Up to 30 kW



#### KEY FEATURES

- Very low Stray inductance
- 2.5 kVrms electrical isolation
- Pin out flexibility
- Custom configurations
- Optimized thermal behavior
- Different DBC Options (Al203–AIN)
- Press-fit and solder pin options

#### CONFIGURATIONS

- CIB
- Six-pack
- Three level t-type
- Four Pack
- Half Brige
- Boost
- Customized configurations

### ACEPACK DRIVE

120 kW to 300 kW



#### KEY FEATURES

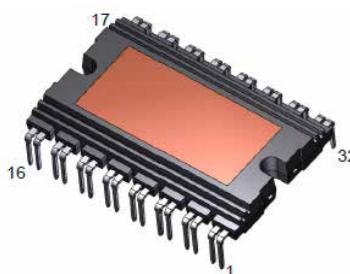
- AMB substrate for enhanced thermal dissipation
- 3 different bus bar configuration options
- Extremely low energies dissipation
- Direct Cooled Cu Base Plate with pin fins

#### CONFIGURATIONS

- Six-pack

### ACEPACK DMT32

120 kW to 300 kW



#### KEY FEATURES

- Designed for automotive applications
- Different DBC Options (Al203–AIN)
- 2.5 kV insulation voltage
- 1200 V SiC MOSFET, Rectifiers
- Several configurations
- Integrated NTC temperature sensor

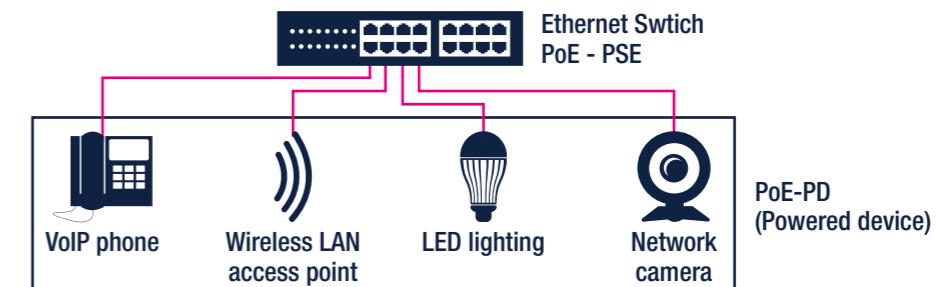
#### CONFIGURATIONS

- Six-pack
- Four Pack
- Customized configurations



## POWER OVER ETHERNET ICs

Power over Ethernet (PoE) is a widely adopted technology used to transfer both data and electrical power over an RJ-45 cable. ST offers solutions for PoE applications on the powered devices (PD) side that integrate a standard Power over Ethernet (PoE) interface and a current mode PWM controller to simplify the design of the power supply sections of all powered devices. ST PoE-PD ICs are compliant with the more recent IEEE 802.3bt specification.



#### PoE-PD devices

##### PM8803

- IEEE 802.3at PD interface
- PWM current mode controller with double gate driver
- Integrated 100 V, 0.45 W, 1 A hot-swap MOSFET
- Supports flyback, forward active clamp, and flyback with synchronous rectification topologies

##### PM8800A

- IEEE 802.3af PD interface
- PWM current mode controller
- Integrated 100 V, 0.5 W, 800 mA hot-swap MOSFET
- Supports both isolated and non-isolated topologies

##### PM8804

- PWM current mode controller
- Double Gate Driver
- Support Isolated Active Forward Converter
- Input voltage up to 75 VDC
- Embedded start-up (20 mA)
- Slope compensation
- Programmable fixed frequency (up to 1 MHz)

##### PM8805

- IEEE 802.3bt PoE-PD interface
- System in Package
- Dual Active bridges
- HotSwap MOSFET
- Compact package (10 times smaller than discrete BOM) with high thermal performances
- 100 W capability

#### Main standards

##### PM8800A PoE-PD (IEEE 802.3af)

13 W

##### PM8803 PoE-PD (IEEE 802.3at)

25 W

##### PM8805+PM8804 PoE-PD (IEEE 802.3bt)

71 W

Power at  
PoE-PD input

#### Power over Ethernet power supply protection

##### PEP01-5841

- Power supply protection compliant with IEC61000-4-5 Level 2 : 1 kV
- Allow to use 100 V power Mosfet
- Stand off voltage: 58 V
- Surface mount SO-8 package

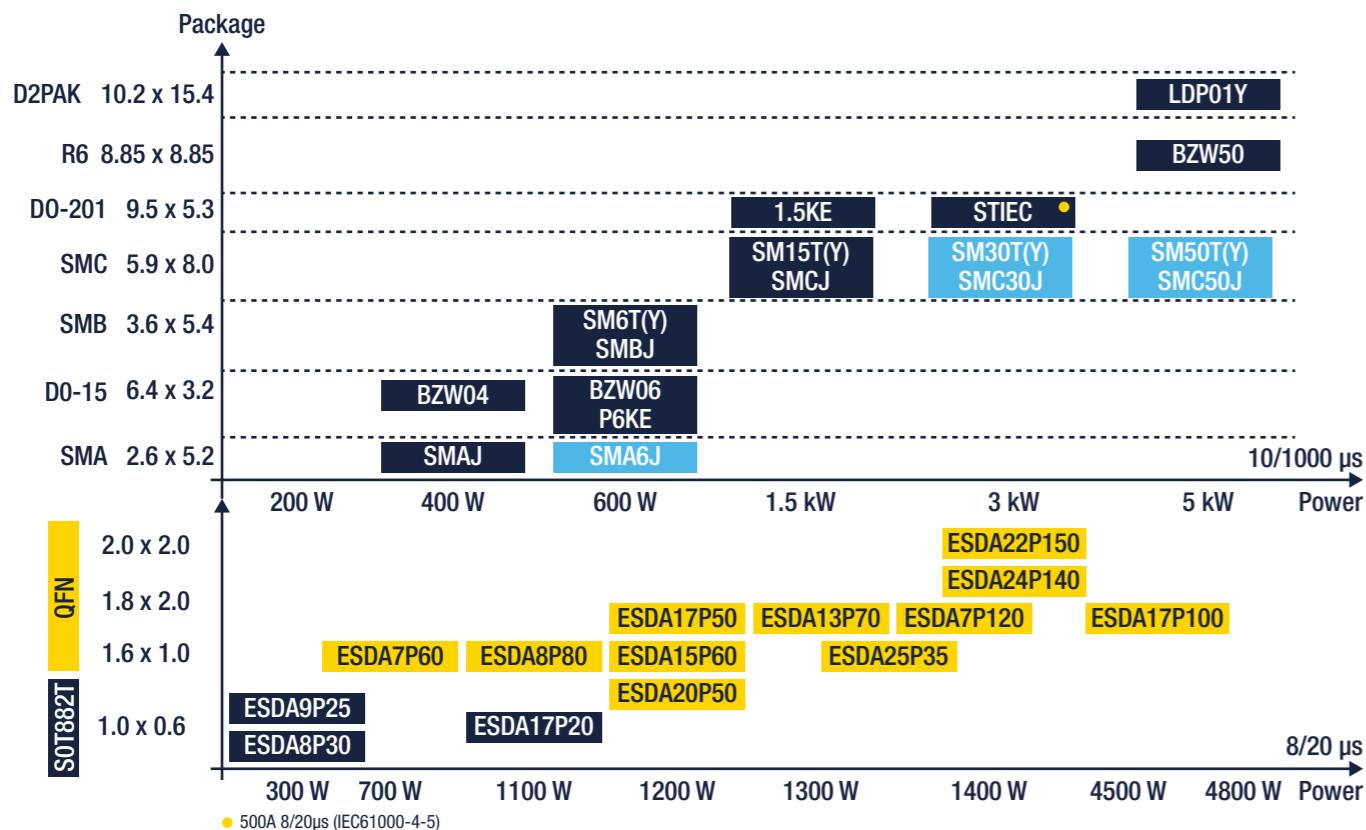
[www.st.com/PoE](http://www.st.com/PoE)

## PROTECTION DEVICES

### TVS

The **TVS Transient Voltage Suppressor** is an avalanche diode designed to clamp over-voltages and dissipate high transient energy. TVS are power devices to protect applications against Electrical Over-Stress (EOS), specifically against surge events as defined by IEC 61000-4-5.

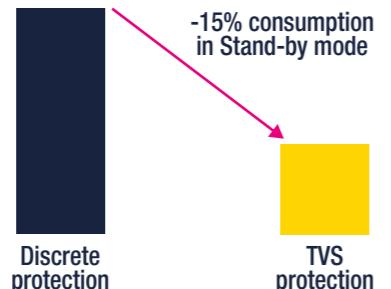
A large choice of package is available to meet application requirements.



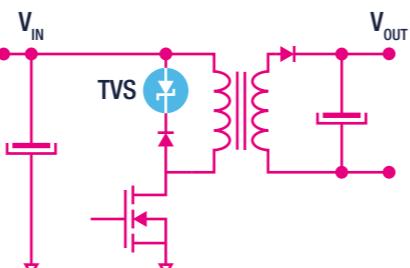
### TVS Transil series against repetitive overvoltage in high temperature conditions

#### TVS

- Clamping voltage characteristics defined at 25 °C, 85 °C and 125 °C
- Stand-off voltage range: from 85 to 188 V
- Low leakage current: 0.2 µA at 25 °C
- Maximum operating junction temperatures:
  - SMB and SMC: 150 °C
  - DO-15 and DO-201: 175°C

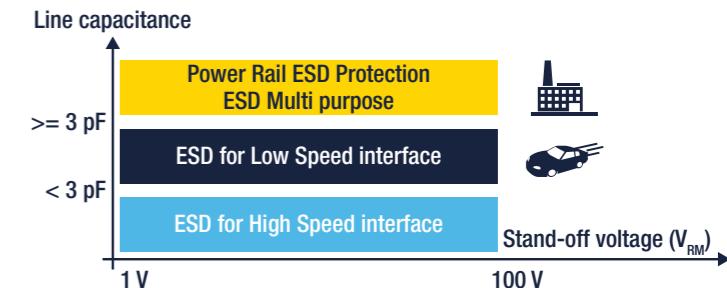


### MOSFET Protection with TVS



### ESD protection

Driven by market needs, ST **ESD protection** devices are available as single line devices for flexibility and multi-line arrays for integration in compact applications. All these devices are rated according to IEC 61000-4-2 and specific requirements, such as low capacitance and bandwidth for high speed lines. A large choice of packages is available to meet application requirements.



### Power delivery Protections

Ultimate TVS protection for USB fast-charging ports

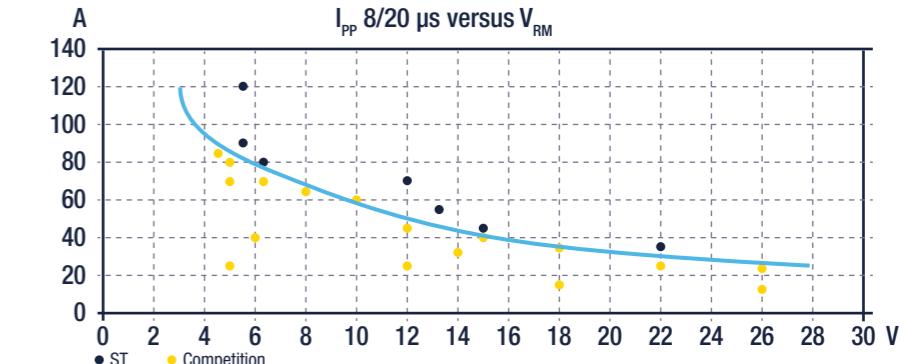
#### ESDAxxP

Strong and thin protection, the ESDAxxP series helps to stop damages due to the surge events

#### KEY FEATURES & BENEFITS

- Complete voltage range: 5 to 22 V
- High 8/20 µs surge protection capability from 25 to 160 A peak pulse current
- 4 small, thin packages:
  - ST1610x (1.6 x 1.0 mm)
  - QFN (2.0 x 1.8 mm)
  - QFN (2.0 x 2.0 mm)
  - SOD882T (1.0 x 0.6 mm)
- High-power, miniature protection
- Saves PCB real-estate
- Highest peak pulse current in the market

### Peak pulse current performance



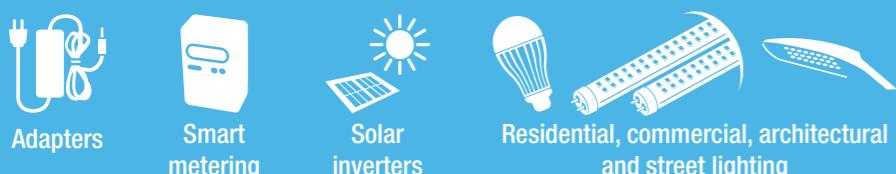
Type	STM32	Pins	5 V - 15 W	9 - 27 W	15 - 45 W	20 V - 100 W
All	With or without STM32	D+/D-	ESDAXLC5-1U2	ESDAXLC5-1U2	ESDAXLC5-1U2	ESDAXLC5-1U2
		SSRx/SSTx	ESDZX051-1BF4	ESDZX051-1BF4	ESDZX051-1BF4	ESDZX051-1BF4
		CC1/CC2	ESDZV5-1BF4	ESDALC14-1BF4	ESDZV18-1BF4	ESDZV201-1BF4 ESDL20-1BF4
	SBU1/SBU1	ESDA6V1L	ESDA14V2L	ESDA25L	ESDA25L	
Sink	Yes	ESDA7P60-1U1M	ESDA13P70-1U1M	ESDA17P20-1F2	ESDA22P150-1U3M	
		ESDA7P120-1U1M	ESDA15P60-1U1M	ESDA17P50-1U1M	ESDA24P140-1U3M	
		ESDA8P30-1T2	ESDA17P100-1U2M	ESDA17P100-1U2M	ESDA25P35-1U1M	
Source	Yes	ESDA9P25-1T2	SMA10A	SMA18A	SMAJ22A	
		SMA6.0A				
DRP	Yes		TCPP01-M12			
			TCPP02-M18			
			TCPP03-M20			

Note: 1 available in Q4 2021

### MAIN APPLICATIONS



### MAIN APPLICATIONS



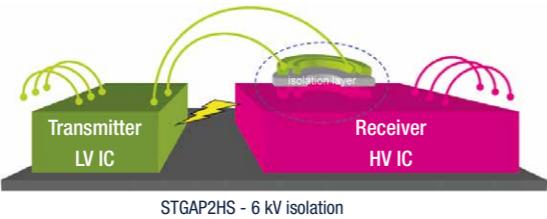
[www.st.com/eos8-20-protection](http://www.st.com/eos8-20-protection)

Note: \* is used as a wildcard character for related part number

[www.st.com/esd-protection](http://www.st.com/esd-protection)

## STDRIVE AND STGAP GATE DRIVERS

ST power MOSFETs and IGBTs gate drivers include integrated high-voltage half-bridge, single and multiple low-voltage gate drivers. Robustness and reliability, system integration and flexibility. The STGAP series of isolated gate drivers provides galvanic isolation between the input section, which connects to the control part of the system and the MOSFET or IGBT being driven.



L6389E	L6390	<b>STDRIVE601 (3-Phase HV)</b>	TD350E
L6388E	L6392	L6491	TD352
A/L6387E	L6391	L6494	TD351
L6386E/AD	L6393	L6498	PM8851
L6385E	L6395		PM8841
L6384E	L6398		PM8834
	L6399		

### 600 V gate drivers

- Half bridge
- 4 A source/sink driver high current capability (L6491)
- Integrated bootstrap diode
- Adjustable deadtime (L6494L)
- Comparator, op amp integrated, smart SD, interlocking and program. DT (L6390)
- Extended temperature range (A version)

### 3-Phase

- Best In Class for propagation delay 85 ns
- 200 mA/350 mA sink / source driver current capability
- Integrated bootstrap diode



### Low side gate drivers

- 2 level turn-off (TD35\*)
- Miller clamp (TD35\*)
- Pulse transf / opto input (TD35\*)
- Dual independent low side driver (PM8834)
- 4 A source/sink driver high current capability (PM8834)

### Galvanically-isolated single and dual gate drivers

- Up to 6 kV isolation (STGAP2HS)
- High voltage rail up to 1.7 kV
- Up to 5 A source/sink driver current capability
- 2 Level turn-off (STGAP1B)
- Miller clamp, negative gate supply
- Optimized for SiC MOSFET driving (STGAP2SiCS)

### STDRIVE600 - High voltage half-bridge gate driver for GaN transistors

- dV/dt immunity  $\pm 200$  V/ns
- Driver current capability:
  - 1.3/2.4 A source/sink typ @ 25 °C, 6 V
  - 5.5/6 A source/sink typ @ 25 °C, 15 V
- Separated turn on and turn off gate driver pins
- 45 ns propagation delay with tight matching
- 3.3 V, 5 V TTL/CMOS inputs with hysteresis
- Interlocking function
- UVLO on low-side and high-side sections

## MAIN APPLICATIONS



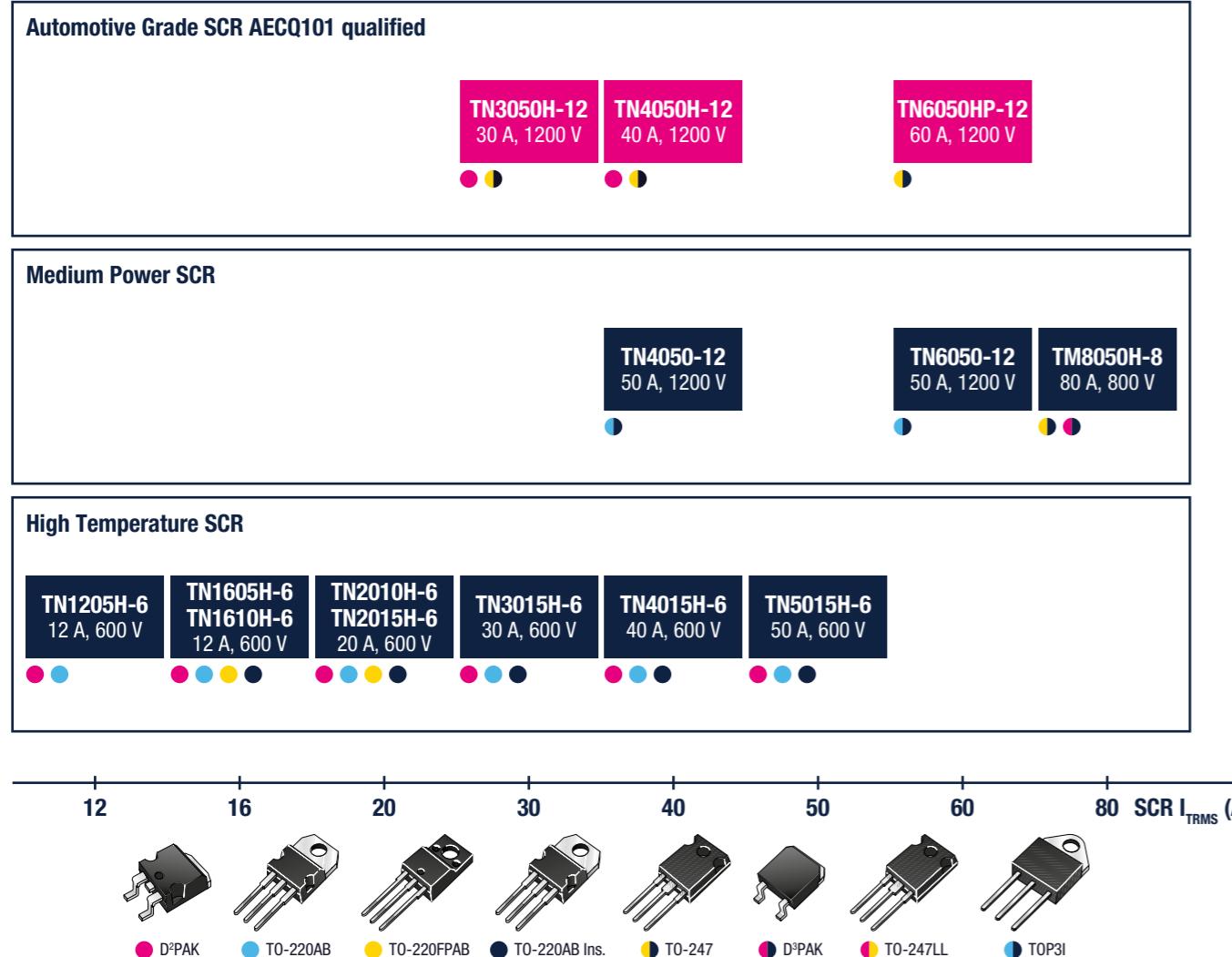
Lighting  
Solar inverters  
HEV / EV

[www.st.com/stdrive](http://www.st.com/stdrive)



## THYRISTORS

Available in through-hole and surface-mount packages, ST **high-temperature Silicon Controlled Rectifiers SCR** provide designers with more headroom for heatsink reduction or more compactness. In addition, the voltage surge immunity is fully specified at 150 °C, ensuring designs are precise and secure. These 12 - 80 A SCRs are ideal for use in charging stations, solid-state relays, inrush current limiters, motor starters, SMPS, UPS, and renewable-energy junction boxes. The 1200 V automotive-grade thyristor makes AC/DC converters safe by limiting the inrush current and providing insulation against AC line over-voltages.



**1200 V High Temperature SCRs** are now available in Surface Mount packages with top-cooled capability. In discrete package with HU3PAK or in module integration with ACEPACK SMIT package, these products are suitable in all bridge or bridgeless AC/DC converter topologies, where compactness and thermal performances are optimized. Thanks to 150 °C maximum junction temperature, the **1200 V High Temperature SCRs** are suitable for industrial and automotive applications in harsh environments.



Optimized for Industrial, Building and Residential appliances and based on ST new high temperature technology, our 800 V **8H Triacs** can work at 150 °C without compromise. Enabling designers to maximize current density or reduce the heatsink size by up to 50%, these triacs are the right choice to run in very hot, confined environments and improve the reliability of systems such as light control, compact heaters, starters or solid-state relays.

Part number	Package			I <sub>T</sub> (RMS) A max	T <sub>J</sub> °C max	V <sub>DRM</sub> /V <sub>RRM</sub> V max	I <sub>GT</sub> mA max	I <sub>TSM</sub> A max	dV/dt V/μs @ 150 °C min	(dl/dt)c A/ms @ 10 V/μs, @ 150 °C min
	TO-220AB	TO-220AB Ins.	D <sup>2</sup> PAK							
T835H-8	T	I	G	8	150	800	35	80	2000	8
T1235H-8	T	I	G	12				120		12
T1635H-8	T	I	G	16				160		16
T2035H-8	T		G	20				200		20
T3035H-8	T	I	G	30				270		25



## USB TYPE-C® AND POWER DELIVERY CONTROLLERS

With an extensive technology and IPs portfolio, ST provide a range of **USB-IF certified solutions for USB Type-C and Power Delivery** to support implementations in a variety of sink, source, and dual role devices. From USB Type-C interfaces and PD Controllers to Authentication, ST complements the portfolio with Power Management ICs, full range of **protection** for data, and power line protection. ST solutions range from **Type-C port interface ICs to USB PD controllers** and offer wide flexibility with hard wired and MCUs to fit different use cases and all power ratings.

### Standalone solutions

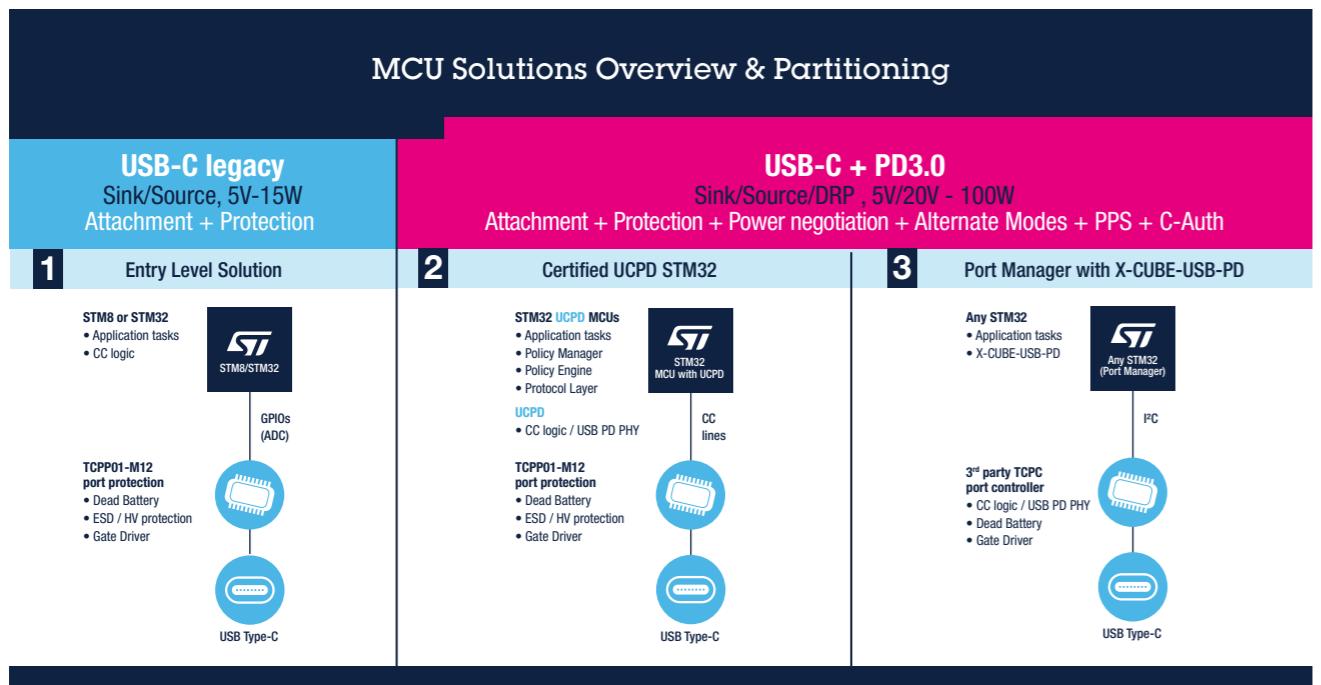
STUSB controllers cover power path applications with optimized partitioning from USB Type-C® Interface for 15 W device to Power Delivery PHY and BMC Driver IC companion chip of STM32-based solutions to standalone full hardware USB PD controller optimized for AC adapters up to 100 W.

### MCU-based solutions

Our STM32 solutions help you manage the complexity of implementing USB Type-C® and Power Delivery technology to ensure that your embedded application supports the latest use cases. The ST ecosystem for USB Type-C reduces the acquisition cost of a technology that requires multiple areas of expertise, such as connectivity, power management, data communication, and authentication.

Combining middleware, configuration, and debugging tools, as well as hardware development platforms, our MCU-based solutions are specifically designed to address this challenge and offer high flexibility to implement USB Type-C and Power Delivery (PD).

A companion Type-C Port Protection device **TCPPO1-M12** is proposed for advanced protection of the USB-C connector line in sink applications, such as CC and Vbus line. For source applications like power adapters, **TCPPO2-M18** is recommended (mass-production Q4-2020). For Dual Role Port applications (DRP), **TCPPO3-M20** is recommended (mass-production Q4-2020).



### STM32 USB PD3.0 controllers

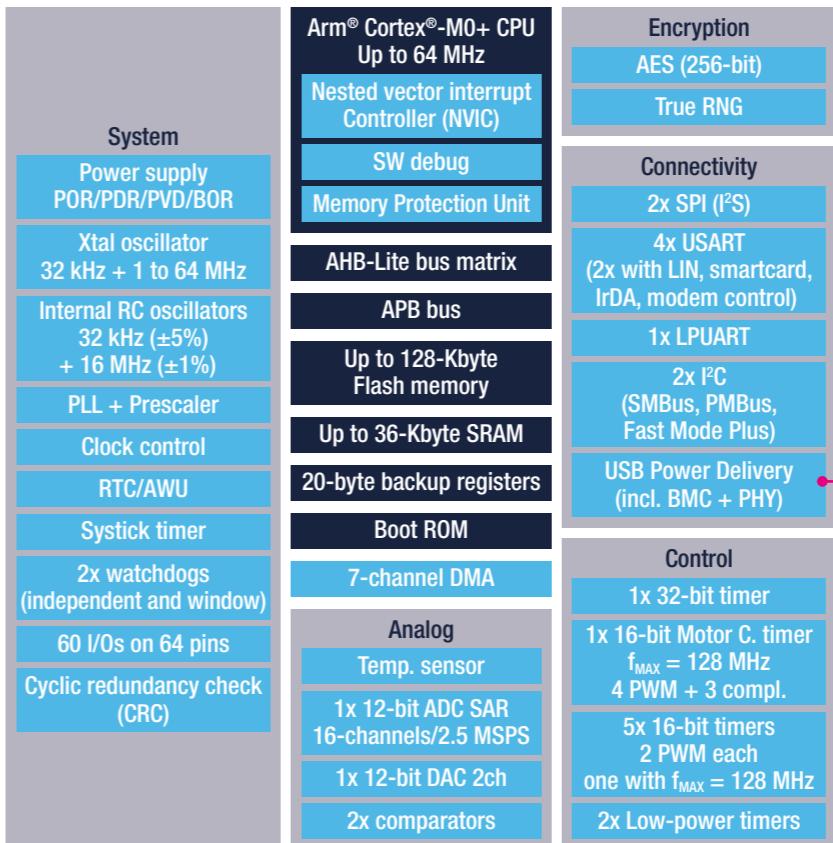
Introduced in December 2017, **STM32G0** is the world's 1st standard USB PD 3.0 microcontroller with a UCPD interface (UCPD stands for USB Type-C and Power Delivery).

This new IP, available in **STM32G0/G4/L5 series**, allows development of USB-C sink, source and dual role devices in a wide range of embedded applications.

UCPD-enabled STM32G0/G4/L5 provides a high flexibility to migrate embedded applications to USB-C and Power Delivery technology, while managing other application environments thanks to the versatile feature set and peripherals available in a traditional MCU. UCPD is certified PD3.0 and supports all new features such as C-Authentication and Programming Power Supply (PPS).

[https://www.st.com/content/st\\_com/en/stm32-usb-c.html](https://www.st.com/content/st_com/en/stm32-usb-c.html)

### STM32G081 block diagram



### UCPD is a new interface that supports:

- USB Type-C connector management
- USB Power Delivery 3.0 communication protocol including C-authentication and Programming Power Supply

### STM32G0 USB-C Ecosystem: for short time-to-market

Our STM32G071B-DISCO kit enables discovery and display of USB-C power and feature capabilities of any USB-C complaint host. Associated with our professional-grade STM32CubeMonitor-UCPD software GUI, the kit acts as a USB PD analyzer and allows customers to debug, configure, and inject USB PD3.0 packets in a single click while monitoring Vbus voltage and Ibus current between two USB-C devices.

Our well-known STM32 configurator STM32CubeMX supports easy setting of UCPD.

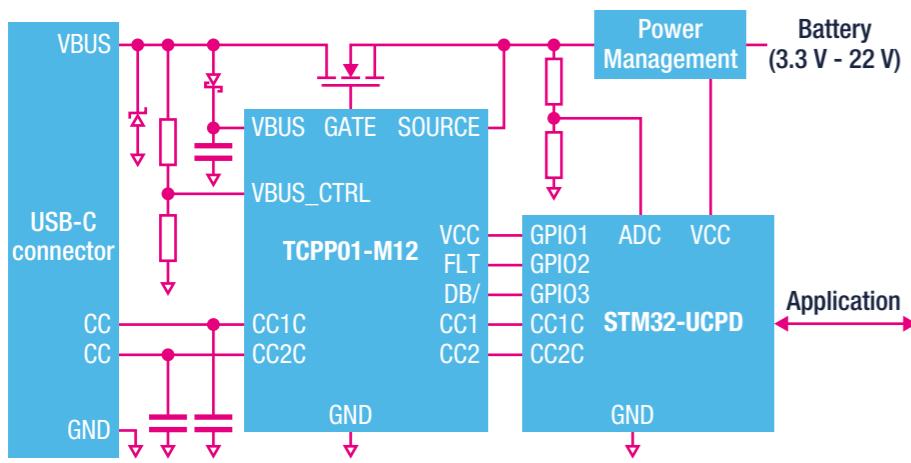
An STM32G081B-eval evaluation board is proposed with two USB-C ports offering 45 W of power with different profiles.



## Type-C Port Protection

### TCPP01-M12

The **TCPP01-M12** (type-C port protection) is a single chip solution for USB type-C port protection that facilitates the migration from USB legacy connectors type-A or type-B to USB type-C connectors. The TCPP01-M12 features 22 V tolerant ESD protection as per IEC61000-4-2 Level 4 on USB type-C connector communication channel (CC) and VBUS lines. To allow fast certification for USB Power Delivery, the TCPP01-M12 provides overvoltage protection on CC1 and CC2 pins when these pins are subjected to short-circuits with the VBUS pin, which may occur when removing the USB Type-C cable from its receptacle. For sink applications, TCPP01-M12 triggers an externally programmable N-MOSFET overvoltage protection on VBUS pin when a defective power source applies a voltage higher than selected OVP threshold. Also, the TCPP01-M12 integrates a “dead battery” management logic that is compliant with the USB Power Delivery specification. The VBUS N-MOSFET load driver can also be used in source applications.



### TCPP03-M20

DRD or DRP applications require careful protection implementation both on the sink power path and the source power path to safely comply with the USB-C Power Delivery specification. **TCPP03-M20** is an MCU companion chip enabling cost-effective USB-C Power Delivery DRD/DRP implementation. It provides protections and functionalities to safely comply with the USB-C Power Delivery specification.

The device drives external N-MOSFETs on VBUS connector pin in the source and sink power path for over-voltage and over-current protection. It provides an analog current sense output accessible for an MCU ADC, thus minimizing system cost.

**TCPP03-M20** helps minimize power consumption during DRP toggling states thanks to its three programmable power modes, allowing a power consumption as low as 3  $\mu$ A maximum up to 125 °C, also thanks to enable pin that wakes up the MCU.

### KEY FEATURES

- Externally programmable VBUS OVP (over voltage protection) and OCP (over current protection) for provider and consumer power paths with fast turn-off
- Two integrated N-MOSFETs gate drivers for VBUS OVP and OCP
- Very low power in “unattached” state during DRP toggling: 3  $\mu$ A max. at 125 °C
- Compliant with PPS (programmable power supply) for fast charging, up to 100 W
- Integrated discharge on VBUS and VCONN
- Current sense on VBUS with analog output
- ESD protection for CC1, CC2, compliant with IEC 61000-4-2 Level 4 ( $\pm 8$  kV contact discharge,  $\pm 15$  kV air discharge)
- VCONN OCP and OVP
- Over voltage protection on CC lines against short-to-VBUS
- Over temperature protection (150 °C typ.)

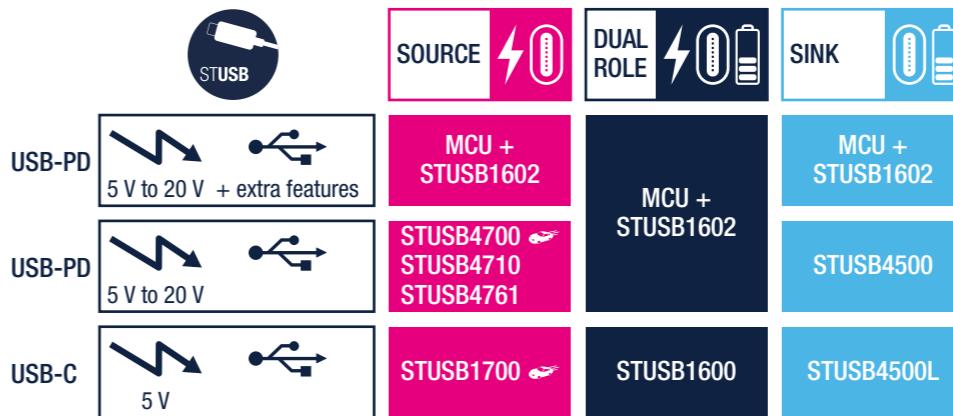
### KEY FEATURES

- ESD protection for CC1, CC2 and VBUS
- Compliant with IEC 61000-4-2 Level 4 ( $\pm 8$  kV contact discharge,  $\pm 15$  kV air discharge)
- Over Voltage Protection on CC lines against short-to-VBUS overvoltage
- Externally programmable Over Voltage Protection on VBUS line
- Integrated VBUS gate driver for external N-MOSFET
- Over Temperature Protection
- Integrated “Dead Battery” management
- Open-drain fault reporting
- Operating junction temperature from -40 °C to 85 °C
- ECOPACK®2 compliant



## STUSB family of standalone (auto-run) USB-C and Power Delivery controllers

Being designed with ST 20 V process technology, the **STUSB family** is natively compliant with USB PD electrical requirements. STUSB controller ICs are certified and integrate the mandatory protection and application features for autonomous port management, without the need for external circuitry. STUSB controllers are optimized for power path applications ranging from 15 to 100 W, on both SINK and SOURCE sides. Being hardwired, STUSB controllers are fast and predictive to guarantee safety and interoperability, while increasing port robustness and minimizing power consumption. Implementation is fast and easy and requires no deep knowledge of the USB PD standard or advanced software skills. Standalone controllers are powered from VBUS to minimize BOM cost and can fully operate without external MCU support. For more flexibility, an MCU can optionally change main power parameters or read port status with a light software layer.



### STUSB controllers: Main common functions

- Manage the type-C port connection
- Enable the power path (VBUS)
- Negotiate power capabilities
- Interact with the power management unit
- Monitor the power path
- Protect the port and manage re-start on fault
- Report major events to the MCU (optional)

### STUSB47xx

- USB PD SOURCE
- Up to 5 programmable PDOs
- Full hardware solution - no software
- Internal and/or external VBUS discharge path
- Very low power consumption
- E-marked cable identification (for >3 A support)
- Over-temperature protection

### STUSB1700

- USB-C 5V SOURCE
- High Voltage protections
- GPIO-controlled current profile (Power sharing, Thermal protection)
- VBUS powered (no LDO needed)
- AEC-Q100 available

### STUSB1602

- USB PD SOURCE/SINK/DUAL ROLE
- Perfect MCU companion chip ensuring port protection, power path monitoring and management, role advertisement and detection, PD PHY communication
- Ready-to-use software frameworks for fast prototyping of most common application scenario such as: basic source, sink, DRP, dual port, but also more complex use cases, which include optional features of PD3.0, vendor defined, battery or extended messages.
- MCU supported:
  - STSW-STUSB010: STM32F072
  - STSW-STUSB012: STM32F446
  - STSW-STUSB014: STM32G474
  - STSW-STUSB015: STM32L4R5

### STUSB1600

- USB-C 5V SOURCE/SINK/DUAL ROLE
- High Voltage protections
- Integrated VBUS discharge
- Dead battery support
- Optional interface to MCU (I<sup>2</sup>C + IRQ)

### STUSB4500

- USB PD SINK
- Dead Battery support
- VBUS powered (ZERO power on VBAT)
- Input Over Voltage protection
- QFN and CSP package available
- SOURCE power profile reporting
- STSW-STUSB002: GUI
- STSW-STUSB003: optional open source software drivers for dynamic power Management
- Mini-dongle: EVAL-SCS001V1

### STUSB4500L

- USB-C 5V SINK
- Dead battery support
- VBUS powered (ZERO power on VBAT)
- Input Over Voltage protection
- SOURCE power budget reporting
- QFN and CSP package available
- Mini-dongle: EVAL-SCS002V1

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Order code: BR2211PMGUIDE

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All other product or service names are the property of their respective owners.



The ST logo features the letters "ST" in a bold, italicized, sans-serif font. A diagonal line starts from the top-left of the "S" and ends at the bottom-right of the "T", creating a dynamic, forward-moving feel.

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