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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.
Sensors

We offer a broad range of silicon-carbide (SiC) power MOSFETs - with the industry’s highest operating junction temperature of 600 V-650 V MDmesh DM9 ST*60DM9, ST*65DM9, 600 V-650 V MDmesh DM6 ST*60DM6, ST*65DM6, 600 V-650 V MinimSST*60SNM9, 600 V-650 V MaxiSST*65SM5, 1200 V MDmesh KS ST*120KS, 600 V: 1200 V – 1700 V SiC MOSFETs SCT*65G3AG, , SCT*N65G2, SCT*120G3AG, SCT*N120G2, SCT*N120, SCT*N170

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).

Typical Block Diagram for String Inverter

Typical Block Diagram for Central Inverter

ST product offering for String and Central Solar Inverter

<table>
<thead>
<tr>
<th>ST product offering for String and Central Solar Inverter</th>
<th>Inverter Power Stage</th>
<th>Power Modules</th>
<th>Display &amp; Disconnector</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC-DC and DC-AC</td>
<td>Inverter Power Stage</td>
<td>Power MOSFETs</td>
<td>ST product offering for String and Central Solar Inverter</td>
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Note: * is used as a wildcard character for related part number
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) is transmitted through serial or wireless connection to a local or remote monitoring and control access point.

Our solution includes MDMesh and STripFET power MOSFETs, high-performance STM32 microcontrollers featuring dedicated peripherals to help implement complex control algorithms. A range of wireless and wired connectivity solutions including multi-standard power line modems complete the solution.

**ST product offering for Microinverter**

<table>
<thead>
<tr>
<th>Power MOSFETs</th>
<th>Diodes</th>
<th>Protections</th>
<th>Signal Conditioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 V - 100 V</td>
<td>650 V</td>
<td>150 V</td>
<td>TVS for Power MOSFET and Power Rail Surge Protection, SMAJ, SM4, SM15T series</td>
</tr>
<tr>
<td>120 V - 250 V</td>
<td>100 V</td>
<td>150 V</td>
<td>TVS for Power MOSFET and Power Rail Surge Protection, SMAJ, SM4, SM15T series</td>
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<td>150 V</td>
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<td>TVS for Power MOSFET and Power Rail Surge Protection, SMAJ, SM4, SM15T series</td>
</tr>
</tbody>
</table>

**Typical Block Diagram**

- **Input File**
- **Out of Phase**
- **Relay**
- **SMF Filter**
- **Power Transistor**
- **Connector**
- **Grid**
- **Smart Meter**
- **DC/DC with MPPT**
- **PV Voltage Sensing**
- **AC grid**
- **AC Disconnect**
- **Inverter**
- **Power Boost**
- **Grid**
- **Data Logger/Internet Gateway**
- **PV panel**
- **Remote Monitoring**
- **Internet Access**
- **Aux PS**
- **PV panel**
- **Data Logger/Internet Gateway**

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 STMS2 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**

<table>
<thead>
<tr>
<th>Power Optimizer</th>
<th>Power MOSFETs</th>
<th>Gate Drivers</th>
<th>By Pass Diodes</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>60 V - 100 V</td>
<td>STripFET F7</td>
<td>STripFET F7</td>
<td>STripFET F7</td>
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</tr>
<tr>
<td>120 V - 250 V</td>
<td>STripFET F7</td>
<td>STripFET F7</td>
<td>STripFET F7</td>
<td>100 V</td>
</tr>
<tr>
<td>250 V - 370 V</td>
<td>STripFET F7</td>
<td>STripFET F7</td>
<td>STripFET F7</td>
<td>100 V</td>
</tr>
<tr>
<td>370 V - 500 V</td>
<td>STripFET F7</td>
<td>STripFET F7</td>
<td>STripFET F7</td>
<td>100 V</td>
</tr>
<tr>
<td>500 V - 620 V</td>
<td>STripFET F7</td>
<td>STripFET F7</td>
<td>STripFET F7</td>
<td>100 V</td>
</tr>
</tbody>
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Typical Block Diagram

- **Data Logger/Internet Gateway**
- **Inverter**
- **PV panels**
- **Remote Monitoring**
- **Internet Access**
- **Aux PS**
- **PV panel**
- **Data Logger/Internet Gateway**
- **Communicate Path**
- **Power Path**

**Notes**

- TVS = Transient Voltage Suppressor
- SMAJ, SM6T, SM15T series
- Zigbee, Thread
- Bluetooth Low Energy
- STMicroelectronics

**STMicroelectronics**

- Local Monitoring
- Internet Access
- Remote Monitoring
- Internet Access
- AC grid
- Aux PS
- PV panels
- Remote Monitoring
- Internet Access
- PV panels
- Data Logger/Internet Gateway
- DC/DC with MPPT
- PV Voltage Sensing
- Grid
- Power Boost
- Grid
- Data Logger/Internet Gateway
- Communication Path
- Power Path
- Grid
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, charging requirements of an increasing number of electric vehicles (EV).

Typical Block Diagram - Home Battery Storage System

ST product offering for Home & Commercial Battery Storage Systems

<table>
<thead>
<tr>
<th>DC-DC Converter</th>
<th>Power MOSFETs</th>
<th>IGBTs</th>
<th>Power Modules</th>
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<td>STPS150</td>
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ST product offering for Hybrid Battery Storage Systems

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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 helps the designers of high-power-density and cost-effective isolated auxiliary power supplies with higher switching frequency and standby consumption (down to less than 4 mW) and breakdown voltages as high as 1050 V. In addition to PWM switching controllers, ST offers a wide portfolio of highly-integrated high-voltage converters for applications up to 100 W, with an extremely low total harmonic distortion.

Non-Isolated Auxiliary SMPS

Non-isolated flyback converters are used for applications where the output power is limited to a few watts. They are simple to implement and do not require an isolation transformer. Some examples include 5 V/0.36 A buck converter (STEVAL-VP319X1B) and 5 V/600 mA buck converter (STEVAL-VP12201B).

Isolated Auxiliary SMPS

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.

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.

ST recommended products for Non-Isolated Auxiliary SMPS

For non-isolated flyback applications, ST offers products like VIPer0P and VIPer*6, which can operate with a wide input voltage range from 40 V to 170 V. They are suitable for applications such as televisions or network analyzers, where high efficiency and low standby consumption are required.

Typical configurations for Non-Isolated Auxiliary Power Supply

In non-isolated flyback configurations, the output voltage is derived from the AC mains. A buck (step-down) topology can be used to generate a positive output with respect to the common terminal and a buck-boost converter can be used to provide both positive and negative outputs.

Main application boards

ST offers a variety of reference design boards for non-isolated auxiliary power supplies, such as STEVAL-VP22201B and STEVAL-VP2221B, which can be used to develop prototypes and verify the performance of the auxiliary power supply design.

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.
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 two e-mode GaN transistors in half-bridge configuration, from standalone controllers, from STM32 microcontrollers and their most integrated digital controller, the MasterGaN series, an advanced power system-in-package integrating a gate driver and highly efficient performance.

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

USB Type-C® PD Adapters and Quick Chargers

Typical configuration

Main application boards and reference designs

Typical block diagram with Certified Source and Sink Standalone Controllers

Source port

USB Type-C receptacle

Power supply

standalone PD controller

Sink port (high power up to 100 W (20 Vbus))

USB Type-C receptacle

Consumer device

standalone PD controller

Main application boards and reference designs

STEBAL-ISC004V1

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

STEBAL-ISC005V1

STUSB4500 USB Power Delivery evaluation board

EVAL-SCS001/2V1

SNK-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 separation board based on TCP02-M18

X-NUCLEO-SNK1M1

USB Type-C™ Power Delivery Source separation board based on TCP02-M12

X-NUCLEO-DRP1M1

USB Type-C™ Power Delivery Dual Role Power separation board based on TCP03-M03
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 StrPiFET 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

- **PFC Block**
  - **Controllers**
    - Low voltage PFC controllers
    - Fab. 75 G, 75 F: VIPer0P, VIPer*1, VIPer122, ALTAIR*
    - Fab. 60 G, 60 F: VIPerGaN50, VIPerGaN65, VIPerGaN100
    - Fab. 90 G, 90 F: VIPerGaN65
  - **Diodes**
    - MOSFETS: 60 V MASTERRAM
    - MOSFETs, as well as standard and field-effect rectifiers (FERD)

- **Isolation Stage**
  - **Converters & Controllers**
    - Flyback Controllers
    - Combo Controllers
    - LLC Analog Controllers
    - SR Analog Controllers
  - **Diodes & Protections**
    - Output Diodes for Flyback
    - Output Diodes for LLC

- **DC-DC Converters**
  - **Stage**
    - TM Analog Controllers
    - TM Digital ICs
    - PFC & LLC for Flyback
    - Switched-Capacitor (SC) DC-DC
    - Buck Converters & Controllers
    - Key Power ICs
  - **Voltage Reference, CC/UV Ctrl**
  - **Post Regulation**

- **Linear Regulators**
  - **Input/Output**
    - Linear Regulators
    - LDOs, Low Dropout (LDO)

- **Power MOSFETs**
  - **High Voltage GaN Converters**
    - 600 V-650 V MDmesh DM2ST, ST*60N*DM9
    - Low Dropout (LDO) Linear Regulators
    - LC200
    - 650 V-650 V MDmesh M6 ST*60DM6

- **Main application boards and reference designs**

  - **EVLM1G1-250WLLC**
    - 250 W resonant DC-DC
  - **EVLSTRNG011-150**
    - 12 V - 150 W power supply based on TM PFC and LLC LLC combo controller
  - **EVL1CM1B-AIO210W**
    - 12 V - 210 W adapter based on TM PFC and LLC LLC combo controller
  - **EVL400W-80PL**
    - 12 V - 400 W adapter based on DC-DC controller

**Typical Block Diagram with PFC Front-End**

- **AC - Input Rect.**
- **PFC**
- **LLC**
- **Flyback**
- **Output Rect.**
- **Synch. Rect. Controller**

**Digital control 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 up to 100 W
  - Digitally selectable fixed output voltages: 3.3 - 5 - 9 - 15 - 20 V
  - PPS: PWM programmable output voltages with 20 mW steps
  - PPS: PWM programmable output current with 50 mA steps
  - More details available on AN3962

**Adaptive-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**

- **3.3 V**
- **5 V**
- **12 V**

- **Power Supply Protection SNSAF208**
- **Switching Controller STPM0565**
- **Low dropout regulator LD1117A**
- **LED**
- **USB Type-C controller STUSB1702**
- **Load switch STD4SP402L1**
- **TVS SMTAT32556**
- **ESD Protection USBCDC-2300**
- **USB Type-C connector**
- **Current Sense TSC1031IYPT**
- **Load switch STD4SP402L1**
- **TVS SMTAT32556**
- **ESD Protection USBCDC-2300**
- **USB Type-C connector**

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

- **AEK-Pow-L5940V1**
- **AEK-MCU-C4MLI1T**
- **AEK-USB-2TYPEC1**
Wireless Charging

Wireless chargers are expected to become ubiquitous in homes, 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 carrier frequency through controlled resistive or capacitive load insertion. Generating the correct amount of power guarantees the highest level of end-of-life battery 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 ST Reader can be connected with the board and discover objects that are NFC enabled.

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 enable customization with ST Super Charge protocol for personal electronics, chargers that are Qi compliant for both Baseline Power Profile (BPP) and Extended Power Profile (EPP), and therefore instruct the operating system to stop transmitting power.

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 recommended products for Desktop PC’s 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 STM8B1 and the STNRF01, GaN Power ICs such as the MASTERG6N series and the GaN Drivers, high-voltage DMEM Power MOSFETs, low-voltage SiRFET Power MOSFETs, and SiC diodes (STPSC*06) 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

Typical Block Diagram

**Power Supply**

**Transmitter**

**Receiver**

**Front-End DC-DC Stages**

**Power stage**

**Regulation**

**Protection**

**Communications**

**Main application boards and reference designs**

**Receivers**

**Transmitters**

**NFC Readers**

**Auxiliary Power Supply**

**DC-DC Stages**

**5 V Post Regulation**

**2 V Post Regulation**

**12 V Post Regulation**
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 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

Main application boards and reference designs

<table>
<thead>
<tr>
<th>Input Stage</th>
<th>SCRs</th>
<th>Diodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Temp. SCR</td>
<td>Bridge Rectifier Diodes STP08, STP12</td>
<td></td>
</tr>
<tr>
<td>1000 V for CCM</td>
<td>STP120, STP120T</td>
<td></td>
</tr>
<tr>
<td>48 V DC</td>
<td>HV HB Gate Drives L449*</td>
<td></td>
</tr>
<tr>
<td>48 V DC-DC Stage</td>
<td>HV HB Gate Drives L449*</td>
<td></td>
</tr>
<tr>
<td>48 V DC-DC Stage</td>
<td>Isolated Gate Drivers STUAP*</td>
<td></td>
</tr>
<tr>
<td>48 V DC-DC Stage</td>
<td>Multiple LS Gate Drivers PMB634</td>
<td></td>
</tr>
<tr>
<td>48 V DC-DC Stage</td>
<td>Single LS Gate Drivers PMB634*</td>
<td></td>
</tr>
</tbody>
</table>

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

Main application boards and reference designs

<table>
<thead>
<tr>
<th>Board Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEVAL-ISA147V3</td>
<td>500 W fully digital AC-DC power supply (D-80MP)</td>
</tr>
<tr>
<td>STEVAL-ISA172V2</td>
<td>6 kW fully digital AC-DC power supply (D-80MP)</td>
</tr>
<tr>
<td>STEVAL-PSL203K1</td>
<td>6 kW Full Bridge LLC resonant digital power supply</td>
</tr>
<tr>
<td>STEVAL-DPSG474</td>
<td>Digital Power Control Board</td>
</tr>
<tr>
<td>STDES-3KWTC</td>
<td>3 kW telecom reference design with Telcom Pole PFC and LLC Converter</td>
</tr>
<tr>
<td>STEVAL-SCR002V1</td>
<td>3 kW 3P w/o current limit for 1 kW 48VDC</td>
</tr>
</tbody>
</table>
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

- **Dual Stage Conversion**
  - 48 V to 5 V - 15 V
  - Unregulated
  - Regulated

- **Direct Conversion**
  - 48 V to 5 V - 15 V
  - Direct Conversion (Isolated/Non-Isolated)

**Stacked Buck (STB)**
- Regulated Conversion from 48V to POL

**Switched Tank Converter (STC)**
- Unregulated Conversion from 48V to POL

**2° Stage (12 V)**
- Multiphase Controller PM67x
- SPS PM67x
- SPS PM7x
- SPS PM8x
- SPS PM9x
- SPS PM10x

**Digital Controller**
- PM67x
- PM67**

**Digital Power Distribution from 12 V Bus**

**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
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 I2C and PMBus® allows configurability for different application requirements.

Typical Block Diagram for SSD Power Management
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

STPMIC06

VIN = 4.5 V to 15.6 V

STPMIC07M

VIN = 2.6 V to 5.5 V

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

Power over Ethernet (PoE)
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 MIDmesh and low-voltage StrinFET 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

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

<table>
<thead>
<tr>
<th>Controller</th>
<th>Power MOSFETs</th>
<th>Drivers</th>
<th>Voltage Reference</th>
<th>Post Regulation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flyback Controllers</strong></td>
<td>TM Analog Controllers 65° 90° 120° 150°, STM2F301, STM2F314, STM2CA1, STR100A, STM304A, STR200A for LLC</td>
<td>Integrated Smart Gates 600 V MASTERGAN</td>
<td>DC-DC Converters ST1512, ST1518, ST1540, ST1550</td>
<td>Low Dropout (LDO) Linear Regulators LS117V, 77350V, L78Vx, L79100</td>
</tr>
</tbody>
</table>

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

~AC~ Input Rect. - PFC - Flyback - LLC - Synch. Rect. controller - OUTDC

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

~AC~ Input Rect. - Totem-Pole PFC - LLC - Gate Driver - Gate Driver - Gate Driver - Synch. Rect. controller - OUTDC

### Main application boards and reference designs

- **EVLML01-250WLLC**: 250 W resonant DC-DC converter based on LLC analog controller and GaN.
- **EVLSTMNG011-150**: 12V-150W power supply based on TM/PFC and HB LLC analog controller.
- **STEVAN-NRG011-150**: 300 W power supply based on TM/PFC and HB LLC digital combo controller.
- **EVL400W-S0PL**: 5V-400W adapter based on CM PFC and HB LLC analog controller.

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### ST recommended products for LED TV Power Supply

<table>
<thead>
<tr>
<th>Controller</th>
<th>Power MOSFETs</th>
<th>Drivers</th>
<th>Voltage Reference</th>
<th>Post Regulation</th>
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<td><strong>Flyback Controllers</strong></td>
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<td>Low Dropout (LDO) Linear Regulators LS117V, 77350V, L78Vx, L79100</td>
</tr>
</tbody>
</table>
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

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

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

Main application boards and reference designs

Note: * under development

Note: ¹ available in Q2 2023

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

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

Main application boards and reference designs

STEVAL-1PS01AJR/DJR/EJR
Evaluation board based on the STPS01 400 mA nano-quiescent synchronous step-down converter with digital voltage selection

STEVAL-1PS02B
Evaluation board based on the STTP502 200 mA nano-quiescent synchronous step-down converter with digital voltage selection and AUX switch

STEVAL-1PS03A
Evaluation board based on STTP503/504 400 mA nano-quiescent synchronous step-down converter with low switch

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

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

EVL6653S-100W
100 W transition-mode PFC pre-regulator

EVLSTNRG011-150
12 V - 150 W power supply based on TM PPC and HELL digital controller

STEVIAL-L7963ADJ
12 V to 3.3 V step down DC/DC converter (Vin = 12 to 58 V)
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
- TM Analog Controllers: L6962*, L6963*, L6964*
- CC/CV Analog Controllers: L6965, L6966, L6981*, L6984
- MCUs & Digital Controllers: STM32G4, STM32G0, STM32F301, STM32F334, STM32F0, STM32G0
- SR Analog Controllers: SRK1000, SRK1001 for Flyback
- SRK2000A, SRK2001 for Flyback
- SRX2000A, SRX2001 for LLC

### Power MOSFETs
- 600 V MOSFETs: STF60N65, STF60N65M2, STF60N65M2-EP
- 60 V-100 V MOSFETs: STF60N45, STF60N50, STF60N60, STF60N90

### Diodes
- 1A, up to 60 V Vin, buck LED driver with digital dimming

### Bluetooth Low Energy (BLE) Module
- BLE 3.0-4.2
- BlueRAG-1, BlueRAG-2, BlueRAG-LC BlueRAG-LPS
- B L E Network Processor
- BlueRAG
- Baluns: B L M N-O12, B L M N-O25, B L M N-O30
- Single Gate Drivers: 60 V-650 V

### Controller & Drivers
- Offline LED Drivers: MCUs & Digital Controllers
- HV Interface Controllers: STM32F103, STM32F303, STM32F334, STM32G0, STM32G4
- Multiple Gate Drivers
- Multiple Gate Drivers
- Multiple Gate Drivers

### Wireless Connectivity
- B L M 2-5-4
- Sub-1GHz MCUs
- STM32L2
- STM30F2
- STM32L0

### Main application boards
- EVAL-HL86D017W35F
- EVAL-PSR01B-35SW
- EVAL-SSR01B-3SW

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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

<table>
<thead>
<tr>
<th>Controllers</th>
<th>Power MOSFETs</th>
<th>Diodes &amp; Protections</th>
<th>MOSFET and IGBT Gate Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offline LED drivers</td>
<td>600 V MDmesh OM2</td>
<td>600 V Ultrasound for TM PFC</td>
<td>HV HB Gate Drivers for GaNs</td>
</tr>
<tr>
<td>LED5000, LED6000, STC240</td>
<td>60 V - 100 V STripFET F7</td>
<td>HV HB Gate Drivers</td>
<td>ST6060D</td>
</tr>
<tr>
<td>LED0001, LED7007, LED7008</td>
<td>STP04/08/16/24, ST25S</td>
<td>60 V-100 V STripFET F7</td>
<td>STF0835</td>
</tr>
<tr>
<td>LED9001, LED9002</td>
<td>ST5060S/150/60/24</td>
<td>650 V Ultrafast for TM PFC</td>
<td>STT0835</td>
</tr>
<tr>
<td>ST5060S/150/60/24</td>
<td>STT0835</td>
<td>650 V Ultrafast for TM PFC</td>
<td>STT0835</td>
</tr>
</tbody>
</table>

Main application boards

- **EVLMG4-500WIBUCK**: High-power inverse buck for dimmable LED application with SMD.
- **EVLO12V**: 200 W LED Driver (CCD) with digital combo controller.
- **EVL699-HVSL**: 150 V - 1 A LED driver featuring TM PFC and LLC resonant converter with analog combo controller.
- **STEVAL-LLL004V1**: 75 W AC-DC digitally controlled non-isolated constant current LED driver
- **STEVAL-LLL066V2**: 100 W LED strip lighting with D4A2.0 communication interface using the STU3835A digital controller.
- **STEVAL-ILL055V2**: 48 W -130 W high efficiency converter with PFC for LED street lighting.
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 802.3at, IEEE 802.3af 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 for DALI Lighting System

ST product offering for LED POE Lighting

<table>
<thead>
<tr>
<th>PoE Interface</th>
<th>Protection</th>
<th>Auxiliary Power Supply</th>
<th>LED Driver</th>
<th>Bluetooth LE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.3at</td>
<td>TVS for Rail Surge</td>
<td>Buck Converter L79008/79000/79003</td>
<td>LED6000/LED5000 Inverse Buck UNLED002</td>
<td>Bluetooth Low Energy 3.3V, Wireless MCU, Modules BlueNRG*, STM32WB*</td>
</tr>
<tr>
<td>IEEE 802.3at</td>
<td>Protection SMAK, SM1, SM1*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEEE 802.3af</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IEEE 802.3at</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

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

LED POE Lighting

IEEE 802.3xx PoE Interface

Main application boards

STEVAL-POEL45W1 45 W PoE powered LED lighting with BLE control
STEVAL-ILL078V1 1 A, up to 80W (AC), 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 DALI 2.0 communication interface using the STLUX385A digital controller
STEVAL-ILM001V1 Plug-in hardware module for the STMK-DISCOVERY interface for DALI communication
EVALKITSTKNX Miniature transceiver STKNX evaluation and development kit

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

<table>
<thead>
<tr>
<th>LED Driver</th>
<th>Power Management</th>
<th>KNX Transceiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Controllers STLUX Development Tools STIW-STLUXBBST, STIW-STLUXBBST2, STIW-STLUXBBST3 Embedded Software STIW-DALI002, STIW-DALI001, STIW-STM8025</td>
<td>TSV Protection on KNX Bus SMA440A TR</td>
<td>STKNX</td>
</tr>
</tbody>
</table>

Refer to LED General Illumination section
LED Wireless Programming

Today’s smart LED bulbs let users control features including brightness and color. These properties are controlled though 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

<table>
<thead>
<tr>
<th>NFC/RFID Reader IC</th>
<th>Protections</th>
<th>Microcontrollers</th>
<th>LED Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFC Reader + MCU</td>
<td>ST2GR</td>
<td>ST8M5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dynamic NFC Tag</td>
<td>STM32F0/STM32G0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dynamic NFC Tag with PWM Output</td>
<td>ST25DV-PWM Series</td>
<td></td>
</tr>
</tbody>
</table>

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

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

- **SiC MOSFETs and Diodes**
- **Transceivers**
- **Signal Conditioning**
- **Power Management**
- **Power MOSFETs and IGBTs**
- **Power Diodes and thyristors**
- **EOS and ESD Protection**
- **BCD Integrated and Isolated Drivers**

**Smart Driving**

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

**32-bit Automotive Microcontrollers**

**32-bit Automotive Microcontrollers**

**FIND OUT MORE**

- www.st.com/electro-mobility
- On Board Charger (OBC)
- Acoustic Vehicle Alerting System (AVAS)
- HV Battery Disconnect & Fire-off System
- Vehicle Control Unit (VCU)

**48 V System**

- Electric Motor or MGU (MHEV)
- DC Fast Charging Station
- On-Board Charger

**12 V System**

- HV Battery Disconnect & Fire-off System
- Vehicle Control Unit (VCU)
- 12 V System
- Electric Traction (Main Inverter)
- Mild Hybrid 48 V Systems

**Smart Driving**

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

**32-bit Automotive Microcontrollers**

**FIND OUT MORE**

- www.st.com/electro-mobility
- 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 SPCS 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

Bidirectional DC/DC Converter
Electric vehicles (EV) use two different power systems, a high-voltage battery (200 to 800 V) 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 SPCS 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
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 CO2 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

**48 V Start-Stop System**

**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

**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)**
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. ST25A 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

<table>
<thead>
<tr>
<th>ST product offering for DC Fast Charging Station</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input stage</strong></td>
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<tr>
<td>-----------------</td>
</tr>
<tr>
<td><strong>Rectifiers</strong></td>
</tr>
<tr>
<td>SI series - 650 V</td>
</tr>
<tr>
<td><strong>Thyristors</strong></td>
</tr>
<tr>
<td>TMH series - 1200 V</td>
</tr>
</tbody>
</table>

**Power MOSFETs**

| **SiC series**    | 650 V | • | • |
| 1200 V | • | • |
| **SiC series**    | 600 V | • | • |
| 1200 V | • | • |
| **Ultrafast RQ series** | 600 V | • | • |
| **Ultrafast R series** | 600 V | • | • |
| **STBR series**   | 800 V | • | • |
| **Schottky series** | 400 V | • | • |
| **1^** | | | |
| **2^** | | | |
| **5^** | | | |
| **8^** | | | |

**Power Line transceivers**

| **ST2100** | • | • |
| **ST7540, ST7560, ST7580** | • | • |
| **3.6 kW PFC totem pole with digital inrush current limiter** | • | • |
| **STPM32, STPM33, STPM34, STPM35, STPM36, STPM37, STPM38** | • | • |
| **LED array drivers** | • | • |
| **LED1642, LED194, LED3165** | • | • |
| **Note:** * is used as a wildcard character for related part number |

Main application boards and reference designs

<table>
<thead>
<tr>
<th>Reference Design</th>
<th>Main application boards</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STDES-PFCBIDIR</strong></td>
<td>15 kW, three-phase, three-level Active Front End (AFE) bidirectional converter</td>
</tr>
<tr>
<td><strong>STDES-VIENNARECT</strong></td>
<td>15 kW, three-phase Vienna rectifier with low cost mixed-signal control for power factor correction</td>
</tr>
<tr>
<td><strong>STDES-30KWRECT</strong></td>
<td>30 kW Vienna PFC rectifier reference design with digital control</td>
</tr>
<tr>
<td><strong>STEVAL-DPSTPFC1</strong></td>
<td>3.6 kW PFC totem pole with digital inrush current limiter</td>
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<td><strong>STDES-30KWRECT</strong></td>
<td>30 kW Vienna PFC rectifier reference design with digital control</td>
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<td><strong>STEVAL-DPSTPFC1</strong></td>
<td>3.6 kW PFC totem pole with digital inrush current limiter</td>
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</tbody>
</table>
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

<table>
<thead>
<tr>
<th>Power MOSFETs</th>
<th>IGBTs &amp; Power Modules</th>
<th>MOSFET/IGBT Gate Drivers</th>
<th>DC-DC</th>
<th>DC-DC</th>
<th>DC-DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFC</td>
<td>MCUs &amp; Digital Controllers</td>
<td>M3</td>
<td>TFI</td>
<td>F</td>
<td>Bi</td>
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<tr>
<td>DC-DC TTF</td>
<td>M3</td>
<td>TFI</td>
<td>F</td>
<td>Bi</td>
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<tr>
<td>DC-DC PS-FB</td>
<td>M3</td>
<td>TFI</td>
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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
Uninterruptible Power Supplies (UPS)

Uninterruptible 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 applications. 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 Uninterruptible Power Supplies (UPS)

<table>
<thead>
<tr>
<th>Rect. &amp; inrush current limiter</th>
<th>DC-AC</th>
<th>Bypass</th>
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<tbody>
<tr>
<td>60 V MDmesh 6M M<em>7</em>0W9M9</td>
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<tr>
<td>60 V-650 V M<em>7</em>0M86M6</td>
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<tr>
<td>60 V-650 V M<em>7</em>0M86M8</td>
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<tr>
<td>120 V VSC MOSFETs</td>
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<td>600 V-650 V M<em>7</em>0M86M9</td>
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<td>3-Phase HV Gate Driver</td>
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### 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 equipment are some of the major home appliance applications that ST, thanks to its wide product line, is able to satisfy with suitable and dedicated power products and high-performing STM32 microcontrollers combined with complementary gate drivers (L638* and L849*). 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 power MOSFETs (IPM) integrating the power stage (both on IGBT and MOSFET discrete), 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

<table>
<thead>
<tr>
<th>Rect. &amp; inrush current limiter</th>
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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

### Topology example

[Diagram of Induction Cooking Topology]

<table>
<thead>
<tr>
<th>Induction Cooking Ranges (Efficiency)</th>
<th>DC-DC</th>
<th>DC-AC</th>
<th>AC-DC</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 V, 1000 Hz series</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>600 V, 1200 Hz series</td>
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<td></td>
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<tr>
<td>650 V, 1500 Hz series</td>
<td></td>
<td></td>
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<tr>
<td>1250 V, 2000 Hz series</td>
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</tbody>
</table>

### Environmental Sensors

- **Humidity**: HTS221
- **Temperature**: STC802
- **Humidity**: HTS221
- **Temperature**: STC802

### Motion Sensors

- **Accelerometer**: LIS3DHHC
- **Proximity Sensors**: TP* - TLV331*, TLA180*

### Power Management

- **STM32F303, STM32F0, STM32G0, STM32G0**
- **STM8**
- **MCU**
- **LDO**
- **LED Drivers**
- **Filter**

### Connectivity

- **Bluetooth Low Energy (BLE)**
- **Wireless Module (WM)**
- **BlueNRG**

### Sensors

- **Environmental Sensors**
- **Humidity Sensors**
- **Temperature Sensors**

### Power Switches

- **MOS / IGBT Drivers**
- **Gate Drivers**
- **Connectivity**
- **Sensors**

### Software tools

**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
- Generates the STM32CubeIDE for each individual node
- Provides a step-by-step optimized design of power section and control loop

**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 preview with full annotated schematic and BOM, and then run the 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.

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.

**Software tools**

- **eDesignSuite**
- **edSim**
- **STM32CubeIDE**
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
• Embedded gate driver easily supplied by the integrated bootstrap diode
• Overtemperature protection
• Extended 3.3 to 15 V input range with hysteresis and pull-down
• Accurate internal timing match
• Interlocking function
• ≤45 to 125°C operating temperature range
• High switching frequency >1 MHz
• No investment to learn GaN required
• Fast time-to-market

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
• ULDO on Vcc and VBOOT
• Thermal shutdown
• Interlocking function
• Shut-down pin
• SO16 narrow package

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.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Package</th>
<th>General description</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIPERGANN60TR</td>
<td>QFN 5x6 with exposed pad</td>
<td>0.45 Ω 850 V 50 W 75 W</td>
<td></td>
</tr>
<tr>
<td>VIPERGANN65TR</td>
<td>QFN 5x6 with exposed pad</td>
<td>0.26 Ω 850 V 65 W 85 W</td>
<td></td>
</tr>
<tr>
<td>VIPERGANN100</td>
<td>QFN 5x6 with exposed pad</td>
<td>0.26 Ω 850 V 75 W* 100 W</td>
<td></td>
</tr>
</tbody>
</table>

*100 W with a PFC in the front end

<table>
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<tr>
<th>Part Number</th>
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</tr>
</thead>
<tbody>
<tr>
<td>STDRIVEG600</td>
<td>High voltage and high-speed half-bridge gate driver for GaN Transistors</td>
<td>SO-16</td>
</tr>
<tr>
<td>STDRIVEG600TR</td>
<td>High voltage and high-speed half-bridge gate driver for GaN Transistors</td>
<td>SO-16</td>
</tr>
<tr>
<td>STDRIVEG600W</td>
<td>Water</td>
<td></td>
</tr>
</tbody>
</table>

MAIN APPLICATIONS

USB PD Adapter
Air Conditioning
TV Power Supply
Home appliances
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.

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

• 30 W/inch³ power density
• >32 Ohm Transformer

• >10 kHz operation with MasterGall and planar transformers
• Small weight and size solution with

>3 W/inch³ power density

• >6.4 kV reinforced galvanically isolated dual communication channel

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

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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.
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. 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 footprint. The new STNRG012 is specifically designed to support LED lighting and industrial applications requiring DC source management, with additional THD optimizer function.

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 antcapacitive 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
- 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

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

www.st.com/ac-dc-converters
www.st.com/pwm-controllers
www.st.com/resonant-controllers
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**

- **Basic features**
- **DVS AMR**
- **Programmable blanking times after toff**
- **Package**

<table>
<thead>
<tr>
<th>Controller</th>
<th>Voltage</th>
<th>DVS AMR</th>
<th>Blank Times</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRK1000</td>
<td>100 V</td>
<td>*</td>
<td>*</td>
<td>SO10</td>
</tr>
<tr>
<td>SRK1001</td>
<td>185 V</td>
<td>*</td>
<td>*</td>
<td>SO8</td>
</tr>
</tbody>
</table>

**Note:** Three options available: SRK1000 (0.5 µs), SRK1000A (2 µs), SRK1000B (2.5 µs)

**Synchronous Rectification Benefits**

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

**SR controllers for LLC resonant**

<table>
<thead>
<tr>
<th>Controller</th>
<th>Basic features</th>
<th>Matched turnoff threshold</th>
<th>Auto-compensation of parasitic inductance</th>
<th>Reduced adaptive turn-on delay</th>
<th>Reduced masking time “current inversion comparator”</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRK2000A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRK2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>SO8</td>
</tr>
<tr>
<td>SRK2001A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**MAIN APPLICATIONS**

- High-power adapters and TVs
- Desktop PCs and Server/Telecoms

**Synchro Boost for LLC resonant**

- **Basic features**
- **Programmable blanking times after toff**
- **Package**

<table>
<thead>
<tr>
<th>Controller</th>
<th>Voltage</th>
<th>DVS AMR</th>
<th>Blank Times</th>
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<td>SRK1000</td>
<td>100 V</td>
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<td>185 V</td>
<td>*</td>
<td>*</td>
<td>SO8</td>
</tr>
</tbody>
</table>

**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
- **TS772/TS782**
  - Operating voltage 2.0 to 5.5 V
  - Rail-to-rail input and output
  - Vio max 200 µV
  - Gain bandwidth 20/30 MHz
- **TS3021, TS3022**
  - Operating voltage 1.8 to 5.5 V
  - Rail-to-rail input and output
  - Vio max 200 µV
  - Gain bandwidth 50 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
- **TSC20/200**
  - Operating voltage -16 to 80 V
  - Amplification gain x20
  - Comparator +Vref embedded
  - Package SO8, MiniSO8
- **TSC2010/12**
  - 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
- **TSC21**
  - Bi-directional
  - Operating voltage -0.3 to 26 V
  - Amplification gain x50 x75 x100 x200 x500 x1000
  - Offset voltage ±35 µV max
  - Gain error 1% max
  - Packages QFN10, SC70-6

**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

**SYNCHRONOUS RECTIFICATION BENEFITS**

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

**MAIN APPLICATIONS**

- Wireless battery charger/ transmitters
- Server/Telecom
- Solar
- UPS
- Lighting
- Factory automation

**WWW.ST.COM**

- www.st.com/opamps
- www.st.com/current-sense-amplifiers
- www.st.com/comparators

**Synchronous rectification controllers**

**MAIN APPLICATIONS**

- Wireless battery charger/ transmitters
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## 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

<table>
<thead>
<tr>
<th>Current (A)</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>Linear charger for Li-ion and Li-Polymer battery packs</td>
</tr>
<tr>
<td>0.8</td>
<td>Thermal regulation, USB power specification supported</td>
</tr>
<tr>
<td>0.65</td>
<td>LDO integrated, USB compatible, Power path</td>
</tr>
<tr>
<td>0.45</td>
<td>LDO integrated, USB compatible, Power path, Swire</td>
</tr>
<tr>
<td>0.2</td>
<td>LDO integrated, USB compatible</td>
</tr>
<tr>
<td>0.04</td>
<td>Ultra low power for ThinFilm and Li-ion batteries</td>
</tr>
</tbody>
</table>

**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 mA 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 a 16-bit register resolution for retrieval by the system controller. Access is via an industry-standard I2C 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**
- Common features
- Designed to be power efficient
- Smart charging and discharging
- 3% accuracy of battery state of charge at power-up
- Reliable battery swap detection
- Foreign object detection (FOD)
- LCD diagnostics

### 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

<table>
<thead>
<tr>
<th>STWBC2-HP</th>
<th>STWBC86</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supports applications up to 70 W</td>
<td>Supports applications up to 70 W</td>
</tr>
<tr>
<td>Qi 1.2.4 / 1.3 compatible</td>
<td>Qi 1.3 compatible</td>
</tr>
<tr>
<td>Qi certified reference design with MP-A2 topology and supports MP-A23</td>
<td>Supports up to 15 W Rx for Qi Extended Power Profile</td>
</tr>
<tr>
<td>Supports up to 5 W Rx for Qi Baseline Power Profile</td>
<td>Supports up to 5 W Rx for Qi Baseline Power Profile</td>
</tr>
</tbody>
</table>

**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

<table>
<thead>
<tr>
<th>STWLC38</th>
<th>STWLC86</th>
<th>STWLC98</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supports up to 5 W in Tx mode (coil dependent)</td>
<td>Supports up to 5 W in Tx mode (coil dependent)</td>
<td></td>
</tr>
<tr>
<td>ARC (Adaptive Rectifier Configuration) mode for enhanced spatial freedom</td>
<td>ARC (Adaptive Rectifier Configuration) mode for enhanced spatial freedom</td>
<td></td>
</tr>
<tr>
<td>ARM 32-bit Cortex™-M3 core up to 64 MHz (STWLC98)</td>
<td>ARM 32-bit Cortex™-M3 core up to 64 MHz (STWLC98)</td>
<td></td>
</tr>
<tr>
<td>Optimized device size (STWLC98)</td>
<td>Optimized device size (STWLC98)</td>
<td></td>
</tr>
</tbody>
</table>

**STWLC98/86**
- Qi 1.3 compatible
- Supports up to 30 W (STWLC86)
- Supports up to 7.5 W (STWLC86)

**STWLC38**
- Qi 1.3 compatible
- Supports up to 15 W (STWLC86)
- Supports up to 70 W (STWLC98) Rx

**STWLC86/98**
- Qi 1.3 compatible
- Supports up to 30 W (STWLC86)
- Supports up to 15 W (STWLC98) in Tx mode
- Embedded OS for Qi 1.3 standalone certification (STWLC98)

**Common features**
- Industry leading efficiency
- Accurate foreign object detection (FOD)
- Best-in-class power consumption with smart standby

**STWLC38**
- Supports up to 5 W in Tx mode (coil dependent)
- ARC (Adaptive Rectifier Configuration) mode for enhanced spatial freedom

**STWLC86/98**
- ARM 32-bit Cortex™-M3 core up to 64 MHz (STWLC98)
- Optimized device size (STWLC98)

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- ARM 32-bit Cortex™-M3 core up to 64 MHz (STWLC98)
- Optimized device size (STWLC98)
**DC-DC SWITCHING CONVERSION ICs**

**DC-DC converters**

ST offers a wide portfolio of **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 W/3 A
- Synchronization capability
- Internal compensation
- Low consumption
- Adjustable fsw
- Internal soft start
- Low quiescent current

**Synchronous buck converter**

**Asynchronous buck converter**

**MAIN APPLICATIONS**

- Smartphones
- TVs
- Computing
- Solar
- UPS
- Lighting
- Set-top boxes
- Wearables
- Server/Telecom
- Home appliances
- Factory automation

**www.st.com/dc-dc-switching-converters**

**DC-DC SWITCHING 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 36V/in

**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

**www.st.com/single-phase-controllers**

**www.st.com/multi-phase-controllers**

**www.st.com/dc-dc-switching-converters**

**www.st.com/single-phase-controllers**

**www.st.com/multi-phase-controllers**

**www.st.com/dc-dc-switching-converters**

**www.st.com/single-phase-controllers**

**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**

<table>
<thead>
<tr>
<th>5 V power supply application</th>
<th>Battery power supply application</th>
<th>Custom application, no output turned ON</th>
<th>5 V power supply application</th>
<th>Battery power supply application</th>
</tr>
</thead>
<tbody>
<tr>
<td>STPMIC1A</td>
<td>STPMIC1B</td>
<td>STPMIC1C</td>
<td>STPMIC1D</td>
<td>STPMIC1E</td>
</tr>
<tr>
<td>Default output Voltage (V)</td>
<td>Default output Voltage (V)</td>
<td>Default output Voltage (V)</td>
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<td>REFDDR</td>
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<td>0.55</td>
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<tr>
<td>BOOST</td>
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<td>N/A</td>
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<td>BUCK1</td>
<td>1.2</td>
<td>1.2</td>
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<tr>
<td>BUCK2</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
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<td>BUCK3</td>
<td>1.8</td>
<td>1.8</td>
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<tr>
<td>BUCK4</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
<td>3.3</td>
</tr>
</tbody>
</table>

Rank = 0: rail not automatically turned ON
Rank = 1: rail automatically turned ON after 7 ms
Rank = 2: rail automatically turned ON after further 3 ms
Rank = 3: rail automatically turned ON after further 3 ms

STPMIC1 and STM32MP1 applications

**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, STNRG011A, 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

**STNRG011**
- 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
- Advanced OLP - Over Load Management (STNRG011A only)

**STNRG012**
- Enhanced fixed on time multi-mode TM PFC controller

**STNRG Digital Power Controllers**

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®-M4 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.

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.

**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

**STM32F3**
- Cortex®-M4 core
- High resolution timer V1 (217ps resolution) with waveform builder and event handler
- 12-bit ADCs up to 2.5 Mfps conversion time
- Built-in analog peripherals for signal conditioning and protection (25ns from fault input to PWM stop)

**STM32G4**
- Cortex®-M4 core
- High resolution timer V2 (1.84ps 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 Birchina

www.st.com/stm32
STM32 Digital Power Ecosystem
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 DPLL, 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.

### SPC58 E Line

<table>
<thead>
<tr>
<th>Feature</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>Triple e200z4d @ 180 MHz</td>
</tr>
<tr>
<td>eFlash Code</td>
<td>4 MB to 6 MB</td>
</tr>
<tr>
<td>Timers</td>
<td>GTM3</td>
</tr>
<tr>
<td>Safety</td>
<td>ASIL-D</td>
</tr>
<tr>
<td>Advanced Networking</td>
<td>8x CAN-FD, FlexRay, 2x Ethernet</td>
</tr>
<tr>
<td>Security</td>
<td>HSM medium</td>
</tr>
<tr>
<td>ADC</td>
<td>5x 12 bit (SAR), 3x 10 bit (SAR), 6x 16 bit (SigmaDelta)</td>
</tr>
<tr>
<td>High Temperature support</td>
<td>(165 °C) Qualified</td>
</tr>
</tbody>
</table>

### Package Options

- **eQFP 64-176** (exposed pad)
- **QFN 48** (exposed pad)

### Networking

- **Ethernet**
- **CAN FD**
- **FlexRay**
- **Open Alliance**

### Scalability

- **Up to:**
  - 3 cores, 200 MHz, 10 MB flash

### Secure & Safety

- **ASIL D**
- **Evita Medium/Full**
- **HIS ISO 26262**

### MAIN APPLICATIONS

- **Vehicle Security**
- **Software over-the-air**
- **Parking Services**
- **Remote Assistance**
- **Maintenance free**
- **Safety**
- **HEV**

---

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.

**AutoDevKit Ecosystem**

- **AEK MCU Discovery and Functional Boards**
- **AEKD System Solution Demonstrators**
- **AutoDevKit**
- **STSW Embedded Software**

Find out more at [www.st.com/autodevkit](http://www.st.com/autodevkit)

Software download: [www.st.com/autodevkitls](http://www.st.com/autodevkitls)

Join our Community at [https://community.st.com/autodevkit](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.

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

MAIN APPLICATIONS

Adapters and TVs
Solar inverters, welding, HEVs, and UPS
PC Desktop and Server/Telecoms
Battery chargers
Residential, commercial, architectural and street lighting

STPSC*065, STPSC*H12

• 650 V (STPSC*065)
• 1200 V (STPSC*H12)
• 2 available trade-offs, low VF and High surge

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.

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

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

www.st.com/sic-diodes
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.

**Main Features**

- Do not degrade or require replacement after a trip event
- Programmable over-current protection and turn-on time
- Latched or autoretry function
- Overvoltage clamp
- Over-temperature protection
- Integrated power device
- Internal undervoltage lockout

**eFuses, a smart offer for a lot of applications**

- eFuses are suitable for various applications such as home appliances, USB connections, server and data storage, and set-top boxes. They provide a convenient and integrated solution for quickly and safely disconnecting a faulty load from a 12 V bus.

**Power Breakers**

- Connected in series to the power rail, ST power breakers can automatically 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 certificate 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
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
- ±320 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/μs typical Common-Mode Transient Immunity
- 6 kV VPEAK Highest Allowable Over-Voltage (V_{com})
- 6 kV VPEAK Maximum Surge Insulation Voltage (V_{ins})
- 1.2 kV VPEAK Maximum Working Insulation Voltage (V_{wor})
- 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**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Version</th>
<th>Input Range</th>
<th>Max. Clock Frequency</th>
<th>Resolution</th>
<th>SNR</th>
<th>Isolation</th>
<th>CMTI</th>
<th>Package &amp; Packing</th>
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<td>ISOSD61</td>
<td>TTL/CMOS</td>
<td>±320 mV</td>
<td>25 MHz</td>
<td>16-bit</td>
<td>86 dB</td>
<td>1.2 kV</td>
<td>30 kV/us</td>
<td>SO16W Tray</td>
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<td>TTL/CMOS</td>
<td>LVDS</td>
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<td>SO16W Tape &amp; Reel</td>
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</table>

**MAIN APPLICATIONS**

- Servo drive
- Factory automation
- EV charging station
- Server & telecom power
### IGBT Applications

**Focus Applications**

- **Home appliances**
- **Automotive**
- **Industrial**
- **Motors**
- **UPS/SMPS, welding equipment, induction heating, solar inverters, traction inverters, on-board chargers, and fast chargers.**

**IGBT Series**

- **H series**
- **V series**
- **M series**
- **IH series**
- **HB series**
- **HB2 series**
- **MH series**
- **MS series**

**Nominal Current**

- 20 to 80 A
- 2 to 20 kHz
- 15 to 100 A
- 8 to 30 kHz
- 15 to 75 A
- 20 to 100 kHz
- 16 to 60 kHz
- 4 to 20 A
- 16 to 60 kHz
- 20, 30 A
- **650 V IH family**
- **600 V IH family**
- **650 V family**

**Breakdown Voltage**

- 600 V
- 650 V
- 1200 V
- 1250 V
- 1500 V

**Switching Frequency**

- 20 to 80 A
- 15 to 75 A
- 50 A (bare die)
- 1200 V
- 16 to 60 kHz
- 2 to 20 KHz
- 2 to 20 kHz
- 8 to 30 kHz
- 150 °C

**Main Applications**

- **Welding**
- **Solar**
- **UPS**
- **Home appliances**
- **Air conditioning**
- **Motor control**
- **Induction heating**

**STG**

- **STG**
- **STG**
- **STG**
- **STG**

**Note:** * is used as a wildcard character for related part number.
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 $R_{th}$ 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

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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.

IPS MAIN FEATURES
- Logic
- Driving
- Protections
- Diagnostic
- Power stage
- Isolation
- ...all on a single chip

www.st.com/ips

Output Current/Channel (A)

<table>
<thead>
<tr>
<th>Current (A)</th>
<th>IPS1025H(Q)-32²</th>
<th>IPS1025H(Q)-32²</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>IPS160H², IPS160H², IPS1025H(Q)-32², VN540SP, VN751, L6370²</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>IPS2050H², IPS2050H²</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>IPS1610, IPS1610, IPS1610, VN316SP, VN316SP, L6370²</td>
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</tr>
<tr>
<td>0.5</td>
<td>IPS4260, VN6140K, VN3030P, VN3030P, L6370²</td>
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<tr>
<td>&lt;0.5</td>
<td>VNI2140, VNI2140, L6370²</td>
<td></td>
</tr>
</tbody>
</table>

Note: 1: Isolated HS  2: 60kV HS  3: LS  4: HS

MAIN APPLICATIONS
- Factory automation
- Vending machines
- Renewable energy
- Lighting for Building Automation
**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). HVLED007 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**

<table>
<thead>
<tr>
<th>Controller</th>
<th>HPF</th>
<th>PSR-CC</th>
<th>PSR-CV</th>
<th>Internal power</th>
<th>MOSFET</th>
<th>Flyback</th>
<th>Buck-boost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVLED0805</td>
<td></td>
<td></td>
<td></td>
<td>8 W</td>
<td>800 V</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HVLED815PF</td>
<td></td>
<td></td>
<td></td>
<td>15 W</td>
<td>800 V</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Offline LED controllers**

<table>
<thead>
<tr>
<th>Controller</th>
<th>HPF</th>
<th>PSR-CC</th>
<th>PSR-CV</th>
<th>Dimming</th>
<th>Flyback</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVLED007</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Topology example**

![Topology example diagram]

**MAIN APPLICATIONS**

- Residential lighting  
  - HVLED07
- Commercial and street lighting  
  - HVLED01A, HVLED01B, HVLED007

**Note:** * output power for European input voltage 230 Vac

---

**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**

<table>
<thead>
<tr>
<th>Converter</th>
<th>Buck</th>
<th>Buck-boost</th>
<th>Dimming</th>
<th>V_{out}</th>
<th>Synchronous</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED000</td>
<td></td>
<td>3 A</td>
<td></td>
<td>18 V</td>
<td></td>
</tr>
<tr>
<td>LED001</td>
<td></td>
<td>3 A</td>
<td></td>
<td>18 V</td>
<td></td>
</tr>
<tr>
<td>ST1CC40</td>
<td></td>
<td>3 A</td>
<td></td>
<td>18 V</td>
<td></td>
</tr>
<tr>
<td>LED5000</td>
<td></td>
<td>3 A</td>
<td></td>
<td>48 V</td>
<td></td>
</tr>
<tr>
<td>LED6000</td>
<td></td>
<td>3 A</td>
<td></td>
<td>61 V</td>
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</tr>
</tbody>
</table>

**DC-DC LED drivers controllers**

<table>
<thead>
<tr>
<th>Controller</th>
<th>Reverse buck</th>
<th>Buck-boost</th>
<th>Boost &amp; Sepic</th>
<th>Dimming</th>
<th>V_{out}</th>
</tr>
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<tbody>
<tr>
<td>HVLED002</td>
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<tr>
<td>LED6001</td>
<td></td>
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<tr>
<td>STLDC08</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Topology examples**

- Synchronous buck
- Asynchronous buck
- Reverse buck

**MAIN APPLICATIONS**

- Halogen bulb replacements and home appliances  
  - LED5000, LED6000
- Traffic signals  
  - LED5000, LED0301, ST1CC40, LED6000, LED0600, HVLED002
- Street lighting  
  - LED6000, HVLED002
- Emergency lighting  
  - LED6000, LED6000, LED0600, HVLED002
- Commercial and architectural lighting  
  - LED6000, LED6000, LED0600, HVLED002

For more information, visit [www.st.com/led](http://www.st.com/led)
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.

Channels

24 channel RGB (8x3) drivers
- Current gain control (LED2472G), constant current (STP24DP05)
- Error detection
- Autopower saving (LED2472G)

5x24 matrix drivers
- 20 mA/dot
- Adjustable luminance for each LED (dot)

4/8 channel drivers
- Current gain control (LED1642GW), constant current (STP16C*/D*)
- Error detection (STP16C*/D*)
- Dot correction (LED1202)
- Autopower saving
- Local dimming (LED1242GW, LED1202), global dimming (STP16C*/D*)

403020 72 80 90 100 400 mA/channel

12/16 channel drivers
- Current gain control (LED1642GW), constant current (STP16C*/D*)
- Error detection (STP16C*/D*)
- Direct I/O (LED8102S)
- Error detection (STP08)
- Global dimming

MAIN APPLICATIONS

Traffic signals
LED8102S, LED2472G, STP24DP05, STP04

Large panel signs
LED1642GW, LED2472G, STP40DP05, STP16, STP04

Home appliances
LED8102S, STP16, STP08, LED1442G/W, STP40MP, STLED524

Special lighting
STP4, LED1642G/W, LED2472G, LED8102S

Smartphones / Wearable
STP4, LED1642G/W, LED8102S, STLED524, LED1202

www.st.com/led

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

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
- 85 mA/row
- STP7707

1 row
- 30 mA/row
- STP7706

0.5 A/1.5 A/2 A/row
- STLD40D

LED row driver controllers

16 rows
- 85 mA/row
- Grouped or independent row dimming
- LED7708

MAIN APPLICATIONS

Smartphones
STL402, STL140

Keyboard and accessories
STLED316S

Home appliances and ATMs
LED7706, LED7707, LED7708, STLED524

www.st.com/led

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

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

LBP01 get reliable your led application

MAIN APPLICATIONS
- Display panels
- Residential, commercial, architectural and street lighting
- Emergency lighting
- Traffic signals

www.st.com/lbp01

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 μA 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 μVrms). 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.

Ultra-low dropout
- High efficiency in low-/medium-power applications
- Best cost/performance trade-off
- Large offer for Iout capability and packaging

Low quiescent current Iq
- 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
- Tablets, smartphones, and wearables
- Healthcare
- Home appliances
- Automotive ADAS, ECU

www.st.com/linear-regulators

Ultra-low dropout Low Iq Low noise, high PSRR
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

Voltage sensor 1
Current sensor 1
Voltage sensor 2
Current sensor 2

STPMS2
The STPMS2, also called smart-sensor, is a dual SD module 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.

STPMS2

KEY FEATURES
• Two 2nd 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,
• Fast digital calibration
• Allows the use of multiple shunts

MAIN APPLICATIONS
Energy metering
EV charging
Lighting
Smart plug
Servers power monitor
Solar charging

METERING ICs

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.

MAIN APPLICATIONS
Smartphones, digital cameras, and camcorders
Fitness, climate, home and factory automation monitoring

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

www.st.com/mppt-dcdc-converters
www.st.com/photovoltaic-ics
www.st.com/mppt-dcdc-converters
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.

**MAIN APPLICATIONS**

- **Adapters**: K5, M5, M2, M2-EP, M6
- **Solar Inverters, EV Charging stations, Energy storage systems and UPS**: K5, M5, M2, DM2, DK5, DM9
- **Welding, residential, commercial and street lighting**: K5, K6, DK5
- **Server/Telecoms**: M9, M5, M6, M2, DM9, DM2, DK5, DM9, DM2

**ST*N*M9**
- Very low $R_{DS(on)}$
- High switching speed
- Suited for hard switching topologies

**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

**ST*N*M2-EP**
- Very low $R_{DS(on)}$
- Small $Q_g$ and capacitance
- Small packages
- Suited for hard switching topologies

**ST*N*K5/6**
- Lowest trr @ Very High Voltage BVDSS
- High dv/dt capability
- Targeting high power 3-phases industrial equipment

**ST*N*DK5**
- Lowest trr @ Very High Voltage BVDSS
- High dv/dt capability
- Targeting high power 3-phases industrial equipment

**ST*N*M5**
- Lower $R_{DS(on)} \times$ area vs previous generation
- Extremely low gate charge ($Q_g$)
- Optimized capacitance profile for better efficiency @ light load
- Optimized threshold voltage (VTH) and gate resistance (RG) values for soft switching

**ST*N*M6**
- 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

**ST*N*DM6**
- Improved intrinsic diode reverse recovery time (trr)
- Higher dv/dt and di/dt capability
- Optimized body diode recovery phase and softness

**ST*N*DM2**
- Very low $R_{DS(on)}$
- High switching speed
- Suited for hard switching topologies

**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

**ST*N*K6**
- Very low $R_{DS(on)}$
- Small $Q_g$ and capacitance
- Small packages
- Suited for hard switching topologies

**ST*N*K5/6**
- Extremely low $Q_g$
- Optimized for light load conditions
- Tailored for high-frequency applications (M2-EP)
- Suited for hard switching & ZVS/LLC topologies

**ST*N*DK5**
- Very low $R_{DS(on)}$
- Small $Q_g$ and capacitance
- Small packages
- Suited for hard switching topologies

**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

**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

**ST*N*DM9**
- Very low $R_{DS(on)}$
- High switching speed
- Suited for hard switching topologies

**ST*N*DM2**
- Extremely low $Q_g$
- Optimized for light load conditions
- Tailored for high-frequency applications (M2-EP)
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- High switching speed
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**ST*N*DM9**
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- High switching speed
- Suited for hard switching topologies

**ST*N*K6**
- Very low $R_{DS(on)}$
- Small $Q_g$ and capacitance
- Small packages
- Suited for hard switching topologies

**ST*N*K5/6**
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- Small packages
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- Industry’s best $R_{DS(on)}$ for 650V voltage range
- Lowest $Q_g$
- Higher reverse diode dv/dt and MOSFET dv/dt ruggedness
**SiC MOSFETs**

Based on the advanced and innovative properties of wide-bandgap materials, ST silicon carbide (SiC) MOSFETs feature very low \( R_{\text{DS(on)}} \) 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.

**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**

- **H6 series**
  - Very good \( R_{\text{DS(on)}} \)
  - Soft diode recovery
  - Suited for OR-ing, square-wave HB, battery management

- **F6 series**
  - Wide voltage range
  - Soft diode recovery
  - Very good \( R_{\text{DS(on)}} \)
  - Suited for load-safety switch, buck and sync rectification

- **F7 series**
  - Extremely low \( R_{\text{DS(on)}} \)
  - 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

**SiC mosfets, the real breakthrough in high voltage switching**

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

**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, SO-8, TO-220, TO-220FP, TO-247, PowerFLAT (5 x 6)/(3.3 x 3.3)/(2 x 2), SO-8 and SOT23-6L.

**MAIN APPLICATIONS**

- Motor drive & factory automation
- HEVs / EVs (Traction Inverter, OBC, DC/DC)
- Charging station
- UPS & Data center
- Power supply
- Solar inverters

www.st.com/sicmos
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 thermometer and offer the best compromise between conduction and switching losses, maximizing the efficiency of any converter system in hard-switching circuits 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

ACEPACK DRIVE
120 kW to 300 kW

ACEPACK DMT32
120 kW to 300 kW

KEY FEATURES
• Very low Stray inductance
• 2.5 kVrms electrical isolation
• Pin out flexibility
• Custom configurations
• Optimized thermal behavior
• Different DBC Options (Al2O3–AlN)
• Press-fit and solder pin options

CONFIGURATIONS
• CIB
• Six-pack
• Three level T-type
• Four Pack
• Half Brige
• Boost
• Customized configurations

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

KEY FEATURES
• Designed for automotive applications
• Different DBC Options (Al2O3–AlN)
• 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

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
PM8803
PM8805+PM8804

Power at PoE-PD input
13 W 25 W 71 W

Power over Ethernet power supply protection

• 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
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.

www.st.com/eos8-20-protection

MOSFET Protection with TVS

Discrete protection

-15% consumption in Stand-by mode

TVS protection

MAIN APPLICATIONS

Adapters Smart metering Solar inverters Residential, commercial, architectural and street lighting

www.st.com/esd-20-protection

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

ESDaxP

Strong and thin protection, the ESDaxP 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

www.st.com/esd-protection

MAIN APPLICATIONS

Tablets, smartphones, and digital cameras Healthcare I/O microcontrollers and signal conditioning

Factory automation Human machine interface (HMI) Smart metering SIM cards, Ethernet, and HDMI/VXI ports

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

**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 (TD351*)
- Pulse transf / opto input (TD351*)
- 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 (STGP1B)
- Miller clamp, negative gate supply
- Optimized for SiC MOSFET driving (STGAP2SiCS)

**STDRIVE601 - High voltage half-bridge gate driver for GaN transistors**
- \( \pm 200 \) 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**
- Factory automation
- Home appliances
- Motor control
- Lighting
- Solar inverters
- HEV / EV

www.st.com/stdrive
THYRISTORS

Available in through-hole and surface-mount packages, ST high-temperature Silicon Controlled Rectifiers (SCRs) 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.

Automotive Grade SCR AECQ101 qualified

<table>
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<tr>
<th>Part number</th>
<th>Package</th>
<th>T(°C)</th>
<th>I max (A)</th>
<th>V max (V)</th>
<th>I G (mA)</th>
<th>dV/dt (V/µs)</th>
<th>dI/dt (A/ms)</th>
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Medium Power SCR

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<th>V max (V)</th>
<th>I G (mA)</th>
<th>dV/dt (V/µs)</th>
<th>dI/dt (A/ms)</th>
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High Temperature SCR

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<th>Package</th>
<th>T(°C)</th>
<th>I max (A)</th>
<th>V max (V)</th>
<th>I G (mA)</th>
<th>dV/dt (V/µs)</th>
<th>dI/dt (A/ms)</th>
</tr>
</thead>
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<td>TN1205H-6</td>
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<td>150</td>
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<tr>
<td>TN5015H-6</td>
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<td>50</td>
<td>600</td>
<td>20</td>
<td>20</td>
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</tr>
</tbody>
</table>

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.

MAIN APPLICATIONS

AC/DC Conversion SMPS & PSU
UPS
EV on-board charger
Motor Control

MAIN APPLICATIONS

Home appliances
Air conditioning
Lighting
Heating
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 standalone full hardware USB PD controllers 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 technology.

STUSB controllers are recommended for advanced protection of the USB-C® connector line in sink applications, such as CC and VBUS line. For source applications (like power adapters), TCPC02-M18 is recommended (mass-production Q4-2020). For Dual Role Port applications (DRP), TCPC03-M20 is recommended (mass-production Q4-2020).

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

Our STM32G071DB-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 PD0.0 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 STM32G071DB-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 µA 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-MOSFET gate drivers for VBUS OVP and OCP.
- Very low power in "unattached" state during DRP toggling: 3 µA 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 CC, CC compliant with IEC 61000-4-2 Level 4 (+8 kV contact discharge, ±15 kV air discharge)
- VCONN OCP and OVP
- Over voltage protection on CC lines against short-to- VBUS
- Over temperature protection (150 °C typ.)

**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)

**TCPP01-M12**

- ESD protection for CC1, CC2 and VBUS
- Compliant with IEC 61000-4-2 Level 4 ±15 kV contact discharge, ±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

**STUSB47xx**

- USB PD SOURCE
- Up to 5 programmable PD2s
- 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

**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-SCS002V1

**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

**STUSB1600**

- USB-C 5V 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: STM32F466
  - STSW-STUSB014: STM32G474
  - STSW-STUSB015: STM32L4R5

**STUSB1602**

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

**STUSB1700**

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

**STUSB1800**

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

**STUSB84710**

- SOURCE
- MCU + STUSB1602
- MCU + STUSB1800
- STUSB4500L
- STUSB4500
- STUSB84700
- STUSB84710
- STUSB84761
- STUSB1700
- STUSB1600
- STUSB4500L
- STUSB1602
- STUSB1800