Power management guide
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When designing a power management system or subsystem, regardless of whether it is an energy generation or distribution system, a power supply or an 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
- PowerGaN transistors
- GaN power ICs
- HV and LV power MOSFETs 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

ST provides a selection of new 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 traditional solutions.

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

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

Sensors with galvanically-isolated gate drivers and high-performance STM32 microcontrollers, our solutions enable engineers to design.

We offer a broad range of silicon-carbide (SiC) power MOSFETs – with the industry’s highest operating junction temperature of high input voltages (up to 1500 V).

Typical block diagram for string inverter

*ST product offering for string and central solar inverter:

- **600 V MDmesh DM9 ST*60N*DM9
- **650 V MDmesh M5 ST*65M5
- **1200 V MDmesh K5 ST*N120K5
- **1200 V M series STG*M120DF3
- **1200 V H series STG*H65DFB2
- **1200 V H series STG*H120DFB2
- **650 V HB series STG*V60DF
- **1200 V HB series STG*H65DFB
- **1200 V H series STG*H120DFB
- **600 V HB series STG*V60DF
- **1200 V HB series STG*H65DFB
- **1200 V H series STG*H120DFB
- **600 V HB series STG*V60DF
- **1200 V HB series STG*H65DFB
- **1200 V H series STG*H120DFB
- **600 V HB series STG*V60DF
- **1200 V HB series STG*H65DFB
- **1200 V H series STG*H120DFB
- **600 V HB series STG*V60DF
- **1200 V HB series STG*H65DFB
- **1200 V H series STG*H120DFB
- **600 V HB series STG*V60DF
- **1200 V HB series STG*H65DFB
- **1200 V H series STG*H120DFB
- **600 V HB series STG*V60DF
- **1200 V HB series STG*H65DFB
- **1200 V H series STG*H120DFB

**ST product offering for central inverter**

- **600 V series STG*V60DF
- **650 V HB series STG*H65DFB
- **1200 V series STG*H120DFB2

**Power modules**

- **ACEPACK**
- **Power modules**
- **A2F12M12W2-F1
- **A1F25M12W2-F1
- **A1P25S12M3
- **A1P35S12M3
- **A1P50S65M2
- **A2F12M12W2-F1
- **A1F25M12W2-F1
- **A1P25S12M3
- **A1P35S12M3
- **A1P50S65M2
- **A2F12M12W2-F1
- **A1F25M12W2-F1
- **A1P25S12M3
- **A1P35S12M3
- **A1P50S65M2

**Connectivity**

- **BlueNRG, STM32WB, STM32WBA5
- **Zigbee, Thread STM32WB
- **Bluetooth Low Energy BlueNRG, STM32WB, STM32WBA5
- **Power Line transceivers ST8160, ST7580
- **RS-422 and RS-485 ST485*, STR485*
- **IIS3DHHC, IIS2DH, IIS2ICLX
- **ST3485*, STR485*
- **ST8500, ST7580
- **IIS2MDC
- **IIS3DHHC, IIS2DH, IIS2ICLX
- **ST3485*, STR485*
- **ST8500, ST7580
- **IIS2MDC
- **IIS3DHHC, IIS2DH, IIS2ICLX
- **ST3485*, STR485*
- **ST8500, ST7580
- **IIS2MDC
- **IIS3DHHC, IIS2DH, IIS2ICLX
- **ST3485*, STR485*
- **ST8500, ST7580
- **IIS2MDC

**Applications**

**ENERGY GENERATION AND DISTRIBUTION**

Solar centralized generation - solar inverters (string and central)

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

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

Typical block diagram for central inverter

**String and central inverter**

Typical block diagram for string inverter

**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) generated from all the microinverters in the installation are collected by a concentrator and dispatched to a local or remote monitoring and control access point.

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

ST product offering for microinverter

<table>
<thead>
<tr>
<th>Power MOSFETs</th>
<th>Diods</th>
<th>Protections</th>
<th>Signal conditioning</th>
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<tr>
<td>600 V-650 V</td>
<td>600 V Ultrafast</td>
<td>TVS for power MOSFET and power rail surge protection</td>
<td>SVM, SM1, STM1 series</td>
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<tr>
<td>STF*1206</td>
<td>STP*1206</td>
<td>STM32F4</td>
<td>STM32F3</td>
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<tr>
<td>STF<em>60N</em></td>
<td>STM32F3</td>
<td>STM32F0</td>
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<tr>
<td>STF<em>60M</em></td>
<td>STP<em>60M</em></td>
<td>STM32F4</td>
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</tr>
<tr>
<td>STF<em>60E</em></td>
<td>STP<em>60E</em></td>
<td>STP*60DF</td>
<td></td>
</tr>
<tr>
<td>STF<em>60D</em></td>
<td>STP<em>60D</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>800 V-900 V</td>
<td>100 V Trench Schottky</td>
<td>STM32F3</td>
<td></td>
</tr>
<tr>
<td>STF*120DF</td>
<td>STP*120DF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>650 V-1200 V</td>
<td>30 V to 45 V</td>
<td>STM32F3</td>
<td></td>
</tr>
<tr>
<td>STF*120G1</td>
<td>STP*120G1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>650 V-1200 V</td>
<td>200 V to 45 V</td>
<td>STM32F4</td>
<td></td>
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<tr>
<td>STF*120DF</td>
<td>STP*120DF</td>
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</table>

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 maximizes power generation. This results in an improved energy yield of the overall solar system compared to traditional string or central inverter based architectures.

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

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

ST product offering for power optimizer

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<th>Power optimizers</th>
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<th>By pass diodes</th>
<th>Sources</th>
<th>Protections</th>
<th>Signal conditioning</th>
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<td>STM32F34</td>
<td>60 V to 120 V</td>
<td>Power Schottky</td>
<td>STM32F0</td>
<td>STM32F0</td>
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<td>STM32F35</td>
<td>45 V to 60 V</td>
<td>Power Schottky</td>
<td>STM32F0</td>
<td>STM32F0</td>
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</tr>
<tr>
<td>STM32F36</td>
<td>100 V to 150 V</td>
<td>Power Schottky</td>
<td>STM32F0</td>
<td>STM32F0</td>
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</tbody>
</table>

Typical block diagram
Energy distribution - home and 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 times, and to help avoid problems with stability and voltage drop associated with the fast-changing requirements of an increasing number of electric vehicles (EV).

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

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

Typical block diagram - home battery storage system

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**ST product offering for home and commercial battery storage systems**

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<th>DC-DC converter</th>
<th>Power modules</th>
<th>IGBTs</th>
<th>MOSFET and IGBT gate drivers</th>
<th>Stages and discretes</th>
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<td>60 V Ultrafast</td>
<td>650 V series</td>
<td>STP8F12</td>
<td>STP15F12, STP20F12, STP30F12, STP60F12</td>
</tr>
<tr>
<td>DC-DC converter</td>
<td>600 V Ultrafast</td>
<td>650 V series</td>
<td>STP8F12</td>
<td>STP15F12, STP20F12, STP30F12, STP60F12</td>
</tr>
</tbody>
</table>

**System Control stage**

- **MCUs:*** STM32F103C8T6, STM32F103C8T6
- **Signal conditioning:** STMicroelectronics
- **EEPROM:** STMicroelectronics
- **Connectivity:** Wi-Fi, BLE, Zigbee, Thread, STMicroelectronics

**Data Logger / Internet Gateway**

- **MCUs:** STM32L152C8T6, STM32L152C8T6
- **Connectivity:** Wi-Fi, BLE, Zigbee, Thread, STMicroelectronics

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Note: * denotes an unspecified value for related part number. 
1: only for bidirectional DC-DC converter 
2: only for commercial battery storage systems
INDUSTRIAL POWER AND TOOLS

Uninterruptable power supplies (UPS)

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

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

ST product offering for uninterruptable power supplies (UPS)

### Power MOSFETs

#### Main features:
- High power efficiency
- High reliability

### IGBTs

#### Main features:
- High voltage handling
- Low switching losses

### Diodes

#### Main features:
- Fast reverse recovery
- Low forward voltage drop

### Op-amp V/I sensing

#### Main features:
- High precision
- Low power consumption

### Protection

#### Main features:
- Overvoltage protection
- Undervoltage protection

### Bridge rectifier diodes

#### Main features:
- High current capability
- Low forward voltage drop

### Power modules

#### Main features:
- High power density
- High efficiency

### Power controllers

#### Main features:
- Digital and analog control
- Gate drivers integration

### Battery management

#### Main features:
- Charge and discharge management
- Overcharge and overdischarge protection

### Wireless Charging

#### Main features:
- Qi-compatible wireless power
- Low profile

### Secure Identification

#### Main features:
- Secure digital identification
- Anti-counterfeiting

### Industrial battery chargers

Industrial battery charger solutions target at highly efficient charging operation, enhanced battery lifetime and protection of Li-ion batteries used in different applications such as cordless power tools, garden tools, AGV and service robots, light electric vehicle (LEV) including e-bike, e-scooter, e-rickshaw, e-microcars, e-golf-cart, and e-forklift.

Specifically for cordless power tools, bidirectional power converters are more and more required to replace with one single power supply the two converters, one typically used to generate the AC voltage and one to recharge the battery pack. The use of a single converter will reduce the space required for the power electronics and will make this space available to increase the number of cells in the battery pack. In this way the UPS operating time will be extended.

ST takes into account the different needs of this wide range of use cases, which can feature sophisticated or cost-optimized BOM, for hobby or professional use, by offering scalable solutions thanks to its wide portfolio of power discrete and modules, digital and analog controllers, combined with gate drivers and analog.

Typical configuration for Single-Phase architecture for Low/Medium power winding

![Diagram of a single-phase UPS configuration](image)

*For more detailed information, please refer to the application section.*

**Main application boards and reference designs**

- STDE3-2KW/5CH440V: 3.6 kW 48 V battery charger, reference design for industrial light electric vehicles (LiEVS)
- STEVAL-DPSLPCF1: 3.6 kW 48 V Power Phase with digital link current limiter
- STEVAL-WBC2TX70*: Qi-compatible wireless power transformer for 70 W applications
- STEVAL-WLC99RX*: Qi-compatible wireless power receiver for 70 W applications
### ST product offering for industrial welding

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<tr>
<th>MOSFET/IGBT gate drivers</th>
<th>IGBTs and power modules</th>
<th>Power MOSFETs</th>
<th>Diodes and protections</th>
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<tr>
<td>Single low side gate drivers PM65N1, T030*</td>
<td>600 V series STW60DF</td>
<td>600 V-650 V MOSFETs M9 ST60M9, ST65M9</td>
<td>600 V Ultrafast STTP60DF, STTP60H, STTP706</td>
</tr>
<tr>
<td>Multiple low side gate drivers PM65H4</td>
<td>650 V HB series STHP65DF, STHP65FB</td>
<td>600 V-650 V MOSFETs M6 ST60M6, ST65M6</td>
<td>1200 V Ultrafast STTP60H, STTP912</td>
</tr>
<tr>
<td>HV HB gate drivers L649*</td>
<td>650 V HB series STHP65DF</td>
<td>600 V-650 V MOSFETs M2 ST60M2, ST65M2</td>
<td>SiC diodes STPS65V6, STPS12H</td>
</tr>
<tr>
<td>HV HB gate drivers for Gallium STDRIVEG600*</td>
<td>650 V-1200 V SiC MOSFETs SCT60M1, SCT60M2, SCT120M3</td>
<td>TVS for power rail surge protection SMITE, SMIC0J, SMIC0JU</td>
<td></td>
</tr>
<tr>
<td>Single low side gate drivers ST50**</td>
<td>650 V-1200 V SiC MOSFETs SCT65M1, SCT65M2, SCT125M3</td>
<td></td>
<td></td>
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<tr>
<td>Multiple low side gate drivers ST50**</td>
<td>650 V-1200 V SiC MOSFETs SCT65M1, SCT65M2, SCT125M3</td>
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</tr>
<tr>
<td>HV HB gate drivers L649*</td>
<td>600 V-1200 V SiC MOSFETs SCT60M1, SCT60M2, SCT120M3</td>
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### Electro-Mobility

#### Key applications

- **Mild hybrid 48 V systems**
- **DC-DC converter**
- **Battery management system (BMS)**
- **Charging station**
- **Electric traction** (Main inverter)
- **On-board charger**
- **Acoustic vehicle alerting system**
- **HV battery disconnect and fire-off system**
- **Power Schottky high temperature**
- **On-board microcontrollers**

### Solutions

**ST key products and solutions for electro-mobility applications include**:

#### Power MOSFETs and diodes

- ST key products and solutions for electro-mobility applications include:

#### Power diodes and thyristors

- ST key products and solutions for electro-mobility applications include:

#### Signal conditioning

- ST key products and solutions for electro-mobility applications include:

#### Power Management

- ST key products and solutions for electro-mobility applications include:

#### BCD integrated and isolated drivers

- ST key products and solutions for electro-mobility applications include:

### Find out more

- **www.st.com/electro-mobility**
- **HV and SF development tools – Sample kits, evaluation kits, product selectors**

#### DC Fast Charging Station

**48 V System**

**12 V System**

**On-Board Charger**

**BMS**

**ICE**

**Smart driving**

**PHEV and BEV only**

**HV/48 V/12 V**

**DC-DC**

**Electric Motor**

**Power diodes and thyristors**

**Eos and ESD protection**

**Power Schottky high temperature**

**HV battery disconnect and fire-off system**

**On-board microcontrollers**

**On-board charger (OBC)**

**Battery management system (BMS)**

**Charging station**

**HV battery disconnect and fire-off system**

**Vehicle control unit (VCU)**

**Smart driving**

**FIND OUT MORE**

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

**Battery management system (BMS)**

**Charging station**

**DC-DC converter**

**Electric traction** (Main inverter)

**Mild hybrid 48 V systems**

### Arc 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.

### Industrial welding

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.

ST product offering for industrial welding

<table>
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<tr>
<th>Internal power stage</th>
<th>MOSFET/IGBT gate drivers</th>
<th>IGBTs and power modules</th>
<th>Power MOSFETs</th>
<th>Diodes and protections</th>
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<td>PFC</td>
<td>MO1k STG60D5 STG60M9 STG60M9 STG32D5 STG32M9 STG32M6 STG60D4 Digital controllers STG60D4A</td>
<td>600 V-650 V MOSFETs M9 ST60M9, ST65M9</td>
<td>600 V Ultrafast STTP60DF, STTP60H, STTP706</td>
<td></td>
</tr>
<tr>
<td>DC-DC PFC (low/medium power)</td>
<td>STG60M9 STG60M6 STG60M6 STG32D4 STG32M6 STG32M4 STG60D4 Digital controllers STG60D4A</td>
<td>600 V-650 V MOSFETs M6 ST60M6, ST65M6</td>
<td>1200 V Ultrafast STTP60H, STTP912</td>
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</tr>
<tr>
<td>DC-DC PFC (medium/high power)</td>
<td>STG60M9 STG60M6 STG60M6 STG32D4 STG32M6 STG32M4 STG60D4 Digital controllers STG60D4A</td>
<td>600 V-650 V MOSFETs M2 ST60M2, ST65M2</td>
<td>SiC diodes STPS65V6, STPS12H</td>
<td></td>
</tr>
<tr>
<td>Secondary inverter</td>
<td>STG60M9 STG60M6 STG60M6 STG32D4 STG32M6 STG32M4 STG60D4 Digital controllers STG60D4A</td>
<td>600 V-650 V MOSFETs M1 ST60M1, ST65M1</td>
<td>TVS for power rail surge protection SMITE, SMIC0J, SMIC0JU</td>
<td></td>
</tr>
</tbody>
</table>

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

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**Find out more**

www.st.com/electro-mobility

On-board charger (OBC)

Battery management system (BMS)

Charging station

DC-DC converter

HV battery disconnect and fire-off system

Small electric vehicles

Electric traction (Main inverter)

Mild hybrid 48 V systems
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 electromagnetic compatibility (EMC) challenges, as well as provide fail-safe operation to ensure reliability and safety for the driver and passengers. To help developers increase inverter power efficiency and reduce size and weight, ST has a wide portfolio of discrete semiconductors, including AEC-Q101 qualified silicon and silicon carbide (SiC) MOSFETs and diodes, as well as IGBTs. These are complemented by AEC-Q100 qualified galvanically isolated IGBT and MOSFET gate drivers and SPC5 32-bit automotive microcontrollers for implementing scalable, cost-effective, and energy-efficient solutions. Furthermore, ST offers a compact and high-power-density solutions with the 750 V and 1200 V ACEPACK DRIVE power modules based on SiC Gen3 technology.

Bidirectional DC-DC converter
Electric vehicles (EV) use two different power systems, a high-voltage battery (200 to 800 VDC) 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 DC-DC converter must be bidirectional, and very efficient and highly reliable. ST has a wide offer of discrete semiconductors including AEC-Q101 qualified silicon and silicon carbide (SiC) MOSFETs and diodes, as well as IGBTs. These are complemented by AEC-Q100 qualified galvanically isolated IGBT and MOSFET gate drivers and SPC5 32-bit automotive microcontrollers to enable scalable, cost-effective, and energy-efficient solutions. ST product portfolio has been enlarged with power module family AGG-324 compliant, including ACEPACK DMT-32, ACEPACK 1 and ACEPACK 2 with SiC power switches.

Typical block diagram - main inverter

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. It therefore 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 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.

ST product portfolio has been enlarged with power module family AQG-324 compliant, including ACEPACK DMT-32 with SiC power switches.

48 V 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 of 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.

ST product portfolio has been enlarged with power module family AQG-324 compliant, by including ACEPACK DMT-32 with SiC power switches.
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)
- **Battery thermal management** to drive resistive loads to maintain optimal temperature of battery pack in any environmental condition and so optimize efficiency and lifetime

A discharge circuit is present using an HV power MOSFET (MDmesh K5 AG) working in linear mode to discharge the battery in case of malfunctioning or accident. Battery thermal management is improved by using IGBT 1200 V MS series (GW1A0MS120DF4AG) 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 150 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.

We also provide eDesignSuite - Digital power workbench SW design tool.

### Typical block diagram - DC fast charging station

![Typical block diagram - DC fast charging station](image)

### Main application boards and reference designs

- **STDES-PFCBIDIR**: 15 kW, three-phase, three-level active front-end (AFE) bidirectional converter
- **STDES-DABDIDIR**: 25 kW dual active Bridge (DAB) bidirectional power converter for EV charging and BESS
- **STDES-RECTFD**: 15 kW, three-level, three-phase Vienna rectifier with digital control for power factor correction
- **STDES-30KWREICT**: 30 kW Vienna PFC rectifier reference design with digital control

### ST product offering for DC Fast charging Station

<table>
<thead>
<tr>
<th>Component</th>
<th>DC-DC</th>
<th>Control units</th>
<th>Driving stage</th>
<th>Current sensing and signal conditioning</th>
<th>E-car connectivity</th>
</tr>
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<tbody>
<tr>
<td>Rectifiers</td>
<td>3phase</td>
<td>150 kW</td>
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<td>Voltage regulators</td>
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![Typical block diagram - DC fast charging station](image)

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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 offers a wide portfolio of highly-integrated high-voltage converters for applications up to 100 W, with an extremely low total standby consumption (down to less than 4 mW) and breakdown voltages as high as 1050 V. In addition to PWM switching controllers, power MOSFETs, and diodes, we offer an extensive set of evaluation tools, as well as DesignSuite SW design tool to help engineers develop high-efficiency and compact auxiliary power supply solutions.

### 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 supply’s duty-cycle.

ST helps the designers of high-power-density and cost-effective isolated auxiliary power supplies with higher switching frequency 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.

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

<table>
<thead>
<tr>
<th>HV converters</th>
<th>HV Power MOSFETS</th>
<th>Voltage Ref</th>
<th>Output diodes</th>
<th>Synch Rect</th>
<th>LDO</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSR-CV</td>
<td>VIPerGaN100</td>
<td>STH*06</td>
<td>160 V Trench Schottky, FERD*06</td>
<td>Low dropout (LDO) linear regulators LDF, LDFM, LDK220, LDK330, LLD212, ST230, ST232</td>
<td></td>
</tr>
<tr>
<td>Non-isolated flyback</td>
<td>VIPerGaN50, VIPer<em>5, VIPGaN</em>5</td>
<td>800 V to 1200 V Ultrafast STTH<em>06, STTH</em>10, STTH*12</td>
<td>SEPIC<em>600 100 V Trench Schottky STPST</em>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isolated flyback</td>
<td>VIPer<em>7, VIPer</em>8</td>
<td>5 V/1.2 A isolated SSR</td>
<td>SEPIC 5 V/1.2 A non-isolated STEVAL-VP22201B</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Typical configurations for Non-Isolated auxiliary power supply

- **Buck Converter**
- **Buck-Boost Converter**
- **PWM Controller**
- **IC Supply & Feedback**
- **Flyback Converter**
- **Main application boards**

### Main application boards and reference designs

- **STEVAPL-VP2201B**
- **STEVAPL-VP319X1B**
- **STEVAPL-VP22201B**
- **STEVAPL-ISA196V1**

Note: * is used as a wildcard character for related part number.
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 digital enabling a faster and more efficient charging solution.

The new slim and reversible USB Type-C™ connector with USB power delivery (PD) feature provides up to 240 W (48 V, 5 A)

**ST recommended products for USB Type-C power delivery smart chargers and adapters**

<table>
<thead>
<tr>
<th>Power stage primary side</th>
<th>Fully integrated controller</th>
<th>Secondary controller</th>
<th>Power stage secondary side</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Controller</td>
<td>Integrated smart GaNs</td>
<td>HV MOSFET</td>
<td>Diodes</td>
</tr>
<tr>
<td>ST-ONE ST-OHMP</td>
<td>STUSB1602A</td>
<td>STM32F3</td>
<td>5V</td>
</tr>
<tr>
<td>ST-ONE ST-OHMP</td>
<td>STUSB1602A</td>
<td>STM32F3</td>
<td>9V</td>
</tr>
<tr>
<td>All STM32 and STM (5 V only)</td>
<td>STMicroelectronics with UCPD</td>
<td>STM32L0, STM32L0A, STM32L0A</td>
<td>15V</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STM32L0A</td>
<td>20V</td>
</tr>
</tbody>
</table>

**Typical configuration**

- **Primary controller**
  - Integrated smart GaNs
  - HV MOSFETs
  - Diodes

- **Secondary controller**
  - LV MOSFETs
  - Diodes

**Main application boards and reference designs**

- **EVLONE55W**
  - 55 W USB Type-C™ power delivery reference design with integrated GaN

- **EVLONE140W**
  - 140 W USB-PD 1.1 compliant reference design with integrated GaN and GaN HV converter

- **EVLONEMP**
  - Very high density 65 W multi-port (USB Type-C™ and USB Type-A) power delivery with integrated GaN

**Main application boards and reference designs**

- **STEVAL-ISC004V1**
  - STUSB47 USB power delivery evaluation board (with on-board DC-DC)

- **STEVAL-2STPD01**
  - USB Type-C™ power delivery dual port adapter

- **EVAL-SCS001/2V1**
  - 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 TCP01-M18

- **X-NUCLEO-SNK1M1**
  - USB Type-C™ power delivery sink separation board based on TCP01-M12

- **X-NUCLEO-DRP1M1**
  - USB Type-C™ power delivery dual role power separation board based on TCP01-M13
Automotive-grade USB Type-C and power delivery solution
The USB Type-C port and 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 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

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) in working transition mode (TM) followed by a flyback, forward, or half-biased 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 StrFET 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

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

Typical block diagram with PFC front-end

Main application boards and reference designs

Note: EU CoC ver. 5 Tier 2 and EUP Lot 6 Tier 2 compliance ensured
Wireless charging

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). This can be done using devices 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 to the receiving coil (RX). Generating the correct amount of power required by the receiving coil is achieved by implementing an intelligent control scheme that enables adaptation to load variation to minimize power consumption, together with optimized heat management during operation. It is recommended to add an NFC Reader or a tag (ST Reader ICs can detect Type A, B, F, or V NFC cards) and therefore instruct the operating system to stop transmitting power.

ST also offers evaluation and development tools and reference designs to help developers with accurate foreign object detection (FOD) and reverse power injection. In order to prevent unwanted damage to any NFC cards that might be close to the wireless charging source during operation, it is recommended to add an NFC Reader. The NFC Reader is able to detect the presence of the NFC card or tag (ST Reader ICs can detect Type A, B, F, or V NFC cards), and therefore instruct the operating system to stop transmitting power.

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

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Server and telecom power

AC-DC PSU and DC-DC power distribution

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

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

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

Typical block diagram for server PSU
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.

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

![Typical configuration for 48 V isolated direct conversion](Image)

![SSD power management](Image)

Note: * is used as a wildcard character for related part number
Power over Ethernet (PoE)

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

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

Typical block diagram for PoE power management

Main application boards and reference designs

- **STEVAL-POE001V1**
  - Power over Ethernet (PoE) - IEEE 802.3af compliant interface

- **STEVAL-POE002V1**
  - 5 V/8 A, synchronous flyback converter, power over Ethernet (PoE) IEEE 802.3af compliant reference design

- **STEVAL-POE005V1**
  - 12 V/3 A, active clamp forward converter, power over Ethernet (PoE) IEEE 802.3af compliant reference design

- **STEVAL-POE006V1**
  - 3.3/20 A, active clamp forward converter, power over Ethernet (PoE) IEEE 802.3af compliant reference design
LED TV power supply

Beyond their outstanding image quality, new-generation televisions have a very thin form factor. To achieve these stringent requirements, PSUs typically have a power factor corrector (PFC) stage and use advanced topologies like half-bridge LLC (HB-LLC) resonant. ST offers a broad portfolio of high-voltage MDmesh and low-voltage STripFET power MOSFETs, field-effect rectifier diodes (FERD), Schottky and Ultrafast diodes, a full range of protection ICs, as well as dedicated analog and digital switching controllers, which negate the necessity of auxiliary power by consuming very low power at no load. In addition, STM32 microcontrollers enable developers to exploit the full potential of digital PSU implementations.

**ST recommended products for LED TV power supply**

<table>
<thead>
<tr>
<th>Input rectifier</th>
<th>SCR</th>
<th>PFC Block</th>
<th>Isolation stage</th>
<th>Controllers</th>
<th>Power MOSFETs</th>
<th>Diodes</th>
<th>Op-amp VS sensing</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM analog controllers</td>
<td>L6982A*, L6983*, L6984*</td>
<td>L6985, L6986, L6987*, L6994</td>
<td>MCUs and digital controllers</td>
<td>STM3020, STM3025, STM32F301, STM32F304, STM32G0, STM32G0A4</td>
<td>650 V GaN GaN ST*60GAL</td>
<td>600 V ultrafast for TM</td>
<td>STTH<em>K06</em></td>
</tr>
<tr>
<td>FIEC controllers</td>
<td>TM analog controllers</td>
<td>L6986A, L6986B, L6987, L6988, L6989, STC963</td>
<td>PFC and LLC Flyback controllers</td>
<td>STM031, STM032, STM033, STM3120, STM32F304, STM32G0A4</td>
<td>650 V GaN GaN ST*65GAL</td>
<td>600 V ultrafast for TM</td>
<td>STTH<em>K06</em></td>
</tr>
<tr>
<td>LLC analog controllers</td>
<td>L6995, L6996</td>
<td>Asymmetrical HB controllers</td>
<td>L6981</td>
<td>SR9100, SR9101, SR9104</td>
<td>650 V GaN GaN ST*65GAL</td>
<td>600 V ultrafast for TM</td>
<td>STTH<em>K06</em></td>
</tr>
</tbody>
</table>

**Typical block diagram for analog control solutions with no Aux supply, for small/medium panel size**

**Typical block diagram for digital control solutions for medium/large panel size**

**Main application boards and reference designs**

**Typical block diagram for analog control solutions for small panel size**
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

ST product offering for switching converters (DC-DC)
Typical block diagram of a medical power supply for artificial ventilators

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 modes. Often, the backup battery is part of the power supply to guarantee continuity of operation when the main supply is interrupted.

Main evaluation boards

STEVAL-ISA203V1
- Input voltage range: 42 - 56 V DC
- Switching frequency: 250 kHz
- Output: 60 W
- Voltage: 12 V DC
- Current: 5 A
- Peak efficiency > 94%

STEVAL-ISA204V1
- Input voltage range: 42 - 56 V DC
- Switching frequency: 250 kHz
- Output: 100 W
- Voltage: 5 V DC
- Current: up to 20 A
- Peak efficiency > 94%

Typical 48 Vin, up to 65 W Pout, synchronous flyback configuration

Typical 48 Vin, > 65 W Pout, active clamp forward configuration

Main application boards and reference designs

EVL6564-100W
100 W transition-mode PFC pre-regulator

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

STEVAL-L7983ADJ
12 V to 3.3 V step down DC-DC converter (VIN = 12 to 56 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 eDesignSuite SW design tool to help developers design high-efficiency LED lighting solutions.

Typical block diagram
ST product offering for LED general illumination

<table>
<thead>
<tr>
<th>Controllers and converters</th>
<th>Power MOSFETs</th>
<th>Diodes</th>
<th>MOSFET and IGBT gate drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offline LED drivers</td>
<td>VQFP44, VQFP64</td>
<td>VQFP64, VQFP100</td>
<td>Single LS gate drivers</td>
</tr>
<tr>
<td>STM32F0, STM32G0, STM32L0</td>
<td>VQFP44, VQFP64</td>
<td>VQFP64, VQFP100</td>
<td>Single LS gate drivers</td>
</tr>
<tr>
<td>RCC controllers</td>
<td>VQFP44, VQFP64</td>
<td>VQFP64, VQFP100</td>
<td>Single LS gate drivers</td>
</tr>
<tr>
<td>STM32F0, STM32G0, STM32F3</td>
<td>VQFP44, VQFP64</td>
<td>VQFP64, VQFP100</td>
<td>Single LS gate drivers</td>
</tr>
</tbody>
</table>

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 transformations 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

Main application boards

- **EVLH010PSR50W**: High power invasive buck for standalone LED application with SiC
- **EVLH010SSR50W**: High power invasive buck for standalone LED application with SiC
- **EVL012V**: 250 W LED driver (CCM) with digital control
- **STEVAL-LLL004V1**: 75 W AC-DC digitally controlled non-isolated constant current LED driver
- **EVL0150-HVSL**: 150 V - 1 A LED driver featuring TM PPC and LLC resonant converter with analog combo controller
- **EVL0669-HVSL**: 150 V - 1 A LED driver featuring TM PPC and LLC resonant converter with analog combo controller
- **STEVAL-ILL066V2**: 100 W LED street lighting with DALI2.0 communication interface using the STLG3351A digital controller
- **STEVAL-LLL009V1**: 300 W very high AC input voltage LED driver with digital power control
**ST product offering for LED street lighting**

<table>
<thead>
<tr>
<th>Controllers</th>
<th>Power MOSFETs</th>
<th>Diodes and protections</th>
<th>MOSFET and IGBT gate drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM PFC analog controllers</td>
<td>600 V NMOS; DM8 STN6DM8</td>
<td>600 V Ultralow for TM PFC</td>
<td>Hi-EB gate drivers for GaNs</td>
</tr>
<tr>
<td>L6592, L6593*, L6594*</td>
<td>600 V NMOS DM8 STN6DM8</td>
<td>STT6006</td>
<td>STW-MM000</td>
</tr>
<tr>
<td>DC-DC PFC analog controllers</td>
<td>600 V NMOS NM8 STN6NM8</td>
<td>600 V Ultralow for CM PFC</td>
<td>Single LS gate drivers</td>
</tr>
<tr>
<td>L4985, L4986, L4987*, L4988*</td>
<td>600 V NMOS DC8 STN6DC8</td>
<td>STT6008</td>
<td>PM6184</td>
</tr>
<tr>
<td>Offline LED drivers</td>
<td>600 V NMOS DC8 STN6DC8</td>
<td>SC diodes</td>
<td>Multiple LS gate drivers</td>
</tr>
<tr>
<td>HLED101, HLED101B, HLED1001, HLED1002, HLED1007</td>
<td>600 V NMOS DC8 STN8DC8</td>
<td>STT6009</td>
<td>PM6184</td>
</tr>
<tr>
<td>PFC and LLC/LCC Combo controllers</td>
<td>600 V NMOS DC8 STN6DC8</td>
<td>Output diodes for flyback</td>
<td>H/IV gate drivers</td>
</tr>
<tr>
<td>STCM1, STMRG011, STM8012</td>
<td>800 V NMOS K8 STN8K8</td>
<td>Schmitt, FERD, ultrast, SPI</td>
<td>LED*</td>
</tr>
<tr>
<td>LLC/LCC controllers</td>
<td>950 V NMOS K8 STN9K8</td>
<td>Clamp, FERD, STIWN</td>
<td>Isolated gate drivers</td>
</tr>
<tr>
<td>L6999*, L6999</td>
<td>950 V NMOS K8 STN9K8</td>
<td>Voltage reference</td>
<td>STAP*</td>
</tr>
<tr>
<td>MCUs and digital controllers</td>
<td>1000 V NMOS K8 STN10K8</td>
<td>Voltage and current Ctrl</td>
<td>Voltage reference</td>
</tr>
<tr>
<td>STM32F0, STM32G0, STM32F301</td>
<td>950 V NMOS K8 STN9K8</td>
<td>STM*, SEA0*</td>
<td>T52*, T57*, T58*, T59*, T59*</td>
</tr>
<tr>
<td>STM32F301, STM32M204, STM32N388A</td>
<td>950 V NMOS K8 STN9K8</td>
<td>DC/DC boost LED drivers</td>
<td>GaN power ICs</td>
</tr>
<tr>
<td>SR analog controllers</td>
<td>950 V NMOS K8 STN9K8</td>
<td>LED array drivers</td>
<td>Integrated Smart GaN</td>
</tr>
<tr>
<td>SRK1001, SRK1002, SRK1014 for flyback</td>
<td>950 V NMOS K8 STN9K8</td>
<td>DC-DC boost LED drivers</td>
<td>N117S49</td>
</tr>
<tr>
<td>SRK2000A, SRK2001</td>
<td>950 V NMOS K8 STN9K8</td>
<td>LED array drivers</td>
<td>GaN power ICs</td>
</tr>
<tr>
<td>SR analog controllers</td>
<td>950 V NMOS K8 STN9K8</td>
<td>DC-DC boost LED drivers</td>
<td>Integrated Smart GaN</td>
</tr>
<tr>
<td>STM32F103</td>
<td>950 V NMOS K8 STN9K8</td>
<td>LED array drivers</td>
<td>N117S49</td>
</tr>
<tr>
<td>STM32F334, STM32G4</td>
<td>950 V NMOS K8 STN9K8</td>
<td>LED array drivers</td>
<td>GaN power ICs</td>
</tr>
<tr>
<td>STM32F103</td>
<td>950 V NMOS K8 STN9K8</td>
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<td>950 V NMOS K8 STN9K8</td>
<td>LED array drivers</td>
<td>Integrated Smart GaN</td>
</tr>
</tbody>
</table>

**Power supply**

- **Control unit**
  - STM32F0
  - STM32G0
  - STM32F301
  - STM32M204
  - STM32N388A
- **Protection switches**
  - STM32F0
  - STM32G0
  - STM32F301
  - STM32M204
  - STM32N388A
- **Diodes and discrete**
  - STM32F0
  - STM32G0
  - STM32F301
  - STM32M204
  - STM32N388A
- **LED bypass**
  - STM32F0
  - STM32G0
  - STM32F301
  - STM32M204
  - STM32N388A

**Temperature sensors**

- STM32F0
- STM32G0
- STM32F301
- STM32M204
- STM32N388A

**LED driver**

- Offline LED drivers
  - HLED1002

**Connectivity**

- Power Line transceivers
  - STS730, STS731

**LED POE lighting**

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

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

**Typical block diagram**

**ST product offering for LED PoE lighting**

<table>
<thead>
<tr>
<th>PoE Interface</th>
<th>Protections</th>
<th>Auxiliary power supply</th>
<th>LED driver</th>
<th>Bluetooth LE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.3af</td>
<td>PM8800A</td>
<td>PD power rail surge protection</td>
<td>STP40A/60A/624 STSD*</td>
<td>Bluetooth Low Energy</td>
</tr>
<tr>
<td>IEEE 802.3at</td>
<td>PM8805</td>
<td>SM15T</td>
<td>STPS* L7983</td>
<td>BlueNRG*</td>
</tr>
<tr>
<td>IEEE 802.3bt</td>
<td>PM8806A</td>
<td>STSD*</td>
<td>FERD* STP40A/60A/624</td>
<td>BlueNRG*</td>
</tr>
</tbody>
</table>

**LED POE Lighting**

- 48 V PoE interface
- 48 V

**LED Driver**

- 48 V

**Auxiliary PS**

- Low energy

**BlueNRG**

- Bluetooth Low Energy

**Main application boards**

- STEVAL-POEL45W1
  - 45 W PoE powered LED lighting with BLE control
- STEVAL-ILL078V1
  - 48 V 48 V
- STEVAL-ILE056V1
  - 48 V 48 V
- STEVAL-ILL078V1
  - Bluetooth LE
- STEVAL-ILL056V1
  - Bluetooth LE
- STEVAL-ILL056V1
  - Bluetooth LE

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

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

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

DALI lighting solution

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

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

Typical block diagram for DALI lighting system

ST product offering for lighting controls

LED driver

- Power management
- KNX Transceiver

Digital controllers
- STLUX
- Development tools
- STM8:STLLUXBUS2, STW:STLLUXBUDD2

Embedded software
- STM:STM32L1, STM8

MCU
- STM32F1, STM32L1, STM8

Typical block diagram for DALI lighting system

85-305 V (AC)

3.3 V

48 V (DC)

Main application boards

- STEVAL-ILL066V2
- STEVAL-ILM001V1
- EVALKITSTKNX

ST product offering for LED wireless programming

LED wireless programming

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

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

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

Typical block diagram of LED wireless programming

13.56 MHz electromagnetic field

ST product offering for LED wireless programming

Main application boards

- ST25R3911B-DISCO
- ST25DV-PWM-eSET
- ST25DV64KC-DISCO
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 a difference in a challenging and competitive market.

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

Typical block diagram of a smart watch

MAJOR HOME APPLIANCES

Refrigeration, washing, drying, and miscellaneous equipment

The white goods market requires low-cost and high-energy-efficiency solutions. The refrigeration, washing, drying, and miscellaneous (air conditioner, water heater) equipment is some of the major home appliance applications that ST is able to satisfy with various power products and high-performance STM32 microcontrollers, along with complementary gate drivers (L638* and L649*). High-efficiency PFC is guaranteed using our SiC diodes (STPS5C*), new high-voltage MDmesh MOSFETs, or field stop trench-gate IGBTs. To reach the 3-phase inverter design effort, ST offers the SLUNLM family (small low-loss intelligent molded module) of highly-integrated, high-efficiency intelligent power modules (IPM) integrating the power stage (both on IGBT and MOSFET discrete), driving network, and protections. Another approach for designing a 3-phase inverter is based on the use of six discrete IGBT MOSFETs with the new STDRI/VE601 3-phase gate drivers. High robustness against inrush current is ensured by new SCRs in the front-end stage. The STPW programmable electronic power breaker family provides a convenient and integrated solution for quickly and safely disconnecting a fault load from a 12 V bus.

ST product offering for refrigeration, washing, drying, and miscellaneous equipment

<table>
<thead>
<tr>
<th>Rect. and inrush current limiter</th>
<th>Diodes</th>
<th>IGBTs</th>
<th>User Interface</th>
<th>HV converters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power MOSFETs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power breakers</strong></td>
<td></td>
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<tr>
<td><strong>PFC</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>MOSFET and IGBT gate drivers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Post regulation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * is used as a wildcard character for isolated port number

Typical configuration

Main application boards and reference designs

STEVAL-PS03A02
Evaluation board based on the STPS02 400 mA iSOS-08 synchronous step-down converter with digital voltage selection

STEVAL-PS03A03
Evaluation board based on the STPS03A 400 mA iSOS-08 synchronous step-down converter with load switch

STEVAL-PS03A04
Evaluation board based on the STPS04A 400 mA iSOS-08 synchronous step-down converter with load switch

STEVAL-PS03A05
Evaluation board based on the STPS05A 400 mA iSOS-08 synchronous step-down converter with load switch

STEVAL-PS03A06
Evaluation board based on the STPS06A 400 mA iSOS-08 synchronous step-down converter with load switch

STEVAL-PS03A07
Evaluation board based on the STPS07A 400 mA iSOS-08 synchronous step-down converter with load switch

STEVAL-PS03A08
Evaluation board based on the STPS08A 400 mA iSOS-08 synchronous step-down converter with load switch

Note: * is used as a wildcard character for isolated port number

Typical board layout of a smart watch

Main application boards

STEVAIL-HT008V1
3 kVA digital inrush current limiter based on TEC

STEVAIL-HV008M
3 kVA iPS-08 inrush current limiter based on iLIMM™
## 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 efficiency converters. ST also offers environmental sensors and LED diodes that, together with a selection of high-voltage gate drivers and lower levels of electro-magnetic interferences (EMI).

The power converter in these appliances as they also help achieve lower levels of electro-magnetic interferences (EMI).

### ST product offering for induction cooking

<table>
<thead>
<tr>
<th>ST product offering for induction cooking</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Note: * is used as a wildcard character for related part number</td>
<td></td>
</tr>
<tr>
<td><strong>Power Switch</strong></td>
<td></td>
</tr>
<tr>
<td>STM8, STM32F0, STM32G0</td>
<td></td>
</tr>
<tr>
<td>STM32F4, STM32F7</td>
<td></td>
</tr>
<tr>
<td><strong>Gate drivers</strong></td>
<td></td>
</tr>
<tr>
<td>Multi gate-drivers PMB5834</td>
<td></td>
</tr>
<tr>
<td>Single LS gate-drivers PMB581</td>
<td></td>
</tr>
<tr>
<td><strong>Sensors</strong></td>
<td></td>
</tr>
<tr>
<td>Environmental sensors - STSHM03</td>
<td></td>
</tr>
<tr>
<td><strong>NFC</strong></td>
<td></td>
</tr>
<tr>
<td>STS5R316, STS5R318</td>
<td></td>
</tr>
</tbody>
</table>

### User interface example

<table>
<thead>
<tr>
<th>User interface example</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bridge Rectifier</td>
<td></td>
</tr>
<tr>
<td>Filter</td>
<td></td>
</tr>
<tr>
<td>Power Management</td>
<td></td>
</tr>
<tr>
<td>Linear Voltage Regulators</td>
<td></td>
</tr>
<tr>
<td>AC-DC</td>
<td></td>
</tr>
<tr>
<td>DC-DC</td>
<td></td>
</tr>
</tbody>
</table>

### Topology example

<table>
<thead>
<tr>
<th>Inverter Stage and Resonant tank</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Switch Plate</td>
<td></td>
</tr>
<tr>
<td>MOS / IGBT Drivers</td>
<td></td>
</tr>
</tbody>
</table>

### Power management

<table>
<thead>
<tr>
<th>Power management</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>VIPerPlus L9898, L7983, L7985, L7986, L7987</td>
<td></td>
</tr>
<tr>
<td>L698*, L7983, L7986, L7987</td>
<td></td>
</tr>
<tr>
<td>ST25R3916, ST25R3918</td>
<td></td>
</tr>
</tbody>
</table>

### Software tools

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

**eDesignSuite - power management design center**

eDesignSuite is a comprehensive and flexible suite of design aids 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 accelerate 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 designer.

### POWER SUPPLY DESIGN TOOL

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

### LED LIGHTING DESIGN TOOL

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

### DIGITAL POWER WORKBENCH

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

### POWER TREE DESIGNER

- **Characterize each node in the tree**
- **Check for consistency**
- **Design each individual node**

**eDsIm** is a fast and powerful electrical simulation tool for SMPS and analog ICs integrated in the eDesignSuite tool. It features enhanced accuracy and higher convergence speed for SMPS, enabling a simulation time 10-50x faster than the classic analog SPICE simulators. Design your analog circuit using the eDesignSuite engine, display a preview with full annotated schematic and BOM, and then run the electrical simulation through eDsIm to get fast and accurate simulations and reliable design validation, thus reducing the effort and risks related to hardware prototyping. With the eDsIm tool, you can also create your schematic from scratch using ST models or simulate your SMPS and analog ICs from a list of predefined ST application schematics-test benches, that you can partially modify according to your needs.
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 offers 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
- No investment to learn GaN required
- Frequency >1 MHz
- Interlocking function
- Dynamic blanking
- 45 ns short propagation delay
- Embedded gate driver easily supplied by the integrated bootstrap diode
- Frequency jitter for EMI suppression
- Input voltage feedback compensation for mains independent OPP variation
- Very low parasitic inductance package technology
- Reduced power losses and passive device size

**PowerGaN**

ST is expanding its STPOWER power transistor family with the PowerGaN G-HEMT family. GaN (gallium nitride) is a wide-bandgap semiconductor material capable of supporting higher voltages than traditional silicon without compromising on-resistance and thus reducing conduction losses. Products developed in gallium nitride technology can be switched much more efficiently, resulting in significant switching loss reduction. These devices feature higher frequency operation, with improved power density to allow the reduction of the size of passive components in power conversion applications.

**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, a small QFN6x6 package. The VIPerGaN series offers excellent design opportunities for compact and light fast chargers, adapters, and power supplies up to 100 W with a wide input range.

**MAIN APPLICATIONS**
- USB PD adapter
- Air conditioning
- TV power supply
- Home appliances
- Server and telecom power
- Smart chargers and adapters
- GBC
- Energy generation and distribution
- Led lighting

**Main Applications**

- **USB PD adapter**
- **Air conditioning**
- **TV power supply**
- **Home appliances**
- **Server and telecom power**
- **Smart chargers and adapters**
- **GBC**
- **Energy generation and distribution**
- **Led lighting**

**Gallium Nitride (GaN) Power ICs and discrete GaN drivers**

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.

**KEY FEATURES AND BENEFITS**
- Accurate internal timing match
- High side
- Low side
- Supported topologies
- Integration
- Resonant, ACF
- Quasi-resonant (QR)
- High-voltage GaN converters – VIPerGaN series

**Table of GaN drivers**

<table>
<thead>
<tr>
<th>Part number</th>
<th>General description</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>STDRIVEG600</td>
<td>High voltage and high-speed half-bridge gate driver for GaN transistors</td>
<td>50-16</td>
</tr>
<tr>
<td>STDRIVEG600TR</td>
<td>High voltage and high-speed half-bridge gate driver for GaN transistors</td>
<td>50-16</td>
</tr>
<tr>
<td>STDRIVEG600WR</td>
<td>High voltage and high-speed half-bridge gate driver for GaN transistors</td>
<td>Wafer</td>
</tr>
</tbody>
</table>

**Table of GaN devices**

<table>
<thead>
<tr>
<th>Part number</th>
<th>VDS</th>
<th>RDS(max)</th>
<th>ID</th>
<th>Series</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGD1R0865AL</td>
<td>650 V</td>
<td>65 mΩ</td>
<td>25 A</td>
<td>G-HEMT</td>
</tr>
<tr>
<td>SGD12R0865AL</td>
<td>650 V</td>
<td>120 mΩ</td>
<td>15 A</td>
<td>G-HEMT</td>
</tr>
</tbody>
</table>
AC-DC CONVERSION ICs

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

ST-ONE (single USB port) and ST-ONE MP (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.

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 VIPer1, VIPer5, VIPer6, VIPer7, VIPer8 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 VIPer1 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 VIPer6 family and integrates a 1050 V avalanche-rugged power MOSFET, suitable for cost effective 1-phase/3-phases smart meters, industrial systems, and lightning 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.
PFC controllers

ST power factor correction (PFC) controllers operate in transition mode (TM, suitable for P ≤250 W) and continuous current mode (CCM, suitable for P >250 W), and are suitable for wide-range mains operation. These devices embed advanced protection features, which make the SMPS more robust and compact, requiring fewer external components. These features include output overvoltage, brown-out, feedback disconnection, and boost inductor saturation protection. The high-voltage start-up capability present in the L6564H and L6563H helps improve the SMPS standby efficiency in systems that do not include an auxiliary power supply.

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

MAIN APPLICATIONS

Adapters and TVs
L6562A*, L6563*, L6564, L4985, L4986
Commercial and street lighting
L6562A*, L6563*, L6564*, L4985, L4986, L4981*, L4984D
Desktop PCs and Server
L4985, L4986, L4981*, L4984D

PWM and resonant controllers

ST portfolio of advanced controllers includes a variety of primary controllers intended to fit high-performance applications. Very high efficiency is achieved with single-ended topologies at a fixed switching frequency or with quasi-resonant operation. The new STCH03 offline constant-current primary-side regulation controller (PSR-CC) guarantees very low power consumption in no-load condition. For high-power, high-current applications, ST offers controllers for bridge-half resonant and asymmetrical half-bridge topologies. The STCM81 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.

MAIN APPLICATIONS

Tablets and smartphones
L6565, L6566*, STCH03
Laptops
L6565, L6566*, STCH03, STCM1
High-power adapters and TVs
L6565, L6566*, L6599*, L6699, STCM1
Desktop PCs, commercial, and street lighting
L6599*, L6699, STCM1

STCM81

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

Asymmetrical half-bridge controller

STNRG012

• Ultra-low start-up current
• Ultra-low start-up current
• Ultra-low start-up current

STCH03

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

STNM091

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

L6564

Line-modulated, fixed-off-time (LM-FOT) control

L6564* L6566* L6563*

L6563*

Fixed frequency, average-current mode

L4981A

Line modulated frequency, average-current mode

L4981B

Quasi-fixed frequency, peak-current mode

L4985A/B

Quasi-fixed frequency, peak-current mode, adjustable PGOOD

L4986A/B

www.st.com/ac-dc-converters
www.st.com/pfc-controllers
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.

**Synchronous rectification benefits**

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

**SR controllers for flyback**

<table>
<thead>
<tr>
<th>Basic features</th>
<th>DVS</th>
<th>AMR</th>
<th>Programmable blanking times after toff</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRK1000</td>
<td></td>
<td>100 V • Fixed (3 PIN available to cover 3 different values)**</td>
<td>SOT23-6L•</td>
<td></td>
</tr>
<tr>
<td>SRK1001</td>
<td>185 V • Fixed (4 PIN available to cover 2 values and logic or standard level MOSFETs)**</td>
<td>SG8•</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRK1004</td>
<td>185 V • Fixed (2 different values)**</td>
<td>DFN 2x2•</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**SR controllers for LLC resonant**

<table>
<thead>
<tr>
<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 &quot;current inversion comparator&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRK2000A</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>SRK2001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRK2001A</td>
<td></td>
<td></td>
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<td></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

**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

- **TSC200**
  - Operating voltage -16 to 80 V
  - Amplification gain x20
  - Comparator +Vref embedded
  - Package SO8, Minis08

**Comparators**

- **TS3021, TS3022**
  - Propagation delay 38 ns
  - Low current consumption: 73 µA
  - Rail-to-rail inputs
  - Push-pull outputs
  - Supply operation from 1.8 to 5 V

- **TS3011**
  - Propagation delay 8 ns
  - Low current consumption 470 µA
  - Rail-to-rail inputs
  - Push-pull outputs
  - Supply operation from 2.2 to 5 V

**Main applications**

- **High-power adapters and TVs**
- **Desktop PCs and Server/Telecoms**
- **Wireless battery charger transmitters**
- **Server/Telecom**
- **Solar**
- **UPS**
- **Lighting**
- **Factory automation**

**Main applications**

- **Wireless battery chargers and transmitters**
- **Server/Telecom**
- **Solar**
- **UPS**
- **Lighting**
- **Factory automation**

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

**www.st.com/ac-dc-converters**
**www.st.com/synchronous-rectification-controllers**

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

**www.st.com**
STWLC99
Ultra low power for ThinFilm
Active object
STWLC38
STWLC98
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 as low as 10 mA up to 1.0 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>Device</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>STC4054</td>
<td>Linear charger for Li-Ion and Li-Polymer battery packs</td>
</tr>
<tr>
<td>0.8</td>
<td>STC4054</td>
<td>Linear battery charger</td>
</tr>
<tr>
<td>0.65</td>
<td>STBC02</td>
<td>Linear battery charger</td>
</tr>
<tr>
<td>0.45</td>
<td>STBC02</td>
<td>Linear battery charger</td>
</tr>
<tr>
<td>0.2</td>
<td>STB501</td>
<td>Linear battery charger</td>
</tr>
<tr>
<td>0.04</td>
<td>STBC15</td>
<td>Linear battery charger</td>
</tr>
</tbody>
</table>

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

STC3117
• Programmable low battery alarm
• Internal temperature sensor

MAIN APPLICATIONS
- Bluetooth accessories STC4054
- USB L6924U, STC4054, STBCFG01
- Fitness STNS01, STBC02, STBC03
- Smartphones STBCFG01, STC3115, S3T3117

Wireless charging ICs
ST fully covers wireless charging applications with dedicated ICs for both transmitter and receiver. The STWB, compatible with Qi standard, and the STWB2C86 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
STWB2C2-HP
• Supports applications up to 70 W
• Qi 1.3 compatible
• Qi certified reference design with MP-A2 topology and supports MP-A23

STWB2C86
• 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

STWB2C2-HP
• Supports applications up to 70 W
• Qi 1.3 compatible
• Supports up to 15 W Rx for Qi extended power profile
• Supports up to 5 W Rx for Qi baseline power profile

STWB2C86
•Qi 1.3 compatible
• Supports up to 70 W (STWB2C86)
• Supports up to 15 W (STWB2C98)
• Supports up to 25 W (STWB2C99) in Tx mode
• Embedded OS for Qi 1.3 standalone certification (STWB2C98)

You can also refer to the detailed technical specifications in the STMicroelectronics datasheets for more information.
DC-DC SWITCHING CONVERSION ICs

DC-DC controllers
ST offers a wide portfolio of DC-DC switching controllers for server and telecom applications according to market requirements: single-phase controllers with embedded drivers, advanced single-phase controllers with embedded non-volatile memory (NVM), and our newest controllers with or without SPS (Smart power stage) compatibility, as well as multiphase digital controllers for CPU and DDR memory power supplies. The newest L3751 controller ensures high reliability in industrial applications with high Vdrop and robotics with potential high voltage spikes due to inductive loads.

Single-phase Buck controllers
- **L6726A**: Single-phase cost effective PWM controller
- **A6727**: Single-phase cost effective PWM controller for automotive applications
- **PM6680**: Dual-output PWM controller up to 36 Vin
- **L3751**: Wide 6 to 75 V input voltage synchronous buck controller

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

Single-phase buck-boost controller
- **STPM802**: Single-phase synchronous buck-boost controller

**MAIN APPLICATIONS**

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

*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 off</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>
<td>Default output voltage (V)</td>
<td>Default output voltage (V)</td>
</tr>
<tr>
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<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>LD02</td>
<td>1.8</td>
<td>1.8</td>
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<td>LD03</td>
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<td>LD04</td>
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<td>3.3</td>
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<tr>
<td>LD05</td>
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<td>LD06</td>
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<td>REFDDR</td>
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<td>BUCK2</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

### MAIN APPLICATIONS

- **Home automation**
- **Industrial control**
- **POS terminals**
- **Networking**
- **Medical monitoring**

---

**Diagram:**

- **VDD2**
- **VDD**
- **VCC**
- **I2C & control signals**
- **LPDDR2/3**
- **DDR3/DDR3L**
- **VTT**
- **VDDQ_DDR**
- **VDDCORE**
- **VDDPLL**
- **PMIC CONTROL:**
  - I2C
  - INTn
  - WAKEUP
  - POWER ON
  - RESETH

---

**Main Components:**

- **STPMIC1**
  - Boost
  - Pwr SW1
  - Pwr SW2
  - BUCK4
  - BUCK5
  - BUCK6
  - LD01
  - LD02
  - LD03
  - LD04
  - LD05
  - LD06

---

**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 guarantee high reliability, safety, and BOM optimization. Configurable through an intuitive GUI, ST NRG 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**

<table>
<thead>
<tr>
<th>Traditional ~AC partitioning main</th>
<th>Active x-cap discharge</th>
<th>PFC with x-cap start up</th>
<th>Primary controller</th>
<th>Synchronization rectification IC driver</th>
<th>CC / CV controller</th>
</tr>
</thead>
<tbody>
<tr>
<td>With STNRG011 ~AC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STNRG011A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STNRG012</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HV AC Line Interface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HV half Bridge Driver</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LLC Controller</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power Management and Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

- **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

- **STNRG011A**
  - Time-shift control of resonant half-bridge
  - ROM memory for SW digital algorithms
  - NVM memory for programmable key application parameters
  - Advanced OLP - over load management (STNRG011A only)

- **STNRG012**

**MAIN APPLICATIONS**

- **TV power supply and All-in-One**
  - STNRG011, STNRG011A
- **High power adapters**
  - STNRG011, STNRG011A
- **LED lighting**
  - STNRG012
- **Industrial and medical equipment**
  - STNRG012
- **Emergency lighting**
  - STNRG012

**Microcontrollers for digital power**

The 32-bit microcontrollers most suitable for power management applications are the STM32F334 and the STM32G474 MCU from the mixed-signal STM32F3 series and STM32G4 series, the STM32H743 MCU from the high performance STM32H7 series, and those of the entry-level STM32G0 series. The STM32G0 series has a 32-bit ARM® Cortex®-M0+ core (with MPU) running at 64 MHz, and is well suited for cost-sensitive applications. STM32G0 MCUs combine real-time performance, low-power operation, and the advanced architecture and peripherals of the STM32 platform.

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

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

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

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

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

**STM32G0**

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

**STM32F334**

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

**STM32G474**

- Cortex®-M4 core
- High resolution timer V2 (164 ps resolution) with waveform builder and event handler
- Mathematical accelerator, digital SMPS power factor correction
- High-speed ADCs for precise and accurate control (4 Msps)

**STM32H743**

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

**STM32 digital power ecosystem**

- www.st.com/stm32
- www.biricha.com
### 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>SPC58 E-Line</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core</strong></td>
<td>Triple 3x e200z4d @ 180 MHz</td>
</tr>
<tr>
<td><strong>eFlash Code</strong></td>
<td>4 MB to 6 MB</td>
</tr>
<tr>
<td><strong>Timers</strong></td>
<td>GTM3</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td>ASIL-D</td>
</tr>
<tr>
<td><strong>Advanced networking</strong></td>
<td>8x CAN-FD</td>
</tr>
<tr>
<td></td>
<td>FlexRay</td>
</tr>
<tr>
<td></td>
<td>2x Ethernet</td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>HSM medium</td>
</tr>
<tr>
<td><strong>ADC</strong></td>
<td>5x 12 bit (SAR)</td>
</tr>
<tr>
<td></td>
<td>3x 10 bit (SAR)</td>
</tr>
<tr>
<td></td>
<td>6x 16 bit (SigmaDelta)</td>
</tr>
<tr>
<td><strong>High temperature support (165 Tj)</strong></td>
<td>Qualified</td>
</tr>
</tbody>
</table>

### Package options

- eTQFP 64-176 (exposed pad)
- QFN 48 (exposed pad)

### Networking

- Ethernet
- CAN-FD
- FlexRay
- 2x Ethernet

### Scalability

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

### Secure and Safety

- ASIL D

### MAIN APPLICATIONS

- Vehicle security
- Software over-the-air
- Parking services
- Remote assistance
- Maintenance free
- Safety
- HEV

---

**AutoDevKit Automotive Development Kit Enables Faster ECU Prototyping**

AutoDevKit is a fast-growing toolset for automotive and transportation application development. It allows design engineers to quickly and easily prototype with hardware, firmware, and software, and includes extensive community support.

Our ecosystem offers a wide selection of automotive MCUs and devices covering several automotive applications:

- BMS
- Delivery/logistic robots
- AI on standard MCUs
- Internal and external lighting
- Power distribution
- Audio generation and AVAS
- Motor control: door control, side mirror, tailgate, seat adjustment
- HVAC, ventilation, air quality
- USB Type-C power delivery

Once the MCU platform and the functions needed for the application have been selected, the developer can customize existing demo codes using high-level programming, without needing to deal with complex technical details. Automatic pin configuration and a visual procedure enable easy board assembly with the correct wiring, and the embedded debug allows quick prototyping.

The AutoDevKit ecosystem includes:

- MCU discovery and functional boards
- System solution and demonstrators
- STSW software

**AutoDevKit ecosystem**

- MCU boards
- Connector boards
- Functional boards

**Solution/demonstrator KIT**

- MCU
- Connector
- DC-DC buck converter
- LED driver

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

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

STPST Trench diodes

The trench diode design perpetuates the ST move towards ever increasing compactness in power systems. It covers applications from tiny appliance adaptors (STPST8H100SF takes a mere 30 mm² footprint) to automotive power actuators (-SFY suffix for this 8 Amps). Together with the D2PAK and PSMC surface mount power housing, the slimmer 1 mm SOD123Flat, SOF128Flat, and SMB Flat packages give access to the newer, leaner circuit modules.

SIC diodes

In addition to ensuring compliance with today's most stringent energy efficiency regulations (energy Star, 80Plus, and European efficiency), ST silicon carbide diodes feature four times better dynamic characteristics with 15% less forward voltage (VF) than standard silicon diodes. Silicon carbide diodes belong to the STPOWER family. The efficiency and robustness of solar inverters, motor drives, uninterruptible power supplies, and circuits in electrical vehicles are therefore greatly improved by the use of silicon carbide (SiC) diodes.

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

SIC DIODES BENEFITS

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

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

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

www.st.com/sic-diodes

STPST Trench diodes

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

ST tandem diode

SiC diode

Si diode

STPSC*065, STPSC*H12

www.st.com/schottky
www.st.com/ultrafast-rectifiers
www.st.com/field-effect-rectifier-diodes

www.st.com/sic-diodes

SiC diodes provide zero recovery time with negligible switching losses

Current

Time

Current versus Time for different diode types

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

www.st.com/schottky
www.st.com/ultrafast-rectifiers
www.st.com/field-effect-rectifier-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.

**eFuse 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

**Power breakers**

Connected in series to the power rail, ST power breakers are able to disconnect the electronic circuitry when power consumption exceeds the programmed limit. When this happens, the device automatically opens the integrated power switch, disconnecting the load, and notifies the remote monitoring feature. The STPW programmable electronic power breaker family provides a convenient and integrated solution for quickly and safely disconnecting a faulty load from a 12 V bus.

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

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

**Power breakers**

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

**Typical home appliance block diagram for STPW12**

**eFuse 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

**Legend:**

- Power breaker
- Power MOSFET
- UVLO
- Low side timed switch
- Standard eFuses
- Controlled load switch
- Hot swap and ideal diode controller
- High power eFuse
- 3.3 V or 5 V rail
- Fully programmable
- Dual rail 5 V + 12 V

**Main applications**

- **Home appliances**
  - STEF05, STEF12, STEF12S
- **Server and data storage**
  - STEF033, STEF05, STEF05L, STEF12, STEF12S, STEF12, STEF12S, STELPD01
- **USB connections**
  - STEF05, STEF05L, STEF05S, STELPD01
- **Factory automation**
  - STEF01, STEF12, STEF12S, STEF12, STEF12S
- **Set-top boxes**
  - STEF12, STEF12S

**Factory automation**

- **STPW12**
  - Auto-retry function with programmable delay
  - Adjustable precise power limitation from 11 to 16 W
  - 12 V rails
  - Programmable power limit masking time
  - Over-temperature protection
  - Integrated N-channel power MOSFET
  - Internal undervoltage lockout

**Typical home appliance block diagram for STPW12**

**MAIN APPLICATIONS**

- **Home appliances**
  - STEF05, STEF12, STEF12S
- **Server and data storage**
  - STEF033, STEF05, STEF05L, STEF12, STEF12S, STEF12, STEF12S, STELPD01
- **USB connections**
  - STEF05, STEF05L, STEF05S, STELPD01
- **Factory automation**
  - STEF01, STEF12, STEF12S, STEF12, STEF12S
- **Set-top boxes**
  - STEF12, STEF12S

**MAIN APPLICATIONS**

- **Home appliances**
  - STPW12
- **Air conditioning**
  - STPW12
- **Factory automation**
  - STPW12

**Subsystems**

- **Subsystem 1**
  - (UI, display, control panel, connectivity)
- **Subsystem 2**
  - (Fans, other motor driver, relay driver)
- **Subsystem n**
  - (.....)
GALVANIC ISOLATED SIGMA-DELTA ADC

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

**KEY FEATURES**

- 2nd order 16-bit Sigma-Delta modulator
- ±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 kHz typical common-mode transient immunity
- 6 kV VPEAK highest allowable over-voltage (V_{\text{ov}})
- 6 kV VPEAK maximum surge insulation voltage (V_{\text{isv}})
- 1.2 kV V_{\text{ov}} maximum working insulation voltage (V_{\text{ow}})
- Flexible interface options: Low voltage differential signaling (LVDS) and single ended (TTL/CMOS)
- -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 and packing</th>
</tr>
</thead>
<tbody>
<tr>
<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 V_{ow}</td>
<td>30 kV/us</td>
<td>SO16W tray</td>
</tr>
<tr>
<td>ISOSD61TR</td>
<td>TTL/CMOS</td>
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<td>25 MHz</td>
<td>16-bit</td>
<td>86 dB</td>
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<td>30 kV/us</td>
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<tr>
<td>ISOSD61L</td>
<td>LVDS</td>
<td>±320 mV</td>
<td>25 MHz</td>
<td>16-bit</td>
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<td>30 kV/us</td>
<td>LVDS</td>
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<tr>
<td>ISOSD61LTR</td>
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<td>86 dB</td>
<td>1.2 kV V_{ow}</td>
<td>30 kV/us</td>
<td>LVDS</td>
</tr>
</tbody>
</table>

**MAIN APPLICATIONS**

Serve drive  
Factory automation  
EV charging station  
Server and telecom power
IGBTs

ST offers a comprehensive portfolio of IGBTs (insulated gate bipolar transistors) ranging from 600 to 1700 V in trench gate field-stop (TGFS) technologies. Featuring an optimal trade-off between switching performance and on-state behavior (variant), ST IGBTs are suitable for industrial and automotive segments in applications such as general-purpose inverters, motor control, home appliances, HVAC, UPS/SMPS, welding equipment, induction heating, solar inverters, traction inverters, on-board chargers, and fast chargers.

### Industrial

<table>
<thead>
<tr>
<th>Breakdown Voltage</th>
<th>600 V</th>
<th>650 V</th>
<th>750 V</th>
<th>1200 V</th>
<th>1500 V</th>
<th>1700 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current</td>
<td>4 to 20 A</td>
<td>20 to 80 A</td>
<td>20 to 100 A</td>
<td>20 to 80 A</td>
<td>40 A</td>
<td>8 to 75 A</td>
</tr>
<tr>
<td>Switching frequency</td>
<td>30 kHz</td>
<td>60 kHz</td>
<td>20 kHz</td>
<td>100 kHz</td>
<td>60 kHz</td>
<td>30 kHz</td>
</tr>
</tbody>
</table>

**IGBT Series**

- **H** series
  - 600 V family
  - Low saturation voltage
  - Minimal collector turn-off
  - Series optimized for home appliance applications
  - Very high robustness in final application
  - Automotive eligible

- **V** series
  - Optimized for high switching frequencies
  - Negligible turn-off losses
  - Soft and very fast recovery antiparallel diode
  - AEC-Q101 qualified device

- **M** series
  - 650 V family
  - Wide safe operating area (SOA)
  - Very soft and fast recovery antiparallel diode
  - Suitable for any inverter system up to 20 kHz

### Automotive

<table>
<thead>
<tr>
<th>Breakdown Voltage</th>
<th>600 V</th>
<th>650 V</th>
<th>750 V</th>
<th>1200 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Current</td>
<td>10 to 250 A</td>
<td>20 to 250 A</td>
<td>25 to 400 A</td>
<td>15 to 400 A</td>
</tr>
<tr>
<td>Switching frequency</td>
<td>20 kHz</td>
<td>2 to 8 kHz</td>
<td>2 to 20 kHz</td>
<td>2 to 20 kHz</td>
</tr>
</tbody>
</table>

**IGBT Series**

- **V** series
  - High current and temperature fully tested
  - Dice top and back metallization suitable for high performance linking
  - Low thermal resistance
  - Optimum trade-off between conduction and switching losses
  - Minimal collector turn-off
  - Very low saturation voltage

- **IH** series
  - 650 V IH family - 1350 V IH2 family
  - Wide safe operating area (SOA)
  - Very soft and fast recovery antiparallel diode
  - Designed for automotive application

### Focus Applications

- **Home appliances**
  - Welding, PFC, solar, charger
  - PFC, solar, UPS charger, welding and soft switching
  - Induction heating and soft switching
  - Motor control, PFC, UPS charger, battery thermal management

- **Industrial**
  - Industrial motor control, automotive traction inverter, GPI, Air-Con
  - PFC, solar, UPS charger, welding and soft switching
  - Induction heating and soft switching
  - Motor control, PFC, UPS charger, battery thermal management

- **V series**
  - Induction heating
  - V, VGE=15 V, TJ-start=150 °C

- **IH series**
  - Industrial motor control, GPI, Air-Con

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

- **HB2 series**
  - Very low saturation voltage
  - Reduced gate charge
  - Different diode option
  - Optimum trade-off between conduction and switching losses
  - Low thermal resistance
  - 4 leads package available
  - High efficiency in final application
  - Automotive eligible

- **IH/HH2 series**
  - Minimal tail current
  - Very low drop freewheeling diode
  - Tailored for single-switch topology

**STG**

- **H** series
  - H' - 600 V family
  - 3 µs of short-circuit capability
  - Very low turn-off losses
  - Up to 100 kHz as switching frequency

- **M** series
  - 650 V family
  - 6 µs of short-circuit capability @ TJ = 150 °C
  - Wide safe operating area (SOA)
  - Very soft and fast recovery antiparallel diode
  - Suitable for any inverter system up to 20 kHz

**STG**

- **H** series
  - H' - 600 V family
  - Very low saturation voltage
  - Reduced gate charge
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- **V** series
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  - Soft and very fast recovery antiparallel diode
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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 $R_{\text{th}}$ 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

---

**SLLIMM nano series**
- 600 V IGBT
- 600 V SJ-MOSFET
- 500 V MOSFET
- 1 up to 8 A

**SLLIMM 2nd series**
- 600 V IGBT
- 600 V SJ-MOSFET
- 8 up to 35 A

**SLLIMM high power series**
- IGBT
- 650 V, 50 A
- 1200 V, 10 A

Power rating: 10 to 600 W
Power rating: 300 W to 1 kW
Power rating: 3 to 7 kW

www.st.com/igbt
INTELLIGENT POWER SWITCHES

STMicroelectronics offers intelligent power switches (IPS) for low- and high-side configurations. ST IPS feature a supply voltage range from 6 to 60 V, overload and short-circuit protection, current limitation set for industrial applications, different diagnostic types, high-burst, surge and ESD immunity, very low power dissipation, and fast demagnetization of inductive loads. The devices are designed using ST latest technologies for state-of-the-art solutions in any application field.

**IPS MAIN FEATURES**
- Logic
- Driving
- Protections
- Diagnostic
- Power stage
- ...all in a single chip

www.st.com/ips

---

### MAIN APPLICATIONS

<table>
<thead>
<tr>
<th>Factory automation</th>
<th>Vending machines</th>
<th>Renewable energy</th>
<th>Lighting for building automation</th>
</tr>
</thead>
</table>

---

### Output Current/Channel (A)

<table>
<thead>
<tr>
<th>Current (A)</th>
<th>Single Channel</th>
<th>Dual Channel</th>
<th>Quad Channel</th>
<th>Octal Channels</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>IPS1025H²</td>
<td>IPS2050H²</td>
<td>IPS160H²</td>
<td>IPS2050H²</td>
</tr>
<tr>
<td>2.5</td>
<td>IPS1025H²</td>
<td>IPS2050H²</td>
<td>IPS160H²</td>
<td>IPS2050H²</td>
</tr>
<tr>
<td>1</td>
<td>IPS1025H²</td>
<td>IPS2050H²</td>
<td>IPS160H²</td>
<td>IPS2050H²</td>
</tr>
<tr>
<td>0.5</td>
<td>IPS1025H²</td>
<td>IPS2050H²</td>
<td>IPS160H²</td>
<td>IPS2050H²</td>
</tr>
<tr>
<td>&lt;0.5</td>
<td>IPS1025H²</td>
<td>IPS2050H²</td>
<td>IPS160H²</td>
<td>IPS2050H²</td>
</tr>
</tbody>
</table>

---

### Output Voltage (V)

- Standard $V_{cc}$
- Enhanced $V_{cc}$

---

### Industrial power switches–high-side

Positioning by operating voltage and on-resistance

---

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>Standard</th>
<th>Enhanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.5</td>
<td>IPS1025</td>
<td>VN751</td>
</tr>
<tr>
<td>25</td>
<td>IPS2050</td>
<td>VN1240</td>
</tr>
<tr>
<td>60</td>
<td>IPS160HQ</td>
<td>VN540</td>
</tr>
<tr>
<td>80</td>
<td>IPS160HQ</td>
<td>VN1440</td>
</tr>
<tr>
<td>120</td>
<td>IPS160HQ</td>
<td>VN808</td>
</tr>
</tbody>
</table>
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). HVLED101 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.

Topography example

Main applications

Residential lighting
HVLED815PF
Commercial and street lighting
HVLED001A, HVLED001B, HVLED007, HVLED101

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.

Topography examples

Main applications

Halogen bulbs replacements and home appliances
LED5000, LED6000
Traffic signals
LED5000, LED6000, ST1CC40, LED6000, LED6000, HVLED002
Street lighting
LED5000, LED6000, HVLED002
Emergency lighting
LED6000, LED6000, LED6001, HVLED002
Commercial and architectural lighting
LED6000, LED6000, LED6001, HVLED002
LED array drivers

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

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

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)

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.

MAIN APPLICATIONS

Traffic signals
LED81025, LED2472G, STP24DP05, STP04

Large panel signs
LED1642GW, LED2472G, STP4CMP, STLED524

Home appliances
LED81025, STP16, STP16C*, STP16C*/D*

Special lighting
STP04, LED1642GW, LED2472G, LED81025

Smartphones / wearable
STLED316S, LED1202

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

www.st.com/led
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 an 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

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

- Display panels
- Residential, commercial, architectural 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 Low Iq Low noise, high PSRR

ST0915 LDK120/130 LD39015
ST050 LD046L LD39030
ST120/130/140 LD39050/ ST7302/100/14100
LD6100 LD56050 LD39050/ 100/41000
LD6020 LDCL015 LD57100
LDFM/LDF LDLN015 LD040/0/0.4L
LD59100 LDL112 LD39130
ST020 LD210 LD39200
LDL025/30/50 LD59015 LD39150
L050 L5150 L5300
L99100 L9VR02J L4995

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www.st.com/linear-regulators

MAIN APPLICATIONS

- Tablets, smartphones, and wearables:
  L3301L, L33120, L33920/230, ST120, LD9015, LD5625/30
  /50, STL020, LD56030, LD56050, LD56100, LD59100, LD99101,
  LD9101, LD55650
- Healthcare:
  ST015, ST020, ST15, LD39130, LD56020
- Home appliances:
  LDK202/122, LDF, LDPM, LDL112, ST7302
- Automotive ADAS, ECU:
  LD9130, LD9100, LD5915, LD046L, L5050, L5150, LD99101,
  L9VR02J, L4995, L5300, L9VR100

www.st.com/lp201
STPMS2, 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

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

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

**METERING ICs**

**STPM32, STPM33, and STPM34**

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

**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
- TEG energy harvesting
- Sync Boost ICs

**SPV1040**

**SPV1050**

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

**Thermo-electric generator (TEG)**

**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**
- **Solar inverters, EV charging stations, energy storage systems and UPS**
- **Welding, residential, commercial, and street lighting**
- **Server/Telecoms**

**RDS(on) [Ω]**

![RDS(on) Graph]

**K5/DK5**

- 800V to 1700V

**K6**

- 800V to 950V

**M9 series**

- ST*N*M9
- Best figure of Merit ($R_{DSS} \cdot Q_g$) on the market
- Industry’s best $R_{DSS}$ for 650 V voltage range
- Lowest $Q_g$
- Higher reverse diode dv/dt and MOSFET dv/dt ruggedness

**M5 series**

- ST*N*M5
- Very low $R_{DSS}$
- High switching speed
- Suited for hard switching topologies

**M2/M2-EP series**

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

**DM9 series**

- ST*N*DM9
- Best figure of Merit ($R_{DSS} \cdot Q_g$) on the market
- Improved intrinsic diode reverse recovery time (trr)
- Higher dv/dt and di/dt capability
- Optimized body diode recovery phase and softness

**K5 and K6 series**

- ST*N*K5/6
- Very low $R_{DSS}$
- Small $Q_g$ and capacitance
- Small packages
- Suited for hard switching topologies

**DK5 series**

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

**M6 series**

- ST*N*M6
- Lower $R_{DSS} \times$ area vs previous generation
- Extremely low gate charge ($Q_g$)
- Optimized capacitances profile for better efficiency @ light load
- Optimized threshold voltage (VTH) and gate resistance (RG) values for soft switching

**DM6/DM2 series**

- ST*N*DM6
- ST*N*DM2
- Improved trr of intrinsic diode
- High dv/dt capability
- Suited for ZVS/LLC topologies

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

www.st.com/mosfet


**SiC MOSFETs**

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

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

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

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

![Stic Mosfet Graph](image)

**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

**Sic MOSFETS, the real breakthrough in high voltage switching**

- $V_{BR} = 1700$ V (SCT*N170), 1200 V (SCT*N120G), 650 V (SCT*N65G2), 650 V (SCT*N65G3AG)
- Body diode with no recovery losses
- Low power losses at high temperatures
- Easy to drive
- Low gate charge (SCT*N65G2)

**Main Applications**

- **Motor drive and factory automation**
- **HEVs / EVs** (Traction inverter, OBC, DC-DC)
- **Charging station**
- **UPS and data center power supply**
- **Solar inverters**

**Low-voltage power MOSFETs**

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

**ST StripFET low-voltage MOSFTs support a wide voltage range for synchronous rectification, UPS, motor control, SMPS, power-over-Ethernet (PoE), inverter, automotive, and other applications in a wide range of miniature and high-power packages:**

- **DPak, D2pak, SOT-223, TO-220, TO-220FP, TO-247, PowerFLAT (5 x 6)/(3.3 x 3.3)/(2 x 2), SQ-8 and SOT23-6L.**

**Main Applications**

- **Small motor control and USB battery chargers**
- **HDD, power tools, STB, and game consoles**
- **Server/Telecoms and SMPS**
- **UPS, e-bikes, and fans**
- **Solar inverters, forkifts, and EWs**
POWER MODULE – ACEPACK PACKAGES OPTIONS
ST ACEPACK power modules come with several topologies that address industrial applications such as motor drives, solar inverters, charging stations, UPS, welding tools, and power converter solutions, while they are also suitable for electric vehicle power applications like on-board chargers (OBC), electric traction drives, and power converter solutions. These highly reliable and compact power modules feature an embedded NTC thermistor and offer the best compromise between conduction and switching losses, maximizing the efficiency of any converter system in hard-switching circuitries for an application range from few kW to hundreds of kW. For flexible and stable mounting, PressFIT and additional soldered pin options are provided. These power modules implement power semiconductor switches based on ST state-of-the-art SiC MOSFET and IGBT technologies.

ACEPACK 1
Up to 15 kW

ACEPACK 2
Up to 30 kW

ACEPACK DRIVE
120 kW to 300 kW

ACEPACK DMT-32
up to 22 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 1-type
• Four Pack
• Half bridge
• 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
• SiC MOSFET, rectifiers
• 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

PM8805
• IEEE 802.3at PoE-PD interface
• PWM current mode controller
• System in Package
• Dual active bridges
• HotSwap MOSFET
• Compact package (10 times smaller than discrete BOM) with high thermal performances
• 100 W capability

Main standards
PM8800A
PoE-PD (IEEE 802.3at)

PM8803
PoE-PD (IEEE 802.3at)

PM8805+PM8804
PoE-PD (IEEE 802.3bt)

Power over Ethernet power supply protection

PEP01-5841
• Power supply protection compliant with IEC61000-4-5 level 2: 1 kV
• Allow to use 100 V power MOSFET
• Stand off voltage: 58 V
• Surface mount SO-8 package

www.st.com/PoE
**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.

**MOSFET protection with TVS**

-15% consumption in Stand-by mode

**KEY FEATURES AND 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

**MAIN APPLICATIONS**

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

www.st.com/eos8-20-protection
STDRIVE AND STGAP GATE DRIVERS

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

**600 V gate drivers**
- Half bridge
  - 4 A source/sink driver high current capability (L6491)
  - Integrated bootstrap diode
  - Adjustable deadtime (L6494L)
  - Comparator, op amp integrated, smart SD, interlocking, and program. DT (L6390)
  - Extended temperature range (A version)
- 3-Phase
  - Best In Class for propagation delay 85 ns
  - 200 mA/350 mA sink / source driver current capability
  - Integrated bootstrap diode

**Low side gate drivers**
- 2 level turn-off (TD35*)
- Miller clamp (TD35*)
- Pulse trans/o/pie input (TD35*)
- Dual independent low side driver (PM8834)
- 4 A source/sink driver high current capability (PM8834)

**Galvanically-isolated single and dual gate drivers**
- Up to 6 kV isolation
- High voltage rail up to 1.7 kV
- Up to 5 A source/sink driver current capability
- 2 Level turn-off (STGAP1B)
- Miller clamp, negative gate supply
- Optimized for SiC and for GaN HEMT (STGAP2GSN, STGAP2GS) MOSFET driving (STGAP2SiCS)

**STDRIVEG600 - high voltage half-bridge gate driver for GaN transistors**
- dv/dt immunity ±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

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>
<thead>
<tr>
<th>Part number</th>
<th>Package</th>
<th>Tj °C max</th>
<th>VDRM/VRRM (V)</th>
<th>V max</th>
<th>ITRMS (A)</th>
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<tbody>
<tr>
<td>TN3050H-12</td>
<td>D2PAK</td>
<td>150</td>
<td>1200</td>
<td>30</td>
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<tr>
<td>TN4050H-12</td>
<td>TO-220AB Ins.</td>
<td>150</td>
<td>1200</td>
<td>40</td>
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<tr>
<td>TN6050H-12</td>
<td>TO-247</td>
<td>150</td>
<td>1200</td>
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</table>

Medium Power SCR

<table>
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<th>Part number</th>
<th>Package</th>
<th>Tj °C max</th>
<th>VDRM/VRRM (V)</th>
<th>V max</th>
<th>ITRMS (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TN4050-12</td>
<td>TO-220AB Ins.</td>
<td>150</td>
<td>1200</td>
<td>50</td>
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<tr>
<td>TN6050-12</td>
<td>TO-247</td>
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<td>1200</td>
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<tr>
<td>TN8050H-8</td>
<td>TO-220AB Ins.</td>
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High Temperature SCR

<table>
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<tr>
<th>Part number</th>
<th>Package</th>
<th>Tj °C max</th>
<th>VDRM/VRRM (V)</th>
<th>V max</th>
<th>ITRMS (A)</th>
</tr>
</thead>
<tbody>
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<td>TN1605H-8</td>
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<td>D2PAK</td>
<td>150</td>
<td>600</td>
<td>50</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.

<table>
<thead>
<tr>
<th>Part number</th>
<th>Package</th>
<th>ITRMS (A)</th>
<th>VRRM (V)</th>
<th>Tj °C max</th>
<th>dV/dt (V/µs)</th>
<th>(dI/dt)T (A/ms)</th>
<th>A max</th>
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<tbody>
<tr>
<td>T835H-8</td>
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<td>150</td>
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<td>200</td>
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<tr>
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<td>D2PAK</td>
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<td>5000</td>
<td>150</td>
<td>2000</td>
<td>25</td>
<td>200</td>
</tr>
<tr>
<td>T5035H-8</td>
<td>D2PAK</td>
<td>50</td>
<td>5000</td>
<td>150</td>
<td>2000</td>
<td>25</td>
<td>200</td>
</tr>
</tbody>
</table>

MAIN APPLICATIONS
AC-DC conversion SMPS and PSU
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 power delivery PHY and BMC driver IC companion chip of STM32-based solutions to standalone full hardware USB PD controller optimized for AC adapters up to 100 W.

MCU-based solutions

Our STM32 solutions help you manage the complexity of implementing USB Type-C® and power delivery technology to ensure your application embedded support satisfies 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.

A companion Type-C Port Protection device TCPP01-M12 is 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, TCPP02-M18 is recommended (mass-production Q4-2020). For dual role Port applications (DRP), TCPP03-M20 is recommended.

STM32 USB PD3.0 controllers

Introduced in December 2017, STM32G0 is the world’s 1st standard USB PD 3.0 microcontroller with a UCPD interface (UCPD stands for USB Type-C and power delivery). This new IP, available in STM32G0/G4/L5 series, allows development of USB-C sink, source, and dual role devices in a wide range of embedded applications.

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

https://www.st.com/content/st_com/en/stm32-usb-c.html

STM32G081 block diagram

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

Our STM32G017B-DISCO kit enables discovery and display of USB-C power and feature capabilities of any USB-C compliant host. Associated with our professional-grade STM32CubeMonitor-UCPD software GUI, the kit acts as a USB PD analyzer and allows customers to debug, configure, and inject USB PD3.0 packets in a single click while monitoring Vbus voltage and Ibus current between two USB-C devices.

Our well-known STM32 configurator STM32CubeMX supports easy setting of UCPD. An STM32G018B-evl evaluation board is proposed with two USB-C ports offering 45 W of power with different profiles.
STM32 USB power delivery controller-based solutions

**Key Features**
- USB-C power delivery standard 3.1, standard power range (SPR) up to 100 W
- USB-C certified on X-NUCLEO boards
- Embedded gate drivers for N-MOSFET on consumer and provider paths
- 24 V tolerant on VBUS and CC pins
- Integrated discharge on VBUS and VCONN
- Overvoltage protection on CC lines against short-to-VBUS
- VBUS current sense analog output through amplifier
- 100 mW DCP and 6 V DVP on VCONN
- Integrated “dead battery” management
- Over temperature protection (150 °C typ.)
- ICC communication with two ICC addresses available
- IEC 61000-4-2 level 4 on CC1 and CC2 pins:
  - ±8 kV contact discharge
  - ±15 kV air discharge
- ESD protection devices
- Cost-effective solutions for driving USB-C PD when the application uses a microcontroller.

**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 hardened, STUSB controllers are fast and predictive to guarantee safety and interoperability, while increasing port robustness and minimizing power consumption. Implementation is fast and easy and requires no deep knowledge of the USB PD standard or advanced software skills. Standalone controllers are powered from VBUS to minimize BOM cost and can fully operate without external MCU support. For more flexibility, an MCU can optionally change main power parameters or read port status with a light software layer.

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

**STUSB47xx**
- USB PD SOURCE
  - Up to 5 programmable PDOs
  - Full hardware solution - no software
  - Internal and/or external VBUS
  - Discharge path
  - Very low power consumption
  - E-marked cable identification (for >3 A support)
  - Over-temperature protection

**STUSB1602**
- USB-C 5 V SOURCE
  - High voltage protections
  - GPIO-controlled current profile (power sharing, thermal protection)
  - VBUS powered (no LDO needed)
  - AEC-Q100 available

**STUSB4500L**
- USB-C 5 V SOURCE/SINK/DUAL ROLE
  - USB PD SOURCE/SINK/DUAL ROLE
  - Perfect MCU companion chip ensuring port protection, power path monitoring and management, role advertisement and detection, PD PHY communication
  - Ready-to-use software frameworks for fast prototyping of most common application scenario such as: basic source, sink, DCP dual port, but also more complex use cases, which include optional features of PD3.0, vendor defined, battery, or extended messages.
  - MCU supported:
    - STSW-STUSB001: STM32F446
    - STSW-STUSB002: STM32F469
    - STSW-STUSB003: GUI
  - STUSB: STUSB001: open source software drivers for dynamic power management
    - Mini-dongle: EVAL-SCS001V1

**STUSB4761**
- USB PD SOURCE/INK/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, DCP 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: STM32F469
    - STSW-STUSB014: STM32G474
    - STSW-STUSB015: STM32L498
  - STUSB: STUSB001: open source software drivers for dynamic power management
    - Mini-dongle: EVAL-SCS001V1

**STUSB4500**
- USB PD SINK
  - Dead battery support
  - VBUS powered (ZERO power on VBAT)
  - Input over voltage protection
  - QFN and CSP package available
  - SOURCE power profile reporting
  - STSW-STUSB002: GUI
  - STSW-STUSB003: optional open source software drivers for dynamic power management
    - Mini-dongle: EVAL-SCS001V1

**STUSB4500L**
- USB-C 5 V SINK
  - Dead battery support
  - VBUS powered (ZERO power on VBAT)
  - Input over voltage protection
  - SOURCE power budget reporting
  - MINI-DONGLE: EVAL-SCS002V1
At STMicroelectronics we create technology that starts with You.