Power management Guide
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There is no secret when designing a power management system or sub-system: regardless of the final use, whether it is an energy generation or distribution system, a power supply or a LED driving circuit, an industrial SMPS or an electric vehicle power application, it must provide high efficiency and low standby power, as well as high power density, reliability and safety, while respecting specific cost constraints.

The key enablers for any such system with the above features 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 that has been at the core of ST’s strategy for more than 25 years is the reason why ST today can offer an extensive range of cutting-edge products for power and energy management. ST’s portfolio includes higher-efficiency power technologies such as:

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

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

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

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

Central inverters. In addition we have a range of wireless and wired connectivity solutions. Isolated gate drivers and high-performance STM32 microcontrollers we enable engineers to design high-efficiency string and field-stop IGBTs, that can be also combined into our high-efficiency ACEPACK power modules. Together with galvanically-MOSFETs - with the industry’s highest operating 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, that can be also combined into our high-efficiency ACEPACK power modules. Together with galvanically-isolated gate drivers and high-performance STM32 microcontrollers we enable engineers to design high-efficiency string and central inverters. In addition we have a range of wireless and wired connectivity solutions.

Typical Block Diagram for String Inverter

ST’S product offering for String and Central Solar Inverter

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).

Inverters (String and Central)

Solar Tracker

Communication Path

PV panels

Motor CTRL

Motor CTRL Motion Sensors

Environmental Sensors

Connectivity

Solar Tracker

3-phase Field Oriented Control (FOS)

IE3/IE4/EC, 6K2H, 6K2D, L1

Magnetometer-ISM303DAC

eCompass-ISM303DAC

6-axis IMU-ISM330DLC

Temperature - STTS22H

Pressure - LPS22HH

Humidity - HTS221

Network Access

Bluetooth Low Energy

Bluetooth, ST350B

RS-422 and RS-485

ST3485*, STR485*

BlueNRG, STM32WB

RS-422 and RS-485

ST8500, ST7580

ST3485*, STR485*

BlueNRG, STM32WB

RS-422 and RS-485

ST8500, ST7580

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Solar Distributed Generation - Microinverter

In residential photovoltaic systems Microinverters are often used as an alternative to string inverters to perform the DC to AC conversion at power 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, galoically-isolated gate drivers, high-voltage silicon-carbide (SiC) diodes together with high-performance STM32 microcontrollers – providing a set of 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's product offering for Microinverter

Typical Block Diagram

Solar Distributed Generation - Power Optimizer

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

Power optimizers can help minimize a system's 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 at the same time reducing maintenance costs.

We provide high-performance STM32 microcontrollers as well as 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's product offering for Power Optimizer

Typical Block Diagram
Energy Distribution - Home & Commercial Battery Storage Systems

The adoption of energy storage devices, whose reserve capacity can be used for balancing purposes, peak-load shaving or to shift loads, is increasingly widespread in energy distribution networks. Two use cases are particularly important: the use in residential or commercial buildings to help reduce consumers’ electricity bills by storing energy when it is cheap and releasing it when it is expensive. The storage can often help meet the requirements of smart grid systems.

By interacting with the grid, batteries and potentially solar panels, we can provide a range of power discrete devices including silicon-carbide (SiC) and silicon diodes, isolated gate drivers and high-performance SiC power modules, silicon-carbide (SiC) and silicon power transistors, ACEPACK power modules, silicon-carbide SiC MOSFETs/IGBTs, Power MOSFETs IGBTs Power Modules MOSFET and IGBT Gate Drivers Diodes & Discretes SiC MOSFETs/IGBTs Power Modules MOSFET and IGBT Gate Drivers Diodes & Discretes

We can provide a range of power discretes including silicon-carbide (SiC) and silicon diodes, isolated gate drivers and high-performance SiC power modules, silicon-carbide (SiC) and silicon power transistors, ACEPACK power modules, silicon-carbide SiC MOSFETs/IGBTs, Power MOSFETs IGBTs Power Modules MOSFET and IGBT Gate Drivers Diodes & Discretes

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POWER SUPPLIES

Auxiliary SMPS

Many appliances and equipment require the availability of a switch-mode power supply (SMPS) that works separately from the main power supply to support, for instance, stand-by 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 20 W, with an extremely low total stand-by consumption – down to less than 4 mW – and breakdown voltages as high as 1050 V. In addition to PWM switching controllers, power MOSFETs and diodes, we offer an extensive set of evaluation and development tools as well as reference designs to help engineers develop high-efficiency and compact auxiliary power supply solutions.

Isolated Auxiliary SMPS

In the power range up to 20 W, ST helps the designers of high-power-density and cost-effective isolated auxiliary power supplies with higher switching frequencies solutions to minimize transformer and output capacitor size. The power stage is managed by a high voltage converter.

In the 20 to 75 W power range, the need to meet increasingly tight efficiency and stand-by requirements for auxiliary power supplies has pushed the use of quasi-resonant topologies replacing more mainstream fixed frequency based designs. The power stage is managed by an off-line controller coupled with HV power MOSFETs.

ST’s recommended products for Isolated Auxiliary SMPS

<table>
<thead>
<tr>
<th>HV converters</th>
<th>OLT devices</th>
<th>HV Power MOSFETs</th>
<th>MOSFET Protection</th>
<th>Output diodes</th>
<th>Synch Rect</th>
<th>LDO</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIPer*5</td>
<td>STTH*08</td>
<td>ST<em>60M6, ST</em>65M6</td>
<td>FERD<em>45, FERD</em>50, FERD<em>60, FERD</em>100</td>
<td>Low Dropout LDO, Linear Regulators</td>
<td>LDF, LDK220, LDK320, LDK3212</td>
<td></td>
</tr>
<tr>
<td>VIPer*6</td>
<td>STTH*10</td>
<td>ST<em>105K5, ST</em>120K5</td>
<td>FERD<em>100, FERD</em>50, FERD*45</td>
<td>Low Dropout LDO, Linear Regulators</td>
<td>LDF, LDK220, LDK320, LDK3212</td>
<td></td>
</tr>
<tr>
<td>VIPer*8</td>
<td>STTH*10</td>
<td>ST<em>120K5, ST</em>121K5</td>
<td>FERD<em>100, FERD</em>50, FERD*45</td>
<td>Low Dropout LDO, Linear Regulators</td>
<td>LDF, LDK220, LDK320, LDK3212</td>
<td></td>
</tr>
</tbody>
</table>

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

Typical configurations for Isolated Auxiliary Power Supply up to 20 W based on VIPerPlus or 75W and more based on PWM Controllers

Non Isolated Auxiliary SMPS

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

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

ST’s recommended products for Non-Isolated Auxiliary SMPS

<table>
<thead>
<tr>
<th>Buck</th>
<th>HV converters</th>
<th>VIPer Protection</th>
<th>Reverse-blocking diodes</th>
<th>Output diodes</th>
<th>LDO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buck</td>
<td>VIPer*5</td>
<td>ST*60M6</td>
<td>FERD<em>45, FERD</em>50, FERD*60</td>
<td>Low Dropout LDO, Linear Regulators</td>
<td>LDF, LDK220, LDK320, LDK3212</td>
</tr>
<tr>
<td>Buck-boost</td>
<td>VIPer*6</td>
<td>ST<em>105K5, ST</em>120K5</td>
<td>FERD<em>100, FERD</em>50, FERD*45</td>
<td>Low Dropout LDO, Linear Regulators</td>
<td>LDF, LDK220, LDK320, LDK3212</td>
</tr>
</tbody>
</table>

Typical configurations for Non-Isolated Auxiliary Power Supply

MAIN EVALUATION BOARDS

STEVAL-VP12201B
15 V / 200 mA buck converter

STEVAL-ISA178V1
5 V / 0.36 A buck converter

STEVAL-VP22201B
5 V / 0.2 A buck converter

STEVAL-ISA196V1
5 V / 1.2 A non-isolated flyback converter
Smart Chargers and Adapters

Today, many device charging technologies and standards designed to ensure interoperability and improve convenience and ease of use are available, including wireless charging, quick charge and USB Type-C and Power Delivery.

ST can help engineers design charging solutions that meet requirements set by the mainstream standards – as well as proprietary charging protocols – with innovative converter architectures enabling best-in-class energy efficiency and power density as well as ensuring the lowest possible stand-by power.

**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 100 W (20 V, 5 A) enabling a faster and more efficient charging solution. Having considerably expanded the capability of USB devices, these connectors are now widely found in wall chargers and adapters.

Designers of USB Type-C™ and Power Delivery compliant adapters and wall chargers can benefit from stand-alone controllers, from ST’s microcontrollers and their associated protocol stack, our STSAFE secure element as well as a specifically developed range of protection and filtering devices.

**ST’s recommended products for USB Type-C Power Delivery Subsystem**

<table>
<thead>
<tr>
<th>Type-C and PD Controller</th>
<th>Programmable Solutions</th>
<th>Standalone Solutions</th>
<th>Authentication &amp; Secure MCUs</th>
<th>Protections</th>
<th>LDO</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MCUs</strong></td>
<td><strong>Type-C Controller/ Interface</strong></td>
<td><strong>STM32G0, STM32G4, STM32L5</strong></td>
<td><strong>STSAFE-A</strong></td>
<td><strong>20 V</strong></td>
<td><strong>ST715</strong></td>
</tr>
<tr>
<td></td>
<td><strong>STM32F0, STM32F3</strong></td>
<td><strong>STUSB1602A</strong></td>
<td></td>
<td><strong>15 V</strong></td>
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<tr>
<td></td>
<td><strong>ESP8266</strong></td>
<td><strong>STUSB1600</strong></td>
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<td><strong>5 V</strong></td>
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</table>

**Typical configuration**

**Power supply**

Source port

**USB Type-C receptacle**

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

**USB Type-C receptacle**

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

**Power supply**

**Source port**

**USB Type-C receptacle**

**Sink port**

**USB Type-C receptacle**

**Typical configuration**

**Primary**

- PFC
- Secondary Controller
- MOSFETs
- Diodes

**Secondary**

- Load switch
- USB Type-C Interface (PHY)
- USBSIB

**Protection**

- Over voltage protection
- USB C and PD 3.0 controllers
- ESDL20-1BF4

**MAIN EVALUATION BOARDS AND REFERENCE DESIGNS**

<table>
<thead>
<tr>
<th>STEVAL-ISC004V1</th>
<th>STEVAL-ISC005V1</th>
<th>STEVAL-ISC003V1</th>
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<tbody>
<tr>
<td><strong>Type-C and USB-PD Controllers</strong></td>
<td><strong>Authentcation &amp; Secure MCUs</strong></td>
<td><strong>Protections</strong></td>
</tr>
<tr>
<td><strong>ESDA25P35-1U1M</strong></td>
<td><strong>ESDA27P20-1U0M</strong></td>
<td><strong>ESDA27P20-1U1M</strong></td>
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<tr>
<td><strong>ESDA24P120-1U0M</strong></td>
<td><strong>ESDA24P120-1U1M</strong></td>
<td><strong>ESDA24P120-1U1M</strong></td>
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<tr>
<td><strong>ESDA25W</strong></td>
<td><strong>ESDA27P120-1U0M</strong></td>
<td><strong>ESDA27P120-1U1M</strong></td>
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<td><strong>ESDA27P120-1U0M</strong></td>
<td><strong>ESDA27P120-1U1M</strong></td>
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**Note**: 1 available in Q4 2020
Automotive-grade USB Type-C and Power Delivery solution

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

The Type-C connector supports all the features of previous standards, and ports can be configured to only support 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 stage with synchronous rectification and for higher power, a Power Factor Corrector (PFC) working in Transition Mode (TM) followed by a flyback, forward or half-bridge LLC resonant stage with synchronous rectification.

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

ST’s recommended products for Tablets, Notebook and AIO Adapters

Typical Block Diagram with PFC Front-End

**KEY FEATURES**
- Digital control of phase-shift and synchronous rectification
- PWM programmable output voltages with 20 mA steps
- PPS-I / PPS-II programmable output current with 50 mA steps
- More details available on AN5362

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

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**ST’s recommended products for Tablets, Notebook and AIO Adapters**

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

Wireless chargers are expected to become ubiquitous in hotels, airports, cafes and other public places as they enable topping off the batteries of portable and wearable devices, letting the user forget about cables.

In a wireless battery charging system, power is transferred by electromagnetic induction (inductive power transfer) between a transmitting pad - or dongle (TX) - and the battery-powered device (RX), such as a smartphone, smartwatch or sports gear. The power transmitter unit controls the current in the transmitting coil to transfer the correct amount of power as required by the receiver unit that continuously provides this information to the transmitter by modulating the transmitter carrier frequency through controlled resistive or capacitive load insertion. Generating the correct amount of power guarantees the highest level of end-to-end energy efficiency and helps limit the device’s operating temperature.

We have a range of wireless battery charging solutions including transmitters and receivers providing low stand-by power and foreign objects detection (FOD) feature. In order to prevent unwanted damage to any NFC Cards that might be close to the wireless charging source during operation, it is recommended to add an NFC Reader. The NFC Reader is able to detect the presence of the NFC Card or Tag (ST Reader ICs can detect Type A, B, F, or V NFC Cards), and therefore instruct the operating system to stop transmitting power. ST also offers evaluation and development tools and reference designs to help develop high-efficiency and compact wireless chargers that are Qi compliant.

ST’s recommended products for Wireless Charging

- **Transmitter**
  - STEVAL-ISB047V1
  - STEVAL-ISB044V1
- **Receiver**
  - STEVAL-ISB066WA
  - STEVAL-ISB066RX
- **NFC Readers**
  - ST25R3911B-DISCO
  - ST25R3916-DISCO

**Typical Block Diagram**

**MAIN EVALUATION BOARDS AND REFERENCE DESIGNS**

<table>
<thead>
<tr>
<th>Transmitters</th>
<th>STEVAL-ISB047V1</th>
<th>STEVAL-ISB044V1</th>
<th>STEVAL-ISB04V1</th>
<th>STEVAL-QINFCAU1</th>
<th>STEVAL-ISB04V1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power MOSFETs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diodes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NFC reader</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transmitter</td>
<td>STEVAL-ISB60WA</td>
<td>STEVAL-ISB68RX</td>
<td>STEVAL-ISB60V1</td>
<td>STEVAL-ISB68V1</td>
<td>STEVAL-ISB68V1</td>
</tr>
</tbody>
</table>

**ST’s recommended products for Desktop PC’s Power Supply**

The requirements for the standard ATX PC power market are a small form factor with better performance. An intelligent control scheme that enables the adaption of load variation to minimize power consumption, together with optimized power semiconductors, is the key in meeting market demands. The smart analog and digital controllers, such as the STCM81 and the STNRG011, the high-voltage MDmesh™ Power MOSFETs used for the PFC and DC-DC stages, the low-voltage STripFET Power MOSFETs for synchronous rectification, and SiC diodes (STPS*) help designers develop the best PC power supply solutions to improve efficiency. ST’s DC-DC converters guarantee high power density for the post-regulation.

<table>
<thead>
<tr>
<th>PFC Block</th>
<th>Power MOSFETs</th>
<th>Voltage &amp; Diodes</th>
<th>Output Diodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Controller</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ST25V01, ST25V05</td>
<td>600 V - 1000 V</td>
<td>12 V, 15 V, 18 V</td>
<td>12 V, 15 V, 18 V</td>
</tr>
</tbody>
</table>

**Typical configuration**

**MAIN EVALUATION BOARDS AND REFERENCE DESIGNS**

<table>
<thead>
<tr>
<th>Transmitters</th>
<th>STEVAL-EL663S-250W</th>
<th>STEVAL-EL409W-EUL7</th>
</tr>
</thead>
<tbody>
<tr>
<td>250 W transition-mode PFC pre-regulator</td>
<td>12 V - 400 W SMPS for adapters and ATX power supplies</td>
<td></td>
</tr>
</tbody>
</table>
Server & Telecom Power

AC-DC PSU & DC-DC power distribution

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

In telecom system power, the use of complex digital ASICs for managing growing data traffic is pushing further the power envelope. 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 an extensive product and solution coverage to ensure the most advanced solutions for the Point-of-Load conversion and a recently developed innovative DC-DC conversion from the 48 V DC supply. ingredients for implementing the most efficient and most dense AC-DC 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’S product offering for Server and Telecom AC-DC PSU

Typical Block Diagram for Server PSU

**Input Stage (Rect. & inrush current limiter)**

- Controllers
  - CCM Analog Controllers
  - LLC Analog Controllers
  - MOSFETs & Digital Controllers

- Power MOSFETs
  - 600 V-650 V MDmesh M2
  - 600 V-650 V MDmesh M6
  - 600 V-650 V MDmesh DM2

- Bridge Rectifier Diodes
  - STP108, STP112

- Diodes & Discretes
  - 600 V Ultraval for LLC
  - STTH06
  - STNF12V5

**Diode & Surge Protection**

- TVS for Power MOSFET and Power Rail Surge Protection
  - SMA8F, SMA9F, SMB15, series

- Options
  - STP108, STP112, STP125, STP1400

**Main Evaluation Boards and Reference Designs**

- **STEV1-SA147V0**
  - 500 W fully digital AC-DC power supply (0-SMPS)

- **STEV1-SA172V2**
  - 2 kW fully digital AC-DC power supply (0-SMPS)

- **STEV1-DPS1LCK1**
  - 3 kW Full Bridge LLC resonant digital power supply

**EVLSTMREG-1kW**

- 1 kW SMPS digitally controlled multi-phase interleaved converter

- **STEV1-PFC0V1**
  - 3 kW three-channel digitally controlled interleaved FPC

- **STEV1-PFC0V2**
  - 2 kW two-channel digitally controlled interleaved FPC

- **STEV1-PFC2V1**
  - 2 kW two-channel digitally controlled FPC with digital inrush current limiter

**STEVAL-PFCSTFC1**

- 3.6 kW FPC (ds+ve) with digital inrush current limiter

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

**Note:** *available in Q4 2020
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 that will then be converted to provide the number of DC rails needed to supply the variety of 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 V to 12V intermediate bus conversion. Moreover we offer 12V 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 48V to the point of load, based on the Power Stamp Alliance (PSA) products.

Power Delivery for Modern Data Center

Dual Stage Conversion

Direct Conversion

48 V

48 V

5 V - 15 V

V_{POWER/MAN}

1° Stage (IBC)

STbuck

Transformer Based?

Multiphase Controller
PM67x

SPS PM7x

SPS PM7x

SPS PM7x

SPS PM7x

SPS PM7x

SPS PM7x

SPS PM7x

Direct Conversion* (Isolated/Non-Isolated)

Digital Power Distribution from 12 V Bus

Stacked Buck (STB)

Regulated Conversion

Switched Tank Converter (STC)

Unregulated Conversion

Digital Power

Direct Conversion from 48V to POL

Dual Stage Conversion

Direct Conversion

48 V

48 V

2° Stage (12 V)

Digital Power

Distribution from 12 V Bus

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

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

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

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

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

ST device family is ideal to design 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 as 12V, 5V and 3.3V.

High switching frequency eases the design of compact application while specific control techniques ensures best in class efficiency at heavy and light load operation.

Full programmability via high speed serial interfaces as I2C and PMBus® allows configurability to fit different application requirements.

Typical Block Diagram for SSD Power Management
Power over Ethernet (PoE)

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

We offer a range of products providing a 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 EVALUATION BOARDS AND REFERENCE DESIGNS

STEVAl-POE001V1
Power Over Ethernet (PoE) - IEEE 802.3bt compliant interface

STEVAl-POE002V1
5 V/8 A, synchronous flyback converter. Power over Ethernet (PoE) IEEE 802.3bt compliant reference design

STEVAl-POE003V1
12 V/8 A, active clamp forward converter. Power Over Ethernet (PoE) IEEE 802.3bt compliant reference design

STEVAl-POE004V1
3.3 V/20 A, active clamp forward converter. Power Over Ethernet (PoE) IEEE 802.3bt compliant reference design

Note: * is used as a wildcard character for related part number
LED TV Power Supply

Beyond their outstanding image quality, new-generation televisions have a very thin design, are highly power-efficient and feature a standby power mode. Power Supply Units (PSUs) play a key role in ensuring TVs meet market requirements and have an elegant form factor. To achieve these stringent requirements, PSUs typically have a Power Factor Corrector (PFC) stage and use advanced topologies, like half-bridge LLC (HB-LLC) resonant. ST offers a broad portfolio of high-voltage MDmesh™ and low-voltage STripFET™ power MOSFETs, field-effect rectifier diodes (FERD), Schottky and Ultrafast diodes, a full range of protection ICs as well as dedicated analog and digital switching controllers which negate the necessity of auxiliary power by consuming very low power at no load. In addition, STM32 microcontrollers enable developers to exploit the full potential of digital PSU implementations.

ST's recommended products for LED TV Power Supply

<table>
<thead>
<tr>
<th>Controllers</th>
<th>Power MOSFETs</th>
<th>Diodes</th>
<th>Op amp V/I Sensing</th>
<th>Isolation Stage</th>
</tr>
</thead>
<tbody>
<tr>
<td>PFC Block</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TM Analog Controllers</td>
<td>L6668A*, L6686, L6686L, L6686L1, STCH63</td>
<td>600 V - 650 V MDmesh M2</td>
<td>Precision 0 A Amps (&lt;50 MHz) T52&quot;, T59&quot;, LMN&quot;</td>
<td>Flyback Controllers</td>
</tr>
<tr>
<td>LM64 A &amp; Digital Controllers</td>
<td>STMM3920, STMM3930, STMM3930/1, STMM3934, STMM3934/4, STMM3934A</td>
<td>600 V - 650 V MDmesh M2</td>
<td></td>
<td>L6566A, L6568, L6568L, L6568L1, LLC Analog Controllers</td>
</tr>
<tr>
<td>CCM Analog Controllers</td>
<td>L8951*, L896B</td>
<td>600 V - 650 V MDmesh M2</td>
<td></td>
<td>PFC &amp; LLC Combos Controllers</td>
</tr>
<tr>
<td>MCC Analog Controllers</td>
<td>L8951*, L896B</td>
<td>600 V - 650 V MDmesh M2</td>
<td></td>
<td>STON6B1, STON6B2/1</td>
</tr>
<tr>
<td>LLC Analog Controllers</td>
<td>L6669*, L6689</td>
<td>600 V - 650 V MDmesh M2</td>
<td></td>
<td>Asymmetrical HB Controllers</td>
</tr>
<tr>
<td>MCC Analog Controllers</td>
<td>L6669*, L6689</td>
<td>600 V - 650 V MDmesh M2</td>
<td></td>
<td>L6591</td>
</tr>
<tr>
<td>M2A &amp; Digital Controllers</td>
<td>STMM3920, STMM3930, STMM3930/1, STMM3934, STMM3934/4, STMM3934A</td>
<td>600 V - 650 V MDmesh M2</td>
<td></td>
<td>SR Analog Controllers</td>
</tr>
<tr>
<td>MCC Analog Controllers</td>
<td>L6669*, L6689</td>
<td>600 V - 650 V MDmesh M2</td>
<td></td>
<td>SRK1000, SRK1001 for Flyback</td>
</tr>
<tr>
<td>Asymmetrical HB Controllers</td>
<td>L6591</td>
<td>600 V - 650 V MDmesh M2</td>
<td></td>
<td>SRK3000, SRK3001, SRK3002, SRK3000A for LLC</td>
</tr>
</tbody>
</table>

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

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

```
~ AC ---- Input Rect. ---- PFC ---- Flyback ---- Output Rect. ---- V_{INREC}

TM/CCM PFC controller
Flyback controller
Synch. Rect. controller
```

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

```
~ AC ---- Input Rect. ---- Interleaved PFC ---- Gate Driver ---- Output Rect. ---- V_{INREC}

Interleaved PFC
Gate Driver
Gate Driver
Gate Driver
Synch. Rect. controller
```

MAIN EVALUATION BOARDs AND REFERENCE DESIGNS

STEVAl-IPFC02V1
2 kW two-channel digitally controlled interleaved PFC

STEVAl-OPFC12V1
3.6 kW PFC inbati pole with digital inrush current limiter

STEVAl-OPFC12V1*
3.6 kW PFC inbati pole with digital inrush current limiter

EVLSTM01-G0011-150
12 V - 150 W power supply based on TM PFC and HB LLC digital combo controller

EVLSTM01-A0210W
12 V - 210 W adapter based on TM PFC and HB LLC analog combo controller

Note: * available in Q4 2020
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 meet the specific efficiency and size design targets.

ST’s broad product portfolio includes highly-integrated DC-DC converters and PWM controllers, power MOSFETs and rectifiers, protection ICs, 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 our eDesignSuite that 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

Synchronous buck converter

Asynchronous buck converter

Multi-phase Buck controller

Single-phase buck controller

MAIN EVALUATION BOARDS AND REFERENCE DESIGNS

STEVAL-ISA152V1
Asynch. buck up to 60 Vin, 3.3 Vout - 3 A Iout

STEVAL-ISA208V1
Synch. Buck 38 Vin, 5 Vout 3 A Iout

STEVAL-1PS02B
Synch. Buck with Aux Switch, 5.5 Vin, Dynamic Voltage Selection up to 2.5V - 400 mA

STEVAL-ISA205V1
Synch. Buck 12 Vin, 3.3 Vout 2 A Iout, Auto. Grade

ST’s product offering for Switching Converters (DC-DC)

STB83T

L6920DB/DC

ST8R00

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

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

### MAIN EVALUATION BOARDS

**STEVAL-ISA203V1**
- Input Voltage range: 42 - 56 V DC
- Switching Frequency - 250 kHz
- Output:  
  - Power: 60 W
  - Voltage: 12 V DC  
- Current: 5 A
- Peak Efficiency > 94%

**STEVAL-ISA204V1**
- Input Voltage range: 42 - 56 V DC
- Switching Frequency - 250 kHz
- Output:  
  - Power: 100 W  
  - Voltage: 5 V DC  
- Current: up to 20 A
- Peak Efficiency > 94%

**STEVAL-1PS01A/R/1PS01D/R/1PS01EJR**  
Evaluation board based on the ST1PS01 400 mA nano-quieted synchronous step-down converter with digital voltage selection

**STEVAL-1PS02**  
Evaluation board based on the ST1PS2 400 mA nano-quieted synchronous step-down converter with digital voltage selection and AUX switch

**STEVAL-LD0001V1**  
Quad high performance LDO evaluation board based on LD1212, LD1225, LD39130S and STLQ020
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 dimension of the application, including retrofit bulbs, high-bay lights, low-bay lights, 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 the smart home, smart building and smart city environment. ST’s portfolio includes a variety of RF transceivers, Bluetooth Low Energy (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, software for BLE Mesh enables mesh networking of connected smart lighting end products. Modern applications include a range of connectivity features to implement remote monitoring and control, making LED lighting

Typical Block Diagram

ST’S product offering for LED General Illumination

Note: 1 available in Q4 2020

STGAP* L649*, L6395 PM88*1

Main Evaluation Boards

EVLHLED007W3SF 35 W LED driver with very low THD, based on Transition Mode Flyback converter (Odie)
EVAL-PSR018-3SW 35 W LED Driver with very high efficiency based on GR Flyback converter with PSR (Cloud)
EVAL-IBD002-3SW 35 W inverse buck with LED current control and with Analog/PWM dimming

STEVAL-ILL079V4 35 W LED Driver with very high efficiency based on CC GR flyback converter
STEVAL-LLL004V1 75 W AC-DC digitally controlled non isolated constant current LED driver
STEVAL-ILL078V1 1A, up to 60 V Vin, buck LED driver with digital dimming

Main Evaluation boards

STEVAL-ILL070V4

STEVAL-LLL004V1

STEVAL-ILL078V1

EVLHLED007W3SF

EVAL-PSR018-3SW

EVAL-IBD002-3SW

STEVAL-ILL079V4

STEVAL-LLL004V1

STEVAL-ILL078V1

EVLHLED007W3SF 35 W LED driver with very low THD, based on Transition Mode Flyback converter (Odie)
EVAL-PSR018-3SW 35 W LED Driver with very high efficiency based on GR Flyback converter with PSR (Cloud)
EVAL-IBD002-3SW 35 W inverse buck with LED current control and with Analog/PWM dimming

STEVAL-ILL079V4 35 W LED Driver with very high efficiency based on CC GR flyback converter
STEVAL-LLL004V1 75 W AC-DC digitally controlled non isolated constant current LED driver
STEVAL-ILL078V1 1A, up to 60 V Vin, buck LED driver with digital dimming
LED Street Lighting

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

We have a broad range of wired and wireless connectivity, power management and LED driving solutions. A range of high-to-specific road and weather conditions to support administrations transforming cities in Smart Cities.

**Typical Block Diagram**

**ST’S product offering for LED Street Lighting**

<table>
<thead>
<tr>
<th>Controllers</th>
<th>Power MOSFETs</th>
<th>Diodes &amp; Discrete</th>
<th>MOSFET and IGBT Gate Drivers</th>
</tr>
</thead>
<tbody>
<tr>
<td>TM PFC Analog Controllers L6852, L6853, L6854</td>
<td>800 V to 1050 V DMesh KS</td>
<td>60 V - 100 V VSMPFET F7</td>
<td>Single LG Gate Drivers PM691*</td>
</tr>
<tr>
<td>COM PFC Analog Controllers L4481, L4484D</td>
<td>950 V DMesh DNS</td>
<td></td>
<td>Multiple LG Gate Drivers PM8634</td>
</tr>
<tr>
<td>Offline LED drivers MAXE9015A, MAXE9027</td>
<td>600 V - 650 V DMesh M2</td>
<td>SC Diodes SR*60M2</td>
<td></td>
</tr>
<tr>
<td>PFC &amp; LCC Comb Controller STM081, STM9012</td>
<td>500 V - 606 V DMesh M6</td>
<td>Output Diodes for Flyback Schottky, FERD, Ultrafast</td>
<td></td>
</tr>
<tr>
<td>LLC Comb Controller L6699, L6699A</td>
<td>600 V - 650 V DMesh DM2</td>
<td>STP<em>100, FERD</em>100</td>
<td></td>
</tr>
<tr>
<td>MCUs &amp; Digital Controllers STM32F0, STM32G0, STM32F270, STM32F274, STM32F4, STM32Q4, STM32L0</td>
<td>600 V - 650 V DMesh MS2</td>
<td>Output Diodes for LCC/LCC Schottky, FERD</td>
<td></td>
</tr>
<tr>
<td>SR Analog Controllers SRX1000, SRX1010 for Flyback SRX2030A, SRX3030, SRX3030A for LLC</td>
<td>500 V - 606 V DMesh MS2</td>
<td>STP<em>100, FERD</em>100</td>
<td></td>
</tr>
</tbody>
</table>

**MAIN EVALUATION BOARDS**

**STEVAL-LLL006V1**

100 W - 1.4 A constant current LED Driver with Driac sub-1GHz connectivity based on QR flyback and inverse buck converters.

**EVLOWLED-STC02**

80 W - 1.4 A primary side current loop control LED driver based on DR flyback and inverse buck converters.

**STEVAL-ILL059V2**

100 W LED street lighting with DALI2.0 communication interface using the STLUC365A digital controller.
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 including protection features such as under-voltage lockout (UVLO) and in-rush current limitation as well as the control of the 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, optimized DC-DC conversion solutions for supplying the LEDs.

Typical Block Diagram

ST’S 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>
</tr>
</thead>
<tbody>
<tr>
<td>IEEE 802.3AT</td>
<td>TVS for Power Rail Surge Protection SMA4F, SMB15F</td>
<td>Buck LED8000</td>
<td>60 V-100 V STripFET F7 STM8F767, STM8F768, STM8F769 Fischler Diodes STPS*</td>
</tr>
<tr>
<td>IEEE 802.3AT</td>
<td>TVS for Power Rail Surge Protection SMA4F, SMB15F</td>
<td>Inverse Buck LED6002</td>
<td>60 V-100 V STripFET F7 STM8F767, STM8F768, STM8F769 Fischler Diodes STPS*</td>
</tr>
</tbody>
</table>

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

MAIN EVALUATION BOARDS

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

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

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’s 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’s updated in 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’S product offering for Lighting Controls

<table>
<thead>
<tr>
<th>LED Driver</th>
<th>Power Management</th>
<th>KNX Transceiver</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital Controllers</td>
<td>STLUX Development Tools STW8-STLUXD02, STSW-STLUXD002</td>
<td>STW8-STLUXD02, STSW-STLUXD001, STSW-STM32D002</td>
</tr>
<tr>
<td>MDC2</td>
<td>STM32F, STM32L1, STM8</td>
<td>Refer to LED General Illumination section</td>
</tr>
<tr>
<td>STP Protection on KNX Bus SMA4FCA-TR</td>
<td></td>
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</tr>
</tbody>
</table>

MAIN EVALUATION BOARDS

STEVAL-ILL060V2
100 W LED street lighting evaluation board with DALI 2.0 communication interface using the STLUX385A digital controller

STEVAL-ILM001V1
Plug-in hardware module for the STM32 DISCOVERY interface for DALI communication
ELECTRO-MOBILITY

Key applications

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

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

ST provides a comprehensive portfolio of semiconductor solutions to support the electrification of vehicles, ranging from basic power diodes and thyristors to advanced SiC MOSFETs and SiC Schottky diodes. ST’s solutions enable the optimization of energy consumption, efficiency, and performance in electric vehicles.

**Typical Block Diagram of LED Wireless Programming**

The diagram illustrates the flow of data and components involved in the LED wireless programming process. It shows the interaction between the NFC Reader + MCU, STMicroelectronics’ Microcontrollers, Dynamic NFC Tag, and LED Driver, all within an electromagnetic field.

**ST’S product offering for LED Wireless Programming**

| NFC/RFID Reader IC | 
|---------------------|---|
| **NFC Reader + MCU** | ST25R |
| **Protection** | STIM8, STIM32F0, STIM32G0 |
| **Microcontrollers** | | |
| **LED Driver for high-end market** | ST25DV/FC Series |
| **Antenna Protection Reader**: ESD2V18-18F4 | Tag: USBL06-2066 |
| **MCUs and Digital Controllers** | M4LE001*, M4LE002, L4LE001*, LED0000, LED2000 |
| **LED Driver**: STP04/08/16/24, LED12/16/24* |
| **LED Driver for entry-level market** | ST25DV/PWM Series |
| **Dynamic NFC Tag with PWM Output** | | |
| **Antenna** | | |
| **NFC/RFID Reader IC** | | |
| **Microcontroller** | | |

**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.

**Main Evaluation Boards**

- **ST25R3911B-DISCO**: Discovery kit for ST25R3911B high-performance HF reader/NFC
- **ST25DV-PWM-eSET**: Discovery kit for ST25DV-PWM NFC/RFID tag IC
- **ST25DV-DISCOVERY**: Discovery kit for ST25DV04 Dynamic NFC/RFID tag IC

**Solutions**

ST’s key products and solutions for Electro-Mobility applications include.

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

**Hardware & Software Development Tools**

- **Sample Kits**
- **Evaluation Kits**
- **Product Selectors**

**FIND OUT MORE**

- **www.st.com/electro-mobility**
- **Battery Management System (BMS)**
- **Charging Station**
- **DC-DC Converter**
- **Small Electric Vehicles**
- **Electric Traction (Main Inverter)**
- **Mild Hybrid 48 V Systems**
Main Traction Inverter

The traction inverter converts energy from the vehicle’s battery to drive the electrical engine. This key component has a direct impact on a vehicle’s road performance, driving range and reliability, which also depends on the inverter’s 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 currents along with the associated Electro Magnetic Compatibility (EMC) challenges as well as provide fail-safe operation to ensure dependability and safety for the driver and passengers. To help developers increase the inverter’s 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.

Bidirectional DC/DC Converter

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

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

FIND OUT MORE
www.st.com/main-inverter-electric-traction

FIND OUT MORE
www.st.com/bidirectional-dc-dc-converter
On-Board Charger (OBC)

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

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

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

Start-Stop System

A start-stop system aims at reducing the amount of engine idle time, by shutting down and restarting the internal combustion engine automatically when the vehicle stops. Thus, it contributes to improving fuel economy and reducing CO2 emissions. This is especially useful in urban environments where vehicles can spend significant amounts of time in traffic.

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

ST’s solutions include silicon power MOSFETs, protections, gate drivers and microcontrollers which are in accordance to AEC-Q100 and AEC-Q101 standards.

48 V Start-Stop System

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ST’s solutions include silicon power MOSFETs, protections, gate drivers and microcontrollers which are in accordance to AEC-Q100 and AEC-Q101 standards.
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 150 km driving range in just 10-12 minutes.

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

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

Typical Block Diagram

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**ST’S product offering for DC Fast Charging Station**

<table>
<thead>
<tr>
<th>Input stage</th>
<th>DC/DC Control units</th>
<th>Driving stage</th>
<th>Current sensing &amp; signal conditioning</th>
<th>Aux SMPS</th>
<th>HMI</th>
<th>Metering</th>
<th>Connectivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>3ph PFC</td>
<td>1st side</td>
<td>2nd side</td>
<td>1st side</td>
<td>2nd side</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Recollers**
- SiC series - 650 V
- SiC series - 1200 V
- Ultralast RQ series - 600 V
- Ultralast R series - 600 V
- STBR series - 800V/1200V
- Schottky series - 40/45/60/100V

**Thyristors**
- TN series - 1200 V
- TNX series - 1200 V
- TM505H series - 800 V
- TN305KH, TN1505KH series - 1200 V

**TVS protections**
- SMARTY, SM6TY, SM15TY, SM30TY

**HMI ESD protections**
- ESDAxxY series, EMIF06-1005MX12Y

**Power MOSFETs**
- SiC series - 650/1200 V
- M5 series - 650 V
- M6 series - 650V/550 V
- DM6 series - 600/1000 V
- DM2 series - 600V/550 V
- KS series - 1200 V

**IGBTs**
- H series - 1200 V
- HB series - 650 V
- HB2 series - 650 V
- V series - 600V

**ACEPACK Power Modules**
- Customized modules

**MCUs (32bit)**
- STM32F334, STM32F4, STM32F3
- STM32F2L, STM32F1, STM32G

**Gate drivers**
- L6941
- STGAP1AS

**Memories (EEPROM)**
- M24**, M95**

**Current sense amplifiers**
- TSC102, TSC2010, TSC2011, TSC2012

**Power line transceivers**
- ST2100

**Bluetooth**
- 5.0 and Wireless M20

**Low Energy Transceivers**
- Modules

**NFC/Rfid**
- Dynamic tags

**Metrology IDs**
- STM32, STM32, STM32

**LED array drivers**
- LED1642, STP08, STP16, LED77*, LED4025

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Note: * is used as a wildcard character for related part number
**INDUSTRIAL POWER & TOOLS**

**Industrial Welding**

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

The main requirements in an SMPS for welding are high efficiency and reliability as well as power density to enable lighter and more compact designs. We have a range of power MOSFETs and diodes – both Si and SiC based for higher efficiency – and IGBTs as well as galvanically isolated gate drivers and high-performance 32-bit STM32 microcontrollers to enable compact designs with higher efficiency.

**ST’S product offering for Industrial Welding**

<table>
<thead>
<tr>
<th>MOSFET/IGBT Drivers</th>
<th>Power MOSFETs</th>
<th>Diodes &amp; Discretes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single LS Gate Drivers PM1F1, TDO1*</td>
<td>600 V-650 V MOSFET M02</td>
<td>650 V Ultrafast STM10W06, STM10W09, STT10Y10</td>
</tr>
<tr>
<td>Multiple LS Gate Drivers PM1M4</td>
<td>600 V-650 V MOSFET M06</td>
<td>1200 V Ultrafast STTH12</td>
</tr>
<tr>
<td>Isolated Gate Drivers STIAM*</td>
<td>650 V-650 V MOSFET M15</td>
<td>SC Diodes STPS106S, STPS21H2</td>
</tr>
<tr>
<td>HV HB Gate Drivers L409</td>
<td>650 V-650 V MOSFET M2</td>
<td>TVS for Power Rail Surge Protection STM1, STM1Y, SMCo2J series</td>
</tr>
</tbody>
</table>

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

1. **PFC (optional)**
2. **Bus Voltage**
3. **Primary Side Power Stage**
4. **Controller**
5. **HF Transformer**
6. **Rectifier**
7. **Inductor**
8. **Welding Torch**
9. **Working Piece**
10. **Output Current / Voltage sensing**

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

1. **PFC (optional)**
2. **Bus Voltage**
3. **Primary Side Power Stage**
4. **Controller**
5. **HF Transformer**
6. **Rectifier**
7. **Inductor**
8. **Transformer**
9. **Primary Current sensing**
10. **Secondary Inverter**
11. **Welding Torch**
12. **Working Piece**
13. **Output Current / Voltage sensing**

Note: * is used as a wildcard character for related part number.
Uninterruptible Power Supplies (UPS)

Uninterruptible Power Supplies (UPS) ensure continuity of supply by converting the DC voltage from a battery or battery bank to an AC voltage with the requested amplitude and frequency in case of power outages. Depending on application requirements, an UPS can be built with a simple off-line configuration or with a double conversion on-line 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 MOSFETs as well as galvanically-isolated and high-voltage gate drivers, PFC controllers and high-performance STM32 microcontrollers to enable high-efficiency, high-reliability UPS designs.

ST’s product offering for Uninterruptible Power Supplies (UPS)

| Rect. & inrush current limiter | SCRs & TRVs | DC-AC | DC-DC | Diodes | Gate drivers | Protection
|-----|-----|-----|-----|-----|-----|-----
| High Temp. SCR | TNY15H-16, TNY600H-18, TNY500H-12W | Bridge Rectifier Diodes | STBR06, STBR12 | Bypass | Diodes | Rectifier & inrush current limiter

Uninterruptible Power Supplies

Refrigeration, Washing, Drying and Miscellaneous Equipment

The white goods market requires low-cost and high-energy-efficiency solutions. The refrigeration, washing, drying and the miscellaneous (Air conditioner, water heater) equipment are some of the major home appliance applications that ST, thanks to its wide product portfolio, is able to satisfy with suitable and dedicated power products and high-performing STM32 microcontrollers combined with complementary gate drivers (LS8F and LS89F). Using SiC diodes (STPS4C), high-voltage MDmesh MOSFETs or suitable field-stop trench-gate IGBTs, high-efficiency PFC is guaranteed. To reduce the 3-phase inverter design effort, ST offers the SLIMIM™ 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 IGBTs/MOSFETs with the new 3-phase gate drivers STDRIVE601. High reliability against the inrush current is ensured by new SCRIs in the front-end stage.

ST’s product offering for Refrigeration, Washing, Drying and Miscellaneous Equipment

| Rect. & inrush current limiter | SCRs & TRVs | DC-AC | DC-DC | Diodes | Gate drivers | Protection
|-----|-----|-----|-----|-----|-----|-----
| High Temp. SCR | TNY15H-16, TNY600H-18, TNY500H-12W | Bridge Rectifier Diodes | STBR06, STBR12 | Bypass | Diodes | Rectifier & inrush current limiter

STMicroelectronics
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 the LED and LCD display drivers, touchscreen controllers and proximity and sensors required for touch or touch-less user interfaces.

ST’s product offering for Induction Cooking

<table>
<thead>
<tr>
<th>Topology example</th>
<th>Single-switch quasi-resonant (voltage resonance)</th>
<th>STMicroelectronics</th>
<th>IGBTs</th>
<th>MOSFET and IGBT Gate Drivers</th>
<th>Sensors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STMM*</td>
<td>STM32/STM100</td>
<td></td>
<td>Multiple LS Gate Drivers PM8614</td>
<td>Environmental Sensors</td>
</tr>
<tr>
<td></td>
<td>1250 V Br series STSTY15-125DF</td>
<td></td>
<td></td>
<td>Single LS Gate Drivers PM8614*</td>
<td>Humidity - HTS221</td>
</tr>
<tr>
<td></td>
<td>STMS1021</td>
<td></td>
<td></td>
<td>MOSFET and IGBT Gate Drivers</td>
<td>Temperature - STM320</td>
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<td>Temperature - STS751</td>
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<td>Motion Sensors</td>
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<td>Accelerometer - EKDN60</td>
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<td></td>
<td>Proximity Sensors</td>
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<td>TSP - VL53L, VL6180*</td>
</tr>
</tbody>
</table>

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

SMART SIMULATOR AND SYSTEM DESIGN ENGINE

- Automatic proposal for complete solution or fully customizable design
- Fully annotated and interactive schematics
- Complete and interactive bill of materials
- Set of analysis diagrams (main current and voltage simulations, efficiency curves, Bode stability and power-loss data)
- Fully interactive transformer design
- NFC design based on STNRGPF digital controllers including C code generation

Power conversion and LED lighting

- Power MOSFETs, Diodes, AC Switches
- Part numbers proposed based on application electrical specifications
- I/V curves comparison among several part numbers
- Power losses calculated based on voltage/current target application waveform

SIMULATORS AND SMART SELECTORS

- Power MOSFETs, Diodes, AC Switches
- Part numbers proposed based on application electrical specifications
- I/V curves comparison among several part numbers
- Power losses calculated based on voltage/current target application waveform

CONFIGURATORS

- STLUX & STNRG SMEDs configurator
- SMED configurator schemes
- Input configuration
- Clock, comparators and ADC settings
- FSM (finite state machine) configuration
- C code generation
- Load register setting on board in a click

Software tools

eDesignSuite is a comprehensive and flexible suite of design aid utilities and engineering tools, that streamlines development of winning solutions with a wide range of ST products meeting user’s application requirements.

Explore the advanced features of our Power Management Design Center, an on-line design tool that smartly helps designers of power management systems and subsystems accelerating the engineering development process - select-evaluate-refine and prototyping - for a large and growing number of ICs and Discrete in our broad portfolio.

The software tool supports a variety of switching power converters, in power supply, LED lighting and battery charger applications, making easy the design path from user’s specification to circuit’s analysis and customization.

The main features of the tool are: automatic proposal for complete solution or fully customizable design, fully annotated and interactive schematics, complete and interactive bill of materials, main current and voltage simulations, efficiency curves, Bode stability and power-loss data, and fully interactive transformer design.
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 a wide-range mains operation. These devices embed advanced protection features, which make 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*

Commercial and street lighting
L6562A*, L6563*, L6564*, L4981*, L4984D

Desktop PCs and Servers
L4981*, L4984D

www.st.com/ac-dc-conversion
www.st.com/pfc-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/AR</th>
<th>Program control</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRK1000</strong></td>
<td>100 V</td>
<td>185 V</td>
<td>-</td>
</tr>
<tr>
<td><strong>SRK1001</strong></td>
<td>-</td>
<td>-</td>
<td>SOT23-6L</td>
</tr>
</tbody>
</table>

**SYNCRONOUS RECTIFICATION BENEFITS**
- Improved efficiency
- Better thermal performance
- High power density
- Increased reliability

### SR controllers for LLC resonant

<table>
<thead>
<tr>
<th>Basic features</th>
<th>Matched turn-off threshold</th>
<th>Auto-compensation of parasitic inductance</th>
<th>Reduced adaptive turn-on delay</th>
<th>Reduced masking time (<em>current inversion comparator</em>)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRK2000A</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>SRK2001</strong></td>
<td>-</td>
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<td>-</td>
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<tr>
<td><strong>SRK2001A</strong></td>
<td>-</td>
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<td>-</td>
</tr>
</tbody>
</table>

### MAIN APPLICATIONS

- **High-power adapters and TVs**
  - SRK1000, SRK1001
- **Desktop PCs and Server/Telecoms**
  - SRK2000A, SRK2001, SRK2001A

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

**Available in Q4 2020**

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

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### PWM and resonant controllers

ST’s portfolio of advanced controllers includes a variety of primary controllers intended to fit high-performance applications. Very high efficiency is achieved with single-ended topologies at a fixed switching frequency or with quasi-resonant operation; the new STCH03 offline constant-current primary-side regulation controller (PSR-CC) guarantees very low power consumption at no load condition. For high-power, high-current applications, ST offers controllers for half-bridge resonant and asymmetrical half-bridge controllers. The STCM81 and STNRG011 combo controllers including high-voltage start-up, Xcap discharge circuit, PFC and resonant driving stages, guarantee high performance and high integration with a smaller pinout. The new STNRG012 is specifically designed to support LED lighting and industrial applications requiring DC source management, with additional THD optimizer function.

### Flyback controllers

- **STCH03**
  - Offline quasi-resonant controller in SO-8 package
  - Constant-current primary-side regulation mode (PSR-CC) or constant-voltage regulation with optocoupler
  - Advanced burst mode operation (< 10 mW consumption @ no load)
  - UVP, autorestart/latched OVP and internal OTP
  - 650 V HV start up

- **L6566**
  - Offline fixed-frequency or quasi-resonant controllers
  - S suited for SMPS with PFC front-end (A version)
  - S suited for SMPS with 3-phase mains (BH version)
  - 700 V start-up (A/B version), 840 V start-up (BH version)
  - Brownton protection

- **L6565**
  - Offline quasi-resonant controller
  - Constant power vs mains change
  - Ultra-low start-up current

### HB-LLC resonant controllers

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

- **L6599A**
  - PFC interface
  - Brown out
  - 700 V start-up voltage

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

- **STCM81**
  - 800 V start-up voltage
  - Embedded X-cap discharge circuit
  - Transition Mode (TM) PFC control method
  - Self-adjusting dead-time and anti-capacitive mode for LLC

### 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)

- **STNRG012**
  - Enhanced fixed on time multi-mode TM PFC controller
  - Time-shift control of resonant half-bridge
  - ROM memory for SW digital algorithms
  - NVM memory for programmable key application parameters

### Asymmetrical half-bridge controller

- **L6691**
  - PFC interface
  - Brown out
  - 700 V start-up voltage

### Main applications

- **Desktop PCs, commercial and street lighting**
  - L6699, STCM81, STNRG011

- **High-power adapters and TVs**
  - L6565, L6566*, STCH03, STCM81, STNRG011

- **Laptops**
  - L6565, L6566*, STCH03, STCM81, STNRG011

- **Tablets and smartphones**
  - L6565, L6566*, STCH03

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

**Available in Q4 2020**

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

Signal conditioning devices include Operational Amplifiers and Current Sensing 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**
  - 5 V zero-drift amplifier
  - Input offset voltage 25 µV max
  - Gain bandwidth 3 MHz
- **TSE712, TSE7192**
  - 36 V amplifier
  - Input offset voltage 300 µV max
  - Gain bandwidth 6 MHz (unity gain stable) or 22 MHz

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

**MAIN APPLICATIONS**

Wireless battery charger transmitters

Adapter

Server/Telecom

Solar

UPS

Lighting

Factory automation

Typical application schematic for high-side current measurement

Comparators
- **TSC201**
  - Operating voltage: -20 to 70 V
  - Amplification gain x20 x50 x100
  - Gain error: 0.3% max
  - Packages SO8
- **TSC202**
  - Propagation delay: 38 ns
  - Low current consumption: 73 µA
  - Rail-to-rail inputs
  - Push-pull outputs
  - Supply operation from 1.8 to 5 V

**MAIN APPLICATIONS**

Adapters

Battery chargers

Residential, commercial and street lighting

www.st.com/ac-dc-converters

www.st.com/voltage-and-current-controllers

Typical application schematic for fault detection using a non-inverting comparator, with hysteresis
BATTERY MANAGEMENT ICS

Battery chargers and battery monitoring ICs

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

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Battery chargers

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2 A</td>
<td>STBCFG01</td>
</tr>
<tr>
<td>1 A</td>
<td>L6924D, L6924D</td>
</tr>
<tr>
<td>0.8 A</td>
<td>STC4054, STDC08</td>
</tr>
<tr>
<td>0.65 A</td>
<td>STBC03</td>
</tr>
<tr>
<td>0.45 A</td>
<td>STBC02</td>
</tr>
<tr>
<td>0.2 A</td>
<td>STN501</td>
</tr>
<tr>
<td>0.04 A</td>
<td>STBC15</td>
</tr>
</tbody>
</table>

ST’s battery fuel gauge ICs can be located in the battery pack or in the handheld device and integrate functions to monitor the battery voltage, current and temperature. Using a built-in Coulomb counter, these fuel gauge ICs calculate battery charge and store the data in 16-bit register resolution for retrieval by the system controller. Access is via an industry-standard I2C interface, enabling the controller to create an accurate graphical representation of the remaining battery-operating time.

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STC3115

- OptimGauge™ algorithm for STC3115
- OptimGauge+™ algorithm for SCT3117

STC3117

- Programmable low battery alarm
- Internal temperature sensor

FUEL GAUGE ICS MAIN BENEFITS

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

STWBC-WA, STWBC-EP, STWBC-MC

- Supports applications up to 5 W
- Qi A11 certified

STWBC-WA

- Supports applications up to 2.5 W
- Wireless power transmitter dedicated to wearables
- Qi extended power certified

STWBC-EP

- Supports application up to 15 W
- Qi extended power certified

STWBC-MC

- Support multi-coil applications up to 15 W
- Qi extended power certified

Wireless power transmitters

STWLC68

- Qi 1.2.4 certified
- Supports applications up to 15 W in proprietary mode
- Supports up to 7.5W Tx (dependant on coil)
- Industry leading efficiency
- Accurate voltage and current measurements for FOD
- Robust device protection from over-voltage events

Wireless charging ICs

ST fully covers wireless charging applications with dedicated ICs for both transmitter and receiver. The STWBC, STWBC-EP and STWBC-MC, compatible with Qi standard, and the STWBC-WA, dedicated to wearable applications, make-up ST’s wireless power transmitters (Tx) family. The receiver family (Rx) consists of the STWLC68 dedicated to Qi compliant consumer applications.

Wireless power transmitters

STWLC68

- Supports application up to 15 W
- Qi extended power certified

STWBC-WA

- Supports applications up to 5 W
- Qi A11 certified

STWBC-EP

- Supports applications up to 2.5 W
- Wireless power transmitter dedicated to wearables
- Qi extended power certified

STWBC-MC

- Support multi-coil applications up to 15 W
- Qi extended power certified
DC-DC controllers

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

**Single-phase Buck controllers**
- **L672***
  - Single-phase cost effective PWM controller
- **L673***
  - Single-phase PWM controller with embedded driver and light load efficiency optimization
- **PM6680**
  - Analog single-phase controller with SVID with embedded gate driver
- **PM6697**
  - Dual-output PWM controller up to 36Vin

**Multi-phase Buck controllers**
- **PM676***
  - Fully digital buck controller with PMBus for CPU/DDR
- **PM677***
  - Fully digital buck controller with PMBus for advanced CPU/DDR

**MAIN APPLICATIONS**
- Servers
- Microservers
- Telecoms
- PC desktop

---

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

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- **PM676***
  - Fully digital buck controller with PMBus for CPU/DDR
- **PM677***
  - Fully digital buck controller with PMBus for advanced CPU/DDR

**MAIN APPLICATIONS**
- Servers
- Microservers
- Telecoms
- PC desktop
DIGITAL POWER CONTROLLERS AND MICROCONTROLLERS

Digital power controllers

ST’s offers a number of advanced digital controllers, featuring innovative solutions to optimize converter efficiency in a wide range of load conditions (especially at light loads) and to have more flexibility. ST offers two main digital controller families tailored for specific applications: STLUX for lighting and STNRG for power conversion. In STLUX and STNRG families, the innovative SMED (state machine, event-driven) digital technology and the integrated microcontroller make STLUX and STNRG easily programmable and versatile. SMED is a hardware state machine triggered by internal or external events.

Digital controllers tailored for power conversion and lighting applications

STNRG
• Common features
• Innovative digital control technique based on 6 programmable SMEDs with max PWM resolution of 1.3 ns
• Customizable algorithm for higher conversion efficiency
• Internal 96 MHz PLL
• Operating temperature -40 to 105°C
• Serial, I2C and GPIO interfaces

STNRG*
• Digital controller tailored for power conversion
• Up to 4 comparators with external reference

STLUX
• Digital controller tailored for lighting applications
• Suitable for primary-side regulation and multi-string lighting applications
• DALI 2.0 for remote control and connectivity

Digital controller for interleaved CCM boost PFC

STNRGPF01  STNRGPF02  STNRGPF12
• Digital controller fully configurable through GUI for fast and easy design, does not require writing any firmware
• Mixed signal architecture
• 3-channel interleaved boost PFC (STNRGPF01)
• 2-channel interleaved boost PFC (STNRGPF02 and STNRGPF12)
• Inrush current limiter (digital with STNRGPF12, mechanical with STNRGPF02)
• Ideal for wide power range above 500 W
• Reduced EMI filter and inductor volume
• Reduced output capacitor RMS current
• Flexible working frequency up to 300 kHz to drive both MOSFETs and RGBs
• Configurable phase shedding for wide load range high efficiency conversion
• Programmable fast overcurrent and thermal protection (STNRGPF02 and STNRGPF12)
• On-chip UART/I2C digital interfaces for convenient connectivity
• Ideal for outdoor applications with -40 to +105°C operating range

Digital microcontrollers

STMicroelectronics (STM) offers a number of advanced digital controllers, featuring innovative solutions to optimize converter efficiency in a wide range of load conditions (especially at light loads) and to have more flexibility. ST offers two main digital controller families tailored for specific applications: STLUX for lighting and STNRG for power conversion. In STLUX and STNRG families, the innovative SMED (state machine, event-driven) digital technology and the integrated microcontroller make STLUX and STNRG easily programmable and versatile. SMED is a hardware state machine triggered by internal or external events.

Main applications

Solar
HEV charging stations
UPS
Factory automation
Commercial, architectural and street lighting

Main applications

Solar
HEV charging stations
UPS
Factory automation
Commercial, architectural and street lighting

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 particularly 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.

Finally, the STM32H7 series has a 32-bit ARM® Cortex®-M7 running at 480 MHz with precision FPU, DSP and advanced MPU. These MCU specifically address digital power conversion applications such as digital switched-mode power supplies, lighting, welding, solar, wireless charging, motor control and way more.

STM3200
• 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

STM32G474
• Cortex®-M4 core
• High resolution timer V1 (217ps resolution) with waveform builder and event handler
• 12-bit ADCs up 2.5 Msps conversion time
• Built-in analog peripherals for signal conditioning and protection (25ns from fault input to PWM stop)

STM32G0
• ARM Cortex®-M4 up to 170 MHz

STM32F334
• Cortex®-M4 core
• High resolution timer V1 (217ps resolution) with waveform builder and event handler
• 12-bit ADCs up 2.5 Msps conversion time
• Built-in analog peripherals for signal conditioning and protection (25ns from fault input to PWM stop)

STM32H743
• Cortex®-M7 core
• High performance up to 480 MHz
• High resolution timer V1 (2.1ns resolution) for real time control
• High-speed ADCs for precise and accurate control (3.6 Msps)

STM32G474 block diagram

Connectivity
4x SPI, 4x I2C, 1x UART
1x USB-C PD3.0 (+PHY)
3x CAN FD
2x FS half duplex, TAI

External Interface
PMIC 8-BIT / 16-BIT FPGA, DDR, DRAM, SDRAM, Nor Flash
Quad SPI

Accelerators
ART Accelerator™
32-Bit CCS-SRAM

Math Accelerators
16-bit (High) Floating Point

Timers
1x 16-bit timers
1x 16-bit basic timers
1x 16-bit advanced motor control timers
1x 32-bit timers
1x 16-bit LP timer
1x 16-bit (25MHz) 12-channel mc 104pm A, delay line

Analog
3x 12-bit ADC w/ PWM conversion
7x Comparators
7x DAC (3x 16-bit + 4x 8-bit)
1x 8-channel 7.5kΩ

Memory Protection Unit

External Interface

ART Accelerator™
32-Bit CCS-SRAM

Math Accelerators
16-bit (High) Floating Point

Timers
1x 16-bit timers
1x 16-bit basic timers
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1x 32-bit timers
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1x 16-bit (25MHz) 12-channel mc 104pm A, delay line

Analog
3x 12-bit ADC w/ PWM conversion
7x Comparators
7x DAC (3x 16-bit + 4x 8-bit)
1x 8-channel 7.5kΩ

Memory Protection Unit

STM32G0
• ARM Cortex®-M0 core
• Voltage conversion
• 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

STM32G4
• Cortex®-M4+ core
• High resolution timer V2 (184ps resolution) with waveform builder and event handler
• Mathematical accelerator, digital smps and power factor correction
• High-speed ADCs for precise and accurate control
• Dual bank flash for live upgrade

STM32H7
• Cortex®-M7 core
• High performance up to 480 MHz
• High resolution timer V1 (2.1ns resolution) for real time control
• High-speed ADCs for precise and accurate control (3.6 Msps)
Automotive microcontrollers for in-car digital power

SPCs automotive microcontrollers family are suited for in-car digital power applications such as traction inverters, on-board chargers, bidirectional DC/DC as well as 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>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>Triple 3x e200z4d @ 180 MHz</td>
</tr>
<tr>
<td>eFlash Code</td>
<td>4 MB to 6 MB</td>
</tr>
<tr>
<td>Timers</td>
<td>GTM3</td>
</tr>
<tr>
<td>Safety</td>
<td>ASIL-D</td>
</tr>
<tr>
<td>Advanced Networking</td>
<td>8x CAN-FD, FlexRay, 2x Ethernet</td>
</tr>
<tr>
<td>Security</td>
<td>HSM medium</td>
</tr>
<tr>
<td>ADC</td>
<td>5x 12 bit (SAR), 3x 10 bit (SAR), 6x 16 bit (SigmaDelta)</td>
</tr>
<tr>
<td>High Temperature support</td>
<td>Qualified</td>
</tr>
</tbody>
</table>

---

**SPC58 E Line**

*Scalability*

Up to:

- 3 cores, 200 MHz, 10 MB flash

---

**Packaging Options**

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

**Networking**

- Ethernet
- LIN
- CAN FD
- FlexRay
- Open Alliance

**Secure & Safety**

- Evita Medium/Full
- HIS 26262
SiC diodes

In addition to ensuring compliance with today’s most stringent energy efficiency regulations (Energy Star, 80Plus, and European Efficiency), ST’s silicon-carbide diodes show four times better dynamic characteristics with 15% less forward voltage (VF) than standard silicon diodes. Silicon-carbide diodes belong to our 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 encapsulated in package sizes from DPAK to TO-247, including the ceramic insulated TO-220 as well as the slim and compact PowerFLAT™ 8x8 featuring an excellent thermal performance, the new standard for high-voltage (HV) surface-mount (SMD) packages and available for 650 V SiC Diodes from 4 A to 10 A.

**SiC DIODES BENEFITS**

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

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

STPSC*065, STPSC*H12

- 650 V (STPSCx065)
- 1200 V (STPSCxH12)
- 2 available trade-offs, low VF and High surge

**MAIN APPLICATIONS**

- Solar inverters
- HEV
- UPS
- Charging Station
- Server/Telecoms and PFC

www.st.com/sic-diodes
Power breakers

Connected in series to the power rail, ST’s power breakers are able to disconnect the electronic circuitry if 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. STMicroelectronics’ STPW programmable electronic power breaker family provides a convenient, integrated solution for quickly and safely disconnecting a faulty load from a 12 V bus.

Inserted between the power rail and the load, the 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 to 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.

### MAIN APPLICATIONS

- **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

- **HOT-SWAP POWER MANAGEMENT**

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

- **eFuses, a smart offer for a lots applications**

- **MAIN APPLICATIONS**
  - **Home appliances**
    - STEF03, STEF01, STEF12, STEF12S
  - **Server and Data Storage**
    - STEF03, STEF01, STEF12, STEF12S
  - **USB connections**
    - STEF03, STEF05, STEF05L, STEF05S
  - **Factory automation**
    - STEF01, STEF12, STEF12S
  - **Set-top boxes**
    - STEF12, STEF12S

- **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**

- **HOT-SWAP POWER MANAGEMENT**

- **eFuses**

- **MAIN APPLICATIONS**

- **Home appliances**
  - STEPW12

- **Factory automation**
  - STEPW12

- **Air conditioning**
  - STEPW12

- **USB connections**
  - STEPW12

- **Server and Data Storage**
  - STEPW12

- **Set-top boxes**
  - STEPW12

- **Typical home appliance block diagram for STEPW12**

- **www.st.com/efuse**
ST offers a comprehensive portfolio of **IGBTs (Insulated Gate Bipolar Transistors)** ranging from 600 to 1250 V in trench-gate field-stop (TFS) technologies. Featuring an optimal trade-off between switching performance and on-state behavior (variant), ST’s 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 & fast chargers.

### Breakdown Voltage

<table>
<thead>
<tr>
<th>IGBT Series</th>
<th>Voltage (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>H</strong></td>
<td>600 to 1250</td>
</tr>
<tr>
<td><strong>V</strong></td>
<td>600 to 1250</td>
</tr>
<tr>
<td><strong>M</strong></td>
<td>600 to 1250</td>
</tr>
<tr>
<td><strong>HB</strong></td>
<td>600 to 1250</td>
</tr>
<tr>
<td><strong>HB2</strong></td>
<td>600 to 1250</td>
</tr>
<tr>
<td><strong>IH</strong></td>
<td>600 to 1250</td>
</tr>
<tr>
<td><strong>S</strong></td>
<td>600 to 1250</td>
</tr>
<tr>
<td><strong>M</strong></td>
<td>600 to 1250</td>
</tr>
<tr>
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</tr>
<tr>
<td><strong>IH</strong></td>
<td>600 to 1250</td>
</tr>
</tbody>
</table>

### Switching Frequency

- **H** series: Up to 20 kHz
- **V** series: Up to 20 kHz
- **M** series: Up to 20 kHz
- **HB** series: Up to 20 kHz
- **HB2** series: Up to 20 kHz
- **IH** series: Up to 20 kHz

### Focus Applications

- **Home appliances (fans, pumps, washing machines, and dryers)**
- **Industrial motor control, automotive牵引 inverter, GPI, Air-Con**
- **High frequency converters, PFC, solar, UPS, charger**
- **Welding, induction heating and soft switching**
- **Industrial motor control, Gpl, Air-Con**
- **High frequency converters, solar, UPS, charger**
- **Induction heating and soft switching**
- **Industrial motor control, Gpl, Air-Con**
- **Induction heating, microcontroller and soft switching**

### IGBTs

**HB series**

- **STD**
  - 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**

- **STD**
  - 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 series**

- **STD**
  - 650 V family
  - Very low VCE(sat): 1.5 V @ ICN
  - Very low Eoff
  - Low drop forward voltage diode
  - Designed for soft commutation application only
  - 1250 V family
  - Minimized tail current
  - Very low drop freewheeling diode
  - Tailored for single-switch topology

**S series**

- **STD**
  - 10 µs of short-circuit capability
  - Starting TJ = 150 °C
  - Very soft and fast recovery antiparallel diode
  - Designed for soft commutation application
  - Suitable for very low frequency application, up to 8 kHz

### MAIN APPLICATIONS

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

---

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

STMicroelectronics offers intelligent power switches (IPS) for low- and high-side configurations. ST’s 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. Devices are designed using ST’s latest technologies, thus offering state-of-the-art solutions in any application field.

MAIN APPLICATIONS

Factory automation  Vending machines  Renewable energy  Lighting for Building Automation

www.st.com/ips

KEY FEATURES

• Logic
• Driving
• Protections
• Diagnostic
• Power stage ...all on a single chip

www.st.com/igbt

MAIN APPLICATIONS

Fan  Fridge  Washing Machine  Air conditioning  Motor control

www.st.com/igbt
LED DRIVERS

Offline LED drivers

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

Offline LED converters with PSR

<table>
<thead>
<tr>
<th>Controller</th>
<th>PoutMax</th>
<th>VinMax</th>
<th>Dimming</th>
<th>Flyback</th>
<th>Buck-boost</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVLED001A</td>
<td>8 W</td>
<td>800 V</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HVLED001B</td>
<td>15 W</td>
<td>800 V</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Offline LED controllers with PSR

<table>
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<th>PoutMax</th>
<th>VinMax</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVLED007</td>
<td>8 W</td>
<td>800 V</td>
</tr>
</tbody>
</table>

Offline LED controllers

<table>
<thead>
<tr>
<th>Controller</th>
<th>PoutMax</th>
<th>VinMax</th>
</tr>
</thead>
<tbody>
<tr>
<td>HVLED007</td>
<td>15 W</td>
<td>800 V</td>
</tr>
</tbody>
</table>

Topography example

![Topology example diagram]

MAIN APPLICATIONS

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

Note: * output power for European input voltage 230 Vac
LED array drivers
ST’s 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.

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
Large panel signs
Home appliances
Special lighting
Wearable/High End consumer

LED row driver converters
6 rows
- 85 mA/row
- 30 mA/row
- 20 mA/row

LED row driver controllers
16 rows
- 85 mA/row
- Grouped or independent row dimming

LED matrix driver
5 x 24 matrix
- 20 mA/dot
- Adjustable luminance for each LED (dot)
LED bypass protection
The LBP01 series of LED bypass protection devices are bypass switches that can be connected in parallel with 1 or 2 LEDs. In the event of a LED failure, this device shunts the current through other LEDs. It also provides overvoltage protection against surges as defined in IEC 61000-4-2 and IEC 61000-4-5.

LBP01 get reliable your led application
- Keep LED strings on in case of LED open mode failure
- Reduced maintenance cost
- Increase lifetime of the lighting system

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

www.st.com/lbp01

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

www.st.com/lbp01

LINEAR VOLTAGE REGULATORS
ST offers a complete portfolio of industry-standard high-performance regulators for both positive and negative outputs. Among our products, you can find the optimal combination of ultra-low 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). All this coupled with a choice of the smallest form factor packages for size-conscious applications such as a 0.47 x 0.47 mm STSTAMP™ package.

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

Low quiescent current Iq
- Extending battery life
- Suitable for space-constrained battery-powered applications

Low noise, high PSRR
- High signal fidelity
- Reduced size of external filter components

MAIN APPLICATIONS
- Tablets, smartphones, and wearables
- Healthcare
- Home appliances
- Automotive ADAS, ECU

www.st.com/linear-regulators

www.st.com/lbp01
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 a 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

Fitness, climate, home and factory automation monitoring

SPV1050

Smartphones, digital cameras, and camcorders

SPV1040

Set-top boxes and PC card satellite receiver

www.st.com/photovoltaic-ics

www.st.com/mppt-dcdc-converters

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

LNB SUPPLIES

LNB supplies ICs

ST’s LNB (low-noise block) supply ICs are intended for analog and digital satellite receivers, satellite TVs, satellite PC cards. These devices are monolithic voltage regulator and interface ICs specifically designed to provide the 13/18 V power supply and the 22 kHz tone signaling to the LNB downconverter in antenna dishes or to the multi-switch box.

Single tuner ICs

LNBH22S LNBH29 LNBH30

Dual-tuner IC

LNBH26S

Main common features

• Complete interface between LNB and I2C bus
• 15 output voltage levels
• Output surge robustness up to 40 V
• P2P compatibility between single- and dual-tuner versions
• Stable with ceramic and electrolytic capacitors
• Built-in high-efficiency 12 V DC-DC converter
• Selectable output current limit by external resistor
• Compliant with main satellite-receiver output-voltage specifications
• Accurate built-in 22 kHz tone generator suits widely accepted standards
• Internal overload and over-temperature protection

MAIN APPLICATIONS

Set-top boxes and PC card satellite receiver

www.st.com/lnb-supplies

www.st.com/lnb-supplies
POWER MOSFETs

High-voltage power MOSFETs

ST’s HV Power MOSFET portfolio offers a broad range of breakdown voltages from 400 to 1500 V, with low gate charge and low on-resistance, combined with state-of-the-art packaging. ST’s MDmesh™ high-voltage MOSFETs 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.

Low-voltage power MOSFETs

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

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

- Very good RDS(on)
- Soft diode recovery
- Suited for OR-ing, square-wave HB, battery mgmt topologies
- Wide voltage range
- Soft diode recovery
- Very good RDS(on)
- Suited for load-safety switch, buck and sync rectification
- Extremely low RDS(on)
- Optimized body diode (low Qrr) and intrinsic capacitance for an excellent switching performance
- Proper Crss/Ciss ratio for best-in-class EMI performance
- Suited for flyback and sync rectification

K5 series

ST*N*K5
- Very low RDS(on)
- Small Qg and capacitance
- Small packages
- Suited for hard switching topologies

M5 series

ST*N*M5
- Extremely low RDS(on)
- High switching speed
- Suited for hard switching topologies

M2/M2-EP series

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

DM2 & DM6 series

ST*N*DM2
- Lower RDS(on) x area vs previous generation
- Extremely low gate charge (Qg)
- Optimized capacitance profile for better efficiency @ light load
- Optimized threshold voltage (VTH) and gate resistance (RG) values for soft switching

K6 series

ST*N*K6
- Lowest trr @ Very High Voltage BVDSS
- High dv/dt capability
- Targeting high power 3-phases industrial equipment

M6 series

ST*N*M6
- Lower RDS(on) x area vs previous generation
- Extremely low gate charge (Qg)
- Optimized capacitance profile for better efficiency @ light load
- Optimized threshold voltage (VTH) and gate resistance (RG) values for soft switching

F7 series

ST*N*F7
- Extremely low RDS(on)
- Optimized body diode (low Qm) and intrinsic capacitance for an excellent switching performance
- Proper Crss/Ciss ratio for best-in-class EMI performance
- Suited for flyback and sync rectification

H6 series

ST*N*H6
- Very good RDS(on)
- Soft diode recovery
- Suited for OR-ing, square-wave HB, battery mgmt topologies

H7 series

ST*N*H7
- Wide voltage range
- Soft diode recovery
- Very good RDS(on)
- Suited for load-safety switch, buck and sync rectification

Main applications

- Small motor control and USB battery chargers
- HHD, power tools, STB, and game consoles
- Server/Telecoms and SMPS
- UPS, e-bikes, and fans
- Solar inverters, forklifts, and ERRs

Note: * is used as a wildcard character for related part number
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’s PoE-PD ICs are compliant with both the more recent IEEE 802.3bt specification.

- 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

ST’s PoE-PD devices

- 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

- IEEE 802.3bt PD interface
- Double Gate Driver
- Support Isolated Active Forward Converter
- Input voltage up to 75 VDC
- Embedded start-up (20 mA)
- Slope compensation
- Programmable fixed frequency (up to 1 MHz)

Main standards

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

PoE-PD devices

- PM8803
- PM8804
- PM8805
- PM8801
- PM8800A

SIC MOSFETs

Based on the advanced and innovative properties of wide bandgap materials, ST’s silicon carbide (SiC) MOSFETs feature very low RDS(on) per area for the new 650 V/1200 V Gen2 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 with minimal variation versus the temperature. These features render the device perfectly suitable for high-efficiency and high power density applications.

SIC MOSFETS MAIN BENEFITS

- Reduced size/cost of passive components
- Higher system efficiency
- Reduced cooling requirements and heat sink size

SiC MOSFETS MAIN BENEFITS

- Body diode with no recovery losses
- Low power losses at high temperatures
- Easy to drive
- Low gate charge (SCT*N65G2)

APPLICATIONS

H1: Motor drive & factory automation
H2: HEVs / EVs (Traction Inverter, OBC, DC/DC)
H3: Charging station
H4: UPS & Data center
H5: Solar inverters

Main standards

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

Power over Ethernet power supply protection

PEP01-5041

- 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

Note 1: coming soon
* is used as a wildcard character for related part number

SiC MOSFETS

- VBR = 1200 V (SCT*N120G2), 650 V (SCT*N65G2)
- Low power losses at high temperature
- High operating temperature capability (200 °C)

SiC MOSFETS

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PROTECTION DEVICES

TVS

The TVS Transient Voltage Suppressor is an avalanche diode specially 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.

Power delivery Protections

Ultimate TVS protection for USB fast-charging ports

ESDaxxP

Strong and thin protection, the ESDaxxP-1U1M series helps to stop damages due to the surge events.

MAIN APPLICATIONS

Tablets, smartphones, and digital cameras

Healthcare

I/O microcontrollers and signal conditioning

Factory automation

Human machine interface (HMI)

Smart metering

SIM cards, Ethernet, and HDMI/DVI ports

TVS Transistor series against repetitive overvoltage in high temperature conditions

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

Discrete protection

TVS protection

MOSFET Protection with TVS

-15% consumption in Stand-by mode

Power delivery Protections

Ultimate TVS protection for USB fast-charging ports

ESDaxxP

Strong and thin protection, the ESDaxxP-1U1M series helps to stop damages due to the surge events.

KEY FEATURES & BENEFITS

- Complete voltage range 5 V, 9 V, 12 V, 15 V and 20 V.
- A unique small and thin package for all the voltages (1.0 mm x 1.6 mm x 0.55 mm) minimizing the PCB area consumption.
- Highest housed 8/20µs IPP in the market, from 35 A to 120 A.

www.st.com/esd-protection

www.st.com/esd8-20-protection

Power delivery Protections

Ultimate TVS protection for USB fast-charging ports

ESDaxxP

Strong and thin protection, the ESDaxxP-1U1M series helps to stop damages due to the surge events.

MAIN APPLICATIONS

Adapters

Smart metering

Solar inverters

Residential, commercial, architectural and street lighting
### STDRIVE MOSFET and IGBT Gate Drivers

ST's power MOSFET and IGBT gate drivers include integrated high-voltage half-bridge, single and multiple low-voltage gate drivers. Robustness and reliability, system integration and flexibility: that's ST’s gate driver offer to you. In particular the STDRIVE families L639*, L649* and STGAP series offer smart functionalities to protect and simplify application implementation and usage.

#### Features
- Gate Driver
- ESD / HV protection
- Dead Battery
- CC logic / USB PD PHY
- Protocol Layer
- Policy Engine
- Application tasks

#### 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)

#### Low side gate drivers
- 2 level turn-off (TD350)
- Miller clamp (TD355)
- Pulse transist / opto input (TD357)
- Dual independent low side driver (PM8834)
- 4 A source/sink driver high current capability (PM8834)

#### Galvanically-isolated single and dual gate drivers
- Up to 6 kV isolation (STGAP2HS)
- High voltage rail up to 1.7 kV
- Up to 5 A source/sink driver current capability
- 2 level turn-off (STGAP1AS)
- Miller clamp, negative gate supply
- Optimized for SiC MOSFET driving (STGAP2SiCS)

**L6743B** - 12 V Half bridge gate driver
- Integrated bootstrap diode
- High frequency operation
- Enable pin
- Adaptive dead-time management
- Flexible gate-driver: 5 V to 12 V compatible
- High-impedance (42) management for output stage shutdown
- Preliminary OV protection
- VDFPN8 3 x 3 mm package

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### 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 lines protection. ST's solutions cover from Type-C port interface ICs to USB PD controllers, and offer a wide flexibility with hard wired and MCU to fit different use cases and every 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 ICs companion chip of STM32 based solution to standalone Full Hardware USB PD Controller optimized for AC adapters up to 100 W.

#### MCU based solutions

Our STM32 solutions will help you to manage the complexity of implementing USB Type-C™ and Power Delivery technology ensuring that your embedded application supports the latest use cases. ST ecosystem for USB Type-C™ reduces the acquisition cost of a technology that requires expertise in different areas 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 great flexibility to implement USB Type-C™ and Power Delivery (PD).

A companion Type-C Port Protection device TCPP01-M12 is proposed for advanced protection of the USB-C connector line in sink applications, such as CC and Vbus line. For source applications like power adapters, TCPP02-M18 is recommended (mass-production Q4-2020). For Dual Role Port applications (DRP), TCPP03-M20 is recommended (mass-production Q4-2020).

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### USB Type-C™ and Power Delivery Controllers

#### USB-C legacy
- Sink/Source, 5V-15W
- Attachment + Protection

#### USB-C + Po3.0
- Sink/Source/DRP, 5V/20V - 100W
- Attachment + Protection + Power negotiation + Alternate Modes + PPS + C-Auth

#### USB-C + Power Delivery Controllers

<table>
<thead>
<tr>
<th>Solution</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB-C legacy</td>
<td>Sink/Source, 5V-15W</td>
</tr>
<tr>
<td>USB-C + PD3.0</td>
<td>Sink/Source/DRP, 5V/20V - 100W</td>
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<tr>
<td>USB-C + Power Delivery Controllers</td>
<td>Attachment + Protection + Power negotiation + Alternate Modes + PPS + C-Auth</td>
</tr>
</tbody>
</table>

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**attached image**

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**www.st.com/stdrive**
STM32 USB PD 3.0 controllers

Introduction: Developed 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 to develop 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 environment thanks to the versatile feature set and peripherals available in a traditional MCU. UCPD is certified PD3.0 and support 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 STM32G071B-DISCO kit allows to discover and display 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 customer to debug, configure and inject in one click USB PD3.0 packets while monitoring Vbus voltage and Ibus current between two USB-C devices.

Our well-known STM32 configurator STM32CubeMx supports easy setting of UCPD. An evaluation board STM32G081B-eval is proposed with two USB-C ports offering 45 W of power with different profiles.

Type-C Port Protection

TCPP01-M12

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

KEY FEATURES

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

TCPP01-M12: Protecting USB Type-C Against Damages and Serving Engineers with Efficiency

Discover and lean

Develop

Configure & Debug

STM32G071B-DISCO

STM32G081B-EVAL

STM32CubeMx

STM32CubeMonitor-UCPD
STUSB family of standalone (auto-run) USB-C and Power Delivery controllers

Being designed with ST’s 20 V process technology, 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 15W to 100W, on both SINK and SOURCE sides. Being hardwired, STUSB controllers are fast and predictive to guarantee safety and interoperability while increasing port robustness and minimizing power consumption. Implementation is fast and easy and requires no deep know how 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 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 majors events to the MCU (optional)

**STUSB1600**

- USB-C SOURCE / SINK / DUAL ROLE
- High Voltage protections
- Integrated VBUS discharge
- Dead battery support
- Optional interface to MCU through I2C + IRQ

**STUSB1700**

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

**STUSB4500L**

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

**STUSB1602**

- STUSB1602: SOURCE / SINK / DUAL ROLE
- STUSB1702: SOURCE – Auto Grade
- Integrated Type-C PHY + BMC coding
- Perfect MCU companion chip ensuring port protection, power path monitoring and management, role advertisement and detection, PD PHY communication
- Integrated 600 mA VCONN switch with integrated protection
- Integrated VBUS and VCONN discharge path
- I2C, SPI+ IRQ MCU interface – Dual I2C address support
- Accessory & dead battery support
- STSW-STUSB010: ready-to-use software frameworks for fast prototyping of most common application scenario such as: basic source, sink and DRP but also more complex use cases, which include optional features of PD3.0, for example VDM, extended messages.

**STUSB4500**

- Role: 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-STUSB003: open source software drivers for dynamic power management

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At STMicroelectronics we create technology that starts with You

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**SOURCE**

- MCU + STUSB1602
- MCU + STUSB1702

**DUAL ROLE**

- MCU + STUSB4500

**STUSB47**

- USB PD SOURCE
- Offers 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 >3A support)
- Over-temperature protection

**STSW-STUSB003**

- Open source software drivers for dynamic power management