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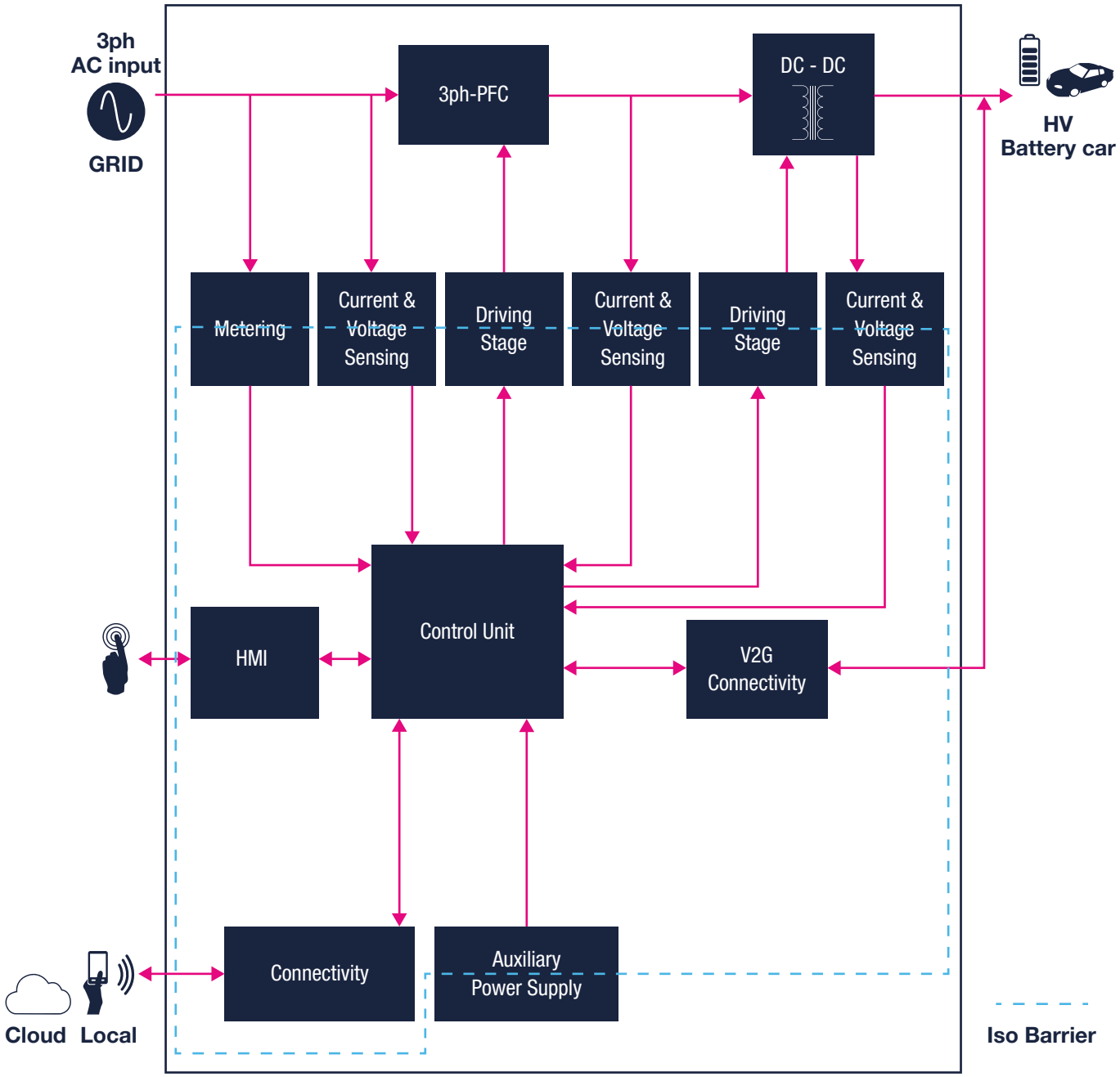
Galvanically isolated products for DC EV charging stations

DC charger
for electric vehicles

General block diagram



Introduction

It is estimated that 80% of all innovations in the automotive industry today are directly or indirectly enabled by electronics.

ST is a solid, innovative, and reliable partner with whom to build the future of transportation.

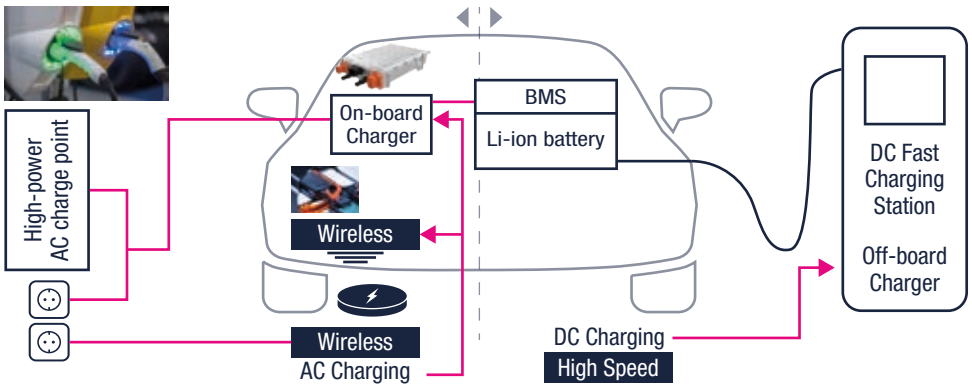
ST's Smart Mobility products and solutions are making driving safer, greener and more connected through the combination of several of our technologies.

The electrification of vehicles is rapidly increasing, driven by the availability of higher performance and more cost-effective battery technologies, and improved mileage as well as ecological awareness, and government incentives and regulations.

ST provides leading-edge solutions for hybrid (HEV) and battery electric vehicles (BEV) based on proven and innovative technologies and backed up with our extensive power management experience.

Best-in-class silicon and silicon-carbide (SiC) MOSFETs and diodes, IGBTs, protection components, galvanically isolated interfaces and sigma-delta modulators, auxiliary SMPS and gate drivers, and microcontrollers make up an unrivaled offer for electric vehicle power management solutions.

The move to battery electric vehicles will be accompanied by a push towards increasing use of wide bandgap technologies such as silicon carbide (SiC) and gallium nitride (GaN).



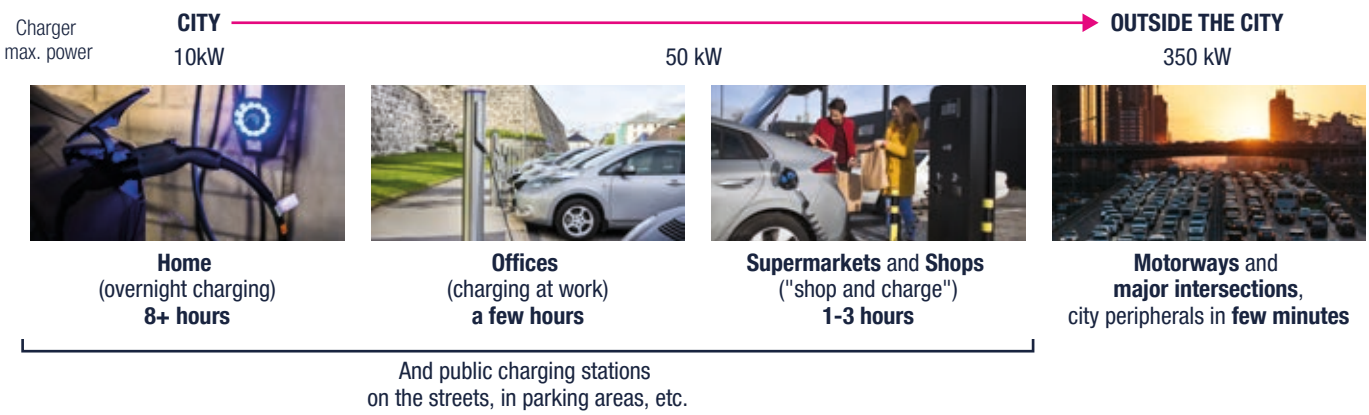
There are two main types of PHEV/BEV charging systems:

- AC onboard charging;
- DC off-board charging.

Some vehicles are also available with a wireless charging option.

Charger	Location	Typical power range
On-board charger (AC)	Integrated in the vehicle	3.7-11 kW, up to 22 kW (43 kW)
Wireless charger (AC)	Receiver integrated in the vehicle /mounted on the vehicle Transmitter located outside of the vehicle	3.2kW - 11 KW
Off-board charger (DC)	Outside of the vehicle	Up to 350 kW

The choice of nominal power of chargers to be installed depends on the location of the charging station.



Gate Drivers

Gate drivers are increasingly key components in the EV charging market where applications need to ensure the proper control for driving the power stage with high accuracy and efficiency. Based on a coreless transformer architecture integrating 6 kV thick-oxide galvanic-isolation technology, ST's STGAP® isolated gate drivers for MOSFETs and IGBTs are key to ensuring high rejection against fast noise transients and improved reliability in harsh environments.

In addition to reducing BOM cost and final application dimensions, these devices feature different driving options with an active Miller clamp circuit that protects against parasitic induced turn-on and a robust design to ensure the signal integrity of the power stage as well as dedicated protection functions such as under-voltage lock-out and thermal shutdown.

The STGAP2 series includes both single- and dual-channel drivers embedded in both narrow and wide packages. Specific versions for driving SiC MOSFETs and IGBTs are available with under-voltage lockout (UVLO) protection to prevent SiC power switches from operating in low-efficiency or unsafe conditions. With reliable switching thanks to a common-mode transient immunity (CMTI) of ±100V/ns, STGAP2 devices feature an input-to-output propagation time less than 75ns to guarantee high PWM accuracy.

It is possible to independently configure turn-on and turn-off times using an external resistor or use a single output with an active Miller clamp function. The single output configuration enhances stability in high-frequency hard-switching applications, leveraging the Miller clamp to prevent excessive oscillation of the power switch.

The logic inputs of STGAP1 and STGAP2 series are compatible with TTL and CMOS logic down to 3.3V for interfacing with a host microcontroller or DSP. Both series are UL-1577 certified.

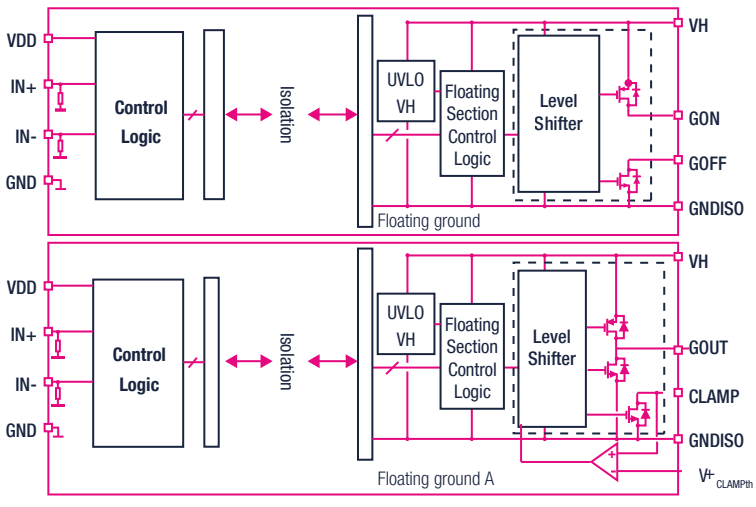
Isolated gate driver key features

STGAP2S, STGAP2SICSN, STGAP2HS, STGAP2SICS

Key product features

- 6kV galvanic isolation
- Specific part number with optimized UVLO for SiC devices
- Transient immunity ± 100 V/ns in all temperature ranges
- High-voltage rail up to 1700V (SO-8N), 1200V (SO-8W)
- Up to 26 V supply voltage
- 4A sink / source driver current capability
- Miller clamp and separate output options
- Propagation delay 75 ns
- Standby function
- Interlocking function

STGAP2SICS package



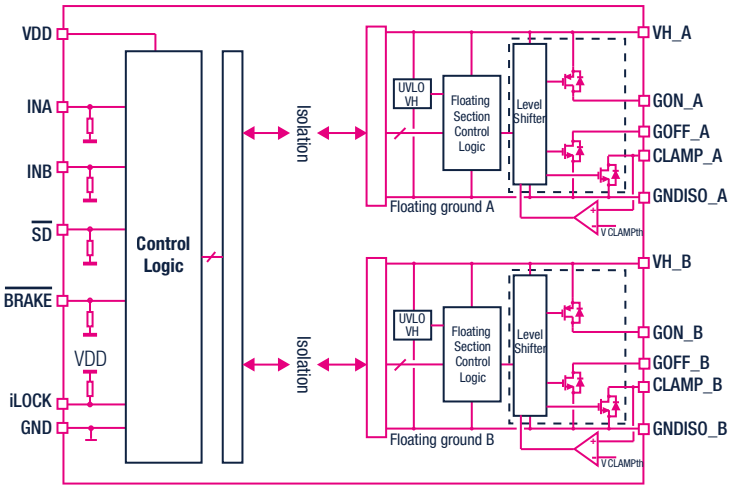
STGAP2SICS block diagram

STGAP2D, STGAP2HD, STGAP2SICD

Key product features

- 6kV galvanic isolation
- Optimized UVLO for SiC devices
- Watchdog
- Transient immunity ± 100 V/ns in all temperature ranges
- Temperature shut-down protection
- High-voltage rail up to 1200 V
- 4 A sink / source driver current capability
- Gate driving voltage up to 26 V
- Separate sink and source for easy gate driving configuration
- 4 A Miller clamp
- Propagation delay 75 ns
- 3.3 to 5 V TTL/ CMOS inputs with hysteresis
- Standby function / Configurable interlocking function / Shut-down pin

STGAP2SICD package



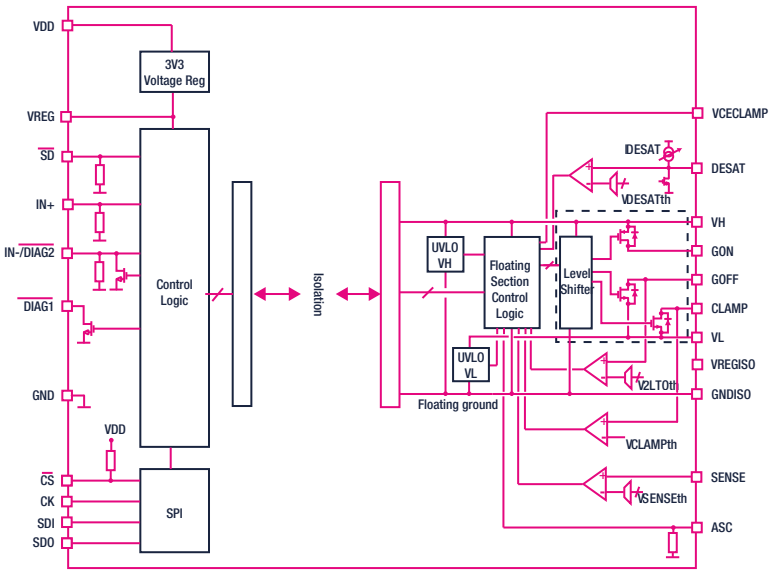
STGAP2SICD block diagram

STGAP1BS

Key product features

- 4 kV Isolation
- UVLO, OVLO, and over-current protection
- Thermal warning and shutdown
- Desaturation and VCE clamp
- High-voltage rail up to 1.5 kV
- Positive drive voltage up to 36 V / Negative gate drive ability (-10 V)
- Short propagation delay 100 ns
- 5 A sink/source current
- Full set of protections and diagnostics available via SPI
- 5 A Active Miller clamp
- 2-level turn-off
- Asynchronous stop command
- Temperature operating range: -40 to 125 °C

STGAP1BS package



STGAP1BS block diagram

Developer resources

Specific evaluation boards are available to support the evaluation and design of applications based on STGAP products.

The EVSTGAP2SICSNC board makes it easy to evaluate all the features of the STGAP2SICSNC isolated 4 A single gate driver while driving a half-bridge power stage with voltage rating up to 520 V. The board's components are easy to access and modify letting developers easily evaluate the driver's performance under different application conditions and fine-tune final application components.

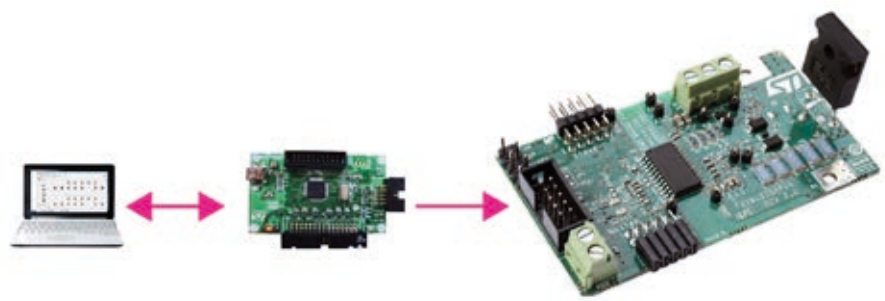
Designed for evaluating the features of the STGAP1B1S galvanically isolated single gate driver while driving a power switch with a voltage rating up to 1500 V, the EVALSTGAP1BS board lets you connect a heatsink to take advantage of the STGAP1B1S ability to handle very-high-power applications.

Using the IBU Motor Control & IPS universal interface board (STEVAL-PCC009V2) and its ready-to-use evaluation firmware (STEVAL-PCC009V2), developers can easily enable, configure or disable all of the driver's protection and control features through the SPI interface.

Technical documentation is available at **www.st.com**

STGAP2SICS evaluation board (EVALSTGAP2SiCS)

STGAP2SiCD evaluation board (EVALSTGAP2SICD)



STGAP1BS evaluation board (EVALSTGAP1BS)

Digital interfaces & ∑-Δ modulators

Digital isolators and galvanically isolated analog-to-digital sigma-delta modulators, play a fundamental role in industrial applications where power and digital worlds must live together.

In DC EV charging stations, standalone sigma-delta modulators are typically used to sense the input and output currents and voltages of a power factor controller (PFC) and DC-DC output stage connected to a HV on-board battery. It converts them into 1-bit digital signals so they can be processed by the host controller through embedded digital demodulator filters DFSDM (Digital Filter for Sigma-Delta Modulator). Afterwards, digital interfaces transfer high-speed input/output digital data to the human interface for data monitoring, processing, and collection. This means that sigma-delta modulators must be very accurate.

Furthermore, when combined with our thick-oxide galvanic-isolation technology it is possible to guarantee the requirements to ensure workplace safety by protecting humans against shocks and preventing ground potential differences or ground loops. Galvanic isolation eliminates stray currents flowing between power system and digital system that causes data transfer errors and effectively rejects fast transient noise signals.

At the application level, a typical combination of a 1-bit ∑Δ modulator and shunt are the perfect choice to achieve a good compromise for high-precision, low-cost solutions with a small form factor.

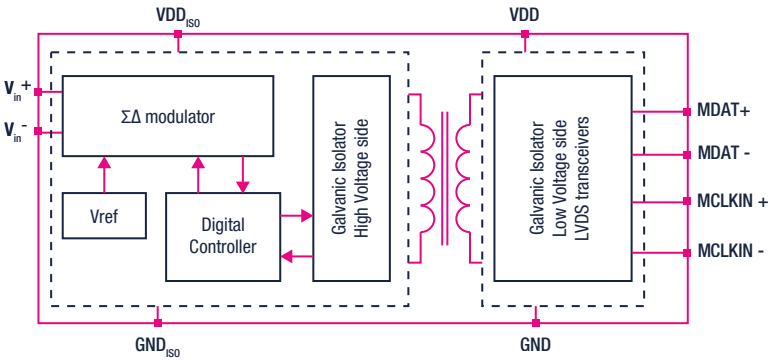
ISOSD61/ISOSD61L

key features

- 16-bit resolution
- ±320 mV input range
- ±250 mV input linear range
- Up to 25 MHz external clock
- Up to 50 kHz bandwidth
- SNR: 86 dB (typical)
- THD: -83 dB (typical)
- CMTI: 30 kV/µs (typical)
- 6 kV peak isolation (V_{IOTM})
- 1.2 kV peak working voltage (V_{IORM})
- LVDS and TTL options
- SO16 wide package
- UL1577 certified (File number: E362869)

ISOSD61L package: LVDS Version

ISOSD61 package: TTL/CMOS Version



Isolated Sigma-Delta Modulator Block Diagram

Leveraging ST's 6kV thick-oxide galvanic-isolation technology, the STISO62x dual-channel digital isolators transfer data between two isolated domains at rates up to 100 Mbit/s with pulse distortion below 3 ns.

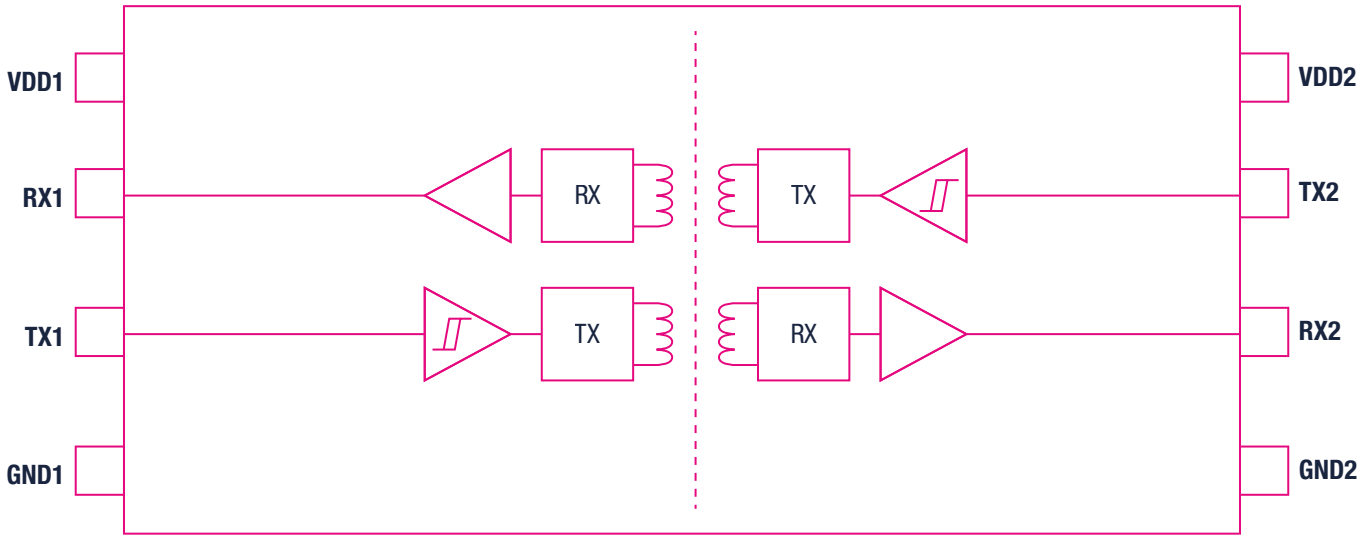
STISO621/STISO621W/STISO620

Key features

- Dual channel, digital isolators with 1 – 1 and 2 - 0 channel direction
- Up to 6 kV peak isolation (VIOTM)
- 1.2 kV peak working voltage (VIORM)
- High common-mode transient immunity: >50 kV/µs
- Data rate up to 100 Mbps
- Pulse width distortion: < 3ns
- 3 to 5.5 V supplies
- 3.3 V and 5V level translation
- –40 to +125°C extended industrial temperature range
- SO8 narrow-body and wide package options (STISO621W)
- UL1577 certified (File number: E362869)

STISO620 Package

STISO621 Package



Developer resources

A variety of evaluation boards and reference designs are available to help you develop applications based on ST's portfolio of digital isolators and galvanically isolated modulators.

Based on the ISOSD61 galvanically isolated sigma-delta modulator with low-voltage differential signaling (LVDS) and single-ended (TTL/CMOS) options, the full-featured ISOSD61 evaluation board (EVALST-ISOSD61T) comes with all the necessary documentation and resources to reduce evaluation and design phases.

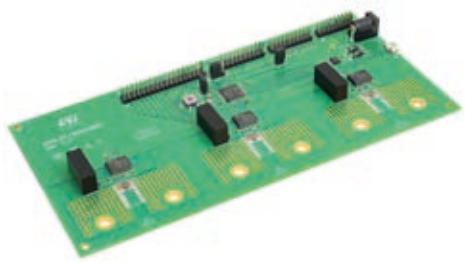
The 3-phase full-shunt current meter evaluation board (EVALST-3PHISOSD), based on the ISOSD61 and a high-performance STM32F413 microcontroller, implements a complete 3-phase current sensing platform based on low-cost shunt sensors.

The input analog signal is oversampled by ISOSD61 and converted into an output bitstreams, thanks to the embedded firmware which exploits the STM32F413's digital filters for sigma-delta modulators (DFSDM) to convert the three bitstreams into 24-bit current data at a selectable sampling rate.

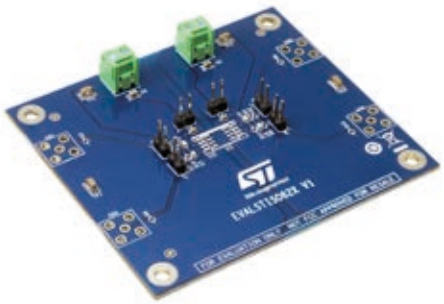
The firmware also implements a virtual COM port communication to easily access the internal parameters to read data and to calibrate the board.

A dual-channel digital isolator evaluation board (EVALSTISO62XV1) is also available to evaluate STISO62x digital isolated interfaces with both SO8 and SO8W packages.

A complete library of technical documentation including datasheets, application notes, user manuals, gerber files, and schematics is available for developers at st.com.



3-phase full-shunt current meter evaluation board (EVALST-3PHISOSD)



Dual-channel digital isolator evaluation board (EVALSTISO62XV1)

Full-featured ISOSD61 evaluation board (EVALST-ISOSD61T)

Auxiliary SMPS

Beside the main power supply which actually provides the necessary energy used to charge the HV battery pack, a low-power bus is needed to supply all the controllers and stand-by circuitries at low voltage.

“ST’s VIPer® high-voltage AC-DC converters combining an advanced pulse width modulation (PWM) controller with a high-voltage power MOSFET in a single package will support this application.
The VIPer portfolio offers flyback and buck configurations backed up by an extremely large palette of protection features to make sure that even the most stringent reliability targets are met.”

- VIPer01
- VIPer11
- VIPer16
- VIPer26
- VIPer26K (1050V MOSFET)
- VIPer17
- VIPer27
- VIPer37
- VIPer31

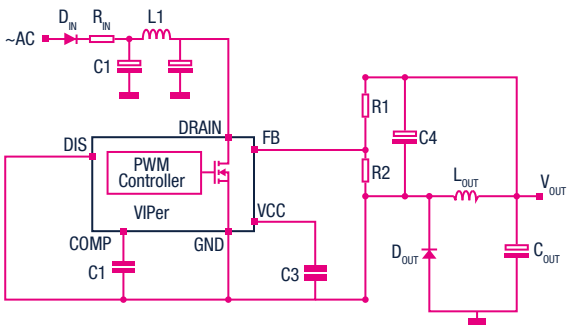
These smart high-voltage converters integrate a HV avalanche-rugged power MOSFET (800V and 1050V) with PWM current mode control. The high breakdown voltage allows an extended input voltage range to be applied, as well as the size of the drain snubber circuit to be reduced.

The ICs meet the most stringent energy-saving standards with very low consumption and burst mode operation under light load.

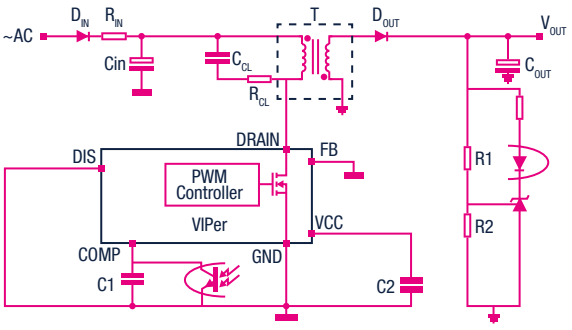
KEY FEATURES

- Can manage power supplies up to 15 W (20 W at 230 VAC input)
- Can support isolated and non-isolated topologies
- Support for PSR configurations
- Requires only a minimum BOM
- Equipped with protection circuits with automatic restart: overload/short-circuit (OLP) and feedback loop disconnection
- Embedded HV start-up
- Soft Start-up

VIPer31 Package



Buck configuration



Isolated Flyback configuration

Developer resources

A variety of evaluation boards and reference designs are available to help you develop applications based on ST's portfolio of VIPer high-voltage converters.

The STEVAL-ISA77V1 evaluation board is a 5 V / 4.25 W power supply set in a non-isolated flyback topology using the innovative VIPer01 IC for building smart power supplies with green energy management (Figure 4).

The STEVAL-VP26K01B reference design implements a 15 V / 1.5 W buck converter for auxiliary power supplies with an ultra-wide input voltage range from 60 to 870 VDC or 90 to 600 VAC. The highly compact design offers tight line and load regulation over the entire input and output range.

The STEVAL-ISA197V1 evaluation board implements a 7.8 W (12 V / 0.65 A) isolated flyback wide range main developed for general purpose applications. The core of the application is the innovative VIPer114LS IC, designed for smart power supplies incorporating green energy management.

The STEVAL-VP318L1F reference design implements a 15 V / 18 W power supply with a wide input voltage range, set in an isolated flyback topology with secondary side regulation (SSR). This board is based on the VIPer31.

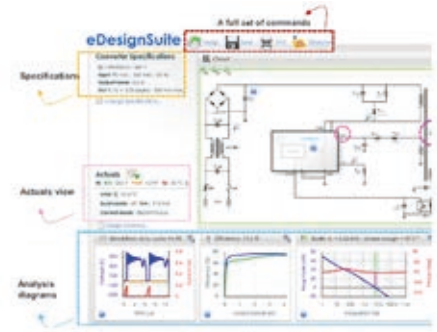
The eDesignSuite is a powerful online tool that helps customers in simulating the use of different STMicroelectronics' devices following their application requirements. VIPer products are of course included in the tool.

5 V / 0.85 A flyback converter evaluation board (STEVAL-ISA177V1)

15 V / 100 mA high voltage buck converter reference design based on VIPER26K (STEVAL-VP26K01B)

12 V, 7.8 W isolated flyback converter based on VIPer114LS (STEVAL-ISA197V1)

15 V / 1.2 A SSR flyback converter based on VIPer318L (STEVAL-VP318L1F)



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